STERLING 360™ WORKSHOP MANUAL

Models: COE 40
COE 45
COE 50

STI-475 (3/06P)

Published by
Freightliner LLC
4747 N. Channel Ave.
Portland OR 97217
Printed in U.S.A.

STERLING 360™

WORKSHOP MANUAL

2007 Model Year

FOREWORD

This Workshop Manual contains maintenance and repair methods for the Sterling 360™. The purpose of this manual is to assist the service technician when the vehicle is serviced.

IMPORTANT: Descriptions and specifications in this manual were in effect at the time of printing. Freightliner LLC reserves the right to discontinue models, and to change specifications or design at any time without notice and without incurring obligation. Descriptions and specifications contained in this publication provide no warranty, express or implied, and are subject to revision and editions without notice. For additional information, please contact Freightliner LLC, Service Systems and Documentation, P.O. Box 3849, Portland, OR 97208-3849, U.S.A. or refer to **http://www.Freightliner.com** and **http://www.SterlingTrucks.com**.

Whenever you see instructions in this manual to discard materials, you should attempt to reclaim and recycle them. To preserve our environment, follow appropriate environmental rules and regulations when disposing of materials.

NOTICE: Do not replace suspension, axle, or steering parts (such as springs, wheels, hubs, and steering gears) with used parts. Used parts may have been subjected to collisions or improper use and have undetected structural damage.

© 2006 Freightliner LLC

All rights reserved. No part of this publication, in whole or in part, may be translated, reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of Freightliner LLC.

GROUP INDEX

GENERAL 00
MAINTENANCE SCHEDULE 01
ENGINE 11
LUBRICATION 12
FUEL AND ENGINE CONTROL 13A
ELECTRONICALLY CONTROLLED FUEL SYSTEM 13E
COOLING 14
INTAKE AND EXHAUST 15
EMISSION CONTROL 17
CLUTCH 21
MANUAL TRANSMISSION 22
AUTOMATIC TRANSMISSION 23
PROPELLER SHAFT 25
FRONT AXLE 26
REAR AXLE 27
WHEEL AND TIRE 31
FRONT SUSPENSION 33
REAR SUSPENSION 34
BRAKE 35A
ANTI-LOCK BRAKE SYSTEM (ABS) 35E
PARKING BRAKE 36
STEERING 37
BUMPER AND FRAME 41
CAB 42
DOOR 43
EXTERIOR 51
INTERIOR 52
ELECTRICAL 54
HEATER, AIR CONDITIONER, AND VENTILATION 55

GROUP 00 INDEX

EQUIPMENT TYPE CODES LIST 00-2

POWER TRAIN TABLE 00-3

HOW TO READ THIS MANUAL 00-4

CHASSIS NUMBER, ENGINE NUMBER,
POWER TRAIN LABEL 00-10

VEHICLE IDENTIFICATION NUMBER 00-11

PRECAUTIONS FOR MAINTENANCE OPERATION 00-13

PRECAUTIONS FOR ELECTRIC WELDING 00-23

JACKING THE VEHICLE 00-25

DIAGNOSIS CODES
1. Diagnosis Codes 00-27
2. Retrieving Diagnosis Codes Using the Multi-Use Tester 00-27
3. Retrieving Diagnosis Codes Using the Flashing Diagnostic Light 00-28

TABLE OF STANDARD TORQUE VALUES 00-30

EQUIPMENT TYPE CODES LIST

Component	Name plate marking					Code description
Engine						
4M50-T	4	M	5	0	T	
						Turbocharged Order of development within same series Order of development among different series Diesel engine No. of cylinders (4)
Clutch						
C5W33	C	5	W	33		
						Disc OD Facing material (W: Woven) Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the clutch
Transmission						
M036S5W	M	036	S	5	W	
						Variation (W: With directly-mounted transfer) Forward speeds Type of mesh (S: Synchromesh) Load carrying capacity of truck class (tonnage) on which the transmission is primarily used Initial letter of the transmission
Propeller shaft (driveshaft)						
P3	P	3				
						Load carrying capacity of truck class (tonnage) on which the propeller shaft is primarily used Initial letter of the propeller shaft
Front axle						
F200T	F	200	T			
						Vehicle type (T: Truck) Load carrying capacity of truck class (tonnage) on which the front axle is primarily used Initial letter of the front axle
Rear axle						
R033T	R	03	3	T		
						Vehicle type (T: Truck) Order of development within same series Load carrying capacity of truck class (tonnage) on which the rear axle is primarily used Initial letter of the rear axle
Reduction and differential						
D033H	D	03	3	H		
						Tooth profile (H: Hypoid gear) Order of development within same series Load carrying capacity of truck class (tonnage) on which the component is primarily used Initial letter of the reduction & differential

POWER TRAIN TABLE

Vehicle model	Engine	Clutch	Transmission	Propeller shaft	Rear axle	Reduction & differential
FE84DD6SLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DE6SLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DG6SLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DH6SLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DDZSLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DEZSLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DGZSLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DHZSLSUE	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE85DDZSLSUE	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DEZSLSUE	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DGZSLSUE	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DHZSLSUE	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DJZSLSUE	4M50-T8	Torque converter	M036A6	P3	R035T	D035H

HOW TO READ THIS MANUAL

This manual consists of the following parts:
- Specifications
- Structure and operation
- Troubleshooting
- On-vehicle inspection and adjustment
- Service procedures

Specifications

- This section gives crucial dimensions, fluid quantities, or tolerances needed to keep the vehicle in good working order.

Structure and operation

- This section gives general information about the component or system and explains how the component or system works.

Troubleshooting

- This section gives specific information about how to read fault codes and correct common service problems.

On-vehicle inspection and adjustment

- This section contains procedures for inspection and adjustment of individual parts and assemblies, including specific items to check and adjust. Whether specified or not, check for looseness, excessive play, backlash, cracks, damage, etc.
- Service standards are given in the manual to provide criteria for acceptance or rejection of any part.
- Even if not mentioned specifically in the service procedure, always do a routine visual check and cleaning of reused parts before installing them on the vehicle.

Service procedures

- This section contains procedures for servicing vehicle components and systems, including removal, installation, disassembly, assembly, inspection, etc.

Alert messages

- This workshop manual contains important hazard messages under the following four headings that identify the nature and importance of the information:

DANGER ⚠	Imminent hazards that will result in severe personal injury or death.
WARNING ⚠	Hazards or unsafe practices that could result in severe personal injury or death.
CAUTION ⚠	Hazards or unsafe practices that could result in minor personal injury and/or damage to products or property.
NOTE	Relevant information that is helpful or informative but not associated with any risk or hazard.

Terms and Units

● Front and rear

The front is the forward direction of the vehicle and the rear is the reverse direction.

● Left and right

When facing forward, towards the front of the vehicle, objects on the left are on the left-hand side of the vehicle and objects on the right are on the right-hand side of the vehicle.

● Standard values

Standard values include the design dimensions of individual parts, the standard clearance between two parts when assembled, and the standard value for a parts assembly.

● Limit

Limits indicate wear dimensions of parts that become no longer serviceable when worn and must be replaced or repaired.

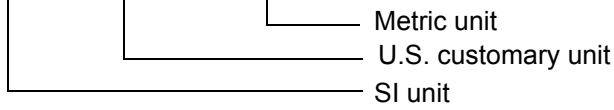
● Torque values

- In each section, specific values are given for non-standard fasteners.
- When no torque value is specified, use the “Table of standard torques” in this section. (Values for standard torques are based on thread size and material.)
- When a fastener is to be tightened “wet,” this will be indicated. Where there is no indication, assume it is dry.

● Units

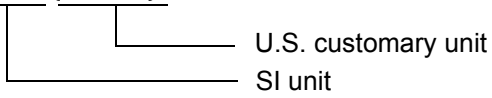
Torque values and other measurements are given in SI* units with U.S. customary and metric units added in brackets { }.
*SI: Le Système International d’Unités

Example: 390 N·m {290 lbf·ft, 40 kgf·m}



Unit		SI unit {U.S. customary, metric unit}	Conversion factor
Force		N {lb, kgf}	9.80665 N {2.2046 lb, 1 kgf}
Moment of force		N·m {lbf·ft, kgf·m}	9.80665 N·m {7.2329 lbf·ft, 1 kgf·m}
Pressure	Positive pressure	kPa {psi, kgf/cm^2}	98.0665 kPa {14.22 psi, 1 kgf/cm^2}
	Vacuum pressure	kPa {inHg, mmHg}	0.133322 kPa {0.03937 inHg, 1 mmHg}
Volume		J {BTU, kcal}	4186.05 J {3.96825BTU, 1 kcal}
Heat quantity		W {BTU/h, kcal/h}	1.16279W {3.96825BTU/h, 1 kcal/h}

Example: 30 mm {1.18 in.}

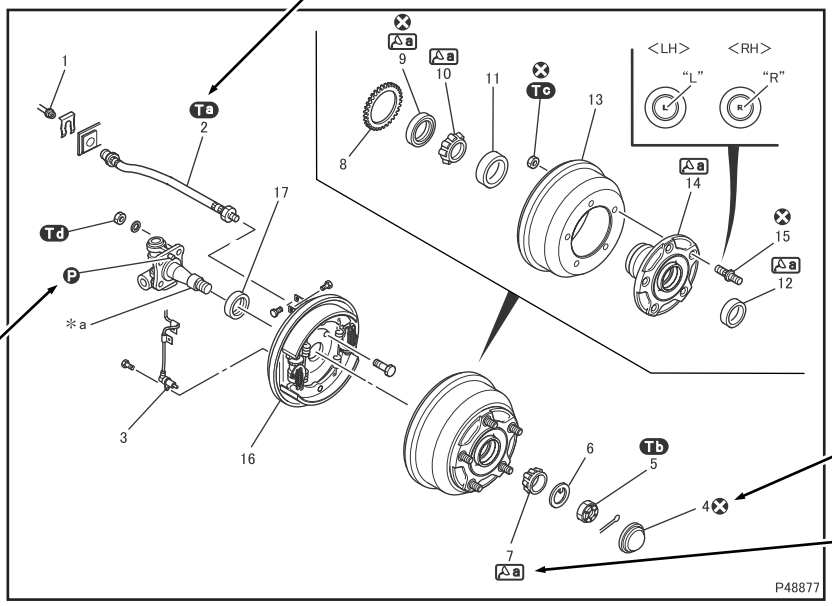


Unit	SI unit {U.S. customary unit}	Conversion factor
Length	mm {in.}	1 mm {0.03937 in.}
	m {ft.}	1 m {3.2808 ft.}
	km {mile}	1 km {0.6214 mile}
Weight	kg {lb}	1 kg {2.2046 lb}
	g {oz}	1 g {0.035274 oz}
Temperature (in degree Celsius)	°C {° F}	1°C {(1°C × 1.8 + 32)° F}
Velocity	km/h {mph}	1 km/h {0.6214 mph}
	m/s {ft/s}	1 m/s {3.281 ft/s}
Volume	L {qt}, L {gal}	1 L {1.05336 qt}, 1 L {0.2642 gal}
	cm^3 {cu.in.}	1 cm^3 {0.061023 cu.in.}
Area	m^2 {in^2}, m^2 {ft^2}	1 m^2 {1.550 × 10^3 in^2}, 1 m^2 {1.076 × 10 ft^2}

Symbol	Denotation	Application	Remarks
Ta	Torque value	Parts not tightened to standard torques (standard torques specified where necessary for servicing)	Specific values are shown in the tables. See Table of Standard Torques for fasteners for which no specific values are specified.
P	Locating pin	Parts to be positioned for installation	
⊗	Expendable part	Parts not to be reused	Replace the part whenever removed.
△a	Lubricant and/or sealant	Parts to be coated with lubricant or sealant for assembly or installation	The type of lubricant and/or sealant, and the quantity required, etc. are specified in the table.
Ca	Special tool	Parts for which special tools are required for service operation	Tool name/shape and part number are shown in table.
*a	Associated part	Parts associated with those removed/disassembled for servicing	

Denotes that tightening torque is specified.

WHEEL HUB AND BRAKE DRUM



Indicates position of locating pin.

Identifies non-reusable parts.

Denotes that coating with lubricant or sealant is required.

P48877

● Disassembly sequence

1 Brake pipe
2 Brake hose
3 Wheel speed sensor
4 Hub cap
5 Lock nut
6 Lock washer
7 Outer bearing inner race
8 Anti-lock brake system rotor
9 Oil seal
10 Inner bearing inner race
11 Inner bearing outer race
12 Outer bearing outer race
13 Brake drum
14 Wheel hub
15 Hub bolt
16 Front drum brake (See Gr.35A)
17 Spacer

*a : Knuckle
P : Locating pin
⊗ : Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (unit : mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
7, 10, 11, 12	Starting torque of wheel hub bearing (Tangential force at hub bolt position with oil seal fitted in)		1 to 3.5 N·m {0.7 to 2.6 ft.lbs, 0.10 to 0.35 kgf·m} (Tangential force:8.8 to 28.4 N {2.0 to 6.4 lbs, 0.9 to 2.9 kgf})	–	Adjust or replace
14	Brake drum	Inside diameter	320 {12.6}	322 {12.7}	Repair or replace
		Cylindricality	0.05 {0.0020}	0.05 {0.0079}	

These location numbers correspond with disassembly sequence numbers.

P58289N

"Wet" is indicated when part is to be tightened with oil or grease applied to its threaded part.

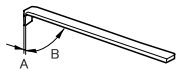
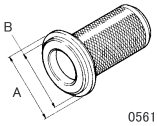
Tightening torque (unit: N·m {ft.lbs, kgf·m})

Mark	Part to be tightened	Tightening torque	Remarks
Ta	Brake force tightening	13 to 17 {9.6 to 13, 1.3 to 1.7}	–
Tb	Lock nut	113 ± 15 {83 ± 11, 11.5 ± 1.5}	Wet
Tc	Nut (brake drum and wheel hub mounting)	343 ± 39 {250 ± 29, 35 ± 4}	–
Td	Nut (front drum brake mounting)	118 ± 20 {87 ± 15, 12 ± 2}	–

Lubricant and/or sealant

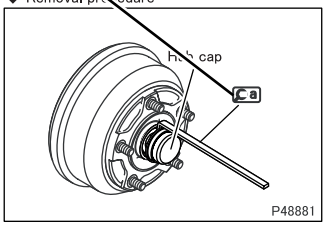
Mark	Point of application	Specified lubricant and/or sealant	Quantity
Sa	Between rolls of outer bearing inner race and inner bearing inner race	Mitsubishi wheel bearing grease	As required
	Inside wheel hub		395 ± 40 g {13.9 ± 1.41 oz}

Special tools (unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Hub Cap Wrench A: 0.5°, B: 78°  P49261	MB999108	Removal of hub cap
Cb	Oil Seal Installer A: ϕ84 {3.31}, B: ϕ70 {2.76}  05619	MB999097	Installation of oil seal

Identification marks for special tools are the same as used in the text.

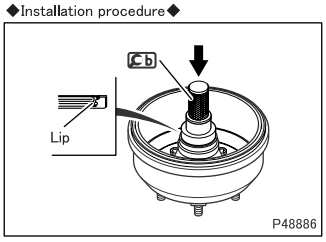
◆ Removal procedure



P48881

■Removal: Hub cap

◆Installation procedure◆



P48886

■Installation: Oil seal
Apply grease to the lip of the oil seal, then fit the oil seal onto the wheel huh in the illustrated direction.

P58290N

M E M O

TROUBLESHOOTING

1. Diagnosis Procedure
2. Diagnostic Precautions
3. Inspections Based On Diagnosis Codes
4. Multi-Use Tester Service Data
5. Actuator Tests Performed Using Multi-Use Tester
6. Inspections Performed At Electronic Control Unit Connectors

INSPECTION OF ELECTRICAL EQUIPMENT

INSTALLED LOCATIONS OF PARTS

ELECTRIC CIRCUIT DIAGRAM

This section suggests areas to inspect for each diagnosis code.

There are the diagnosis code and message displayed on the Multi-Use Tester. Numerical values in parenthesis are added only when a diagnostic code indicated in the Multi-Use Tester display differs from the code indicated by flashing the diagnostic light.

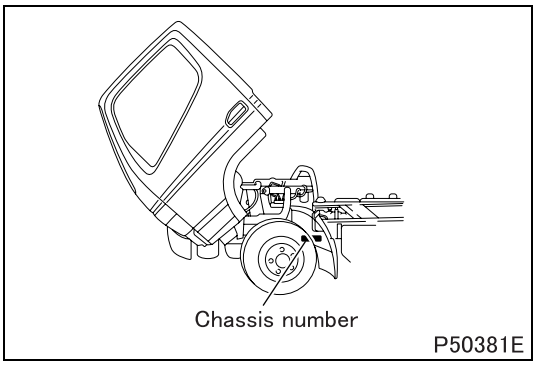
P1463: Exhaust Brake M/V1 (diagnostic light flashes: 93)

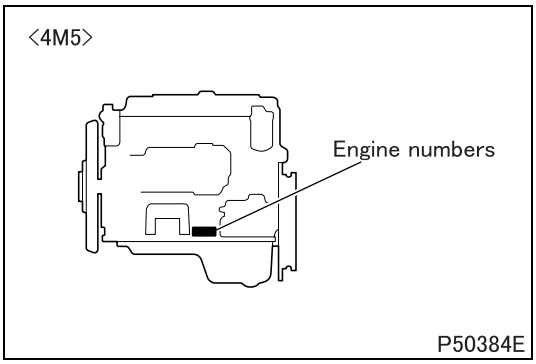
Code generation criteria		Exhaust brake 3-Way magnetic valve (output side) power-supply circuit shorted out
Resettability		Normal signal with starter switch in the ON position
Electronic control unit control		Auxiliary brake control disabled
In-spec-tion item	Service data	87: Exhaust brake M/V1
	Actuator test	AC: Auxiliary brake m/V1
	Electronic control unit connector	⑰: Exhaust brake 3-Way magnetic valve
	Electrical part	#565: Exhaust brake 3-Way magnetic valve
	Wiring diagram	Exhaust brake 3-Way magnetic valve circuit

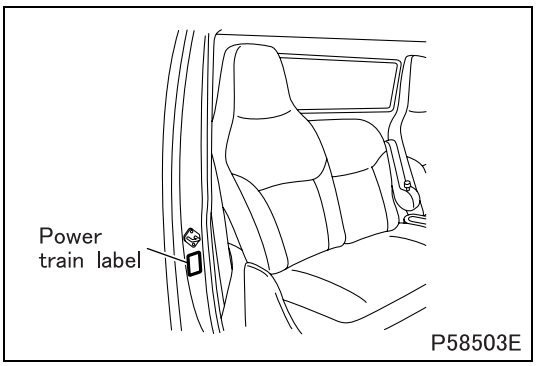
Refer to “Inspection of Electrical Equipment.”

Refer to “Electric Circuit Diagram.”

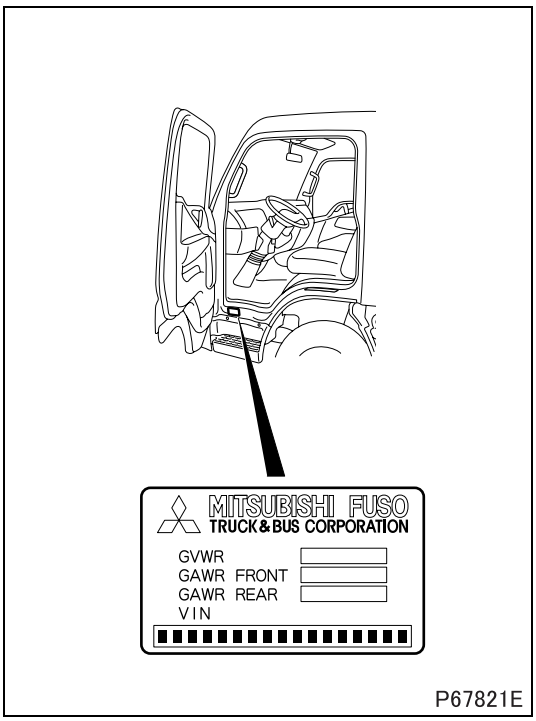
- Chassis and engine numbers are allocated to each vehicle and engine as they are produced. These numbers are required for registration.







- The power train label, located on the passenger door B-pillar, indicates the vehicle model, chassis number and the serial numbers of the vehicle's powertrain components.



- The vehicle identification number is punch-marked on the plate attached inside the driver's door, as shown in the illustration.
  The vehicle identification number consists of a 17-digit set of alphanumeric characters. Each digit represents the following specifications.

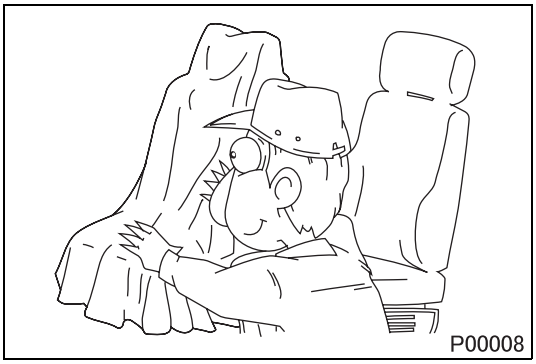
J	L	S	B	B	D	1	S	■	7	K	■■■■■■
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)

(1)	Country	J:	Japan
(2)	Make	L:	Mitsubishi Fuso
(3)	Type	S:	Sterling incomplete vehicle
(4)	Gross vehicle weight / Brake system		
		B:	14,001 to 16,000 lb / Hydraulic
		C:	16,001 to 19,500 lb / Hydraulic
(5)	Line	B:	Sterling 360 COE 40/45
		C:	Sterling 360 COE 50
(6)	Series (Wheel base)	D:	2.90 to 3.19 m (9.51 to 10.46 ft.)
		E:	3.20 to 3.49 m (10.49 to 11.44 ft.)
		G:	3.80 to 4.09 m (12.46 to 13.41 ft.)
		H:	4.10 to 4.39 m (13.45 to 14.40 ft.)
		J:	4.40 to 4.69 m (14.43 to 15.38 ft.)
(7)	Cab chassis type	1:	COE 4X2 chassis cab
(8)	Engine	S:	Proprietary 4M50 4.9 L inline 4 Diesel
(9)	Check digit		
(10)	Model year	7:	2007
(11)	Plant	K:	Kawasaki
(12)	Plant sequential number		

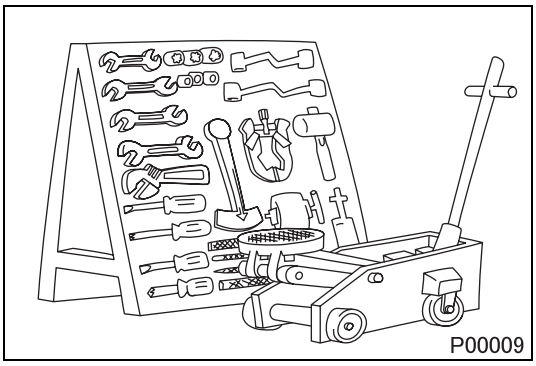
DANGER ⚠

This product contains or emits chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Before performing any service operations, inquire into the customer's complaints, determine the condition of the vehicle, check the distance traveled, look into the severity and type of service it has undergone, and note any other relevant factors. Assemble all the information needed to help you to service the vehicle efficiently.
- Check the location of the fault, and identify its cause. Based on your findings, determine whether parts must be removed or replaced. Follow the service procedures in this manual.


P00008

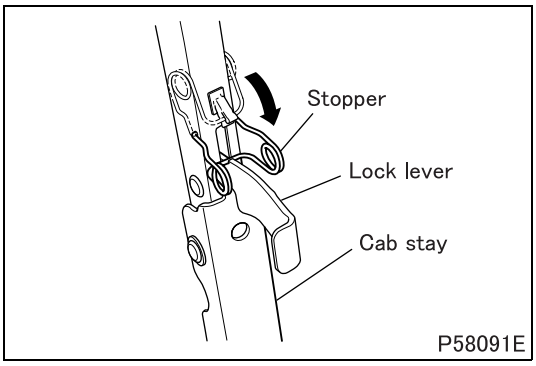
- Perform service operations on a level surface. Before starting, take the following preparatory steps:
  - To prevent soiling and damage, place covers over the seats, trim and floor in the cab and over the paint work of the body.


P00009

- Have ready all the tools necessary for the job, including special tools as required.

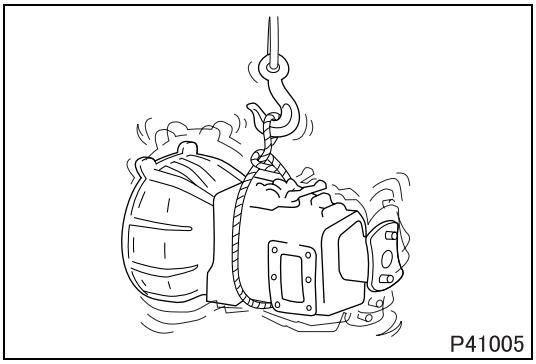
CAUTION ⚠

- **Special tools must be used whenever this manual requires them. Do not attempt to use other tools since they could cause injuries and/or vehicle damage.**

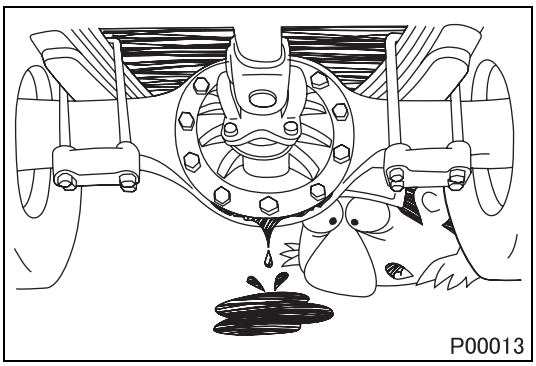


P58091E

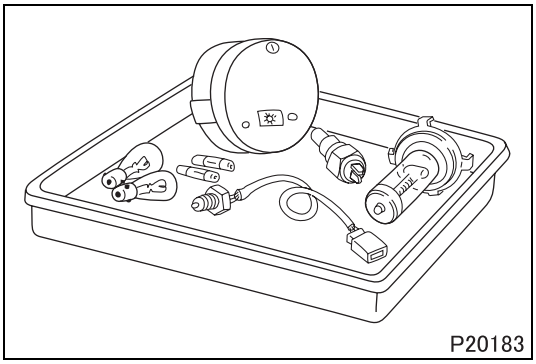
- When tilting the cab, be sure to engage the stopper (hold-down) with the lock lever. This will secure the cab stay and support the cab.
- Take extreme care when removing or installing heavy units such as the engine, transmission, or axle. When lifting heavy units using a cable etc., observe the following precautions.
- Know the weight of the unit being lifted. Use a lifting device and cable that is strong enough to support that weight.



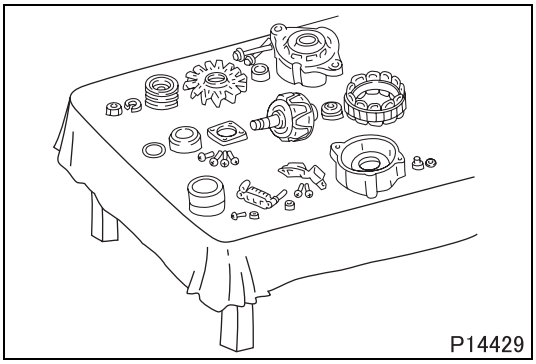
- If lifting eyes are not provided, tie a cable around the unit taking into account the unit's center of gravity.
- Do not allow anyone to walk or stand underneath a unit suspended on a lifting device.
- Never work in shoes with oily soles.
  When working with a partner or in a group, use pre-arranged signals and pay constant attention to safety. Be careful not to touch switches and levers unintentionally.



- Inspect for fluid leaks before washing the vehicle. Signs of fluid leaks may go unnoticed on a freshly-washed vehicle.


P20183

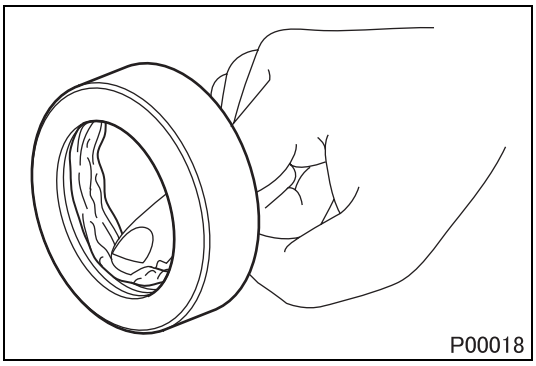
- Have replacement parts ready for installation.
- Oil seals, packings, O-rings and other rubber parts, gaskets, and split pins must be replaced with new ones after removal.
- When disassembling parts, visually check them for wear, cracks, damage, deformation, deterioration, rust, corrosion, defective rotation, fatigue, clogging and any other possible defect.


P14429

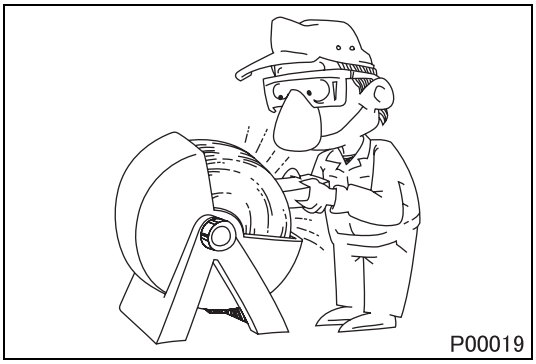
- To facilitate correct reassembly of parts, mark them with a paint pen before disassembly and arrange the disassembled parts neatly. Make alignment marks where they will not detract from parts' functionality and appearance.
- After removing parts from the vehicle, cover the area to keep it free of dust.

NOTE

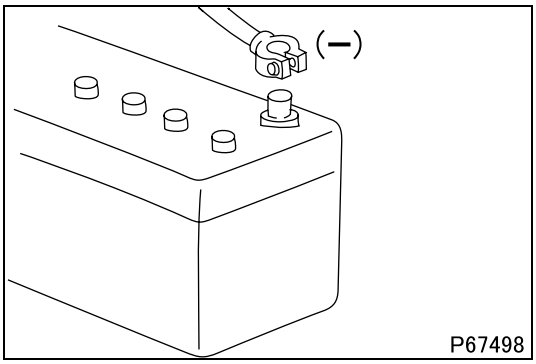
- **Be careful not to mix up identical parts, similar parts and parts that have left/right alignments.**
- **Keep new replacement parts and original (removed) parts separate.**


P00018

- Apply oil or grease as specified to O-rings, oil seals, dust seals and bearings before reassembly.
- Always use the required oils and greases when performing inspection or replacement. Immediately wipe away any excess oil or grease with a shop towel.


P00019

- Wear safety goggles when using power tools or equipment. Wear gloves when necessary, and watch out for sharp edges and other items that might injure your hands.

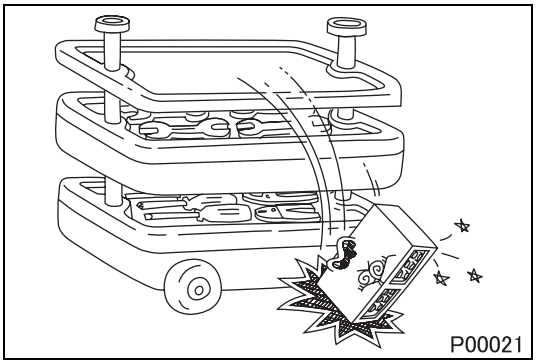


P67498

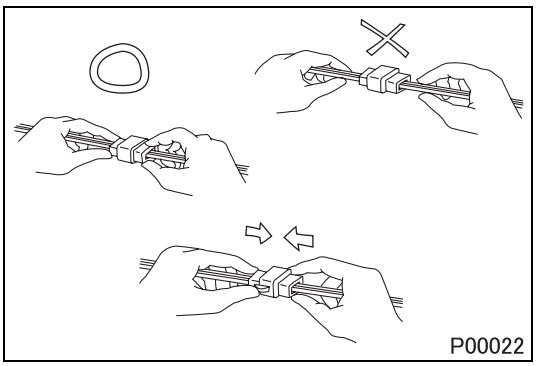
- Before working on the electrical system, disconnect the battery (–) terminal to prevent short circuits.

CAUTION ⚠

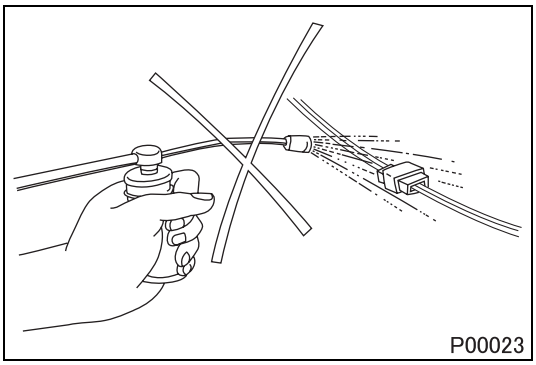
- **Make sure the ignition switch and all light switches are OFF before disconnecting or connecting battery cable. This will prevent damage to semiconductor components.**


P00021

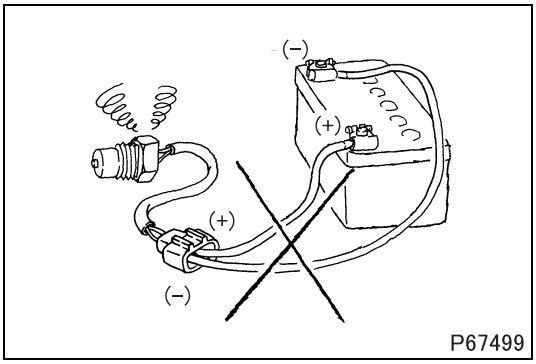
- Carefully handle sensors, relays, and other items that are sensitive to shock and heat. Do not remove or paint the cover of any control unit.


P00022

- When separating connectors, grasp the connectors themselves rather than the harnesses.
- To separate locking connectors, first push them in the direction of the arrows. To reconnect locking connectors, push them together until they click.

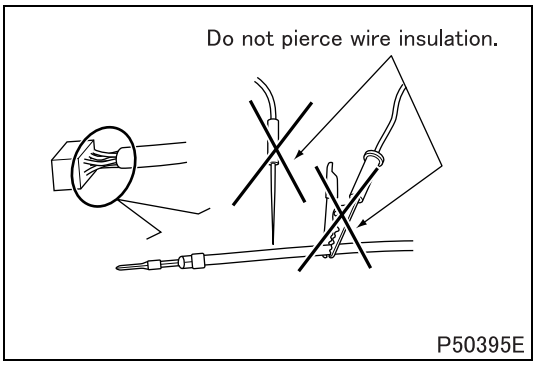

P00023

- Before washing the vehicle, cover all electrical parts to keep them dry. (Use plastic sheets or the like.) Keep water away from harness connectors and sensors and immediately wipe off any water that gets on them.



- When applying a voltage to a part for inspection purposes, check that the (+) and (–) cables are connected properly then gradually increase the voltage from zero. Do not exceed the specified voltage.
  Remember that control units and sensors do not necessarily operate on battery voltage.

1. Handling Precautions for Electric Circuits



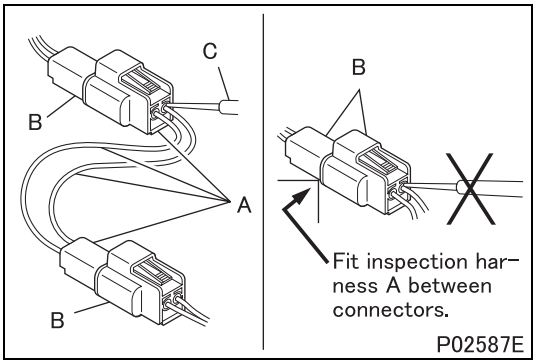
CAUTION ⚠

- **Do not pierce wire insulation with test probes or alligator clips when performing electrical inspections. Doing so can hasten corrosion, particularly with the chassis harness.**

1.1 Inspection of harnesses

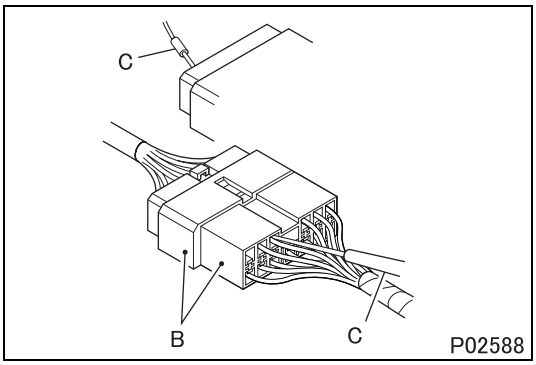
(1) Inspections with connectors fitted together

(1.1) Waterproof connectors

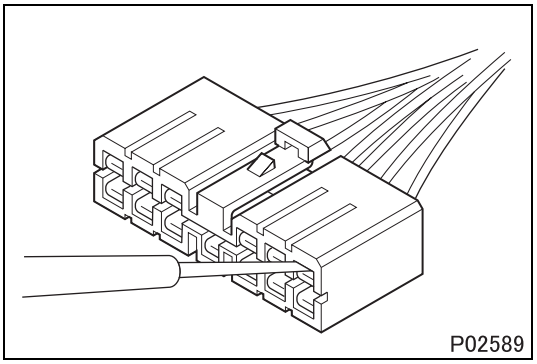


- Connect an inspection harness and connector **A** between the connectors **B** of the circuit to be inspected. Perform the inspection by applying a test probe **C** to the connectors of the inspection harness. Do not insert the test probe **C** into the wire-entry sides of the waterproof connectors since this would damage their waterproof seals and lead to rust.

(1.2) Non-waterproof connectors



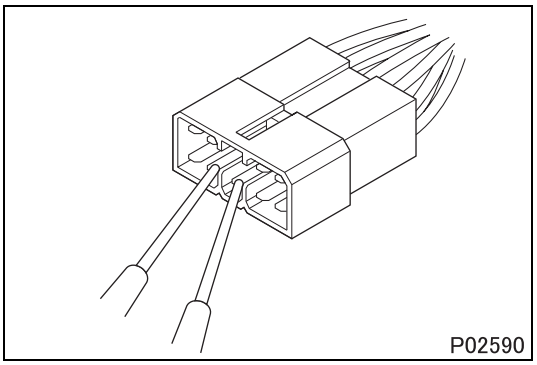
- Perform the inspection by inserting a test probe **C** into the wire-entry sides of the connectors. An extra-narrow probe is required for control unit connectors, which are smaller than other types of connector. Do not force a regular-size probe into control unit connectors since this would cause damage.


P02589

(2) Inspections with connectors separated

(2.1) Inspections on female terminals

- Perform the inspection by carefully inserting a test probe into the terminals. Do not force the test probe into the terminals since this could deform them and cause poor connections.

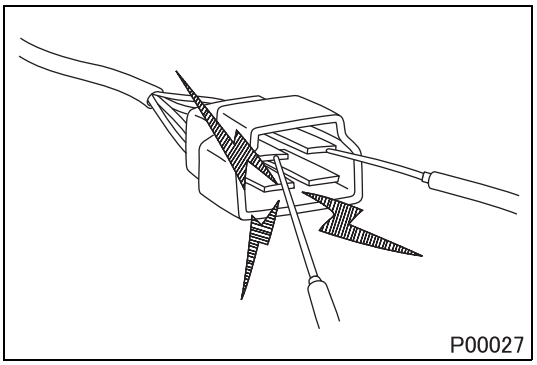

P02590

(2.2) Inspections on male terminals

- Perform the inspection by applying test probes directly to the pins.

CAUTION ⚠

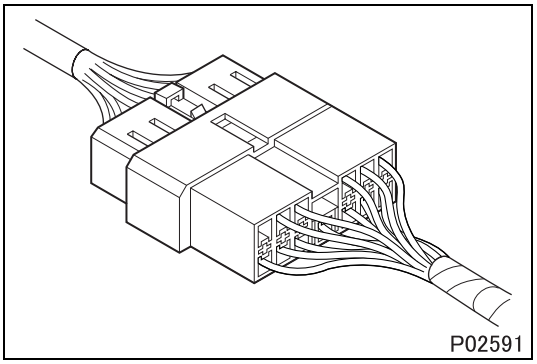
- **Be careful not to short-circuit pins through the test probes. If the pins of a control unit connector become short-circuited, this can cause damage to the control unit's internal circuitry.**


P00027

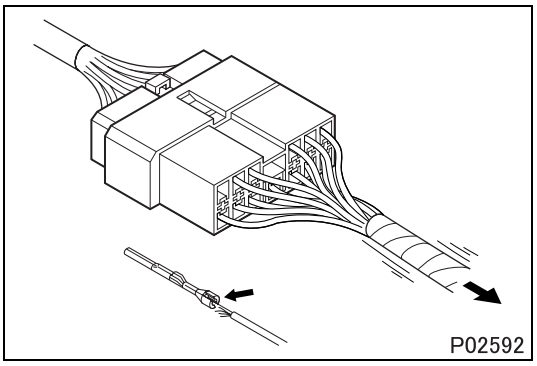
- When using a multimeter to check continuity, do not allow the test probes to touch the wrong terminals.

1.2 Inspection of connectors

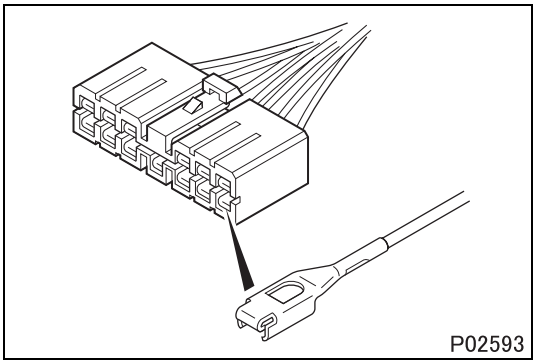
(1) Visual inspection


P02591

- Check that the connectors are fitted together securely.

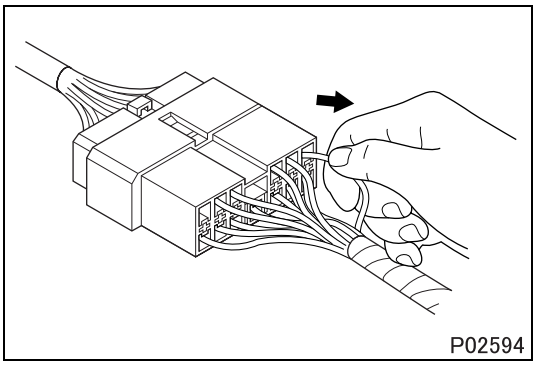

P02592

- Check for wires that have separated from their terminals due to pulling of the harness.


P02593

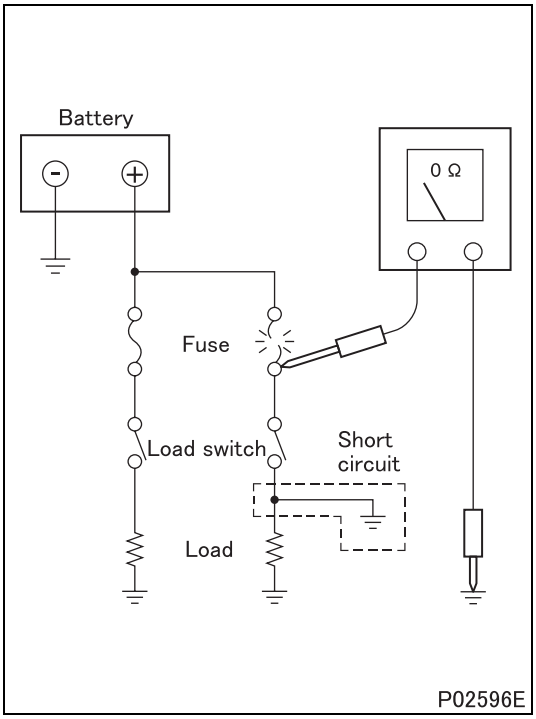
- Check that male and female terminals fit together tightly.

- Check for defective connections caused by loose terminals, by corrosion on terminals, or by contamination of terminals by foreign materials.


P02594

(2) Checking for loose terminals

- On a connector, if terminal retainers become damaged, male and female terminals may not mate with each other when the connector bodies are fitted together. To check for such terminals, gently tug on each wire and see whether any terminals slip out of their connector housings.

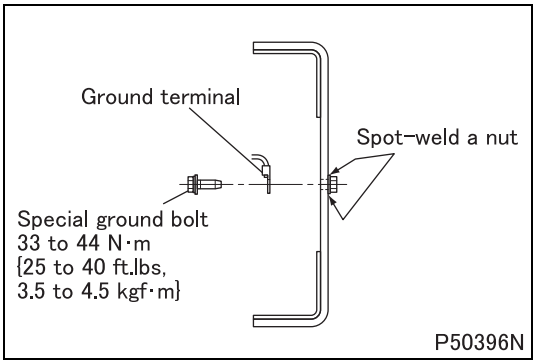


P02596E

1.3 Inspections when a fuse blows

- Remove the fuse, then measure the resistance between ground and the fuse's load side.
  Next, close the switch of each circuit connected to the fuse. If the resistance measurement between any switch and ground is zero, there is a short circuit between the switch and the load. If the resistance measurement is not zero, the circuit is not currently short-circuited; the fuse probably blew due to a momentary short circuit.

- The main causes of short circuits are as follows:
  - Harnesses trapped between chassis parts
  - Harness insulation damage due to friction or heat
  - Moisture in connectors or circuitry
  - Human error (accidental short-circuiting of components)



1.4 Inspection of chassis ground

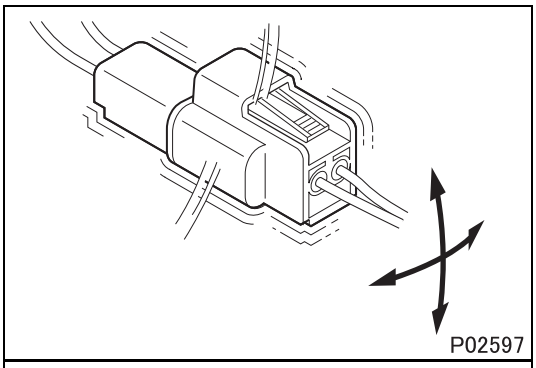
- A special ground bolt is used to tighten a ground terminal. When servicing the ground point, be sure to follow the procedures described below:
  - When reinstalling the ground bolt
    Tighten the ground bolt to the specified torque.
  - When relocating the ground point
    A special ground bolt must be used. Spot-weld a nut to a frame and tighten the ground bolt to the specified torque. Be sure to apply touch-up paint to the welded point.

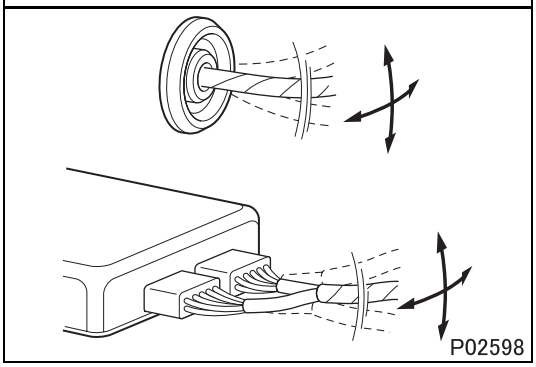
2. Service Precautions for Alternators

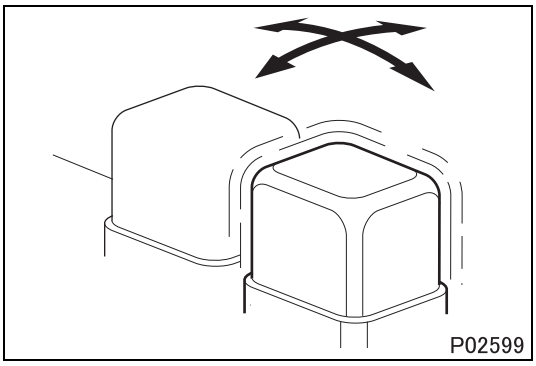
When servicing alternators, observe the following precautions:

- Never reverse the polarity of battery connections.
  If the polarity of the battery connections were to be reversed, a large current would flow from the battery to the alternator, damaging the diodes and regulator.
- Never disconnect the battery cables with the engine running.
  Disconnection of the battery cables during engine operation would cause a surge voltage, leading to damage to the diodes and regulator.
- Never perform inspections using a high-voltage multimeter.
  The use of a high-voltage multimeter could damage the diodes and regulator.
- Keep alternators dry.
  Water on alternators can cause internal short circuits and damage.
- Never operate an alternator with the B and L terminals short-circuited. Operation with the B and L terminals connected together would damage the diode trio.
- Disconnect the battery cables before quick-charging the battery with a quick charger.
  Unless the battery cables are disconnected, quick-charging can damage the diodes and regulator.

3. Intermittent Faults


P02597


P02598


P02599

- An intermittent fault typically occurs only under certain operating conditions. Once these conditions have been identified, the cause of the intermittent fault is easy to determine. First, ask the customer about the vehicle operating conditions and weather conditions under which the fault occurs. Also ask about the frequency with which the fault occurs and about the fault symptoms. Then reproduce the fault based on this information.
  Determine in this way if factors such as heat or vibration play a role in producing the fault. If vibration is a possible factor, try to reproduce the fault by doing the following:
  - Gently move connectors up and down and to left and right.
  - Gently move wiring harnesses up and down and to left and right.
  - Gently wiggle sensors and other devices by hand.
  - Gently wiggle wiring harnesses on suspension systems and other moving parts.

- To identify the connectors, harnesses, and other devices to be checked, consult the troubleshooting procedures for the affected system in this manual.

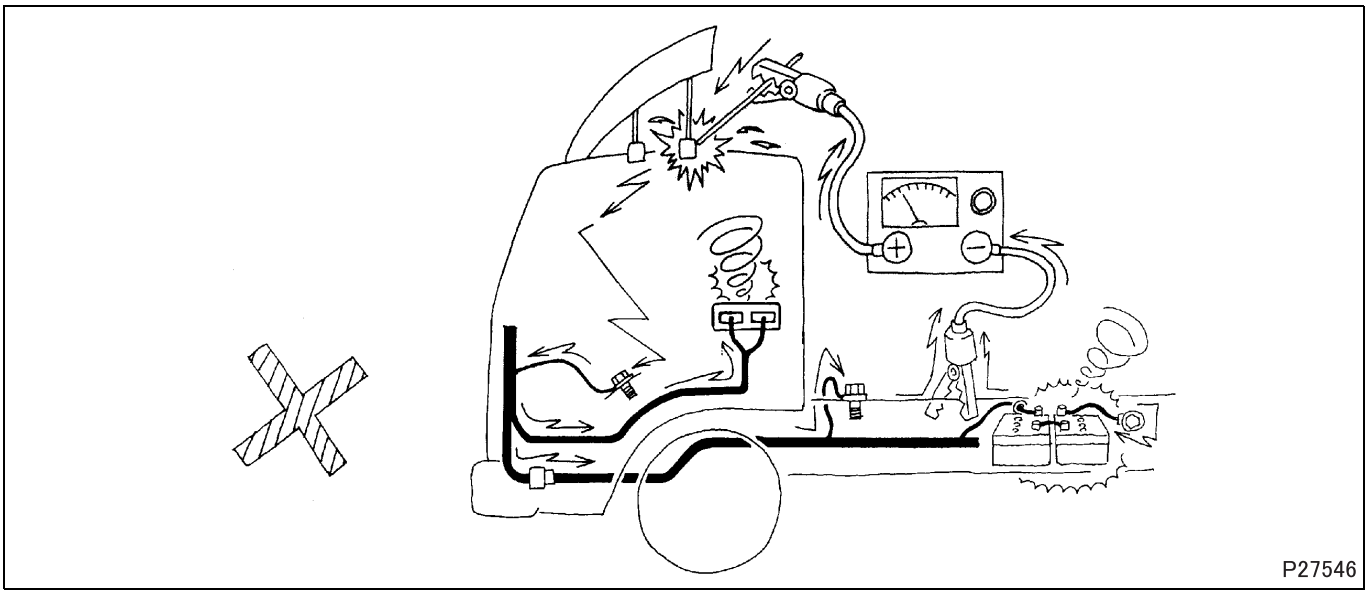
M E M O

4. Precautions for Electric Welding

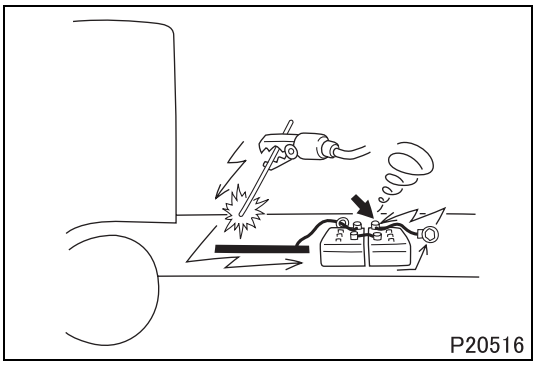
WARNING ⚠

- **Before performing any electric welding on a vehicle, disconnect the battery power and ground cable, and any electronic control units or similar devices installed on the vehicle. Electric currents produced during electric welding can damage various electrical components on the vehicle, which could result in malfunction of the components.**

Electric current from the welder flows to ground via the vehicle's metal parts. Unless appropriate steps are taken, this current can damage control units, other electrical devices and wiring harnesses.
Any electrical device near the point of attachment of the welding ground strap is especially liable to damage.



- Current flows backward as shown below.



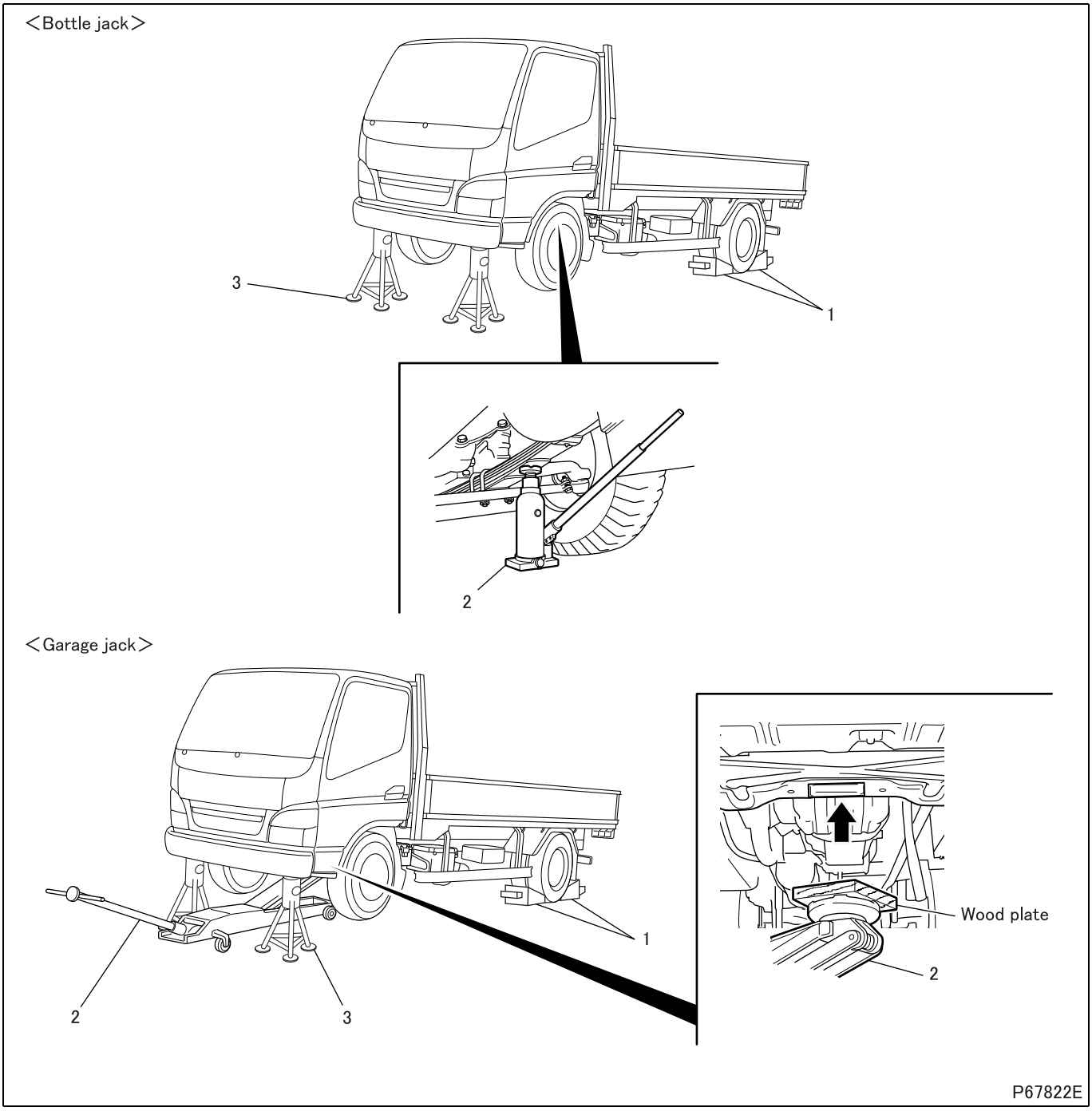
4.1 From battery (–) terminal

To prevent damage to the battery and to electrical devices that are connected directly to the battery, it is essential to disconnect the batteries.

4.2 Procedure

- Park the vehicle on a level surface. Shut down the engine and turn the ignition switch to LOCK.
- Set the parking brake and chock the front and rear tires.
- Disconnect the batteries.
- Attach the welding ground strap as close as possible to the work being done. If the frame is being welded, do not attach the welding ground strap to the cab. Similarly, If the cab is being welded, do not attach the welding ground strap to the frame.
- Cover all parts of the vehicle that may be damaged by welding sparks.
- Disconnect the engine, transmission, and ABS electronic control units.

<Front of vehicle>



Jacking procedure

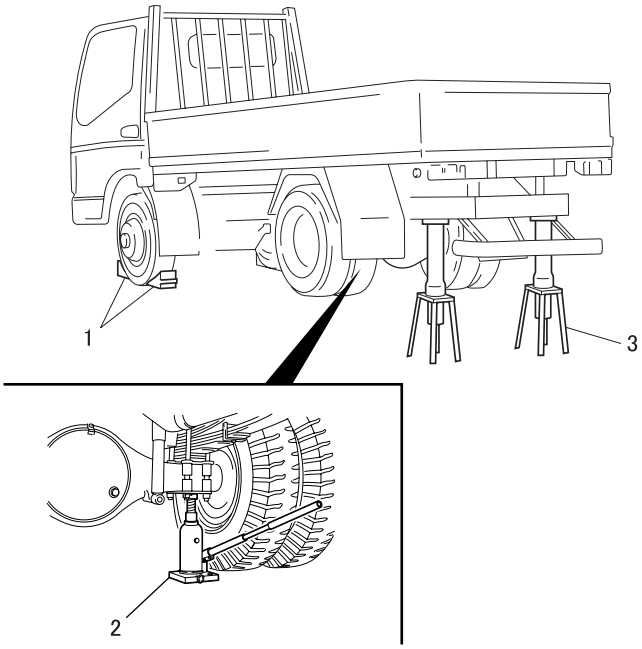
1 Chock the rear tires.
2 Using an axle or floor jack, raise the front of the vehicle.
3 Support the vehicle frame on safety stands.

WARNING ⚠

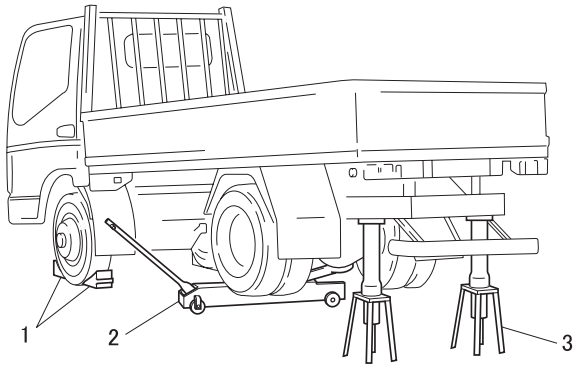
- **To prevent the vehicle from rolling, chock the tires firmly and do not remove the chocks until the operation is completed.**
- **Never work around or under a vehicle that is supported only by a jack. Always support the vehicle with safety stands. Jacks can slip, allowing the vehicle to fall, which could result in serious injury or death.**

<Rear of Vehicle>

＜Bottle jack＞



＜Garage jack＞



P58509E

Jacking up procedure

1 Chock the front tires.
2 Using an axle or floor jack, raise the front of the vehicle.
3 Support the vehicle frame on safety stands.

WARNING ⚠

- **To prevent the vehicle from rolling, chock the tires firmly and do not remove the chocks until the operation is completed.**
- **Never work around or under a vehicle that is supported only by a jack. Always support the vehicle with safety stands. Jacks can slip, allowing the vehicle to fall, which could result in serious injury or death.**

1. Diagnosis Codes

- There are two ways to retrieve diagnosis codes. Either one can be used.
  - Using the Multi-Use Tester
  - Flashing a diagnostic light on the instrument cluster
- The table below indicates the diagnostic light used, the systems to which it applies, and the methods usable for individual systems.

1.1 Diagnostic lights

Diagnostic light	System	Flashing of warning lamp	Reference Group
CHECK ENGINE	Common rail	O	13E
	Exhaust gas recirculation		17
	Starter continuous energizing preventing function, Preheating system		54
	Automatic transmission	O	23
ABS	Anti-lock brake system	O	35E

2. Retrieving Diagnosis Codes Using the Multi-Use Tester

2.1 Connecting the Multi-Use Tester

- To connect the Multi-Use Tester, follow the instructions included with the MUT-III tester.

2.2 Diagnosis codes saved in memory

(1) Present and past diagnosis codes

●Present diagnosis codes

- When the ignition switch is turned to ON, any faults detected by the engine, transmission, or ABS electronic control units (ECUs) are broadcast as diagnosis codes.
- On the instrument cluster, the check engine, transmission warning, or ABS warning light flashes, depending on the originating ECU.

●Past diagnosis codes

- Past diagnosis codes are saved in the memory of the originating ECU.
- When the fault has been corrected, or when the ignition switch is turned from OFF to ON, present diagnosis codes are saved as past diagnosis codes.
- The diagnostic light (applicable warning light) does not illuminate for past diagnosis codes.

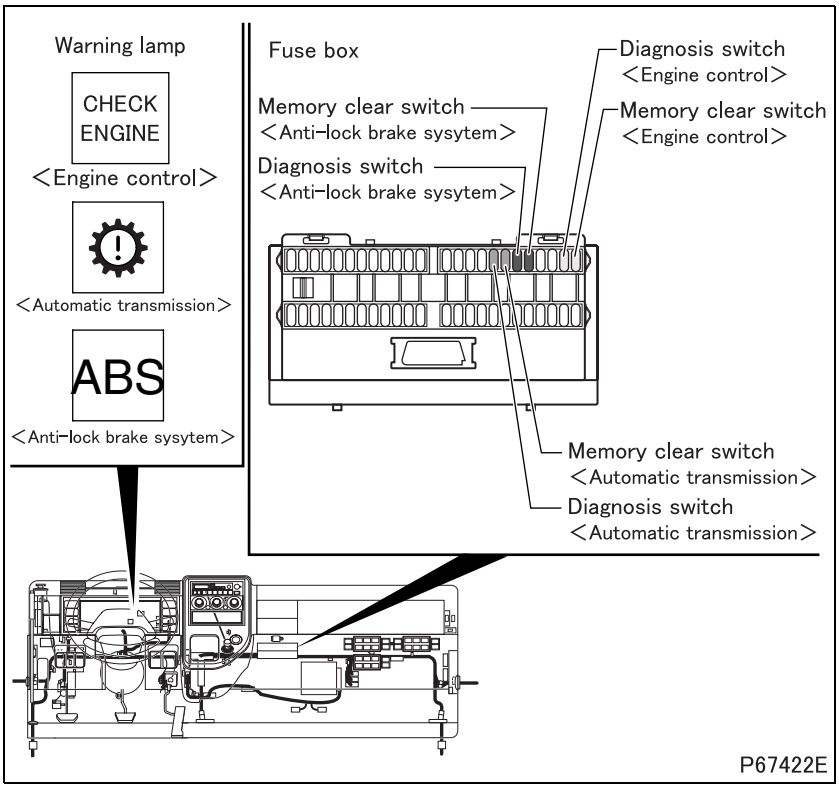
- Access to diagnosis codes
- Turn the ignition switch to ON.
- Use the Multi-Use Tester to display diagnosis codes saved in the memory of the originating ECU and to identify the location of the fault.

(2) Clearing diagnosis codes

- Turn the ignition switch to ON, but do not start the engine.

Use the Multi-Use Tester to delete all the diagnosis codes saved in the memory of the ECUs.

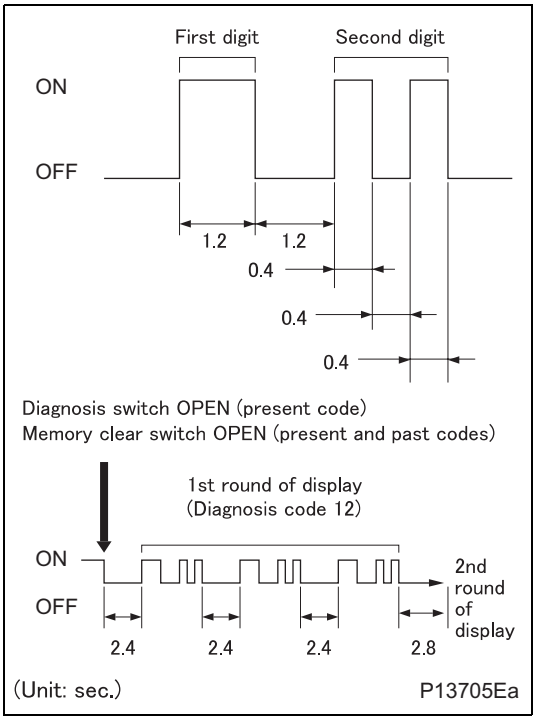
3. Retrieving Diagnosis Codes Using the Flashing Diagnostic Light



- Use the diagnosis and memory clear switches to display diagnosis codes.
- Each ECU has its own diagnosis and memory clear switch.
- The diagnostic light for the engine ECU is the check engine warning.
- The diagnostic light for the transmission control unit is the automatic transmission warning.
- The diagnostic light for the ABS ECU is the ABS warning.

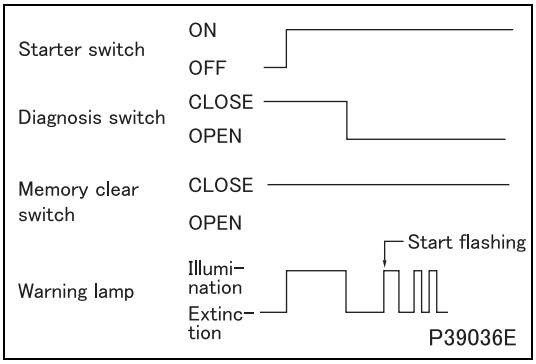
CAUTION ⚠

- **Disconnecting and connecting the memory clear switch can erase past diagnosis codes from memory. Before handling diagnosis codes, carefully follow the procedure described below to avoid erasing codes inadvertently.**



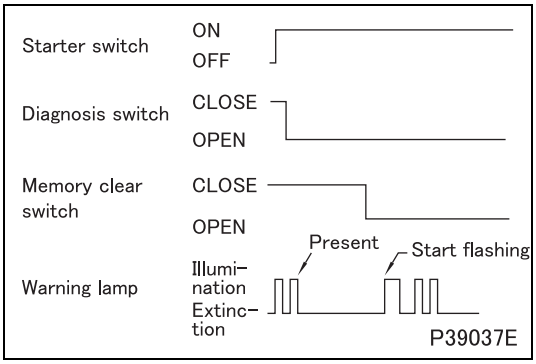
3.1 Reading diagnosis codes

- To read a diagnosis code, observe how many times the diagnostic light flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - First digit: 1.2 sec.
  - Second digit: 0.4 sec.
- A diagnosis code consists of the flashing of the first digit, followed by the flashing of the second digit, in that order. If a diagnosis code has “0” in the first digit, only the second digit will be flashed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be repeated 3 times, followed by any subsequent codes. This will continue until the codes are corrected or the ignition switch is turned OFF.



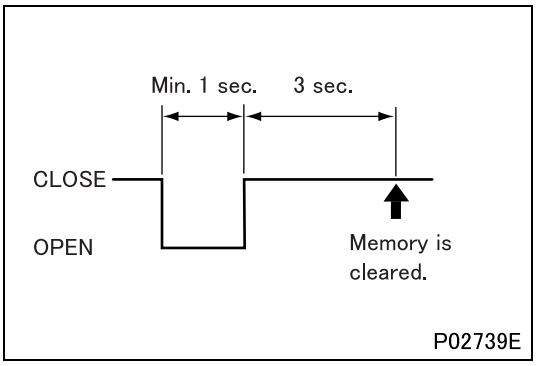
3.2 Present diagnosis codes

- Turn the ignition switch ON.
- Disconnect the diagnosis switch.
- The diagnostic light will flash, displaying any diagnosis codes.
- When the diagnosis switch is connected, the electronic control unit will immediately stop displaying diagnosis codes.



3.3 Present and past diagnosis codes

- Turn the ignition switch to the ON position.
- Disconnect the diagnosis switch.
- Disconnect the memory clear switch.
- The diagnostic light will flash the diagnosis codes saved in the memory of its ECU.
- Turn the ignition switch to the OFF position. Connect the memory clear switch and then connect the diagnosis switch. The electronic control unit terminates (exits) the diagnosis code displaying mode.



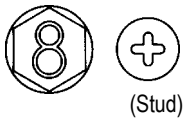
3.4 Erasing diagnosis codes

- Turn the ignition switch to the ON position, but do not start the engine.
- Disconnect the memory clear switch and reconnect it. All diagnosis codes will be erased.
- To prevent the diagnosis codes from being erased, turn the ignition switch to the OFF position. Reconnect the memory clear switch with the ignition OFF.

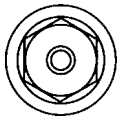
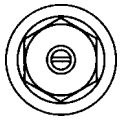
TABLE OF STANDARD TORQUES

- Use specified bolts and nuts. Tighten them to the torque values specified in this section unless otherwise stated.
- Threaded portions and bearing surfaces should be dry.
- When the nut is in a different strength class than the bolt (or stud), use the torque value for the bolt (or stud).

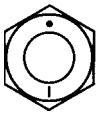
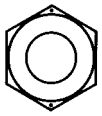
Hexagon Headed Bolt, Stud (Torque: N·m {lbf·ft, kgf·m})

Strength	4T		7T		8T	
Identification symbol / Nominal diameter	(Stud)		(Stud)		 (Stud)	
M5	2 to 3 {1.5 to 2.2, 0.2 to 0.3}	–	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	5 to 7 {3.7 to 5.2, 0.5 to 0.7}	–
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	7 to 10 {5.2 to 7.4, 0.7 to 1.0}	–	8 to 12 {5.9 to 8.9, 0.8 to 1.2}	–
M8	9 to 13 {6.6 to 9.6, 0.9 to 1.3}	–	16 to 24 {12 to 18, 1.7 to 2.5}	–	19 to 28 {14 to 21, 2.0 to 2.9}	–
M10	18 to 27 {13 to 20, 1.8 to 2.7}	17 to 25 {13 to 18, 1.8 to 2.6}	34 to 50 {25 to 37, 3.5 to 5.1}	32 to 48 {24 to 35, 3.3 to 4.9}	45 to 60 {33 to 44, 4.5 to 6.0}	37 to 55 {27 to 41, 3.8 to 5.7}
M12	34 to 50 {25 to 37, 3.4 to 5.1}	31 to 45 {23 to 33, 3.1 to 4.6}	70 to 90 {52 to 66, 7.0 to 9.5}	65 to 85 {48 to 63, 6.5 to 8.5}	80 to 105 {59 to 77, 8.5 to 11}	75 to 95 {55 to 70, 7.5 to 10}
M14	60 to 80 {44 to 59, 6.0 to 8.0}	55 to 75 {41 to 55, 5.5 to 7.5}	110 to 150 {81 to 110, 11 to 15}	100 to 140 {74 to 105, 11 to 14}	130 to 170 {96 to 125, 13 to 17}	120 to 160 {89 to 120, 12 to 16}
M16	90 to 120 {66 to 89, 9 to 12}	90 to 110 {66 to 81, 9 to 11}	170 to 220 {125 to 160, 17 to 23}	160 to 210 {120 to 155, 16 to 21}	200 to 260 {145 to 190, 20 to 27}	190 to 240 {140 to 175, 19 to 25}
M18	130 to 170 {96 to 125, 14 to 18}	120 to 150 {89 to 110, 12 to 16}	250 to 330 {185 to 245, 25 to 33}	220 to 290 {160 to 215, 23 to 30}	290 to 380 {215 to 280, 30 to 39}	250 to 340 {185 to 250, 26 to 35}
M20	180 to 240 {130 to 175, 19 to 25}	170 to 220 {125 to 160, 17 to 22}	340 to 460 {250 to 340, 35 to 47}	310 to 410 {230 to 300, 32 to 42}	400 to 530 {295 to 390, 41 to 55}	360 to 480 {265 to 355, 37 to 49}
M22	250 to 330 {185 to 245, 25 to 33}	230 to 300 {170 to 220, 23 to 30}	460 to 620 {340 to 455, 47 to 63}	420 to 560 {310 to 415, 43 to 57}	540 to 720 {400 to 530, 55 to 73}	490 to 650 {360 to 480, 50 to 67}
M24	320 to 430 {235 to 315, 33 to 44}	290 to 380 {215 to 280, 29 to 39}	600 to 810 {440 to 595, 62 to 83}	540 to 720 {400 to 530, 55 to 73}	700 to 940 {515 to 695, 72 to 96}	620 to 830 {455 to 610, 63 to 85}

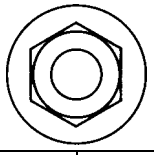
Hexagon Headed Flange Bolt (Torque: N·m {lbf·ft, kgf·m})

Strength	4T		7T		8T	
Identification symbol / Nominal diameter						
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	8 to 12 {5.9 to 8.9, 0.8 to 1.2}	–	10 to 14 {7.4 to 10, 1.0 to 1.4}	–
M8	10 to 15 {7.4 to 11, 1.0 to 1.5}	–	19 to 28 {14 to 21, 2.0 to 2.9}	–	22 to 33 {16 to 24, 2.3 to 3.3}	–
M10	21 to 31 {15 to 23, 2.1 to 3.1}	20 to 29 {15 to 21, 2.0 to 3.0}	45 to 55 {33 to 41, 4.5 to 5.5}	37 to 54 {27 to 40, 3.8 to 5.6}	50 to 65 {37 to 48, 5.0 to 6.5}	50 to 60 {37 to 44, 5.0 to 6.5}
M12	38 to 56 {28 to 41, 3.8 to 5.5}	35 to 51 {26 to 38, 3.5 to 5.2}	80 to 105 {59 to 77, 8.0 to 10.5}	70 to 95 {52 to 95, 7.5 to 9.5}	90 to 120 {66 to 89, 9 to 12}	85 to 110 {63 to 81, 8.5 to 11}

Hexagon Nuts (Torque: N·m {lbf·ft, kgf·m})

Strength	4T		6T	
Identification symbol			 	
Nominal diameter	Standard screw thread	Coarse screw thread	Standard screw thread	Coarse screw thread
M5	2 to 3 {1.5 to 2.2, 0.2 to 0.3}	–	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	7 to 10 {5.2 to 7.4, 0.7 to 1.0}	–
M8	9 to 13 {6.6 to 9.6, 0.9 to 1.3}	–	16 to 24 {12 to 18, 1.7 to 2.5}	–
M10	18 to 27 {13 to 20, 1.8 to 2.7}	17 to 25 {13 to 18, 1.8 to 2.6}	34 to 50 {25 to 37, 3.5 to 5.1}	32 to 48 {24 to 35, 3.3 to 4.9}
M12	34 to 50 {25 to 37, 3.4 to 5.1}	31 to 45 {23 to 33, 3.1 to 4.6}	70 to 90 {52 to 66, 7.0 to 9.5}	65 to 85 {48 to 63, 6.5 to 8.5}
M14	60 to 80 {44 to 59, 6.0 to 8.0}	55 to 75 {41 to 55, 5.5 to 7.5}	110 to 150 {81 to 110, 11 to 15}	100 to 140 {74 to 105, 11 to 14}
M16	90 to 120 {66 to 89, 9 to 12}	90 to 110 {66 to 81, 9 to 11}	170 to 220 {125 to 160, 17 to 23}	160 to 210 {120 to 155, 16 to 21}
M18	130 to 170 {96 to 125, 14 to 18}	120 to 150 {89 to 110, 12 to 16}	250 to 330 {185 to 245, 25 to 33}	220 to 290 {160 to 215, 23 to 30}
M20	180 to 240 {130 to 175, 19 to 25}	170 to 220 {125 to 160, 17 to 22}	340 to 460 {250 to 340, 35 to 47}	310 to 410 {230 to 300, 32 to 42}
M22	250 to 330 {185 to 245, 25 to 33}	230 to 300 {170 to 220, 23 to 30}	460 to 620 {340 to 455, 47 to 63}	420 to 560 {310 to 415, 43 to 57}
M24	320 to 430 {235 to 315, 33 to 44}	290 to 380 {215 to 280, 29 to 39}	600 to 810 {440 to 595, 62 to 83}	540 to 720 {400 to 530, 55 to 73}

Hexagon Flange Nuts (Torque: N·m {lbf·ft, kgf·m})

Strength	4T	
Identification symbol		
Nominal diameter	Standard screw thread	Coarse screw thread
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
M8	10 to 15 {7.4 to 11, 1.0 to 1.5}	–
M10	21 to 31 {15 to 23, 2.1 to 3.1}	20 to 29 {15 to 21, 2.0 to 3.0}
M12	38 to 56 {28 to 41, 3.8 to 5.6}	35 to 51 {26 to 38, 3.5 to 5.2}

Torque Values for General-Purpose Flare Nut: N·m {lbf·ft, kgf·m}

Pipe diameter	ϕ4.76 mm {0.19 in.}	ϕ6.35 mm {0.25 in.}	ϕ8 mm {0.31 in.}	ϕ10 mm {0.39 in.}	ϕ12 mm {0.47 in.}	ϕ15 mm {0.59 in.}
Torque value	17 {13, 1.7}	25 {18, 2.6}	39 {29, 4.0}	59 {44, 6.0}	88 {65, 9.0}	98 {72, 10}

Torque Values for General-Purpose Air Piping Nylon Tube (DIN Type): N·m {lbf·ft, kgf·m}

Nominal diameter × wall thickness	6 × 1 mm {0.24 × 0.039 in.}	10 × 1.25 mm {0.39 × 0.049 in.}	12 × 1.5 mm {0.47 × 0.059 in.}	15 × 1.5 mm {0.59 × 0.059 in.}
Torque value	20^{+6}_{0} {$15^{+4.4}_{0}$ $2.0^{+0.6}_{0}$}	34^{+10}_{0} {$25^{+7.4}_{0}$ $3.5^{+1.0}_{0}$}	49^{+10}_{0} {$36^{+7.4}_{0}$ $5.0^{+1.0}_{0}$}	54^{+5}_{0} {$40^{+3.7}_{0}$ $5.5^{+0.5}_{0}$}

Torque Values for General-Purpose Air Piping Nylon Tube (SAE Type): N·m {lbf·ft, kgf·m}

Nominal diameter	1/4 in.	3/8 in.	1/2 in.	5/8 in.
Torque value	13^{+4}_{0} {$9.6^{+3.0}_{0}$ $1.3^{+0.4}_{0}$}	29^{+5}_{0} {$21^{+3.7}_{0}$ $3.0^{+0.5}_{0}$}	49^{+5}_{0} {$36^{+3.7}_{0}$ $5.0^{+0.5}_{0}$}	64^{+5}_{0} {$47^{+3.7}_{0}$ $6.5^{+0.5}_{0}$}

GROUP 01 INDEX

HOW TO READ THE MAINTENANCE SCHEDULE TABLES 01-2

MAINTENANCE SCHEDULE TABLES 01-4

MAINTENANCE OPERATIONS 01-8

LUBRICATION TABLES 01-14

LUBRICATION 01-16

HOW TO READ THE MAINTENANCE SCHEDULE TABLES

Example Table:

Ⓔ: Exhaust emission items.
Ⓝ: Noise control items.

Item (1)	Time of inspection and maintenance (2)									Working procedures (3)	Reference Gr (4)
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150 ,000 miles		
ENGINE											
Fuel, oil, or coolant leaks from engine	×									Check engine for fuel, oil and coolant leaks.	Gr11, 12 13A, 14
ⒺⓃ Engine conditions	×									Check the engine for smooth starting and quiet running.	Gr11, 13 15, 17, 54
Manifold bolts and nuts torque							×			Check inlet exhaust manifold dolts and nuts for looseness.	Gr15
Ⓔ Check and adjust valve clearance		×					×			Check valve clearance with thickness gauge.	Gr11
Ⓔ Oil filter replacement			Every 10,000 km/6,000 miles or 12 months							Replace oil filters	Gr12

(1) This column contains the maintenance and inspection items.

(2) The inspection and service intervals are based on the assumption that the vehicle will be driven approximately 60,000 kilometers (36,000 miles) per year.
Mandatory inspections are indicated by an "×" or by the appropriate period between servicing.

(3) This column (working procedures) provides a simplified explanation of the operational procedures involved for each inspection or maintenance item.

(4) This column (Reference group) refers to the "group number" in this manual where detailed procedures can be found.

M E M O

MAINTENANCE SCHEDULE TABLES

Ⓔ: Exhaust emission items.
Ⓝ: Noise control items.

Item	Time of inspection and maintenance									Working procedures	Reference Group
			Inspection interval								
	Pre-operational checks	New vehicle at 4 000 km/ 2,500 miles	Every 10 000 km/ 6000 miles	Every 20 000 km/ 12,000 miles	Every 30 000 km/ 18,000 miles	Every 40 000 km/ 24,000 miles	Every 50 000 km/ 30,000 miles	Every 90 000 km/ 54,000 miles	Every 250 000 km/ 150,000 miles		
ENGINE											
Coolant, fuel and oil leaks	×									Check beneath the vehicle for signs of leakage.	Gr11, 12, 13A, 14
ⒺⓃ Engine condition	×									Check that the engine starts smoothly and runs quietly.	Gr11, 13, 15, 17, 54
Manifold fastener torque							×			Check intake and exhaust manifold fastener torques.	Gr15
Ⓔ Valve lash		×					×			Check valve lash with a feeler gauge.	Gr11
Ⓔ Engine oil filter			Every 10 000 km/6000 miles or 12 months							Replace the filter element.	Gr12
Ⓔ Fuel filter			Every 20 000 km/12,000 miles or 12 months							Replace the filter element.	Gr13A
Ⓔ Fuel system			Every 20 000 km/12,000 miles or 12 months							Check the fuel tank, cap, and lines for leakage.	Gr13A
ⒺⓃ Engine drive belt	×		Every 10 000 km/6000 miles or 12 months							Visually inspect the belt. Check belt tension.	Gr14
Ⓔ Cooling system				×						Inspect the radiator, radiator mounts, pressure cap, and coolant hoses. Remove dust and deposits from the radiator and charge air cooler.	Gr14
Coolant level	×									Check the coolant level and add coolant if necessary.	Gr14
Coolant change			Every 24 months							Replace the coolant.	Gr14
Ⓔ Turbocharger									×	Check the turbocharger rotor play.	Gr15
Air cleaner element			Every 5 000 km/3000 miles							Clean the air cleaner element.	Gr15
ⒺⓃ Air cleaner element replacement						×				Replace the air cleaner element.	Gr15
ⒺⓃ Exhaust system				×						Inspect the exhaust system for emission and noise control problems.	Gr15
POWER TRAIN											
Clutch pedal	×									Check the clutch pedal free play.	Gr21
Clutch wear			×							Check clutch disc wear.	Gr21
Shift selector	×		Every 30 000 km/18,000 miles or 6 months							Check the operation of the shift selector	Gr21
Propeller shaft yoke		×	×							Check flange yoke bolts for looseness. Check the universal joint for play.	Gr25

Item	Time of inspection and maintenance									Working procedures	Reference Group
			Inspection interval								
	Pre-operational checks	New vehicle at 4 000 km/ 2,500 miles	Every 10 000 km/ 6000 miles	Every 20 000 km/ 12,000 miles	Every 30 000 km/ 18,000 miles	Every 40 000 km/ 24,000 miles	Every 50 000 km/ 30,000 miles	Every 90 000 km/ 54,000 miles	Every 250 000 km/ 150,000 miles		
Propeller shaft midship bearing							×			Check midship bearing lubrication. Check midship bearing for wear, damage and play.	Gr25
FRONT AND REAR AXLE											
Wheel bearing					×					Check wheel hub bearing for play.	Gr26, 27
Wheel bearing seals					×					Replace wheel hub bearing grease and seals.	Gr26, 27
Wheel and tire	×		×							Check tire inflation pressure. Measure tire tread depth. Visually check tire tread and sidewall for cracks and damage. Check wheels for corrosion, deformation, and cracks.	Gr01
			×							Rotate all tires.	
Wheel nuts		×	×							Check wheel nut torques. After changing a wheel, check at the first 50 to 100 km/30 to 60 miles l.	Gr01
SUSPENSION SYSTEM											
Suspension	×									Check for broken springs. Check the vehicle body for tilt toward either side.	Gr33, 34
U-bolts		×		×						At the first 1,000 km/600 miles, remove and tighten the U-bolt nuts.	Gr33, 34
BRAKING SYSTEM											
Service brake. pedal	×									Check brake pedal free play and stroke.	Gr35A
Service brake. performance	×									Depress the brake pedal and check that the brakes work effectively and evenly on all wheels.	Gr35A
Disc brake			×							Check brake pad and disc.	Gr35A
Parking brake lever stroke	×									Check parking brake lever stroke.	Gr36
Brake system			×							Inspect the brake lines and hoses for signs of leakage. Inspect the brake master and slave cylinders.	Gr35A
STEERING SYSTEM											
Steering wheel free play	×									With the engine running, check the steering wheel free play.	Gr37
Steering wheel. operation	×									While driving slowly, check steering wheel operation.	Gr37

Item	Time of inspection and maintenance									Working procedures	Reference Group
			Inspection interval								
	Pre-operational checks	New vehicle at 4 000 km/ 2,500 miles	Every 10 000 km/ 6000 miles	Every 20 000 km/ 12,000 miles	Every 30 000 km/ 18,000 miles	Every 40 000 km/ 24,000 miles	Every 50 000 km/ 30,000 miles	Every 90 000 km/ 54,000 miles	Every 250 000 km/ 150,000 miles		
Steering system			×							Inspect the steering system for looseness, steering wheel play and operating condition. Check for oil leaks. Check the booster and oil pumps for proper function.	Gr37
CAB											
Defroster operation	×									Make sure that warm air blows properly onto the windshield.	Gr55
Rear view mirror	×									Seated in the driver's seat, adjust the angles for clear views of the sides and rear. Make sure the mirrors are clean.	Gr51
License plate and reflector	×									Check the license plate and reflectors for loose installation, damage, and dirt.	–
Door locks	×									Verify that the door lock operates properly.	Gr43
Seat belts	×									Confirm that the seat belt fastens correctly.	Gr52

Item	Time of inspection and maintenance									Working procedures	Reference Group
			Inspection interval								
	Pre-operational checks	New vehicle at 4 000 km/ 2,500 miles	Every 10 000 km/ 6000 miles	Every 20 000 km/ 12,000 miles	Every 30 000 km/ 18,000 miles	Every 40 000 km/ 24,000 miles	Every 50 000 km/ 30,000 miles	Every 90 000 km/ 54,000 miles	Every 250 000 km/ 150,000 miles		
ELECTRICAL SYSTEM											
Horn operation	×									Check that the horn is working properly.	Gr54
Washer fluid level	×									Check the windshield washer fluid level and add fluid if necessary.	–
Windshield wiper and washer	×									Check the washer for proper fluid spray direction and the wipers for normal operation.	Gr51, 54
Lighting system	×									Make sure that each light works properly. Check lenses for dirt and damage.	Gr54
Instrument cluster	×									Check that all gauges and telltales are working properly.	Gr54

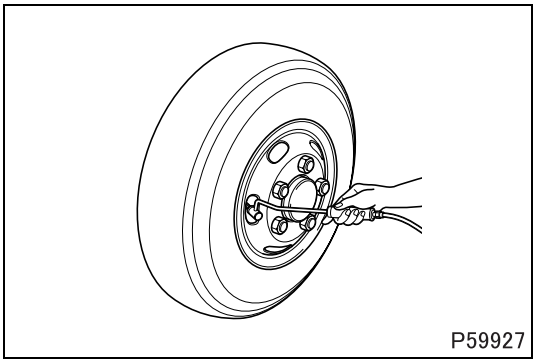
Tire

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
–	Depth of tire tread grooves	–	1.6 {0.063}	Replace

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
–	Wheel nut	490 ± 49 {360 ± 36}	–


P59927

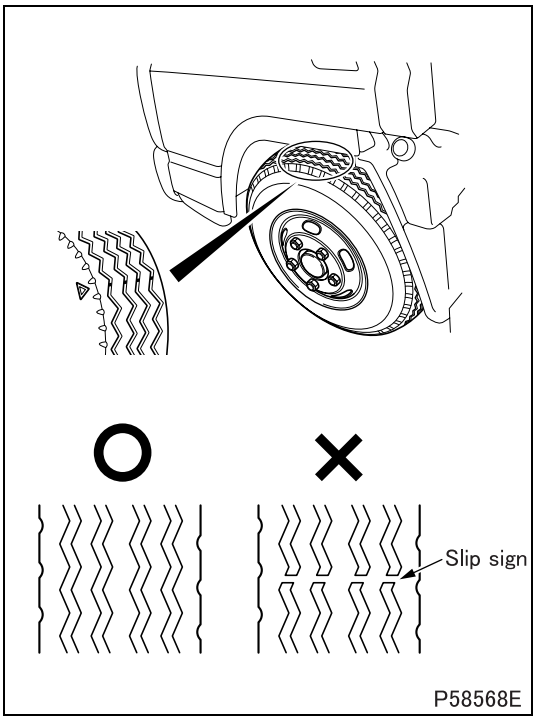
Check inflation pressure

Check air pressure before the vehicle is driven, while the tires are still cool.

Item / Vehicle model	Tire size	Air pressure kPa {psi}
COE 40/45	LT215/85R16-10PR (load range E)	550 {80, 5.5}
COE 50	215/75R17.5 124/123L (load range F)	690 {100, 7.0}

WARNING ⚠

Inflate tires to the standard inflation pressure. Tire underinflation or overinflation will damage wheels and tires and could result in a blowout, causing possible personal injury and property damage.



P58568E

CAUTION ⚠

- **Always install the valve caps after checking or adjusting air pressure. Unless the valve caps are in place, dirt and dust may stick in the valves and cause a flat tire.**

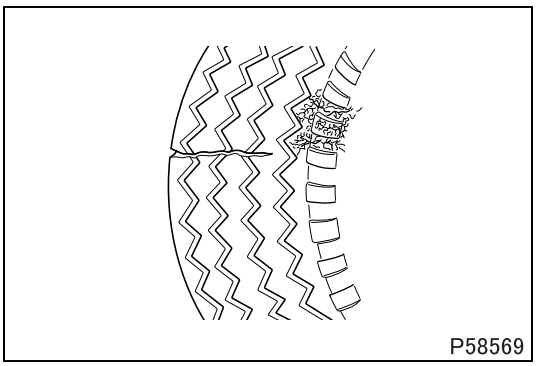
- Make sure the valve cap is securely fitted on each tire.
- It is not necessary to increase tire pressure before high-speed driving.
- On dual wheels, inflate both inner and outer tires to the same pressure.

Check tread depth

- Check all around each tire to make sure the remaining tread is deep enough.
- When the tread wears, slip signs (wear bars) appear across the tire at locations corresponding to the ⧋ marks.

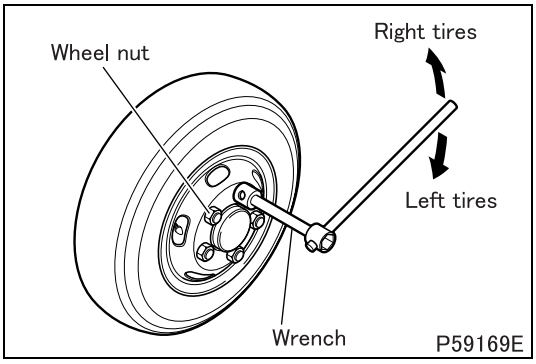
WARNING ⚠

To prevent an injury accident or loss of life, replace worn tires as soon as possible. Worn tires are more susceptible to punctures. They are also more likely to skid and/or hydroplane.


P58569

Check for cracks, damage, and objects embedded in the treads

- Check the tread surface and sidewalls of each tire for cracks, damage, and excessive or unusual wear.
- Check for metal pieces, nails, and stones embedded in the tread or caught between the tires (on dual-wheel axles).



Remove the wheel

- Set the parking brake and chock the front or rear tires, as applicable.
- Position a jack under the front or rear axle jacking point of the vehicle, as applicable. Raise the vehicle high enough to take weight off the wheel, but low enough that the tire still touches the ground.
- Loosen the wheel nuts slightly. The wheel nuts for right tires have right-hand threads "**R**", and the wheel nuts for left tires have left-hand threads "**L**".

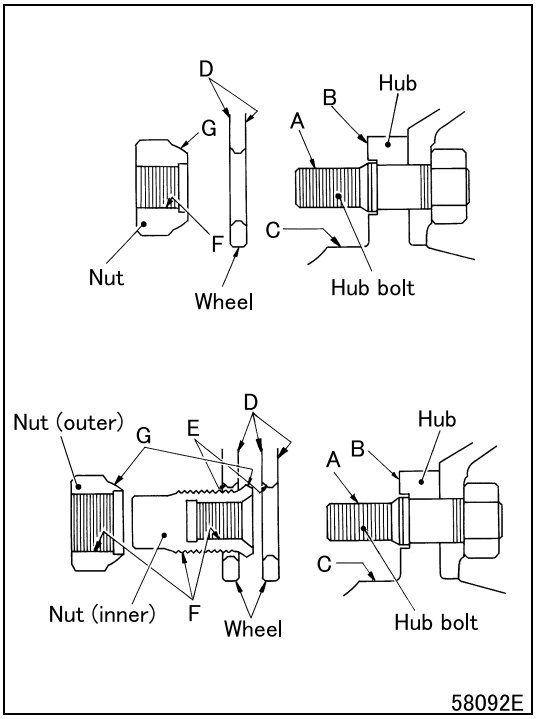
WARNING ⚠

Make certain that the socket is fully seated on the wheel nut. If not, the wrench could slip off the nut and cause a personal injury.

CAUTION ⚠

At this time, do not loosen the wheel nuts too much. You could damage the threads.

- Raise the vehicle until the tire is just clear of the ground. Remove the wheel nuts, and then remove the wheel and tire assembly.
- When working on dual-wheel axles, remove the outside wheel and tire assembly first. Then lower the vehicle and loosen the nuts on the inside tire. After doing this, raise the vehicle again and remove the wheel and tire assembly.



Mounting the wheel

Clean the following areas before mounting the wheel. Dirt or debris in these areas could cause the wheel nuts to become loose during operation.

- **A:** Hub bolt thread area
- **B:** Wheel mounting surface of hub
- **C:** Wheel alignment area of hub
- **D:** Disc wheel mating surface
- **E:** Disc wheel nut mounting surface
- **F:** Wheel nut thread area
- **G:** Wheel nut spherical area

- Even if only the outside tire is to be changed, do not mount it until the inner wheel nuts have been fastened at the specified torque.
- When installing dual wheels, make sure that the air valve on the inner tire is not lined up with the air valve on the outer tire.

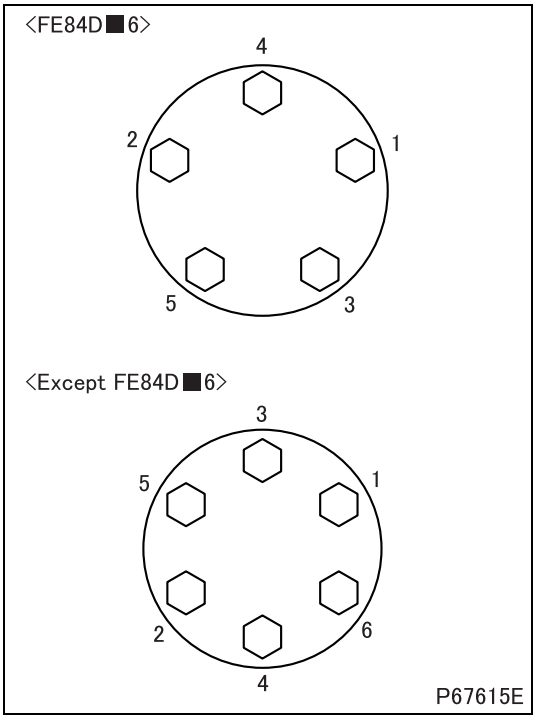
WARNING ⚠

If wheel studs or nut threads are damaged, or the disc wheel is cracked or otherwise damaged, replace the wheel. A damaged wheel could work loose and cause an injury accident.

CAUTION ⚠

Check hub bolt threads carefully for damage before putting the tire on.

- Mount the wheel on the hub. Install the wheel nuts tight enough to hold the wheel in position.
- If the wheel nut has a spherical end, direct the spherical end toward the wheel. Center the nuts on the wheel studs.
- Lower the vehicle until the tire makes contact with the ground.



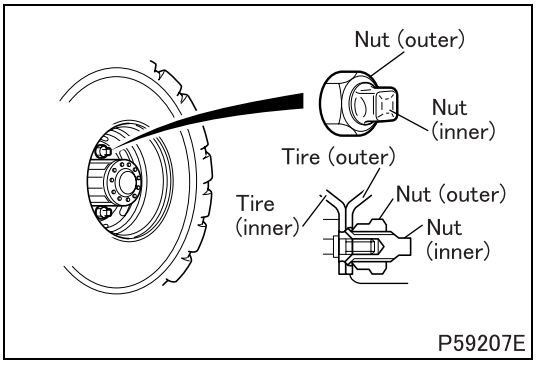
- Tighten the nuts in the order as illustrated, tightening each nut two or three times. To finish, tighten each nut at the specified torque.

WARNING ⚠

- **Tighten all wheel nuts to the required torque value. When replacing the outer wheel in a dual-wheel set, be sure to tighten the inner wheel nuts before tightening the outer wheel nuts. If the nuts are not tight, the wheel may work loose and cause an injury accident.**

CAUTION ⚠

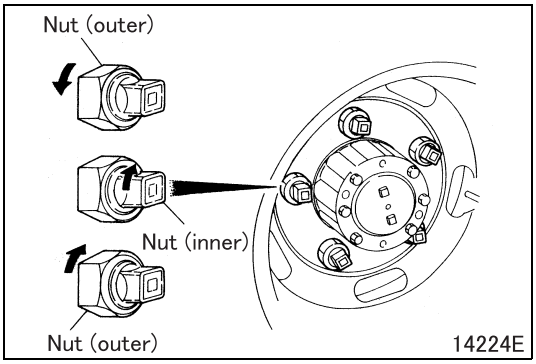
- **Do not coat the threads of the wheel nuts with grease. If the wheel nuts are over-tightened, they could be damaged.**



- On dual rear wheels, mount the outer wheel as described below.
  - When finished mounting the inner wheel and fully tightening the inner wheel nuts, raise the vehicle on the jack again.
  - Mount the outer wheel on the wheel hub, then tighten the wheel nuts to hold the wheel in position.
  - Tighten the wheel nuts in three stages, ending with the final torque shown in the table. Use the tightening sequence shown in the illustration.

Check the wheel nuts

The wheel nuts should be checked for looseness every 10 000 km (6000 miles). All nuts should be tightened to the specified torque value.



- On dual-wheel assemblies, check the wheel nuts as follows:

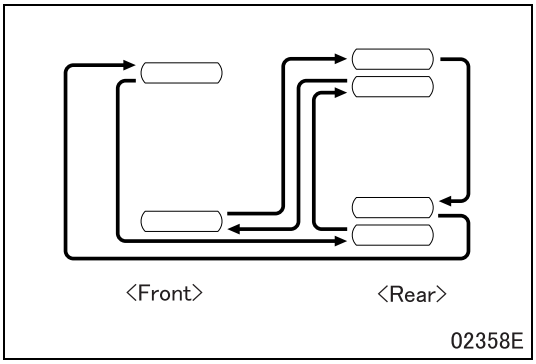
(1) Loosen the outer wheel nuts.
(2) Tighten the inner wheel nuts to the specified torque.
(3) Tighten the outer wheel nuts to the specified torque.

CAUTION ⚠

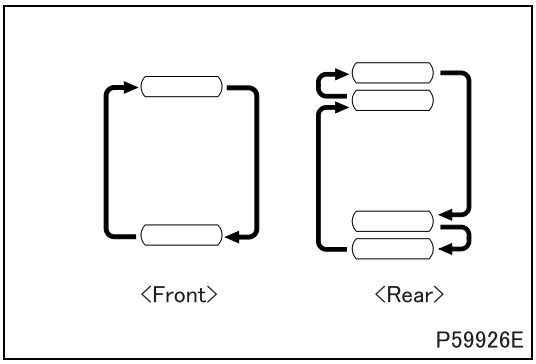
If the outer wheel nuts are tightened without first being loosened, it might not be possible to tighten them to the specified torque.

Tire rotation

The amount of wear on a tire depends on its position on the vehicle. To equalize wear and extend life as much as possible, rotate the tires every 10 000 km (6000 miles) in the rotation order shown below:



- When the tread pattern for all tires is identical:



- When the tread patterns are different for the front and rear tires:

NOTE

- *If using different tread patterns on the front and rear wheels, select tires with a ribbed tread for the front wheels and tires with a traction-type tread for the rear wheels.*

WARNING ⚠

- **After a wheel has been replaced, the wheel nuts will loosen somewhat as they wear in, creating a potential for an injury accident. Tighten the wheel nuts again after the vehicle has been driven 50 to 100 km (30 to 60 miles).**
- **Be sure to use tires of the approved type. Mixing bias-ply and radial tires on the same vehicle results in impaired steering and could cause an injury accident or loss of life.**

M E M O

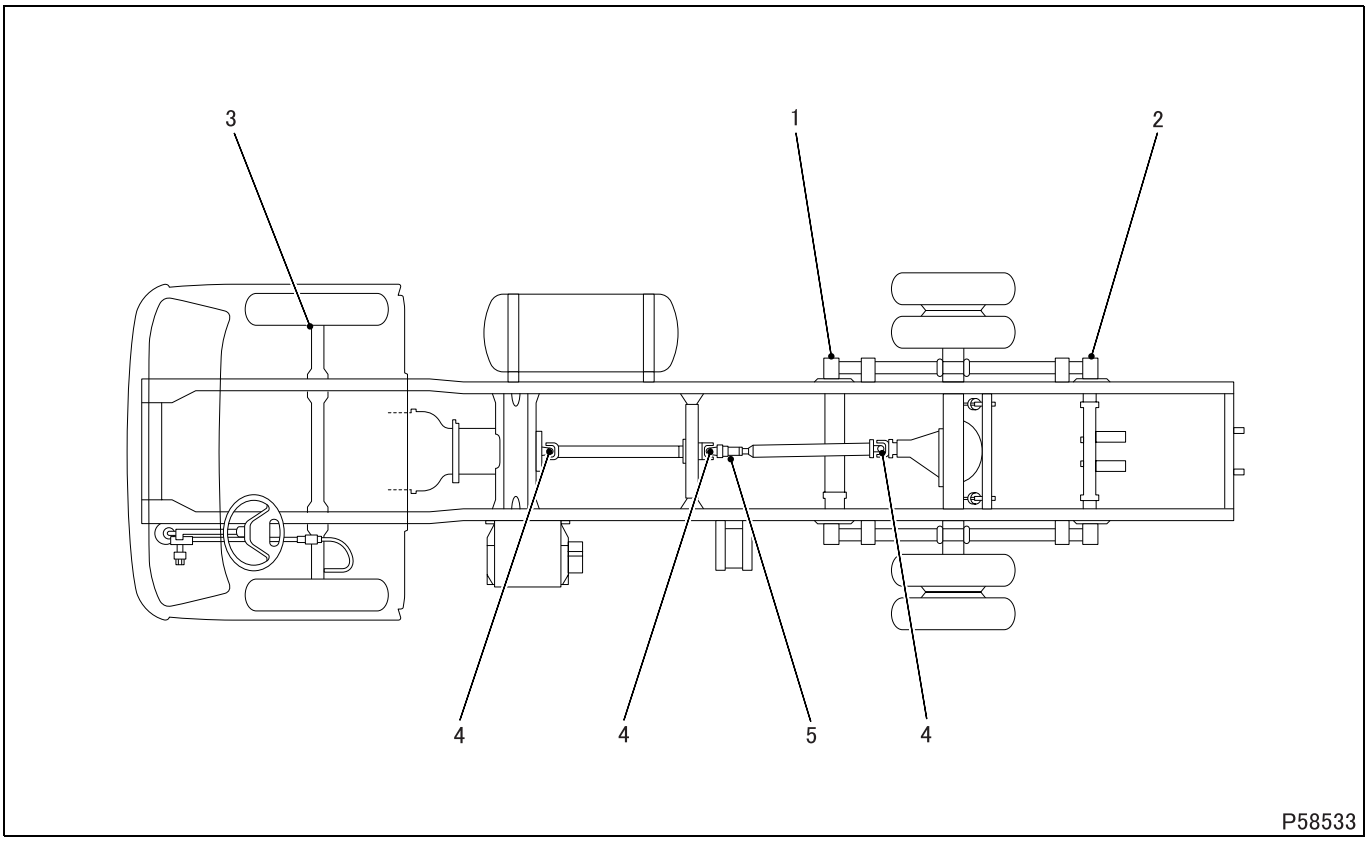
LUBRICATION TABLES

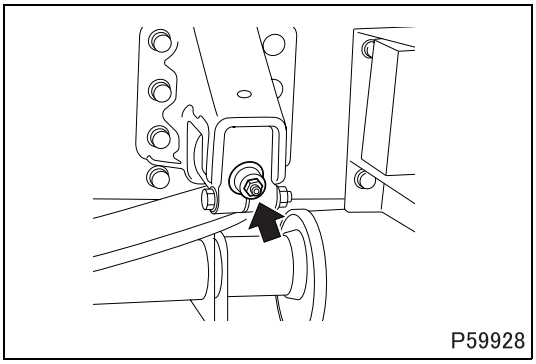
Ⓔ: Exhaust emission items.

Items	Time of inspection and maintenance							Lubricant specifications	Reference Gr
	Pre-operational checks	New vehicle at 4 000 km/ 2500 miles	Inspection interval: Every 10 000 km/ 6000 miles	Every 20 000 km/ 12,000 miles	Every 30 000 km/ 18,000 miles	Every 40 000 km/ 24,000 miles	Every 50 000 km/ 30,000 miles		
Ⓔ Engine oil level check	×							Engine oil API classification, CD, CD/SF, CE, CE/SF or CF-4 or JASO classification DH-1 Over 30°C {86°F} SAE 40 40 to –5°C {104 to 23°F} SAE 30 15 to –15°C {59 to 5°F} SAE 20W-20 Over –15°C {5°F} SAE 15W-40 Below 0°C {32°F} SAE 10W-30	Gr12
Ⓔ Engine oil change		×	×						
Manual transmission oil level			×					Gear oil API classification GL-3 SAE 80 (temperate climate) GL-3 SAE 90 (warm climate) GL-4 SAE 90 (tropical climate) Use engine oil when operating vehicle for long periods at high speeds API classification CC SAE 30 or SAE 40	Gr22
Manual transmission oil change		×			×				
Automatic transmission fluid (ATF) level check			×					Mobil ATF3309 manufactured by Exxon Mobil	Gr23
ATF change						×			
Rear axle oil level check			×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more <Limited-slip differential only> Limited-slip differential oil API classification GL-5 SAE 90	Gr27
Rear axle oil change		×			×				
Hub bearing lubrication					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26, 27
Brake fluid level check	×							Brake fluid <SAE J1703f or FMVSS No. 116 DOT3>	Gr35A
Brake fluid change							×		
Power steering fluid level check			×					Automatic transmission fluid <DEXRON, DEXRON II or DEXRON III>	Gr37
Power steering fluid change							×		
Lubrication of propeller shaft: Midship bearing							×	Bearing grease [NLGI No. 3 (Li soap)]	Gr25
Lubrication of propeller shaft: Universal joint, slip joint			×					Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr11
Rear suspension spring pin lubrication			×					Chassis grease [NLGI No. 1 (Li soap)]	Gr11.
King pin bearing lubrication			×					Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr11
Door hinge lubrication			×					Chassis grease [NLGI No. 1 (Li soap)]	Gr43
Anchor hook lubrication			×					Chassis grease [NLGI No. 1 (Li soap)]	Gr42

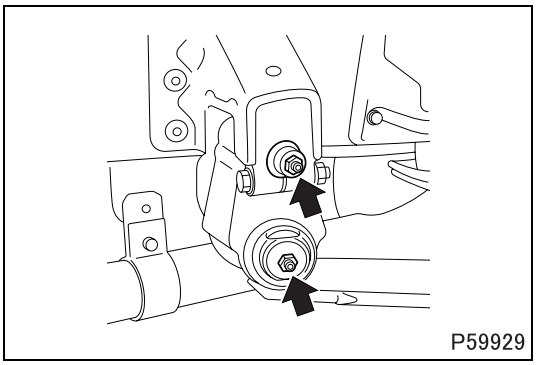
Chassis lubrication

Remove all dust and dirt from the grease fittings. Always use the recommended grease. The areas requiring grease are shown in the following illustration.

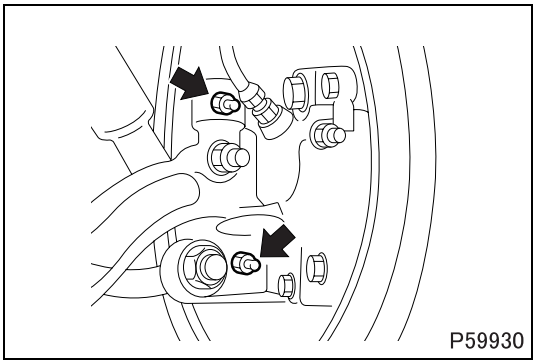




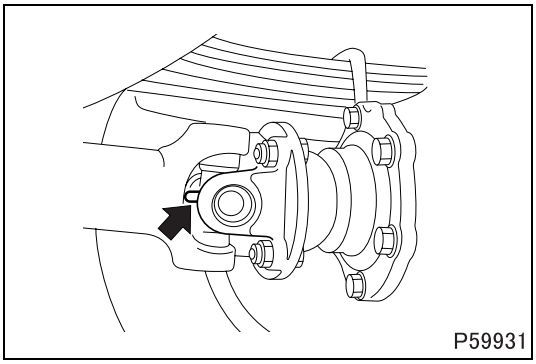
1. Rear spring pin, forward (2 points total, one on each side)



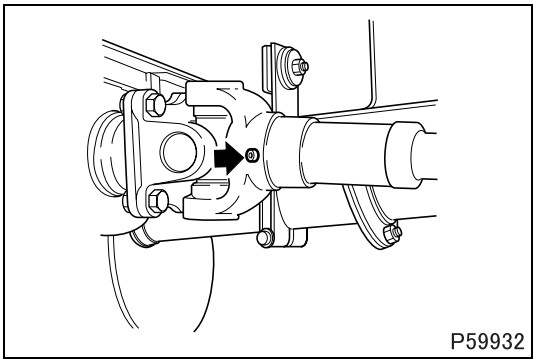
2. Rear spring pin, aft (4 points total, two on each side)



3. King pin bearing (4 points total, two on each side)



4. Propeller shaft (driveshaft) universal joint



5. Propeller shaft (driveshaft) slip joint

Group 11 INDEX

SPECIFICATIONS 11-2

STRUCTURE AND OPERATION
1. Exploded View 11-3
2. Cylinder Head, Cylinder Head Gasket, Camshaft, and Camshaft Frame 11-4
3. Valve Mechanism 11-5
4. Connecting Rod 11-6
5. Piston 11-6
6. Timing Gears 11-7
7. Flywheel 11-7
8. Balance Shafts 11-8
9. Crankcase and Main Bearings 11-9
10. Oil Seals 11-11

TROUBLESHOOTING 11-12

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Measuring Compression Pressure 11-14
2. Inspection and Adjustment of Valve Clearances 11-16

ENGINE REMOVAL AND INSTALLATION 11-20

ROCKER COVER 11-24

ROCKERS AND CAMSHAFTS 11-26

CYLINDER HEAD AND VALVE MECHANISM 11-36

PISTONS, CONNECTING ROD AND CYLINDER LINERS 11-50

FLYWHEEL 11-62

FRONT CASE 11-66

TIMING GEARS AND BALANCE SHAFTS 11-72

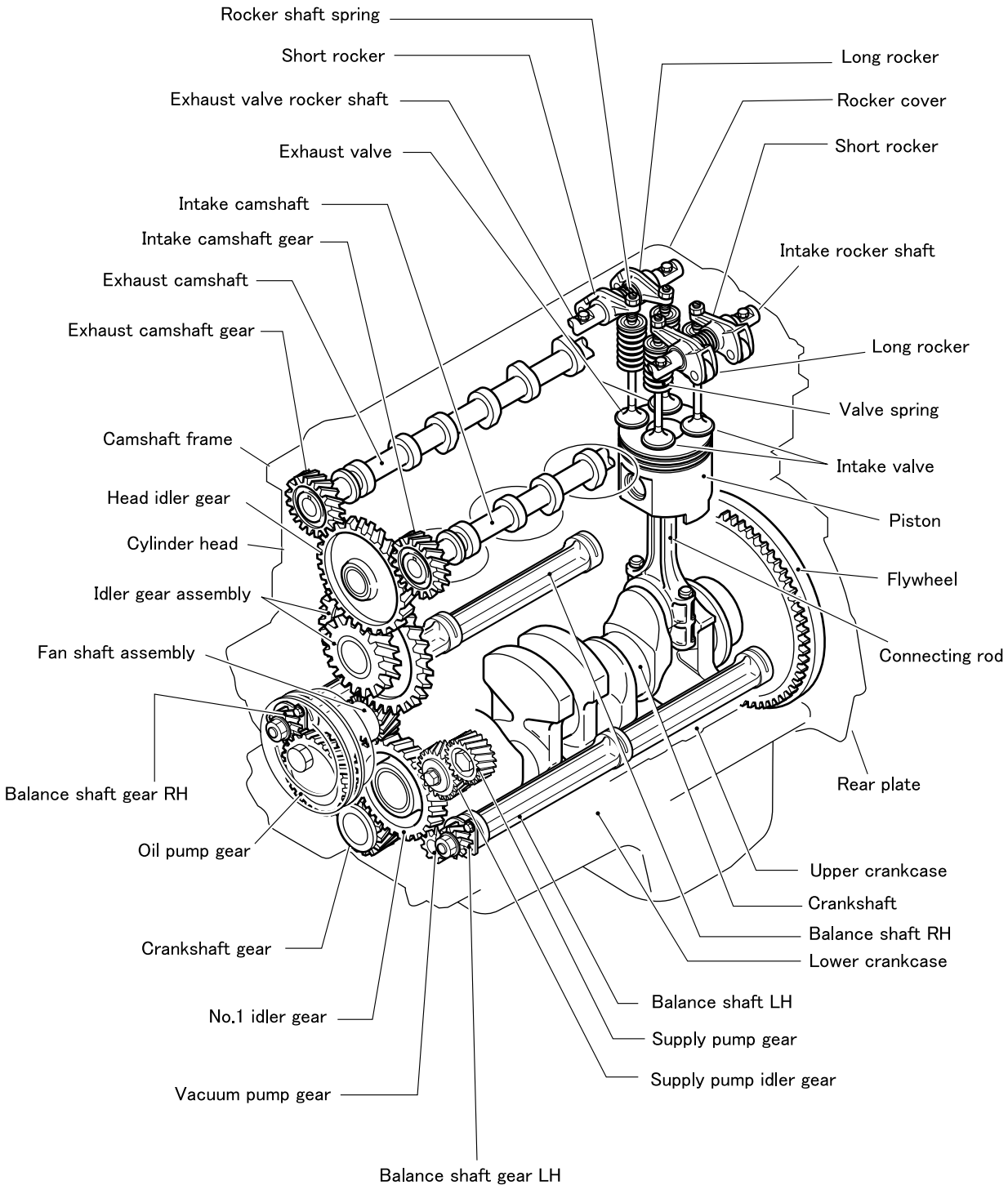
CRANKSHAFT AND CRANKCASE 11-80

BALANCE SHAFT BUSHINGS 11-88

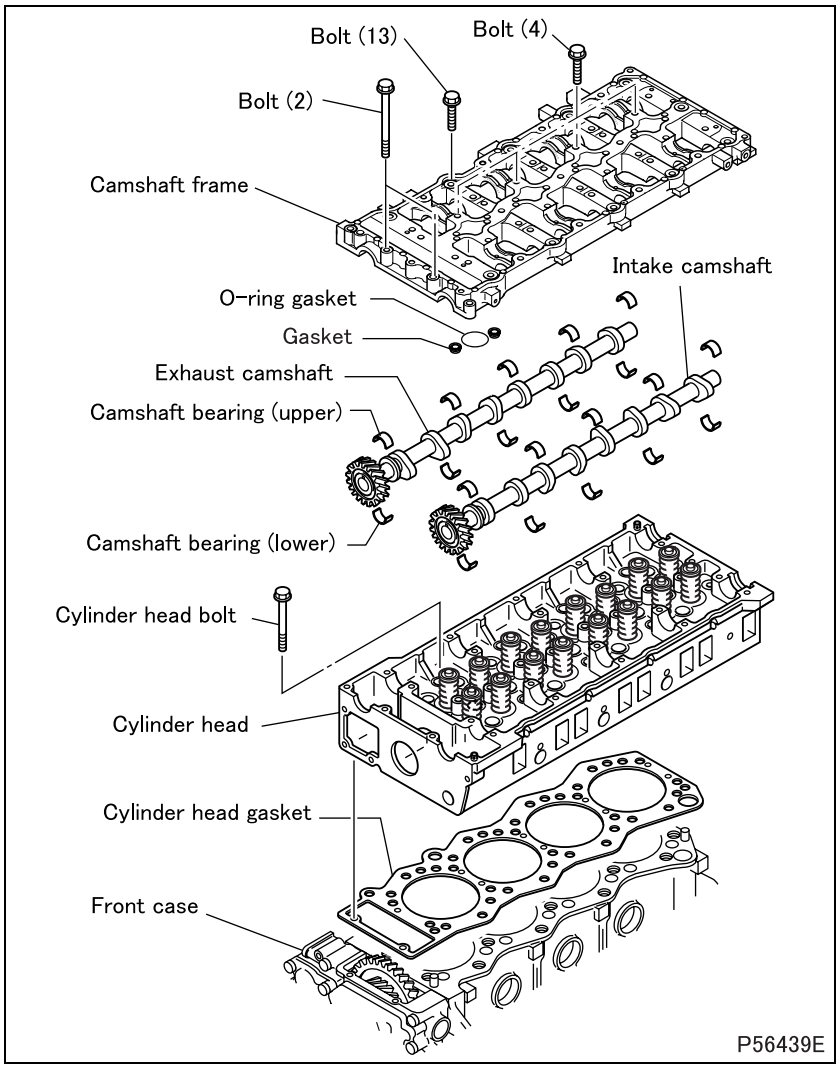
SPECIFICATIONS

Item		Specifications	
Engine model		4M50T7	4M50T8
Type		4-cylinder, in-line, water-cooled, 4-cycle diesel engine	
Combustion chamber		Direct injection type	
Valve mechanism		Double overhead camshaft (DOHC)	
Maximum output	HP / rpm	147 / 2700	175 / 2700
Maximum torque	ft.lbf / rpm	347 / 1600	391 / 1600
Bore × stroke	mm {in.}	ϕ114 × 120 {ϕ4.49 × 4.72}	
Total displacement	L {qts}	4.899 {4899}	
Compression ratio		17.5	

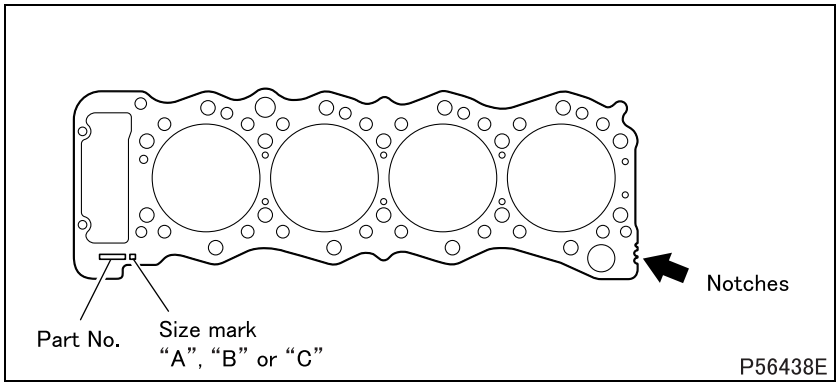
1. Exploded View



2. Cylinder Head, Cylinder Head Gasket, Camshaft, and Camshaft Frame



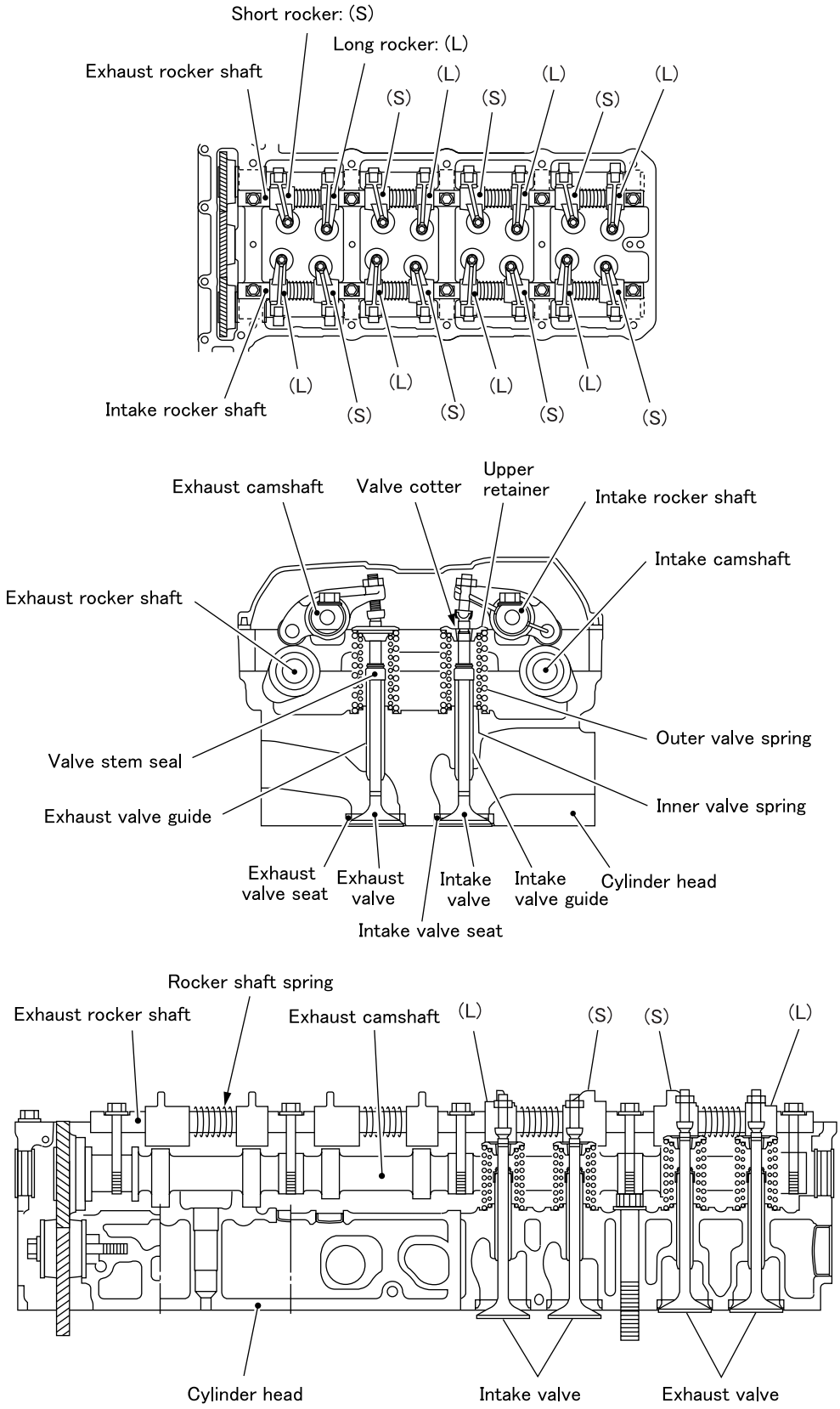
- The camshaft is supported at its journals from below by the cylinder head and retained from above by the camshaft frame.
- The upper and lower camshaft bearings are identical, but cannot be interchanged when they are reinstalled.
- The exhaust camshaft and the intake camshaft have identical gears but different cams.
- The thirteen shortest bolts and four shorter bolts fasten the camshaft frame onto the cylinder head.
- The two long bolts fasten the camshaft frame to the front case.



2.1 Cylinder head gasket

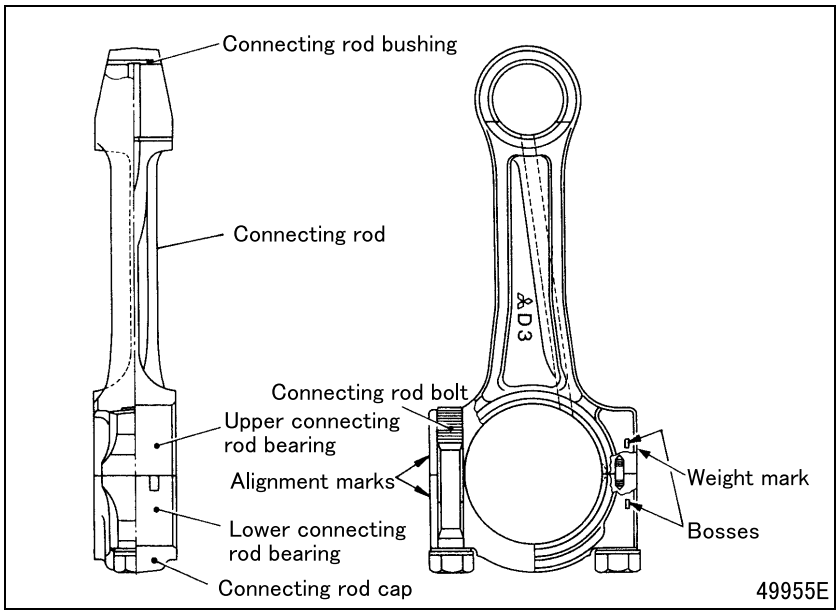
- Select and use a cylinder head gasket of a thickness that can accommodate the piston projection.
- The size (thickness) class of the gasket can be identified by the shape of the notches and size mark cut on the edge of each gasket.

3. Valve Mechanism



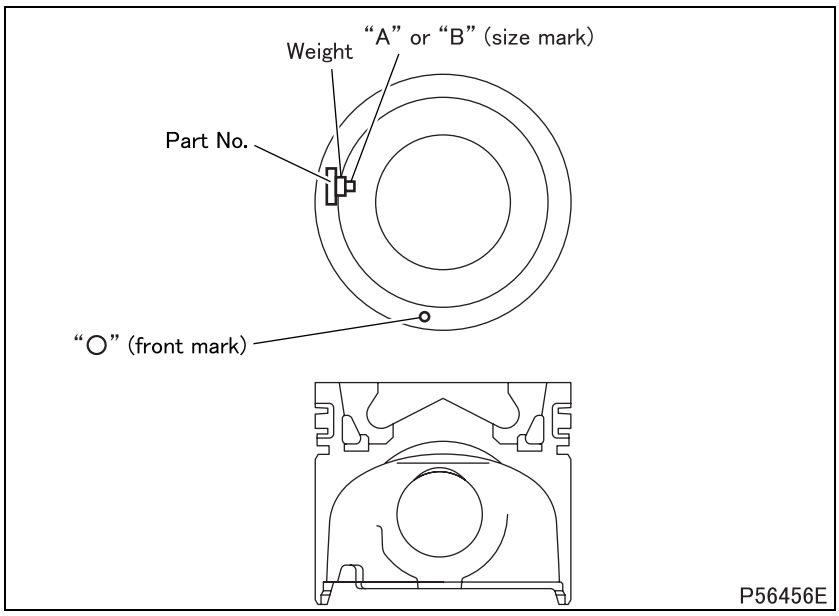
- The short rockers and the long rockers are installed differently, as shown in the illustration.
- Each valve has an inner valve spring and an outer valve spring.

4. Connecting Rod



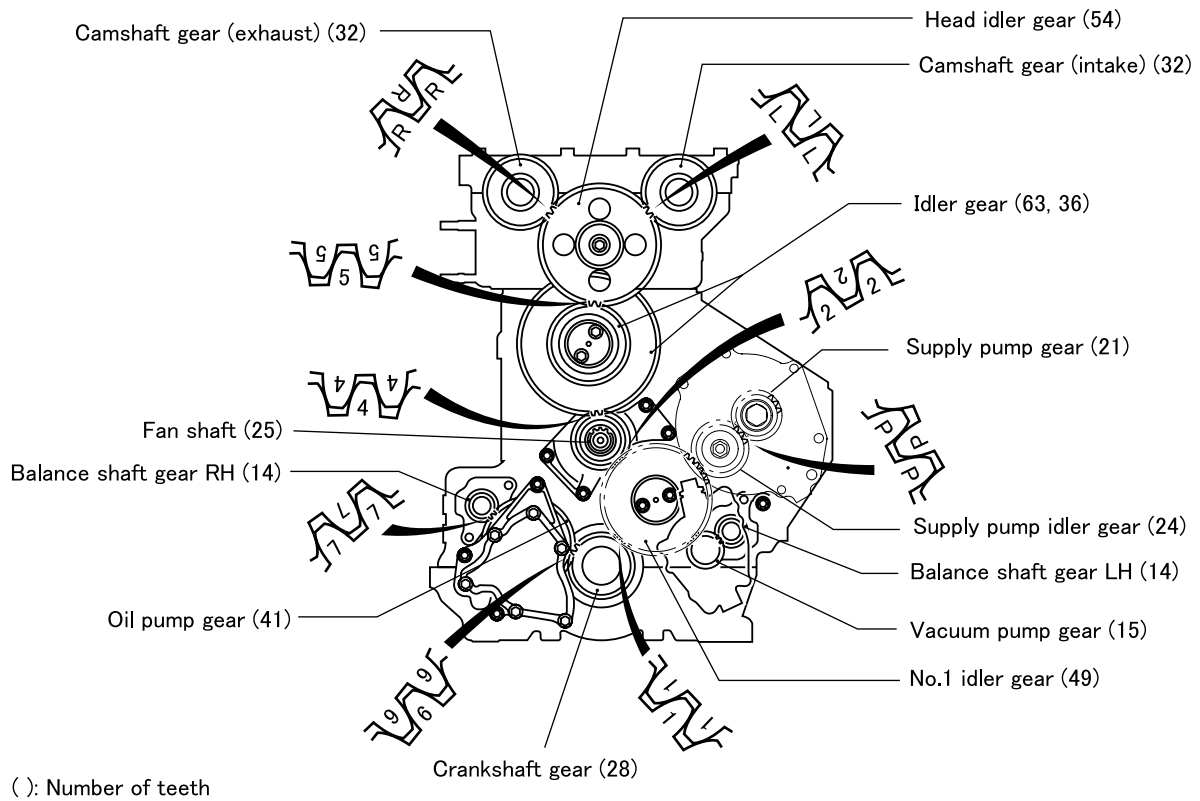
Weight mark:
"C" to **"G"**
(with **"G"** as the maximum)

5. Piston



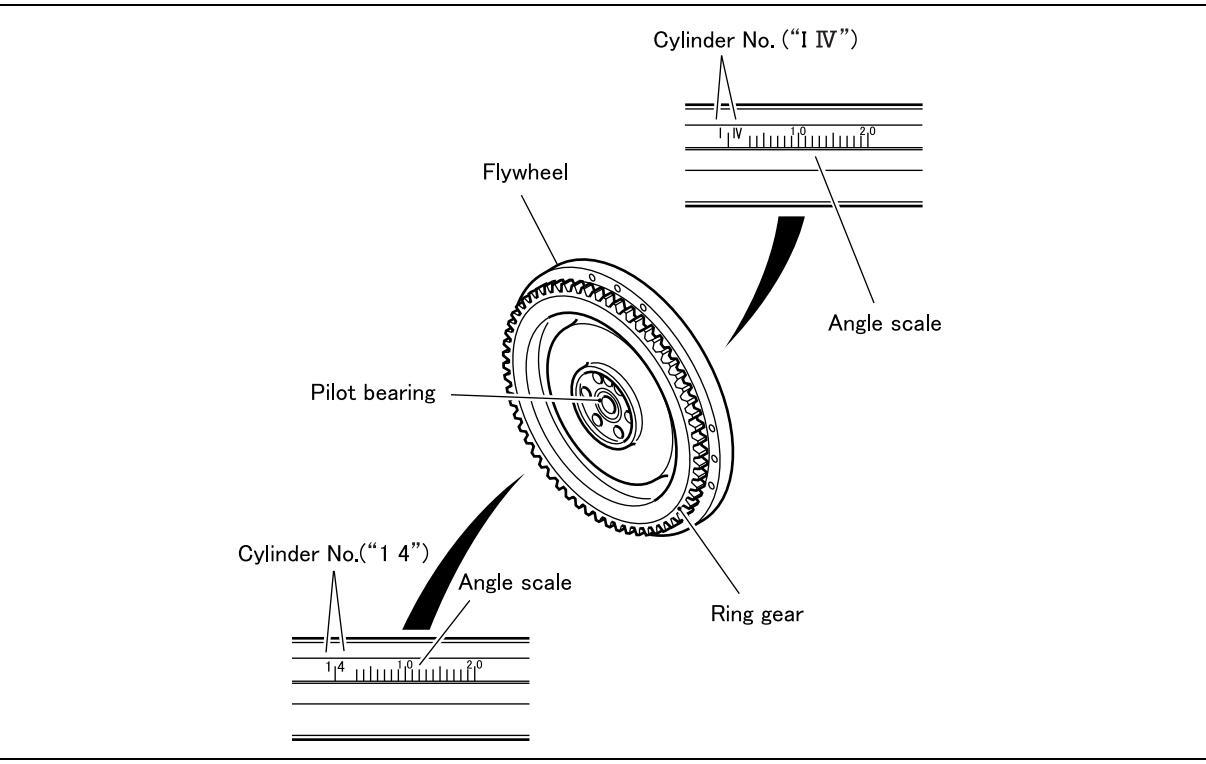
- Each piston must be mated with a cylinder in the upper crankcase that has the same size mark as the piston. The pistons are marked with either **"A"** or **"B"**, where **"B"** stands for the larger and **"A"** for the smaller of the two available diameters.
- The pistons have been made lightweight by use of a special aluminum alloy, as well as by the reduction of their height.

6. Timing Gears

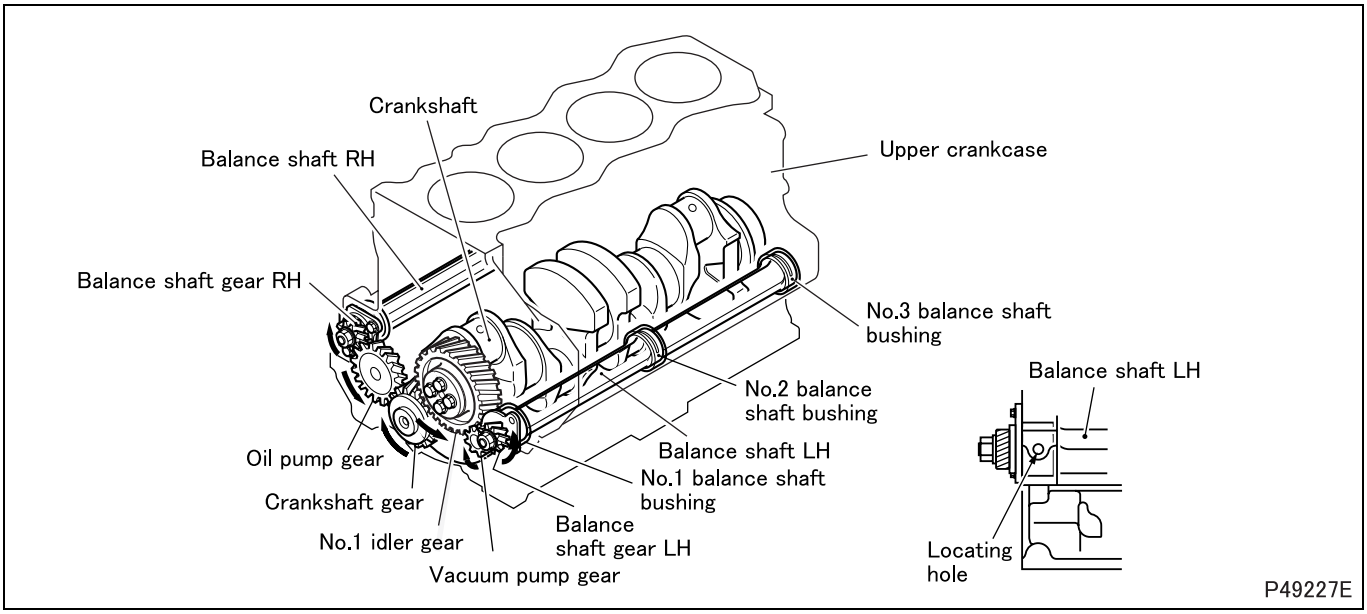


- All gears, except the vacuum pump gear, each has timing mark(s) to ensure correct engagement during assembly.

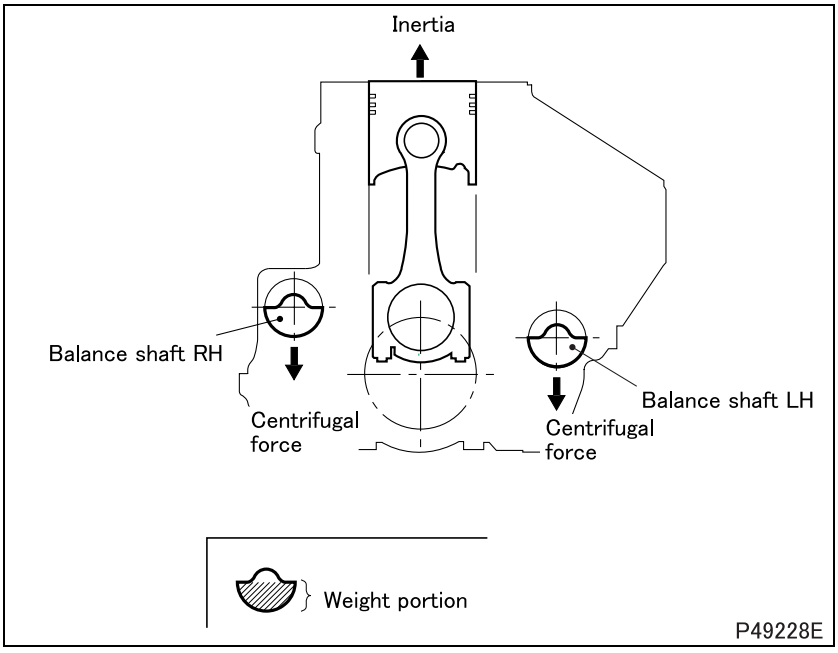
7. Flywheel



8. Balance Shafts



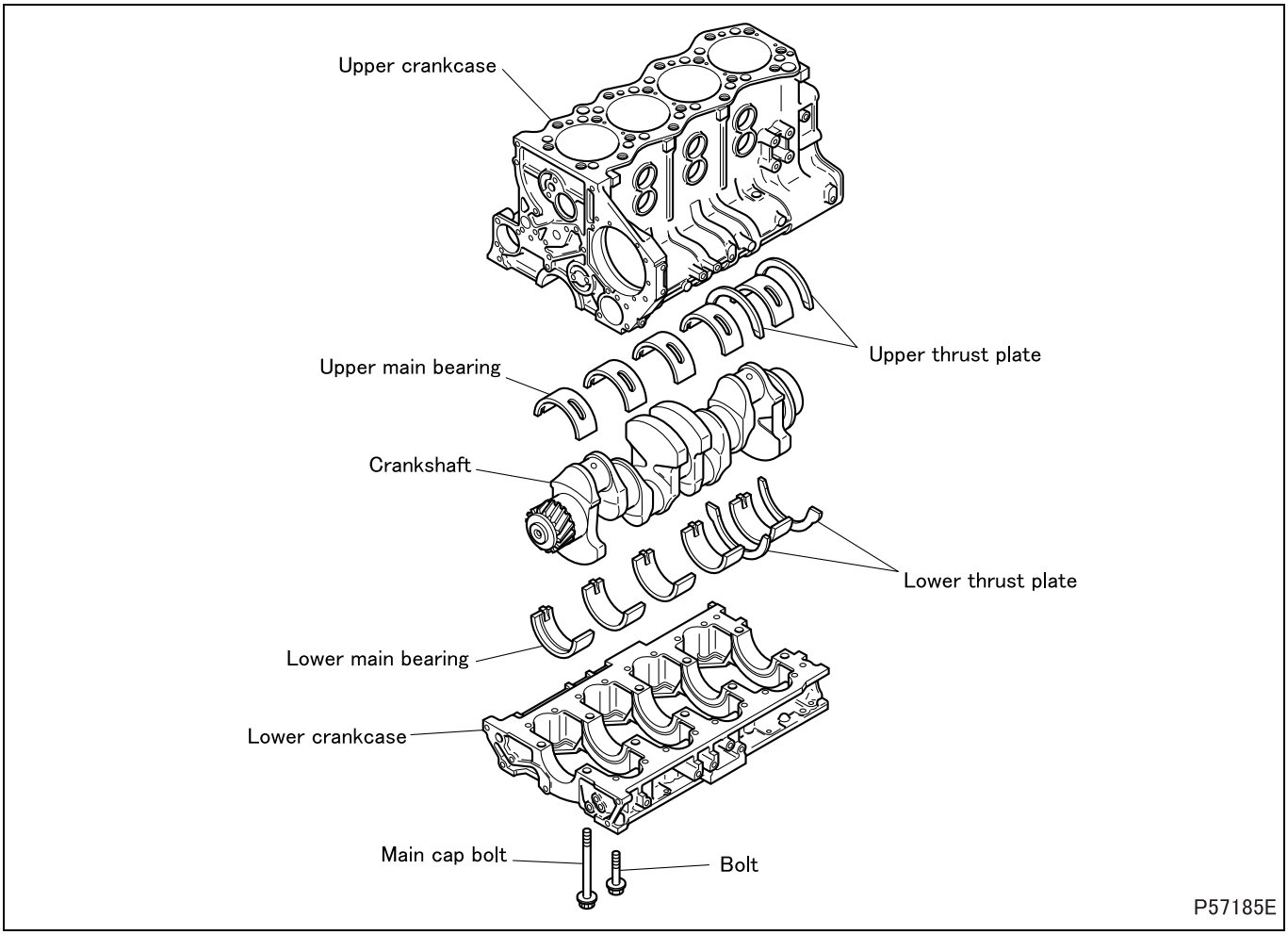
- The balance shaft RH and balance shaft LH are mounted in the upper crankcase on the right and left sides of the crankshaft. The balance shafts reduce the vibration of the engine caused by the rotation of the crankshaft.
- The balance shaft RH and balance shaft LH are both driven by timing gears. Each balance shaft is held in the upper crankcase by way of three balance shaft bushings.
- The balance shaft LH has a locating hole to enable correct installation.

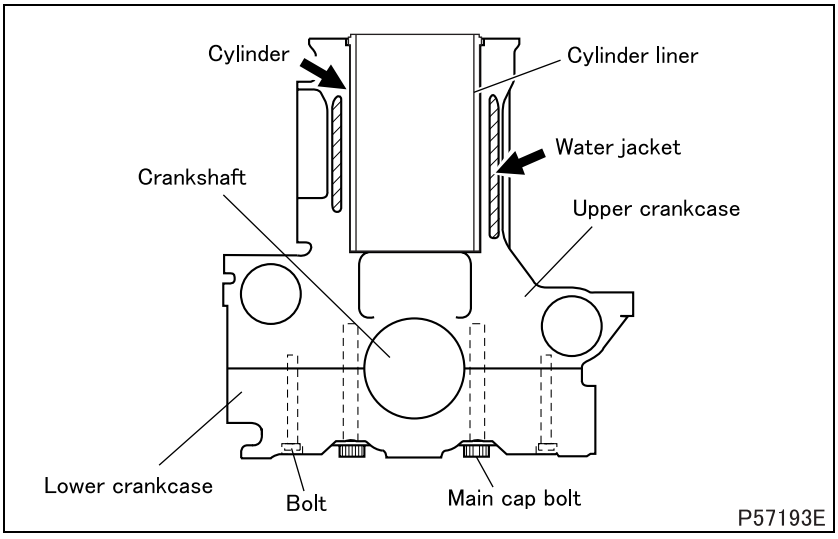


8.1 Reduction of vertical vibration (secondary vibration element)

- When the piston moves up and down, vertical vibrations are generated at the top dead center (TDC) and bottom dead center (BDC) due to inertia.
- The balance shaft LH and the balance shaft RH rotate so that their weight portions are at the bottom positions when a piston is at TDC and at the top positions when the piston is at BDC, i.e., the weight portions are always on the opposite side to the piston head.
- This creates centrifugal forces in the balance shaft RH and balance shaft LH, the total of which is equal in amount to the inertia force that the piston creates when it is at TDC or BDC. These centrifugal forces in the balance shafts cancel out the inertia forces resulting from piston's movements and reduce the amount of vertical vibration.
- The balance shafts also reduce the moment created around the crankshaft (which constitutes secondary vibration elements) when the engine is running in the middle-to-high speed range.

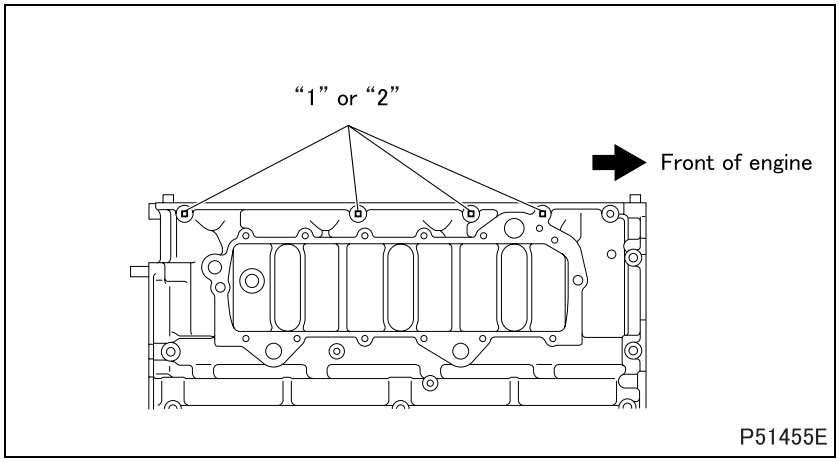
9. Crankcase and Main Bearings



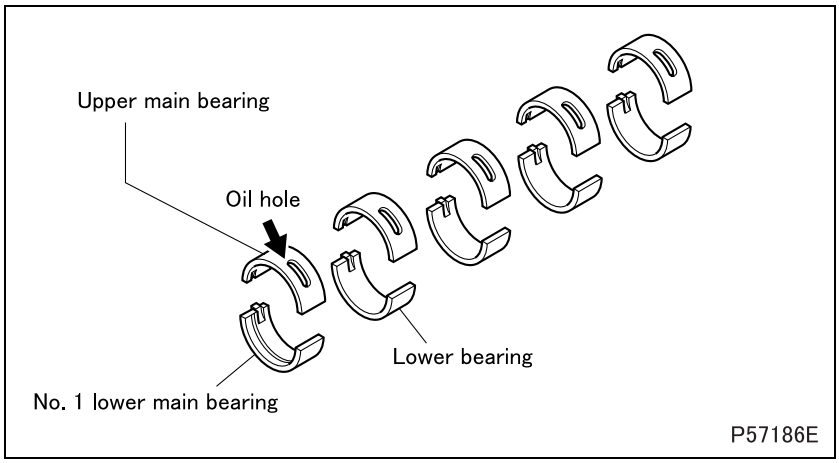


9.1 Crankcase

- The crankcase is a two-piece type consisting of an upper crankcase and a lower crankcase, which hold the crankshaft in between.
- Cylinder liners are inserted into the cylinder bores in the upper crankcase.
- An water jacket is formed in the walls of these cylinders to cool them down.
- The main cap bolts and the bolts that fasten the upper and lower crankcases together are tightened using a special method.

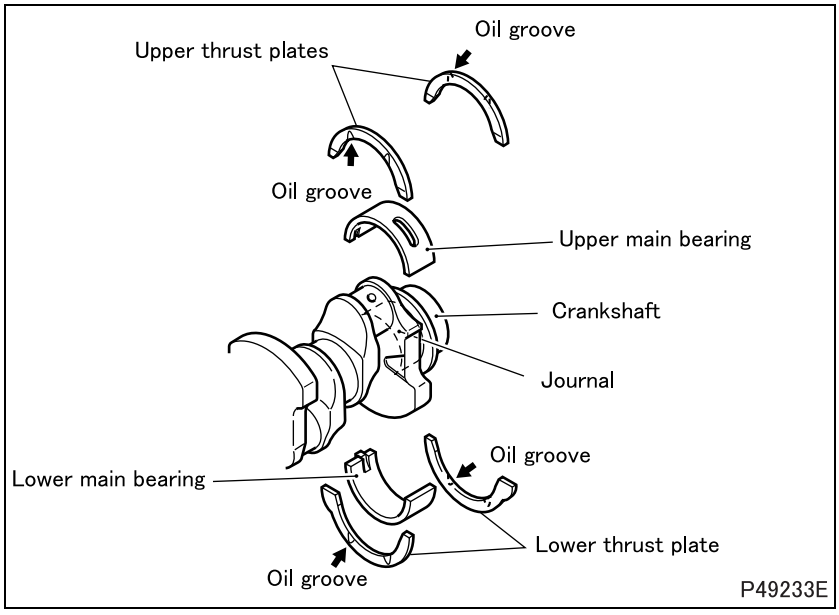


- The upper crankcase is marked with a size mark (**"1"** or **"2"**) to be used as a reference in selecting cylinder liners.
- The first to forth size marks from the front of the engine correspond to the No. 1 to No. 4 cylinders.



9.2 Main bearing

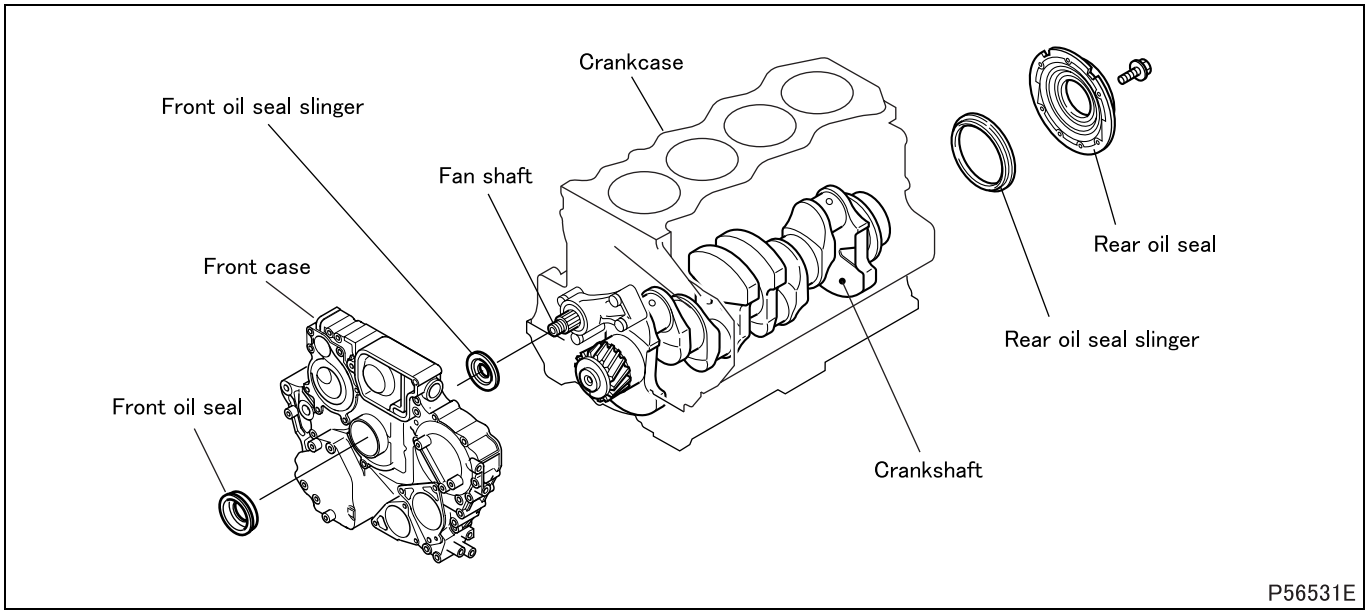
- The upper main bearings have oil holes through which engine oil is supplied to the crankshaft journals.
- An oil groove is provided in the No. 1 lower bearing.

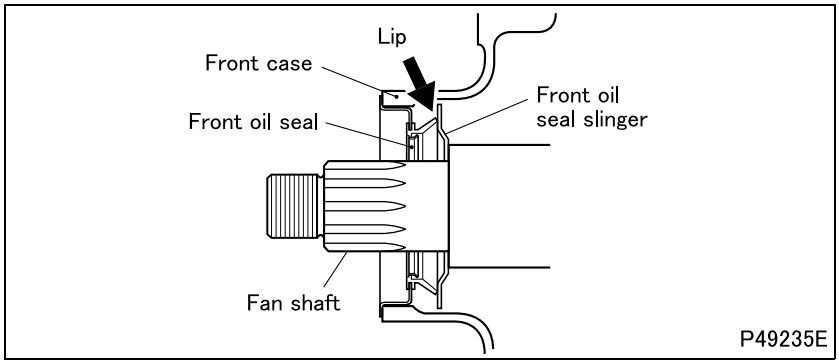


9.3 Thrust plates

- Two upper and lower thrust plate pairs are installed on both sides of the upper and lower main bearings at the rearmost journal of the crankshaft.
- Select the thrust plates of a thickness that can accommodate the crankshaft end play. The thrust plates each have two oil grooves, which assures their minimum friction against the crankshaft journal.

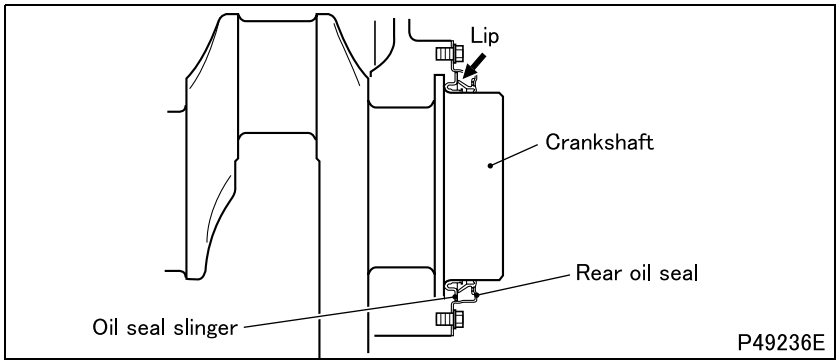
10. Oil Seals





10.1Front oil seal

- The front oil seal is fitted in the front case and prevents oil from leaking by contact of its lip with the front oil seal slinger.
- The front oil seal slinger is press-fitted onto the fan shaft.



10.2Rear oil seal

- The rear oil seal is fitted in the crankcase assembly and prevents oil from leaking by contact of its lip with the rear oil seal slinger.
- The rear oil seal slinger is press-fitted onto the rear end of the crankshaft.

Possible causes / Symptoms		Low power output	Abnormal engine noise	Reference Gr
Cylinder head and valve mechanism	Incorrect valve clearance	O	O	
	Defective cylinder head gasket	O	O	
	Worn valve and valve seat; carbon deposits	O	O	
	Weakened valve spring	O	O	
	Defective rocker shaft and camshaft frame		O	
	Poor lubrication of rocker shaft and camshaft frame		O	
Timing gears	Incorrect backlash in timing gears		O	
	Poor lubrication of timing gears and idler shaft		O	
Camshaft	Excessive end play in camshaft		O	
	Worn camshaft		O	
Pistons and connecting rods	Worn/damaged piston ring groove(s)	O	O	
	Worn/damaged piston ring(s)	O	O	
	Worn piston pin and connecting rod small end		O	
Crankshaft	Excessive end play in crankshaft		O	
	Incorrectly fitted crankshaft		O	
	Worn/damaged crankshaft pins and connecting rod bearings		O	
	Worn/damaged crankshaft journals and main bearings		O	
Fuel system	Defective supply pump	O	O	Gr13E
	Faulty fuel spray from injector	O	O	Gr13A
	Air trapped in fuel system	O		
Cooling system	Malfunctioning cooling system components	O		Gr14
	Loose/damaged V-belts		O	
Intake and exhaust system	Clogged air cleaner	O	O	Gr15
	Clogged muffler	O	O	
Incorrect oil viscosity		O		Gr12
Improper fuel		O		
Incorrectly fitted piping and hoses			O	
Defective/incorrectly fitted alternator and other auxiliaries			O	

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Measuring Compression Pressure

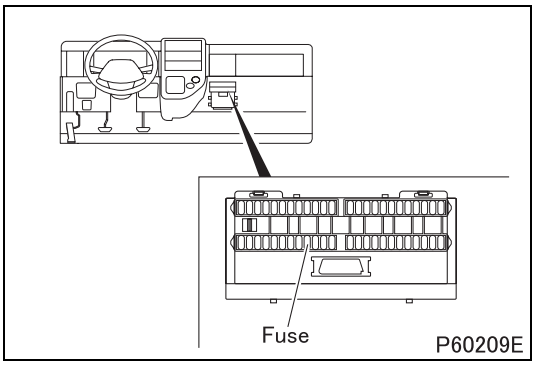
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Compression pressure	Each cylinder (at 200 rpm)	2550 kPa {370 psi, 26 kgf/cm^2}	1960 kPa {285 psi, 20 kgf/cm^2}	Inspect
		Cylinder-to-cylinder pressure difference	–	390 kPa {57 psi, 4 kgf/cm^2} or less	Inspect

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ca	Compression gauge adapter f580413	MH063434	Measuring compression pressure

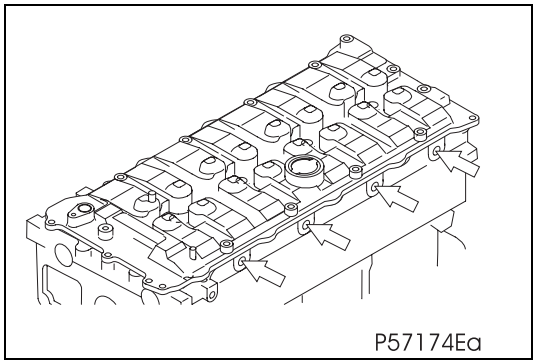
- A drop in compression pressure can be used as a guide to determine when the engine should be overhauled.
- Measure the compression pressure at regular intervals. Keeping track of its transitions can provide a useful tool for troubleshooting. On new vehicles and vehicles with newly replaced parts, the compression pressure will be somewhat higher depending on the break-in condition of piston rings, valve seats, etc., but this will return to normal as the parts wear down.
- Before the compression measurement, confirm that the engine oil, starter, and battery are in normal condition.
- Place the vehicle in the following conditions.
  - Warm up the engine until the coolant temperature reaches approximately 75 to 85°C {167 to 185°F}.
  - Turn off the lights and auxiliaries.
  - Place the transmission in neutral (in the parking range P for automatic transmissions).
  - Place the steering wheel in the straight-ahead position.



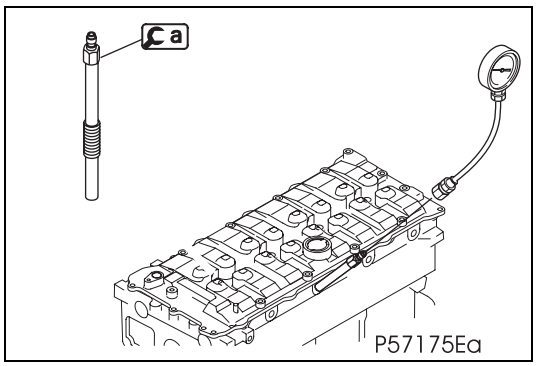
- Remove the fuse (M9) to prevent fuel from being injected when the engine is cranked by the starter.

CAUTION ⚠

- **When cranking the engine, never shut off the power to the engine ECU by disconnecting the engine ECU connector or the like.**
- **If the engine is cranked while shutting off the power to the engine ECU, the ECU cannot control the supply pump and this may cause failure to the pump.**



- Disconnect the glow plug connecting plate and remove all the glow plugs.
- Cover the glow plug mounting holes with shop towels. After cranking the engine by the starter, check that no foreign substances are deposited on the shop towels.
- If there are deposits (such as engine oil or coolant) on the shop towels, the following may be the cause:
  - Deposits of engine oil alone can mean a defective piston ring seal; the piston rings must be inspected.
  - Deposits of both engine oil and coolant can mean cracks in the cylinders; the crankcase must be replaced.



WARNING ⚠

- **When coolant and engine oil deposits are evident, cranking the engine could be dangerous as these substances, heated to high temperatures, will blow out from the glow plug mounting holes. Make sure to stay away from the glow plug mounting holes when the engine is being cranked.**

CAUTION ⚠

- **Never cut off the engine electronic control unit power supply when cranking the engine.**

- Install [a] in one of the glow plug mounting holes. Then, connect a compression gauge to [a].
- Crank the engine and measure the compression pressure for all the cylinders one after another. Determine the compression pressure difference between the cylinders.
- If the compression pressure is below the limit or the cylinder-to-cylinder pressure differences are not within the limit, pour a small amount of engine oil into the corresponding glow plug mounting hole and remeasure the compression pressure.
  - If the compression pressure increases, the piston rings and cylinder surfaces may be badly worn or otherwise damaged.
  - If the compression pressure remains unchanged, there may be seizure in the valves, the valves may be incorrectly seated or the cylinder head gasket may be defective.

2. Inspection and Adjustment of Valve Clearances

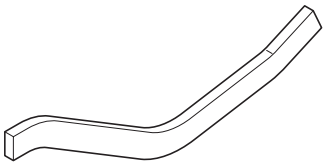
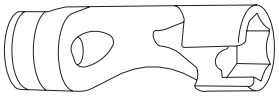
Service standards (Unit: mm {in.})

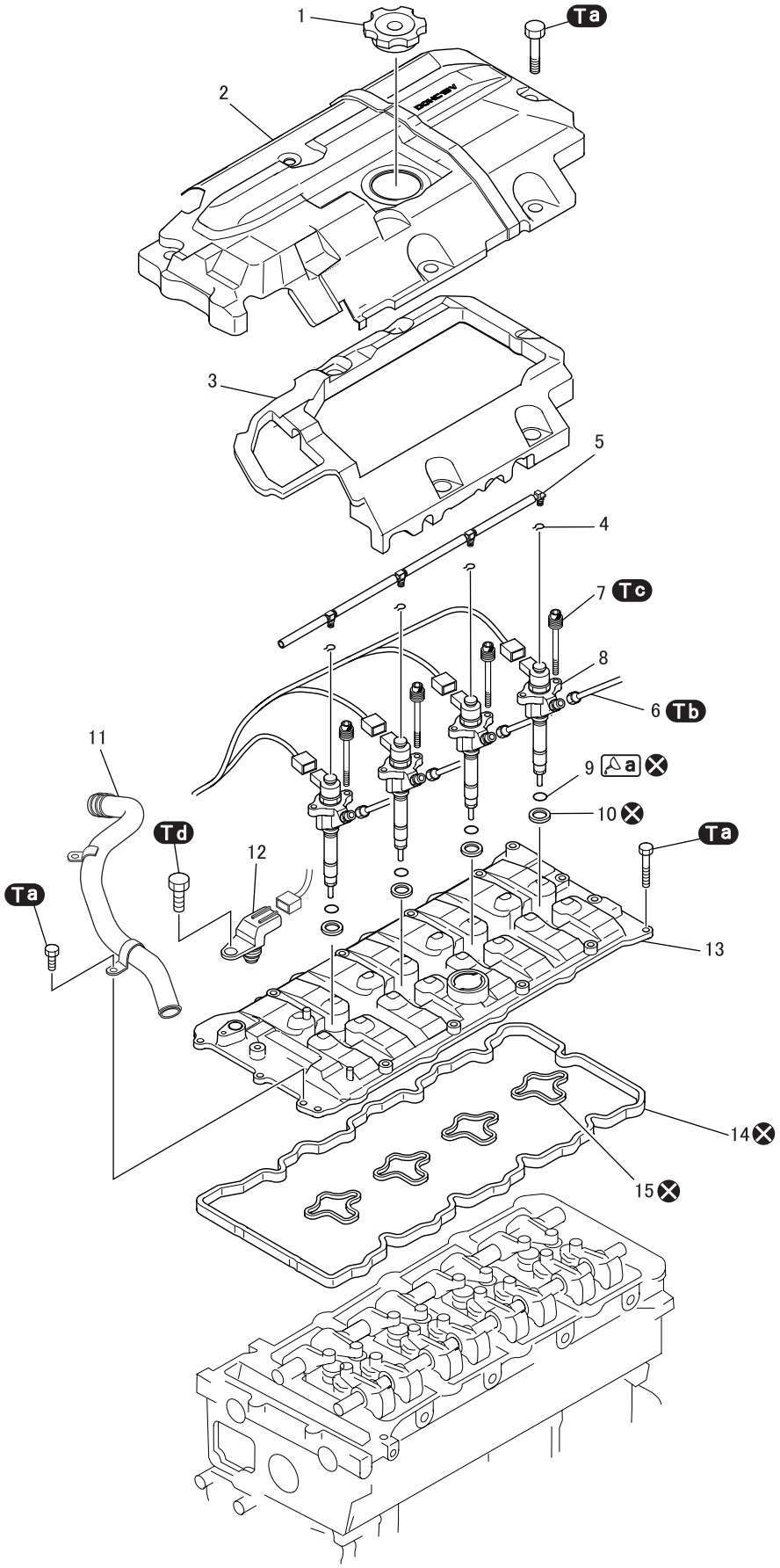
Location	Maintenance item		Standard value	Limit	Remedy
–	Valve clearance (when cold)	Intake valve	0.4 {0.016}	–	Adjust
		Exhaust valve	0.5 {0.020}	–	

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (cover installation)	23.2 {17, 2.4}	–
	Bolt (rocker cover installation)		
	Bolt (PCV pipe installation)		
Tb	Injection pipe (union nut installation)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
Tc	Bolt (injector installation)	5.2 to 7.2 {3.8 to 5.3, 0.53 to 0.73}	–
Td	Bolt (cylinder sensor installation)	8 {5.9, 0.82}	–
–	Lock nut (adjusting screw stopping)	20.6 {15, 2.1}	–

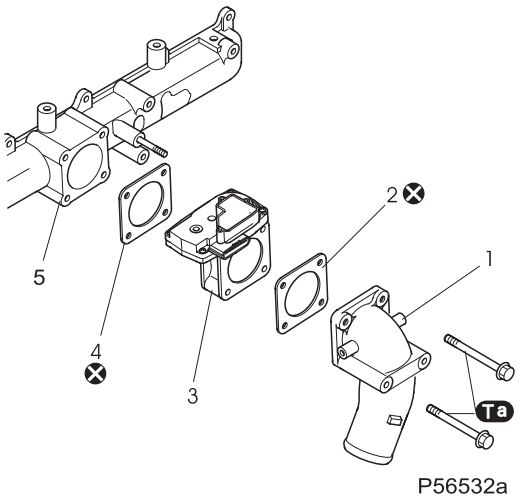
Special tools

Mark	Tool name and shape	Part No.	Application
Ca	Cranking handle (design may vary)  P58299	MH063704	Turning the fan pulley
Cb	Fuel line wrench  02/23/2006 f544802	HAZET 4550-1 SnapOn FRXM17	Tightening the fuel lines


1
Ta
2
3
5
4
7 Tc
8
6 Tb
11
9 a
10
Td
12
Ta
Ta
13
14
15
P67426

1 Oil filler cap
2 Cover
3 Rocker cover rubber
4 Snap ring
5 Fuel return hose
6 Fuel line
7 Bolt (with hexagonal hole)
8 Injector
9 O-ring
10 Tip gasket
11 PCV pipe
12 Cylinder sensor
13 Rocker cover
14 Rocker cover gasket A
15 Rocker cover gasket B

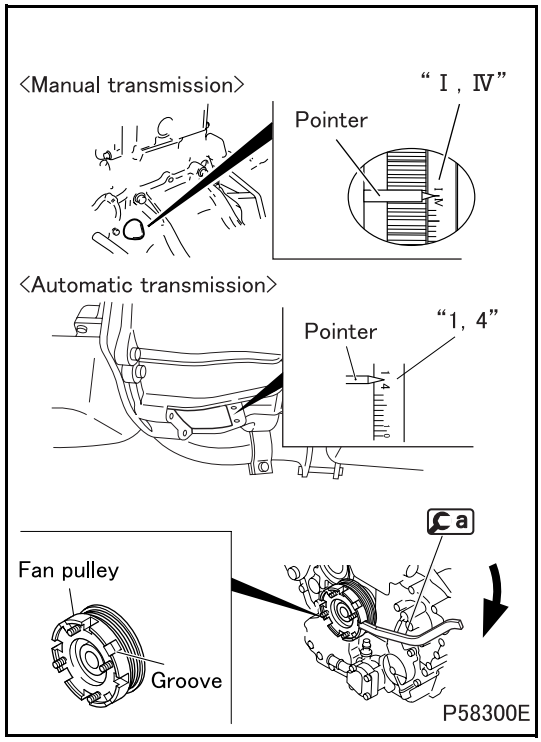
⊗: Non-reusable parts
PCV: Positive Crankcase Ventilation



P56532a

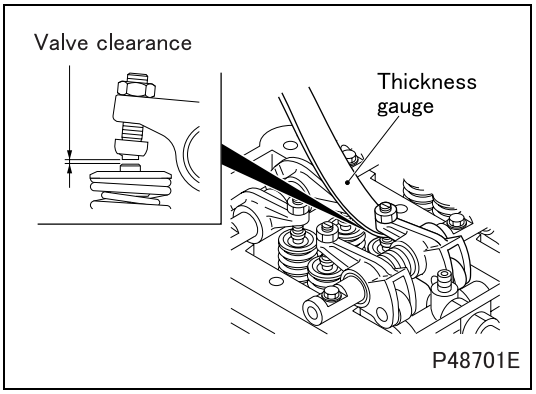
1 Air inlet duct
2 Gasket
3 Intake throttle
4 Gasket
5 Intake manifold

Adjust the valves when the engine is cold.
1. Tilt and secure the cab.
2. Disconnect the EGR harness at the throttle body.
3. Remove the air inlet duct mounting bolts and remove the intake throttle.
4. Remove the oil cap.
5. Remove the cover.
6. Remove the rocker cover rubber.
7. Using compressed air, blow any debris from around the injectors.
8. Disconnect the fuel return lines.
9. Disconnect the wire harness from the injectors.
10. Remove the fuel return line mount bolts (one on the valve cover and one on the side of the engine). Carefully move the return line out of the way.
11. Remove the fuel lines.
12. Remove the injectors.
13. Disconnect the PCV pipe at the left of the engine and move it out of the way.
14. Remove the cylinder sensor.
15. Remove the rocker cover.
16. Using the cranking handle tool, rotate the engine until the number one cylinder is at TDC. The timing mark on the left camshaft will line up. Verify that the flywheel is also showing the "I, IV" mark.
NOTE: Mark the flywheel for easy access later.



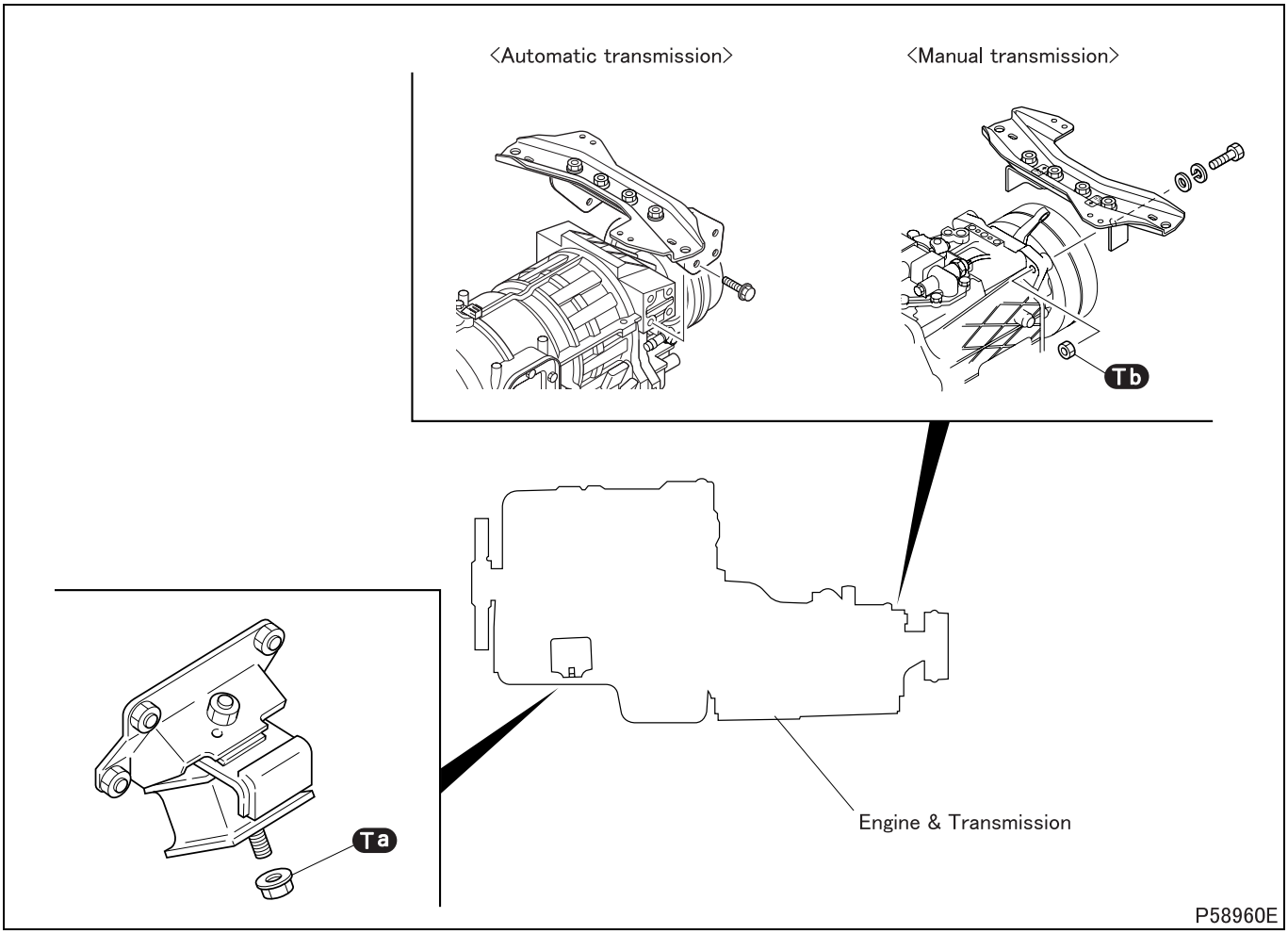
P58300E

Cylinder No.	1		2		3		4	
Valve	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder piston at TDC on compression stroke	O	O	O	–	–	O	–	–
No. 4 cylinder piston at TDC on compression stroke	–	–	–	O	O	–	O	O



17. Adjust the valve clearances.
- Loosen the lock nut.
- Back off the adjuster screw and insert the feeler gauge under the rocker.
- Tighten the adjuster screw until the feeler gauge drags slightly.
- Hold the adjuster screw in position and tighten the lock nut. See tightening table.
- Recheck the valve clearance with the thickness gauge, and re-adjust if the measurements are not within the specified value range.
- Repeat for each valve.
- Rotate the engine one turn to the #4 position, and adjust remaining valves.

18. Make sure that all gaskets are securely in place and install the rocker cover.
19. Install the injectors.
20. Connect the fuel return lines.
21. Install the fuel return line mount bolts.
22. Install the fuel lines.
23. Position and connect the PCV pipe.
24. Install the rubber.
25. Install the cover.
26. Install the throttle body and air inlet duct.
27. Connect the EGR harness at the throttle body.
28. Start the engine and verify proper operation.



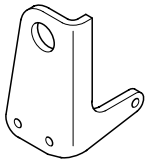
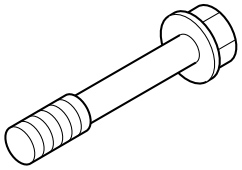
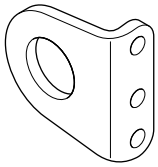
CAUTION ⚠

- **Only use hoisting equipment appropriate for the engine and transmission weight (approximately 600 kg {1320 lb}).**

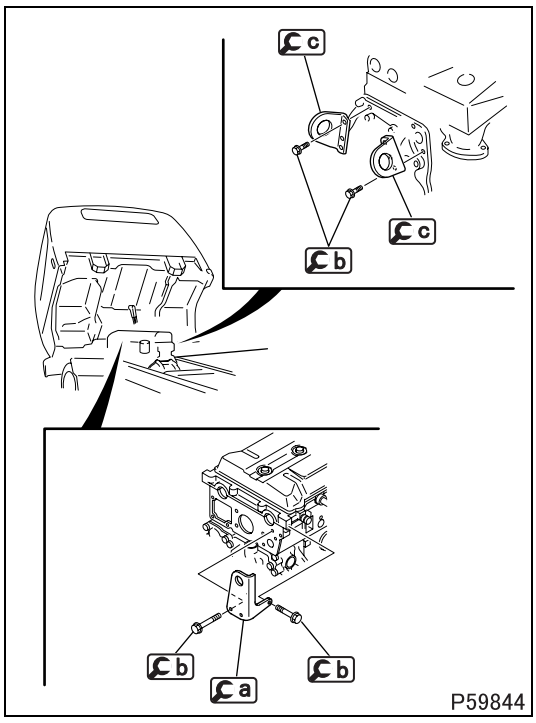
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (front mounting installation)	69 to 88 {51 to 65, 7 to 9}	–
Tb	Nut (rear mounting installation)	130 to 170 {96 to 125, 13 to 17}	–

Special tools

Mark	Tool name and shape	Part No.	Application
a	Engine front hanger  P57188	MH063636	Removal and installation of engine
b	Flange bolt  P29984	MF140429 MF140433 MF140421	Installation of engine front hanger
c	Engine rear hanger  P58957	MH063711	Removal and installation of engine

◆Work before removal◆

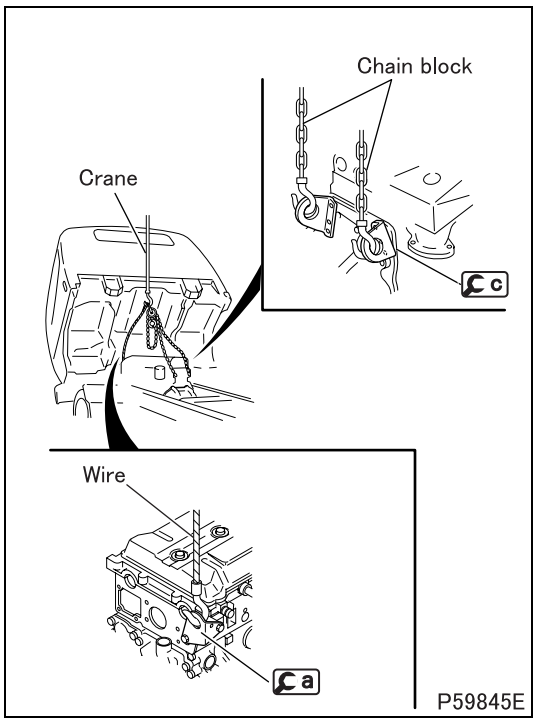


P59844

■ **Preparing for engine removal: Installation of engine front hanger and flange bolt**

- Install a, b and c on the engine.

◆Removal procedure◆

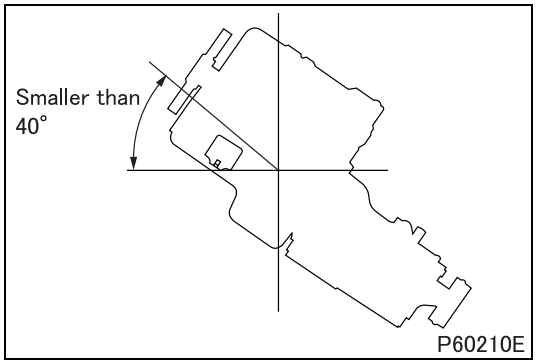


■ **Removal: Engine and transmission**

- Hook the wire rope on a and hitch the chain block to c. Then, pull all the slack out of the slings by a crane.

CAUTION ⚠

- **The slings must be strong enough to hang the engine and transmission assembly (weighing approximately 600 kg {1320 lb}).**
- **Be sure to keep the slings away from the exhaust gas recirculation pipes.**



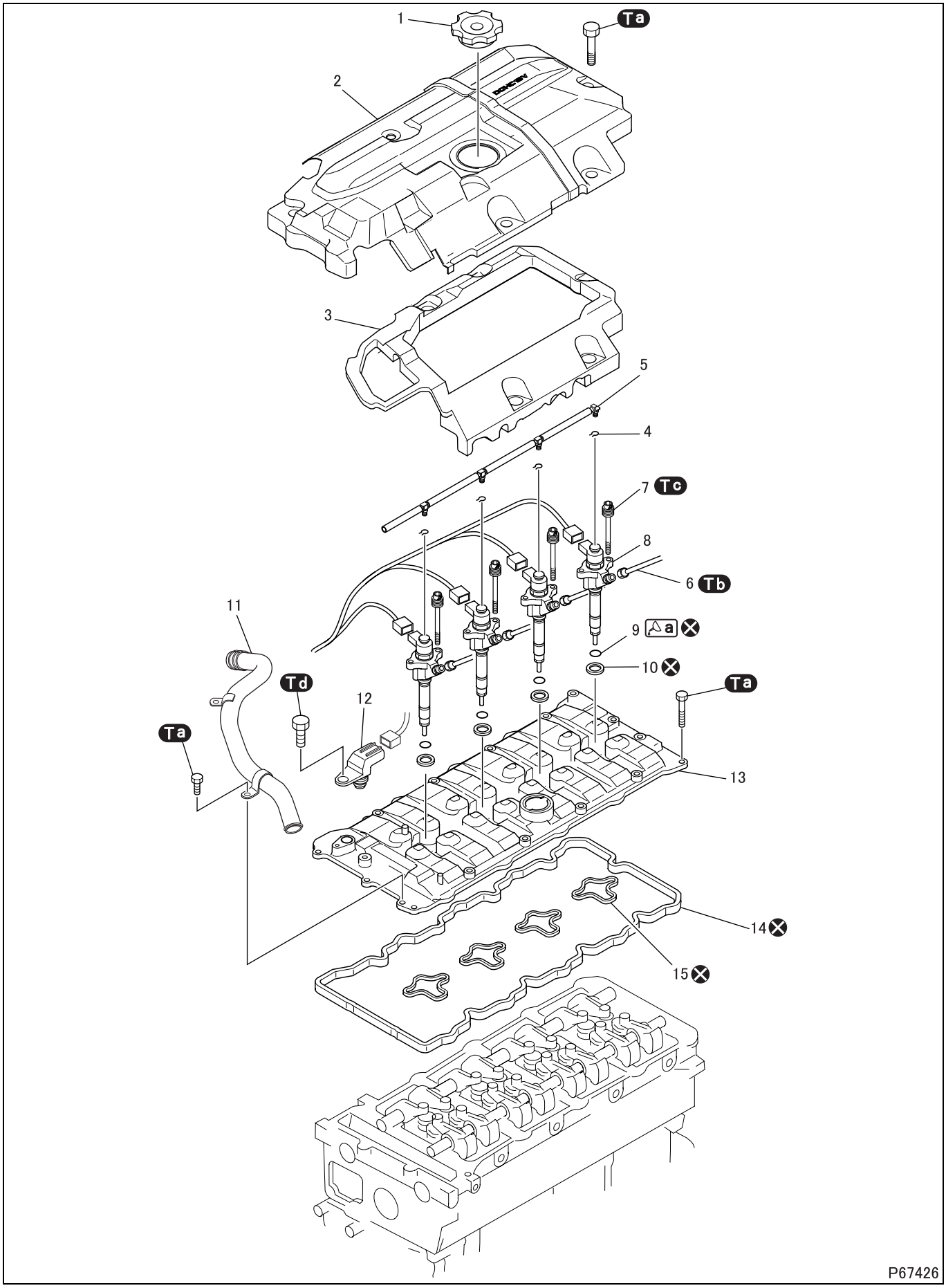
- Make sure that all harnesses and pipes are disconnected.
- Lift the engine and transmission assembly slowing. Take care not to bump the assembly against the frame and cab.

CAUTION ⚠

- **When lifting the engine and transmission assembly, do not incline it more than 40°.**

M E M O

ROCKER COVER



● **Disassembly sequence**

1 Oil filler cap
2 Cover
3 Rocker cover rubber
4 Snap ring
5 Fuel return hose
6 Injection pipe
7 Bolt (with hexagonal hole)
8 Injector
9 O-ring
10 Tip gasket
11 PCV pipe
12 Cylinder sensor
13 Rocker cover
14 Rocker cover gasket A
15 Rocker cover gasket B

⊗: Non-reusable parts
PCV: Positive Crankcase Ventilation

● **Assembly sequence**

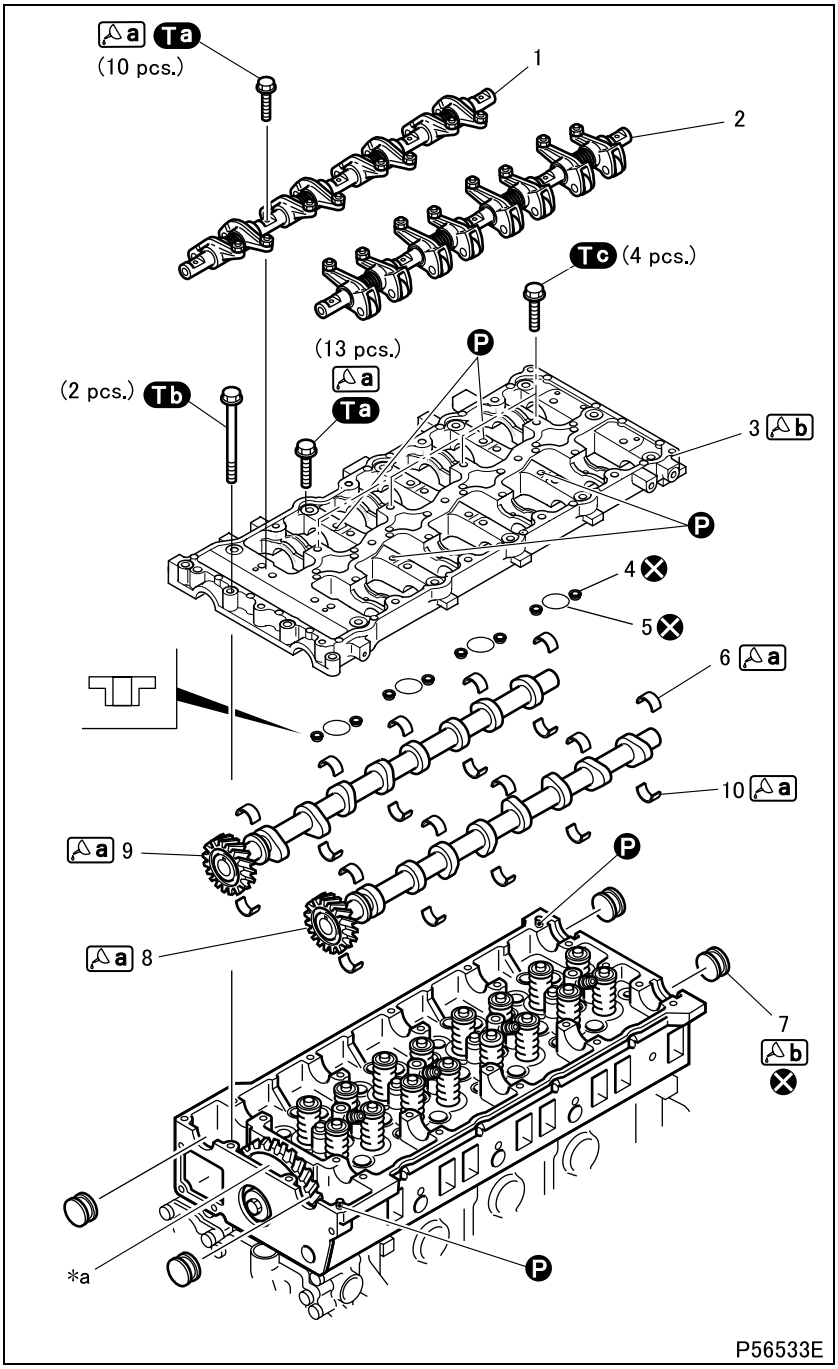
Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (cover installation)	23.2 {17, 2.4}	–
	Bolt (rocker cover installation)		
	Bolt (PCV pipe installation)		
Tb	Injection pipe (union nut installation)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
Tc	Bolt (injector installation)	5.2 to 7.2 {3.8 to 5.3, 0.53 to 0.73}	–
Td	Bolt (cylinder sensor installation)	8 {5.9, 0.82}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required



● Disassembly sequence

1 Exhaust rocker shaft
(See later sections.)
2 Intake rocker shaft
(See later sections.)
3 Camshaft frame
4 Gasket
5 O-ring
6 Upper camshaft bearing
7 Packing
8 Intake camshaft
(See later sections.)
9 Exhaust camshaft
(See later sections.)
10 Lower camshaft bearing

***a**: Head idler gear
Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **The camshaft frame and cylinder head are manufactured as a matched set. Never replace the camshaft frame or the cylinder head individually.**
- **Do not change the upper and lower camshaft bearing combinations. Do not interchange the position of an upper and lower camshaft bearing set with that of another.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash	Head idler gear-to-camshaft gear	0.080 to 0.126 {0.0031 to 0.0050}	0.3 {0.012}	Replace
		Head idler gear-to-idler gear	0.103 to 0.158 {0.0041 to 0.0062}	0.3 {0.012}	
–	End play	Camshaft	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Inspect
		Head idler gear	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	
6, 8, 10	Camshaft bearing-to-intake camshaft clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.024}	Replace
6, 8, 10	Camshaft bearing-to-exhaust camshaft clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.024}	Replace
6, 10	Camshaft bearing span (when free)		–	35.5 {1.40} or less	Replace

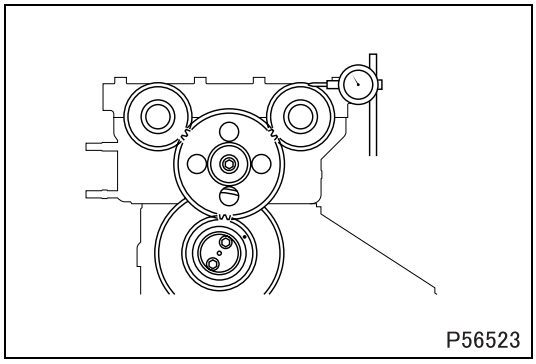
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (rocker shaft installation: 10 places)	27.5 {20, 2.8}	Wet
	Bolt (camshaft frame installation: 13 places)		
Tb	Bolt (camshaft installation: 2 places)	23.5 {17, 2.4}	–
Tc	Bolt (camshaft frame installation: 4 places)	23.2 {17, 2.4}	–

Lubricant and/or sealant

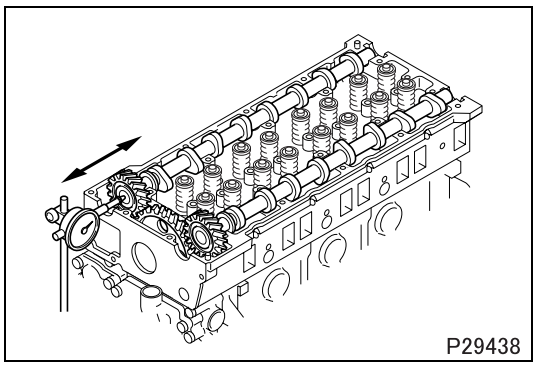
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads and seat	Engine oil	As required
	Camshaft bearing inner surface		
	Camshaft journals and cams		
b	Cylinder head mounting surface of camshaft frame	ThreeBond 1207C or D	As required
	Entire periphery of packing		

◆Work before removal◆



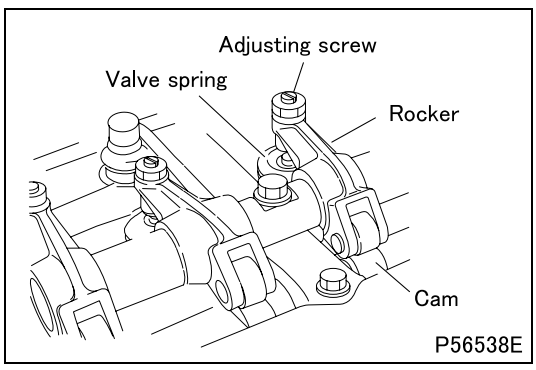
■ Inspection: Backlash between gears

- Measure the backlash at three or more locations for each pair of gears.
- If any of the measurements exceeds the specified limit, replace the defective part(s).



■ Inspection: Camshaft end play

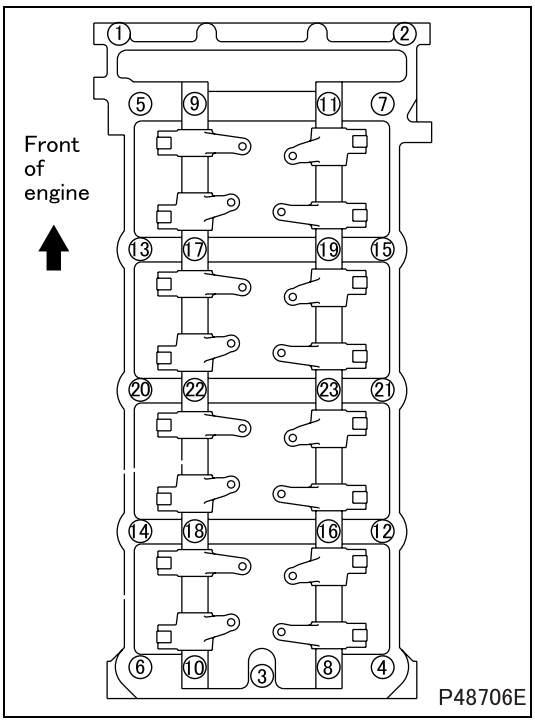
- If the end play exceeds the specified limit, replace the defective part(s).



■ Releasing valve spring tension

- Before removing the bolts in the next process, loosen the adjusting screws on the rockers whose valve springs are compressed (due to the cams lifting these rockers). This operation is necessary to release the tension in the valve springs, thus preventing other parts from undue forces when the bolts are removed.

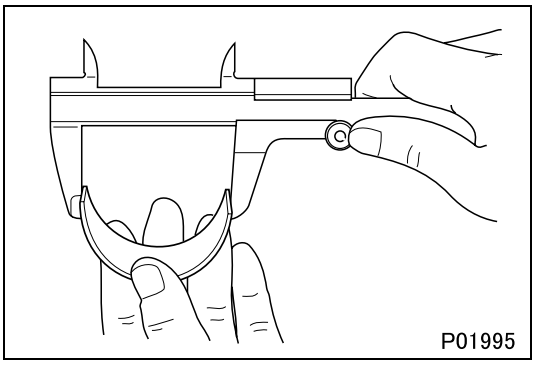
◆Removal procedure◆



■ **Removal: Rocker shafts and camshaft frame**

- Loosen the rocker shaft installation bolts (10 places) and the camshaft frame installation bolts (13 places) in several passes in the order indicated in the illustration (1 to 23). Then, remove the rocker shafts and the camshaft frame.

◆Inspection procedure◆

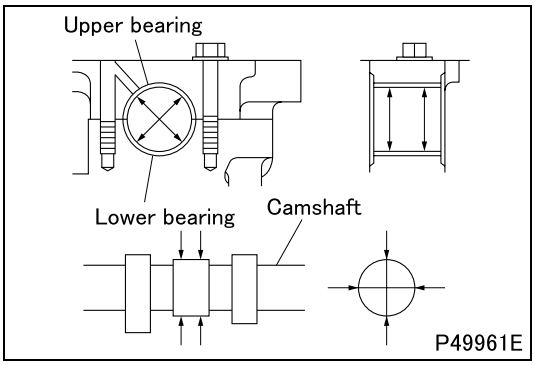


■ **Inspection: Camshaft bearing free span**

CAUTION ⚠

- **Do not force the bearings open.**
- **When replacing the bearings, always replace the upper and lower bearings as a set.**

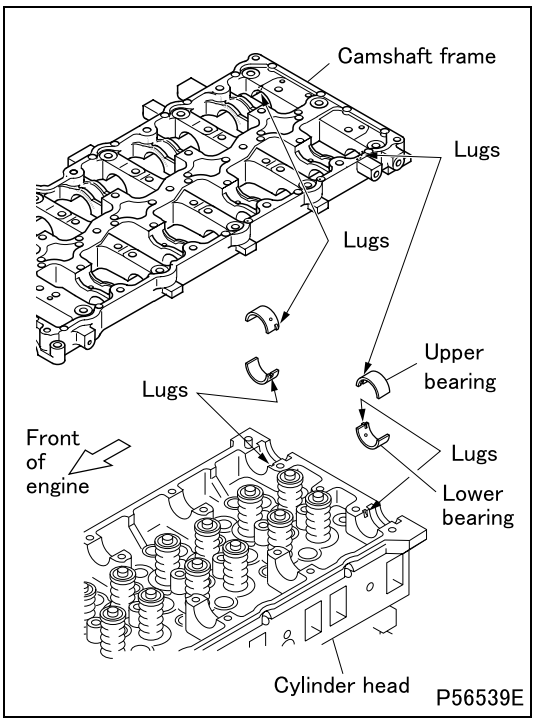
- Replace the bearings if the measurement is not within the standard value range.



■ **Inspection: Camshaft bearing-to-camshaft clearance**

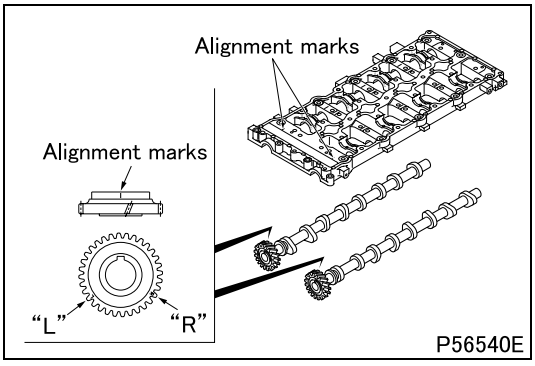
- If the measurement is not within the standard value range, replace the defective part(s).

◆Installation procedure◆



■ **Installation: Camshaft**

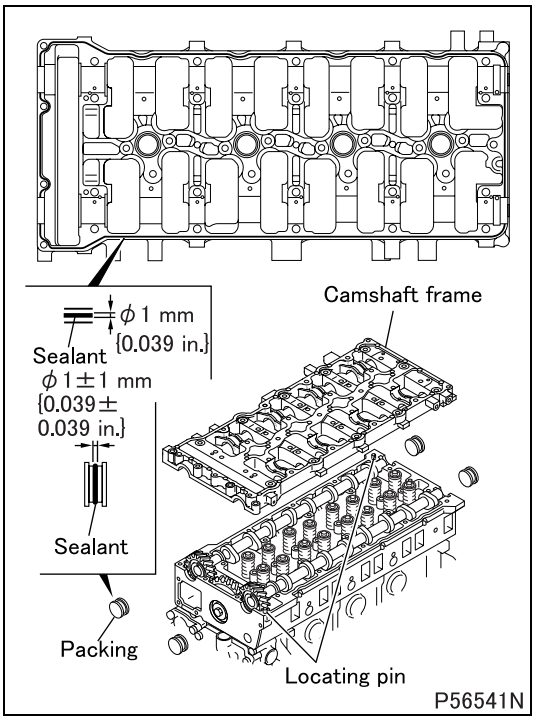
- Install the upper camshaft bearing on the camshaft frame and the lower camshaft bearing on the cylinder head by fitting their lugs into the notches in the camshaft frame and cylinder head.



- Place the No. 1 cylinder piston at the top dead center on the compression stroke.
- Align the mating marks on the camshaft gears with those on the camshaft frame when installing the camshafts.

NOTE

- **Each camshaft gear also has mating mark "L" or "R" for alignment with the head idler gear. This mark may not be exactly aligned with that on the head idler gear, as the position that the head idler gear takes when it is installed may make it impossible to align them. Such a misalignment does not lead to any undesirable consequences.**

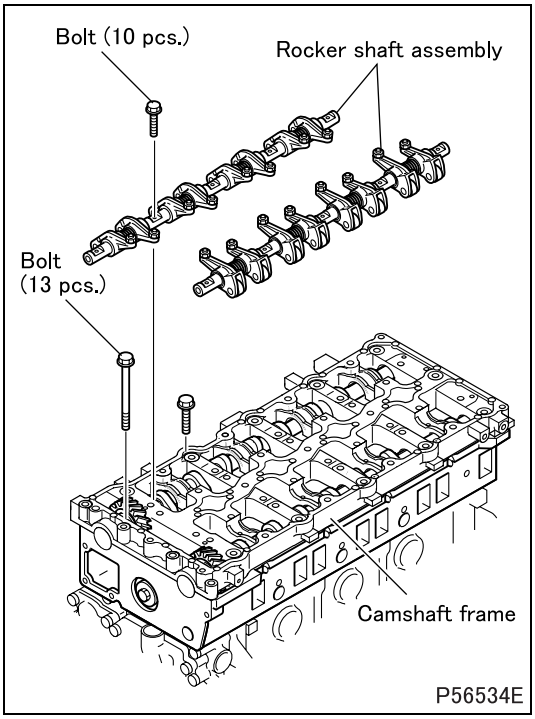


■ **Installation: Rocker shafts and camshaft frame**

- Clean the sealant application surfaces on each part.
- Apply sealant to the entire periphery of the four packings evenly and without any breaks.
- Apply sealant to the camshaft frame evenly and without any breaks.
- Mount the camshaft frame and packing on the cylinder head within three minutes of applying the sealant, being careful not to dislodge the sealant in the process.

CAUTION ⚠

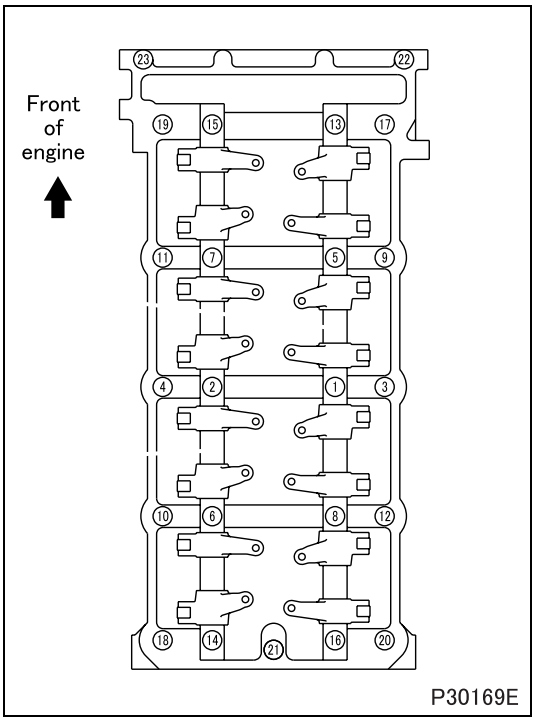
- **Do not run the engine within one hour of installing the rocker shafts and camshaft frame.**



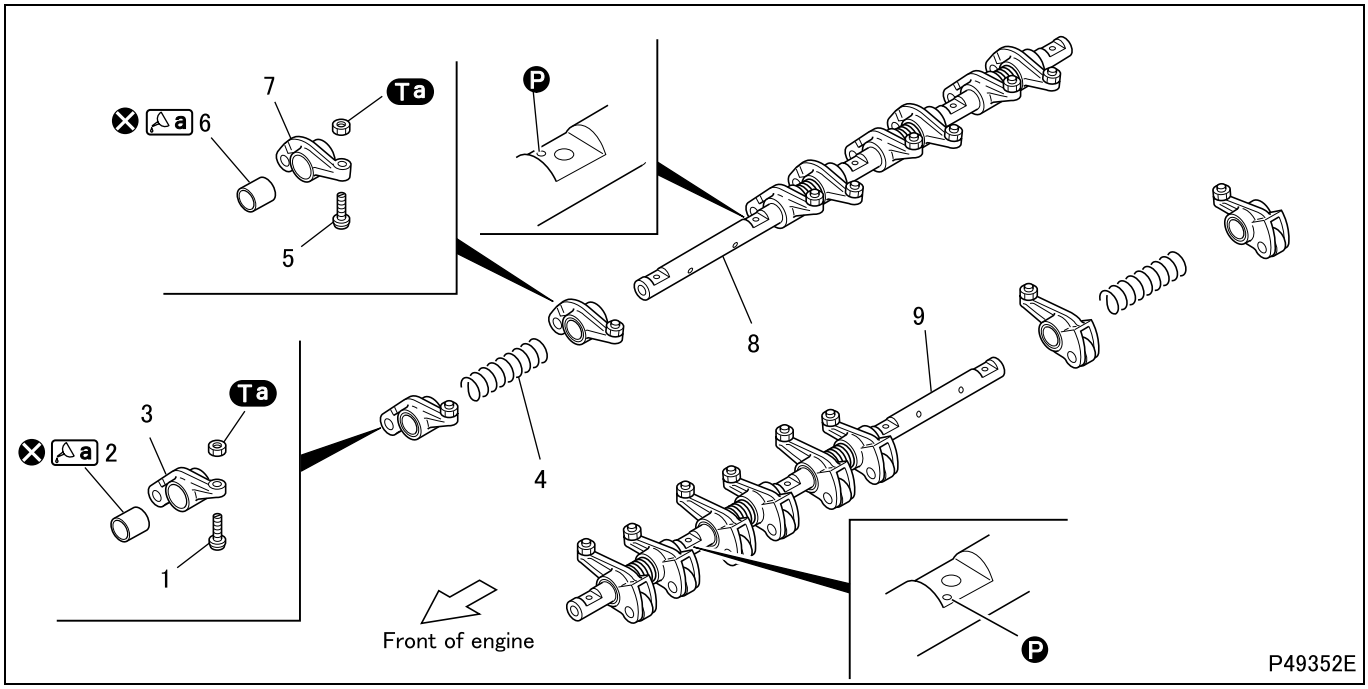
- When installing the camshaft frame on the cylinder head, also install the rocker shafts. Then, tighten the rocker shaft bolts (10 places) and the camshaft frame bolts (13 places) in the order indicated below.

CAUTION ⚠

- **Reapply sealant to the areas specified above if any of the bolts is loosened or removed after the rocker shafts and camshaft frame are installed.**



- Tighten the bolts (1 to 23) to the specified torque in the order indicated in the illustration.



● **Disassembly sequence**

1 Adjusting screw
2 Rocker bushing
3 Short rocker
4 Rocker shaft spring
5 Adjusting screw
6 Rocker bushing
7 Long rocker
8 Exhaust rocker shaft
9 Intake rocker shaft

Ⓟ: Hole for camshaft frame locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The short rockers and long rockers must be installed alternately. Be aware that the order of installation for the intake rockers is different from the order of installation for the exhaust rockers.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3, 7	Rocker (roller) radial play	0.038 to 0.100 {0.0015 to 0.0039}	–	Replace
2, 6, 8, 9	Rocker bushing-to-rocker shaft clearance	0.01 to 0.08 {0.00039 to 0.0031}	0.12 {0.0047}	Replace

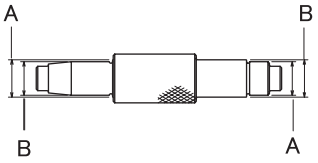
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (adjusting screw stopping)	20.6 {15, 2.1}	–

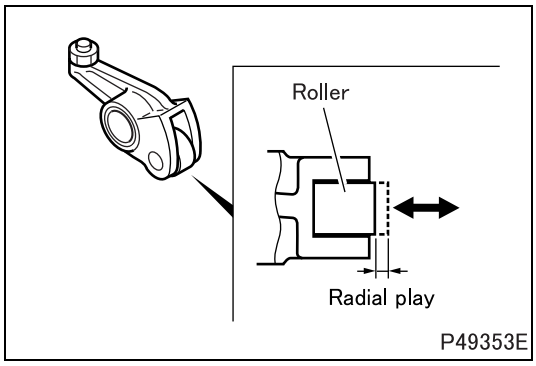
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rocker bushing inner surface	Engine oil	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓒa	Rocker bushing puller A: ϕ22 {ϕ0.87} B: ϕ24.5 {ϕ0.96}  P29932	MH062536	Removal and installation of rocker bushing

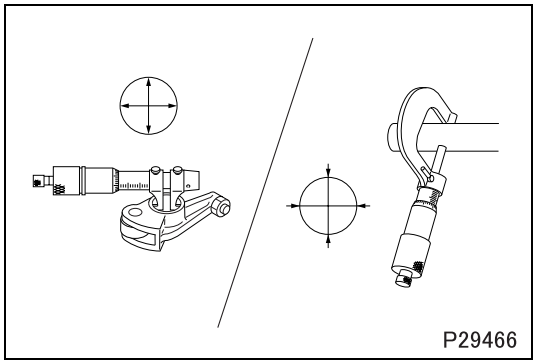
◆Inspection procedure◆



P49353E

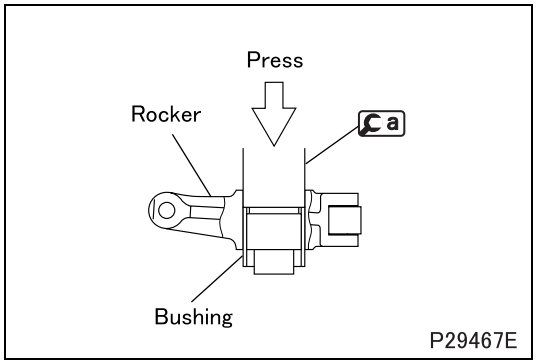
■ Inspection: Rocker (roller) radial clearance

- Replace the rocker if the radial play measurement is not within the standard value range.


P29466

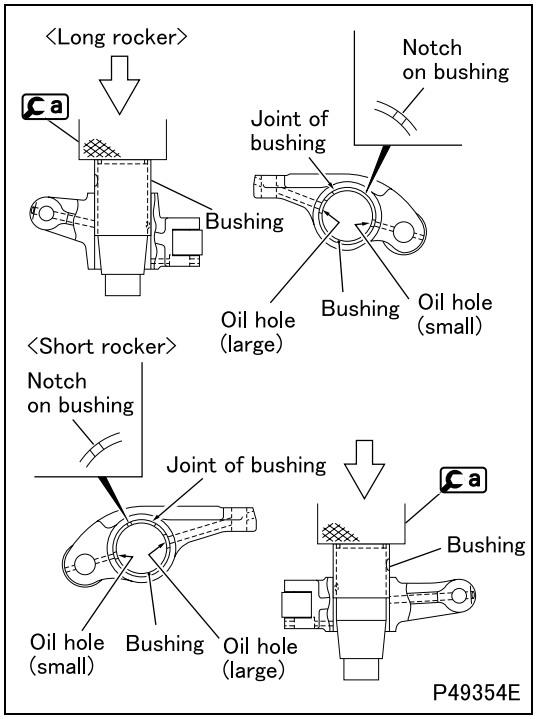
■ Inspection: Rocker bushing-to-rocker shaft clearance

- Replace the bushing if the measurement exceeds the specified limit.



P29467E

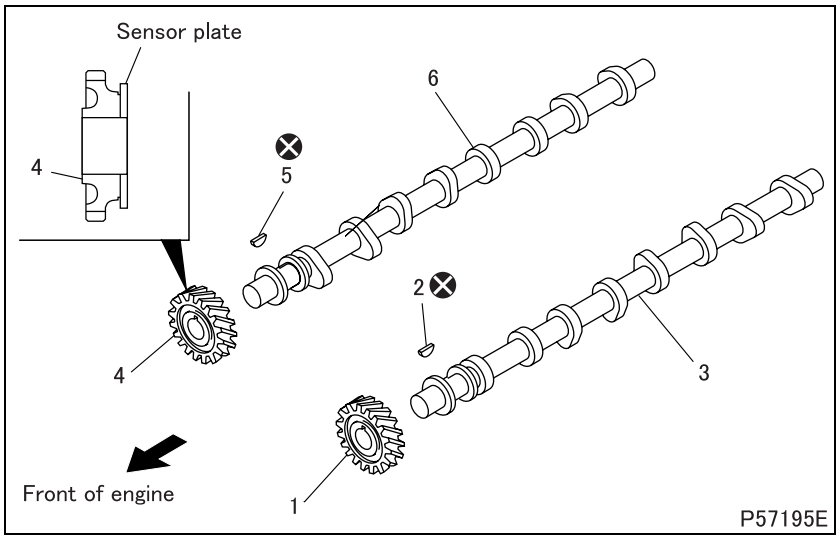
Replacement of rocker bushing
[Removal]



[Installation]

- Press-fit each rocker bushing in the rocker with its ends facing in the illustrated directions.

Camshafts



● Disassembly sequence

1 Intake camshaft gear
2 Key
3 Intake camshaft
4 Exhaust camshaft gear
5 Key
6 Exhaust camshaft

⊗: Non-reusable parts

NOTE

- **Do not remove the camshaft gears unless defects are evident.**

● Assembly sequence

Follow the disassembly sequence in reverse.

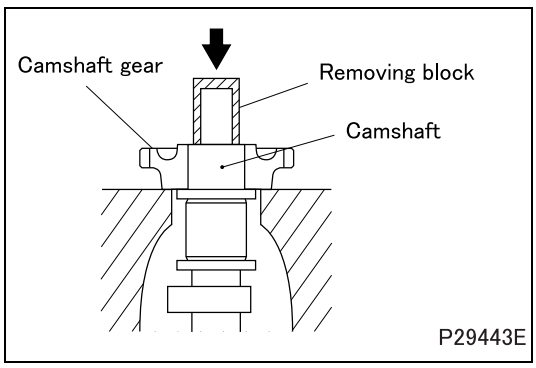
NOTE

- **The exhaust camshaft gear has the sensor plate. Do not mistake it for the intake camshaft gear. If the gears are incorrectly installed, engine malfunction will occur.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy	
1, 3, 4, 6	Camshaft gear-to-camshaft interference			0.007 to 0.041 {0.00028 to 0.0016}	–	Replace	
3	Intake camshaft	Cam lift	Cams for long rockers	7.21 {0.284}	7.16 {0.282}	Replace	Lobe height: 42.219 {1.66} Base circle diameter: 35.009 {1.38}
			Cams for short rockers	9.269 {0.365}	9.219 {0.363}		Lobe height:44.281 {1.74} Base circle diameter: 35.012 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace	
6	Exhaust camshaft	Cam lift	Cams for long rockers	7.184 {0.283}	7.134 {0.281}	Replace	Lobe height: 42.279 {1.66} Base circle diameter: 35.095 {1.38}
			Cams for short rockers	9.242 {0.364}	9.192 {0.362}		Lobe height: 44.359 {1.75} Base circle diameter: 35.117 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace	

◆Removal procedure◆



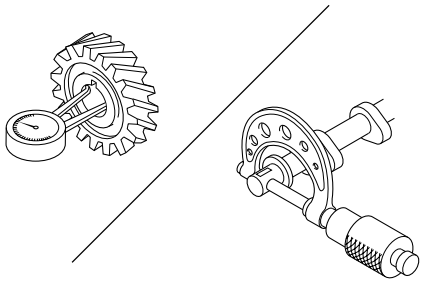
■ Removal: Camshaft gears

- Remove the camshaft gear by pushing on the camshaft using a press.

CAUTION ⚠

- **Do not use a hammer to remove the camshaft gear. Be sure to use a press for this purpose.**

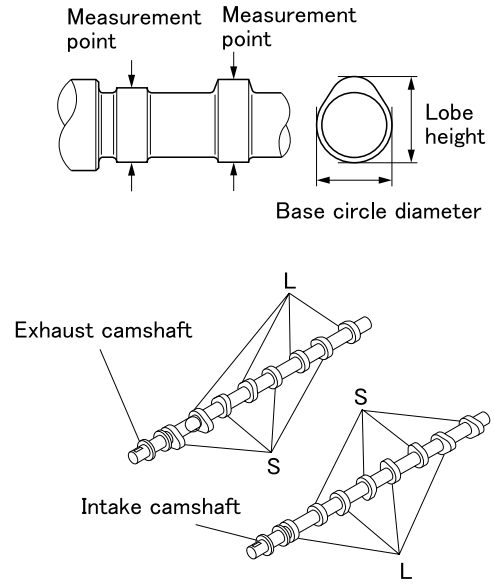
◆Inspection procedure◆



P29446

■ Inspection: Camshaft gear-to-camshaft interference

- If the measurement is not within the standard value range, replace the defective part(s).



P56536E

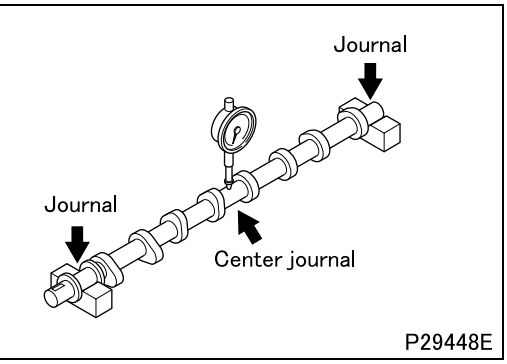
■ Inspection: Camshaft

(1) Cam lift

- Replace the camshaft if the difference between the cam lobe height and base circle diameter measurements is less than the specified limit.

NOTE

- **The cams for the long rockers (L) are different from the cams for the short rockers (S).**



P29448E

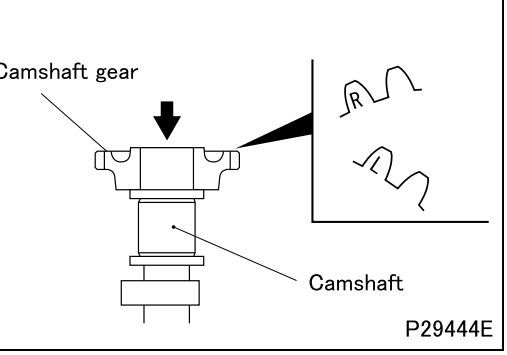
(2) Bend

- Place supports under the journals at the ends of the camshaft and measure the bend of the camshaft at the central journal.
- If the measurement exceeds the specified limit, replace the camshaft.

NOTE

- **Turn the camshaft by one turn and read the dial gauge. Divide the reading by two to obtain the amount of camshaft bend.**

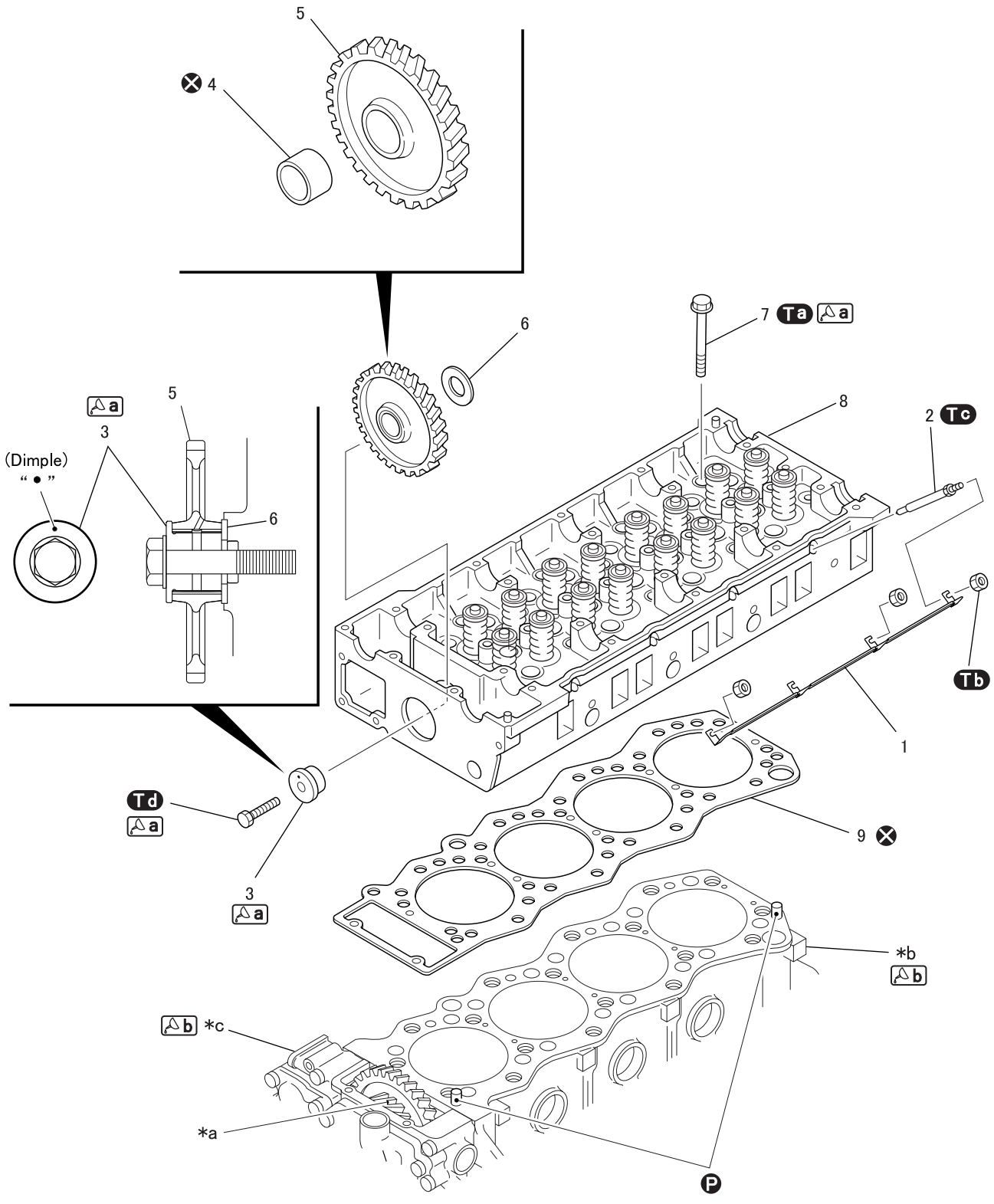
◆Installation procedure◆



P29444E

■ Installation: Camshaft gears

- Heat the camshaft gears to approximately 150°C {302°F} with a gas burner.
- Install the camshaft gear on the camshaft with a mating mark (“R” or “L”) facing in the illustrated direction.
- Press the gear until its end comes in close contact with the flange on the camshaft.



P56542E

● Disassembly sequence

1 Connection plates
2 Glow plug
3 Head idler shaft
4 Head idler gear bushing
5 Head idler gear
6 Thrust plate
7 Cylinder head bolt
8 Cylinder head
(See later sections.)
9 Cylinder head gasket

∗a: Idler gear
∗b: Upper crankcase
∗c: Front case
Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **Be careful not to damage the glow plugs and injectors when placing the cylinder head on the worktable, as they are protruding out of the bottom of the cylinder head.**
- **The cylinder head bolts are tightened using the torque-turn method. Any cylinder head bolt that has three marks indicating that the bolt has been tightened three times already must be replaced with a new one.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Do not forget to install the thrust plate.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Head idler gear end play	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	Replace
3, 4	Head idler shaft-to-head idler gear bushing clearance	0.01 to 0.05 {0.00039 to 0.0020}	0.1 {0.0039}	Replace

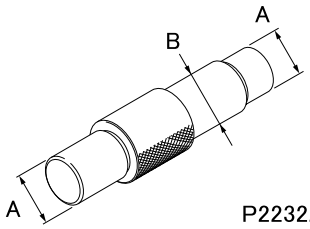
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Cylinder head bolt	147 {110, 15} + 90°	Wet
Tb	Nut (connection plate installation)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–
Tc	Glow plug	19.6 to 24.5 {14 to 18, 2 to 2.5}	–
Td	Bolt (head idler shaft installation)	40.2 {30, 4.1}	Wet

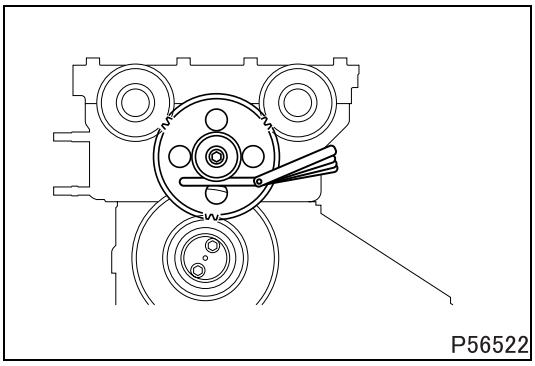
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Bolt (head idler gear installation) threads and seating surface under head		
	Head idler shaft outer peripheral surface		
	Cylinder head bolt threads		
b	Top surfaces of joints between upper crankcase and front case	ThreeBond 1207C	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Idler gear bushing puller A: φ32 {φ1.26}, B: φ35 {φ1.38}  P22322	MH061779	Removal and installation of idler gear bushing

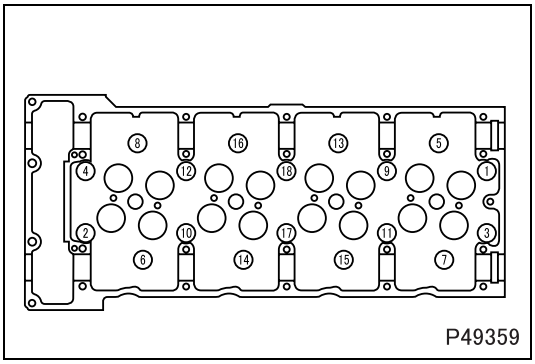
◆Inspection before removal◆


P56522

■ **Inspection: Head idler gear end play**

- If the measurement exceeds the specified limit, replace the defective part(s).

◆Removal procedure◆



P49359

■ **Removal: Cylinder head**

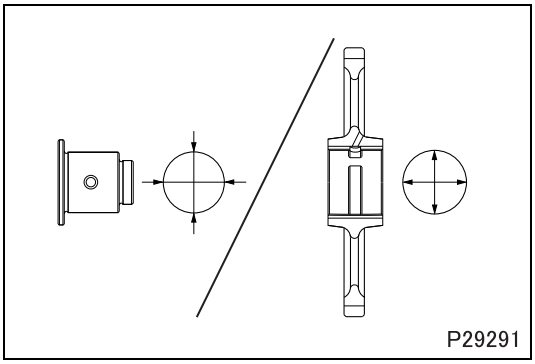
- Loosen the cylinder head bolts (1 to 18) in several passes in the order indicated in the illustration and remove the cylinder head.

■ **Removal: Cylinder head gasket**

CAUTION ⚠

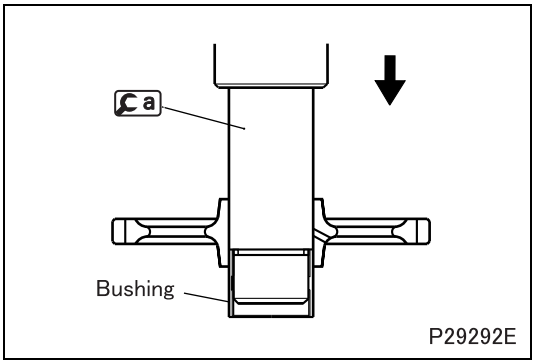
- **When removing the cylinder head gasket, be careful not to scratch the cylinder head, the upper crankcase and the front case.**

◆Inspection procedure◆

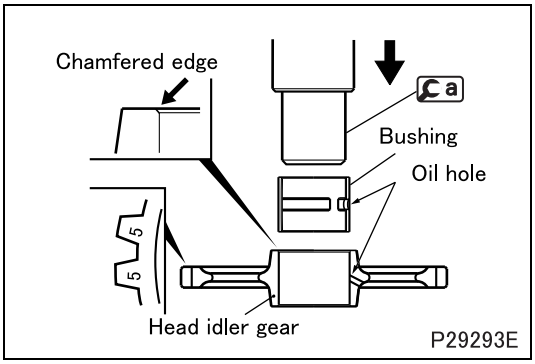

P29291

■ **Inspection: Head idler shaft-to-head idler gear bushing clearance**

- Replace the bushing if the measurement exceeds the specified limit.



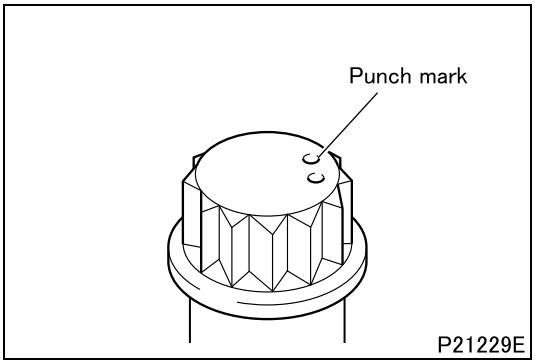
Replacement of head idler gear bushing
[Removal]



[Installation]

- Position the bushing on the head idler gear with their ends facing the illustrated directions and their oil holes on the same line.
- Using a, press the bushing into the head idler gear until it is flush with the lower edge of the chamfer on the head idler gear.
- Remeasure the clearance between the bushing and head idler shaft.
- Ream the bushing if the measurement is less than the standard value.

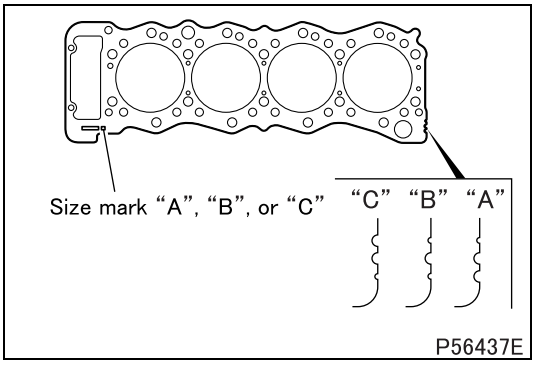
◆Installation procedure◆



■Installation: Cylinder head

CAUTION ⚠

- **Before fitting the cylinder head bolts, check the punch marks on each bolt's head. Do not use the bolt if there are three punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the torque-turn tightening method. Any bolt that already has three punch marks must be replaced.**



- The cylinder head gasket comes in three sizes. Choose the gasket appropriate for the cylinder head by the following procedure.
  - Measure the amount of piston projection for every cylinder. (See the "**PISTONS, CONNECTING RODS AND CYLINDER LINERS**" section.)
  - Select a cylinder head gasket with the appropriate thickness for the average of the piston projection measurements from the table below.
  - If any of the piston projection measurements is more than 0.05 mm {0.0020 in.} larger than the average value, then use the gasket one class higher than that class (A→B, B→C).

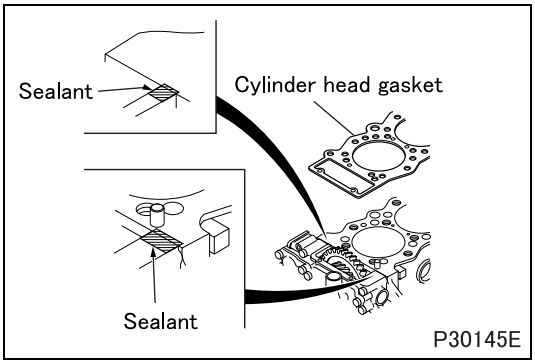
Unit: mm {in.}

Piston projection	Cylinder head gasket	
	Size	Thickness when tightened
–0.088 to –0.027 {–0.0035 to –0.0011}	"A"	0.75 ± 0.03 {0.030 ± 0.0012}
–0.027 to 0.033 {–0.0011 to 0.0013}	"B"	0.80 ± 0.03 {0.031 ± 0.0012}
0.033 to 0.094 {0.0013 to 0.0037}	"C"	0.85 ± 0.03 {0.033 ± 0.0012}

- The size class of the cylinder head gasket can be determined from the size mark or the shape of the notches cut on the gasket edge.

CAUTION ⚠

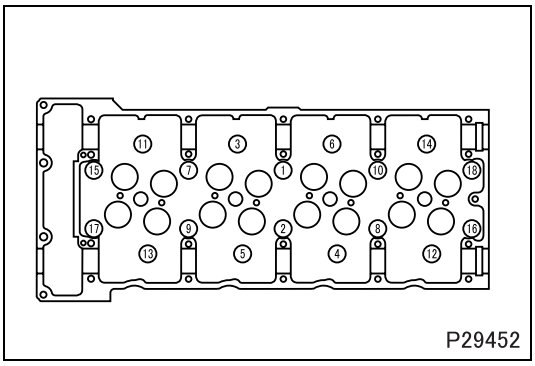
- **Replacement of the piston or connecting rod alters the piston projection. Always measure the amount of piston projection after either or both of them are replaced.**



- Clean the sealant application surfaces of each part.
- Apply sealant to the top surfaces of the joints between the upper crankcase and front case (at two places).
- Install the cylinder head and its gasket on the upper crankcase within three minutes of applying the sealant, being careful not to dislodge the sealant.

CAUTION ⚠

- **Do not run the engine within one hour of mounting the cylinderhead. If any cylinder head bolts are loosened or removed, be sure to reapply sealant to the surfaces specified above.**

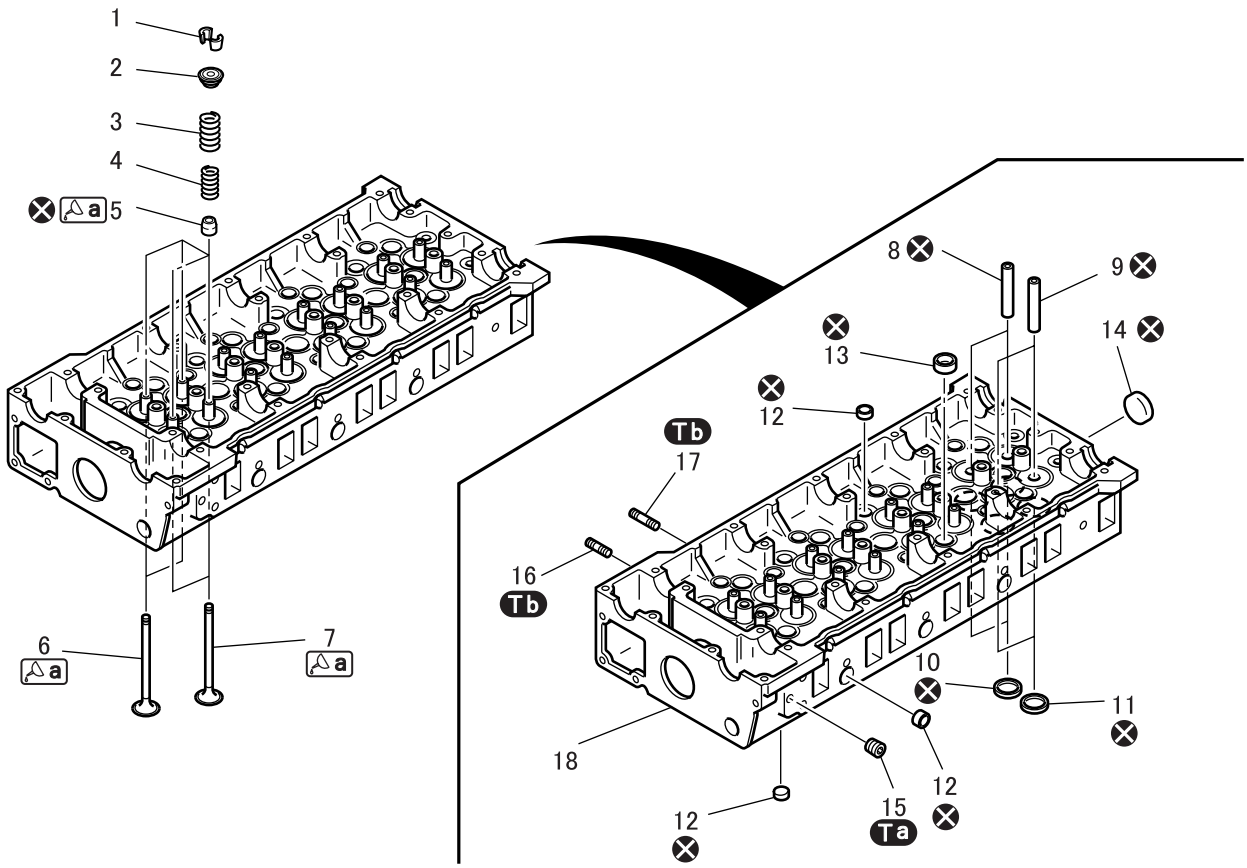


- Tighten the cylinder head bolts (1 to 18) to a torque of 147 N·m {110 lbf·ft, 15 kgf·m} (wet) in the order indicated in the illustration. Then, tighten them further by 90° in the same order.
- After tightening each bolt, make a punch mark on the head of the bolt to indicate the number of times that it has been used.

CAUTION ⚠

- **Cylinder head bolts that have been tightened using the torque-turn method must never be additionally tightened after the final angular tightening.**

Cylinder Head



● Disassembly sequence

1 Valve cotter
2 Upper retainer
3 Outer valve spring
4 Inner valve spring
5 Valve stem seal
6 Exhaust valve
7 Intake valve
8 Exhaust valve guide
9 Intake valve guide
10 Exhaust valve seat
11 Intake valve seat
12 Sealing cap (diameter: 22 mm {0.87 in.})
13 Sealing cap (diameter: 30 mm {1.18 in.})
14 Sealing cap (diameter: 40 mm {1.57 in.})
15 Taper plug
16 Stud (short)
17 Stud (long)
18 Cylinder head

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **When an intake valve or exhaust valve have been removed, make sure to replace the valve stem seal.**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
3	Outer valve spring	Free length	87.8 {3.46}	–	Replace
		Installed load (57 {2.24} in installed length)	360 N {81 lbs, 36.7 kgf}	–	
		Squareness	–	2.5 {0.098}	
4	Inner valve spring	Free length	78.8 {3.10}	–	Replace
		Installed load (52.3 {2.06} in installed length)	168 N {38 lbs, 17.1 kgf}	–	
		Squareness	–	2.5 {0.098}	
6	Exhaust valve	Stem outside diameter	$\phi 8\ ^{-0.060}_{-0.075}$ {$\phi 0.31\ ^{-0.0024}_{-0.0030}$}	–	Replace
		Sinkage from cylinder head bottom surface	1.5 ± 0.25 {0.059 ± 0.0098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45° ± 15'	–	Reface
6, 8	Exhaust valve stem-to-valve guide clearance		0.07 to 0.10 {0.0028 to 0.0039}	0.2 {0.0079}	Replace
7	Intake valve	Stem outside diameter	$\phi 8\ ^{-0.025}_{-0.040}$ {$\phi 0.31\ ^{-0.00098}_{-0.0016}$}	–	Replace
		Sinkage from cylinder head bottom surface	1.5 ± 0.25 {0.059 ± 0.0098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45° ± 15'	–	Reface
7, 9	Intake valve stem-to-valve guide clearance		0.03 to 0.06 {0.0012 to 0.0024}	0.2 {0.0079}	Replace
10	Exhaust valve seat width		2.5 ± 0.2 {0.098 ± 0.0079}	3.5 {0.14}	Correct or replace
11	Intake valve seat width		2 ± 0.2 {0.079 ± 0.0079}	2.8 {0.11}	Correct or replace
18	Cylinder head	Bottom surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from top surface to bottom surface	107 ± 0.5 {4.21± 0.020}	106.5 {4.19}	Replace

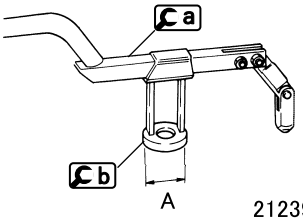
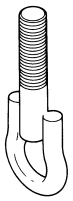
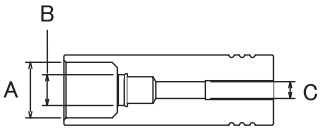
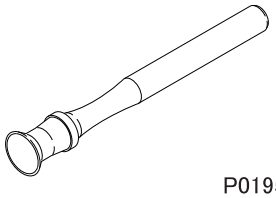
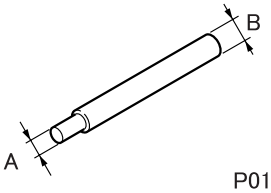
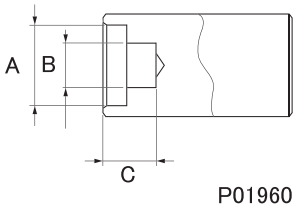
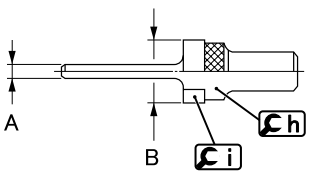
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Tapered plug	14 {10, 1.4}	–
Tb	Stud	20 {15, 2.0}	–

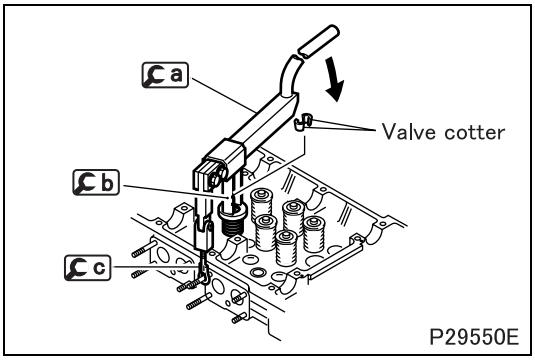
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip of valve stem seal	Engine oil	As required
	Valve stem and valve end		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Valve lifter	MH061668	Removal and installation of valve cotters
b	Valve lifter seat A: ϕ38 {ϕ1.50}	MH061772	
a b A	 21239		
c	Valve lifter hook	MH061679	
	 21240		
d	Valve stem seal installer A: ϕ26.5 {ϕ1.04} B: ϕ14.7 {ϕ0.58} C: ϕ8 {ϕ0.31}	MH063607	Installation of valve stem seals
	 P29931		
e	Valve lapper	30091-07500	Lapping valves and valve seats
	 P01958		
f	Valve guide remover A: ϕ8 {ϕ0.31} B: ϕ12 {ϕ0.47}	31391-10500	Removal of valve guides
	 P01959		
g	Valve guide installer A: ϕ25.5 {ϕ1.00} B: ϕ13 {ϕ0.51} C: 29 {1.14}	MH063604	Installation of valve guides
	 P01960		
h	Caulking tool body A: ϕ8 {ϕ0.31}	31391-13100	Installation of valve seat
i	Installer ring B: ϕ38 {ϕ1.50}	MH063605	
	 P01961B		

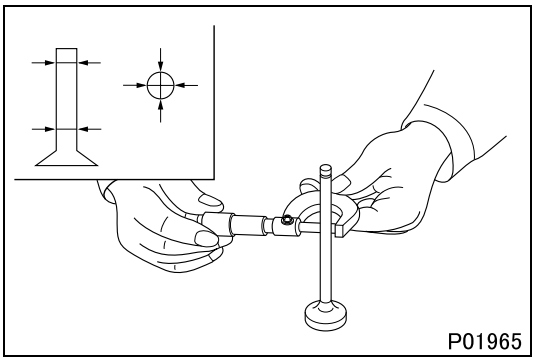
◆Removal procedure◆



■ **Removal: Valve cotters**

- Remove the valve cotters by evenly compressing the valve springs.

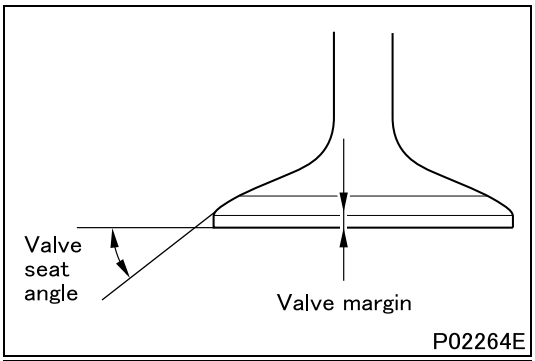
◆Inspection procedure◆



■ **Inspection: Intake valves and exhaust valves**

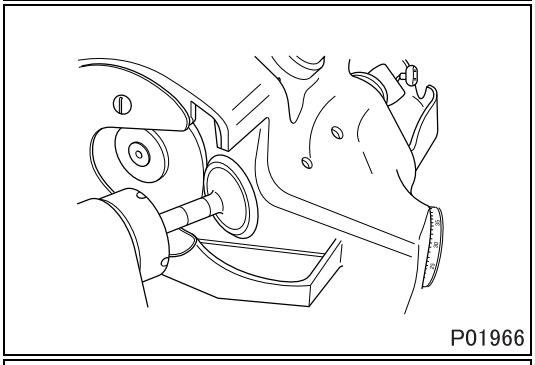
(1) Inspection of valve stem

- Replace the valve if the stem's outside diameter is below the limit or is severely worn.
- When the valve has been replaced with a new one, make sure to lap the valve and valve seat.



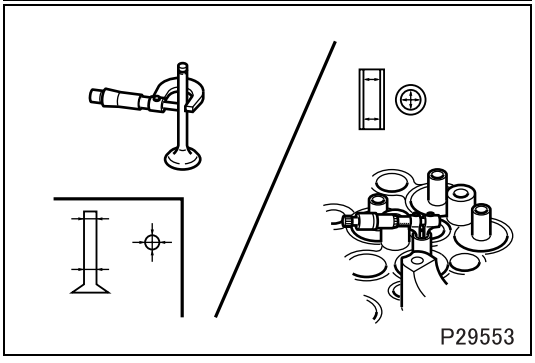
(2) Valve seat angle and valve margin

- Reface or replace the valve if the valve seat angle or valve margin exceeds the specified limits.



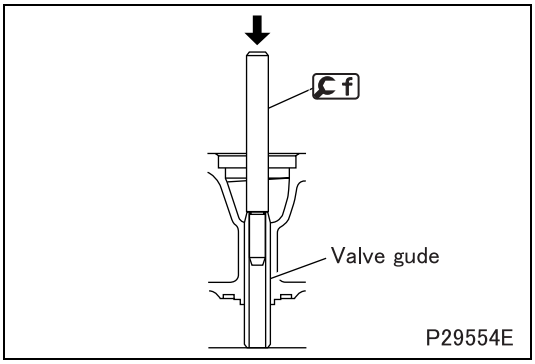
Refacing

- Limit grinding to a necessary minimum.
- If the valve margin is below the limit after grinding, replace the valve.
- After grinding, make sure to lap the valve and valve seat.

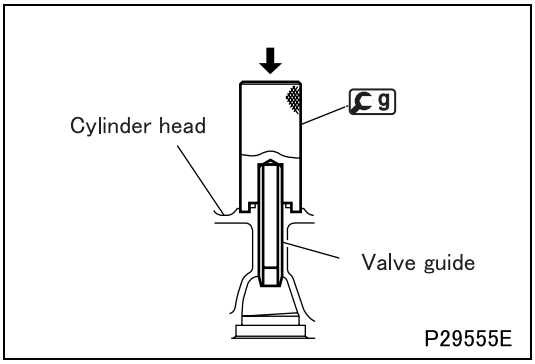


■ **Inspection: Valve-to-valve guide clearance**

- If the clearance exceeds the specified limit, replace the defective part(s).



Replacement of valve guides
[Removal]

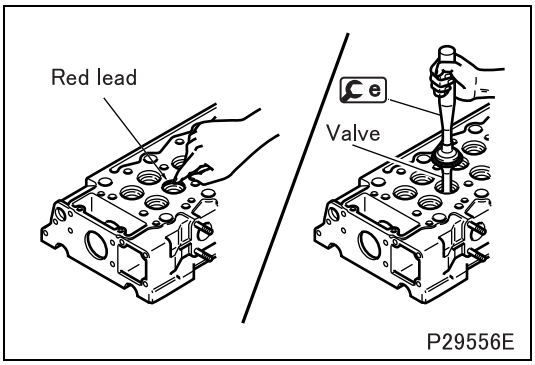


[Installation]

- Install the valve guide until g sits snugly on the cylinder head.

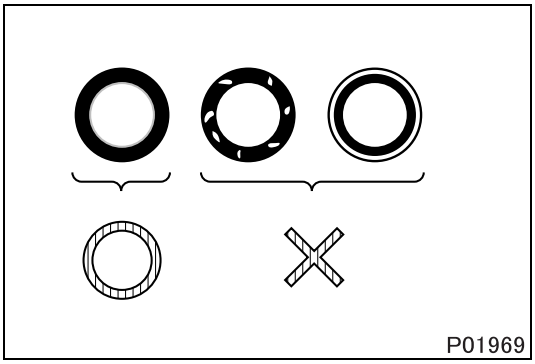
CAUTION ⚠

- **The valve guides must be pressed to the specified depth. Be sure to use g for this operation.**
- **Exhaust valve guides are longer than intake valve guides. Make sure to install the correct type of guide in each location.**



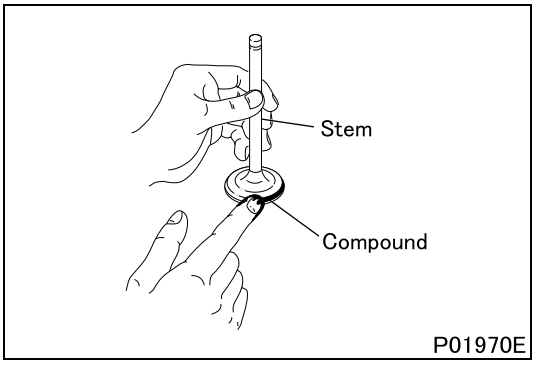
■ Inspection: Contact between valve and valve seat

- Before starting inspection, check that the valve and valve guide are intact.
- Apply an even coat of red lead to the valve contact surface of the valve seat.
- Strike the valve once against the valve seat. Do not rotate the valve during this operation.



- If the red lead deposited on the valve indicates a poor contact pattern, take either of the following corrective actions.

	Corrective action
Minor defect	Lapping
Serious defect	Reface or replace valve and valve seat

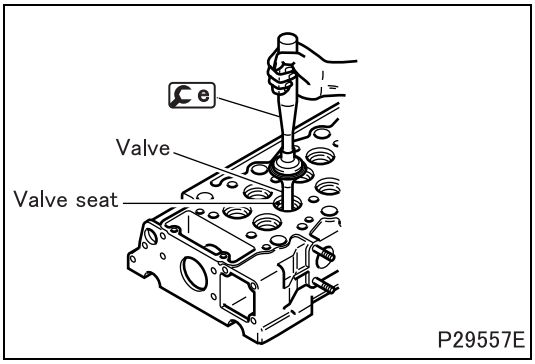


Lapping

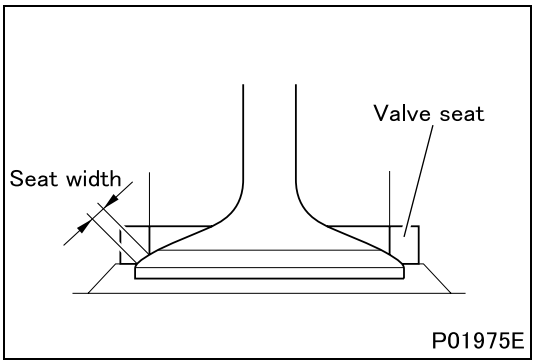
- Perform the valve lapping in the following procedure.
- Apply a thin coat of lapping compound to the seat contact surface of the valve.

CAUTION ⚠

- **Do not put any compound on the stem.**
- **Start with an intermediate-grit compound (120 to 150 grit) and finish with a fine-grit compound (200 grit or more). Do not put any compound on the stem.**
- **Adding a small amount of engine oil to the lapping compound can facilitate even application.**



- Strike the valve several times against the valve seat while rotating the valve a little at a time.
- Wash away the compound with diesel fuel.
- Apply engine oil to the valve contact surface of the valve seat and rub in the valve and seat well.
- Inspect the contact pattern of the valve and valve seat again.
- If the contact pattern is still defective, replace the valve seat.



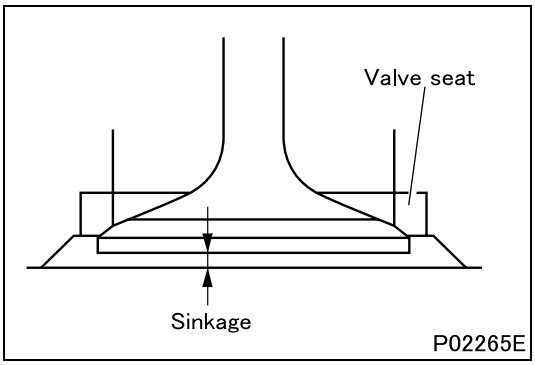
■ Inspection: Valve seats

(1) Valve seat width

- If the measurement exceeds the limit, reface or replace the valve seat.

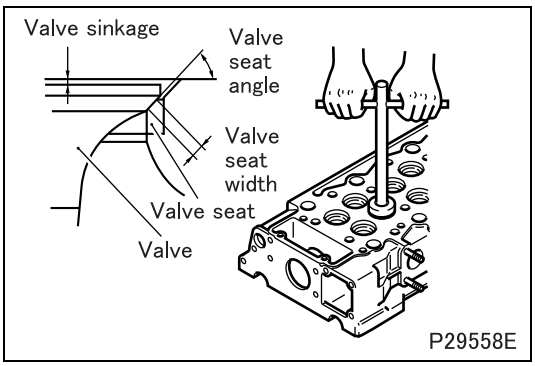
CAUTION ⚠

- **After refacing or replacing the valve seat, make sure to lap the valve seat and valve.**



(2) Valve sinkage from cylinder head bottom surface

- Make sure that the valve and valve seat are pressed together tightly when measuring the sinkage.
- If the measurement exceeds the limit, reface or replace the defective part(s).



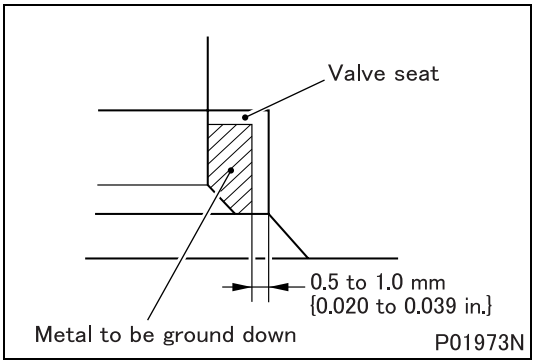
Refacing the valve seat

- Grind the valve seat using a valve seat cutter or valve seat grinder.
- Place a sandpaper of around #400 between the cutter and valve seat and grind the valve seat lightly.
- Use a 15° or 75° cutter to cut the valve seat to a width within the standard range. If the valve seat cannot be refaced to a width within the standard range, replace it.

CAUTION ⚠

- **Make sure that the valve seat refacing does not cause the valve sinkage to exceed the specified limit.**

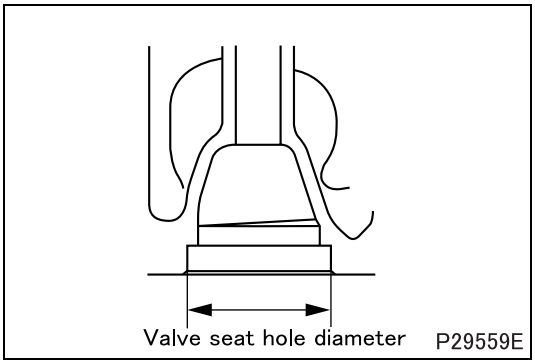
- Lap the valve and valve seat.



Replacement of valve seat

[Removal]

- The valve seats are installed by expansion fitting. To remove a valve seat, grind inside the metal stock to reduce the wall thickness, then remove the valve seat at room temperature.

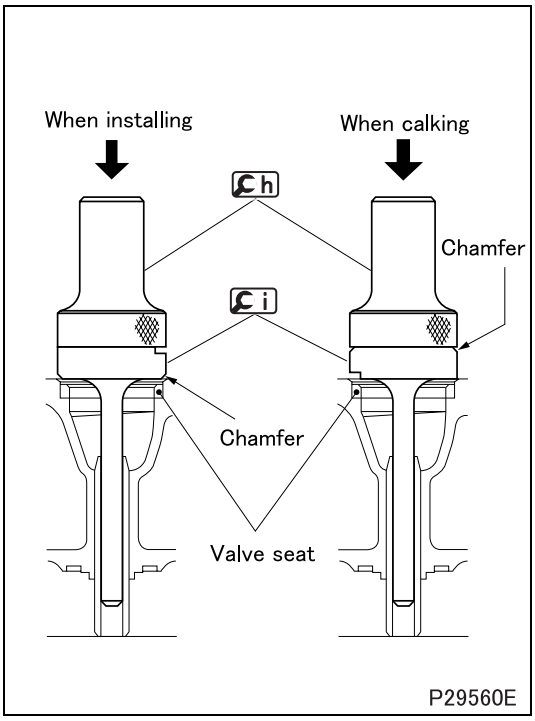


[Installation]

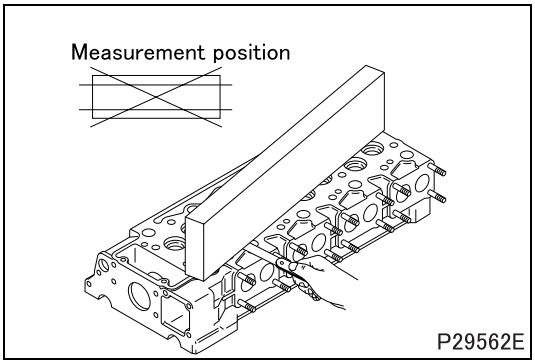
- Check that the diameter of the valve seat hole in the cylinder head conform with the value shown below.

Valve seat hole diameter	$\phi 38\ ^{+0.025}_{0}$ mm {$\phi 1.50\ ^{+0.00098}_{0}$ in.}

- Replace the cylinder head if the measurement deviates from specification.



- Chill the valve seat thoroughly by immersing in it in liquid nitrogen.
- Install the valve seat in the cylinder head using h and i, with the chamfered edge of i toward the valve seat.
- Turn i over so that its chamfered edge is toward h, and calk the valve seat.
- Lap the valve seat and valve.



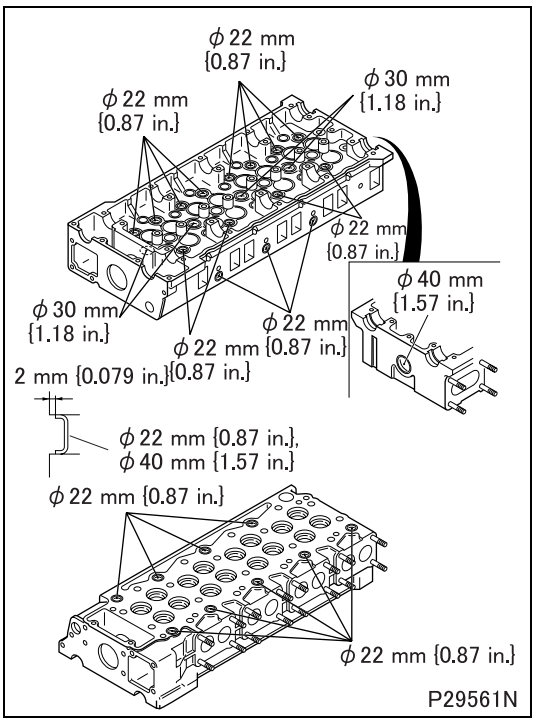
■ Inspection: Cylinder head bottom surface distortion

- If the distortion exceeds the specified limit, rectify it using a surface grinder.

CAUTION ⚠

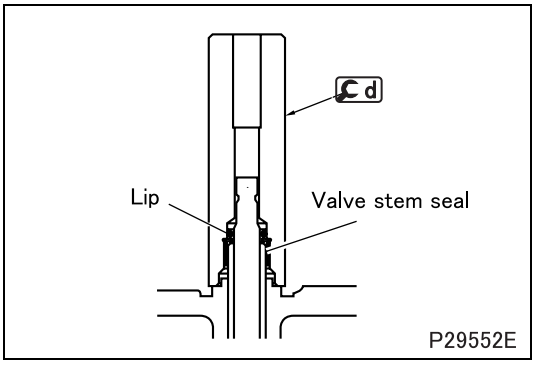
- **When grinding the cylinder head bottom surface, make sure that the height of the cylinder head (from the top surface to the bottom surface) is not reduced to a value below the specified limit.**

◆Installation procedure◆



■Installation: Sealing caps

- Drive the sealing caps into the cylinder head to the specified depth.



■Installation: Valve stem seal

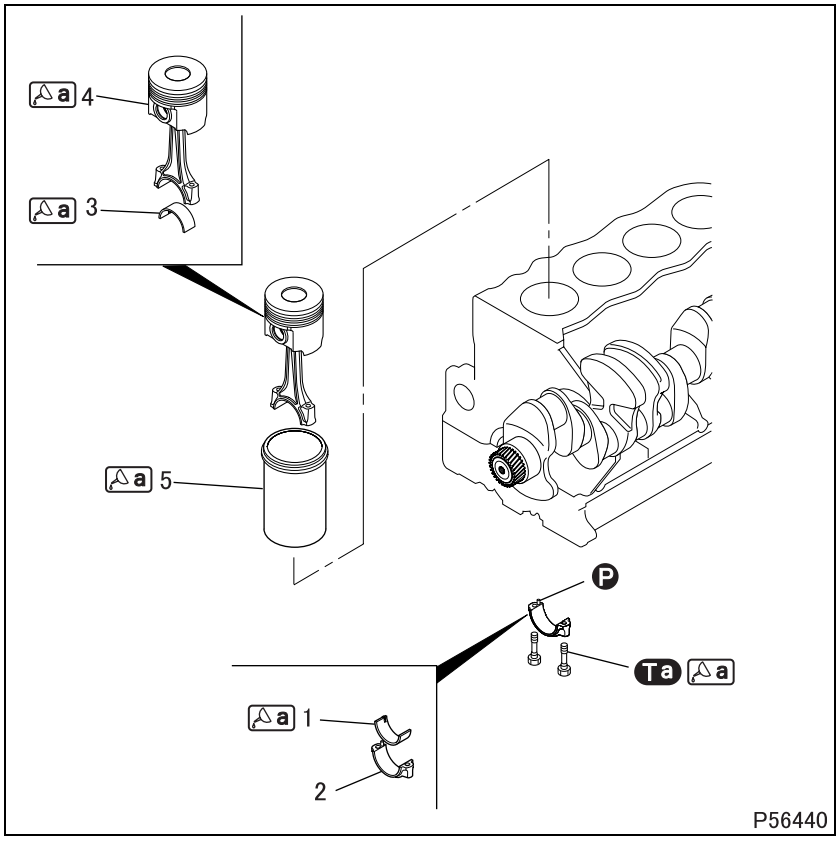
- Apply engine oil to the lip of the valve stem seal.
- Install the valve stem seal until d sits snugly on the cylinder head.

CAUTION ⚠

- **After installing the valve stem seal, check that its spring is not deformed or damaged.**

■Installation: Valve cotter

- To install the valve cotter, follow the removal procedure. (See **"■ Removal: Valve cotter"**.)



● **Disassembly sequence**

1 Lower connecting rod bearing
2 Connecting rod cap
3 Upper connecting rod bearing
4 Piston and connecting rod assembly (See later sections.)
5 Cylinder liner

Ⓟ: Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Piston projection from crankcase top surface (average value)		–0.088 to 0.094 {–0.0035 to 0.037}	–	Inspect
–	Connecting rod end play		0.15 to 0.45 {0.0059 to 0.018}	0.6 {0.024}	Inspect
1, 3	Connecting rod bearing	Span when free	–	Less than 69.5 {2.74}	Replace
		Oil clearance	0.034 to 0.093 {0.0013 to 0.0037}	0.2 {0.0079}	
4, 5	Piston-to-cylinder liner clearance		0.181 to 0.201 {0.0071 to 0.0079}	–	Replace

Location	Maintenance item		Standard value	Limit	Remedy
5	Cylinder liner	Flange projection above crankcase top surface	0.01 to 0.07 {0.00039 to 0.0028}	–	Replace
		Bore diameter	ϕ114 to 114.02 {ϕ4.4881 to 4.4889}	ϕ114.25 {ϕ4.50}	
		Out-of-roundness	0.08 {0.0031} or less	–	
		Taper	0.03 {0.0012} or less	–	
		Difference in flange projection from neighboring cylinder liner	0.04 {0.0016} or less	–	

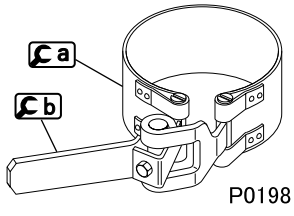
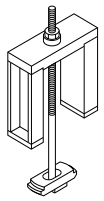
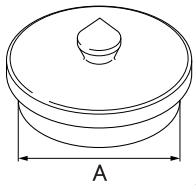
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

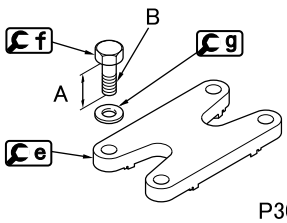
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (connecting rod cap installation)	29 {21, 3.0} + 90° ± 5°	Wet

Lubricant and/or sealant

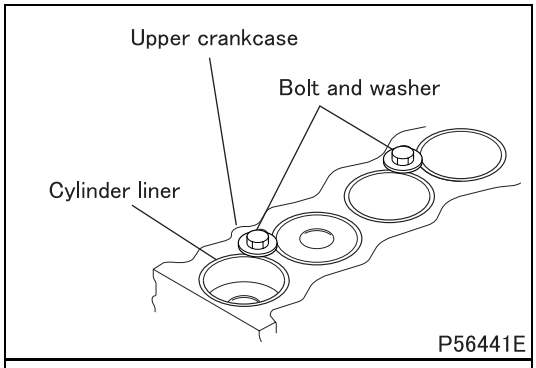
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	Engine oil	As required
	Connecting rod bearing inside surface		
	Upper crankcase contact surface of cylinder liner		
	Piston outside surface		
	Cylinder liner wall surface		

Special tools (Unit: mm {in.})

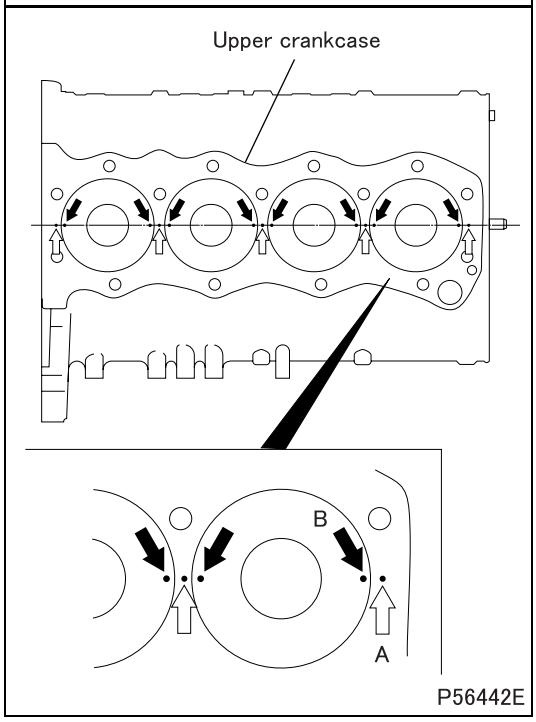
Mark	Tool name and shape		Part No.	Application
a	Piston guide clamp	 P01981	MH064332	Installation of piston and connecting rod assembly
b	Piston guide lever		MH061658	
c	Cylinder liner extractor	 P30008	MH062537	Removal of cylinder liner
d	Cylinder liner installer A: ϕ113.5 {ϕ4.47}	 A P30010	MH063606	Installation of cylinder liner

e	Adapter	 P30009	MH063433	Measurement of cylinder liner flange projection above upper crankcase top surface and difference in flange projection between neighboring cylinder liners
f	Bolt A: 40 {1.57}, B: M14 × 2		MF130625	
g	Washer		MH005012	

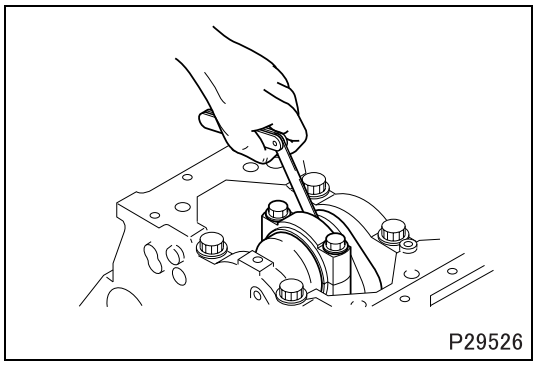
◆Inspection before removal◆



P56441E



P56442E


P29526

■ Retaining cylinder liners

- The cylinder liners slips out of the upper crankcase easily when the upper crankcase is turned over or the crankshaft is rotated with pistons inside liners. To prevent this from happening, retain the flange of each cylinder liner in position with a bolt and washer.

■ Inspection: Piston projection from upper crankcase top surface

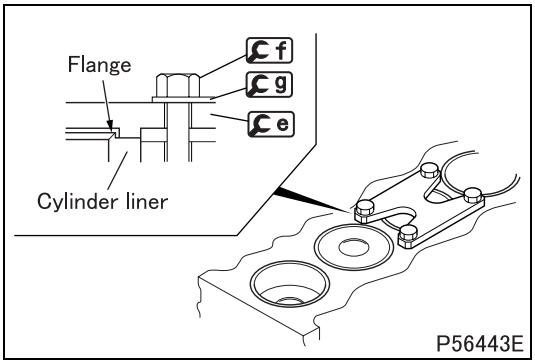
CAUTION ⚠

- **The amount of piston projection affects engine performance and must therefore be inspected without fail.**

- Set the piston at the top dead center.
- Mark reference points **A** (five points in total) on the top surface of the upper crankcase as shown in the illustration. Using each of the marks as a zero point, measure the amount of piston projection relative to the zero point (height of measurement point **B** – height of reference point **A**).
- Make the measurements at the two measurement points **B** for each cylinder (eight points in total) using the reference point **A** nearest to each measurement point, and calculate the average value of all the measurements.
- If the average value is out of the standard value range, check the clearances between all relevant parts.
- Select and use a cylinder head gasket that can accommodate the average piston projection (average value of the eight measurements).

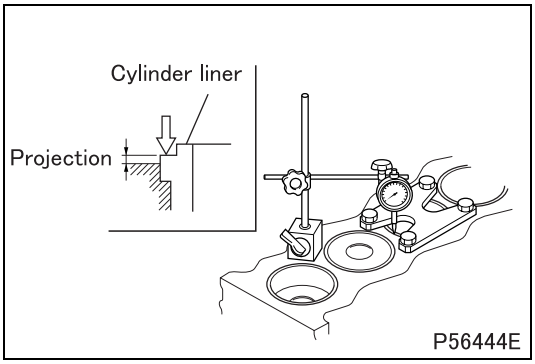
■ Inspection: Connecting rod end play

- Measure the end play for every connecting rod.
- If any measurement exceeds the specified limit, replace the defective part(s).



■ **Inspection: Difference in flange projection between neighboring cylinder liners**

- Install e on the upper crankcase so that it is not lying on top of any part of the flanges. Tighten f to a torque of 49 N·m {36 lbf·ft, 5 kgf·m}.

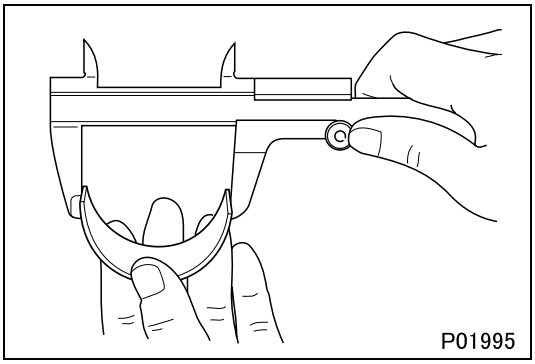


- Measure the amount of projection of the cylinder liner flange above the upper crankcase top surface.
- If the measurement is not within the standard value range, inspect the state of installation of the cylinder liner and then replace the defective part(s).

CAUTION ⚠

- **Insufficient projection of the flange can lead to a reduced pressure around the bore of the cylinder head gasket, causing gas leakage.**

◆Inspection procedure◆

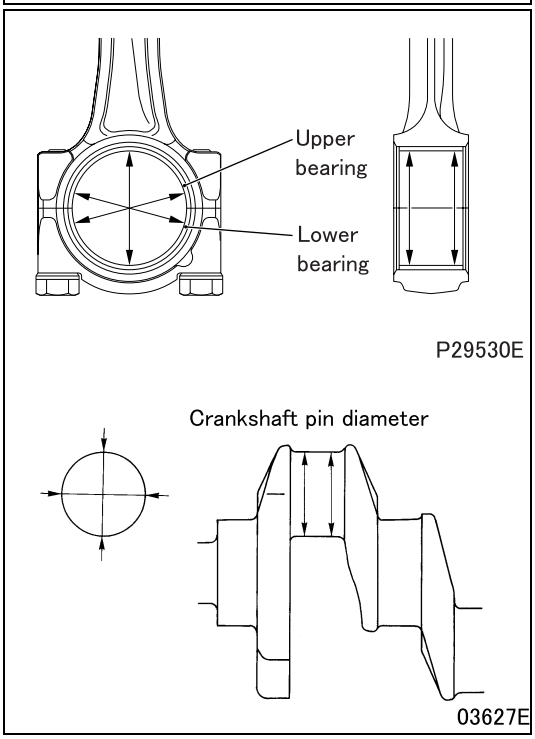

P01995

■ Inspection: Connecting rod bearing span when free

CAUTION ⚠

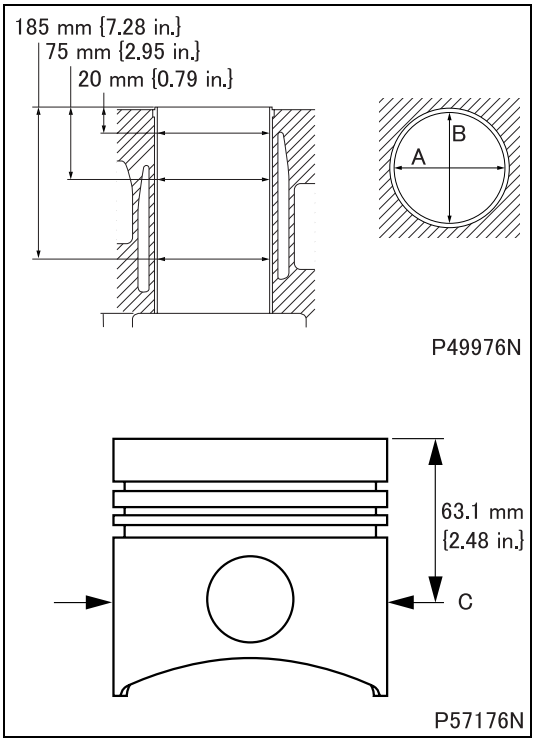
- **Do not attempt to manually expand the bearings.**
- **The upper and lower connecting rod bearings must be replaced as a set.**

- If the span is less than the specified limit, replace both the upper and lower bearings.



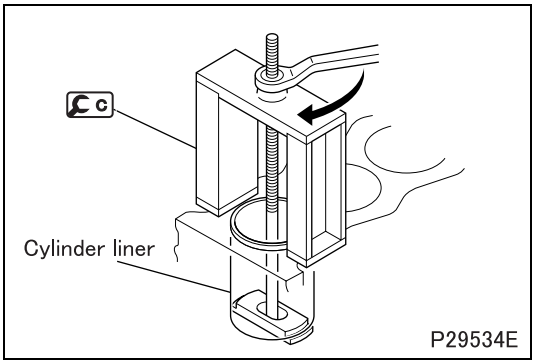
■ Inspection: Connecting rod bearing-to-crankshaft clearance (oil clearance)

- Fit the lower bearing to the connecting rod cap and the upper bearing to the connecting rod, then tighten the bolts to a torque of 30 N·m {22 lbf·ft, 3.1 kgf·m}.
- Measure the inside diameter of the bearing and the diameter of the crankshaft pin.
- If the clearance exceeds the limit, replace the defective part(s).
- If a bearing has to be replaced with an undersized one, machine the crankshaft pin to the specified undersize diameter.

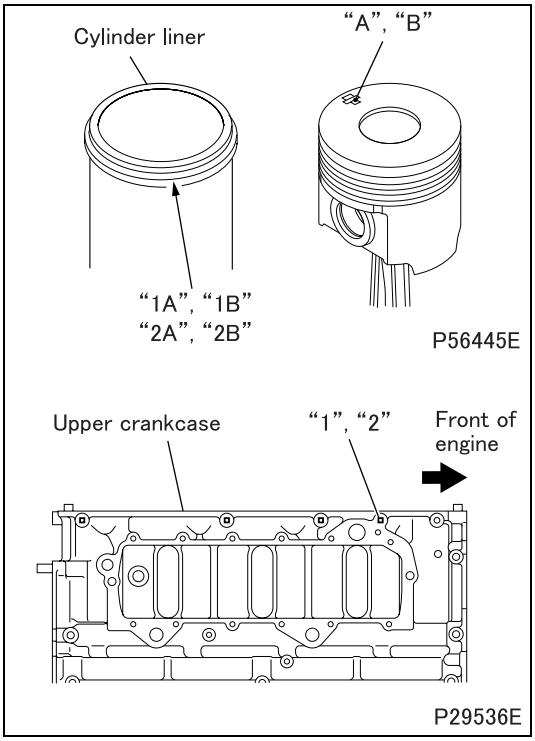


■ Inspection: Piston-to-cylinder liner clearance

- If the measurement is not within the standard value range, replace the defective part(s).
  - **A:** Cylinder bore measurement (in direction of crankshaft axis)
  - **B:** Cylinder bore measurement (in direction perpendicular to crankshaft axis)
  - **C:** Piston diameter measurement (in direction perpendicular to piston pin hole)

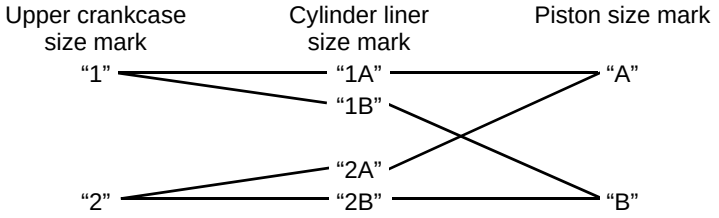


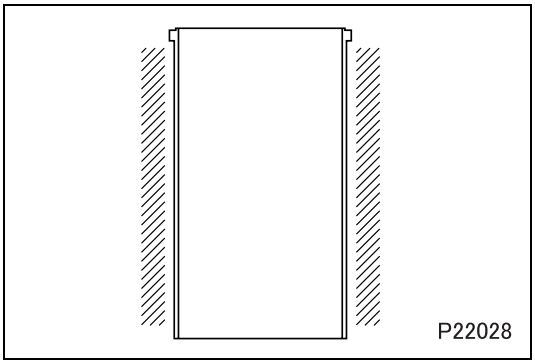
Replacement of cylinder liner
[Removal]



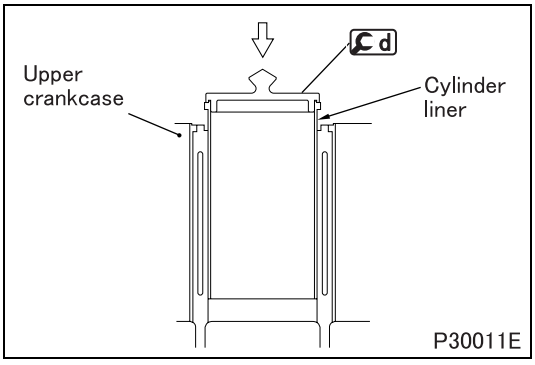
[Installation]

- Select cylinder liners with the same size marks as those on the upper crankcase and the pistons.
- The size marks on the upper crankcase are marked in the order of No. 1 cylinder, No. 2 cylinder, No. 3 cylinder and No. 4 cylinder starting with the front of the engine.





- Apply a thin coat of engine oil to the surfaces surrounding the cylinder liner of the upper crankcase (the shaded areas in the illustration).

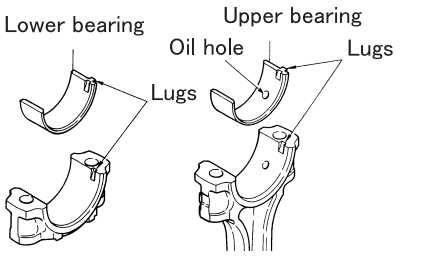


- Insert the cylinder liner into the upper crankcase by pushing down on d by hand slowly and evenly.

CAUTION ⚠

- **Handle the cylinder liner extremely carefully, as its wall is relatively thin and can be easily damaged.**

◆Installation procedure◆

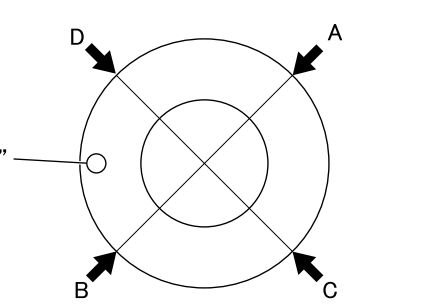


49975E

■ **Installation: Connecting rod bearings**

CAUTION ⚠

- **Do not reverse the positions of the lower bearing and the upper bearing (with oil hole) when installing, as this may cause seizure in the engine.**

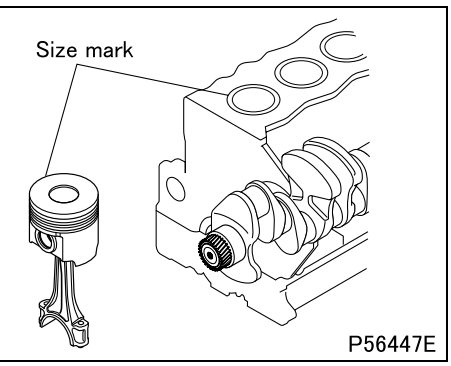


P56446

■ **Installation: Piston and connecting rod assembly**

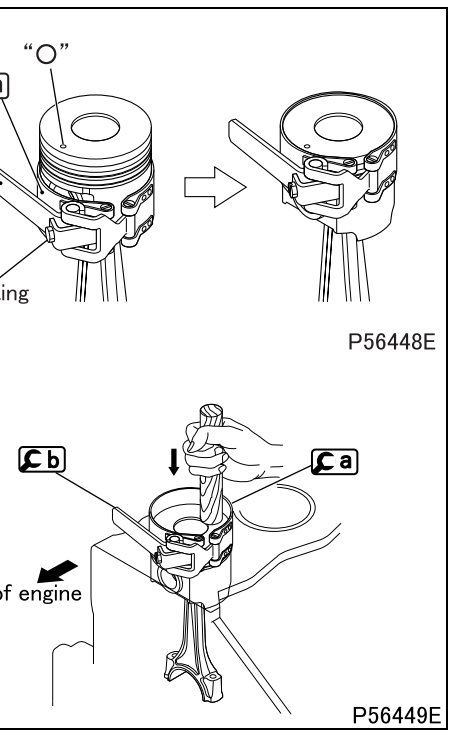
- Check that the piston ring end gaps are in their correct positions.
  - **A:** 1st compression ring gap
  - **B:** 2nd compression ring gap
  - **C:** Oil ring gap
  - **D:** Oil ring expander spring gap

"○": Front mark on piston

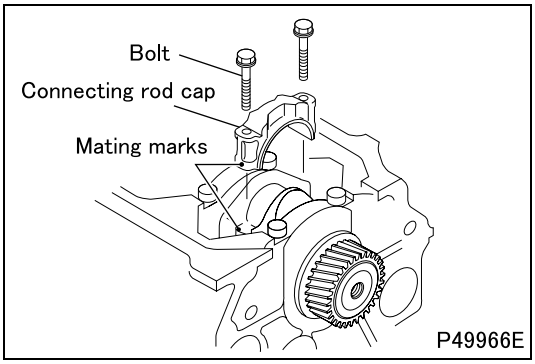


P56447E

- Check that the pistons and the cylinder liners have identical size marks (**"A"** or **"B"**).
- Install the pistons in the cylinder liners. Be careful not to scratch the inner surface of the liner and the crankshaft pins.

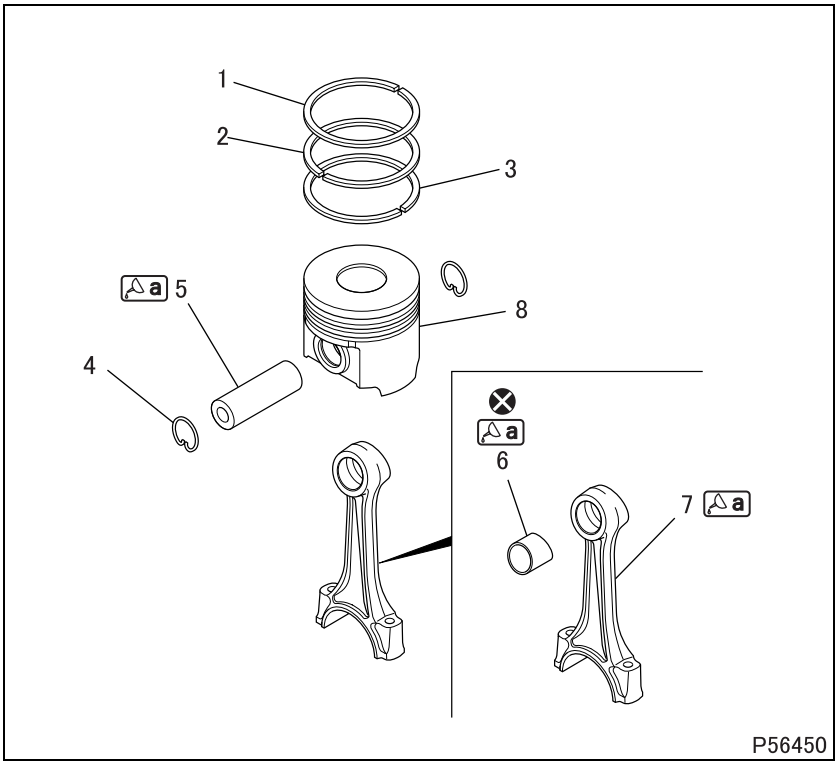


- Face the front mark "○" of the piston toward the front of the engine.
- Using the adjusting bolt of b, adjust the inside diameter of a such that it matches the piston's skirt diameter.
- Remove the tools from the piston and apply engine oil to the following parts before reinstalling the tools around the piston rings:
  - Outside surface of piston
  - Inside surface of a
  - Inside surface of cylinder liner



- After installing the piston and connecting rod assembly, align the mating marks on the connecting rod and connecting rod cap and tighten the bolts alternately in the following manner.
  - First tighten the bolt to a torque of 29 N·m {21 lbf·ft, 3.0 kgf·m}.
  - Tighten the bolt further by turning it clockwise by 90° ± 5°.

Piston and Connecting Rod



● **Disassembly sequence**

1 1st compression ring
2 2nd compression ring
3 Oil ring
4 Snap ring
5 Piston pin
6 Connecting rod bushing
7 Connecting rod
8 Piston

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

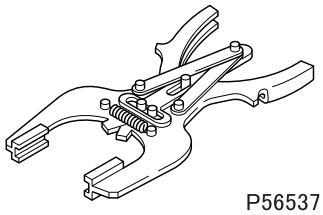
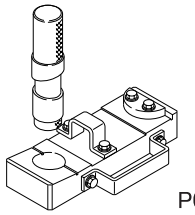
Location	Maintenance item		Standard value	Limit	Remedy
1 to 3	Piston ring end gap	1st compression ring	0.3 to 0.45 {0.012 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.4 to 0.55 {0.016 to 0.022}		
		Oil ring	0.3 to 0.5 {0.012 to 0.020}		
1 to 3, 8	Piston ring side clearance in piston groove	1st compression ring	0.129 to 0.178 {0.0051 to 0.0070}	0.2 {0.0079}	Replace
		2nd compression ring	0.065 to 0.105 {0.0026 to 0.0041}	0.15 {0.0059}	
		Oil ring	0.025 to 0.065 {0.00098 to 0.0026}		
4, 6	Piston pin-to-connecting rod bushing clearance		0.020 to 0.055 {0.00079 to 0.0022}	0.1 {0.0039}	Replace
4, 8	Piston pin-to-piston clearance		0.004 to 0.022 {0.00016 to 0.00087}	0.05 {0.0020}	Replace
7	Connecting rod	Bend	–	0.05 {0.0020}	Replace
		Twist	–	0.1 {0.0039}	

Lubricant and/or sealant

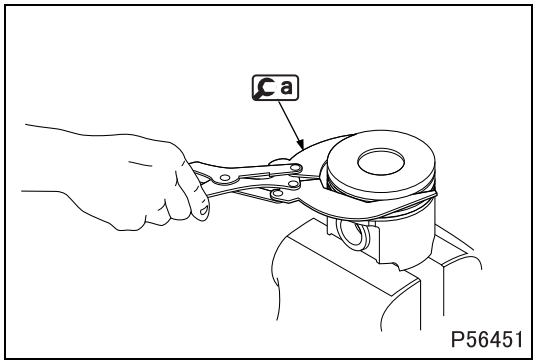
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Piston pin outside surface	Engine oil	As required
	Connecting rod bushing outside surface		
	Connecting rod bushing fitting surface of connecting rod		

PISTONS, CONNECTING ROD AND CYLINDER LINERS

Special tools

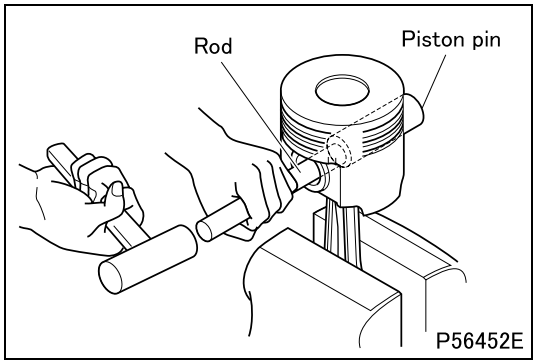
Mark	Tool name and shape	Part No.	Application
ⓒa	Piston ring tool  P56537	MH060014	Removal and installation of piston rings
ⓒb	Connecting rod bushing puller kit  P02015	MH062225	Removal and installation of connecting rod bushings

◆Removal procedure◆



P56451

■ **Removal: Piston ring**

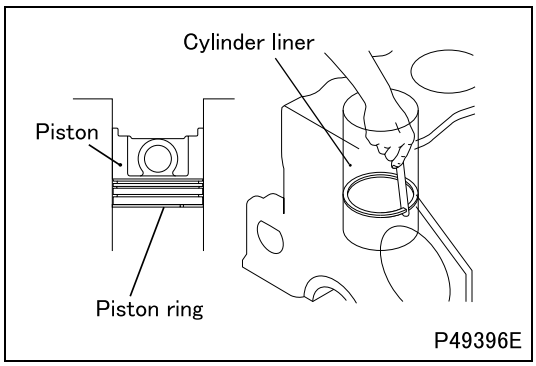


P56452E

■ **Removal: Piston pin**

- Remove the piston pin by striking it with a rod and hammer.
- If the piston pin is difficult to remove, first heat the piston in hot water or with a piston heater.

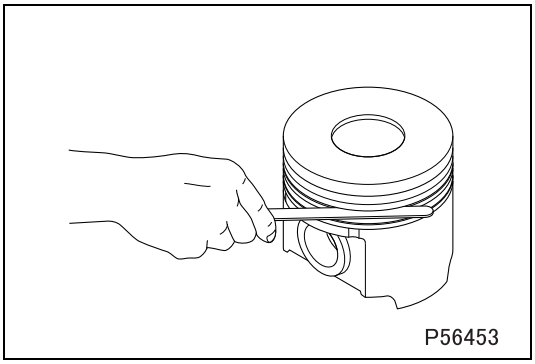
◆Inspection procedure◆



P49396E

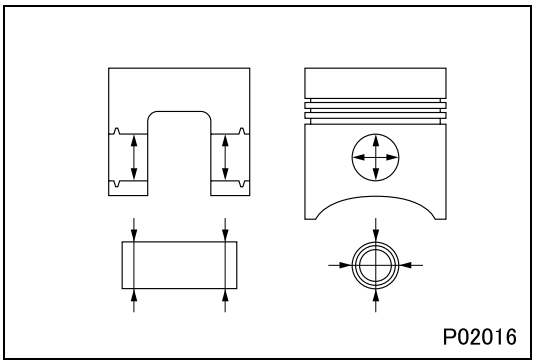
■ **Inspection: Piston ring end gap**

- Using the crown of a piston, push the piston ring horizontally into a cylinder in the cylinder liner until it reaches the lower part of the cylinder liner, where there is relatively small wear.
- Taking care not to move the piston ring, measure the end gap.
- If any of the rings has a gap exceeding the specified limit, replace all the piston rings as a set.



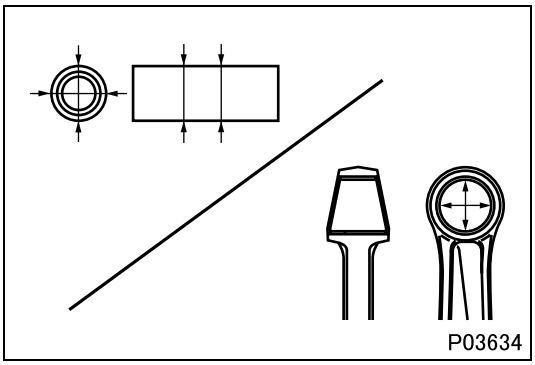
■ **Inspection: Piston ring side clearance in piston groove**

- Remove any carbon deposits from the ring groove in the piston.
- Measure the side clearance of each ring around the piston's entire periphery.
- If any of the measurements exceeds the specified limit, replace the defective part(s). If any of the piston rings is defective, replace all the rings on the piston as a set.



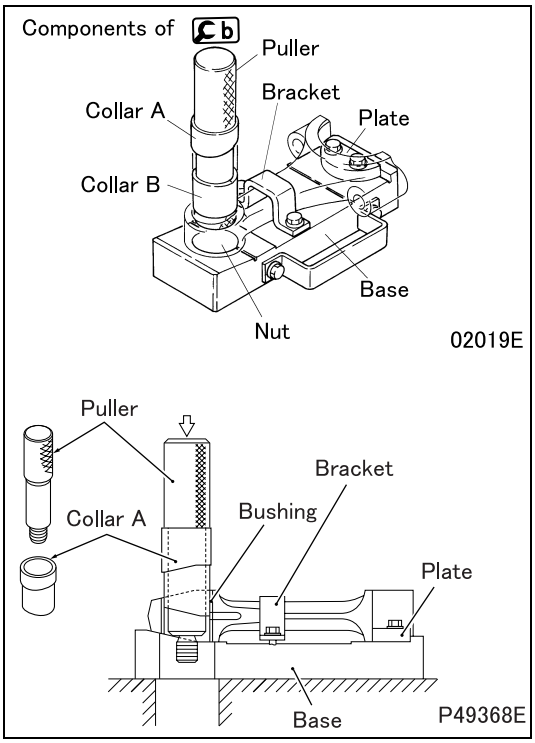
■ **Inspection: Piston pin-to-piston clearance**

- If the measurement exceeds the specified limit, replace the defective part(s).



■ **Inspection: Piston pin-to-connecting rod bushing clearance**

- If any of the measurements exceeds the specified limit, replace the bushing.

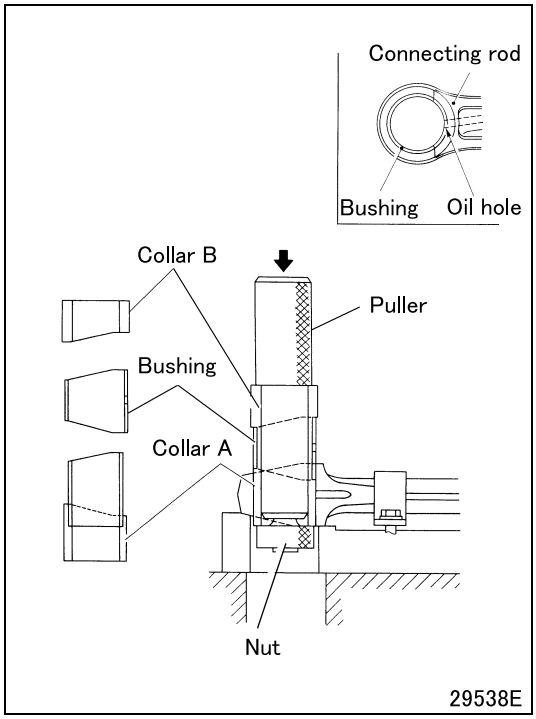


Replacement of connecting rod bushing

- Replace the connecting rod bushing using b.

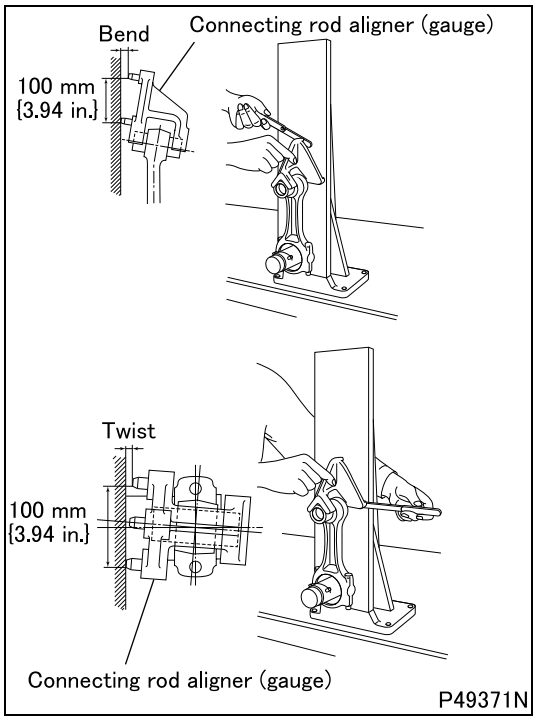
[Removal]

- Remove the upper bearing (if fitted) from the big end of the connecting rod.
- Mount the connecting rod on the base and lock it in position with the bracket and plate.
- Fit collar A over the puller with its ends facing in the illustrated directions. Then, slowly apply a pressure of approximately 49 kN {11020 lbs, 5000 kgf} to the puller with a press to force out the connecting rod bushing.



[Installation]

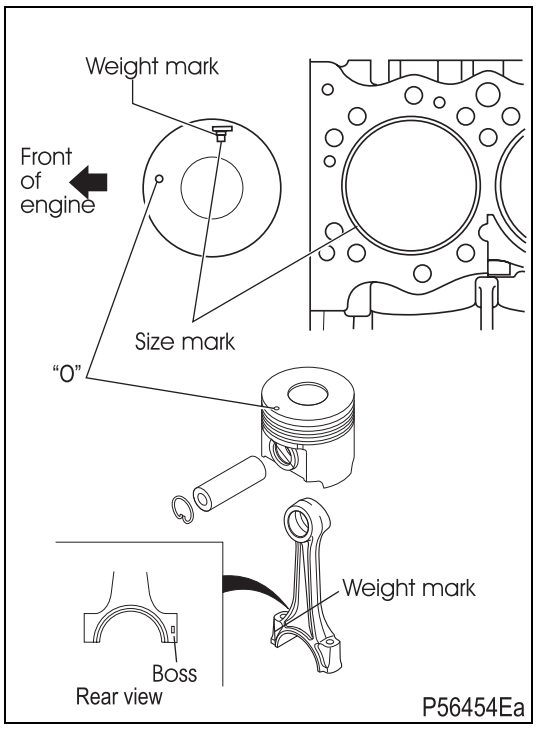
- Apply engine oil to the outside surface of the connecting rod bushing and the bushing fitting surface of the connecting rod.
- Fit collar B, the bushing, and collar A over the puller in the illustrated directions and lock this arrangement together with the nut.
- Align the oil holes in the connecting rod bushing and the connecting rod. Then, use a press to slowly apply a pressure of approximately 49 kN {11020 lbs, 5000 kgf} to the puller until the bushing is forced into place.
- After press-fitting the connecting rod bushing, measure the clearance between the piston pin and connecting rod bushing.
- If the measurement is less than the standard clearance range, ream the bushing.



■Inspection: Connecting rod bend and twist

- Mount the connecting rod on the connecting rod aligner. Also mount the connecting rod bearings, piston pin, and connecting rod cap to create the same conditions as are expected when the connecting rod is mounted on a crankshaft. Tighten the bolts of the connecting rod bearing cap to a torque of 30 N·m {22 lbf·ft, 3.1 kgf·m}.
- Measure the extent of bend and twist in the connecting rod.
- If either measurement exceeds the specified limit, replace the connecting rod.

◆Installation procedure◆



■ Installation: Piston and connecting rod

- When replacing a piston and connecting rod assembly, select and install a new piston and connecting rod by the following procedure.
- Choosing pistons
  - Choose pistons of the same weight for all cylinders.
  - Check that the size marks (**"A"** or **"B"**) on the piston and cylinder liner are identical.

CAUTION ⚠

- **Make sure to use pistons and cylinder liners of the same size. Failure to do so may result in seizures in the engine.**

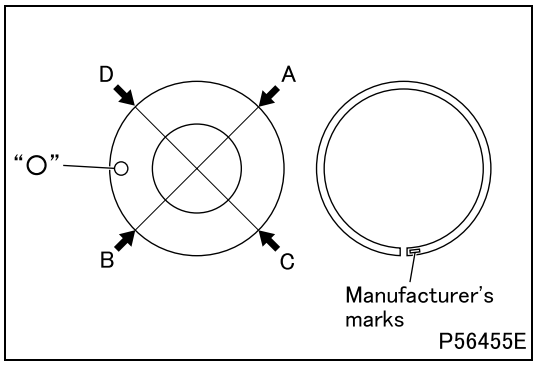
- Choose connecting rod of the same weight for every cylinder.

NOTE: Weight mark: **"C"** to **"G"** (with **"G"** as the maximum)

- Apply engine oil to the piston pin, and assemble the piston and connecting rod with their marks facing in the illustrated directions.

"○": Front mark

- If the piston pin is difficult to insert, heat the piston in hot water or with a piston heater.



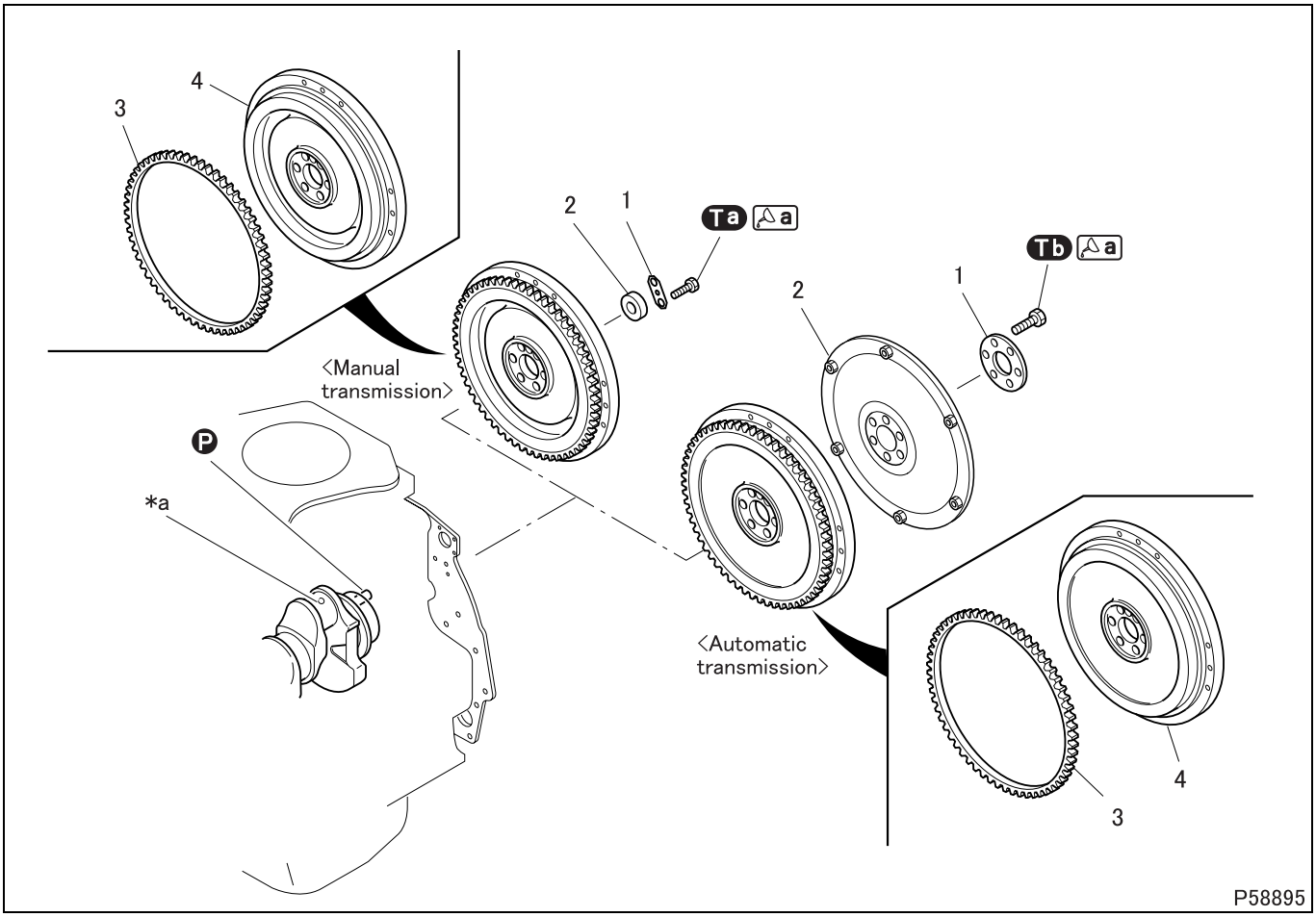
■ Installation: Piston rings

- With the manufacturer's marks (found near the piston ring end gaps) facing up, install the piston rings so that the end gap of each ring is positioned as illustrated.
  - **A:** 1st compression ring end gap
  - **B:** 2nd compression ring end gap
  - **C:** Oil ring end gap
  - **D:** Oil ring's expander spring end gap

"○": Front mark on piston

The manufacturer's marks are present only on the 1st and 2nd compression rings.

FLYWHEEL



● Disassembly sequence

1 Plate <Manual transmission>
Wear plate <Automatic transmission>
2 Bearing <Manual transmission>
Drive plate <Automatic transmission>
3 Ring gear
4 Flywheel assembly

***a**: Crankshaft
P: Locating pin

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
4	Flywheel assembly <Manual transmission>	Friction surface runout (when fitted)	–	0.2 {0.0079}	Rectify or replace
		Friction surface height	19.5 {0.77}	18.5 {0.73}	
		Friction surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	

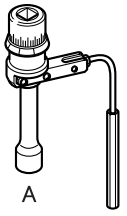
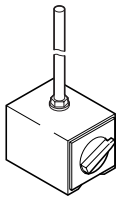
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (flywheel assembly installation)	39 {44, 6.0} + 40°	Wet
Tb	Bolt (flywheel assembly installation)	118 {87, 12} + 90°	Wet

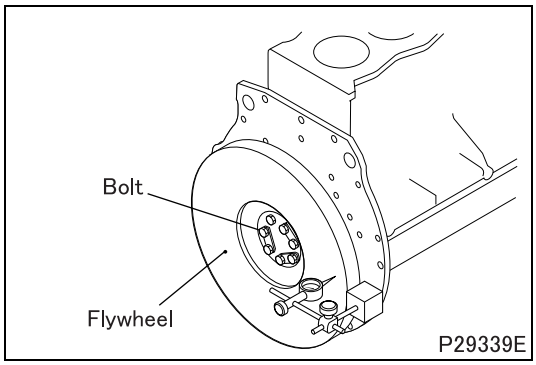
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	Engine oil	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Socket wrench A: Bolt head width across flats: 22 {0.87}  P01984	MH062183	Installation of flywheel assembly
b	Magnet base  P00471	MH062356	

◆Inspection before removal◆



P29339E

■ **Inspection: Flywheel runout <Manual transmission>**

- If the runout exceeds the specified limit, check that the bolts are tightened correctly and that there are no abnormalities on the crankshaft mounting surface. If the runout is still excessive even after necessary steps have been taken according to the check results, rectify or replace the flywheel assembly.

◆Removal procedure◆

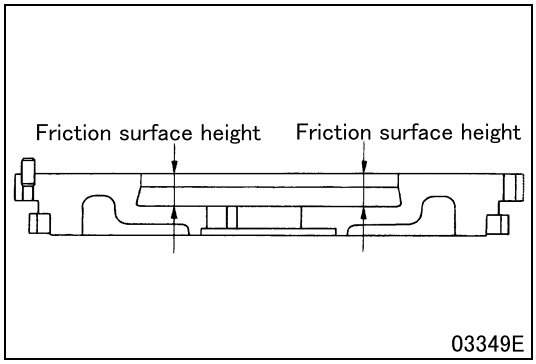
■ **Removal: Ring gear**

- Heat the ring gear evenly with a gas burner or the like until it reaches approximately 200°C {390°F}, then remove it from the flywheel assembly.

WARNING ⚠

- **You could get burnt if you touch the heated ring gear.**

◆Inspection procedure◆

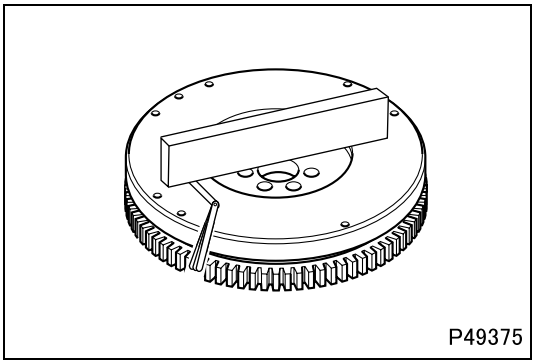


03349E

■ **Inspection: Flywheel assembly <Manual transmission>**

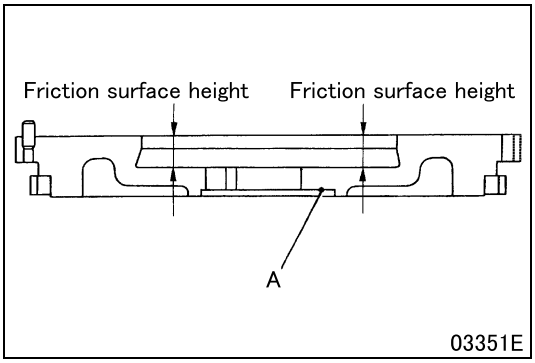
(1) Friction surface height

- If the height is below the specified limit, rectify or replace the flywheel assembly.


P49375

(2) Friction surface distortion

- If the measured amount of distortion is above the specified limit, rectify or replace the flywheel assembly.

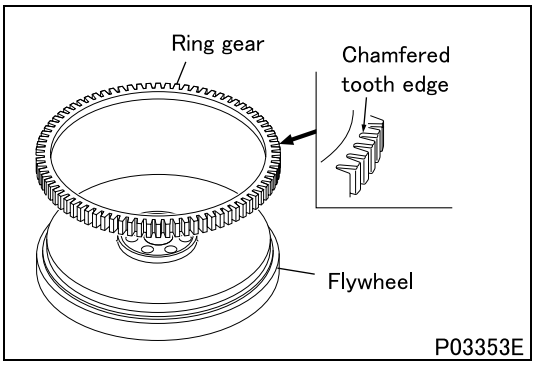


03351E

Rectification of friction surface

- Rectify the friction surface so that its height is not below the specified limit, and it is parallel with surface **A** with an error not exceeding 0.1 mm {0.0039 in.}.

◆Installation procedure◆



P03353E

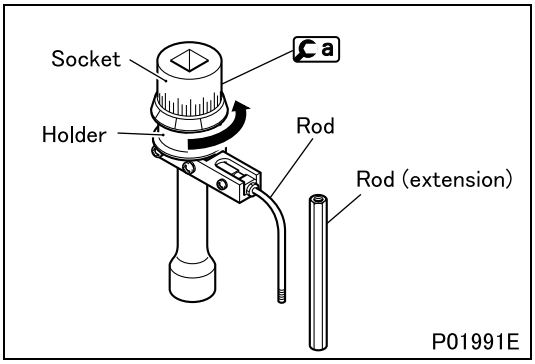
■ Installation: Ring gear

- Heat the ring gear evenly with a gas burner or the like until it reaches approximately 200°C {390°F}.

WARNING ⚠

- **You could get burnt if you touch the heated ring gear.**

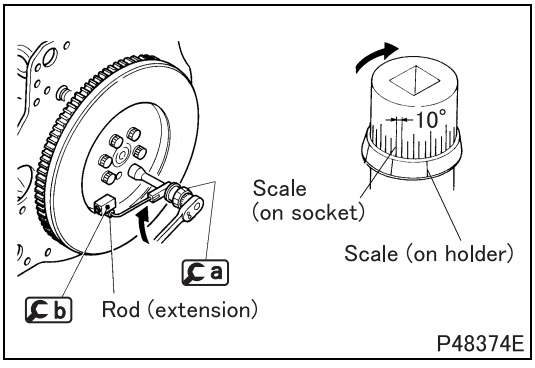
- Fit the ring gear with the side having non-chamfered tooth edges toward the flywheel.



P01991E

■ Installation: Flywheel <Manual transmission>

- Tighten all the bolts to 59 N·m {44 lbf·ft, 6.0 kgf·m} and then additionally tighten them by the following procedure.
- Rotate the holder of a counterclockwise to pretension the internal spring.

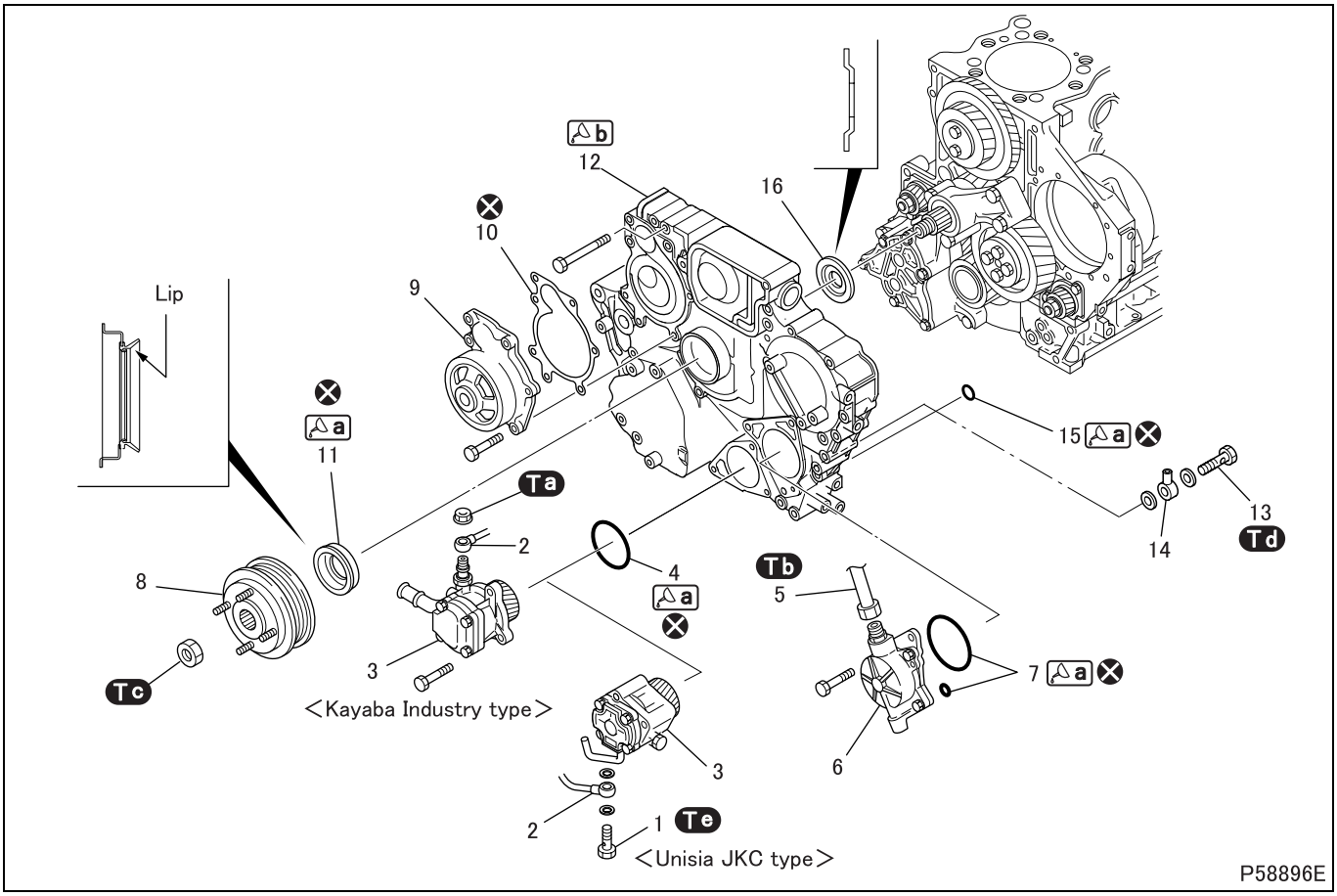


P48374E

- Fit a on the bolt and set b so that the rod (extension) is held pressed against it by the spring force.
- Align a scale mark on the socket with a scale mark on the holder. (This point will be the point of reference, or the 0° point.)
- Starting with this point of reference, turn the socket clockwise with a wrench by 40° ± 5° (one graduation on the socket scale represents 10°).

M E M O

FRONT CASE



● **Disassembly sequence**

1 Eyebolt <Unisia JKC type>
2 Power steering pipe
3 Power steering oil pump (See Gr37)
4 O-ring
5 Vacuum pipe
6 Vacuum pump (See Gr35A)
7 O-ring
8 Fan pulley
9 Water pump (See Gr14)
10 Gasket
11 Front oil seal
12 Front case
13 Eyebolt
14 Oil jet
15 O-ring
16 Front oil seal slinger

⊗: Non-reusable parts

CAUTION ⚠

- **Do not remove the front oil seal unless defects are evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

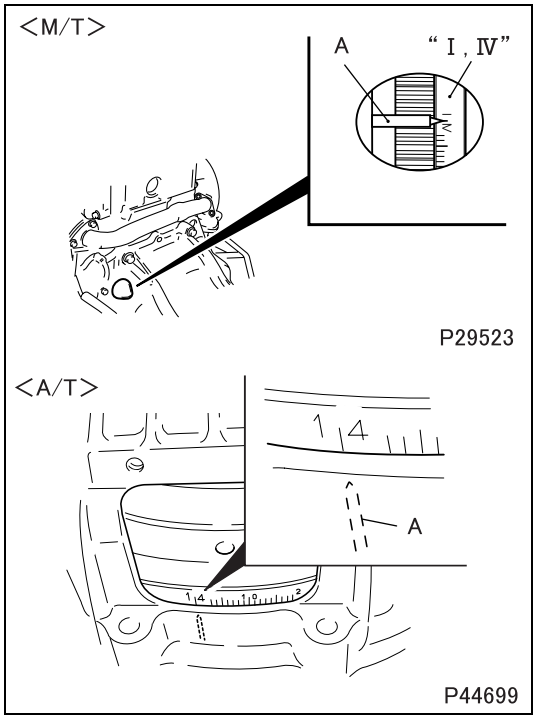
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (power steering pipe installation)	29.4 to 39.2 {22 to 29, 3 to 4}	–
Tb	Vacuum pipe	29.4 {22, 3.0}	–
Tc	Nut (fan pulley installation)	196.1 {145, 20.0}	–
Td	Eyebolt (oil jet installation)	10 {7.4, 1.0}	–
Te	Eyebolt (power steering pipe installation)	49.0 to 63.7 {36 to 47, 5.0 to 6.5}	–

Lubricant and/or sealant

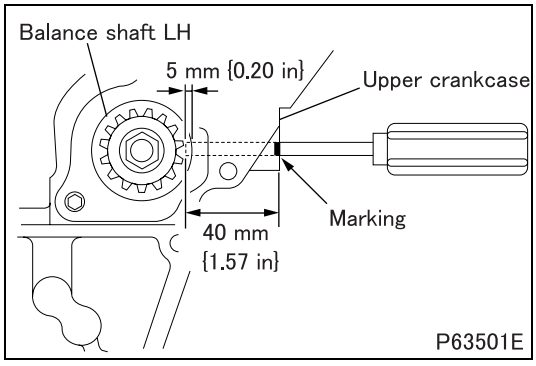
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Front oil seal lip		
b	Front case installation surfaces	ThreeBond 1207C or D	As required

◆Removal procedure◆



■ **Removal: Vacuum pump**

- The vacuum pump also serves for positioning the balance shaft LH. Therefore, before removing the vacuum pump, hold the balance shaft in position by the following procedure.
- Align the pointer A to between the inscribed lines (**Ⅰ** and **Ⅳ** or **1** and **4**) on the flywheel. (Place No.1 cylinder piston at the top dead center on compression stroke.)



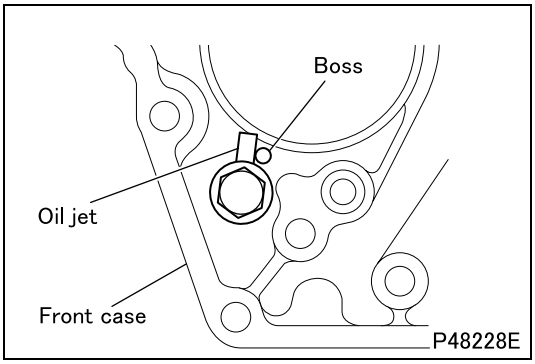
- Remove the upper crankcase plug.
- Mark a screwdriver or the like (ϕ4.5 mm {0.18 in} or less) at a point 40 mm {1.57 in} apart from its tip.
- Insert the screwdriver or the like (ϕ4.5 mm {0.18 in} or less) into the plug hole until it lightly touches the balance shaft LH.

CAUTION ⚠

- **Do not press the screwdriver hard against the balance shaft LH, as this may damage No.1 journal of the balance shaft.**

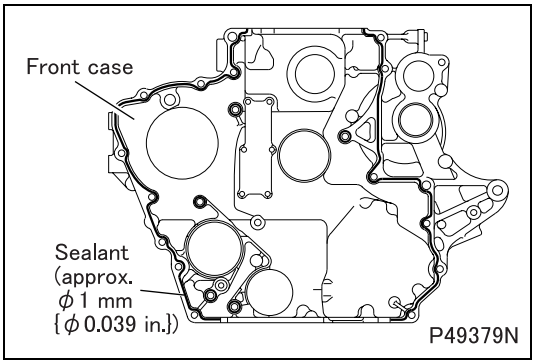
- Put the tip of the screwdriver or the like into the shaft supporting hole at No.1 journal of the balance shaft.
- This insertion depth of the screwdriver or the like into the shaft supporting hole should be 5 mm.
- Remove the vacuum pump with the screwdriver or the like inserted in the hole.

◆Installation procedure◆



■ **Installation: Oil jet**

- When installed, the oil jet must be in contact with the front case and its nozzle must face in the illustrated direction.

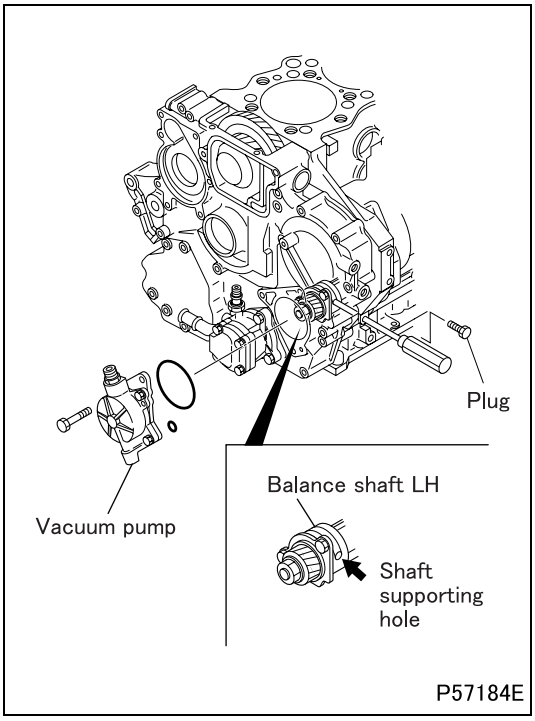


■ **Installation: Front case**

- Clean the sealant application surfaces of each part.
- Apply evenly thick beads of sealant to the upper crankcase mounting surface of the front case without any breaks.
- Mount the front case within three minutes of applying the sealant, being careful not to dislodge the sealant.

CAUTION ⚠

- **Do not run the engine within one hour of installing the front case.**
- **If the front case mounting bolts are loosened or removed, be sure to reapply sealant to the front case.**



■ **Installation: Vacuum pump**

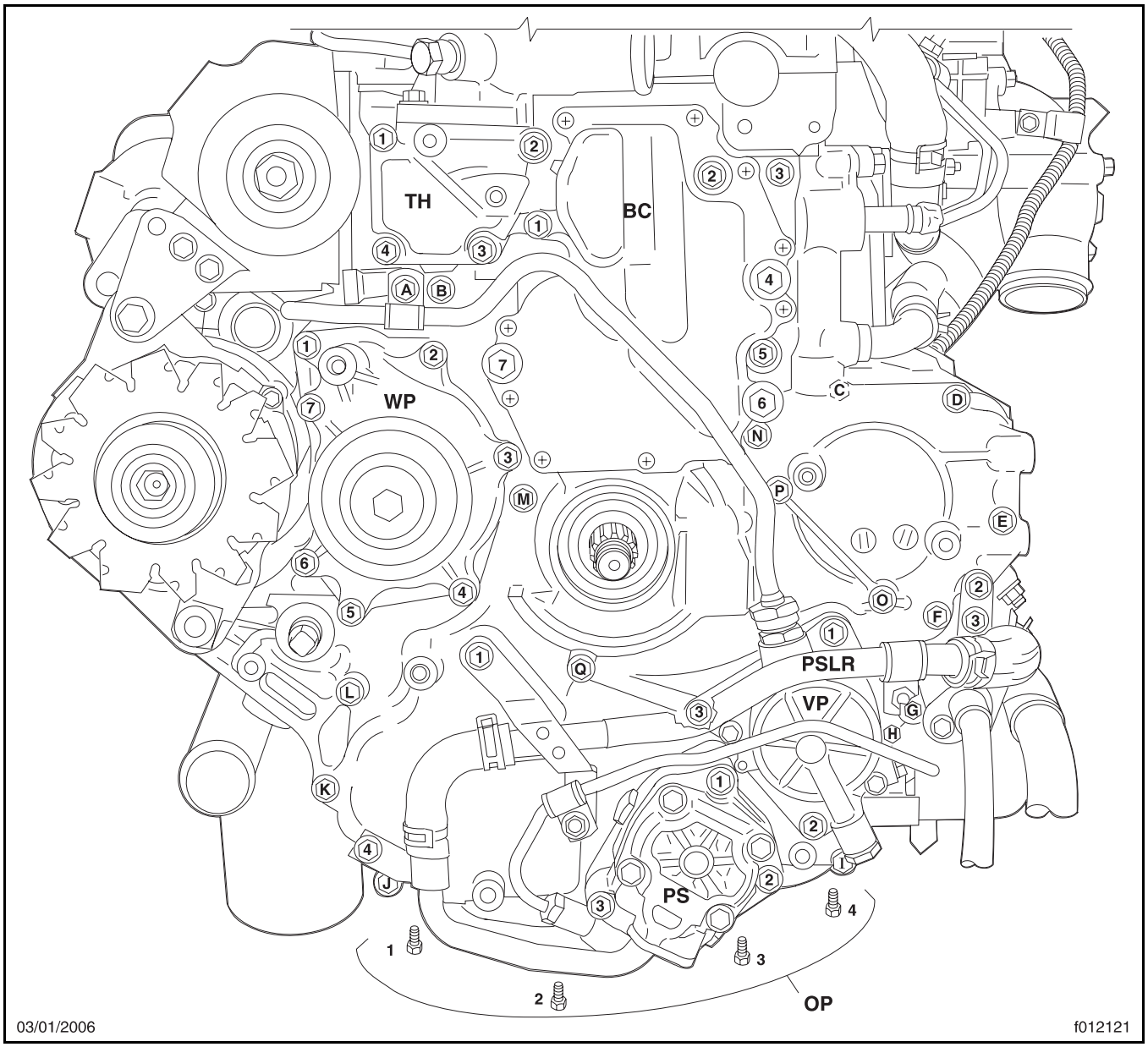
- The vacuum pump also serves as an element holding the balance shaft LH in place. Therefore, before installing the vacuum pump, hold the balance shaft LH in the correct position by the following procedure.
  - Place the No. 1 cylinder piston at the top dead center on compression stroke.
  - Remove the upper crankcase plug.
  - Insert a screwdriver or a similar tool into the plug hole until it lightly touches the balance shaft LH.

CAUTION ⚠

- **Do not press the screwdriver strongly against the balance shaft LH, as this may damage the No. 1 journal of the balance shaft.**

  - Turn the balance shaft LH slowly until the screwdriver aligns with the shaft support hole at the No. 1 journal and insert the screwdriver into the hole.
- Install the vacuum pump.
- After installing the vacuum pump, remove the screwdriver and reinstall the plug.

◆Bolt identification◆



Bolt identification (Unit: MM)

Breather cover (bc)	
Bolt #	**Bolt diameter and length**
1	M8 x 30
2	M8 x 20
3	M8 x 20
4	M8 x 100 (with spacer & washer)
5	M8 x 70
6	M8 x 35 (with spacer & washer)
7	M8 x 35 (with spacer & washer)

Water pump (wp)	
Bolt #	**Bolt diameter and length**
1	M8 x 80
2	M8 x 80
3	M8 x 25
4	M8 x 80
5	M8 x 85
6	M8 x 25
7	M8 x 25

Noise suppression shield	
Bolt #	**Bolt diameter and length**
1	M8 x 20 (with spacer & washer)
2	M8 x 20 (with spacer & washer)
3	M8 x 20 (with spacer & washer)
4	M8 x 80 (with spacer & washer)
5	M8 x 20 (with spacer & washer)

Power steering pump (ps)	
Bolt #	**Bolt diameter and length**
1	M8 x 80
2	M8 x 130
3	M8 x 80

Power steering return line brackets (psrl)	
Bolt #	**Bolt diameter and length**
1	M8 x 15
2	M8 x 15
3	M8 x 15
4	M8 x 15

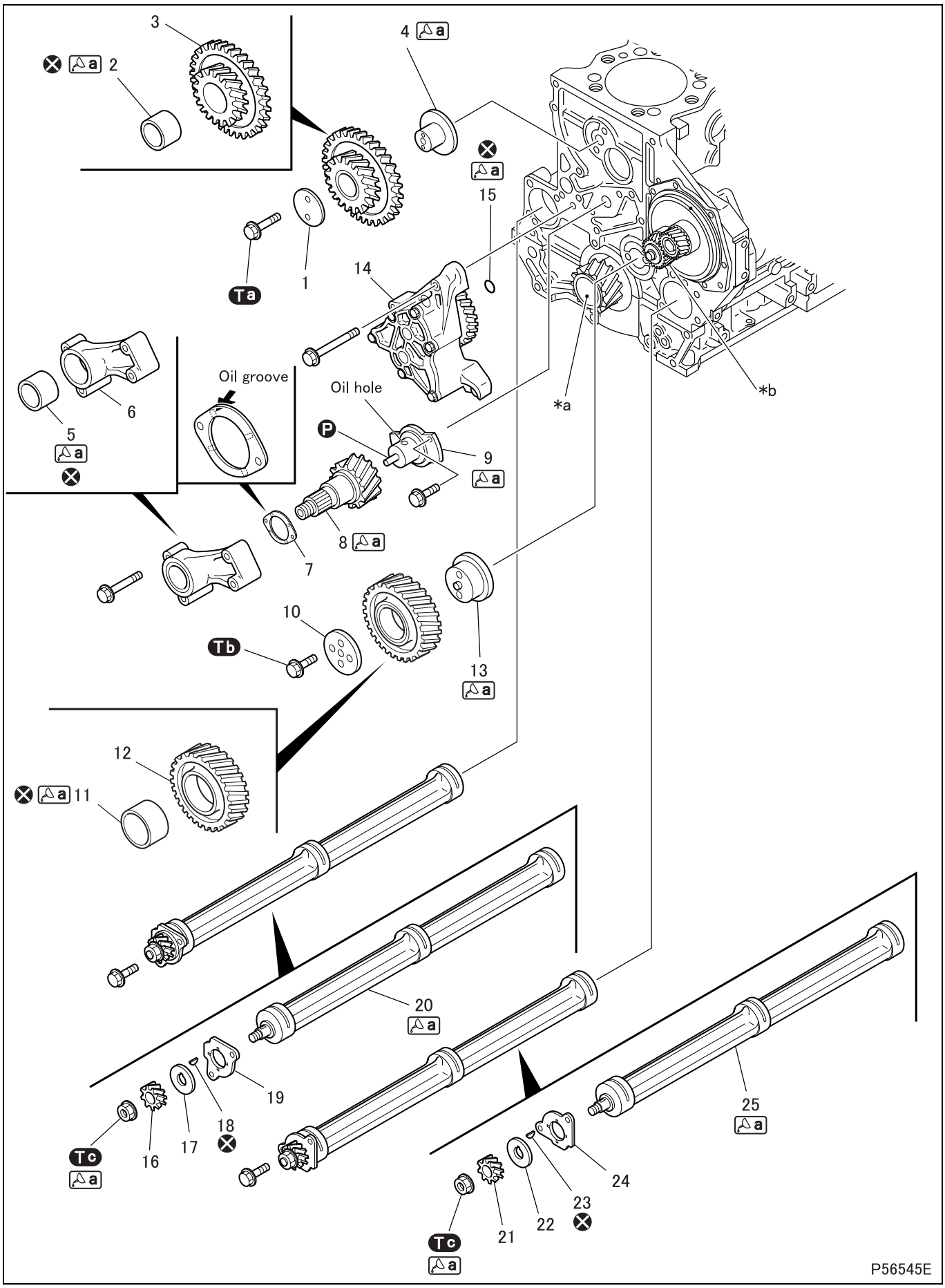
Vacuum pump (vp)	
Bolt #	**Bolt diameter and length**
1	M8 x 75
2	M8 x 75
3	M8 x 20

Thermostat housing (th)	
Bolt #	**Bolt diameter and length**
1	M8 x 15
2	M8 x 55
3	M8 x 15
4	M8 x 15

Oil pan (op)	
Bolt #	**Bolt diameter and length**
1	M8 x 10
2	M8 x 10
3	M8 x 10
4	M8 x 10

Front cover	
Bolt #	**Bolt diameter and length**
a	M8 x 25
b	M8 x 75
c	M8 x 100
d	M8 x 100
e	M8 x 100
f	M8 x 100
g	M8 x 65
h	M8 x 45
i	M8 x 65
j	M8 x 75
k	M8 x 75
l	M8 x 75
m	M8 x 60
n	M8 x 100
o	M8 x 75
p	M8 x 75
q	M8 x 75

M E M O


3
2
4
15
1
Ta
14
Oil groove
Oil hole
6
5
9
8
7
*a
*b
10
Tb
13
12
11
20
19
18
17
16
Tc
25
24
23
22
21
Tc
P56545E

● Disassembly sequence

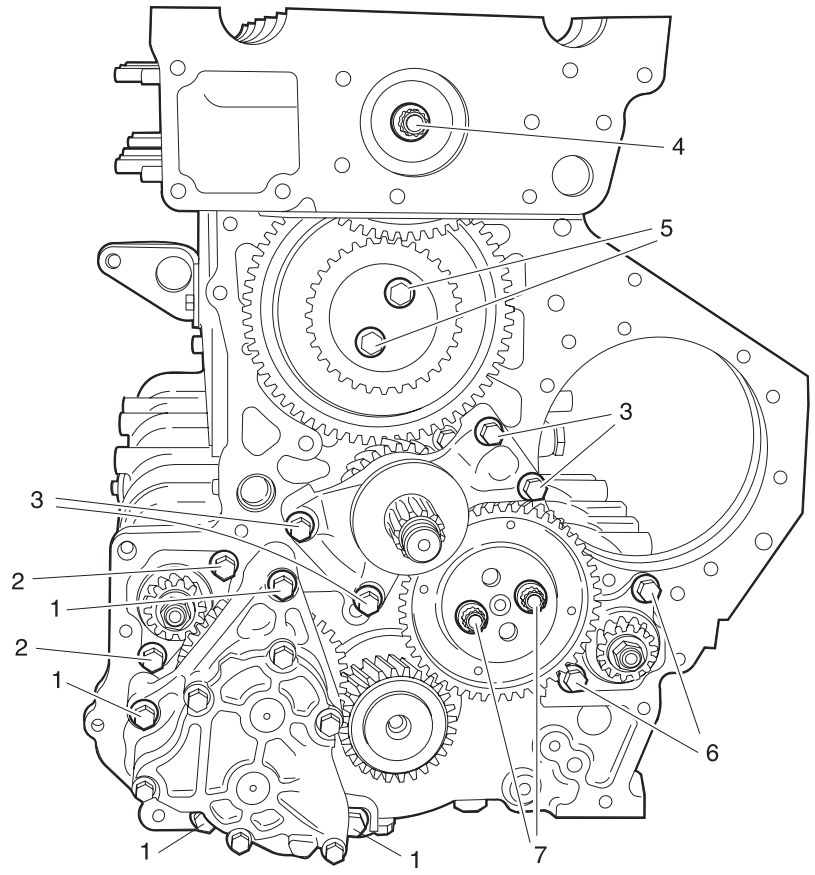
1 Thrust plate
2 Idler gear bushing
3 Idler gear
4 Idler shaft
5 Fan shaft case bushing
6 Fan shaft case
7 Thrust plate
8 Fan shaft
9 Fan gear shaft
10 Thrust plate
11 No. 1 idler gear bushing
12 No. 1 idler gear
13 No. 1 idler shaft
14 Oil pump (See Gr12)
15 O-ring
16 Balance shaft gear RH
17 Thrust spacer
18 Key
19 Thrust plate
20 Balance shaft RH
21 Balance shaft gear LH
22 Thrust spacer
23 Key
24 Thrust plate
25 Balance shaft LH

***a**: Crankshaft gear
***b**: Supply pump idler gear

Ⓟ: Locating pin
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.



02/23/2006 f012119

1 Oil pump bolts Td
2 Right balance shaft thrust plate bolts Tf
3 Fan shaft case bolts Te
4 Head idler bolt Tg
5 Idler shaft bolts Ta
6 Left balance shaft thrust plate bolts Tf
7 No. 1 idler shaft bolts Tb

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash between gears	Idler gear and fan shaft	0.09 to 0.14 {0.0035 to 0.0055}	0.3 {0.012}	Replace
		Fan shaft and No. 1 idler gear	0.06 to 0.10 {0.0024 to 0.0039}	0.3 {0.012}	
		No. 1 idler gear and crankshaft gear	0.11 to 0.13 {0.0043 to 0.0051}	0.3 {0.012}	
		No. 1 idler gear and supply pump idler gear	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	
		Oil pump gear and crankshaft gear	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	
		Oil pump gear and balance shaft gear RH	0.19 to 0.22 {0.0075 to 0.0087}	0.3 {0.012}	
–	End play of gears and shafts	Idler gear	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Replace
		Fan shaft	0.07 to 0.19 {0.0028 to 0.0075}	0.3 {0.012}	
		No. 1 idler gear	0.15 to 0.25 {0.0059 to 0.0098}	0.3 {0.012}	
		Balance shaft RH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
		Balance shaft LH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
2, 4	Idler gear bushing-to-idler shaft clearance		0.02 to 0.06 {0.00079 to 0.0024}	0.1 {0.0039}	Replace
5, 8	Fan shaft case bushing-to-fan shaft clearance		0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
8, 9	Fan shaft-to-fan gear shaft clearance		0.01 to 0.05 {0.00039 to 0.0020}	0.1 {0.0039}	Replace
11, 13	No. 1 idler gear bushing-to-No. 1 idler shaft clearance		0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
20	Balance shaft RH bend		0.025 {0.00098}	0.05 {0.0020}	Replace
25	Balance shaft LH bend		0.025 {0.00098}	0.05 {0.0020}	Replace

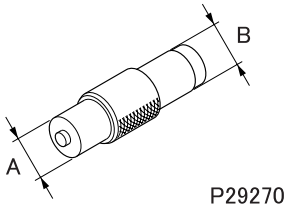
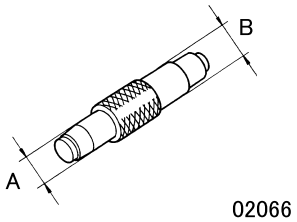
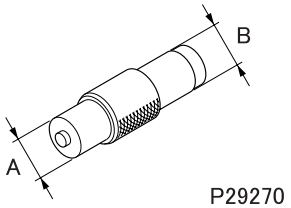
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (idler shaft installation)	32.3 {24, 3.3}	–
Tb	Bolt (No. 1 idler shaft installation)	53.9 {40, 5.5}	–
Tc	Nut (balance shaft gear installation)	96.1 {71, 9.8}	Wet
Td	Bolt (oil pump cover mounting)	27.4 {20, 2.8}	–
Te	Bolt (fan shaft case)	29 {21, 3.0}	–
Tf	Bolt (balance shaft thrust plate)	29 {21, 3.0}	–
Tg	Bolt (head idler shaft installation)	40.2 {30, 4.1}	Wet

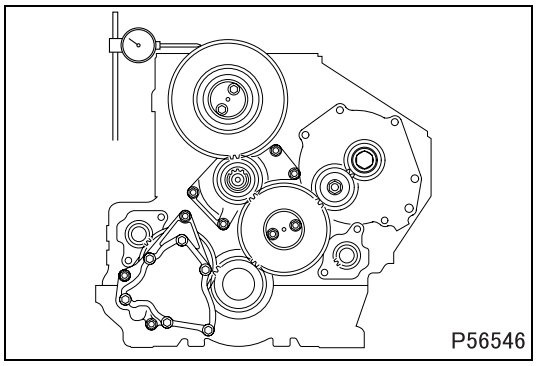
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Inner surface of every bushing	Engine oil	As required
	Outside surface of every shaft		
	O-rings		
	Nut threads		
	Balance shaft journals		

Special tools (Unit: mm {in.})

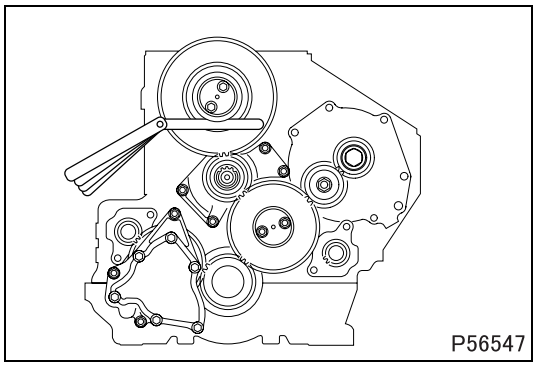
Mark	Tool name and shape	Part No.	Application
a	Idler gear bushing puller A: ϕ46.5 {ϕ1.83}, B: ϕ50 {ϕ1.97} 	MH062540	Removal and installation of idler gear bushing
b	Idler gear bushing puller A: ϕ37 {ϕ1.46}, B: ϕ40 {ϕ1.57} 	MH062601	Removal and installation of fan shaft case bushing
c	Idler gear bushing puller A: ϕ54.5 {ϕ2.15}, B: ϕ58 {ϕ2.28} 	MH062541	Removal and installation of No. 1 idler gear bushing

◆Inspection before removal◆



■ Inspection: Backlash between gears

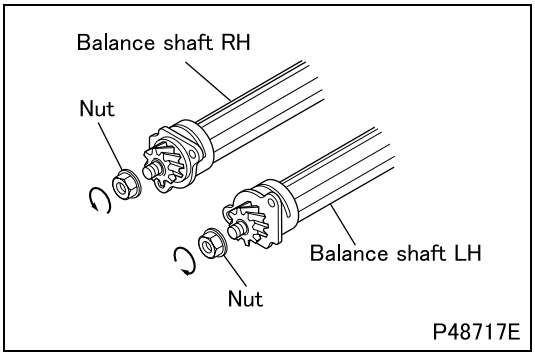
- For each pair of gears, measure the backlash at more than three teeth.
- If any of the measurements exceeds the specified limit, replace the defective part(s).



■ Inspection: End play of each gear and shaft

- If the measurement exceeds the specified limit, replace the defective part(s).

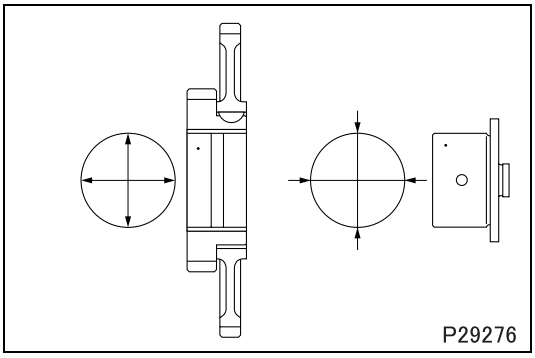
◆Removal procedure◆



■ Removal: Balance shaft

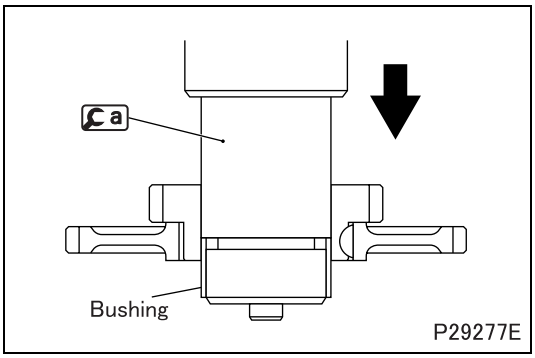
- Remove the balance shaft RH by turning its nut counterclockwise, and the balance shaft LH by turning its nut clockwise.

◆Inspection procedure◆

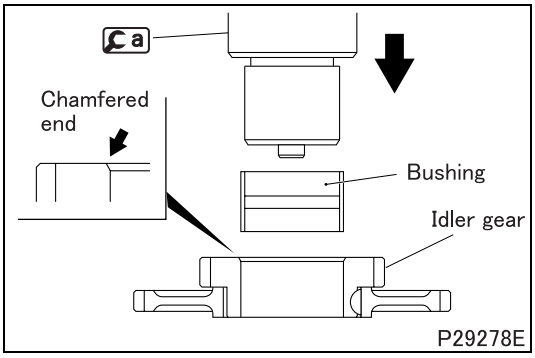


■ Inspection: Idler gear bushing-to-idler shaft clearance

- If the measurement exceeds the specified limit, replace the bushing.

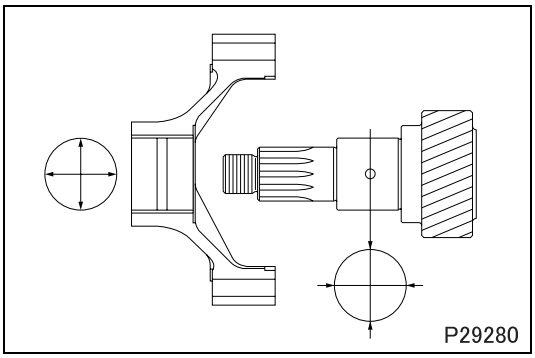


Replacement of idler gear bushing
[Removal]



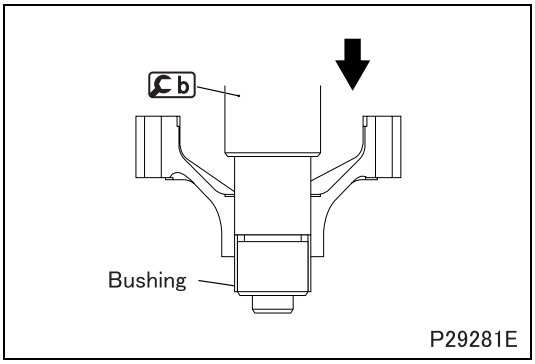
[Installation]

- Place the idler gear with its ends facing as illustrated.
- Press-fit the idler gear bushing until a sits snugly on the chamfered end of the idler gear.
- After press-fitting the bushing, measure the clearance.
- If the measurement is less than the minimum of the standard value range, ream the idler gear bushing until the clearance falls within the standard value range.

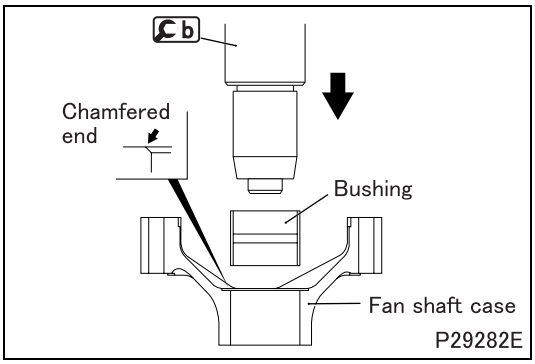


■ Inspection: Fan shaft case bushing-to-fan shaft clearance

- Replace the fan shaft case bushing if the measurement exceeds the specified limit.

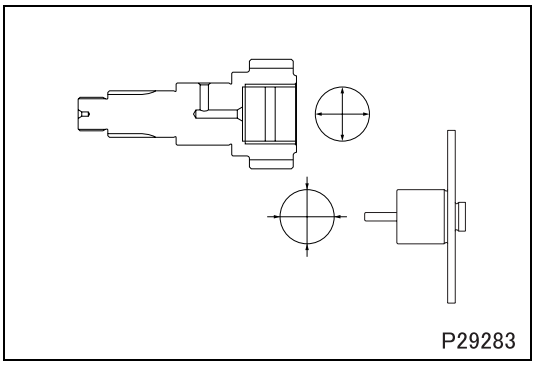


Replacement of fan shaft case bushing
[Removal]



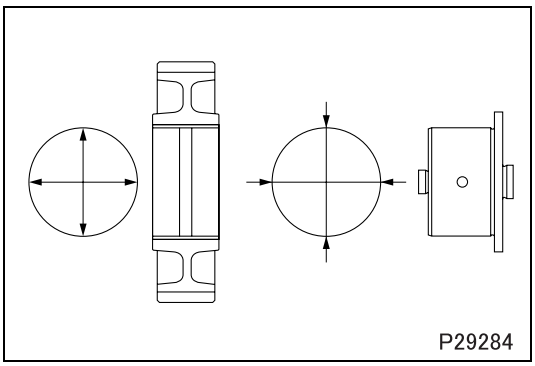
[Installation]

- Position the fan shaft case with its ends facing in the illustrated directions.
- Press in the bushing until b rests snugly on the chamfered end of the fan shaft case.
- After press-fitting the bushing, remeasure the clearance between it and the fan shaft.
- Ream the bushing if the measurement is below the standard value range.



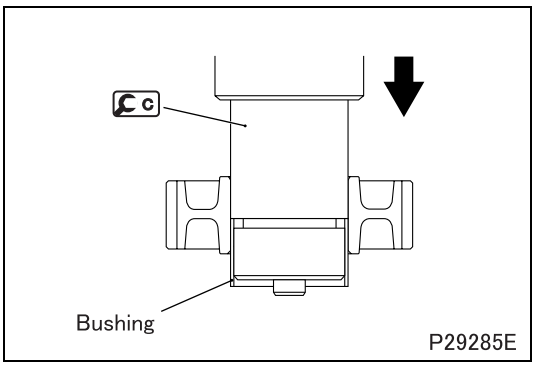
■ Inspection: Fan shaft-to-fan gear shaft clearance

- Replace the fan shaft if the measurement exceeds the specified limit.

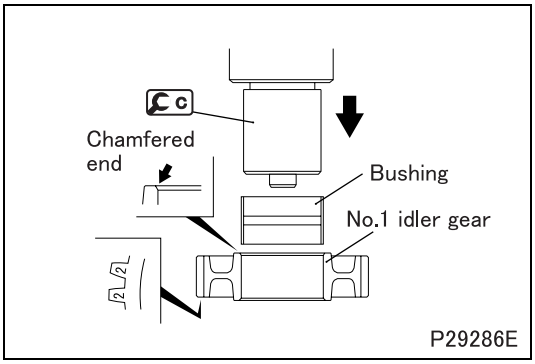


■ Inspection: No. 1 idler gear bushing-to-No. 1 idler shaft clearance

- Replace the bushing if the measurement exceeds the specified limit.

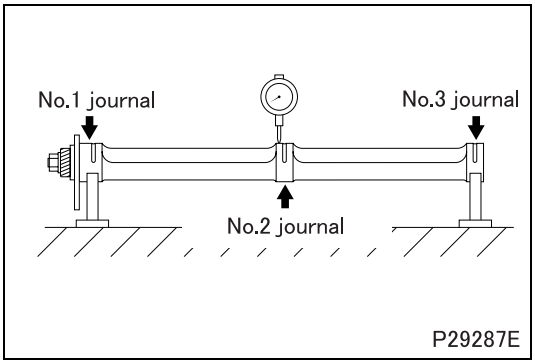


Replacement of No. 1 idler gear bushing
[Removal]



[Installation]

- Position the No. 1 idler gear with its ends facing in the illustrated directions.
- Press in the gear bushing until C sits snugly on the chamfered end of the No. 1 idler gear.
- After press-fitting the bushing, remeasure the clearance between it and the No. 1 idler shaft.
- Ream the busing if the measurement is below the standard value range.



■ Inspection: Balance shaft bend

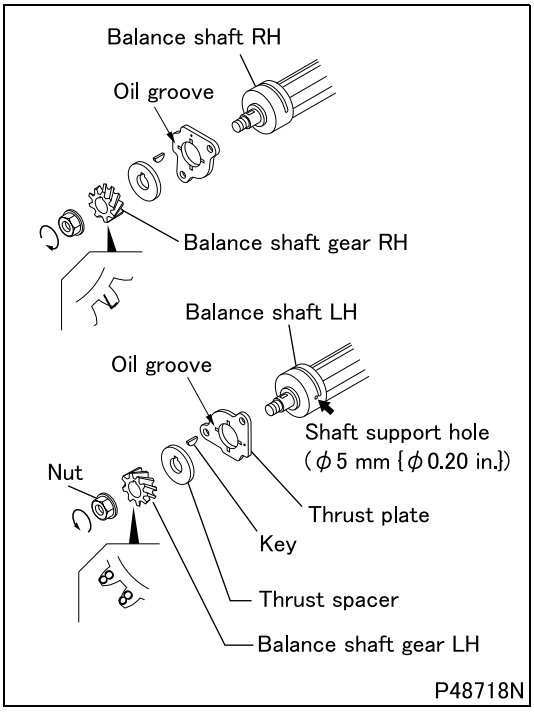
- Place supports under the No. 1 and No. 3 journals of the balance shaft and measure the bend of the balance shaft at the No. 2 journal.

NOTE

- **Turn the balance shaft by one turn and read the dial gauge. Divide the reading by two to obtain the balance shaft bend.**

- If the measurement exceeds the specified limit, replace the balance shaft.

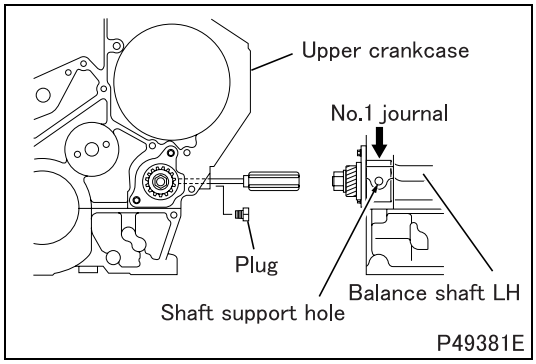
◆Installation procedure◆



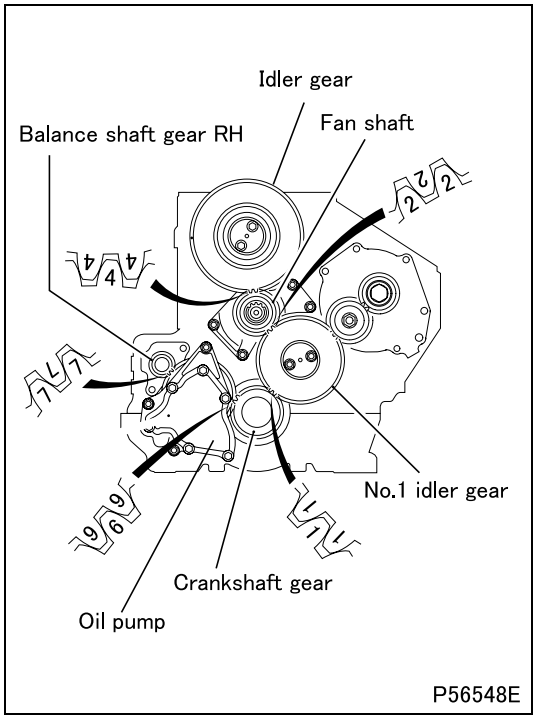
■ Installation: Balance shafts

- Install all the indicated parts on each balance shaft with their ends facing in the illustrated directions.
- Install the balance shaft RH by turning its nut clockwise, and the balance shaft LH by turning its nut counterclockwise.

- Install the balance shaft RH assembly and the balance shaft LH assembly into the crankcase according to the following procedures, which include different instructions between the two balance shafts.
  - The balance shaft RH can be installed in the crankcase without following any special procedure. (The positioning of the gear of the balance shaft RH will be finally determined by installing the oil pump.)



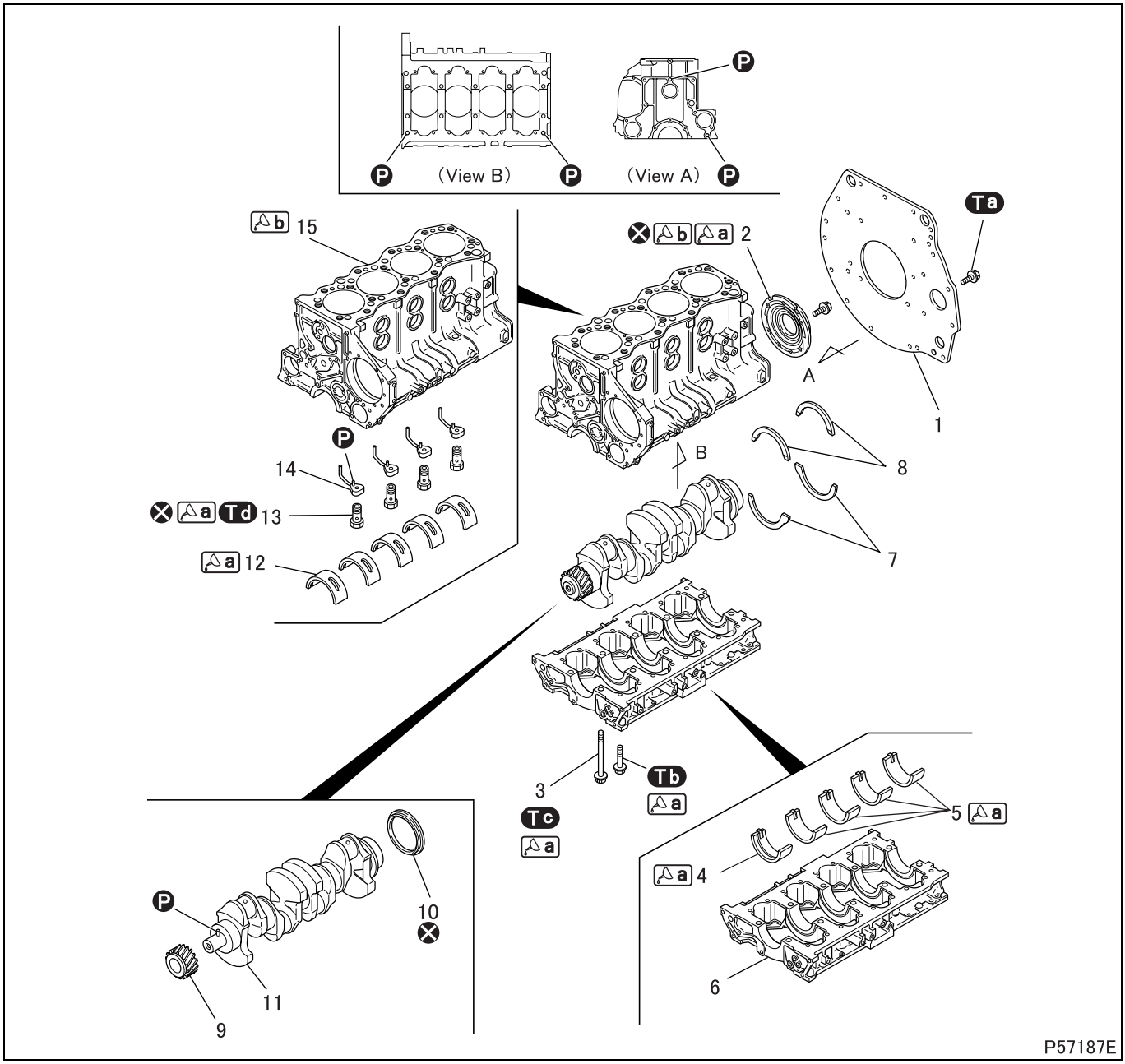
- The gear of the balance shaft LH can be engaged with other gears only after the front case is installed and then the vacuum pump is installed on the crankcase. This necessitates performing the following steps before installing the front case and vacuum pump. (The balance shaft LH cannot be rotated to adjust the gear position after the front case is installed on the crankcase.)
- Remove the plug on the upper crankcase.
- Insert a screwdriver through the plug hole and into the shaft support hole (diameter: 5 mm {0.20 in.}) on the No. 1 journal of the balance shaft LH to hold the shaft against rotation.
- Align the mating marks on each timing gear.
- This positions the balance shaft LH correctly. Leave the balance shaft in this state until installation of the front case and vacuum pump is completed.



■ Installation: Timing gears

- Place the No. 1 cylinder piston at top dead center to position the crankshaft gear.
- Install the oil pump gear by aligning mating mark **“6”** with that on the crankshaft gear, and mating mark **“7”** with that on the balance shaft gear RH.
- Install the No. 1 idler gear by aligning mating mark **“1”** with that on the crankshaft gear.
- Install the fan shaft by aligning mating mark **“2”** with that on the No. 1 idler gear.
- Install the idler gear by aligning mating mark **“4”** with that on the fan shaft.

CRANKSHAFT AND CRANKCASE



● **Disassembly sequence**

1 Rear plate
2 Rear oil seal
3 Main bearing cap bolt
4 No.1 Lower bearing
5 Lower main bearing
6 Lower crankcase
7 Lower thrust plate
8 Upper thrust plate
★ **9** Crankshaft gear
★ **10** Rear oil seal slinger
11 Crankshaft
12 Upper main bearing
13 Check valve
14 Oil jet
15 Upper crankcase

Ⓟ: Locating pin
⊗: Non-reusable parts

NOTE

- **Do not remove the parts marked ★ unless defects are evident.**
- **The lower crankcase and the upper crankcase are machined as a matched set, and cannot be replaced individually.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The main bearing cap bolts are tightened using the torque-turn tightening method. Any bolt that has three punch marks must be replaced.**
- **Do not overtighten the check valve. If it is tightened to a torque exceeding the specification, the check valve may malfunction, resulting in seizures in the engine.**
- **The No. 1 lower bearing has a oil groove. Be sure to install it in the correct position, otherwise a crankshaft seizure may result.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
–	Crankshaft end play			0.10 to 0.28 {0.0039 to 0.011}	0.4 {0.016}	Replace thrust plate
4, 5, 12	Main bearing	Oil clearance	All except No. 3	0.038 to 0.1 {0.0015 to 0.0039}	0.15 {0.0059}	Replace
			No. 3	0.058 to 0.12 {0.0023 to 0.0047}		
		Span when free		–	Less than 91.5 {3.60}	
11	Crankshaft	Bend		0.02 {0.00079} or less	0.05 {0.0020}	Replace
		Pins and journals	Out-of-roundness	0.01 {0.00039} or less	0.03 {0.0012}	Rectify or replace
			Taper	0.006 {0.00024} or less	–	
15	Distortion of upper crankcase top surface			0.07 {0.0028} or less	0.2 {0.0079}	Rectify or replace

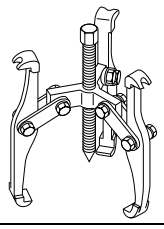
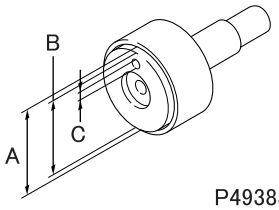
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (rear plate installation)	63.7 {47, 6.5}	–
Tb	Bolt (lower crankcase installation)	23.5 {17, 2.4}	Wet
Tc	Main cap bolt (lower crankcase installation)	49 {36, 5.0} +90°	Wet Reusable up to 3 times
Td	Check valve	29.4 {22, 3.0}	Wet

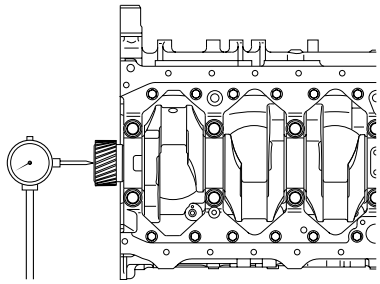
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rear oil seal lip	Engine oil	As required
	Bolt and main bearing cap bolt threads and seating surface of head		
	Main bearing inside surface		
	Check valve threads		
b	Upper and lower crankcase mating surface of rear oil seal	ThreeBond 1207C or D	As required
	Lower crankcase mounting surface of upper crankcase		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Gear puller  P02065	MH061326	Removal of crankshaft gear
b	Rear oil seal slinger installer A: φ103 {φ4.06}, B: φ100 {φ3.94}, C: φ15 {φ0.59}  P49383	MH062677	Installation of rear oil seal slinger

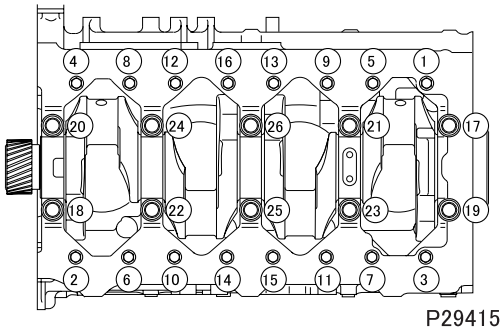
◆Inspection before removal◆


P29413

■ **Inspection: Crankshaft end play**

- If the measurement exceeds the specified limit, replace the thrust plates with oversize ones.
- Available oversizes:
  +0.15 mm, +0.30 mm, +0.45 mm {0.0059, 0.012, 0.018 in.}
- Replace the crankshaft if the end play is too large to adjust using oversize thrust plates.

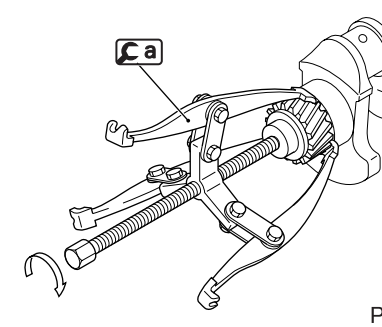
◆Removal procedure◆



P29415

■ **Removal: Lower crankcase**

- Loosen the bolts little by little in the order indicated in the illustration (1 to 16).
- After loosening the bolts, loosen the main cap bolts little by little in the order indicated in the illustration (17 to 26), then remove the main cap bolts.



P29422

■ **Removal: Crankshaft gear**

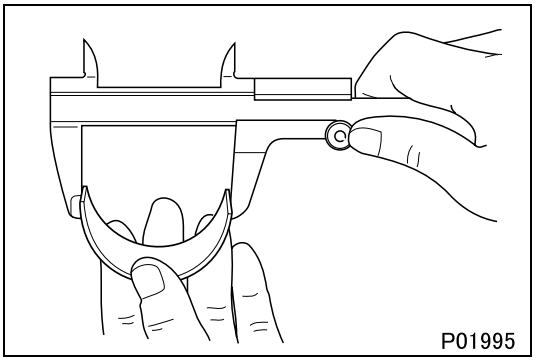
CAUTION ⚠

- **Do not tap off the crankshaft gear as this can damage it.**

■ **Removal: Rear oil seal slinger**

- Taking care not to damage the crankshaft, split the rear oil seal slinger using a chisel or a similar tool.

◆Inspection procedure◆

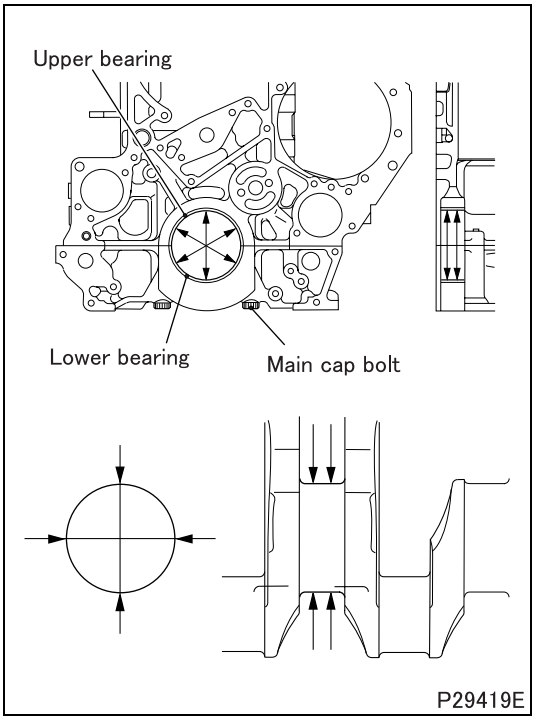


■ **Inspection: Main bearing span when free**

CAUTION ⚠

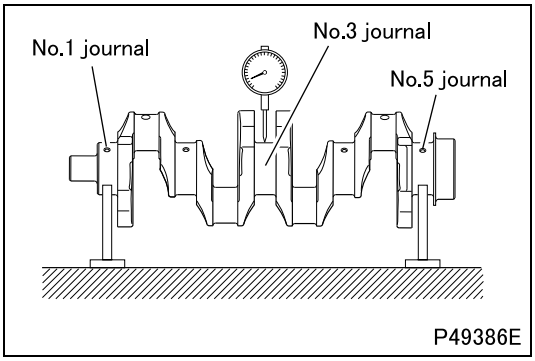
- **Do not attempt to manually expand the bearings.**
- **Always replace the upper and lower bearings as a set.**

- If the measurement exceeds the specified limit, replace the bearing.



■ **Inspection: Main bearing-to-crankshaft clearance**

- Fit the upper bearing into the upper crankcase and the lower bearing into the lower crankcase.
- Tighten the main bearing cap bolts to a torque of 49 N·m {36 lbf·ft, 5.0 kgf·m}.
- Measure the inside diameter of the main bearing and the diameter of the corresponding crankshaft journal.
- If the difference between the measurements exceeds the specified limit, machine the crankshaft journal to one of the specified undersize dimensions indicated on the next page.



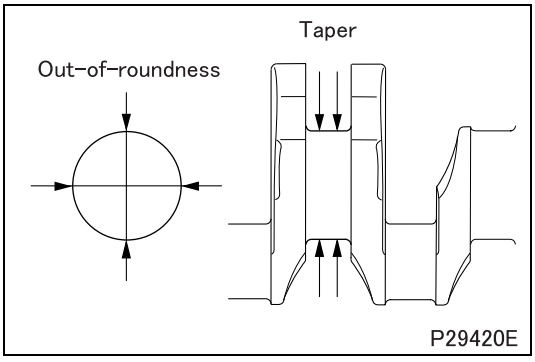
■ **Inspection: Crankshaft**

(1) Bend

- Support the crankshaft at its No. 1 journal and No. 5 journal. Measure the extent of bending in the crankshaft at the center of the No. 3 journal.
- If the measurement exceeds the specified limit, replace the crankshaft.

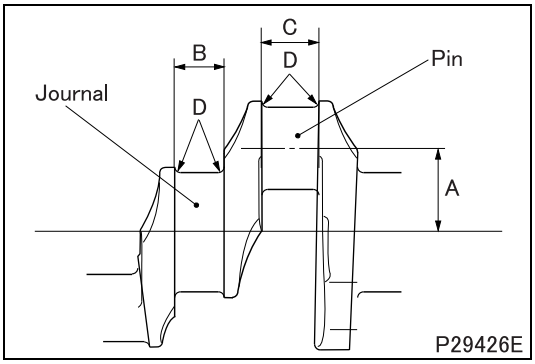
NOTE

- **Turn the crankshaft through one revolution. One-half of the dial indicator reading represents the extent of bending.**



(2) Out-of-roundness and taper of crankshaft journals and pins

- If any of the measurements exceeds the specified limits, grind the crankshaft journal(s) and/or pin(s) to undersize(s) or replace the crankshaft.



Grinding of crankshaft

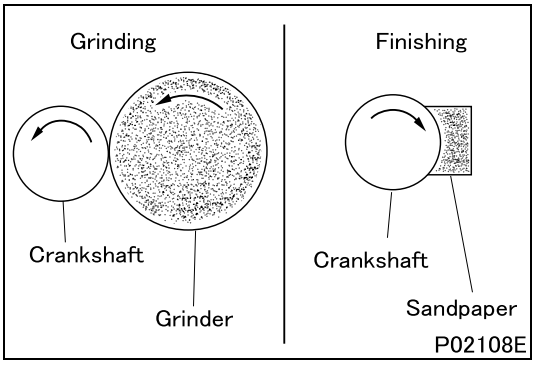
CAUTION ⚠

- **If the crankshaft is ground to an undersize, the main bearings must be replaced with the undersize ones of the corresponding undersize.**

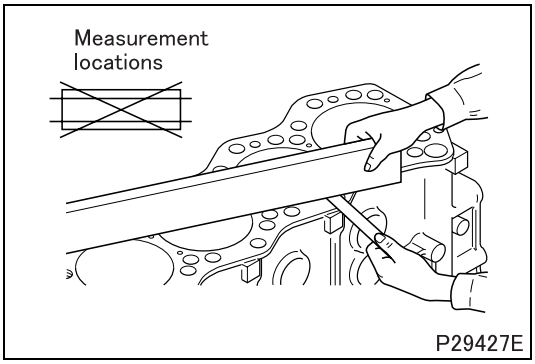
- Do not change the center-to-center distance **A** between the journal and pin.
  A: 60 ± 0.05 mm {2.36 ± 0.0020 in.}
- Do not change the journal width **B** and the pin width **C**.
  B: 33.5 mm {1.32 in.} (No. 1 journal)
  35 mm {1.38 in.} (No. 2 to No. 4 journals)
  $35\ ^{+0.039}_{0}$ mm {$1.38\ ^{+0.0015}_{0}$ in.} (No. 5 journal)
  C: $41\ ^{+0.2}_{0}$ mm {$1.61\ ^{+0.0079}_{0}$ in.} (No. 5 journal)
- Finish the fillets **D** smoothly.
  D: R4 mm {R0.16 in.}
- Carry out a magnetic inspection to check for cracks possibly caused by grinding. Also, check that the harness of the surface has not dropped below Shore hardness number (Hs) 75.
- Replace the crankshaft if defects are evident.

Crankshaft undersize dimensions (Unit: mm {in.})

		Undersizes			
		0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finished journal diameter	No. 1, 2, 4, 5	85.68 to 85.70 {3.37 to 3.37}	85.43 to 85.45 {3.36 to 3.36}	85.18 to 85.20 {3.35 to 3.35}	84.93 to 84.95 {3.34 to 3.34}
	No. 3	85.66 to 85.68 {3.37 to 3.37}	85.41 to 85.43 {3.36 to 3.36}	85.16 to 85.18 {3.35 to 3.35}	84.91 to 84.93 {3.34 to 3.34}
Finished pin diameter		64.69 to 64.71 {2.55 to 2.55}	64.44 to 64.46 {2.54 to 2.54}	64.19 to 64.21 {2.53 to 2.53}	63.94 to 63.96 {2.52 to 2.52}
Out-of-roundness		0.01 {0.00039} or less			
Taper		0.006 {0.00024} or less			



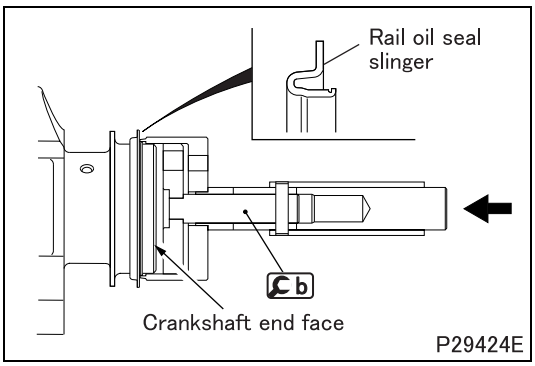
- When grinding, turn both the crankshaft and the grinder counterclockwise as viewed from the crankshaft front end.
- When finishing the crankshaft with whetstone or sandpaper, rotate the crankshaft clockwise.



■ Inspection: Distortion of upper crankcase top surface

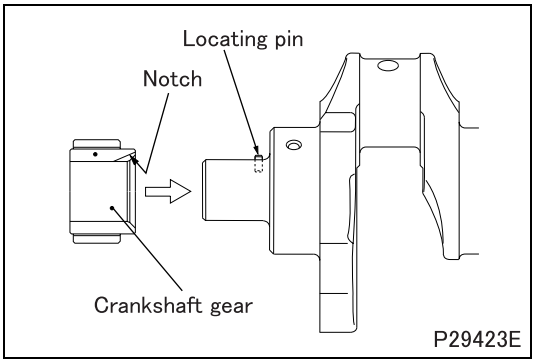
- If the measurement exceeds the specified limit, grind the crankcase top surface with a surface grinder.
- Limit the amount of removed metal to make sure that the amount of piston projection above the crankcase top surface stays within the standard value range.

◆Installation procedure◆



■ **Installation: Rear oil seal slinger**

- Press in the rear oil seal slinger until Cb sits snugly on the crankshaft end surface.



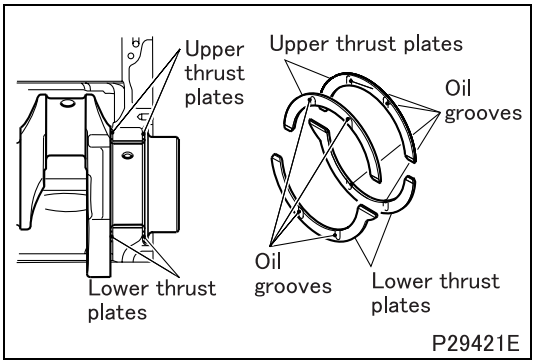
■ **Installation: Crankshaft gear**

- Heat the crankshaft gear to approximately 150°C {300°F} with a gas burner or the like.

CAUTION ⚠

- **Be careful not to get burned.**

- Align the locating pin in the crankshaft with the slot in the crankshaft gear. Drive the gear into position by lightly striking its end face with a plastic hammer.



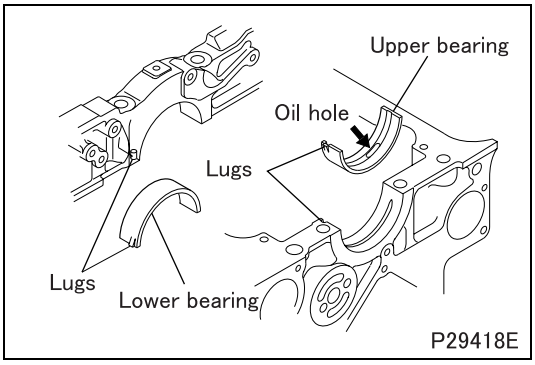
■ **Installation: Thrust plate**

- Install the thrust plates on both sides of the rearmost main bearing with the oil grooves on the inner plates facing inward and those on the outer plates outward as shown in the illustration.

CAUTION ⚠

- **Be sure to orient the oil grooves as indicated above, otherwise seizures may occur in the engine.**

- Use oversize thrust plates when adjusting the crankshaft end play. The upper and lower thrust plates on the same side must be of the same size. The thrust plates on one side may differ in size from those on the other side.

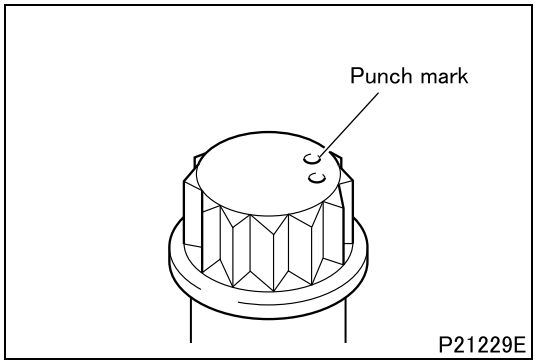


■ **Installation: Main bearings**

- Install the main bearings with their lugs aligned as shown in the illustration. When the crankshaft journals have been ground to an undersize, use undersize main bearings.
  Available main bearing undersizes:
  0.25 mm {0.0098 in.}, 0.50 mm {0.020 in.}, 0.75 mm {0.030 in.}, 1.00 mm {0.039 in.}

CAUTION ⚠

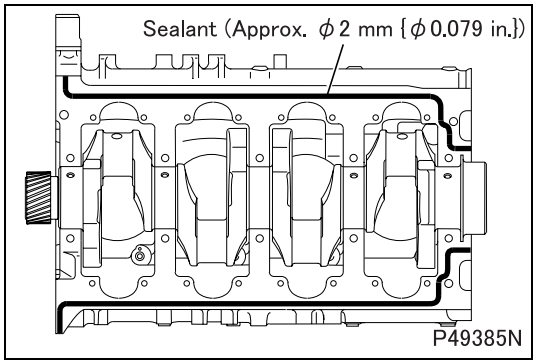
- **The upper main bearing has an oil hole. The lower main bearing has no oil hole. Do not confuse the upper and lower bearings, as this can cause seizure in the engine.**



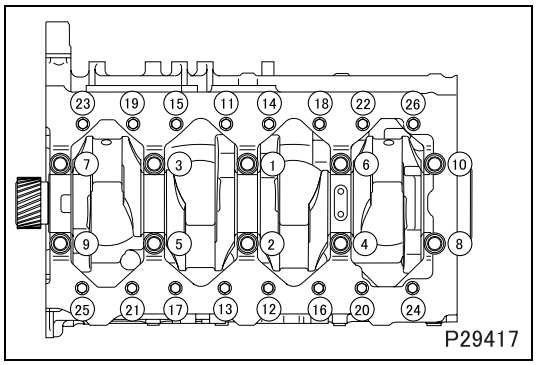
■ **Installation: Lower crankcase**

CAUTION ⚠

- **Before installing the main bearing cap bolts, check the number of punch marks on the head of each bolt. (A bolt with two or less marks is reusable.)**
- **The number of punch marks corresponds with the number of times the main cap bolt has been tightened using the torque-turn tightening method. Any bolt that has three marks (i.e. that has been used three times) must be replaced.**



- Clean all sealant application surfaces.
- Apply evenly thick beads of sealant to the upper crankcase without any breaks as shown in the illustration.
- Install the lower crankcase within three minutes of applying the sealant, being careful not to dislodge the sealant.



- Apply engine oil to the main cap bolt threads and seating surfaces of the bolt heads, then tighten them to a torque of 49 N·m {36 lbf·ft, 5.0 kgf·m} in the order indicated in the illustration (1 to 10).
- Tighten each main cap bolt further by 90° in the same order.
- Finally, tighten each bolt to the specified torque in the order indicated in the illustration (11 to 26).

CAUTION ⚠

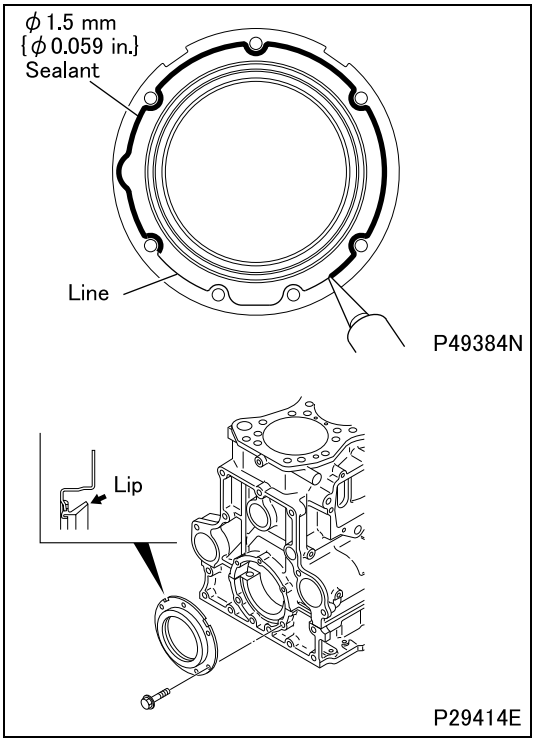
- **After installing the bolts, wait at least an hour before starting the engine.**
- **Apply new beads of sealant whenever the main cap bolts have been loosened or removed.**

- After tightening the bolts using the above torque-turn tightening method, make a punch mark on the head of each bolt to indicate the number of times that it has been used.

CAUTION ⚠

- **The bolts that have been tightened using the torque-turn method must never be additionally tightened after the final angular tightening.**

- After installing the main bearing caps, rotate the crankshaft by hand. If it cannot be rotated smoothly, inspect the main bearing caps for correct installation.



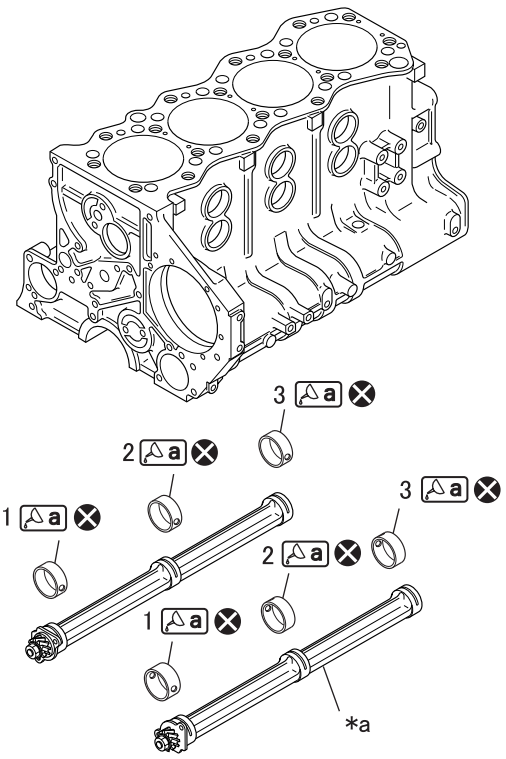
■ **Installation: Rear oil seal**

- Apply engine oil to the lip of the rear oil seal.
- Clean the seal surface of the crankshaft.
- Apply a bead of sealant along the line on the rear oil seal evenly without any breaks.
- Install the rear oil seal within three minutes after applying the sealant. Be careful not to let the applied sealant slip out of place during installation.

CAUTION ⚠

- **After fitting the rear oil seal, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant whenever the mounting bolts of the rear oil seal have been loosened.**

BALANCE SHAFT BUSHINGS



● **Disassembly sequence**

1 No. 1 balance shaft bushing
2 No. 2 balance shaft bushing
3 No. 3 balance shaft bushing

***a**: Balance shaft
⊗: Non-reusable parts

NOTE

- **Do not remove the balance shaft bushings unless defects are evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

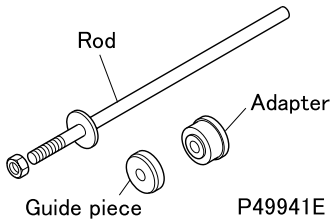
Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
1 to 3, *a	Balance shaft journal-to-balance shaft bushing clearance	No. 1	0.055 to 0.099 {0.0022 to 0.0039}	0.15 {0.0059}	Replace
		No. 2	0.075 to 0.119 {0.030 to 0.0047}		
		No. 3	0.055 to 0.099 {0.0022 to 0.0039}		

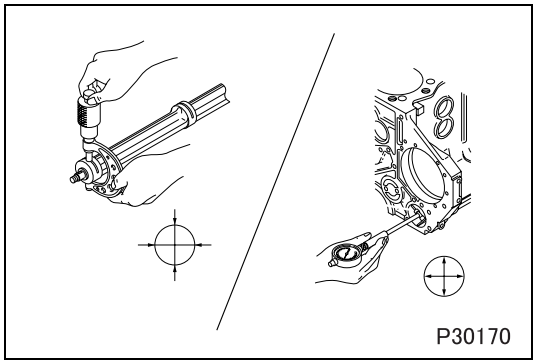
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Balanceshaft bushing inner surface	Engine oil	As required

Special tools

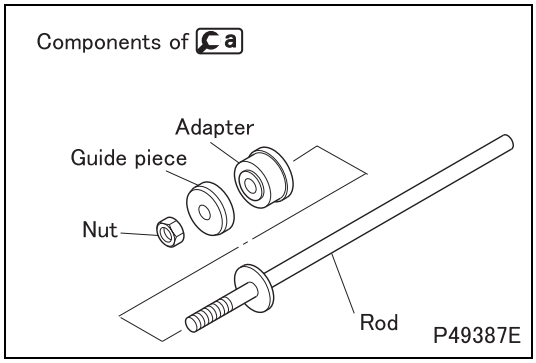
Mark	Tool name and shape	Part No.	Application
a	Balance shaft bushing installer and extractor 	MH062782	Removal and installation of balance shaft bushing

◆Inspection procedure◆



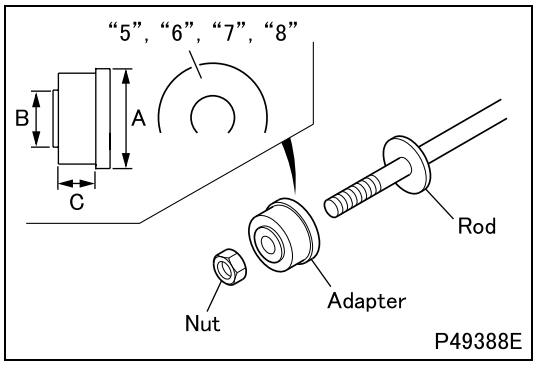
■ **Inspection: Balance shaft-to-balance shaft bushing clearance**

- Replace the bushing if the measurement exceeds the specified limit.



Replacement of balance shaft bushing

- Replace the bushing using a.

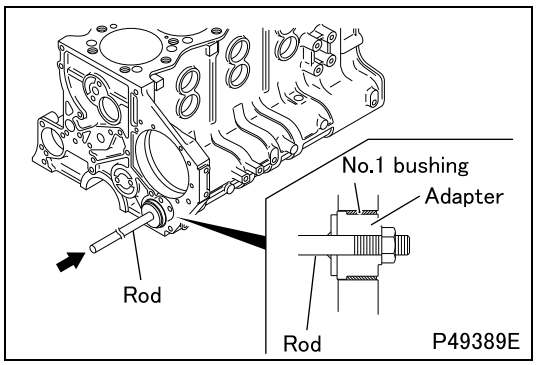


[Removal]

- To remove the bushings, use the rod fitted with an adapter corresponding to the size of each bushing.

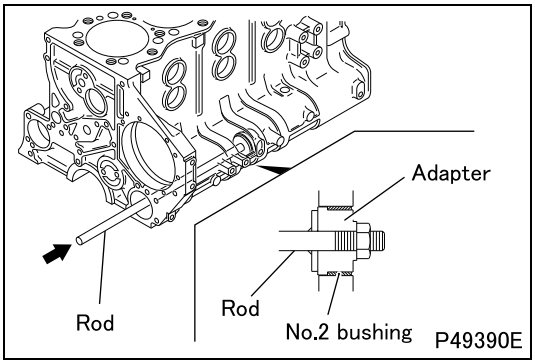
Unit: mm {in.}

Bushing		Adapter			
		Identification mark	A	B	C
No. 1	Left	**"5"**	ϕ55.25 {ϕ2.18}	ϕ 51.5 {ϕ2.03}	26.5 {1.04}
	Right	**"6"**			21.5 {0.85}
No. 2		**"7"**	ϕ 55 {ϕ2.17}	ϕ 51 {ϕ2.01}	
No. 3		**"8"**	ϕ 54.75 {ϕ2.16}	ϕ 50.5 {ϕ1.99}	

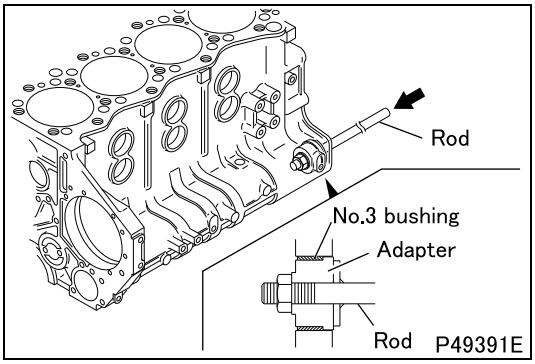


- Remove the No. 1 bushing by tapping on the rod from the front of the engine.

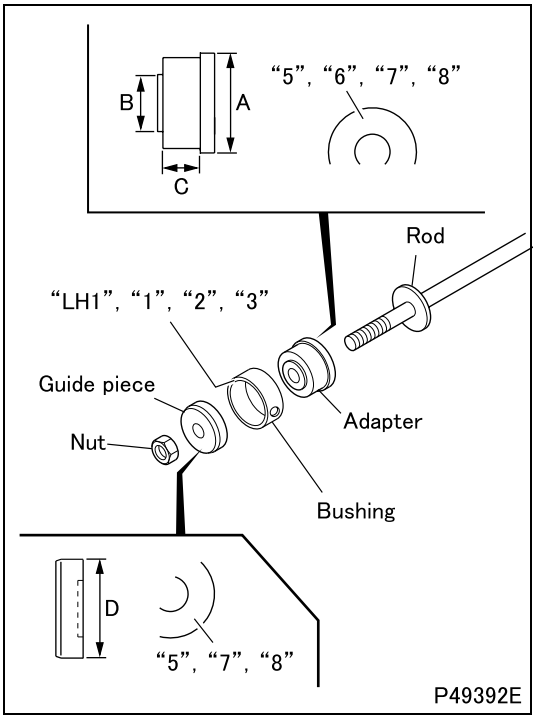
BALANCE SHAFT BUSHINGS



- Remove the No. 2 bushing by tapping on the rod from the front of the engine.



- Remove the No. 3 bushing by tapping on the rod from the back of the engine.

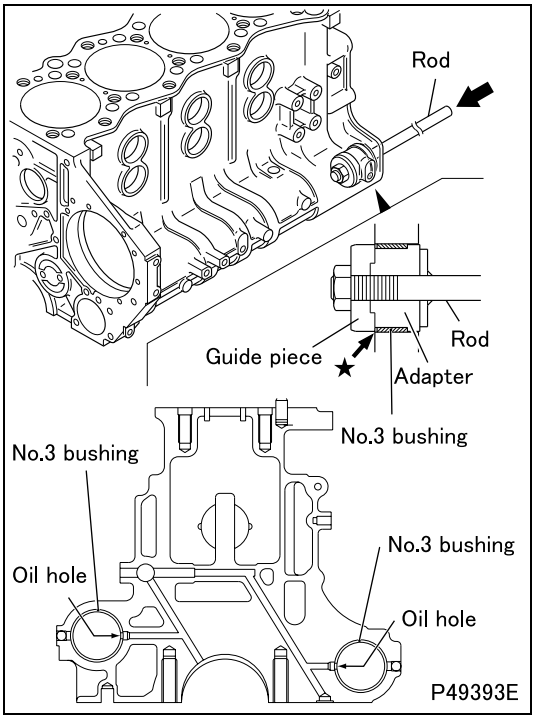


[Installation]

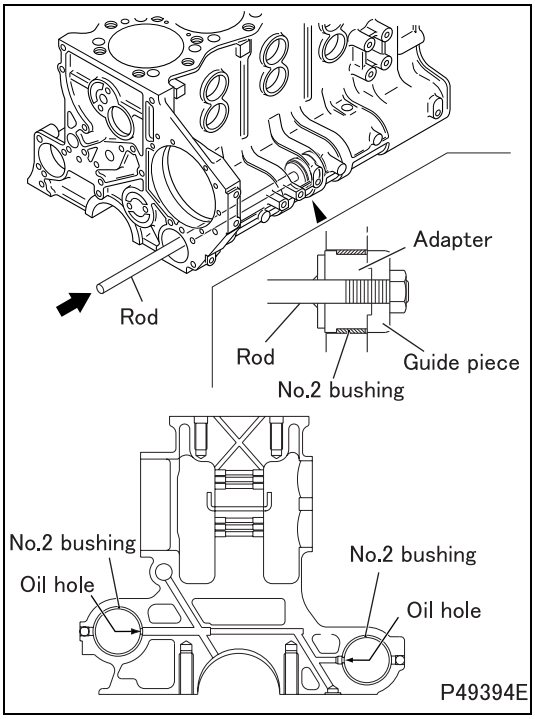
- To install the bushings, use the rod fitted with an adapter corresponding to the size of each bushing. Each bushing has an identification mark. These identification marks are used to distinguish between the No. 1, No. 2 and No. 3 bushings. If the identification mark is not clear, measure the outside diameter of the bushing and use the measurement as a means of identification.

Unit: mm {in.}

Bushing				Adapter				Guide piece	
		Identification mark	Outside diameter	Identification mark	**A**	**B**	**C**	Identification mark	**D**
No. 1	Left	**"LH1"**	ϕ 55.25 {ϕ2.18}	**"5"**	ϕ 55.25 {ϕ2.18}	ϕ 51.5 {ϕ2.03}	26.5 {1.04}	**"5"**	ϕ 55.25 {ϕ2.18}
	Right	**"1"**	ϕ 55.25 {ϕ2.18}	**"6"**			21.5 {0.85}	**"6"**	
No. 2		**"2"**	ϕ55 {ϕ2.17}	**"7"**	ϕ55 {ϕ2.17}	ϕ51 {ϕ2.01}		**"7"**	ϕ55 {ϕ2.17}
No. 3		**"3"**	ϕ 54.75 {ϕ2.16}	**"8"**	ϕ 54.75 {ϕ2.16}	ϕ 50.5 {ϕ1.99}		**"8"**	ϕ 54.75 {ϕ2.16}

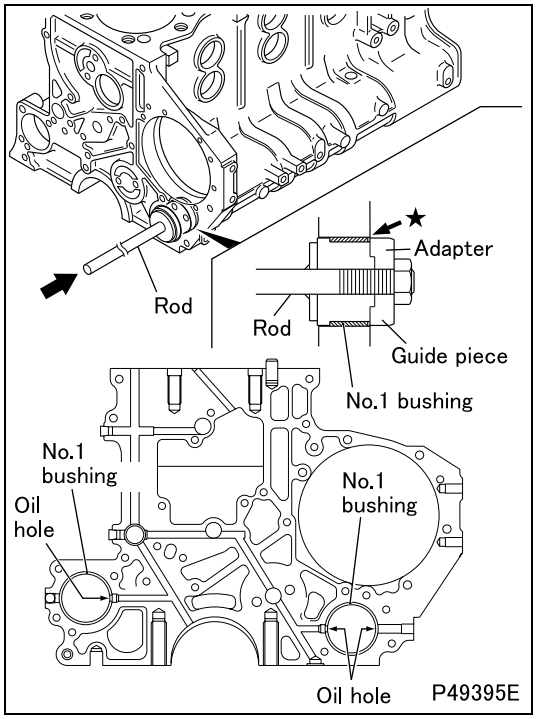


- Align the oil hole in the No. 3 bushing with the oil hole in the upper crankcase.
- Force the No. 3 bushing into the upper crankcase as deep as the ★ mark in the illustration by tapping on the rod from the rear of the engine.



- Align the oil hole in the No. 2 bushing with the oil hole in the upper crankcase.
- Force the No. 2 bushing into the upper crankcase to the illustrated position by tapping on the rod from the front of the engine.

BALANCE SHAFT BUSHINGS



- Align the oil hole(s) in the No. 1 bushing with the oil hole(s) in the upper crankcase.
- Force the No. 1 bushing into the upper crankcase as deep as the ★ mark in the illustration by tapping on the rod from the front of the engine.

CAUTION ⚠

- **The left and right No. 1 bushings are different from each other, and should not be installed in reverse positions.**
- **The left No. 1 bushing has two oil holes, whereas the right No. 1 bushing has only one oil hole.**

GROUP 12 INDEX

SPECIFICATIONS 12-2

STRUCTURE AND OPERATION

1. **Lubrication System 12-3**
2. **Oil Pump 12-4**
3. **Oil Cooler 12-5**
4. **Oil Filter 12-6**
5. **Lubrication of Engine Components 12-7**

TROUBLESHOOTING 12-10

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. **Oil Filter Replacement 12-12**
2. **Engine Oil Replacement 12-14**
3. **Oil Pressure Measurement 12-15**

OIL PAN, OIL STRAINER AND OIL JETS 12-16

OIL PUMP 12-18

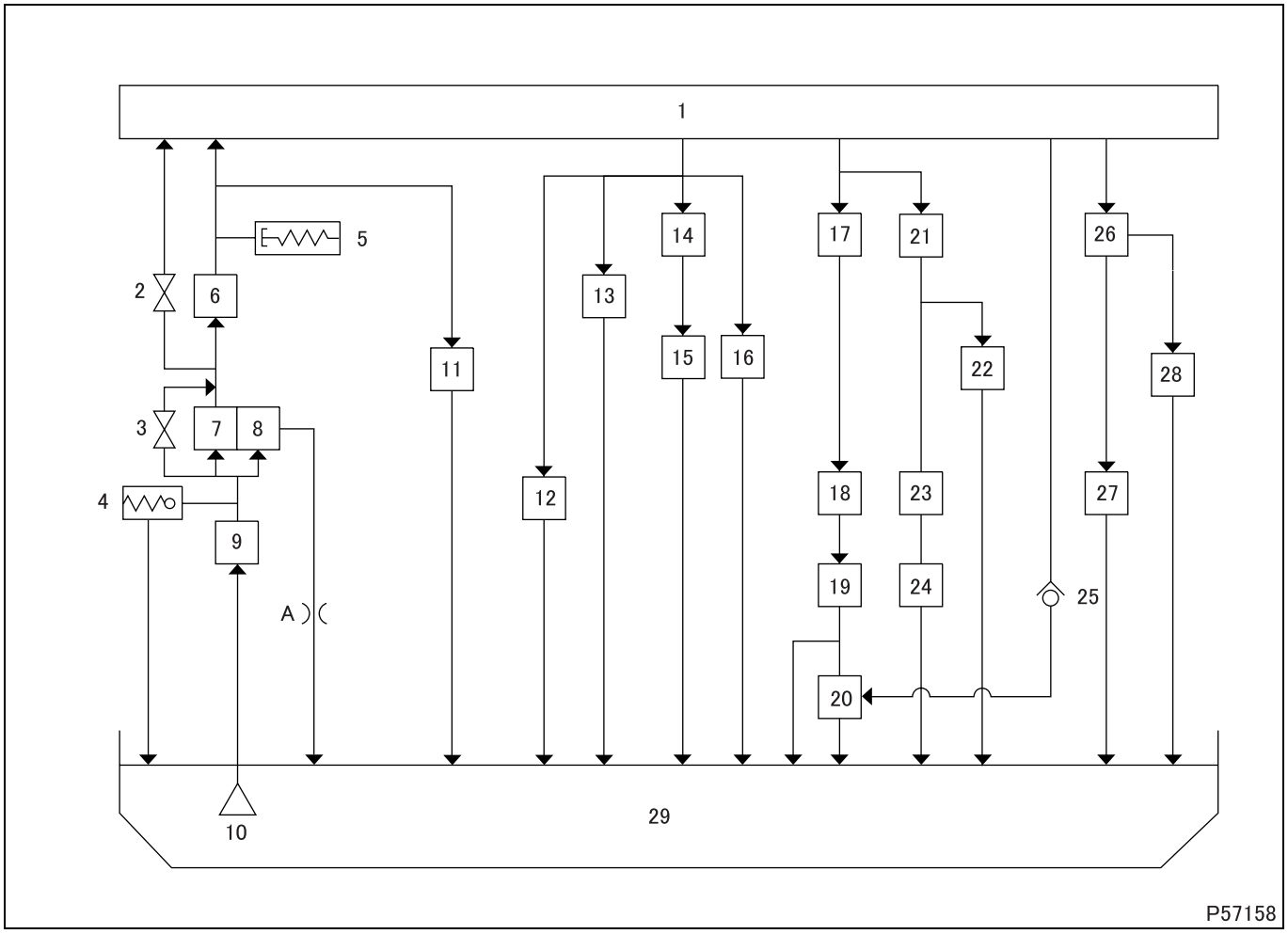
OIL FILTER 12-22

OIL COOLER 12-24

SPECIFICATIONS

Item			Specifications
Method of lubrication			Forced lubrication by oil pump
Oil filter			Spin-on filter paper type
Oil cooler			Shell and plate type (multiple-plate type)
Engine oil	Grade		API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1
	Quantity L (qts)	Oil pan	Approx. 9
		Oil filter	Approx. 1
Regulator valve opening pressure		kPa {psi, kgf/cm^2}	600 $^{+100}_{0}$ {87 $^{+15}_{0}$, 6 $^{+1}_{0}$ }
Bypass valve opening pressure		kPa {psi, kgf/cm^2}	390 ± 29 {57 ± 4.2, 4.0 ± 0.3}

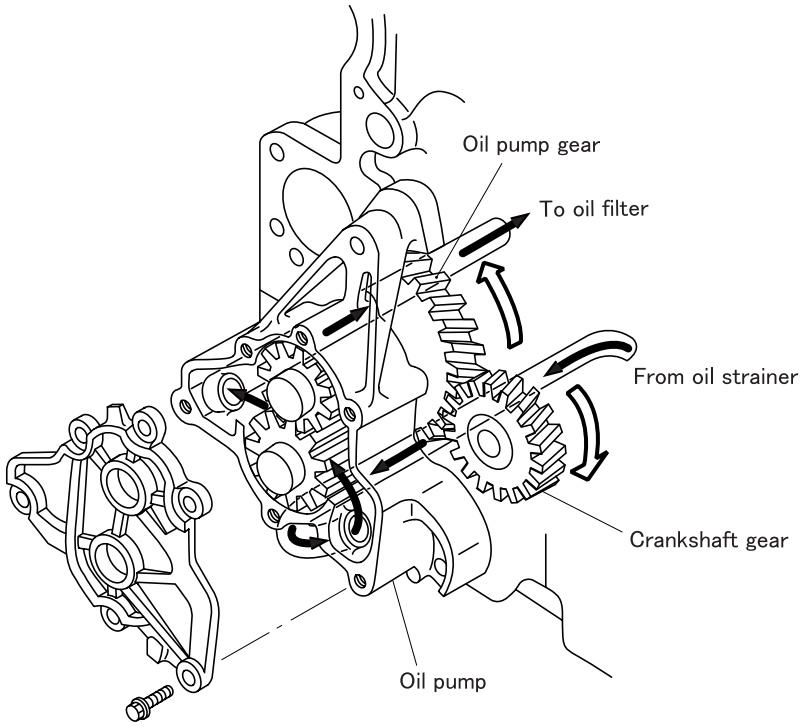
1. Lubrication System



1 Main oil gallery
2 Bypass valve
3 Bypass valve
4 Regulator valve
5 Engine oil pressure switch
6 Oil cooler
7 Full-flow filter element
8 Bypass filter element
9 Oil pump
10 Oil strainer
11 Turbo charger
12 Oil jet for gear
13 Vacuum pump
14 Idler bushing
15 Timing gear
16 Balance shaft bushing LH
17 Crankshaft main bearing
18 Connecting rod bearing
19 Connecting rod bushing
20 Piston
21 Balance shaft bushing RH
22 Supply pump gear bushing
23 Supply pump idler gear bushing
24 Supply pump idler gear shaft
25 Check valve for oil jet
26 Rocker bushing
27 Camshaft bushing
28 Rocker roller
29 Oil pan

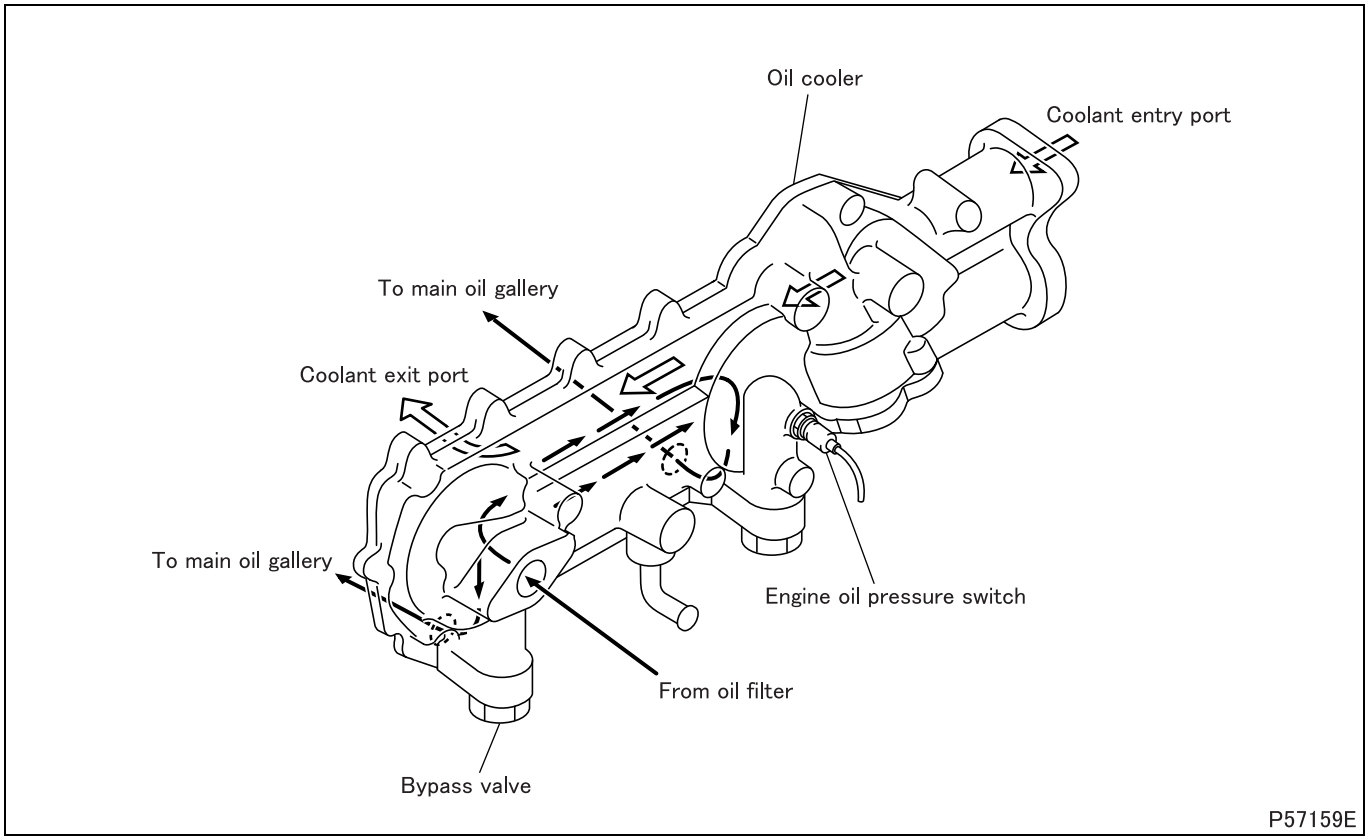
A: Orifice

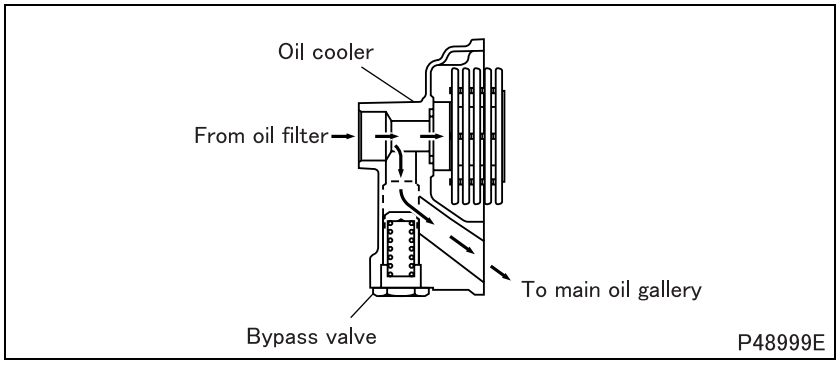
2. Oil Pump



- This engine uses a gear-type oil pump driven by the rotation of the crankshaft transmitted through the engagement of the crankshaft gear and the oil pump gear.

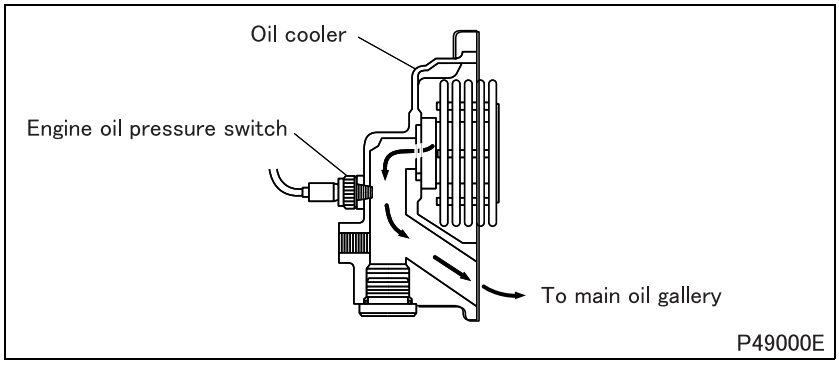
3. Oil Cooler





3.1 Bypass valve

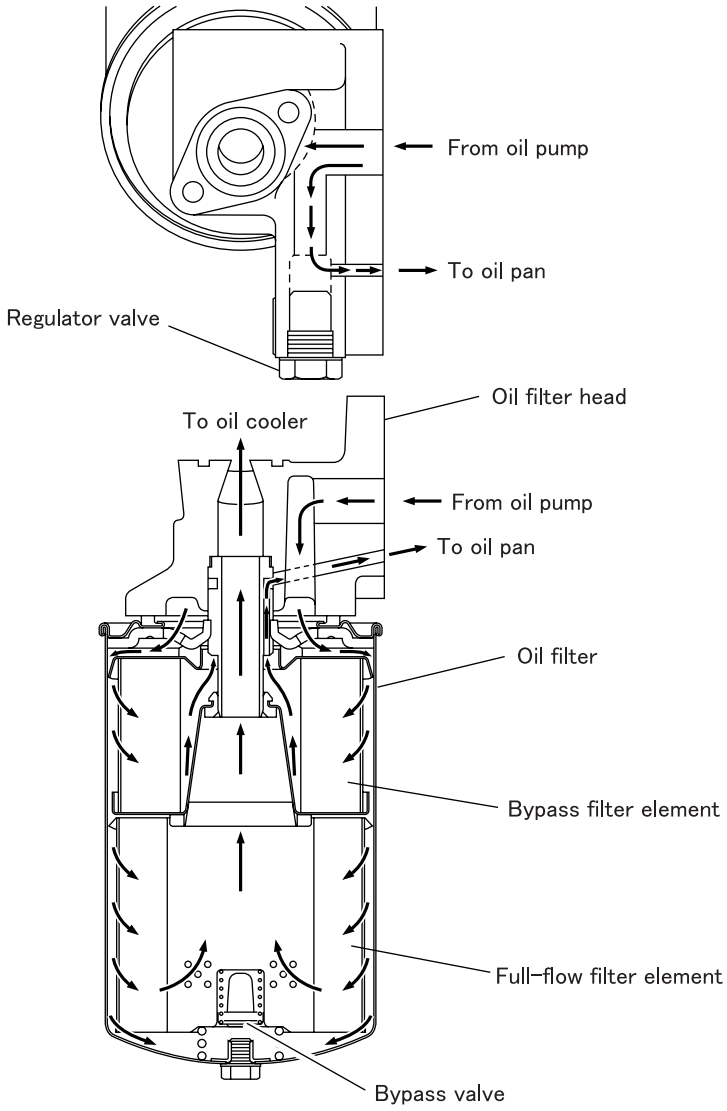
- When the engine oil is cool and its viscosity is high, or when the oil cooler element becomes clogged and restricts the flow of the engine oil, the bypass valve opens to let the engine oil bypass the oil cooler and flow directly to the main oil gallery.



3.2 Engine oil pressure switch

- When the pressure of the engine oil to the main oil gallery drops below the specified level, an electrical contact inside the engine oil pressure switch closes.
- This causes a warning lamp on the meter cluster to illuminate and notify the operator of the excessive pressure drop.

4. Oil Filter

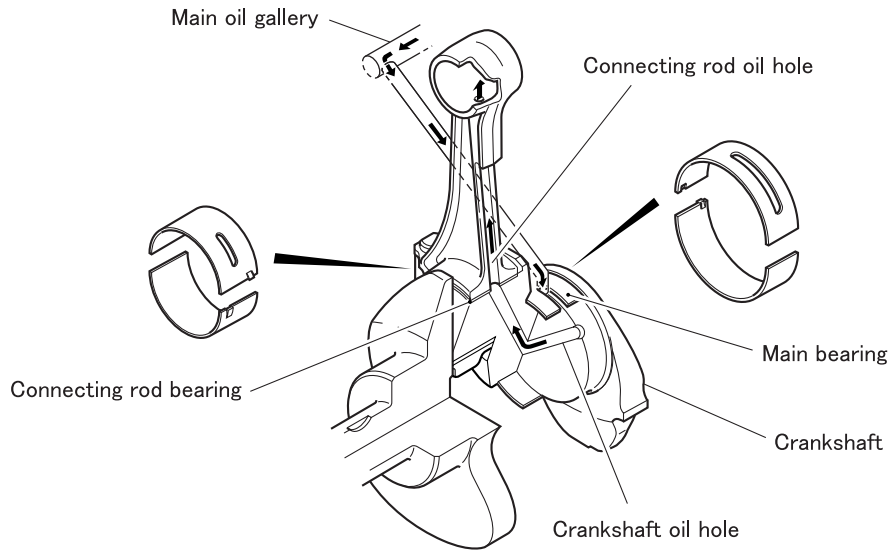


- The oil filter used in this engine is a spin-on, paper-filter type that incorporates both a bypass filter and a full-flow filter.
- A bypass valve is installed in the lower part of the oil filter. When the filter elements are clogged, this valve opens to let the engine oil bypass the filter elements and flow directly to the oil cooler, thereby preventing seizures in the engine.
- A regulator valve is installed on the oil filter head. When the oil pressure in the main oil gallery exceeds the specified level, the regulator valve opens to adjust the oil pressure by returning part of the engine oil to the oil pan.

5. Lubrication of Engine Components

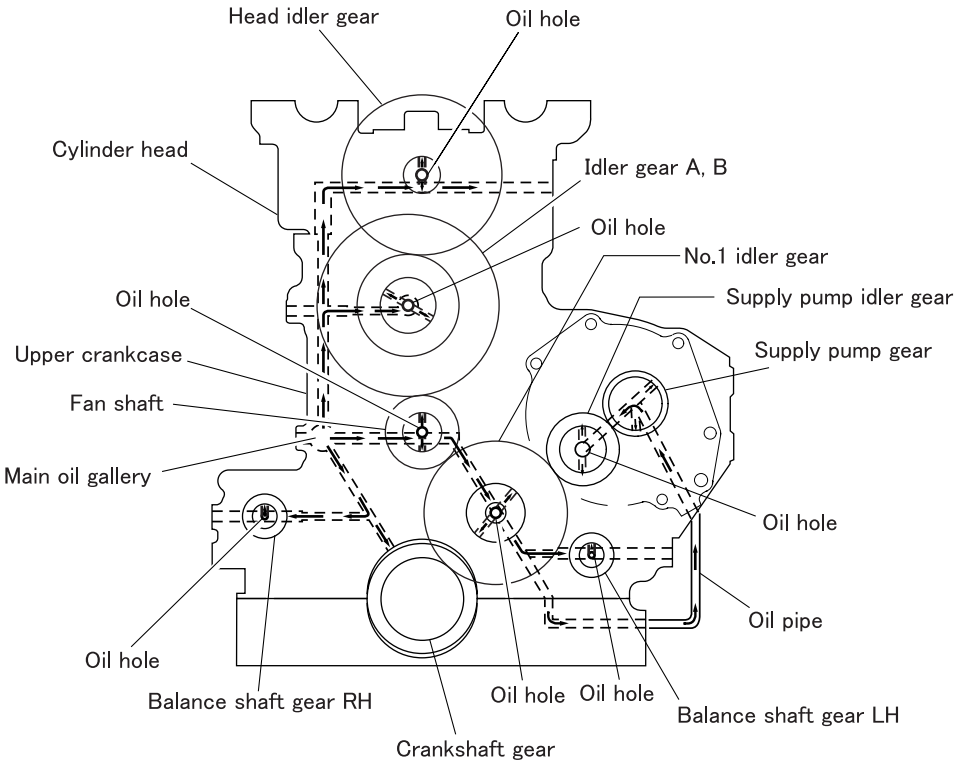
- The engine oil in the main oil gallery lubricates the engine components in the following ways.

5.1 Main bearing and connecting rod bearing

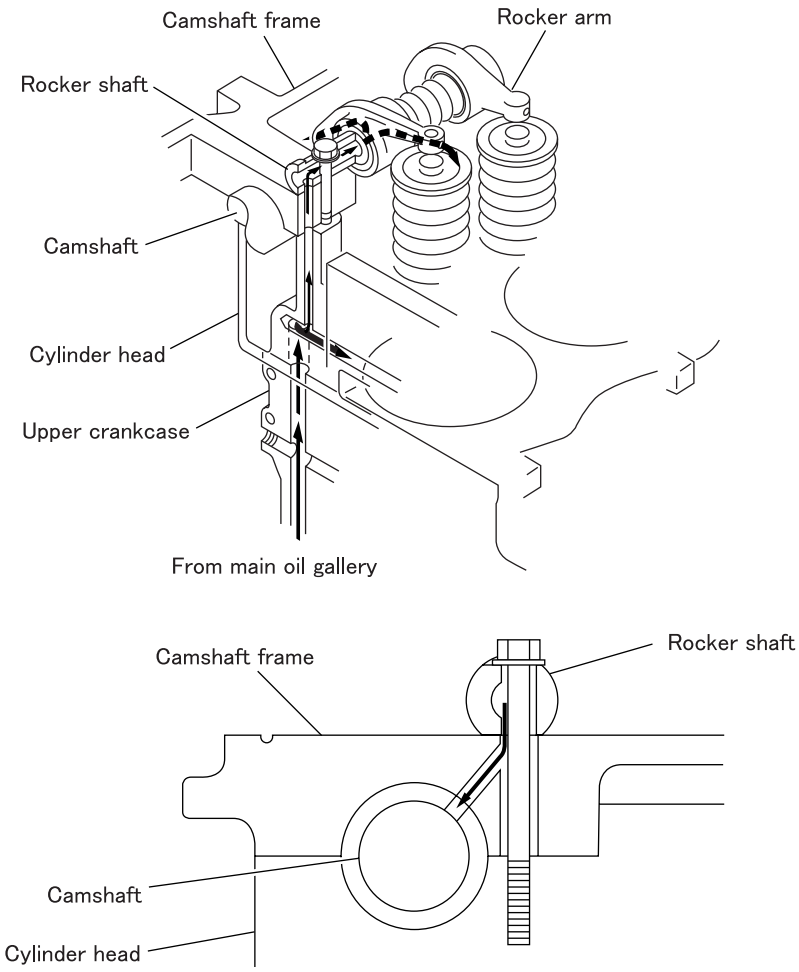


- Engine oil supplied through an oil passage in the crankshaft lubricates the big end (connecting rod bearing) of each connecting rod. Simultaneously, engine oil supplied through an oil passage in the connecting rod lubricates the connecting rod's small end.

5.2 Timing gears

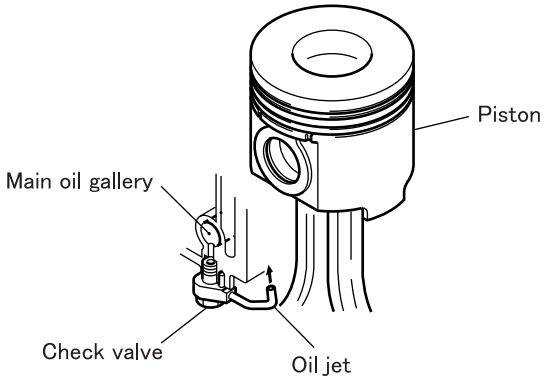


5.3 Valve mechanism



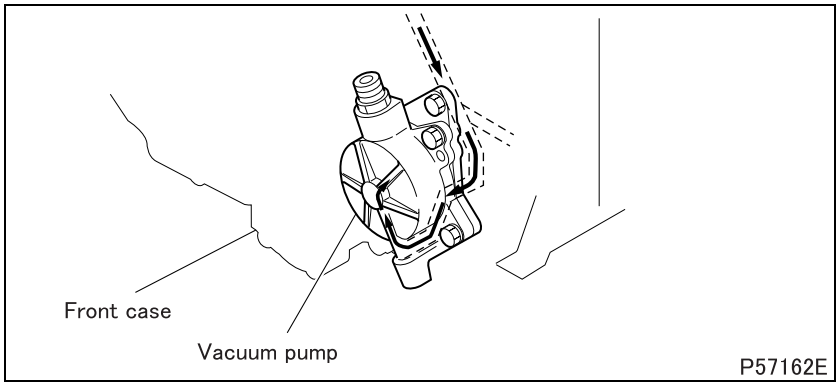
- The engine oil flows from the main oil gallery to the rocker shaft through the oil passages in the upper crankcase, cylinder head, and camshaft frame.
- The engine oil in the rocker shaft lubricates the rocker arms and camshaft, then returns to the oil pan.

5.4 Check valves and oil jets



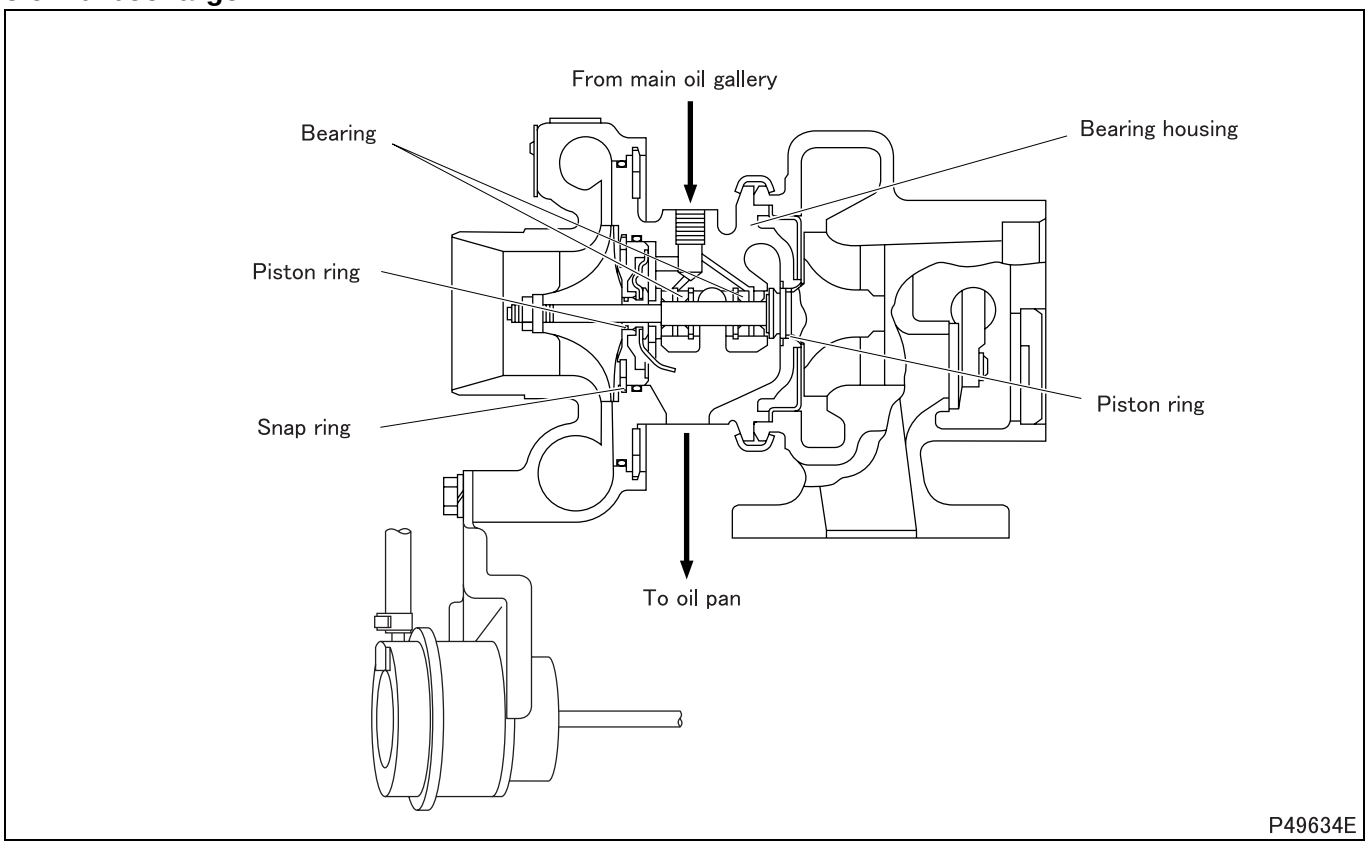
- An oil jet is fitted in the lower part of the main oil gallery for each cylinder.
- Engine oil is sprayed out of the oil jet into the piston to cool the piston.
- Each oil jet is fitted with a check valve that opens and closes at predetermined oil pressure levels. At low engine speeds, the check valve closes to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.

5.5 Vacuum pump



- Engine oil flows through the oil passages in the front case to the vacuum pump.
- The oil in the pump lubricates the vanes, and then is discharged into the front case from the air discharge port of the vacuum pump along with air, and returns to the oil pan.

5.6 Turbocharger



- Engine oil flows from the main oil gallery through the oil pipes to the turbocharger bearing housing and lubricates the inner surfaces of the bearing housing.
- The piston rings mounted on both sides of the turbine wheel shaft act as oil seals.

Possible causes \ Symptoms		Engine is difficult to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	Reference Gr
Oil cooler	Incorrectly mounted element		O	O	O	
	Defective gasket		O	O	O	
	Defective O-ring		O	O	O	
	Clogged element		O	O		
	Damaged element		O	O	O	
	Weakened bypass valve spring		O			
Oil pump	Malfunctioning oil pump		O	O		
	Interference between oil pump gear and oil pump case and/or cover	O		O		
Oil filter	Incorrect installation				O	
	Clogged element		O	O		
	Defective gasket			O		
Weakened regulator valve spring				O		
Incorrectly mounted and/or clogged oil strainer			O	O		
Defective fan shaft front oil seal					O	Gr11
Defective crankshaft rear oil seal					O	
Incorrectly mounted front case					O	
Defective piston cooling oil jet(s)			O	O		
Incorrectly mounted gear lubrication oil jet				O		
Oil working its way up into combustion chamber(s) through piston rings					O	
Oil working its way down into combustion chamber(s) through valves					O	
Too high oil viscosity		O				
Poor oil quality			O			
Deterioration of oil			O			
Fuel mixed with oil			O			

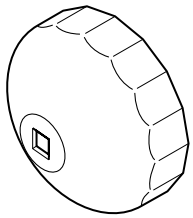
M E M O

1. Oil Filter Replacement

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 L {1.1 qts}

Special tools

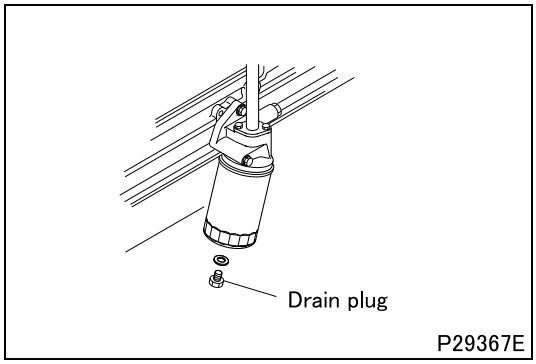
Mark	Tool name and shape	Part No.	Application
a	Oil filter element socket  P08550	MH061566	Removal of oil filter

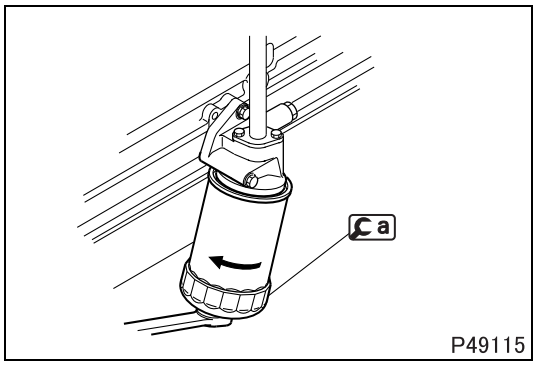
WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

CAUTION ⚠

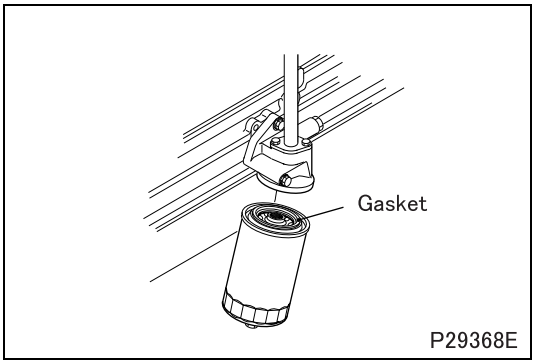
- **Make sure not to put any engine oil on the V-belt when working on the oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**





[Removal]

- Remove the drain plug and drain the oil out of the oil filter.



[Installation]

- Clean the oil filter mounting surfaces of the oil filter head.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil filter head. Then, tighten the filter by turning it further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

2. Engine Oil Replacement

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil filter)	9.8 ± 1.96 {7.2 ± 1.4, 1.0 ± 0.2}	–
–	Drain plug (oil pan)	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	–

Lubricant and/or sealant

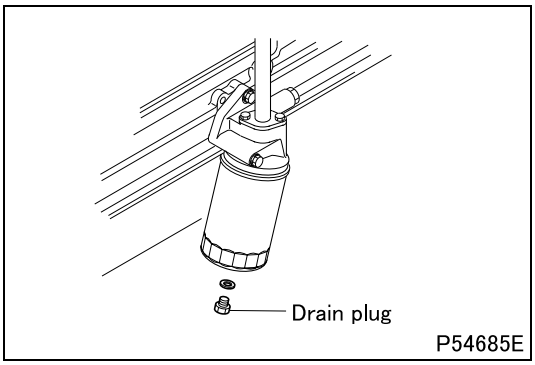
Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 L {1.1 qts}
	Oil pan		Approx. 9 L {9.5 qts}

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

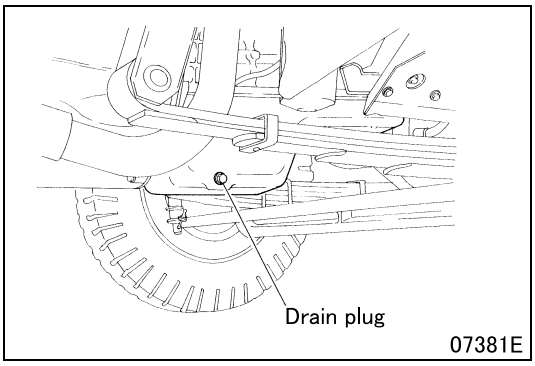
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt during engine oil replacement. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**



[Draining]

- Remove the filler cap.
- Remove the drain plugs of the oil filter and oil pan to drain out the engine oil.



[Refilling]

- Tighten the drain plug to the specified torque, then pour a specified amount of new engine oil into the engine.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

3. Oil Pressure Measurement

Service standards

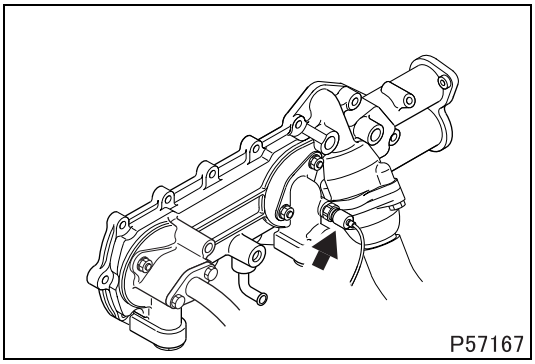
Location	Maintenance item		Standard value	Limit	Remedy
–	Oil pressure (oil temperature at 70 to 90°C {158 to 195°F})	No-load minimum speed	195 kPa {28 psi, 2.0 kgf/cm^2}	98 kPa {14 psi, 1.0 kgf/cm^2}	Inspect
		No-load maximum speed	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm^2}	195 kPa {28 psi, 2.0 kgf/cm^2}	

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

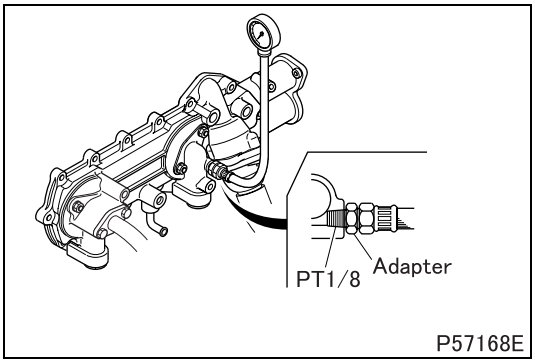
Mark	Parts to be tightened	Tightening torque	Remarks
–	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11, 0.8 to 1.5}	Sealant With cold engine

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Engine oil pressure switch threads	ThreeBond 1215	As required


P57167

- Remove the engine oil pressure switch.



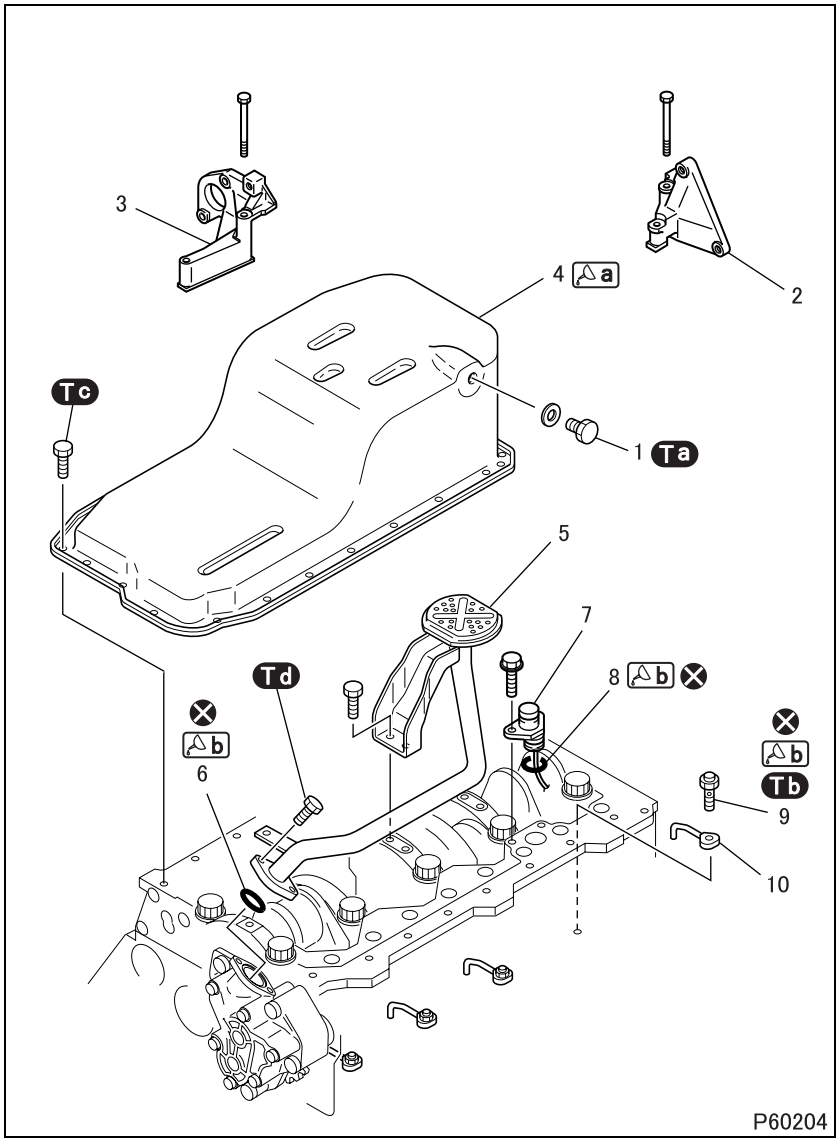
P57168E

- Using an adapter, connect an oil pressure gauge to the engine oil pressure switch mounting hole.
- Warm up the engine until the oil temperature reaches 70 to 90°C {158 to 195°F}.
- Measure the oil pressure while running the engine at a minimum speed and then at maximum speed, both under no load.
- If the measurements are below the specified limits, overhaul the lubrication system.
- After taking the measurements, apply sealant to the threads of the oil pressure switch and tighten the switch to the specified torque.

CAUTION ⚠

- **Reinstall the oil pressure switch only when the engine is cold.**

OIL PAN, OIL STRAINER AND OIL JETS



● Disassembly sequence

1 Drain plug
2 Stiffner RH
3 Stiffner LH
4 Oil pan
5 Oil strainer
6 O-ring
7 Engine oil level sensor
8 O-ring
9 Check valve
10 Oil jet

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure to tighten the check valve only to the specified torque. Overtightening it can cause defective operation, resulting in engine seizure.**

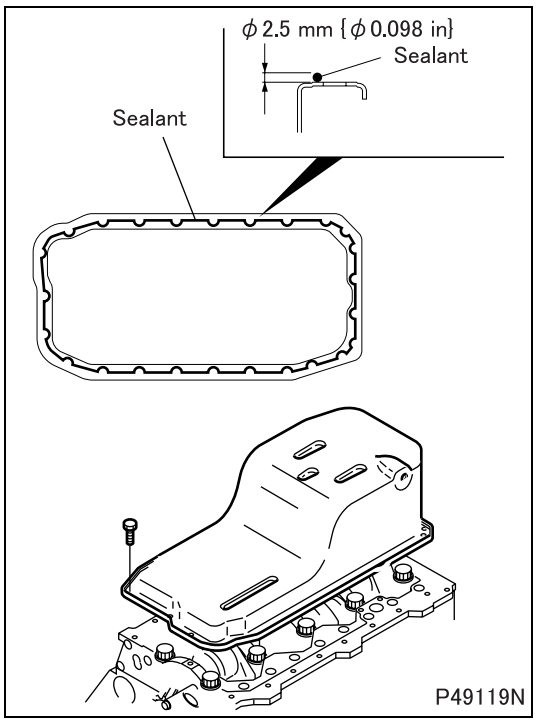
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	–
Tb	Check valve	29.4 {22, 3.0}	Wet
Tc	Bolt (oil pan mounting)	23.5 {17, 2.4}	–
Td	Bolt (oil strainer mounting)	23.2 {17, 2.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Crankcase mounting surface of oil pan	ThreeBond 1207C	As required
b	O-ring	Engine oil	As required
	Check valve threads		

◆Installation procedure◆



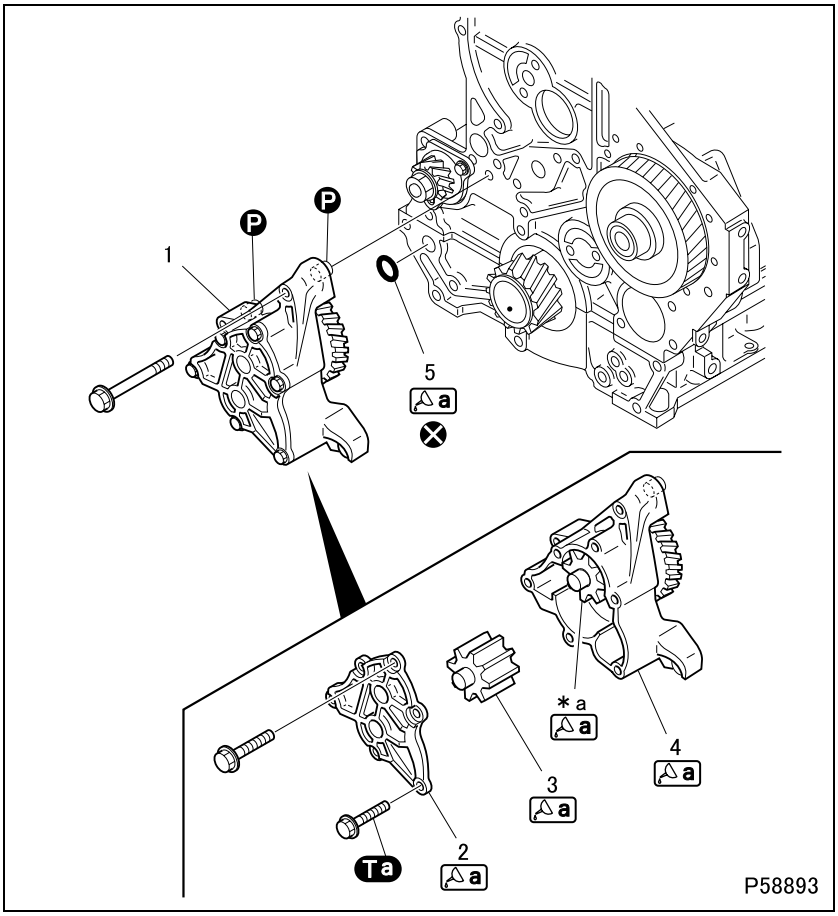
■ **Installation: Oil pan**

- Clean the mating surfaces of each part.
- Apply a bead of sealant to the mating surface of the oil pan evenly and without any breaks as shown in the illustration.
- Mount the oil pan within three minutes of applying the sealant. Make sure that the sealant stays in place.

CAUTION ⚠

- **Do not start the engine less than an hour after installation.**
- **If the oil pan mounting bolts were loosened or removed, be sure to reapply sealant.**

OIL PUMP



● **Disassembly sequence**

1 Oil pump
2 Oil pump cover
3 Driven gear
4 Gear and case assembly
5 O-ring

***a**: Drive gear
Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly procedure in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
2, 3	Oil pump cover-to-driven gear shaft clearance	0.04 to 0.075 {0.0016 to 0.0030}	0.15 {0.0059}	Replace
2, *a	Oil pump cover-to-drive gear shaft clearance	0.04 to 0.075 {0.0016 to 0.0030}	0.15 {0.0059}	Replace
3, 4	Gear and case assembly-to-driven gear shaft clearance	0.04 to 0.075 {0.0016 to 0.0030}	0.15 {0.0059}	Replace
3, 4, *a	Sinkage of each gear from gear and case assembly end surface	0.05 to 0.11 {0.0020 to 0.0043}	0.15 {0.0059}	Replace
	Gear and case assembly-to-tooth tip clearance for each gear	0.13 to 0.22 {0.0051 to 0.0087}	0.23 {0.0091}	Replace

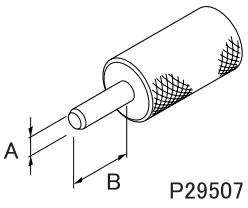
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (oil pump cover mounting)	27.4 {20, 2.8}	–

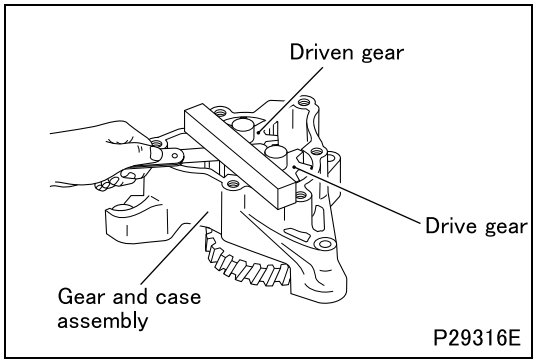
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil pump contact surfaces	Engine oil	As required
	O-ring		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Pump cover pin A: $\phi 7\ ^{0}_{-0.14}$ {$\phi 0.28\ ^{0}_{-0.0055}$} B: 20 {0.79}  P29507	MH063431	Installation of oil pump cover

◆Inspection procedure◆

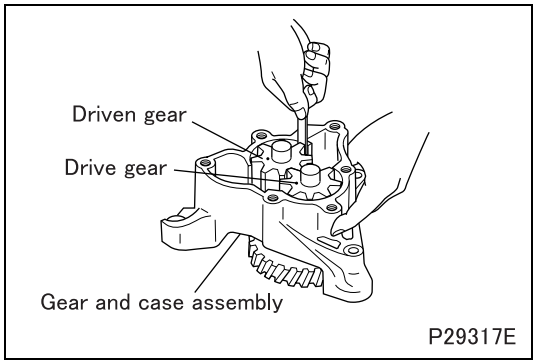


P29316E

■ Inspection: Driven gear, drive gear and gear and case assembly

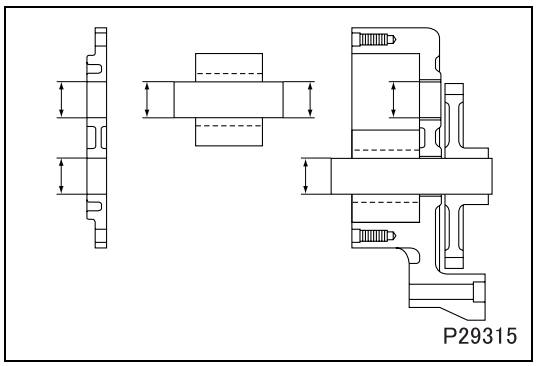
- Carry out the following inspection. Replace the oil pump if any defects are found.

(1) Sinkage of each gear from gear and case assembly end surface



P29317E

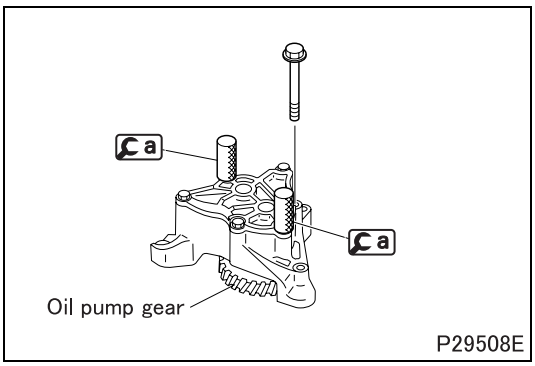
(2) Gear and case assembly-to-tooth tip clearance for each gear


P29315

■ Inspection: Oil pump cover, driven gear, and gear and case assembly

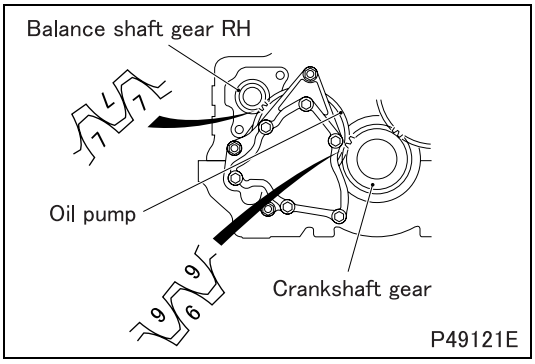
- Measure the clearance between each gear's shaft and the oil pump cover, as well as between each gear's shaft and the gear and case assembly.
- If the measurements are not within the standard value range, replace the oil pump.

◆Installation procedure◆



■ Installation: Oil pump cover and gear and case assembly

- Apply engine oil to each component.
- Hold the oil pump cover in place on the gear and case assembly by fitting two a s in the illustrated locations.
- Install a bolt into an empty bolt hole and tighten it to the specified torque.
- Remove the two a s. Install the rest of the bolts and tighten them to the specified torque.
- After installing all the bolts, turn the oil pump gear by hand and check that it rotates smoothly.
- Disassemble and reassemble the oil pump cover and gear and case assembly if the oil pump gear does not rotate smoothly.

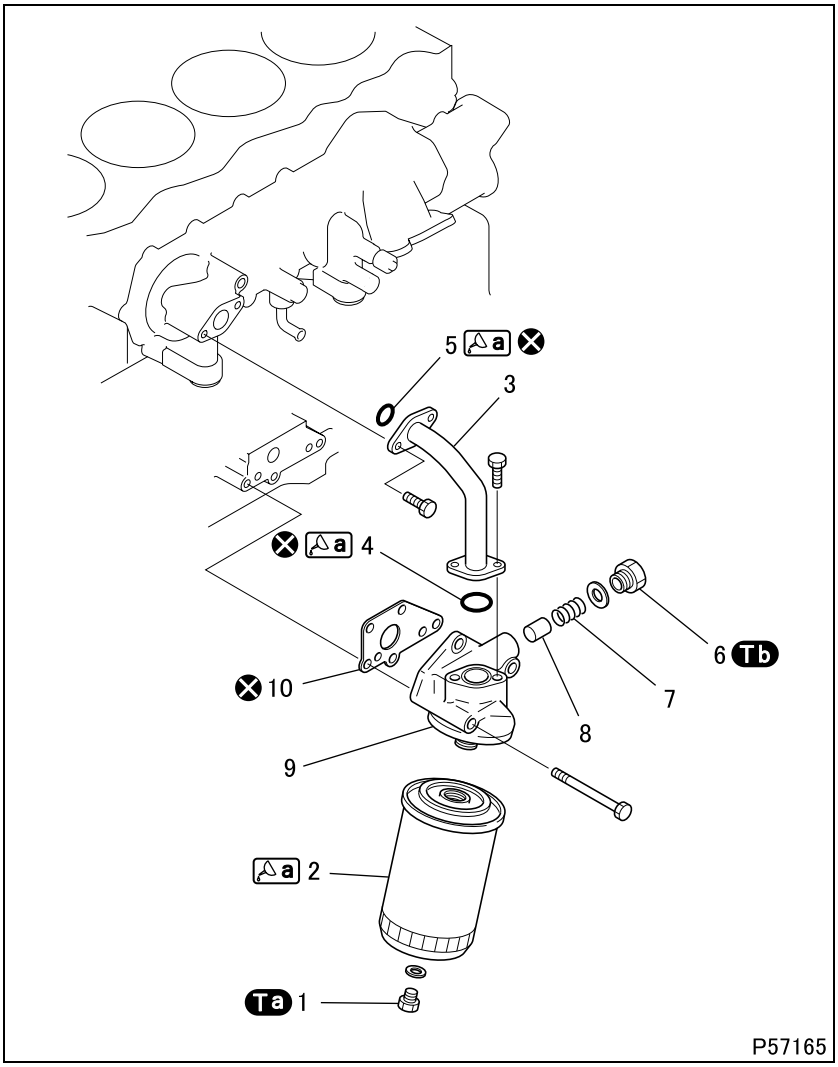


■ Installation: Oil pump

- Place the No.1 cylinder piston at top dead center to bring the crankshaft gear to an appropriate position.
- Inject approximately 5 cm^3 {0.3 cu. in.} of engine oil.
- Align the mating mark "**6**" on the crankshaft gear and the mating mark "**7**" on the balance shaft gear RH with the corresponding mating marks on the oil pump gear, and then install the oil pump gear.

M E M O

OIL FILTER



● Disassembly sequence

1 Drain plug
2 Oil filter
3 Oil pipe
4 O-ring
5 O-ring
6 Plug
7 Regulator valve spring
8 Regulator valve
9 Oil filter head
10 Gasket

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil cooler and oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Make sure to install the gasket in the correct position so that it does not cover up the oil hole.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
7	Load of installed regulator valve spring (installed length: $39^{+0.3}_{0}$ {$1.54^{+0.012}_{0}$})	93.5 ± 0.5 N {21 ± 0.1 lbs, 9.5 ± 0.05 kgf}	–	Replace

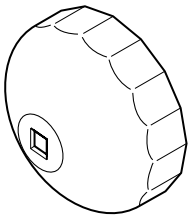
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	9.8 ± 1.96 {7.2 ± 1.4, 1.0 ± 0.2}	–
Tb	Plug (regulator valve mounting)	60 {44, 6.0}	–

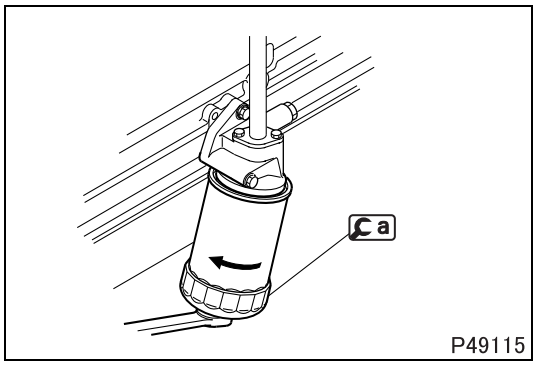
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil filter gasket	Engine oil	As required
	O-ring		

Special tools

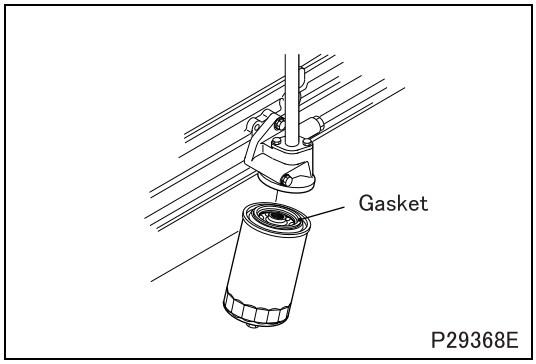
Mark	Tool name and shape	Part No.	Application
a	Oil filter element socket  P08550	MH061566	Removal of oil filter

◆Removal procedure◆



■ **Removal: Oil filter**

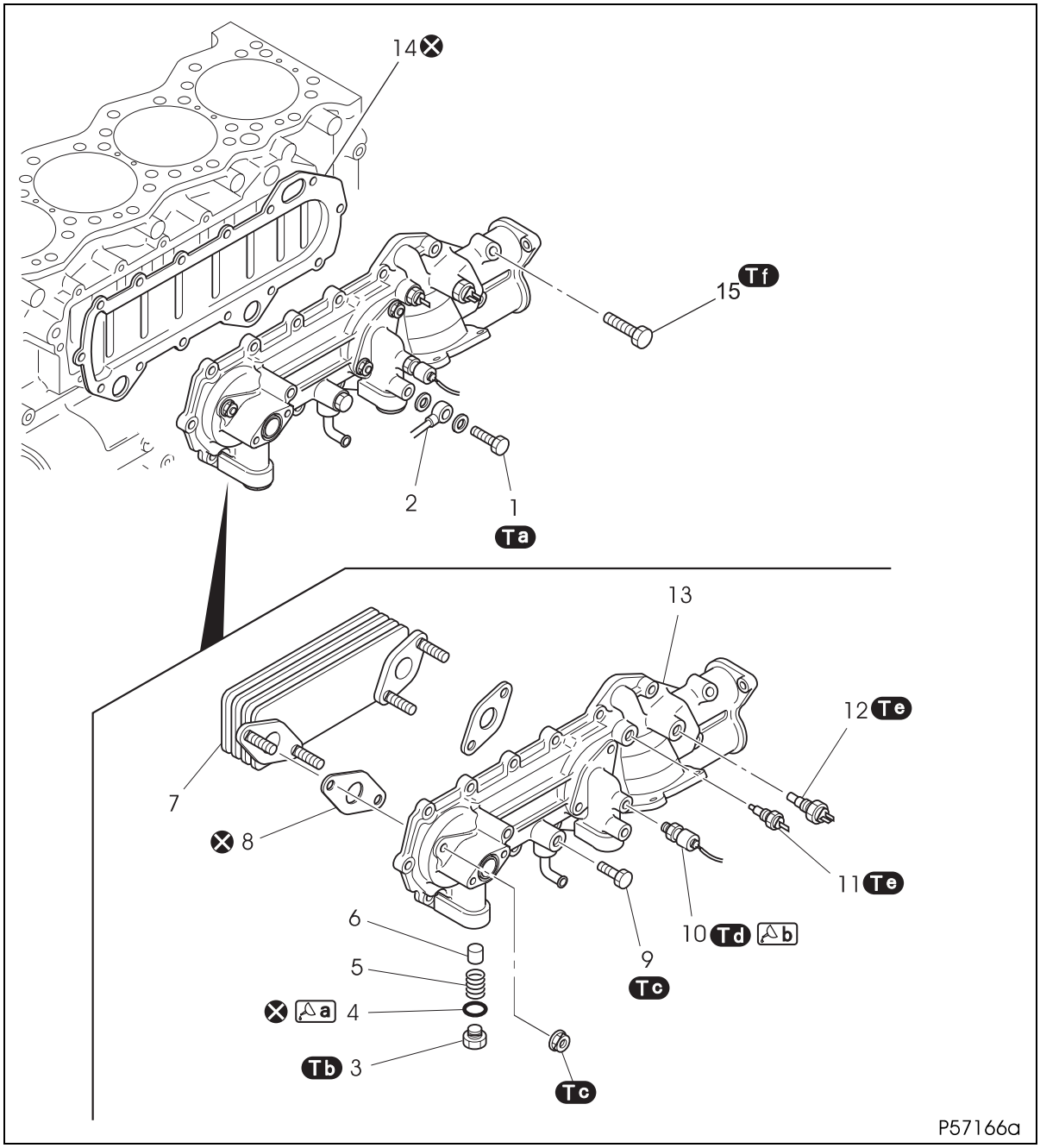
◆Installation procedure◆



■ **Installation: Oil filter**

- Clean the oil filter mounting surface of the oil filter head.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil filter head. Then, tighten the filter by turning further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks from the gasket.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

OIL COOLER



● **Disassembly sequence**

1 Eyebolt
2 Oil pipe
3 Plug
4 O-ring
5 Bypass valve spring
6 Bypass valve
7 Oil cooler element
8 Gasket
9 Water drain valve
10 Engine oil pressure switch
11 Coolant temperature sensor (for water temperature gage)
12 Coolant temperature sensor (for engine control)
13 Oil cooler body
14 Gasket
15 Oil cooler manifold bolt

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
5	Load of bypass valve spring (installed length: $48^{0}_{-0.5}$ {$1.89^{0}_{-0.02}$})	95.3 ± 4.9 N {21 ± 1.1 lbs, 9.7 ± 0.5 kgf}	–	Replace
7	Air leakage from oil cooler element (air pressure: 980 kPa {140 psi, 10 kgf/cm^2} for 15 seconds)	0 cm^3 {0 cu. in.}	–	Replace

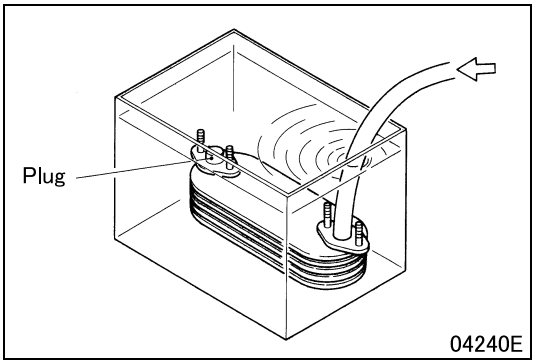
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eyebolt (oil pipe mounting)	21.6 {16, 2.2}	–
Tb	Plug	34.3 ± 4.9 {25 ± 3.6, 3.5 ± 0.5}	–
Tc	Nut (oil cooler element mounting)	24.5 ± 4.9 {18 ± 3.6, 2.5 ± 0.5}	–
	Water drain valve		
Td	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11, 0.8 to 1.5}	Sealant With cold engine
Te	Coolant temperature sensor (for water temperature gage)	34.3 {25, 3.5}	–
	Coolant temperature sensor (for engine control)		
Tf	Oil cooler manifold bolt	23.2 {17, 2.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
b	Engine oil pressure switch threads	ThreeBond 1215	As required

◆Inspection procedure◆



■ Inspection: Oil cooler element

- Plug the outlet of the oil cooler element and connect a hose to the engine oil inlet port. Then, immerse the oil cooler element in a tank of water.
- Apply an air pressure of 980 kPa {140 psi, 10 kgf/cm^2} for 15 seconds through the hose, and check for any air leaks.
- Replace the element if it leaks air.

GROUP 13A INDEX

SPECIFICATIONS 13A-2

STRUCTURE AND OPERATION
1. Fuel System (Flow of Fuel) 13A-3
2. Engine Control 13A-4
3. Fuel Filter 13A-5

TROUBLESHOOTING 13A-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Inspecting and Adjusting No-load Minimum and Maximum Speeds 13A-8
2. Air-bleeding of Fuel System 13A-9
3. Fuel Filter Replacement 13A-10

FUEL TANK
<OUT SIDE FRAME TYPE> 13A-12
<IN SIDE FRAME TYPE> 13A-14

FUEL FILTER 13A-16

ENGINE CONTROL 13A-18

COMMON RAIL 13A-21

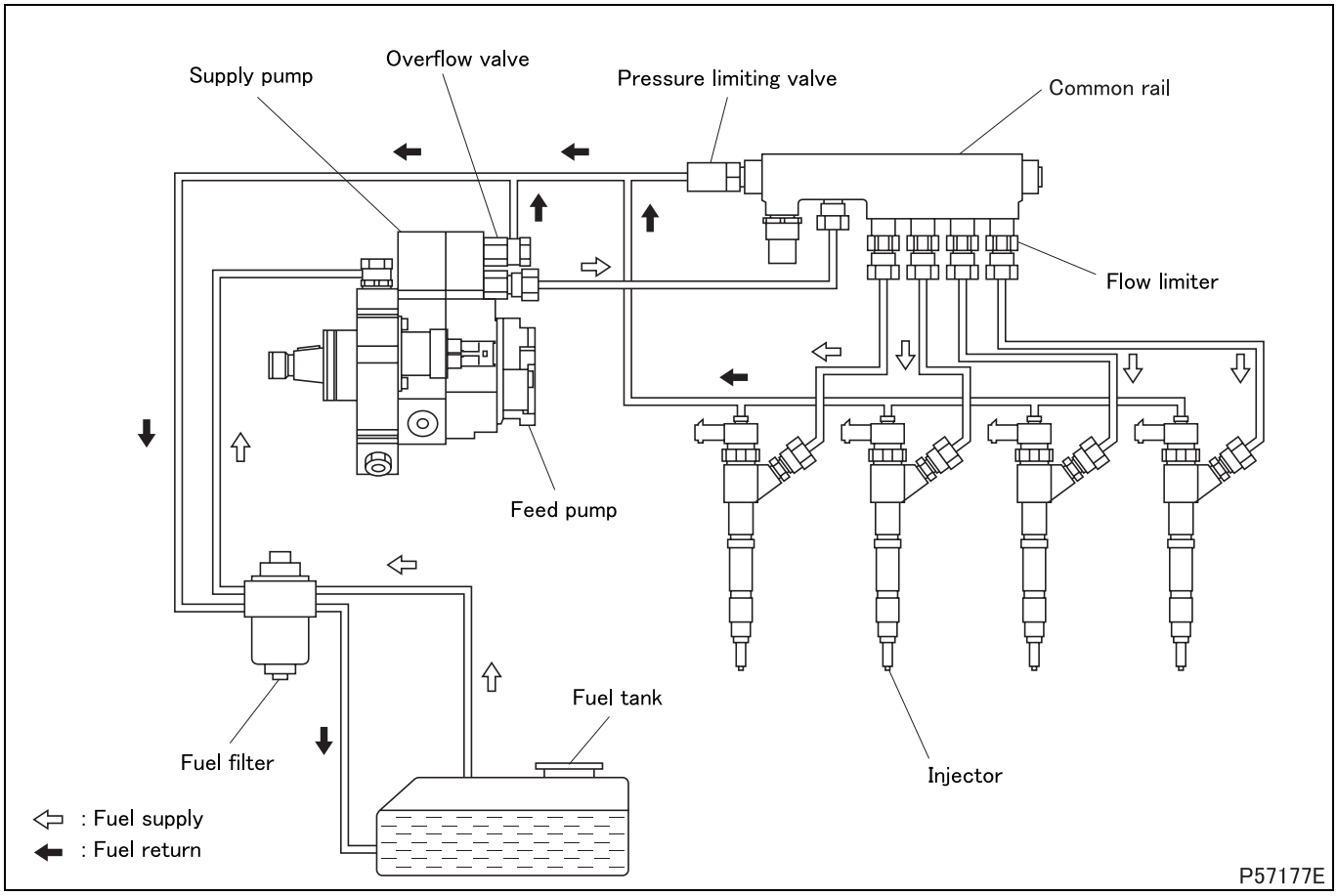
SUPPLY PUMP 13A-22

INJECTOR 13A-26

SPECIFICATIONS

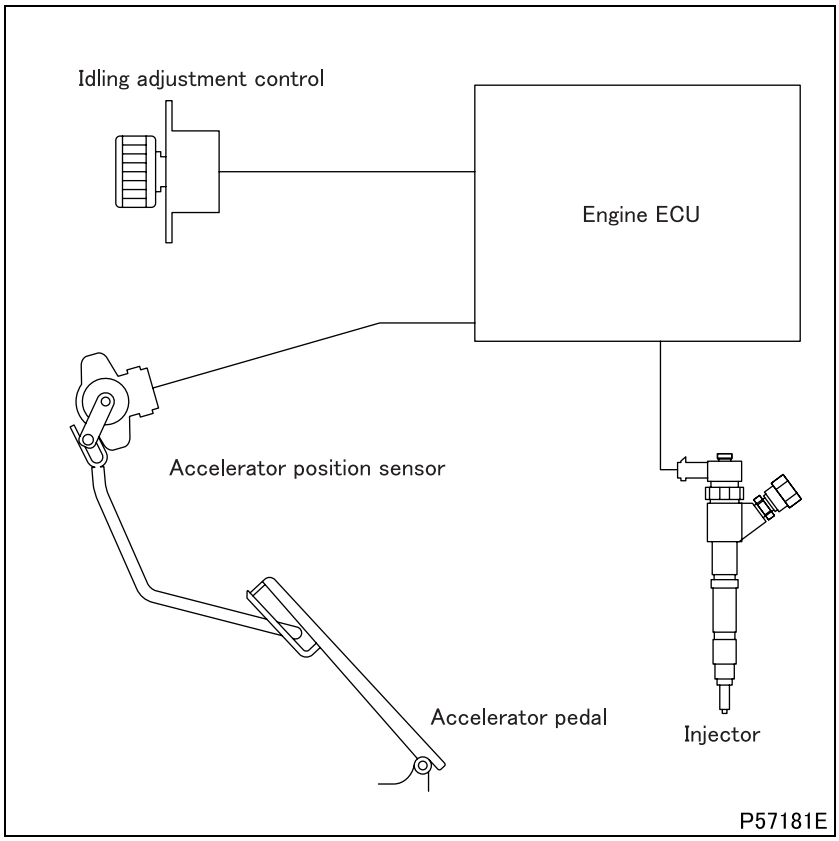
Item			Specifications
Supply pump	Manufacturer		Bosch
	Model		CP3.3
	Control method		Electronic
	Type		Radial, 3-cylinder
	Type		External gear type
	Injection quantity adjustment valve	Model	MPROP
		Rated voltage V	12
	Max. common rail pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
Common rail	Manufacturer		Bosch
	Common rail volume cm^3 {cu.in., ml}		16.5 {1.01, 16.5}
	Pressure limiting valve opening pressure MPa {psi, kgf/cm^2}		185 to 195 {26830 to 28280, 1886 to 1988}
	Common rail pressure sensor supply voltage V		5
Injectors	Manufacturer		Bosch
	Control method		Electrical
	Max. operating pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
	Min. operating pressure MPa {psi, kgf/cm^2}		25 {3630, 255}
Common rail electronic control unit	Manufacturer		Bosch
	Rated voltage V		12

1. Fuel System (Flow of Fuel)



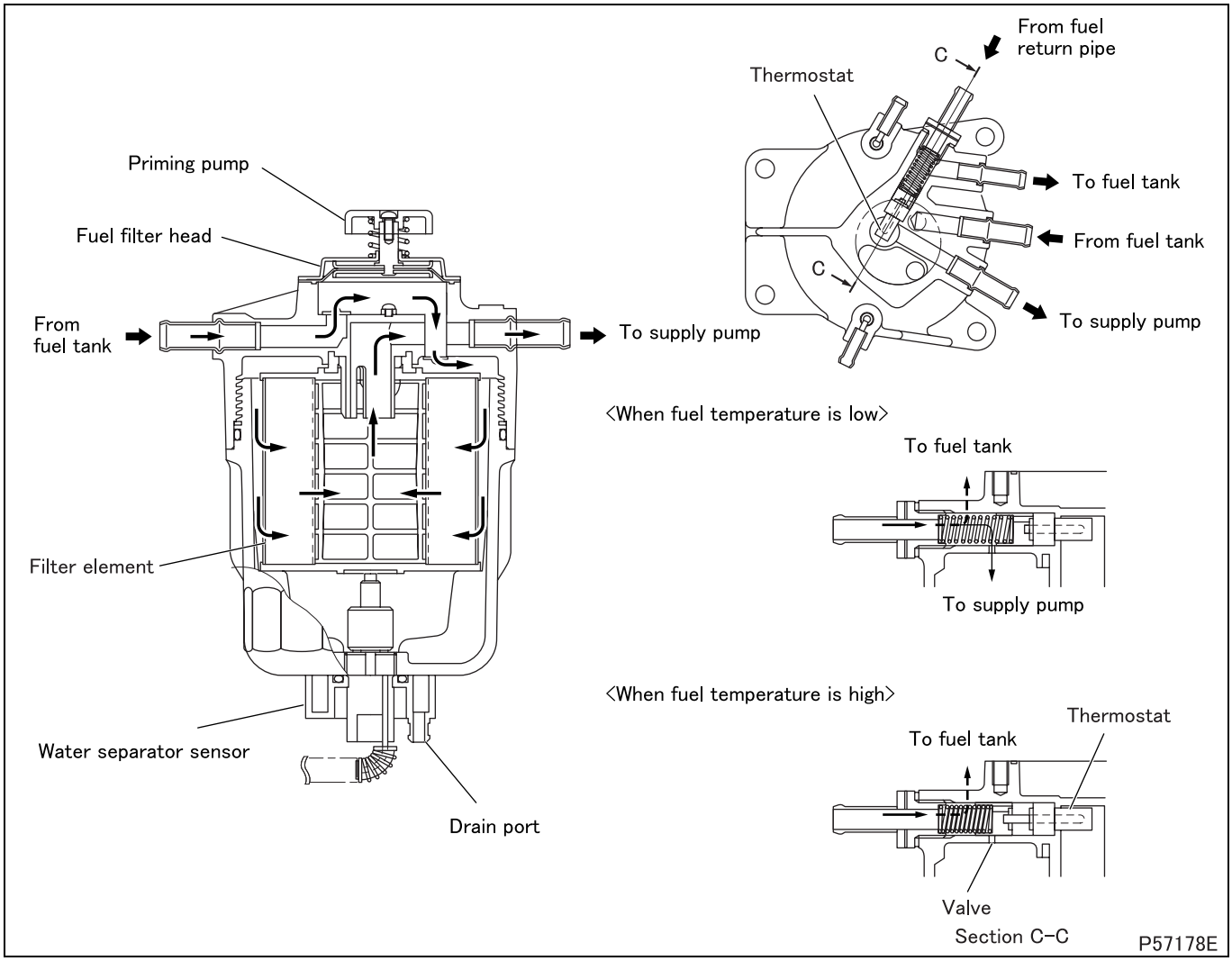
- The feed pump, which is driven by the camshaft inside the supply pump, draws up the fuel from inside the fuel tank and sends it through the fuel filter, where dust and other impurities in the fuel are filtered out.
- The filtered fuel is then sent to the supply pump, where it is compressed. The compressed fuel is accumulated in the common rail for a time, then sprayed out through the injection nozzles into the combustion chamber.
- If fuel leaks from an injection pipe at the pipe joint, the flow limiter is activated to close the fuel passage, preventing the fuel from flowing elsewhere.
- The excess fuel from the injectors returns to the fuel tank through the fuel return hose.
- When the internal fuel pressure of the Common Rail exceeds the limit, the pressure limiting valve opens to allow part of the fuel to return to the fuel tank.
- When the internal fuel pressure of the supply pump exceeds the limit, the overflow valve opens to allow part of the fuel to return to the fuel tank.

2. Engine Control



- The engine is electronically controlled by the engine electronic control unit (ECU).
- The accelerator position sensor detects how much the accelerator pedal is pressed and sends the corresponding electronic signal to the engine electronic control unit, which calculates an appropriate amount of fuel based on the signals and controls fuel injection accordingly.

3. Fuel Filter



- The fuel filter removes impurities in the fuel through the filter element and also separates water from fuel.
- The water that has been separated from the fuel collects at the bottom of the fuel filter. A water separator sensor is installed in the fuel filter, which activates the warning lamp on the meter cluster when the water reaches a certain level.
- The water can be drained through the drain port by loosening the water separator sensor.
- A priming pump is provided at the fuel filter head. The priming pump is used for air-bleeding the fuel system.
- When the fuel temperature rises, the thermostat swells and the valve of the fuel filter head is closed. The high-temperature fuel entirely returns to the fuel tank through the fuel return pipe.
- When the fuel temperature lowers, the thermostat does not swell and the valve to the fuel filter remains open. The high-temperature fuel returning through the fuel return pipe is let through the valve to mix into the fuel around the element. The fuel around the element is warmed as a result and wax in it (precipitated when the fuel temperature is low) is dissolved to prevent clogging of the element.

Possible causes \ Symptoms		Engine refuses to start	Engine is difficult to start	Engine knocks	Engine output is unstable	Engine output is insufficient	Engine maximum speed is too high	Engine is idling unstably	Engine stops soon after starting	Engine does not reach maximum speed	Engine does not stop	Accelerator pedal is too stiff	Fuel supply is insufficient	warning lamp illuminates	Reference Gr
Faulty electronic fuel control system														O	Gr13E
Supply pump	Malfunctioning feed pump check valve		O			O			O		O				*
	Defective feed pump		O			O			O		O				*
	Poorly airtight supply pump overflow valve		O			O			O		O				*
	Open or short circuit failure, poor contact of supply pump M/V		O			O			O		O			O	*
	Defective supply pump M/V, defective supply pump		O			O			O		O				*
Injectors	Open or short circuit failure, poor contact of injector M/V		O	O		O					O			O	*
	Defective injector, defective injector M/V, defective nozzle		O	O		O					O				*
Clogged fuel filter		O			O			O	O						
No fuel in fuel tank		O													
Clogged fuel pipe and/or leaky pipe joints		O													
Air or water in fuel system		O			O			O	O						
Use of low quality fuel			O	O		O		O							
Open or short circuit failure, poor contact of common rail pressure sensor, defective sensor		O	O		O	O			O					O	*
Flow limiter activated				O		O								O	*
Fuel leakage from high pressure pipe joint			O	O	O	O					O				*
Engine control	Poorly adjusted accelerator pedal stopper bolt					O				O					
	Defective accelerator pedal position sensor													O	
Cracked fuel pipe and/or hose													O		

*****: Contact a Bosch service station for repair.

Symptoms / Possible causes	Engine refuses to start	Engine is difficult to start	Engine knocks	Engine output is unstable	Engine output is insufficient	Engine maximum speed is too high	Engine is idling unstably	Engine stops soon after starting	Engine does not reach maximum speed	Engine does not stop	Accelerator pedal is too stiff	Fuel supply is insufficient	warning lamp illuminates	Reference Gr
Inappropriate oil viscosity		O					O							Gr12
Poorly adjusted valve clearance		O					O							Gr11
Defective cylinder head gasket		O					O							
Wear of and/or carbon deposits on valve and valve seat		O					O							
Distorted valve springs		O					O							
Worn or damaged piston rings		O					O							
Worn or damaged piston ring groove		O												
Worn piston and/or cylinder liner		O					O							
Poorly functioning cooling system		O					O							Gr14
Defective starter switch	O	O												Gr54
Defective glow plug		O												
Open-circuited, short-circuited or poorly connected engine speed sensor and/or cylinder sensor	O	O											O	Gr13E
Open-circuited, short-circuited or poorly connected boost pressure sensor			O	O	O				O				O	
Open-circuited, short-circuited or poorly connected coolant temperature sensor	O	O											O	
Poorly connected injection rate adjusting resistor			O		O								O	
Poorly connected idling adjustment control			O				O						O	
Blown fuse	O	O						O					O	Gr54

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspecting and Adjusting No-load Minimum and Maximum Speeds

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	No-load minimum speed (idling speed)	650 ± 25 rpm	–	Adjust
–	No-load maximum speed	3,100 ± 50 rpm	–	Adjust

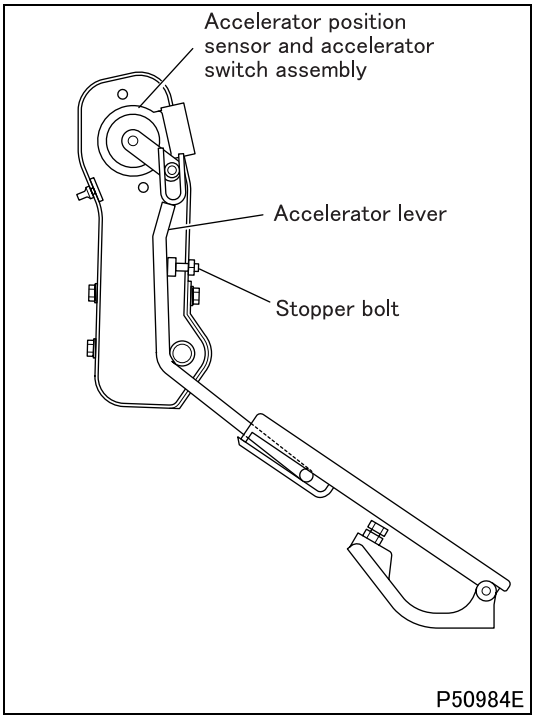
[Work before inspection and adjustment]

- Before starting the inspection and adjustment, carry out the following preparatory steps:
- Warm up the engine until the engine coolant temperature is approximately 80 to 95°C {176 to 203°F};
- turn off all lamps and accessories;
- put the transmission in neutral (P-range for automatic transmission);
- set the steering wheel at the straight-ahead position; and
- attach the probe of the tachometer to an infector.

[Inspection and adjustment]

(1) No-load minimum speed

- Without pressing the accelerator pedal, measure the engine speed.
- If the speed is not within the standard value range, inspect the accelerator position sensor and accelerator switch assembly. (See Gr13E)
- If no defects are evident during the above inspection, check for any diagnosis codes related with the fuel system and inspect the supply pump and engine electronic control unit. (See Gr13E)



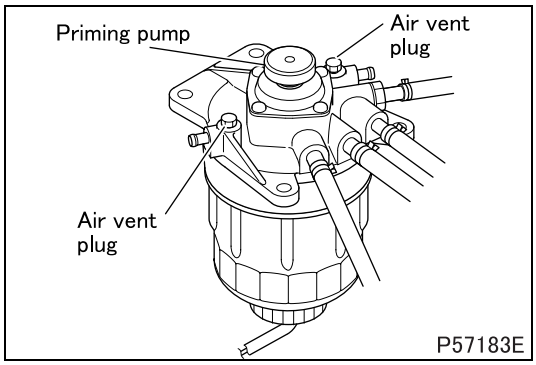
(2) No-load maximum speed

- Press the accelerator pedal as far as it will go.
- With the accelerator lever touching the stopper bolt, measure the engine speed.
- If the speed is not within the standard value range, inspect the accelerator position sensor and accelerator switch assembly. (See Gr13E)
- If no defects are evident during the above inspection, check for any diagnosis codes related with the fuel system and inspect the supply pump and engine electronic control unit. (See Gr13E)

2. Air-bleeding of Fuel System

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Air vent plug	10 ± 2 {7.4 ± 1.5, 1 ± 0.2}	–



- Loosen one of the air vent plugs on the fuel filter.
- Move the priming pump up and down to pump out the fuel.
- Continue operating the priming pump until the fuel flowing out of the air vent plug is free of air bubbles.
- When no more air bubbles are evident, tighten the air vent plug to the specified torque.
- Feed the fuel some more by operating the priming pump further until a strong resistance is felt.

NOTE

- **When the fuel temperature is low, you may not feel the resistance. Be sure to operate the priming pump several times even in such a case.**

- Wipe up any spilled fuel and start the engine.
- Check that there is no fuel leakage.

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To avoid risk of fire, wipe up any spilled fuel.**

3. Fuel Filter Replacement

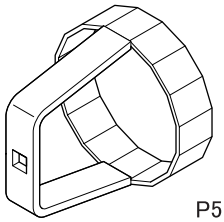
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

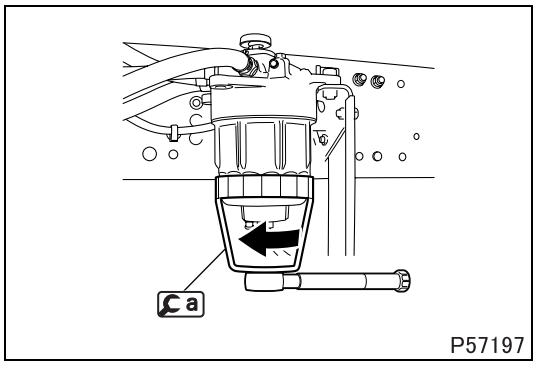
Mark	Parts to be tightened	Tightening torque	Remarks
–	Water separator sensor	5 ± 1 {3.7 ± 0.7, 0.5 ± 0.1}	–
–	Case	30 ± 2 {22 ± 1.5, 3.1 ± 0.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Fuel filter gasket	Engine oil	As required

Special tools

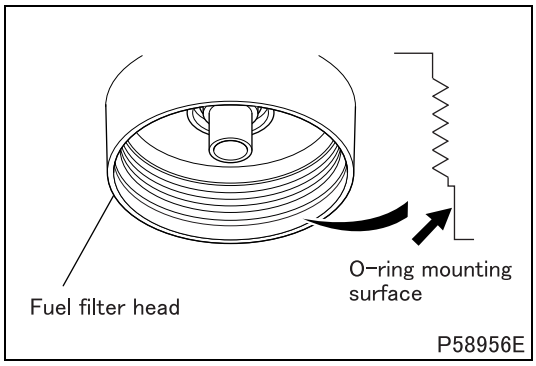
Mark	Tool name and shape	Part No.	Application
ⓒa	Filter wrench  P57179	MH063203	Removal and installation of case



P57197

[Removal]

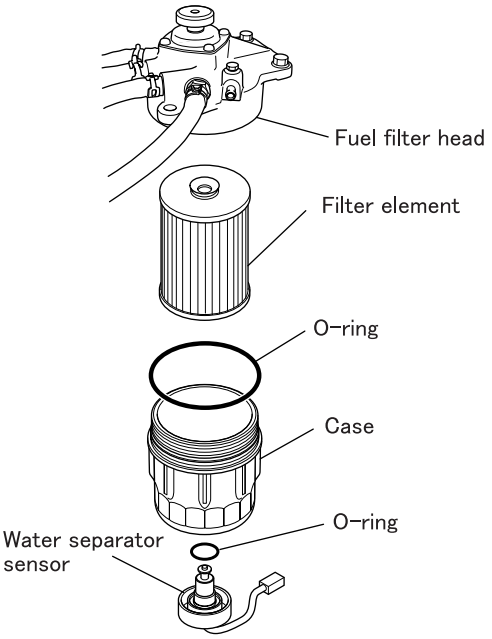
- Loosen the water separator sensor and drain fuel from the case.
- Remove the case using ⓒa.



P58956E

[Installation]

- Clean the O-ring mounting surface of the fuel filter head.

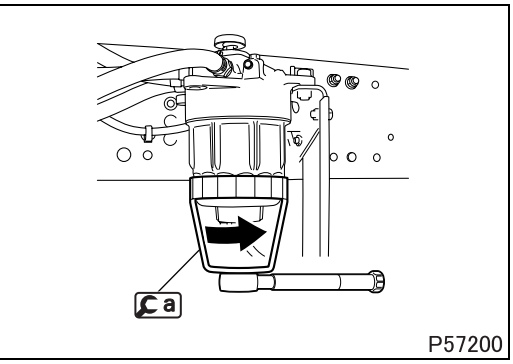


P57199E

- Replace the filter element and O-ring with new one.
- Apply a thin coat of engine oil to the O-ring, and install it on the case and water separator sensor.

CAUTION ⚠

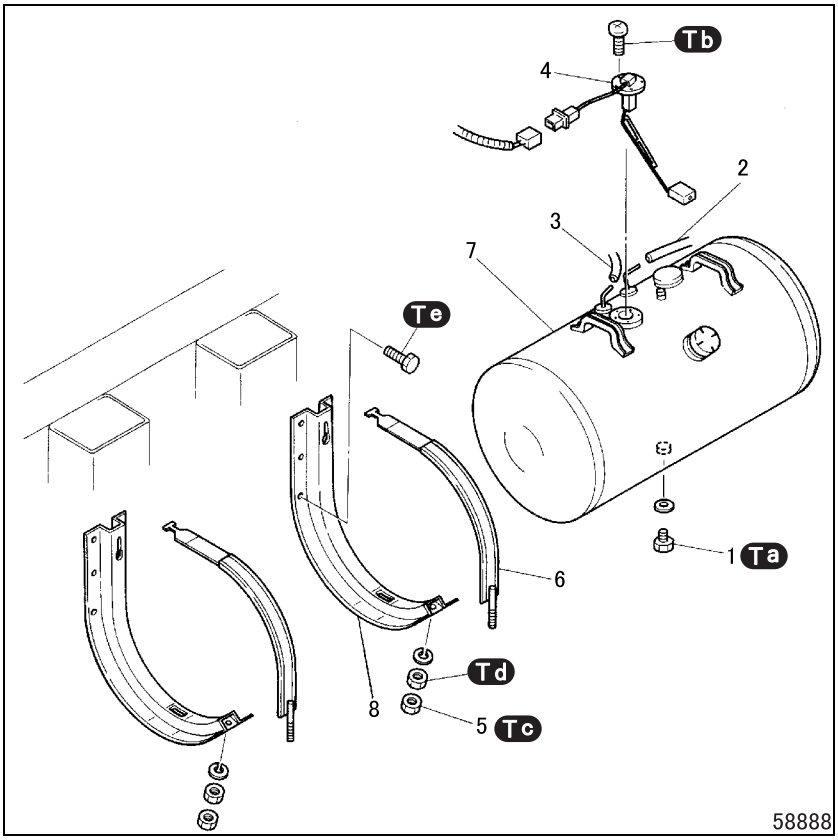
- **Be sure to use only genuine Sterling filter elements. The use of non-genuine fuel filters can cause engine failure.**
- **Prevent fine dust particles from entering the fuel filter and fuel pipe, as they can cause problems such as faulty fuel injection.**



P57200

- Use a to tighten the case to the specified torque.
- Install the water separator sensor, and then air-bleed the fuel system.
- Start the engine, and check that there is no fuel leakage.
- Reinstall the fuel filter if there is any leakage.

FUEL TANK <OUT SIDE FRAME TYPE>



● **Removal sequence**

1 Drain plug
2 Suction hose
3 Return hose
4 Fuel level sensor
5 Lock nut
6 Fuel tank band
7 Fuel tank
8 Fuel tank bracket

● **Installation sequence**

Follow the removal sequence in reverse.

DANGER ⚠

- **Do not allow any flames or sources of heat near the fuel tank, as it may explode.**

WARNING ⚠

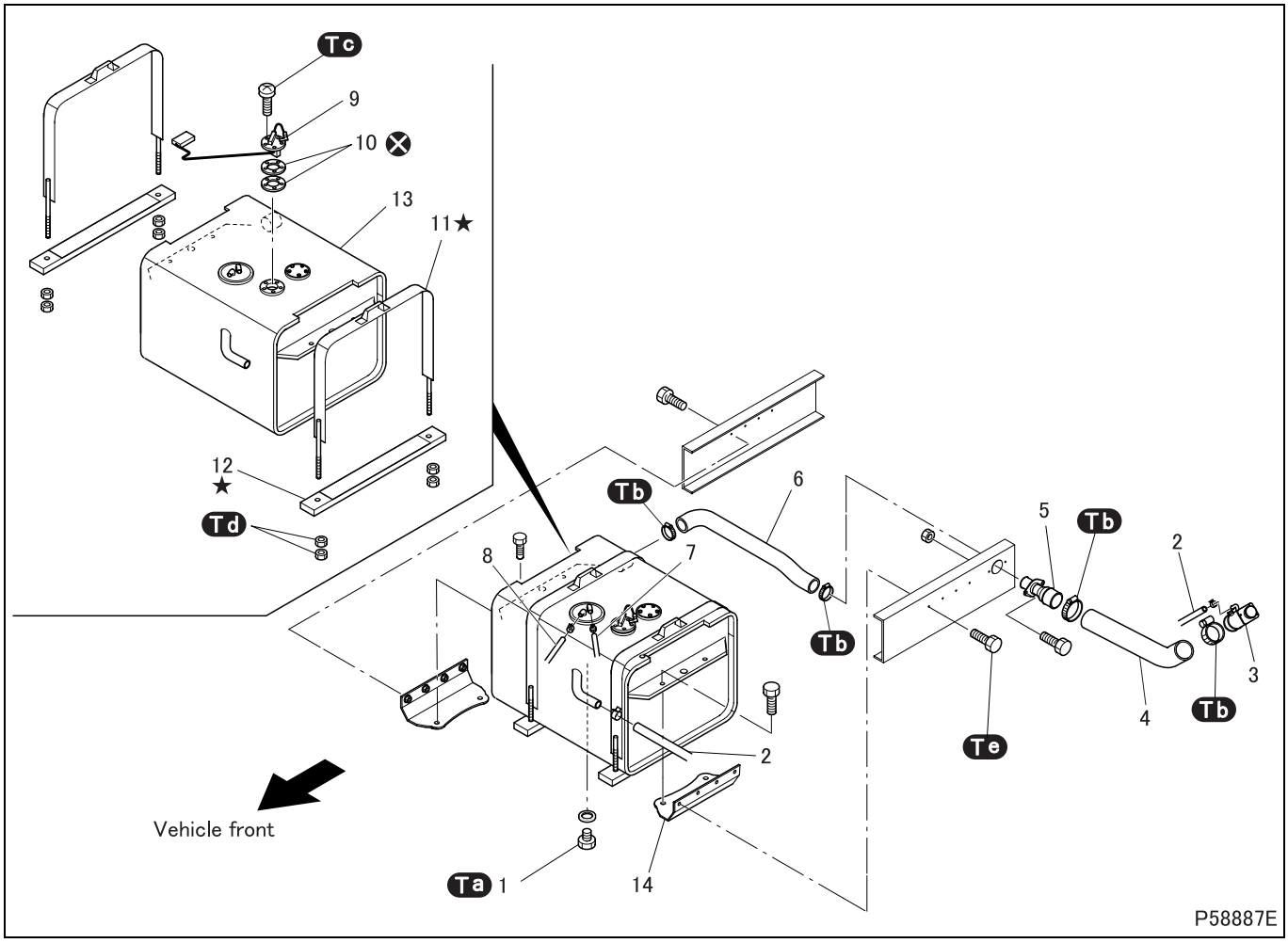
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To avoid risk of fire, wipe up any spilled fuel.**

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	49 to 88.2 {36 to 65, 5.0 to 9.0}	–
Tb	Screw (fuel level sensor mounting)	0.98 to 1.47 {0.7 to 1.1, 0.10 to 0.15}	–
Tc	Lock nut (fuel tank band mounting)	9 to 28 {6.6 to 21, 0.9 to 2.8}	–
Td	Nut (fuel tank band mounting)	6 to 10 {4.4 to 7.4, 0.6 to 1.0}	–
Te	Bolt (fuel tank bracket mounting)	70 to 90 {52 to 66, 7.1 to 9.2}	–

M E M O

FUEL TANK <IN SIDE FRAME TYPE>



● **Removal sequence**

1	Drain plug	**6**	Fuel hose	★**11**	Fuel tank band
2	Air vent tube	**7**	Suction hose	★**12**	Fuel tank support
3	End filler	**8**	Return hose	**13**	Fuel tank
4	Fuel hose	**9**	Fuel lever sensor	**14**	Fuel tank bracket
5	Fuel pipe	**10**	Gasket	⊗:	Non-reusable parts

DANGER ⚠

- **Do not allow any flames or sources of heat near the fuel tank, as it may explode.**

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To avoid risk of fire, wipe up any spilled fuel.**

CAUTION ⚠

- **Install the air vent tube without deformation or slack because it causes shrilling fuel refueling.**

NOTE

- **The parts indicated with the mark ★ should never be removed, loosened or moved unless they are defective.**

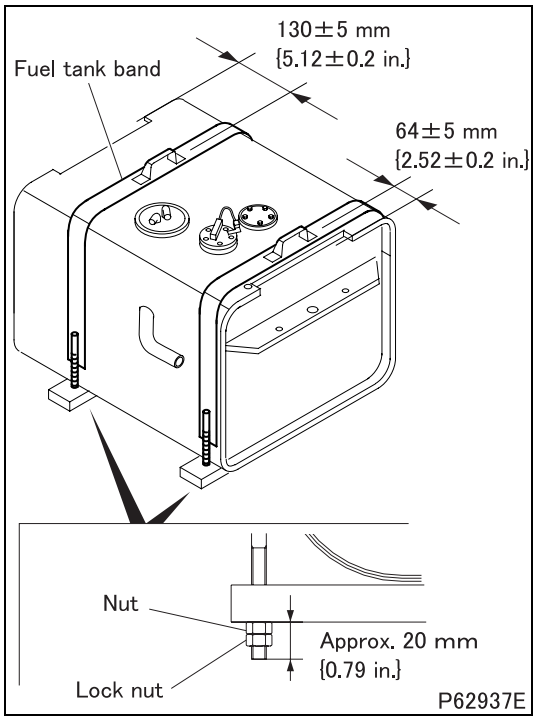
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	29.4 ± 4.9 {22 ± 3.6, 3.0 ± 0.5)	–
Tb	Clamp	3.9 ± 1.0 {2.9 ± 0.7, 0.4 ± 0.1)	–
Tc	Screw (fuel level sensor mounting)	0.98 to 1.47 {0.7 to 1.1, 0.10 to 0.15}	–
Td	Nut (fuel tank band mounting)	3 to 4 {2.2 to 3.0, 0.3 to 0.4}	–
Te	Bolt (fuel tank bracket mounting)	70 to 90 {52 to 66, 7.1 to 9.2}	–

◆Inspection procedure◆



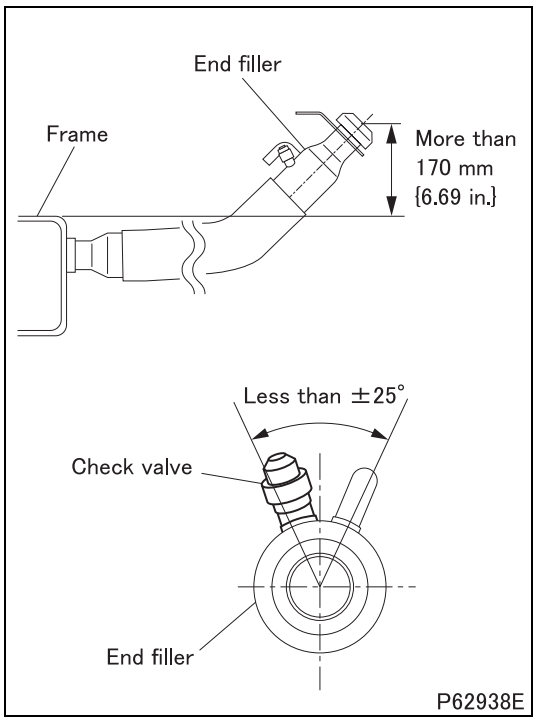
■ **Installation: Fuel tank band**

- Install the fuel tank band so that the position of the band and the protrusion of the band thread is as illustrated.

CAUTION ⚠

- **Install the fuel tank band so that the band isn't over the protrusion of the fuel tank.**

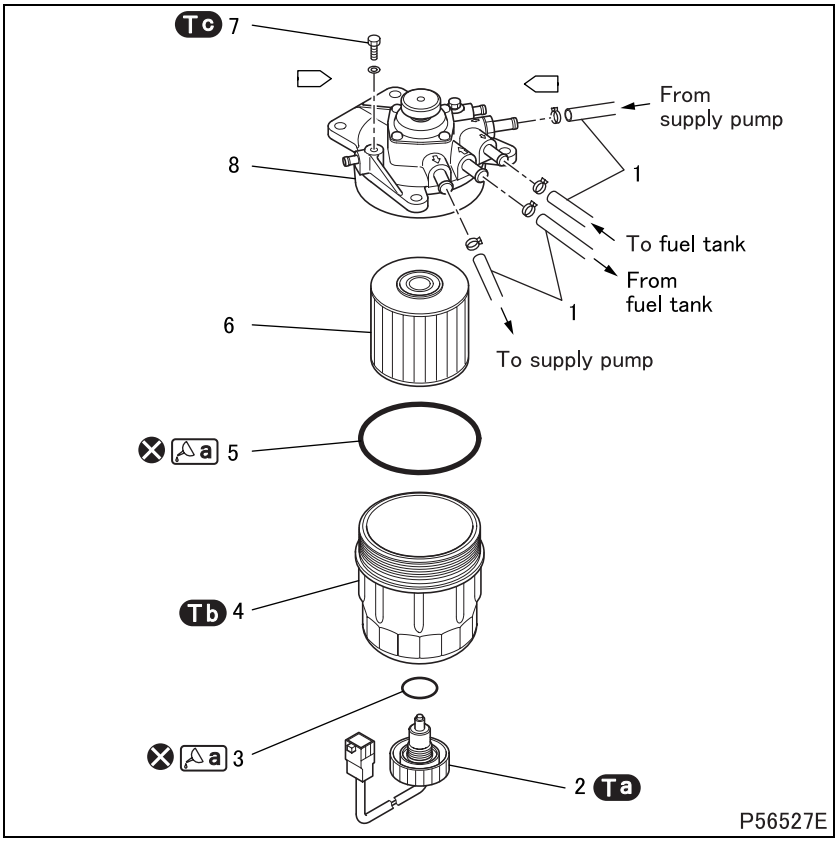
- Tighten the nuts alternately so that the fuel tank contacts the fuel support in order symmetry and evenly.
- After tightening the nuts to the specified torque, tighten the lock nut the specified torque.



■ **Installation: End filler**

- Install the end filler so that the installing positions of the end filler mouth and the check valve are as illustrated.

FUEL FILTER



● Disassembly sequence

1 Fuel hose
2 Water separator sensor
3 O-ring
4 Case
5 O-ring
6 Filter element
7 Plug
8 Fuel filter head

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

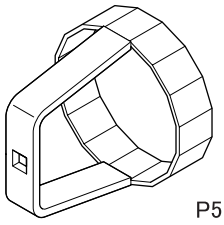
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

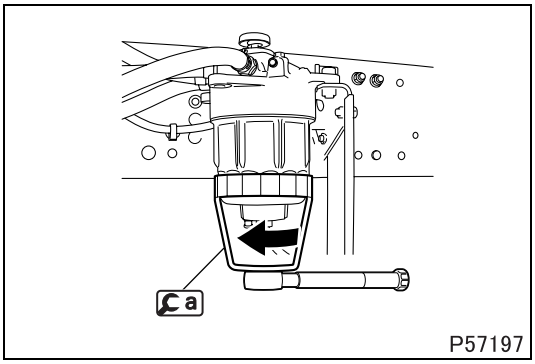
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Water separator sensor	5 ± 1 {3.7 ± 0.7, 0.5 ± 0.1}	–
Tb	Case	30 ± 2 {22 ± 1.5, 3.1 ± 0.2}	–
Tc	Plug	10 ± 2 {7.4 ± 1.5, 1 ± 0.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

Special tools

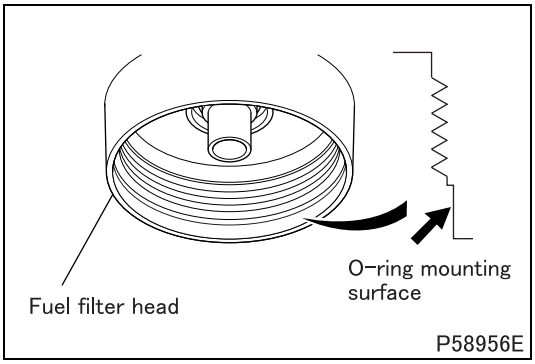
Mark	Tool name and shape	Part No.	Application
a	Filter wrench  P57179	MH063203	Removal and installation of case



■ **Removal: Case**

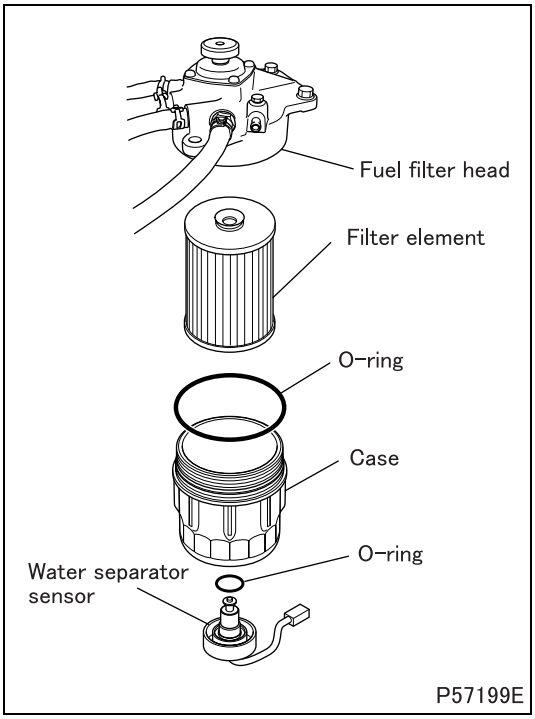
- Loosen the water separator sensor and drain fuel from the case.
- Remove the case using [a].

◆Installation procedure◆



■ **Installation: Case**

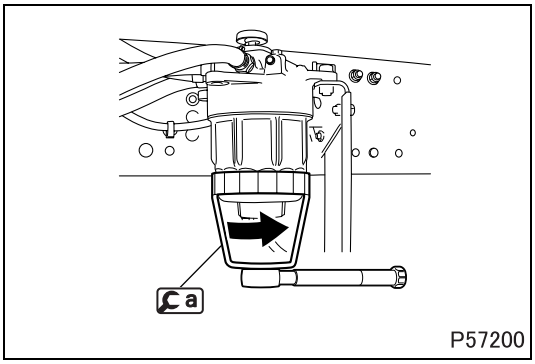
- Clean the O-ring mounting surface of the fuel filter head.



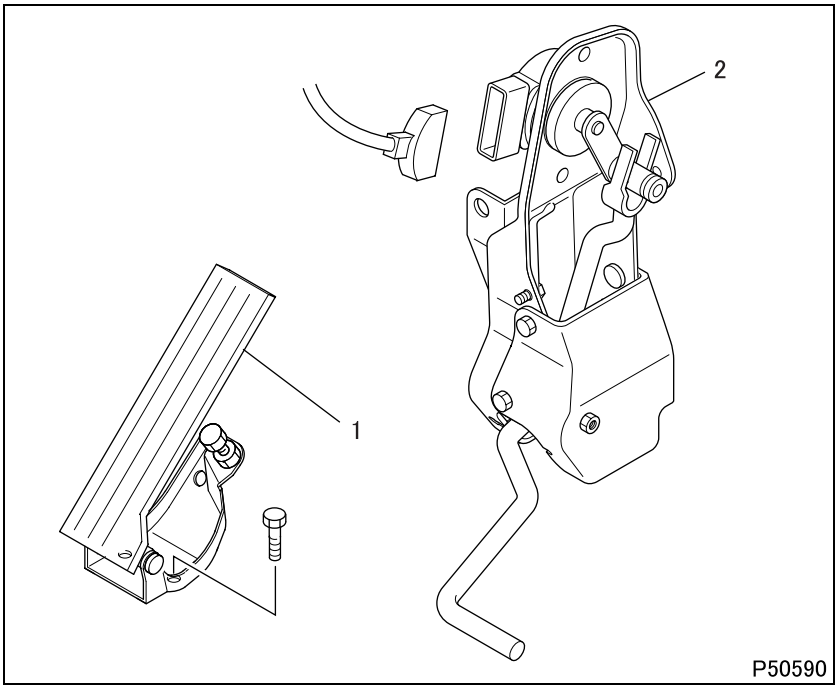
- Replace the filter element and O-ring with new one.
- Apply a thin coat of engine oil to the O-ring, and install it on the case and water separator sensor.

CAUTION ⚠

- **Be sure to use only genuine Sterling filter elements. The use of non-genuine fuel filters can cause engine failure.**
- **Prevent fine dust particles from entering the fuel filter and fuel pipe, as they can cause problems such as faulty fuel injection.**



- Use [a] to tighten the case to the specified torque.
- Install the water separator sensor, and then air-bleed the fuel system.
- Start the engine, and check that there is no fuel leakage.
- Reinstall the fuel filter if there is any leakage.



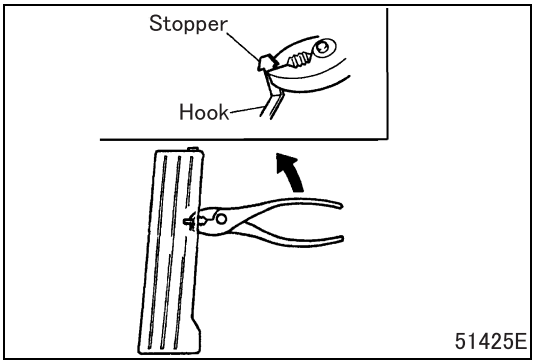
● **Removal sequence**

1. Accelerator pedal (See later sections.)
2. Accelerator link (See later sections.)

● **Installation sequence**

Follow the removal sequence in reverse.

◆Removal procedure◆



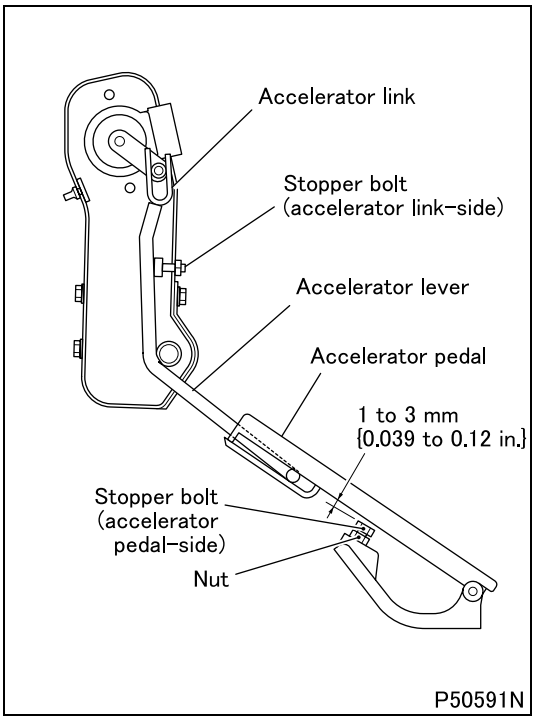
■ **Removal: Accelerator pedal**

- Using pliers, pinch the hook of the stopper on the accelerator pedal. Separate the stopper from the pedal while turning the hook by about 15 degrees.

CAUTION ⚠

- **Do not yank on the stopper, as this may damage it.**

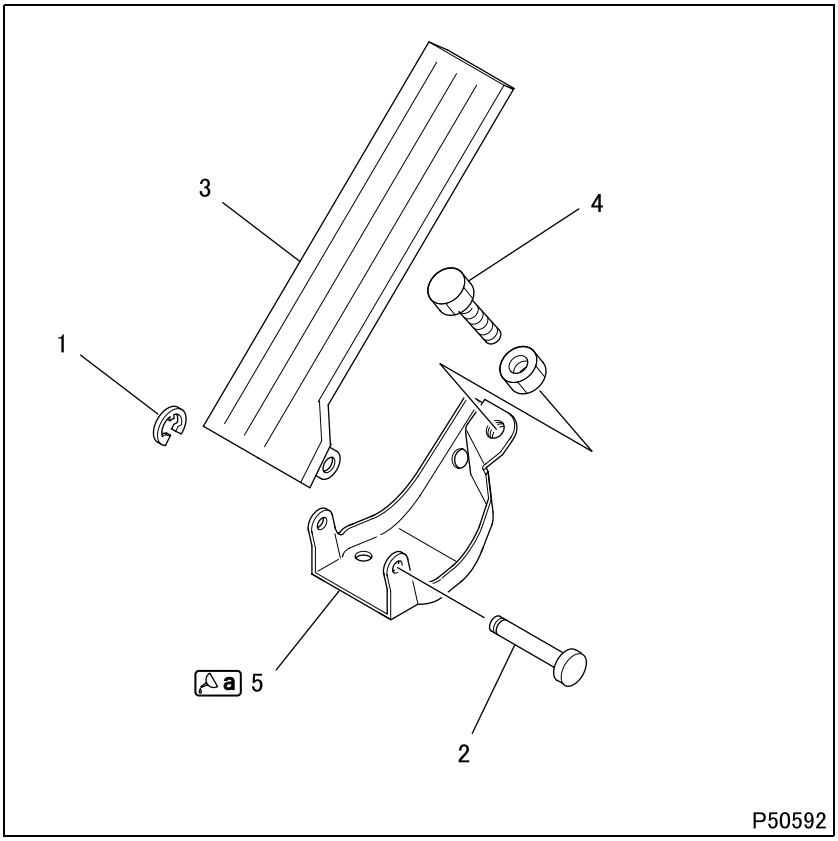
◆Installation procedure◆



■ **Installation: Accelerator pedal**

- Press the accelerator pedal until the accelerator lever touches the accelerator link stopper bolt.
- Check that the clearance between the stopper and the stopper bolt contact surface of the pedal is as indicated in the illustration.
- If the clearance is not within the indicated value range, adjust the stopper bolt and lock it with the nut.

Accelerator Pedal



● Disassembly sequence

1 E-ring
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

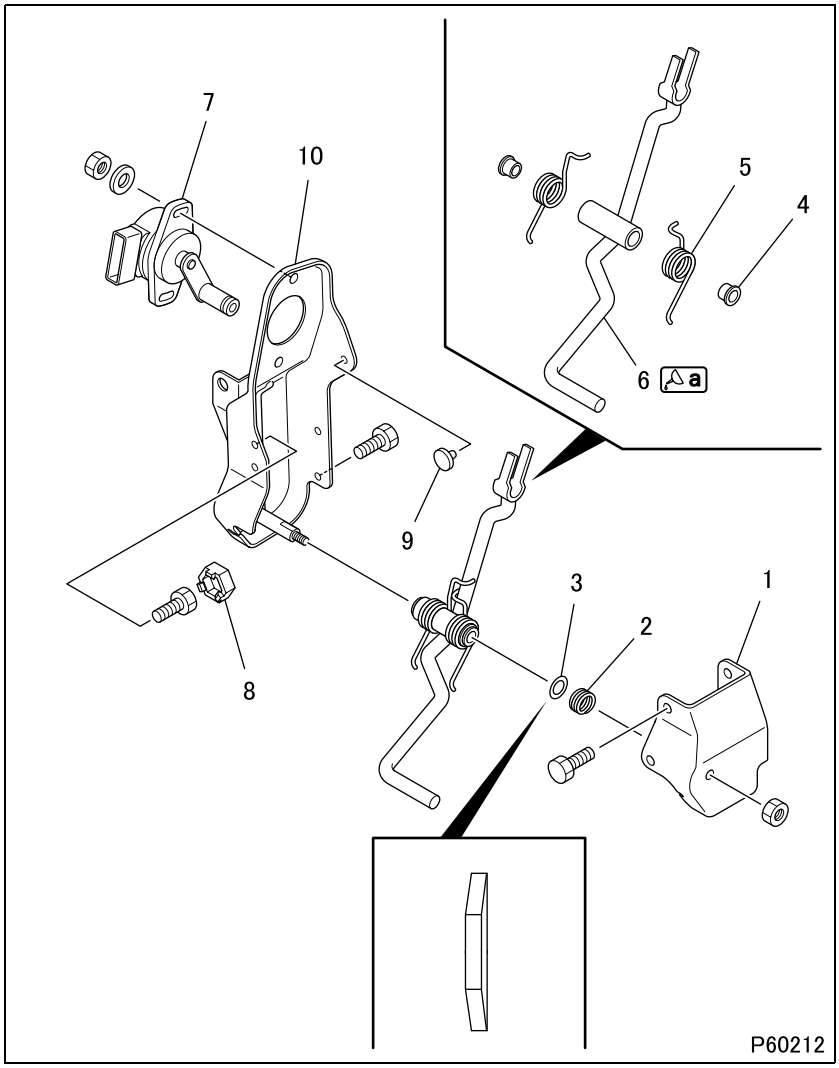
● Assembly sequence

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Accelerator pedal and bracket contact surfaces	Chassis grease [NLGI No. 1 (Li soap)]	As required

Accelerator Linkage



● Disassembly sequence

1 Cover
2 Spring
3 Washer
4 Bushing
5 Return spring
6 Accelerator lever
7 Accelerator position sensor and accelerator switch assembly
8 Lever stopper
9 Rubber stopper
10 Accelerator link bracket

● Assembly sequence

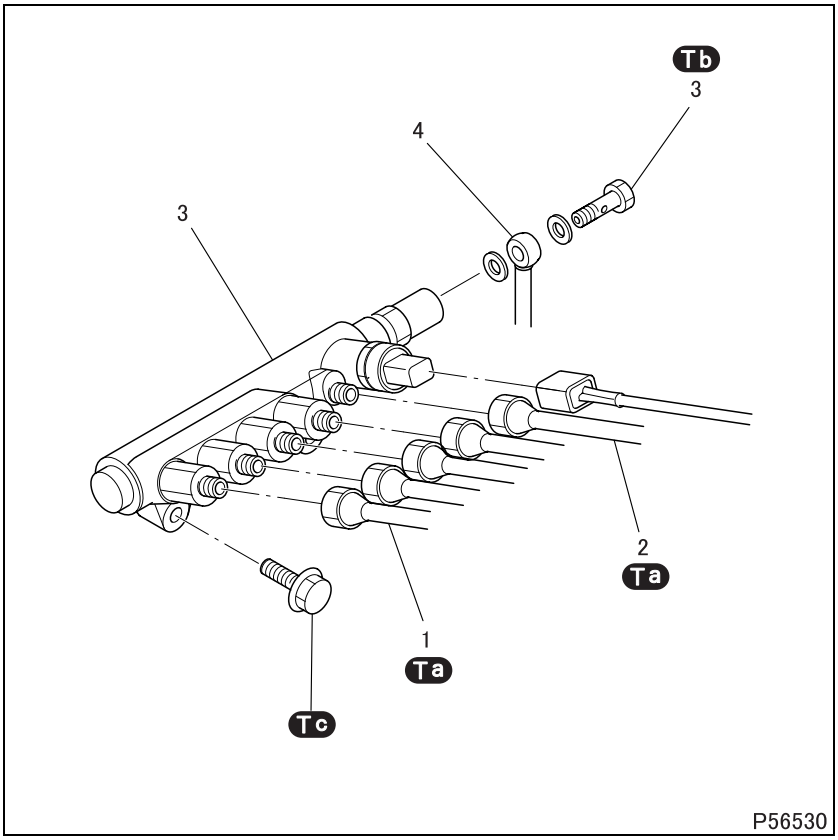
Follow the disassembly sequence in reverse.

NOTE

- **Inspection and adjustment of accelerator position sensor (See Gr13E).**

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Accelerator lever and return spring sliding surface	Chassis grease [NLGI No. 1 (Li soap)]	As required



● Disassembly sequence

1 Injection pipe
2 Fuel pipe
3 Eyebolt
4 Fuel return pipe
5 Common rail

● Assembly sequence

Follow the disassembly sequence in reverse.

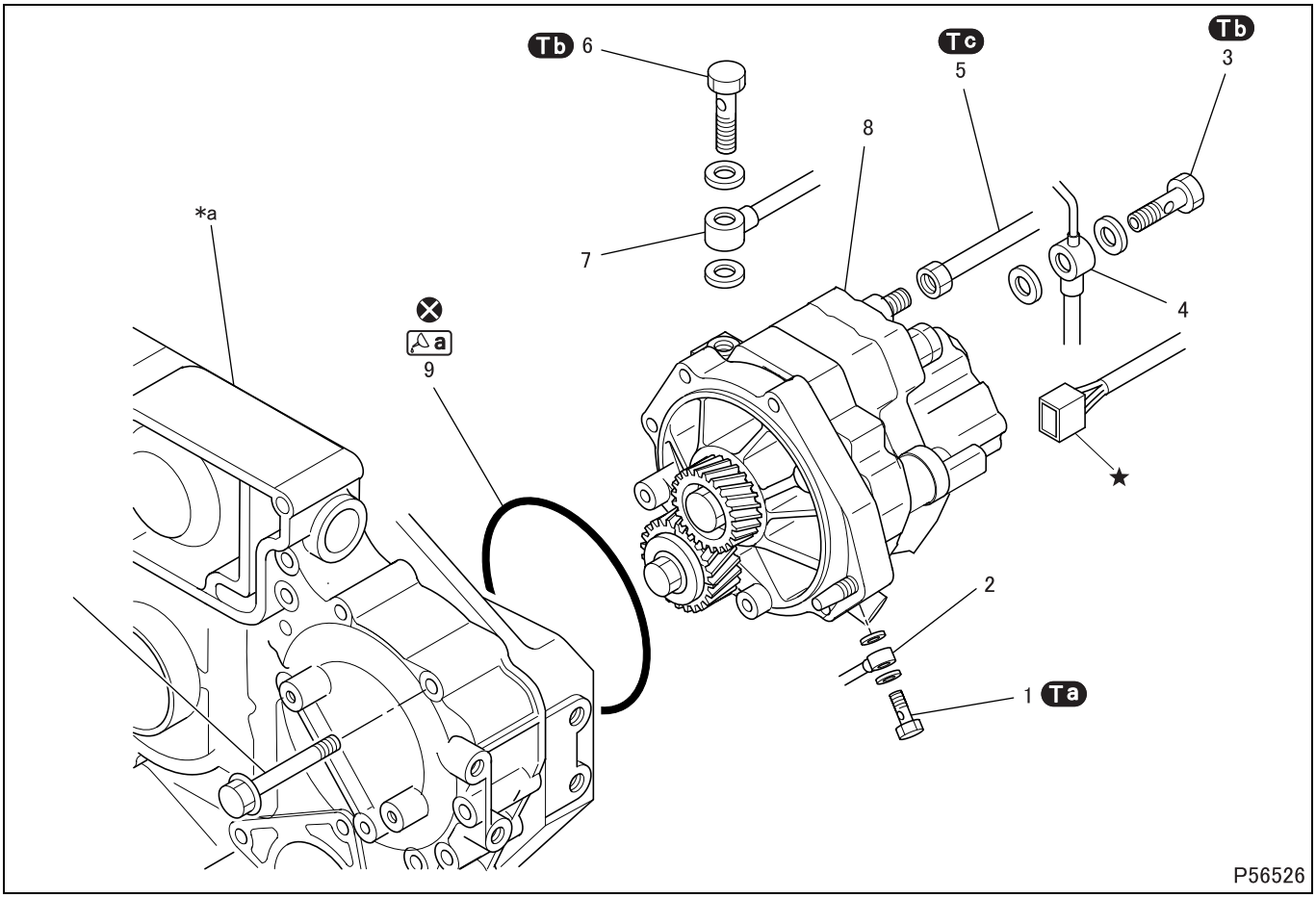
CAUTION ⚠

- **Contact each seating surface fully and evenly, tighten the bolt or nut temporarily, and finally tighten it to the specified torque.**
- **For servicing the common rail, contact a BOSCH service station.**
- **If dust enters the common rail, the engine performance will be greatly affected. To prevent it, be sure to cover up openings left after pipes and other parts are removed. Also, wash eyebolts, gaskets, etc. in light oil to clear of dirt.**
- **Before installing, make sure that the seat surfaces of fuel pipes and injection pipes are free of scratches and irregularities.**

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Location	Parts to be tightened	Tightening torque	Remarks
Ta	Injection pipe (union nut tightening)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
	Fuel pipe (union nut tightening)		
Tb	Eyebolt (fuel return pipe mounting)	25 to 29 {18 to 21, 2.6 to 3.0}	–
Tc	Bolt (common rail mounting)	23.2 {17, 2.4}	–

SUPPLY PUMP



● **Removal sequence**

1 Eyebolt
2 Oil pipe
3 Eyebolt
4 Fuel return pipe
5 Fuel pipe
6 Eyebolt (with gauze filter)
7 Fuel suction pipe
8 Supply pump
9 O-ring

✱a: Front case
⊗: Non-reusable parts

CAUTION ⚠

- **Contact each seating surface fully and evenly, tighten the bolt or nut temporarily, and finally tighten it to the specified torque.**
- **Have the injection pump assembly serviced by a BOSCH service station.**
- **Dirt and dust in the injection pump assembly can seriously detract from engine performance. To prevent this from happening, fully cover all open joints after removing any pipes or hoses.**

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **Make sure that the harness (marked with " ★ ") of MPROP (rail pressure control valve) is connected to the supply pump before starting the engine. Starting the engine without connection causes a malfunction.**

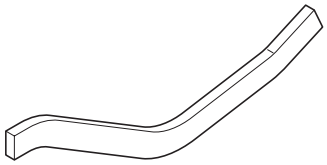
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eyebolt (oil pipe mounting)	23.5 {17, 2.4}	–
Tb	Eyebolt (fuel return pipe mounting)	38.2 {28, 3.9}	–
	Eyebolt (fuel pipe mounting)		
Tc	Fuel pipe (union nut mounting)	20.5 {15, 2.1}	–

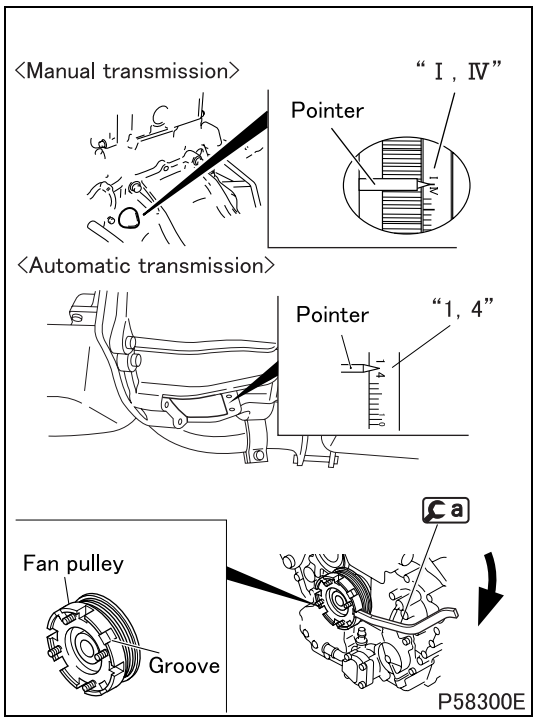
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

Special tools

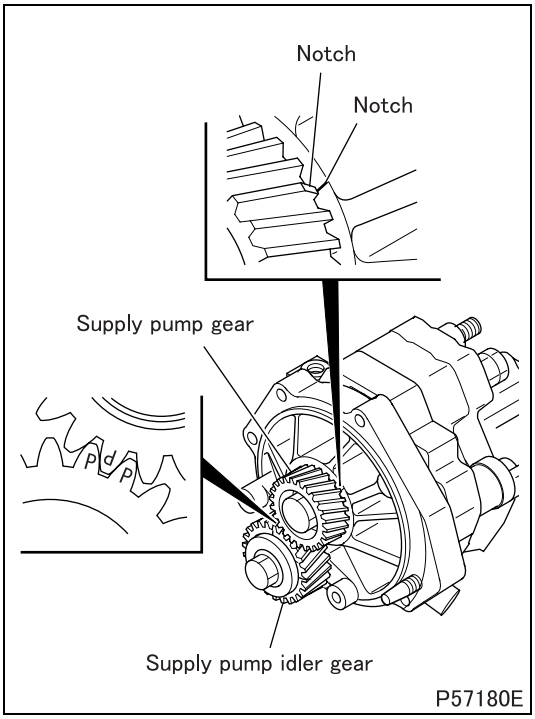
Mark	Tool name and shape	Part No.	Application
a	Cranking handle  P58299	MH063704	Rotating the fan pulley

◆Installation procedure◆



■ Installation: Supply pump

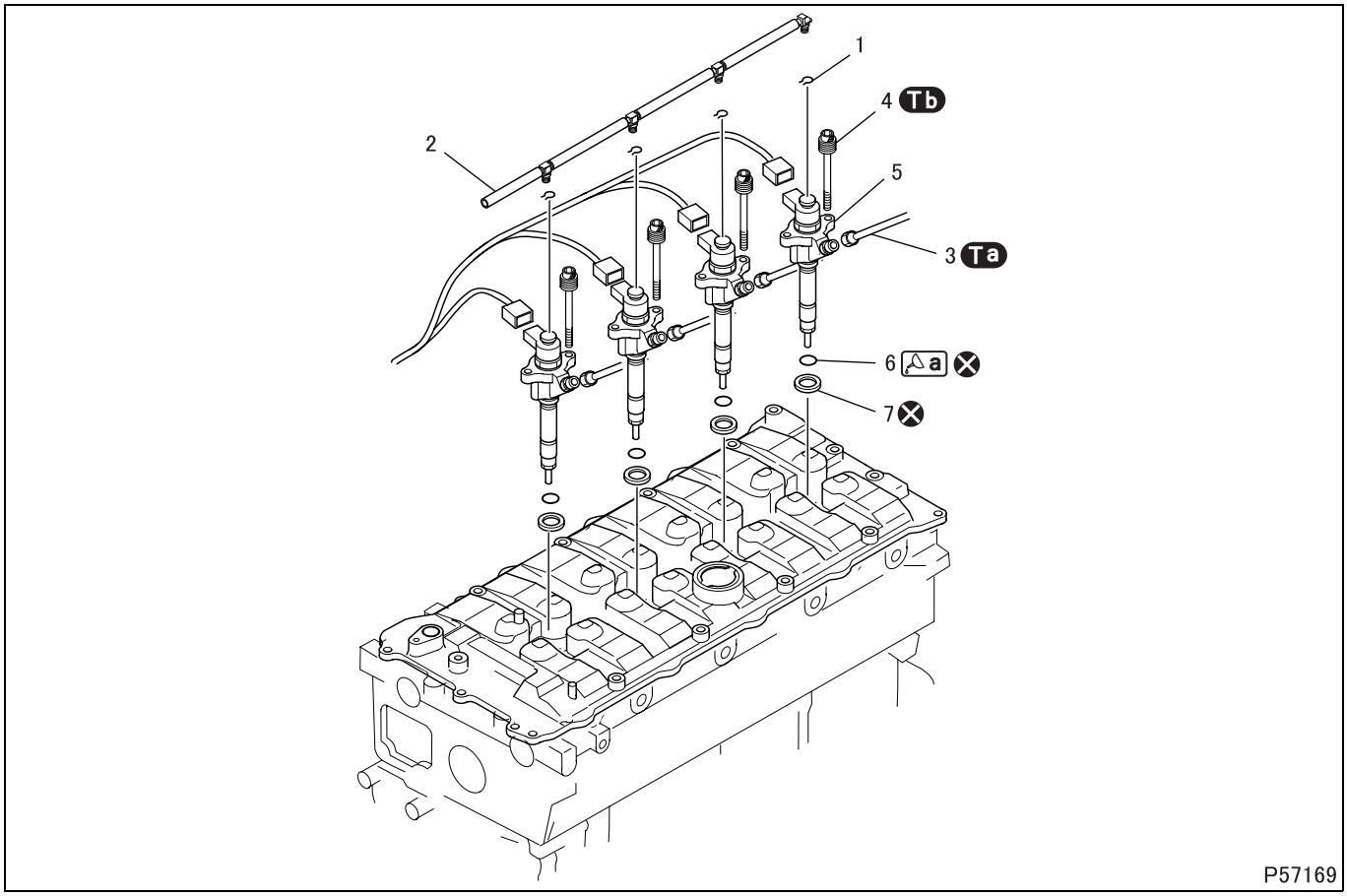
- Remove the rocker cover.
- Bring the No. 1 cylinder piston to the top dead center (TDC) on the compression stroke by the following procedure:
- Hook a on a groove in the fan pulley.
- Turn the fan pulley in the illustrated direction so that the pointer is aligned with the "I – IV" or "1 – 4" mark on the inscribed scale on the flywheel.
- This will place either the No. 1 or No. 4 cylinder piston at TDC on the compression stroke. The cylinder in which the rocker arms for both the intake and exhaust valves can be pushed down by hand by the valve clearance amounts has its piston at TDC. Rotate the engine by one full turn to switch the TDCs of the No. 1 and No. 4 cylinder pistons.



- Align the match mark “P” on the supply pump idler gear with that of the supply pump gear.
- Align the notch on the flange plate with the notch on the supply pump gear.
- Check that the notch on the flange plate and the notch on the supply pump gear are correctly aligned, and then push the supply pump.

M E M O

INJECTOR



● **Disassembly sequence**

1 Snap ring
2 Fuel return hose
3 Injection pipe
4 Bolt (with hexagonal hole)
5 Injector
6 O-ring
7 Nozzle gasket

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Before removing the injectors, always turn the starter switch to the LOCK position.**
- **Fuel is highly flammable. Wipe up spilled fuel to avoid the risk of fire.**

CAUTION ⚠

- **Contact each seating surface fully and evenly, tighten the bolt or nut temporarily, and finally tighten it to the specified torque.**
- **When removing the injectors, take care not to strike them with the tool, etc.**
- **To prevent an injection failure or any other trouble, make sure that no dust enters the injectors and injection pipes.**

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Injection pipe (union nut mounting)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
Tb	Bolt (injector mounting)	5.2 to 7.2 {3.8 to 5.3, 0.53 to 0.73}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

GROUP 13E INDEX

SPECIFICATIONS 13E-2

STRUCTURE AND OPERATION

1. **Overview.....13E-3**
2. **Electronic Control System 13E-12**
3. **Electronic Control Unit Connection Diagram.....13E-18**

TROUBLESHOOTING

1. **Diagnosis Procedure.....13E-20**
2. **Diagnostic Precautions.....13E-21**
3. **Inspections Based on Diagnosis Codes.....13E-22**
4. **Multi-Use Tester Service Data.....13E-36**
5. **Actuator Tests Performed Using Multi-Use Tester 13E-38**
6. **Inspections Performed at Electronic Control Unit Connectors..13E-40**

INSPECTION OF ELECTRICAL EQUIPMENT 13E-43

INSTALLED LOCATIONS OF PARTS 13E-50

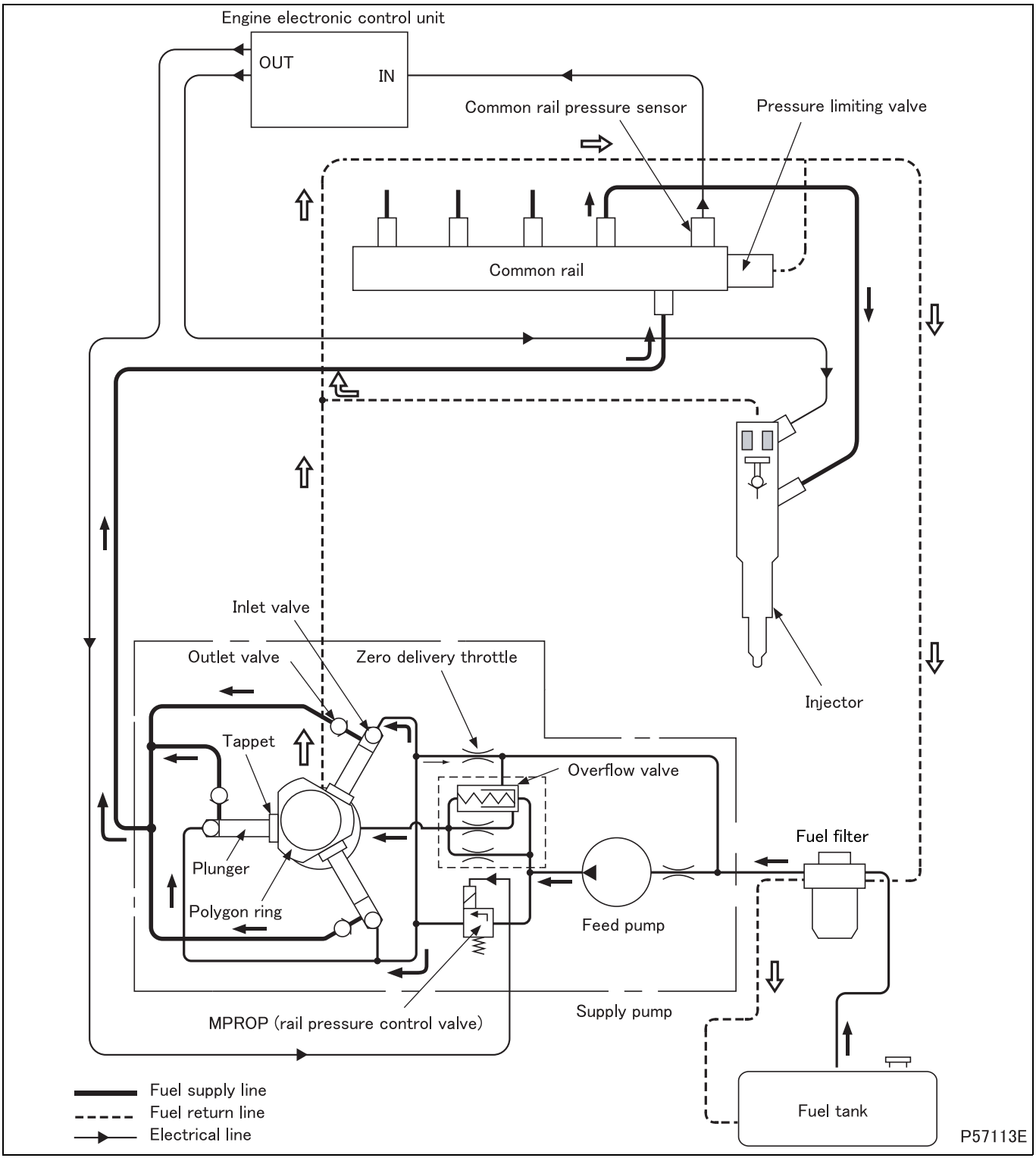
ELECTRIC CIRCUIT DIAGRAM 13E-56

SPECIFICATIONS

Item			Specifications
Supply pump	Manufacturer		Bosch
	Model		CP3.3
	Control method		Electronic
	Type		Radial, 3-cylinder
	Type		External gear type
	Rail pressure control valve	Model	MPROP
		Rated voltage V	12
	Max. common rail pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
Common rail	Manufacturer		Bosch
	Common rail volume cm^3 {cu. in., ml}		16.5 {1.01, 16.5}
	Pressure limiting valve opening pressure MPa {psi, kgf/cm^2}		185 to 195 {26830 to 28280, 1886 to 1988}
	Common rail pressure sensor supply voltage V		5
Injectors	Manufacturer		Bosch
	Control method		Electrical
	Max. operating pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
	Min. operating pressure MPa {psi, kgf/cm^2}		25 {3630, 255}
Common rail electronic control unit	Manufacturer		Bosch
	Rated voltage V		12

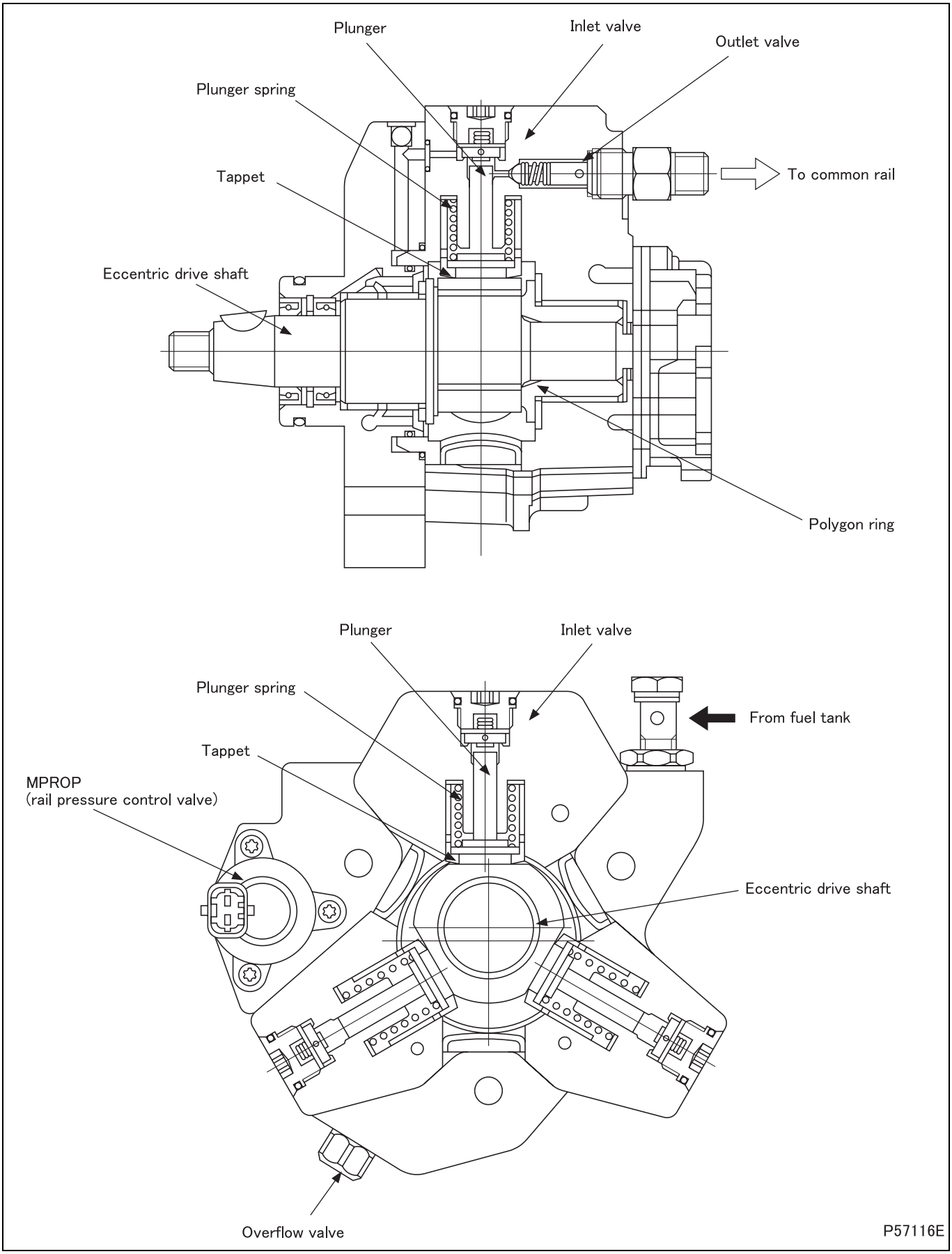
1. Overview

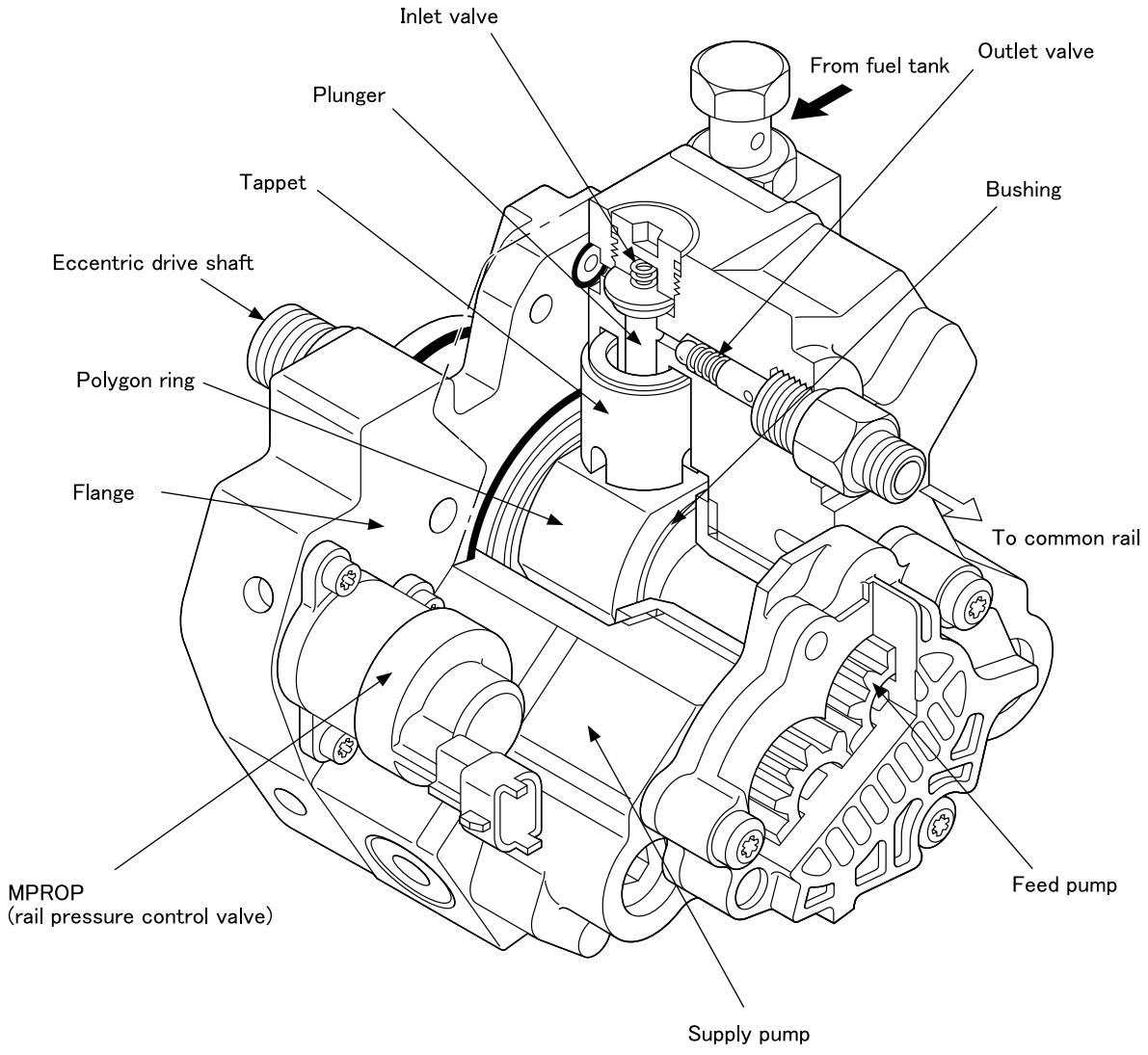
- In the common rail system, an electronic control unit monitors various aspects of the engine (engine speed, throttle opening, coolant temperature, etc.) using information from sensors. In accordance with these data, the electronic control unit effects control over the fuel injection quantity, fuel injection timing, and fuel injection pressure in order to optimize the engine's operation.
- The electronic control unit has a diagnosis function that enables it to recognize abnormalities in the common rail system's major components and alert the driver to them.
- The common rail system consists mainly of an electronically controlled supply pump; injectors; a common rail; and the electronic control unit and sensors that are used to control the other components.



- When the engine is cranked by means of the starter switch, the feed pump (this is located inside the supply pump) simultaneously draws fuel from the fuel tank and feeds it via the fuel filter to the MPROP (rail pressure control valve). A quantity of fuel metered by the MPROP is supplied via the inlet valves to the plunger chambers.
- The fuel in the plunger chambers is pressurized. The outlet valves are then opened, and the fuel is fed under pressure to the common rail.
- The pressurized fuel is held in the common rail and then uniformly fed to the injectors.
- In response to signals from the engine electronic control unit, a magnetic valve in each injector causes the injector to inject fuel into the relevant combustion chamber at the optimal timing and in the optimal quantity.

1.1 Supply pump

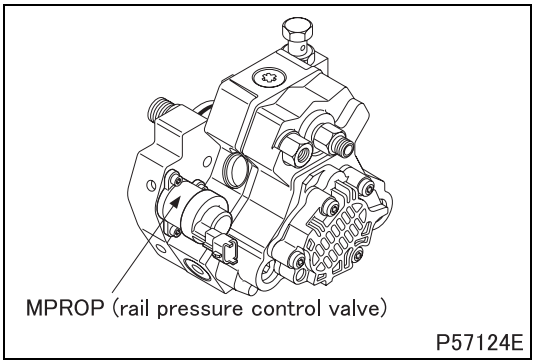




CAUTION ⚠

- **Be sure to connect the MPROP (rail pressure control valve) connector to the engine harness before starting the engine. If the engine were started with the MPROP connector not connected, control of the supply pump by the engine electronic control unit would not be possible and a fault would ensue.**

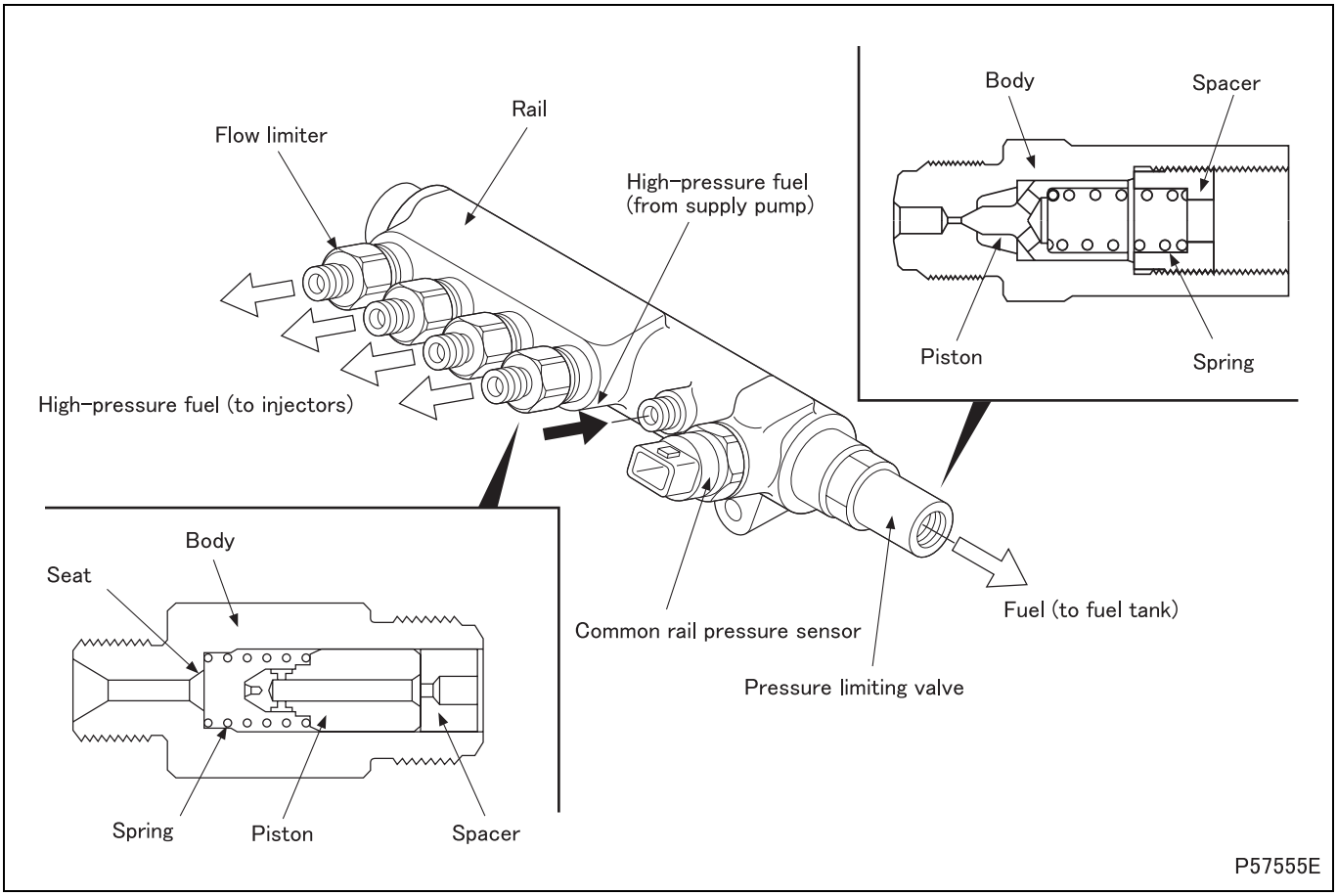
- The supply pump pressurizes fuel and supplies it in a highly pressurized state.
- Fuel drawn from the fuel tank by the feed pump is not supplied directly to the plungers. It is supplied first to the MPROP (rail pressure control valve), which controls the amount of fuel reaching the plungers.
- If the fuel pressure exceeds a certain level, the overflow valve returns fuel to the inlet side of the feed pump. This operation keeps the fuel pressure constant.
- Rotation of the eccentric drive shaft causes (via the tappets) up-down movement of the plungers. Fuel in the plunger chambers is thus highly pressurized.



(1) MPROP (rail pressure control valve)

- The MPROP receives fuel from the feed pump and feeds fuel toward the plungers of the supply pump in such a quantity that the fuel pressure corresponds to that required by the engine electronic control unit.
- When the MPROP is not operating, i.e., when current is not flowing, fuel flows at its maximum rate. When current flows, the piston in the MPROP is pressed down such that fuel is not fed toward the plungers.

1.2 Common rail

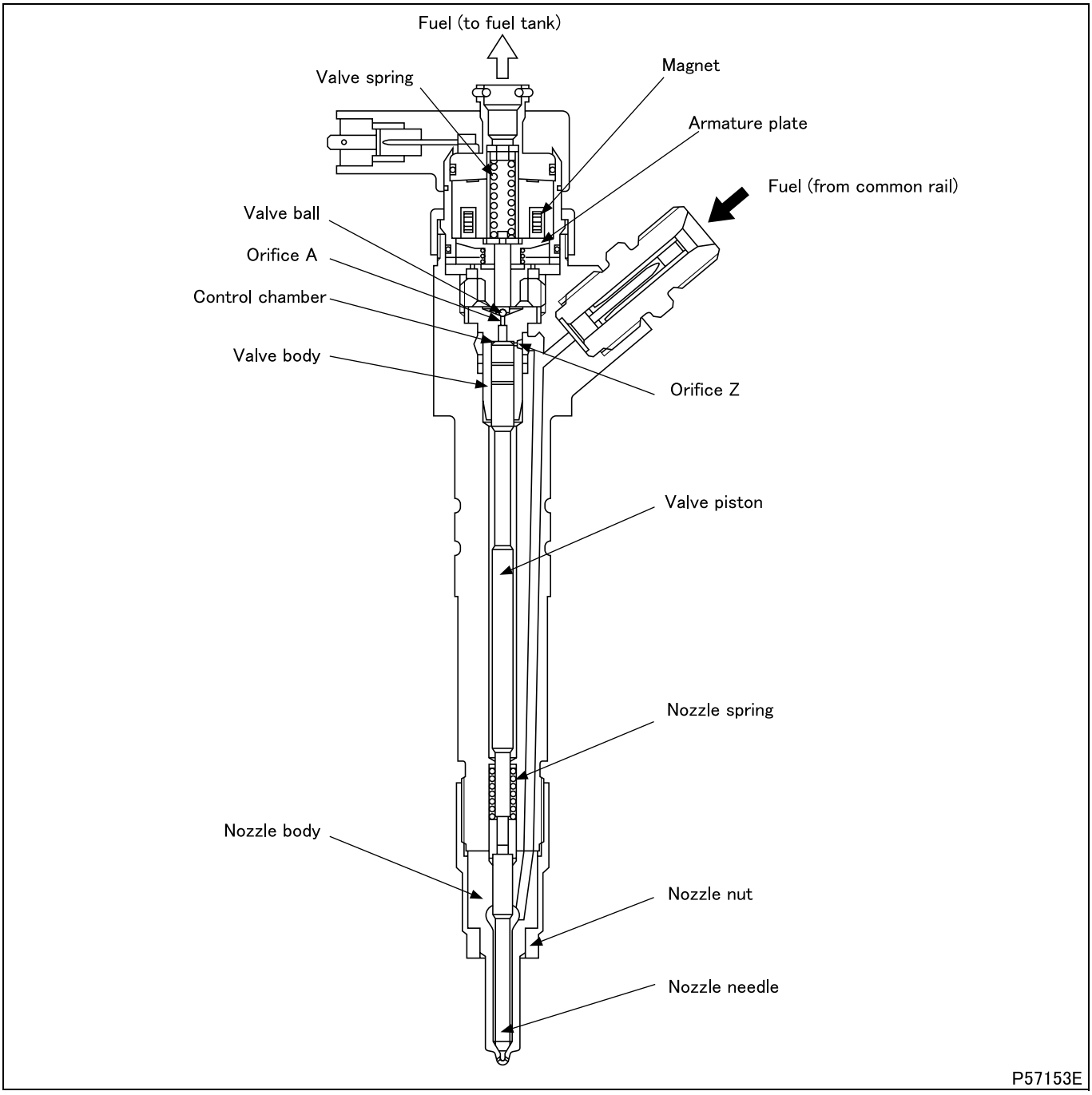


- The common rail distributes to the injectors high-pressure fuel that has been fed from the supply pump.
- Each flow limiter prevents an abnormal outflow of fuel. It does so by blocking the fuel passage in the event of fuel leakage from the injection pipe or excessive injection of fuel from the injector.
- The common rail pressure sensor is used in feedback control. It senses the fuel pressure inside the common rail and feeds a corresponding signal to the electronic control unit.
- If the fuel pressure in the common rail exceeds a certain, set level, the piston in the pressure limiting valve pushes and compresses the spring such that fuel is able to escape. The pressure limiting valve thus prevents the fuel pressure from becoming higher than the set pressure.

Flow limiter

- During normal operation, the piston moves (thus pushing and compressing the spring) to the extent necessary for one injection quantity to pass through. The piston does not make contact with the seat at this time. When injection is complete, the piston is returned to its initial position by the spring.
- If the amount of fuel passing through the flow limiter becomes excessively great, the piston presses against the seat, thereby closing the fuel passage and preventing an abnormal outflow of fuel.
  When the piston has pressed against the seat, it does not return to its original position until the engine has been stopped and the pressure in the common rail has come down.

1.3 Injector



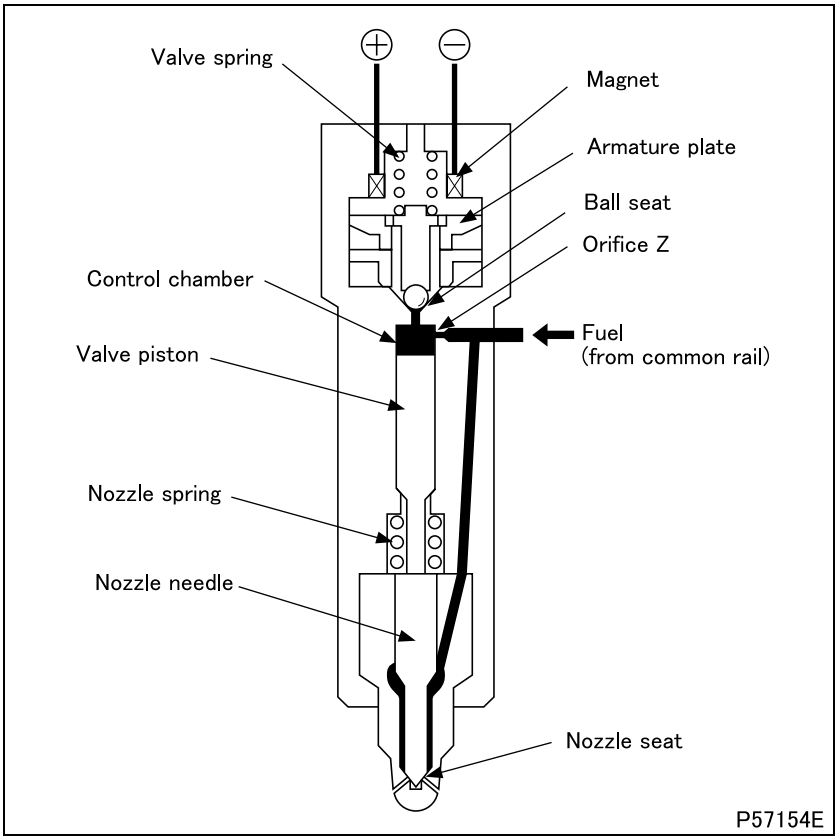
- In accordance with electrical signals from the engine electronic control unit, each injector supplies high-pressure fuel from the common rail to the relevant combustion chamber of the engine at the optimal timing and in the optimal quantity.
- The valve body and valve piston together form the control chamber.
- The functional units of each injector can be broadly defined as follows:

(1) Control section

- The control section consists of the control chamber, magnet, valve spring, armature plate, valve ball, valve body, valve piston, orifice A, and orifice Z. The valve piston is located between the control section and the injection section.

(2) Injection section

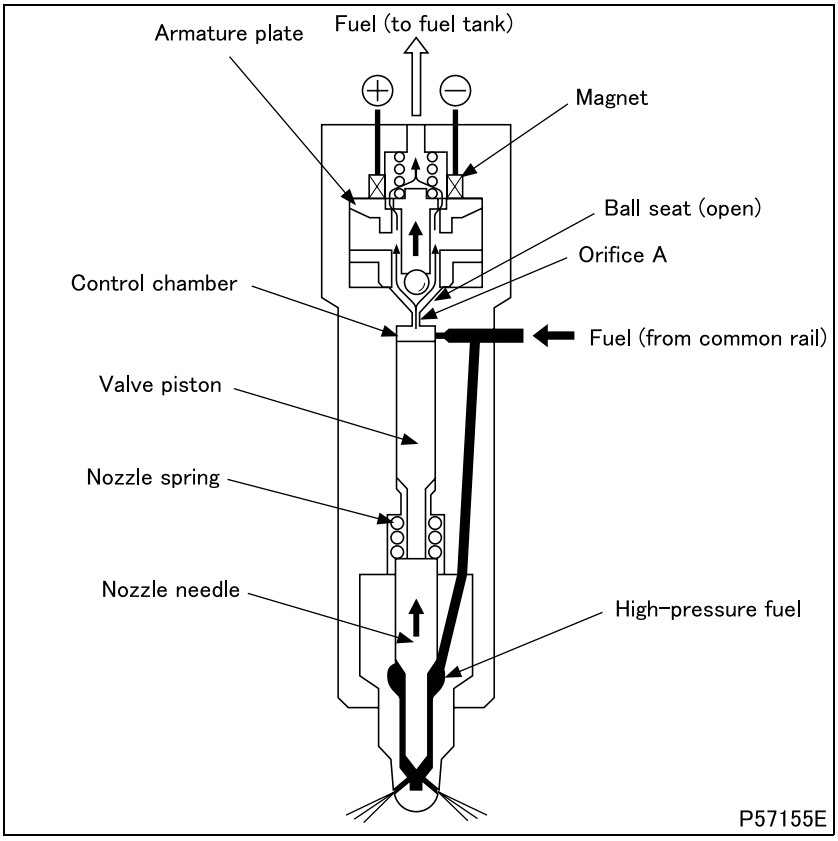
- The injection section consists of the nozzle body, nozzle needle, nozzle spring, and nozzle nut.



(3) Operation

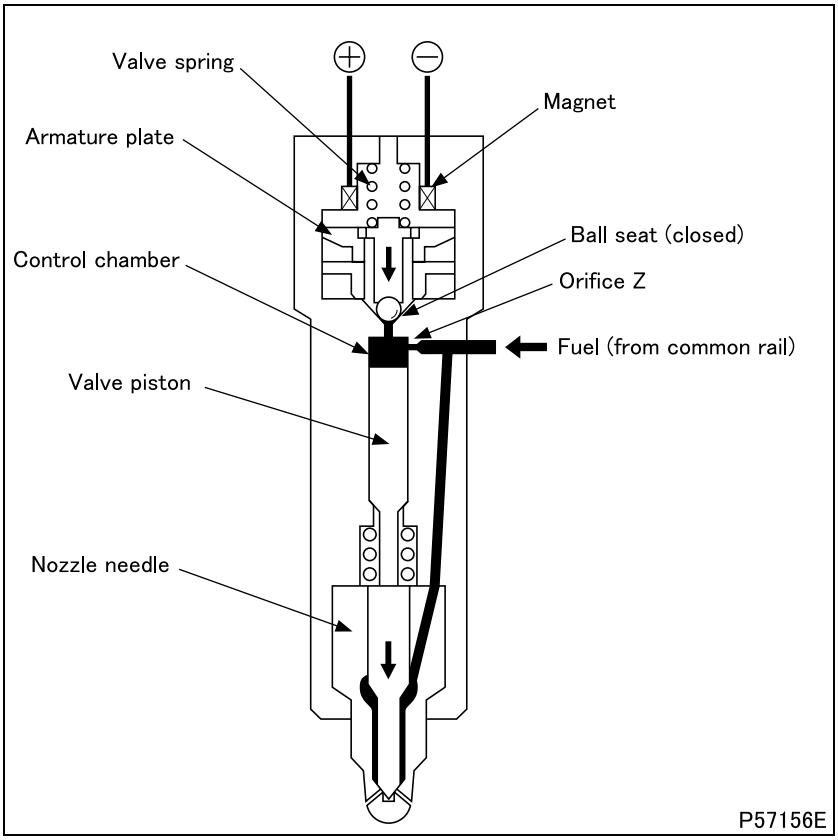
(3.1) Injection not taking place

- With the magnet not energized, the armature plate is pushed up by the valve spring such that the ball seat is closed.
- The high-pressure fuel acts upon the control chamber via orifice Z. The same pressure acts upon the nozzle needle.
- The fuel pressure acting on the nozzle needle cannot overcome the valve piston and nozzle spring, so the nozzle needle stays in its downward-pushed position and injection does not take place.



(3.2) Start of injection

- When the magnet is energized, the resulting electromagnetic force draws the armature plate upward, causing the ball seat to open.
- Fuel in the control chamber passes through the ball seat and orifice A and flows to the fuel tank.
- With the pressure in the control chamber reduced, the fuel acting on the nozzle needle overcomes the valve piston and nozzle spring, pushing up the nozzle needle such that injection starts.
- If the magnet remains energized, the injection rate reaches its maximum level.

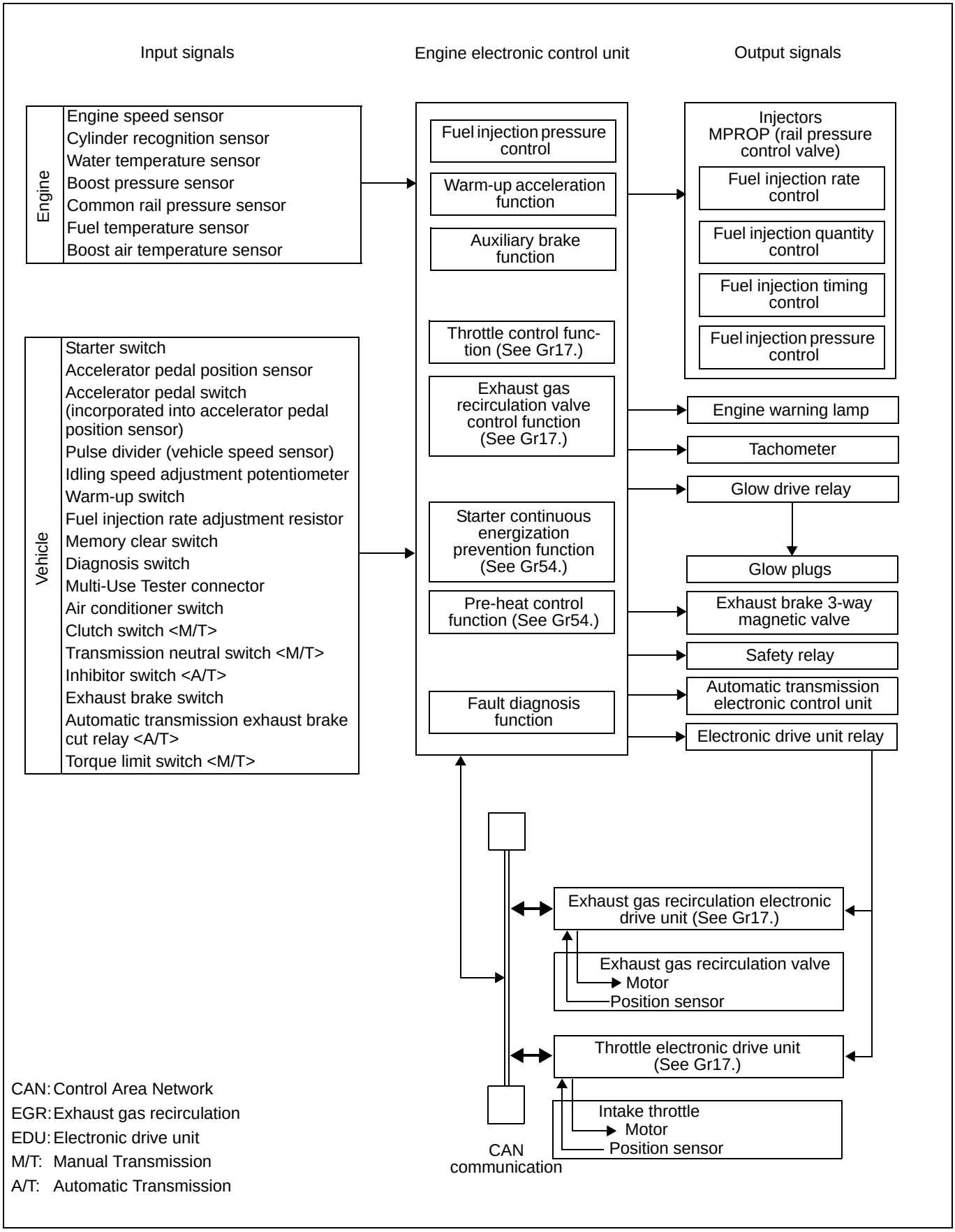


(3.3) End of injection

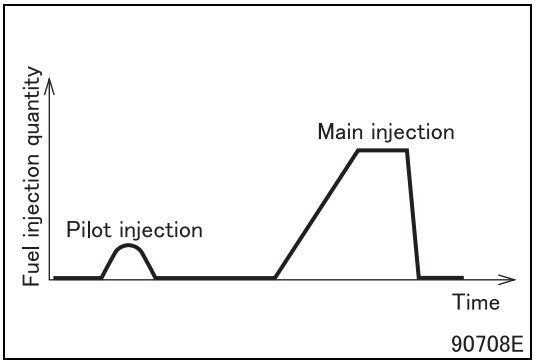
- When energization of the magnet is stopped, the armature plate is pushed downward by the valve spring such that the ball seat closes. At this time, fuel flows into the control chamber via orifice Z, pushing down the valve piston and nozzle needle such that injection finishes.

2. Electronic Control System

2.1 System block diagram



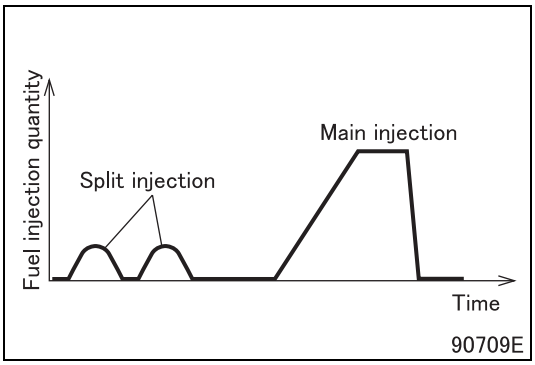
Part	Main function/operation
Engine speed sensor	Sensing of engine speed
Cylinder recognition sensor	Cylinder recognition
Water temperature sensor	Sensing of coolant temperature
Boost pressure sensor	Sensing of boost pressure
Common rail pressure sensor	Sensing of common rail pressure
Fuel temperature sensor	Sensing of fuel temperature
Boost air temperature sensor	Sensing of boost air temperature
Starter switch	Senses that the engine is in starting condition with the starter switch in START position.
Accelerator pedal position sensor	Sensing of extent of accelerator pedal depression
Accelerator pedal switch (incorporated into accelerator pedal position sensor)	Sensing of released/pressed condition of accelerator pedal (ON with pedal released)
Pulse divider (vehicle speed sensor)	Sensing of vehicle speed
Idling speed adjustment potentiometer	Acceleration of warm-up
Warm-up switch	
Fuel injection rate adjustment resistor	Correction of fuel injection rate
Diagnosis switch	Output of diagnosis codes
Memory clear switch	Deletion of diagnosis codes; output of past diagnosis codes
Multi-Use Tester connector	Communication between Multi-Use Tester and common rail system
Air conditioner switch	ON when air conditioner is operating
Clutch switch <Manual transmission>	Sensing of released/pressed condition of clutch pedal (OFF with pedal released)
Transmission neutral switch <Manual transmission>	Detection of transmission neutral condition (OFF with transmission in neutral)
Inhibitor switch <Automatic transmission>	Detection of transmission neutral condition (high idle inhibited with transmission in any range except ‘N’)
Exhaust brake switch <Manual transmission>	Exhaust brake ON/OFF control
Automatic transmission exhaust brake cut relay <Automatic transmission>	
Torque limit switch <Manual transmission>	Detection of 1st and reverse positions
Injectors	Control of fuel injection rate, fuel injection quantity, and fuel injection timing
MPROP (rail pressure control valve)	Control of fuel injection pressure
Engine warning lamp	Indication of system abnormalities
Tachometer	Indication of engine speed (in meter cluster)
Glow drive relay	ON/OFF control of glow plugs
Exhaust brake 3-way magnetic valve	ON/OFF control of exhaust brake valve
Safety relay	Control of starter continuous energization prevention function
Automatic transmission electronic control unit	Output of signals corresponding to engine speed and extent of accelerator pedal depression
Electronic drive unit relay	Supply of power to exhaust gas recirculation electronic drive unit and throttle electronic drive unit
CAN communication (exhaust gas recirculation electronic drive unit and throttle electronic drive unit)	Engine data recognized by the engine electronic control unit are outputted to the CAN bus to enable systems to obtain data that they need for control. Each electronic drive unit issues signals to the engine electronic control unit via the CAN bus to enable it to effect engine control appropriate for each type of system control.



2.2 Fuel injection rate control

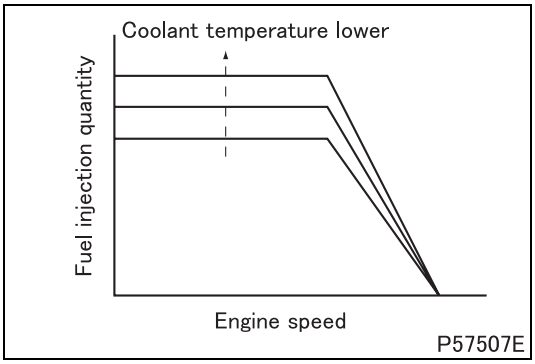
(1) Pilot injection

- Pilot injection entails the injection of an extremely small amount of fuel ahead of the main injection.
- Pilot injection suppresses heat generation early in the injection cycle and thus suppresses NOx generation and noise at the start of combustion.



(2) Split injection control

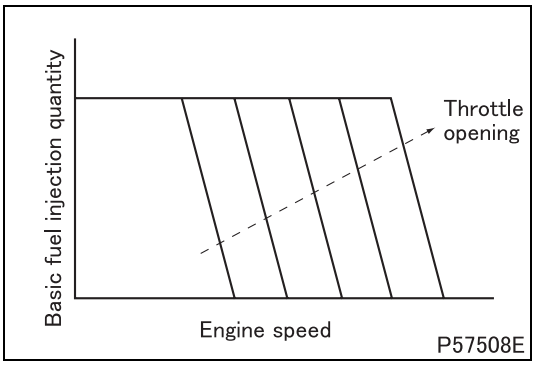
- Split injection entails the injection of an extremely small amount of fuel two or more times ahead of the main injection.
- Split injection increases the fuel's combustibility and thus enhances the engine's cold startability.



2.3 Fuel injection quantity control

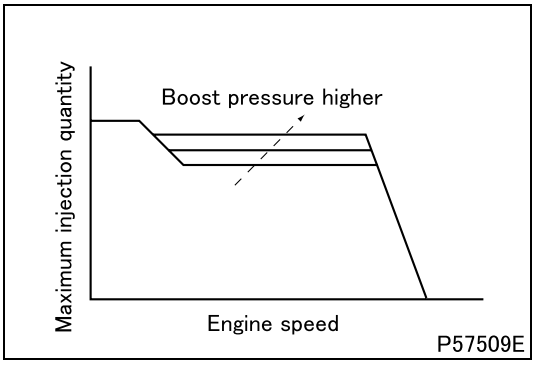
(1) Fuel injection quantity during engine startup

- During engine startup, the fuel injection quantity is determined in accordance with the engine speed and coolant temperature.



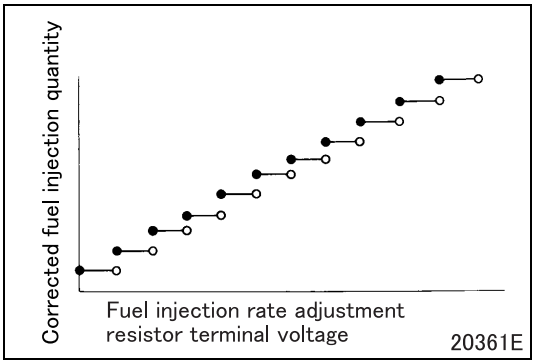
(2) Basic fuel injection quantity

- The basic fuel injection quantity is determined in accordance with the engine speed and throttle opening.



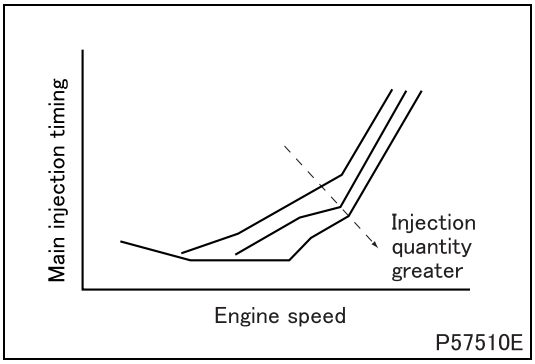
(3) Maximum injection quantity

- The maximum injection quantity is calculated from the engine speed and boost pressure.



(4) Fuel injection rate adjustment resistor correction amount

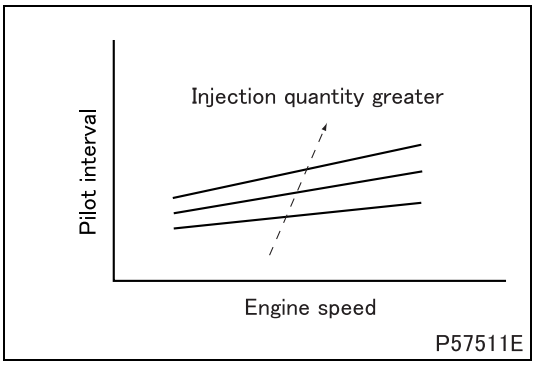
- To limit inconsistency in the injection quantity, the injection quantity is corrected by the fuel injection rate adjustment resistor.



2.4 Fuel injection timing control

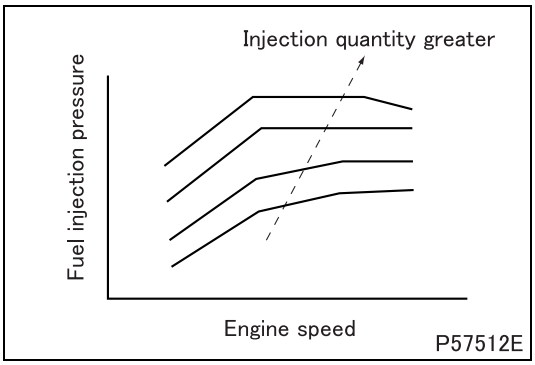
(1) Main injection timing

- The main injection timing is calculated from the fuel injection quantity and engine speed.



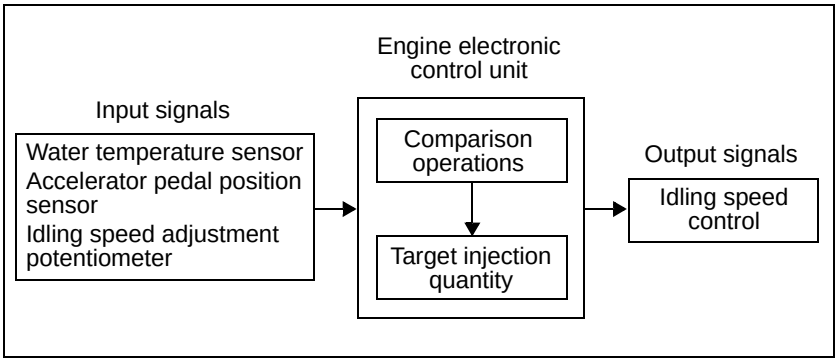
(2) Pilot injection timing (pilot interval)

- The pilot interval is calculated from the fuel injection quantity and engine speed.



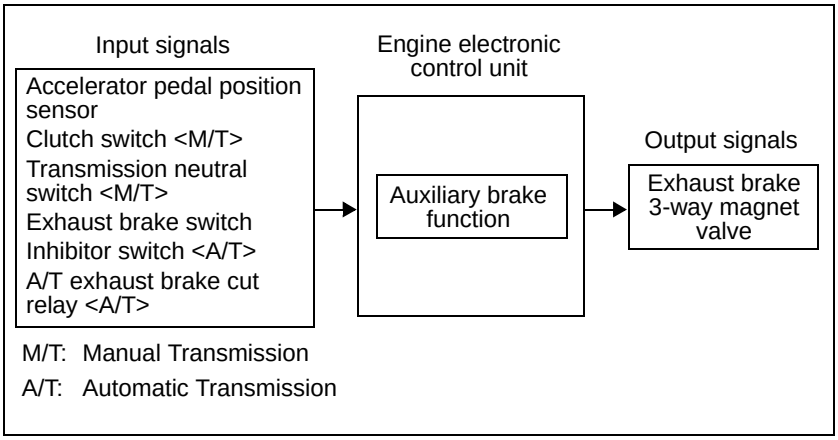
2.5 Fuel injection pressure control

- The fuel injection pressure is calculated from the fuel injection quantity and engine speed.



2.6 Warm-up acceleration function

- The warm-up acceleration function increases engine warm-up by varying the engine's idling speed in accordance with the engine's coolant temperature. It can operate either automatically or manually. Selection is made using the idling speed adjustment potentiometer.



2.7 Auxiliary brake function

- The auxiliary brake function activates or deactivates the exhaust brake 3-way magnet valve according to the vehicle condition to control the exhaust brake.

2.8 Fault diagnosis function

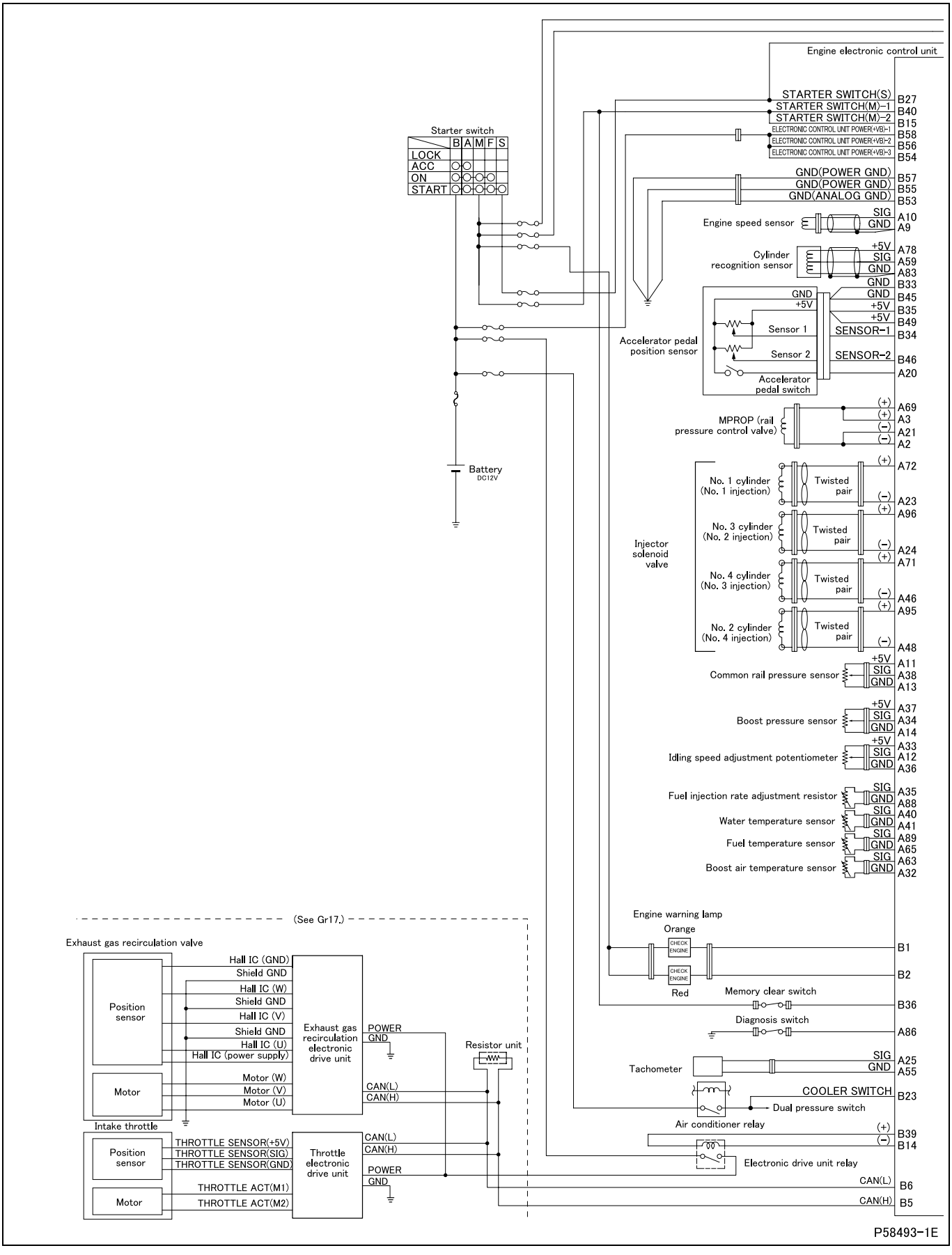
- While the starter switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found faulty, an indication is made in the meter cluster to alert the driver, the fault location is memorized in the form of a diagnosis code, and the control during fault is initiated.
- While the control during fault is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

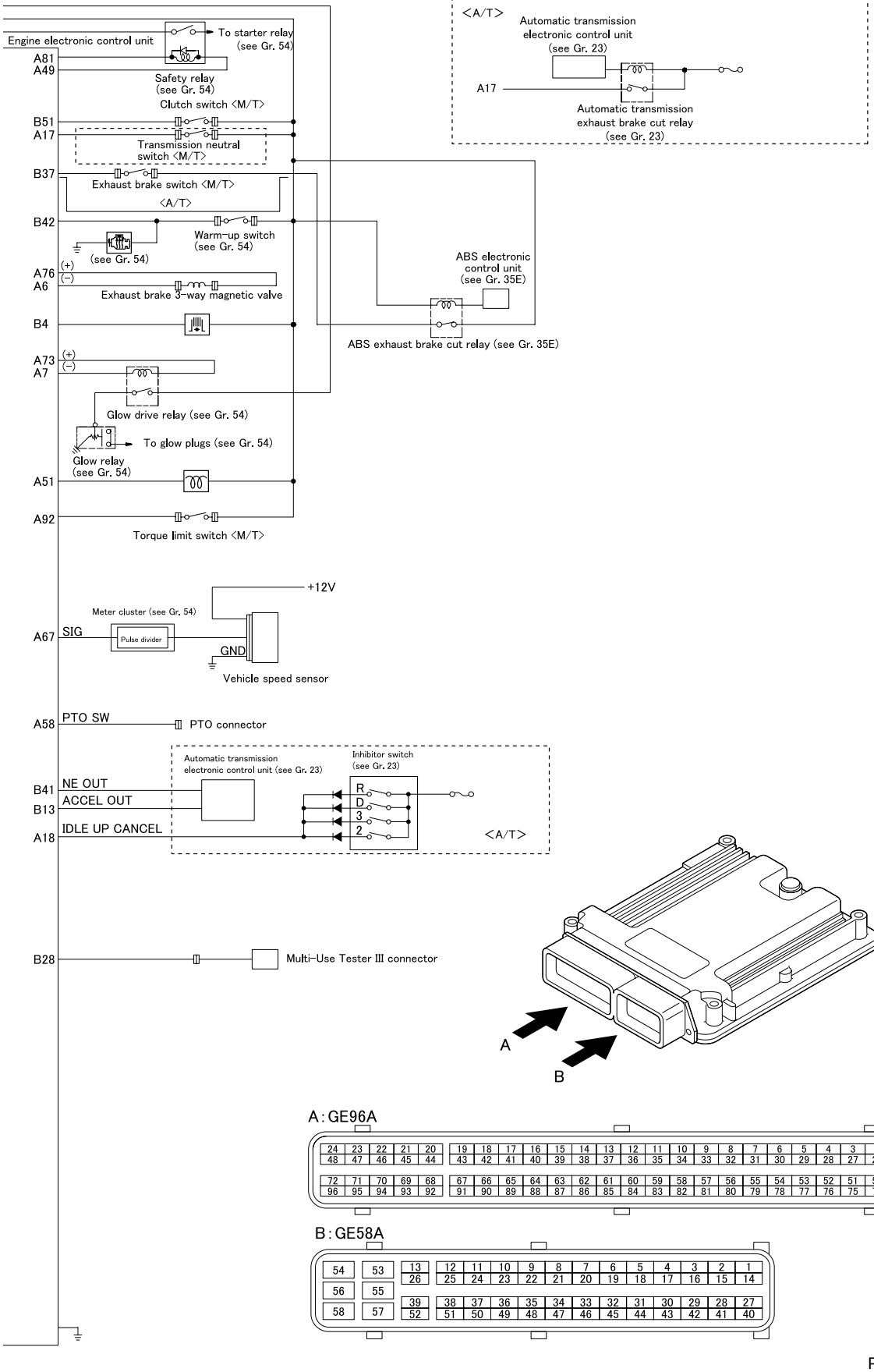
NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

M E M O

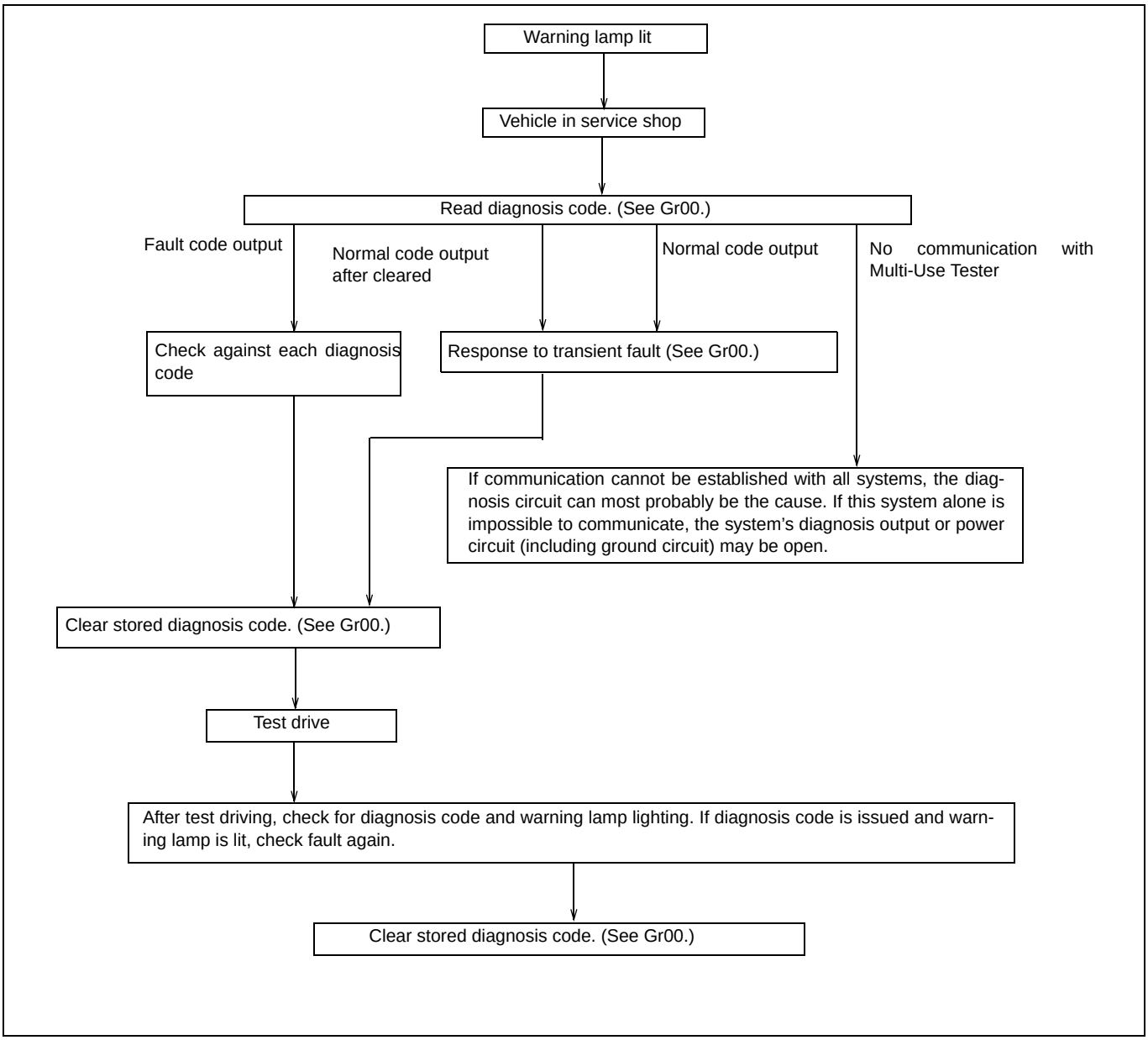
3. Electronic Control Unit Connection Diagram




<A/T>
Automatic transmission electronic control unit (see Gr. 23)
A17
Automatic transmission exhaust brake cut relay (see Gr. 23)
Engine electronic control unit
To starter relay (see Gr. 54)
A81
A49
Safety relay (see Gr. 54)
Clutch switch <M/T>
B51
A17
Transmission neutral switch <M/T>
B37
Exhaust brake switch <M/T>
<A/T>
B42
Warm-up switch (see Gr. 54)
(see Gr. 54)
ABS electronic control unit (see Gr. 35E)
A76
A6
Exhaust brake 3-way magnetic valve
B4
ABS exhaust brake cut relay (see Gr. 35E)
A73
A7
Glow drive relay (see Gr. 54)
To glow plugs (see Gr. 54)
Glow relay (see Gr. 54)
A51
A92
Torque limit switch <M/T>
+12V
Meter cluster (see Gr. 54)
A67
SIG
Pulse divider
GND
Vehicle speed sensor
A58
PTO SW
PTO connector
Automatic transmission electronic control unit (see Gr. 23)
Inhibitor switch (see Gr. 23)
B41
NE OUT
B13
ACCEL OUT
A18
IDLE UP CANCEL
R
D
3
2
<A/T>
B28
Multi-Use Tester III connector
A
B
A : GE96A
B : GE58A
P58493-2E

1. Diagnosis Procedure

- The system can be efficiently inspected for faults using a Multi-Use Tester-III.
  System inspection can be accomplished basically in two ways according to trouble symptom and diagnosis code as shown below.
  - Check against each diagnosis code stored in memory by the electronic control unit
  - Response to transient fault



2. Diagnostic Precautions

- Before measuring voltage, check the battery for charged condition and specific gravity. If system inspection is performed with the battery uncharged or reduced in specific gravity, accurate measurements cannot be achieved.
- To avoid having electrical parts damaged, set the starter switch and lighting switch to LOCK or OFF before disconnecting and reconnecting battery cables.
- Before disconnecting connectors, set the starter switch to LOCK or OFF, then allow at least 20 seconds. Voltage may remain in electric parts or connected circuit.
- When performing measurement with the tester, handle the test bar carefully so that it does not damage internal circuit and other electrical parts of the electronic control unit to result in a short-circuit failure between terminals in connector or between connector and car body.
- Resistance is affected by temperature. Determine the necessity of resistance measurement following given temperature specification as a guide. Otherwise, use normal temperature (10 to 35°C {50 to 95°F}) as the measuring condition.

3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes	Remarks
P0107	Atmospheric Pressure Sensor	19	
P0108	Atmospheric Pressure Sensor	19	
P0112	INT Air Temp. SNSR (Upstream)	44	
P0113	INT Air Temp. SNSR (Upstream)	44	
P0117	Water Temperature Sensor	21	
P0118	Water Temperature Sensor	21	
P0121	Accel Pedal Check (Plausibility)	58	
P0122	Accel Pedal Sensor 1	24	
P0123	Accel Pedal Sensor 1	24	
P0182	Fuel Temp. Sensor (inlet)	41	
P0183	Fuel Temp. Sensor (inlet)	41	
P0192	Common Rail Pressure Sensor	11	
P0193	Common Rail Pressure Sensor	11	
P0200	Injector Circuit 1	82	
P0201	Injector M/V-Cylinder 1	37	
P0202	Injector M/V-Cylinder 2	38	
P0203	Injector M/V-Cylinder 3	39	
P0204	Injector M/V-Cylinder 4	08	
P0219	Engine Overrunning	07	
P0222	Accel Pedal Sensor 2	16	
P0223	Accel Pedal Sensor 2	16	
P0234	Over Boost Error	54	
P0237	Boost Pressure Sensor	32	
P0238	Boost Pressure Sensor	32	
P0251	Common Rail Pressure Defect	36	
P0253	Common Rail Pressure Defect	22	
P0254	Common Rail Pressure Defect	23	
P0335	Engine Revolution Sensor	15	
P0340	Camshaft Position Sensor	12	
P0380	Relay for Glow Relay	26	Gr54
P0381	Glow Lamp	89	Gr54
P0403	EGR 1	67	Gr17
P0500	Vehicle Speed Sensor	25	

Code	Message	Flashes	Remarks
P0506	Idle Volume	31	
P0507	Idle Volume	31	
P0510	Accel SW	65	
P0560	M/V Supply Voltage	79	
P0605	ECU System (Hardware)	33	
P0615	Starter Safety Relay	48	Gr54
P0616	Starter Safety Relay	48	Gr54
P0617	Starter Safety Relay	48	Gr54
P1121	Intake Throttle 1	28	Gr17
P1171	Q Adjustment Resister	34	
P1172	Q Adjustment Resister	34	
P1200	Injector Circuit 2	82	
P1251	Common Rail Pressure M/V 1	63	
P1255	Common Rail Pressure M/V 1	63	
P1256	Common Rail Pressure M/V 1	63	
P1335	Revolution & Position Sensor	14	
P1460	Exhaust Brake M/V 1	93	
P1462	Exhaust Brake M/V 1	93	
P1463	Exhaust Brake M/V 1	93	
P1562	Sensor Supply Voltage 1	81	
P1563	Sensor Supply Voltage 1	81	
P1567	Sensor Supply Voltage 2	81	
P1568	Sensor Supply Voltage 2	81	
P1572	Sensor Supply Voltage 3	81	
P1573	Sensor Supply Voltage 3	81	
P1577	Segment Sensor Supply Voltage	81	
P1578	Segment Sensor Supply Voltage	81	
P1605	ECU System (EEPROM)	33	
P1606	ECU System (Software)	33	
P1625	EDU Relay	84	Gr17
P1630	CAN (EGR)	95	Gr17
P1635	CAN (Intake Throttle)	96	Gr17
P1700	Torque Cut SW	86	

3.2 Diagnosis code generation conditions and inspection items

P0107: Atmospheric Pressure Sensor (warning lamp flashes: 19)

Generation condition		Atmospheric pressure sensor (incorporated into engine electronic control unit) voltage is below standard value (2 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using backup value of 101.3 kPa {15 psi, 1.03 kgf/cm^2}. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	38: Atmospheric Pressure
	Electrical equipment	Engine electronic control unit

P0108: Atmospheric Pressure Sensor (warning lamp flashes: 19)

Generation condition		Atmospheric pressure sensor (incorporated into engine electronic control unit) voltage is below standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using backup value of 101.3 kPa {15 psi, 1.03 kgf/cm^2}. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	38: Atmospheric Pressure
	Electrical equipment	Engine electronic control unit

P0112: INT Air Temp. SNSR (Upstream) (warning lamp flashes: 44)

Generation condition		Boost air temperature sensor voltage is below standard value (0.15 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (25°C {77°F}).
Inspection	Service data	27: Intake Air Temperature
	Electronic control unit connector	01 : Boost air temperature sensor
	Electrical equipment	#305: Boost air temperature sensor
	Electric circuit diagram	Boost air temperature sensor system

P0113: INT Air Temp. SNSR (Upstream) (warning lamp flashes: 44)

Generation condition		Boost air temperature sensor voltage is below standard value (4.85 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (25°C {77°F}).
Inspection	Service data	27: Intake Air Temperature
	Electronic control unit connector	01 : Boost air temperature sensor
	Electrical equipment	#305: Boost air temperature sensor
	Electric circuit diagram	Boost air temperature sensor system

P0117: Water Temperature Sensor (warning lamp flashes: 21)

Generation condition		Water temperature sensor voltage is below standard value (0.2 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Water temperature is assumed as constant –20°C {–4°F} during engine start-up and as constant 80°C {175°C} while vehicle is being driven. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped. • Glow control is stopped.
Inspection	Service data	35: Water Temperature
	Electronic control unit connector	02 : Water temperature sensor
	Electrical equipment	#262: Water temperature sensor
	Electric circuit diagram	Water temperature sensor system

P0118: Water Temperature Sensor (warning lamp flashes: 21)

Generation condition		Water temperature sensor voltage is above standard value (4.85 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Water temperature is assumed as constant –20°C {–4°F} during engine start-up and as constant 80°C {175°C} while vehicle is being driven. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped. • Glow control is stopped.
Inspection	Service data	35: Water Temperature
	Electronic control unit connector	02 : Water temperature sensor
	Electrical equipment	#262: Water temperature sensor
	Electric circuit diagram	Water temperature sensor system

P0121: Accel Pedal Check (Plausibility) (warning lamp flashes: 58)

Generation condition		Accelerator pedal position sensor output voltages 1 and 2 are outside standard range; or compared value is out of specification.
Recoverability		– (Low output)
Control effected by electronic control unit		Control is effected using value of 30 % with accelerator pedal pressed and using value of 0 % with accelerator pedal not pressed. (Output is reduced.)
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 24: Accel Pedal Sensor Voltage 1, 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

P0122: Accel Pedal Sensor 1 (warning lamp flashes: 24)

Generation condition		Accelerator pedal position sensor 1 voltage is below standard value (0.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 2.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 24: Accel Pedal Sensor Voltage 1
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 1 system

P0123: Accel Pedal Sensor 1 (warning lamp flashes: 24)

Generation condition		Accelerator pedal position sensor 1 voltage is below standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 2.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 24: Accel Pedal Sensor Voltage 1
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 1 system

P0182: Fuel Temp. Sensor (inlet) (warning lamp flashes: 41)

Generation condition		Fuel temperature sensor voltage is below standard value (0.15 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value.
Inspection	Service data	36: Fuel Temperature (inlet)
	Electronic control unit connector	04 : Fuel temperature sensor
	Electrical equipment	#323: Fuel temperature sensor
	Electric circuit diagram	Fuel temperature sensor system

P0183: Fuel Temp. Sensor (inlet) (warning lamp flashes: 41)

Generation condition		Fuel temperature sensor voltage is below standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value.
Inspection	Service data	36: Fuel Temperature (inlet)
	Electronic control unit connector	04 : Fuel temperature sensor
	Electrical equipment	#323: Fuel temperature sensor
	Electric circuit diagram	Fuel temperature sensor system

P0192: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		Common rail pressure sensor voltage is below standard value (0.2 V).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P0193: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		Common rail pressure sensor voltage is below standard value (4.8 V).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P0200: Injector Circuit 1 (warning lamp flashes: 82)

Generation condition		Injector magnetic valve circuit (No. 1 and No. 4 cylinder) is short-circuited, open-circuited, or overloaded.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Faulty circuit is stopped, resulting in two-cylinder operation. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator tests	BB: Injector Test 1, BE: Injector Test 4
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 1 cylinder) or (No. 4 cylinder) system

P0201: Injector M/V-Cylinder1 (warning lamp flashes: 37)

Generation condition		Injector magnetic valve (No. 1 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 1 and 4 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BB: Injector Test 1
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 1 cylinder) system

P0202: Injector M/V-Cylinder2 (warning lamp flashes: 38)

Generation condition		Injector magnetic valve (No. 3 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 2 and 3 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BD: Injector Test 3
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 3 cylinder) system

P0203: Injector M/V-Cylinder3 (warning lamp flashes: 39)

Generation condition		Injector magnetic valve (No. 4 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 1 and 4 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BE: Injector Test 4
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 4 cylinder) system

P0204: Injector M/V-Cylinder4 (warning lamp flashes: 08)

Generation condition		Injector magnetic valve (No. 2 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 2 and 3 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BC: Injector Test 2
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 2 cylinder) system

P0219: Engine Overrunning (warning lamp flashes: 07)

Generation condition		Engine speed is higher than specified level.
Recoverability		System recovers if engine speed becomes normal while starter switch in ON position.
Control effected by electronic control unit		• Injectors are turned OFF. • MPROP (rail pressure control valve) stops feeding fuel.
Inspection	Electronic control unit connector	Engine electronic control unit

P0222: Accel Pedal Sensor 2 (warning lamp flashes: 16)

Generation condition		Accelerator pedal position sensor 2 voltage is below standard value (0.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 1.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 2 system

P0223: Accel Pedal Sensor 2 (warning lamp flashes: 16)

Generation condition		Accelerator pedal position sensor 2 voltage is above standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 1.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 2 system

P0234: Over Boost Error (warning lamp flashes: 54)

Generation condition		Boost pressure exceeds the limit.
Recoverability		System recovers if signal becomes normal when starter switchis turned OFF → ON (power is re-supplied to electronic control unit).
Control effected by electronic control unit		Injection volume is limited.
Inspection	Other	Turbocharger (See Gr15.)

P0237: Boost Pressure Sensor (warning lamp flashes: 32)

Generation condition		Boost pressure sensor voltage is below standard value (0.3 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value of 101.3 kPa {1.03 kgf/cm^2}. (Output is reduced, and fuel economy worsens.)
Inspection	Service data	26: Boost Pressure
	Electrical equipment	#318: Boost pressure sensor
	Electric circuit diagram	Boost pressure sensor system

P0238: Boost Pressure Sensor (warning lamp flashes: 32)

Generation condition		Boost pressure sensor voltage is above standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value of 101.3 kPa {1.03 kgf/cm^2}. (Output is reduced, and fuel economy worsens.)
Inspection	Service data	26: Boost Pressure
	Electrical equipment	#318: Boost pressure sensor
	Electric circuit diagram	Boost pressure sensor system

P0251: Common Rail Pressure Defect (warning lamp flashes: 36)

Generation condition		Difference between target rail pressure and actual rail pressure is above standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Injectors are turned OFF. (Engine is stopped.)
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Air-bleeding of fuel system (See Gr13A.) • Inspection of fuel piping (See Gr13A.) • Fuel filter (See Gr13A.) • Supply pump (Have work performed by Bosch Automotive Systems.) • Pressure limiting valve (Have work performed by Bosch Automotive Systems.) • Injectors (Have work performed by Bosch Automotive Systems.)

P0253: Common Rail Pressure Defect (warning lamp flashes: 22)

Generation condition		Actual rail pressure is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Injectors are turned OFF. (Engine is stopped.)
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Air-bleeding of fuel system (See Gr13A.) • Inspection of fuel piping (See Gr13A.) • Fuel filter (See Gr13A.) • Supply pump (Have work performed by Bosch Automotive Systems.) • Pressure limiting valve (Have work performed by Bosch Automotive Systems.) • Injectors (Have work performed by Bosch Automotive Systems.)

P0254: Common Rail Pressure Defect (warning lamp flashes: 23)

Generation condition		Actual rail pressure is high even with delivery rate of zero; or actual rail pressure is above standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Other	Supply pump (Have work performed by Bosch Automotive Systems.)

P0335: Engine Revolution Sensor (warning lamp flashes: 15)

Generation condition		Engine speed sensor emits no pulses or too many pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using cylinder recognition sensor. (Output decreases owing to reduced control accuracy.)
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	06 : Engine speed sensor
	Electrical equipment	#263: Engine speed sensor
	Electric circuit diagram	Engine speed sensor system

P0340: Camshaft Position Sensor (warning lamp flashes: 12)

Generation condition		Cylinder recognition sensor emits no pulses or too many pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using engine speed sensor.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07 : Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P0500: Vehicle Speed Sensor (warning lamp flashes: 25)

Generation condition		Vehicle speed sensor signal is missing or indicates an abnormally high speed.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Engine is controlled normally.
Inspection	Service data	3C: Vehicle Speed
	Electronic control unit connector	08 : Vehicle speed sensor
	Electrical equipment	#265: Vehicle speed sensor
	Electric circuit diagram	Vehicle speed sensor system

P0506: Idle Volume (warning lamp flashes: 21)

Generation condition		Idling speed adjustment potentiometer voltage is below standard value (0.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected with auto idle permanently selected.
Inspection	Service data	3B: Idle Volume Voltage
	Electronic control unit connector	09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer
	Electric circuit diagram	Idling speed adjustment potentiometer system

P0507: Idle Volume (warning lamp flashes: 31)

Generation condition		Idling speed adjustment potentiometer voltage is above standard value (4.6 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected with auto idle permanently selected.
Inspection	Service data	3B: Idle Volume Voltage
	Electronic control unit connector	09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer
	Electric circuit diagram	Idling speed adjustment potentiometer system

P0510: Accel SW (warning lamp flashes: 65)

Generation condition		Accelerator pedal switch signal is abnormal when compared with accelerator pedal position sensor outputs 1 and 2.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control is effected.
Inspection	Service data	73: Accel SW
	Electronic control unit connector	10 : Accelerator pedal switch
	Electrical equipment	#324: Accelerator pedal switch (incorporated into accelerator pedal position sensor)
	Electric circuit diagram	Accelerator pedal switch system

P0560: M/V Supply Voltage (warning lamp flashes: 79)

Generation condition		Circuit (magnetic valve power supply) in electronic control unit is abnormal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs owing to circuit abnormality.
Inspection	Other	Engine electronic control unit

P0605: ECU System (Hardware) (warning lamp flashes: 33)

Generation condition		Circuit (hardware power supply) in electronic control unit is abnormal.
Recoverability		System recovers if signal becomes normal with starter switch in ON position. System does not recover unless diagnosis code is deleted.
Control effected by electronic control unit		No specific control is effected. Failure occurs owing to circuit abnormality.
Inspection	Other	Engine electronic control unit

P1171: Q Adjustment Resistor (warning lamp flashes: 34)

Generation condition		Fuel injection rate adjustment resistor voltage is below standard value (0.2 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (No. 1). (Output is slightly reduced.)
Inspection	Service data	3E: Q Adjustment Resistor No.
	Electronic control unit connector	11 : Fuel injection rate adjustment resistor
	Electrical equipment	#828: Fuel injection rate adjustment resistor
	Electric circuit diagram	Fuel injection rate adjustment resistor

P1172: Q Adjustment Resistor (warning lamp flashes: 34)

Generation condition		Fuel injection rate adjustment resistor voltage is above standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (No. 1). (Output is slightly reduced.)
Inspection	Service data	3E: Q Adjustment Resistor No.
	Electronic control unit connector	11 : Fuel injection rate adjustment resistor
	Electrical equipment	#828: Fuel injection rate adjustment resistor
	Electric circuit diagram	Fuel injection rate adjustment resistor

P1200: Injector Circuit 2 (warning lamp flashes: 82)

Generation condition		Injector magnetic valve circuit (No. 2 and No. 3 cylinder) is short-circuited, open-circuited, or overloaded.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty circuit is stopped, resulting in two-cylinder operation. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator tests	BC: Injector Test 2, BD: Injector Test 3
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 2 cylinder) or (No. 3 cylinder) system

P1251: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		Current flowing to MPROP (rail pressure control valve) is above standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	12 : MPROP (rail pressure control valve)
	Electrical equipment	#574: MPROP (rail pressure control valve)
	Electric circuit diagram	MPROP (rail pressure control valve) system

P1255: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		MPROP (rail pressure control valve) voltage is below standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	12 : MPROP (rail pressure control valve)
	Electrical equipment	#574: MPROP (rail pressure control valve)
	Electric circuit diagram	MPROP (rail pressure control valve) system

P1256: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		MPROP (rail pressure control valve) voltage is above standard value.
Recoverability		High voltage: System recovers if signal becomes normal with starter switch in ON position. Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	12 : MPROP (rail pressure control valve)
	Electrical equipment	#574: MPROP (rail pressure control valve)
	Electric circuit diagram	MPROP (rail pressure control valve) system

P1335: Revolution & Position Sensor (warning lamp flashes: 14)

Generation condition		Engine speed sensor and cylinder recognition sensor emit no pulses or too many pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Injectors are turned OFF. (Engine is stopped.)
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	06 : Engine speed sensor, 07 : Cylinder recognition sensor
	Electrical equipment	#263: Engine speed sensor, #320: Cylinder recognition sensor
	Electric circuit diagram	Engine speed sensor and cylinder recognition sensor systems

P1460: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Current flowing to exhaust brake 3-way magnetic valve is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Operation of exhaust brake is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Auxiliary Brake M/V 1
	Electronic control unit connector	13 : Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1462: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Exhaust brake 3-way magnetic valve voltage is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Operation of exhaust brake is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Auxiliary Brake M/V 1
	Electronic control unit connector	13 : Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1463: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Exhaust brake 3-way magnetic valve voltage is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Operation of exhaust brake is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Auxiliary Brake M/V 1
	Electronic control unit connector	13 : Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1562: Sensor Supply Voltage 1 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 1) in electronic control unit is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	24: Accel Pedal Sensor Voltage 1, 3B: Idle Volume Voltage
	Electronic control unit connector	03 : Accelerator pedal position sensor 1, 09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer, #324: Accelerator pedal position sensor 1
	Electric circuit diagram	Boost air temperature sensor, accelerator pedal position sensor 1, and idling speed adjustment potentiometer systems

P1563: Sensor Supply Voltage 1 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 1) in electronic control unit is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	24: Accel Pedal Sensor Voltage 1, 3B: Idle Volume Voltage
	Electronic control unit connector	03 : Accelerator pedal position sensor 1, 09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer, #324: Accelerator pedal position sensor 1
	Electric circuit diagram	Boost air temperature sensor, accelerator pedal position sensor 1, and idling speed adjustment potentiometer systems

P1567: Sensor Supply Voltage 2 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 2) in electronic control unit is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	25: Accel Pedal Sensor Voltage 2, 26: Boost Pressure
	Electronic control unit connector	03 : Accelerator pedal position sensor 2
	Electrical equipment	#318: Boost pressure sensor, #324: Accelerator pedal position sensor 2
	Electric circuit diagram	Boost pressure sensor, accelerator pedal position sensor 2, and fuel temperature sensor systems

P1568: Sensor Supply Voltage 2 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 2) in electronic control unit is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	25: Accel Pedal Sensor Voltage 2, 26: Boost Pressure
	Electronic control unit connector	03 : Accelerator pedal position sensor 2
	Electrical equipment	#318: Boost pressure sensor, #324: Accelerator pedal position sensor 2
	Electric circuit diagram	Boost pressure sensor, accelerator pedal position sensor 2, and fuel temperature sensor systems

P1572: Sensor Supply Voltage 3 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 3) in electronic control unit is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P1573: Sensor Supply Voltage 3 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 3) in electronic control unit is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P1577: Segment Sensor Supply Voltage (warning lamp flashes: 81)

Generation condition		Cylinder recognition sensor supply voltage is below standard value (0 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07 : Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P1578: Segment Sensor Supply Voltage (warning lamp flashes: 81)

Generation condition		Cylinder recognition sensor supply voltage is above standard value (5 V).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07 : Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P1605: ECU System (EEPROM) (warning lamp flashes: 33)

Generation condition		Reading or writing error occurs during access.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Other	Engine electronic control unit

P1606: ECU System (Software) (warning lamp flashes: 33)

Generation condition		• System overload occurs. • Task execution time exceeds limit duration.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Other	Engine electronic control unit

P1700: Torque Cut SW (warning lamp flashes: 86)

Generation condition		Error occurs in comparison with VN ratio.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control is effected.
Inspection	Service data	7F: Torque Cut Switch
	Electronic control unit connector	14 : Torque limit SW
	Electrical equipment	#163: Torque limit switch
	Electric circuit diagram	Torque limit switch system

4. Multi-Use Tester Service Data

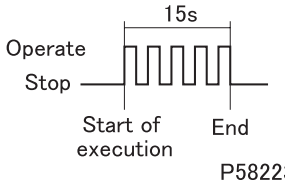
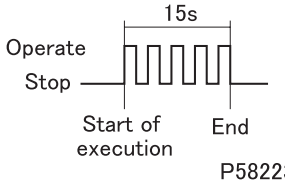
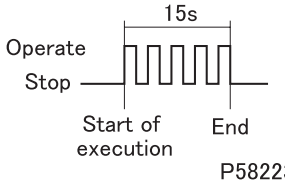
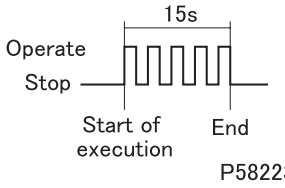
NOTE

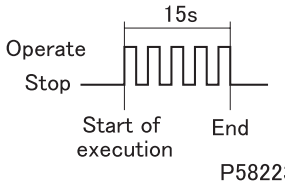
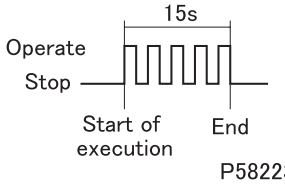
- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
01	Engine Revolution	■■■■.rpm	Racing (engine running)	Value corresponds to tachometer indication.
02	Reference Injection Quantity	■■■.■ %	Starter switch ON	0 %
0C	Difference Common Rail Pressure	■■■.■ %	Engine idling	0 % or lower
1F	EGR Position	■■■.■ %	See Gr17.	–
20	Intake Throttle Position	■■■.■ %	See Gr17.	–
22	Accel Pedal Position (unfiltered)	■■■.■ %	Accelerator pedal not pressed	0 %
			Accelerator pedal gradually pressed	Value gradually increases.
			Accelerator pedal fully pressed	100 %
23	Accel Pedal Position (filtered)	■■■.■ %	Accelerator pedal not pressed	0 %
			Accelerator pedal gradually pressed	Value gradually increases.
			Accelerator pedal fully pressed	100 %
24	Accel Pedal Sensor Voltage 1	■.■■■ V	Accelerator pedal gradually pressed from released position	0.85 to 4.15 V
25	Accel Pedal Sensor Voltage 2	■.■■■ V	Accelerator pedal gradually pressed from released position	0.85 to 4.15 V
26	Boost Pressure	■■■.■ inHg	Engine speed: 3100 rpm	49.9 in.Hg
27	Intake Air Temperature	■■■.■ °F	Engine cold	Value corresponds to ambient temperature.
35	Water Temperature	■■■.■ °F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
36	Fuel Temperature (inlet)	■■■.■ °F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
38	Atmospheric Pressure	■■■.■ inHg	Altitude: 0 m {0 ft.}	29.8 in.Hg
			Altitude: 600 m {1,970 ft.}	28.1 in.Hg
3B	Idle Volume Voltage	■.■■■ V	SLOW to FAST	2.6 to 1.2 V
3C	Vehicle Speed	■■■■.MPH	Vehicle in motion	Value corresponds to speedometer indication.
3E	Q Adjustment Resistor No.	1/2/3/4/5/6/7/8/9/10/11/NON	–	Number matches number marked on fuel injection rate adjustment resistor.
42	Power Supply Voltage	■■.■■ V	Starter switch ON	Value matches battery voltage.
71	Starter SW (S)	ON/OFF	Engine cranked by means of starter switch	ON
			Starter switch in position except START	OFF
72	Starter SW (M)	ON/OFF	Starter switch in ON position	ON
			Starter switch in position except ON	OFF
73	Accel SW	ON/OFF	Accelerator pedal not pressed	ON
			Accelerator pedal pressed	OFF

No.	Item	Data	Inspection condition	Requirement
76	Auxiliary Brake SW 1	ON/OFF	Combination switch ON	ON
			Combination switch OFF	OFF
78	Clutch SW	ON/OFF	Clutch pedal pressed	ON
			Clutch pedal not pressed	OFF
7A	Neutral SW	ON/OFF	• Transmission in neutral <Manual transmission> • Shift lever in N position <Automatic transmission>	ON
			• Transmission not in neutral <Manual transmission> • Shift lever in D position <Automatic transmission>	OFF
7B	Idle Up Cancel SW	ON/OFF	• Shift lever in D position <Automatic transmission>	ON
			• Continuously <Manual transmission> • Shift lever in N position <Automatic transmission>	OFF
			[Actuator test] B8: Idle Up Cancel SW	
7C	Air Conditioner SW 1	ON/OFF	Air conditioner compressor running	ON
			Air conditioner compressor not running	OFF
			[Actuator test] B6: Air Conditioner SW 1	
7E	Cold Start SW	ON/OFF	See Gr54.	–
7F	Troque Cut SW	ON/OFF	Transmission in 1st or reverse	ON
			Transmission not in 1st or reverse	OFF
82	PTO SW	ON/OFF	Switch ON	ON
			Switch OFF	OFF
83	Diagnosis SW	ON/OFF	Diagnosis switch OFF (fuse fitted)	ON
			Diagnosis switch ON (fuse removed)	OFF
84	Memory Clear SW	ON/OFF	Memory clear switch OFF (fuse fitted)	ON
		ON/OFF	Memory clear switch ON (fuse removed)	OFF
87	Exhaust Brake M/V 1	ON/OFF	Exhaust brake operating	ON
			Exhaust brake not operating	OFF
			[Actuator test] AC: Auxiliary Brake M/V 1	
8C	Auxiliary Brake Indicator Lamp	ON/OFF	Exhaust brake operating	ON
			Exhaust brake not operating	OFF
			[Actuator test] AE: Auxiliary Brake Indicator Lamp	
8D	Glow Relay	ON/OFF	See Gr54.	–
8E	Glow Relay Indicator Lamp	ON/OFF	See Gr54.	–
8F	Starter Safety Relay	ON/OFF	See Gr54.	–
90	EDU Power Relay	ON/OFF	See Gr54.	–
91	MIL Lamp	ON/OFF	Starter switch ON (engine not started)	ON
			No error after engine startup	OFF
			[Actuator test] B3: MIL Lamp	
92	Diagnosis Lamp	ON/OFF	Starter switch ON (engine not started)	ON
			No error after engine startup	OFF
			[Actuator test] B4: Diagnosis Lamp	

5. Actuator Tests Performed Using Multi-Use Tester

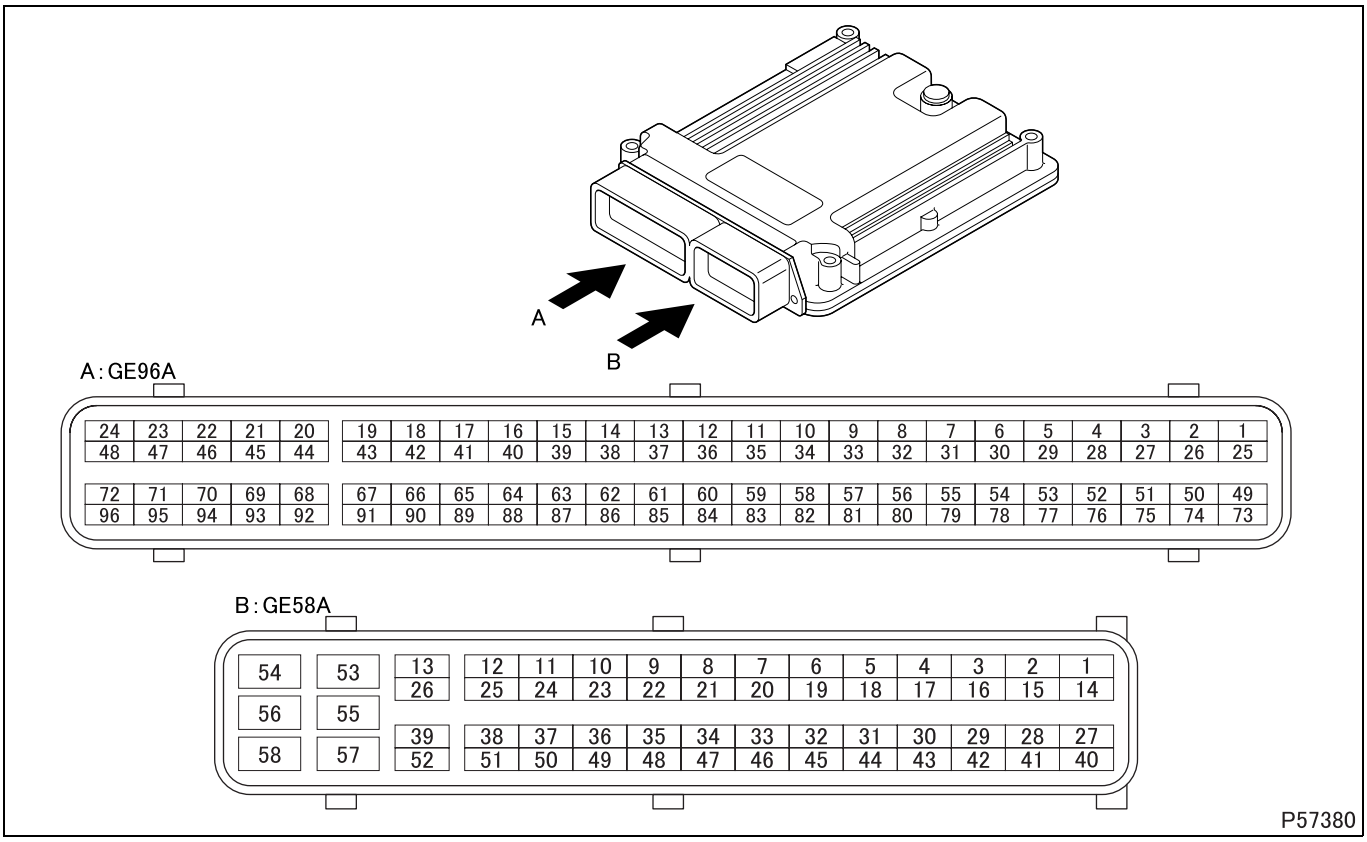
No.	Item	Explanation	Confirmation method
A1	EGR 1	See Gr17.	–
A7	Intake Throttle 1	See Gr17.	–
AC	Auxiliary Brake M/V 1	Exhaust brake 3-way magnetic valve drive signal (Can be executed with engine not running.) 	Operating sound of magnetic valve [Service data] 87: Exhaust brake M/V 1
AE	Auxiliary Brake Indicator Lamp	Exhaust brake indicator lamp drive signal (Can be executed with engine not running.) 	ON/OFF condition of indicator lamp [Service data] 8C: Auxiliary Brake Indicator Lamp
AF	Relay for Glow Relay	See Gr54.	–
B0	Glow Indicator Lamp	See Gr54.	–
B1	Starter Safety Relay	See Gr54.	–
B2	EDU Relay	See Gr17.	–
B3	MIL Lamp	Warning lamp (orange) drive signal 	ON/OFF condition of warning lamp (orange) [Service data] 91: MIL Lamp
B4	Diagnosis Lamp	Warning lamp (orange) drive signal 	ON/OFF condition of warning lamp (red) [Service data] 92: Diagnosis Lamp

No.	Item	Explanation	Confirmation method
B6	Air Conditioner SW 1	Idle up control reproduced by means of dummy signal (air conditioner operation). (Can be executed with vehicle speed of zero and with transmission in neutral.)  P58223E	Increase in idling speed [Service data] 7C: Air conditioner SW 1
B8	Idle Up Cancel SW	Idle up cancel condition reproduced by means of dummy signal (idle up cancel). (Can be executed with vehicle speed of zero and with transmission in neutral.)  P58223E	Idling speed low idle [Service data] 7B: Idle Up Cancel SW
B9	Fuel Leak Check	Rail pressure increased on constant slope (Can be executed with vehicle speed of zero and transmission in neutral and diagnosis switch open.)	Check that no fuel leaks from fuel system.
BB	Injector Test 1	Injector magnetic valve (No. 1 cylinder) not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease
BC	Injector Test 2	Injector magnetic valve (No. 2 cylinder) not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease
BD	Injector Test 3	Injector magnetic valve (No. 3 cylinder) not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease
BE	Injector Test 4	Injector magnetic valve (No. 4 cylinder) not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease

6. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black numbers (01, 02, and so on) correspond to the similarly printed reference numbers in section "**3. Inspections based on diagnosis codes**".

6.1 Electronic control unit connector terminal layout



6.2 Inspection instructions

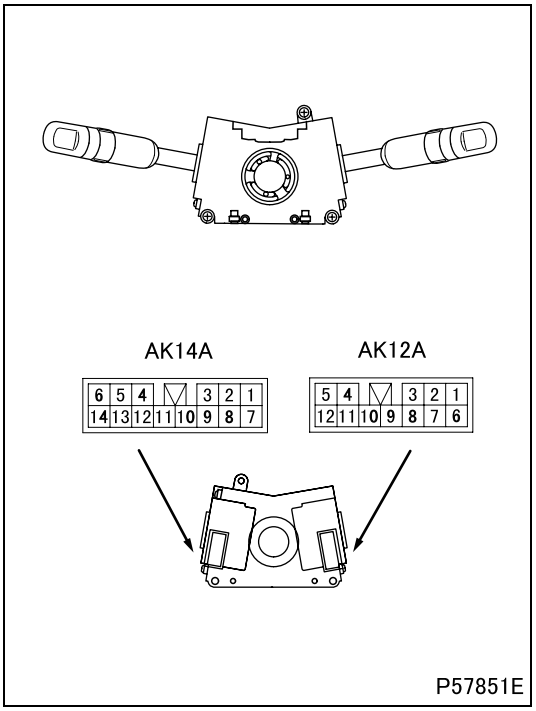
CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
01 Resistance of boost air temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A63-A32 • 0°C {32°F}: $15^{+3.78}_{-2.94}$ kΩ • 20°C {68°F}: $6.514^{+1.473}_{-1.147}$ kΩ • 80°C {176°F}: $0.874^{+0.136}_{-0.115}$ kΩ

Check item	Measurement method
02 Resistance of water temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A40-A41 • 20°C {68°F}: 2.3 to 2.6 kΩ • 80°C {176°F}: 0.30 to 0.34 kΩ
03 Output voltage of accelerator pedal position sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–) B34-B33 and B45 (accelerator pedal position sensor 1) B46-B33 and B45 (accelerator pedal position sensor 2) • With accelerator pedal not pressed: 0.85 ± 0.1 V • With accelerator pedal pressed: 4.15 ± 0.1 V
04 Resistance of fuel temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A89-A65 • 20°C {68°F}: 2.45 $^{+0.14}_{-0.13}$ kΩ • 80°C {176°F}: 0.318 ± 0.01 kΩ • 110°C {230°F}: 0.1417 ± 0.01 kΩ
05 Resistance of injector magnetic valve	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A72-A23 (injector magnetic valve: No. 1 cylinder) A95-A48 (injector magnetic valve: No. 2 cylinder) A96-A24 (injector magnetic valve: No. 3 cylinder) A71-A46 (injector magnetic valve: No. 4 cylinder) • 0.255 ± 0.04 Ω
06 Resistance of engine speed sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A10-A9 • 860 ± 86 kΩ (20°C {68°F})
07 Resistance of cylinder recognition sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A78-A83 (+5 V to GND) • 200 to 1800 kΩ
08 Output voltage of vehicle speed sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) • Turn wheels slowly using chassis dynamometer. [Requirements] Terminals (+)-(–): A67-chassis earth • High pulse voltage: Approx. 8 ± 1 V • Low pulse voltage: 0.5 V or lower
09 Output voltage of idling speed adjustment potentiometer	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A12-A36 • AUTO position: 4.0 ± 0.1 V • SLOW position: 3.0 ± 0.2 V • FAST position: 1.0 ± 0.1 V

Check item	Measurement method
10 Operating voltage of accelerator pedal switch	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A20-B33 and B45 • With accelerator pedal pressed: 0 V • With accelerator pedal not pressed: 5 V
11 Resistance of fuel injection rate adjustment resistor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A35-A88 • No. 1 resistor: 270 ± 13.5 Ω • No. 2 resistor: 510 ± 25.5 Ω • No. 3 resistor: 820 ± 41 Ω • No. 4 resistor: 1,300 ± 65 Ω • No. 5 resistor: 2,000 ± 100 Ω • No. 6 resistor: 3,300 ± 165 Ω • No. 7 resistor: 5,600 ± 280 Ω • No. 8 resistor: 15,000 ± 750 Ω • No. 9 resistor: 390 ± 19.5 Ω • No. 10 resistor: 4,300 ± 215 Ω • No. 11 resistor: 9,100 ± 455 Ω
12 Resistance of MPROP (rail pressure control valve)	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A69-A21, A69-A2, A3-A21, A3-A2 2.6 to 3.15 Ω
13 Voltage of exhaust brake 3-way magnetic valve	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A76-A6 • With exhaust brake operating: Corresponding to battery voltage • With exhaust brake not operating: 0 V
14 Voltage of torque limit switch	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A92-chassis earth • Transmission in 1st or reverse: Corresponding to battery voltage • Transmission not in 1st or reverse: 0 V

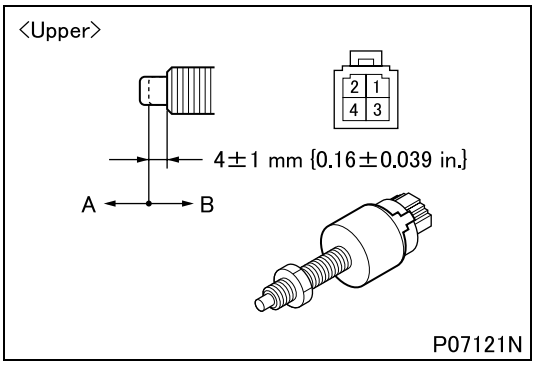


#001 Inspection of combination switch

AK14A connector connection table

Switch position		Terminals with continuity
Exhaust brake switch	OFF	–
	ON	8 - 9

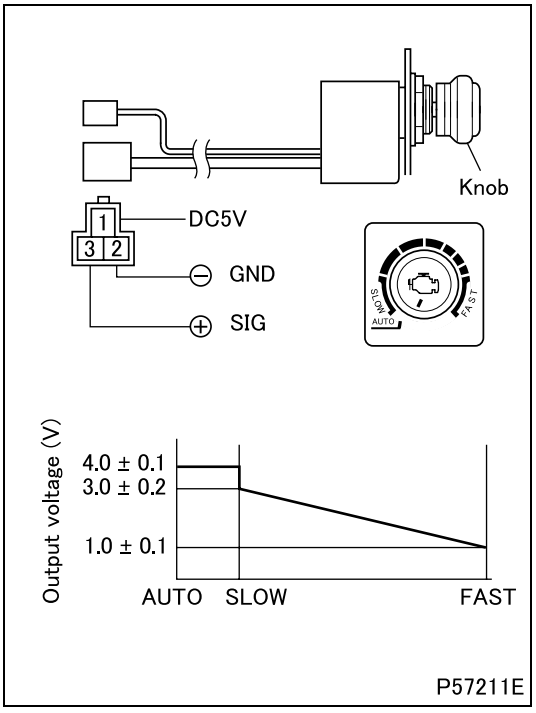
- If there is any abnormality, replace the switch.



#031 Inspection of clutch switch

Switch position	Terminals with continuity
A	1 - 4
B	2 - 3

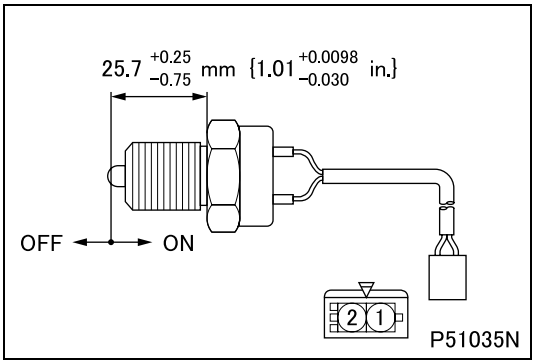
- If there is any abnormality, replace the switch.



#157 Inspection of idling speed adjustment potentiometer

- Apply 5 V DC to terminals 1 and 2 of the idling speed adjustment potentiometer.
- Turn the knob fully counterclockwise. Then, measure the output voltage across terminals 2 and 3 (see the diagrams on the left) while slowly turning the knob clockwise.
- If any measurement is out of specification, replace the idling speed adjustment potentiometer.

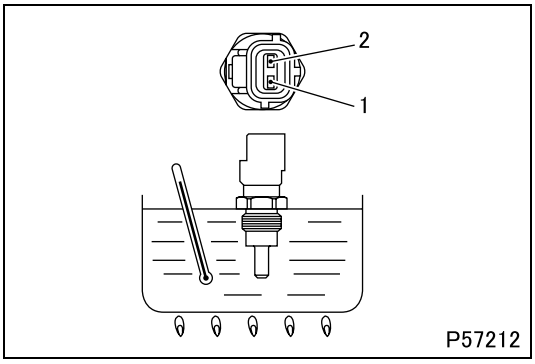
	Knob position	Output voltage
Standard value	AUTO (0°)	4.0 ± 0.1 V
	SLOW (30°)	3.0 ± 0.2 V
	FAST (300°)	1.0 ± 0.1 V



#163 Inspection of torque limit switch

Switch position	Terminals with continuity
OFF	–
ON	1 - 2

- If there is any abnormality, replace the switch.

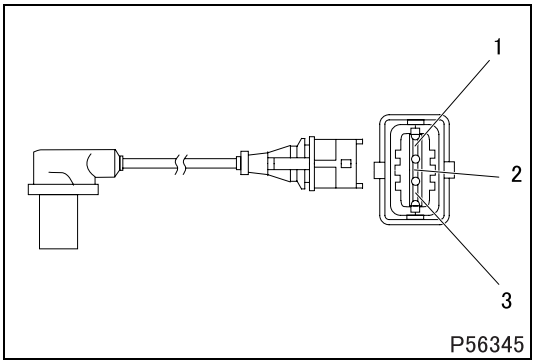


#262 Inspection of water temperature sensor

- Place the water temperature sensor in a container filled with engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil well while doing so.
- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	2.3 to 2.6 kΩ
	80°C {176°F}	0.30 to 0.34 kΩ

- If either measurement is out of specification, replace the sensor.

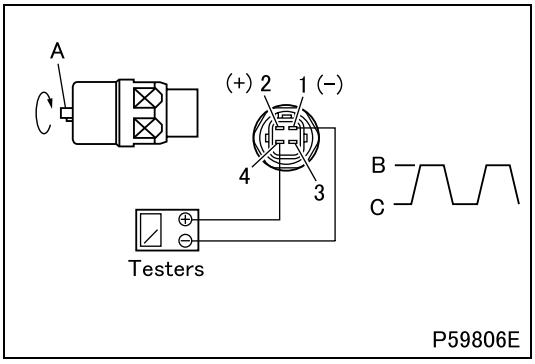


#263 Inspection of engine speed sensor

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	860 ± 86 Ω

- If the measurement is out of specification, replace the sensor.

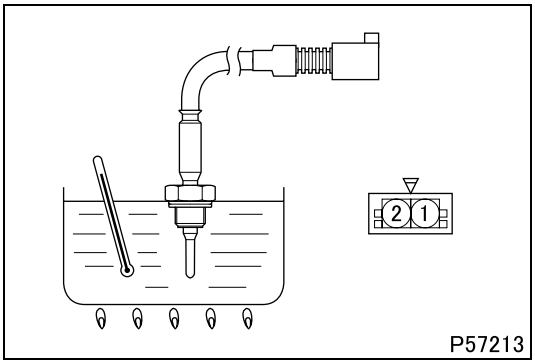


#265 Inspection of vehicle speed sensor

- With the battery voltage applied to terminals 1 and 2, slowly turn part A of the sensor.
- Measure the maximum voltage (high pulse voltage B) and minimum voltage (low pulse voltage C) occurring at each specified pair of terminals.

Terminals	Inspection condition	Standard value
25-pulse output: terminals 1 and 4	Low pulse voltage	0.5 V or lower
	High pulse voltage	8 ± 1 V

- If any measurement is out of specification, replace the sensor.

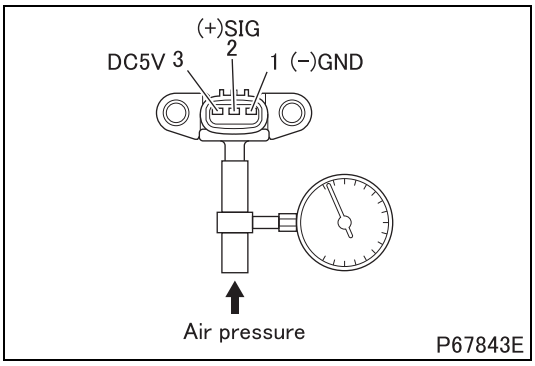


#305 Inspection of boost air temperature sensor

- Place the boost air temperature sensor in a container filled with engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil well while doing so.
- Measure the resistance between terminals 1 and 2.

Standard value	0°C {32°F}	$15\ ^{+3.78}_{-2.94}$ kΩ
	20°C {68°F}	$6.514\ ^{+1.437}_{-1.147}$ kΩ
	80°C {176°F}	$0.874\ ^{+0.136}_{-0.115}$ kΩ

- If either measurement is out of specification, replace the sensor.



##318 Inspection of boost pressure sensor

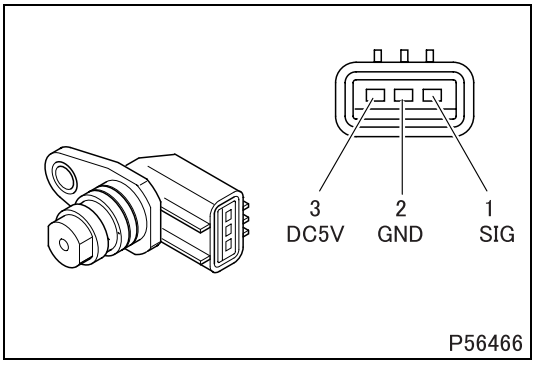
- Apply 5 V DC to terminals 3 and 1.
- Apply air pressure. Gradually increase it and, while doing so, measure the output voltage occurring at terminals 2 and 1.

	Air pressure	Voltage
Standard value	99 kPa {14 psi, 1.0 kg/cm^2}	Approx. 2.5 V
	232.3 kPa {34 psi, 2.3 kg/cm^2}	Approx. 4.5 V

- If any measurement is out of specification, replace the sensor.

#319 Inspection of common rail pressure sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the common rail.

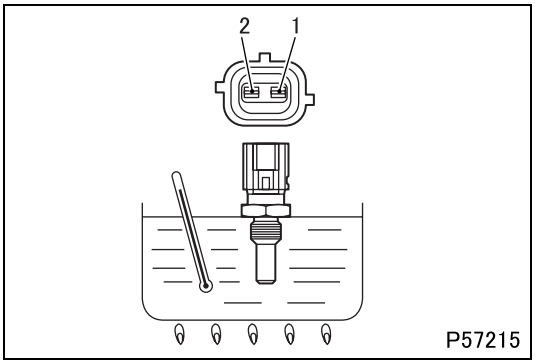


#320 Inspection of cylinder recognition sensor

- Measure the resistance between terminals 2 and 3.

Standard value	200 to 1800 Ω

- If the measurement is out of specification, replace the sensor.

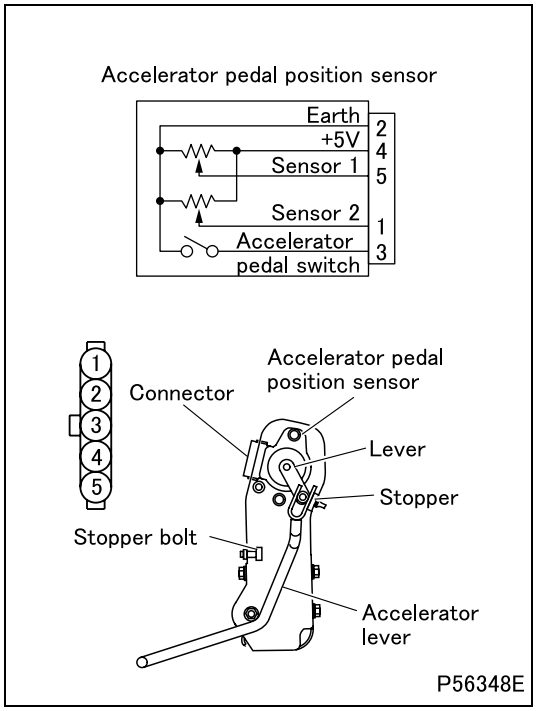


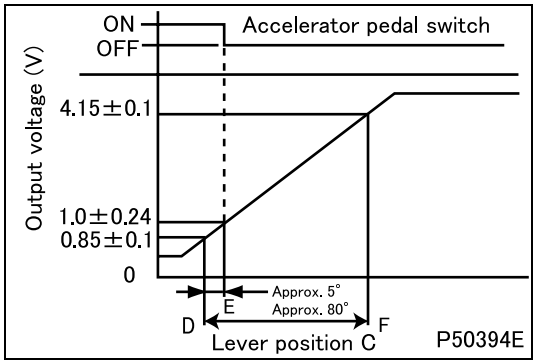
#323 Inspection of fuel temperature sensor

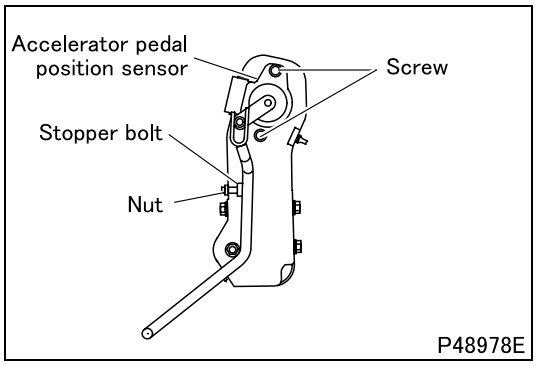
- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	$2.45\ ^{+0.14}_{-0.13}$ kΩ
	80°C {176°F}	0.318 ± 0.01 kΩ
	110°C {230°F}	0.1417 ± 0.01 kΩ

- If any measurement is out of specification, replace the sensor.







#324 Inspection of accelerator pedal position sensor

[Inspection]

- Apply 5 V DC to terminals 4 and 2 of the accelerator pedal position sensor.
- Measure the output voltage at terminals 2 and 5 (sensor 1) and the output voltage at terminals 1 and 2 (sensor 2) with the accelerator lever in each specified position.

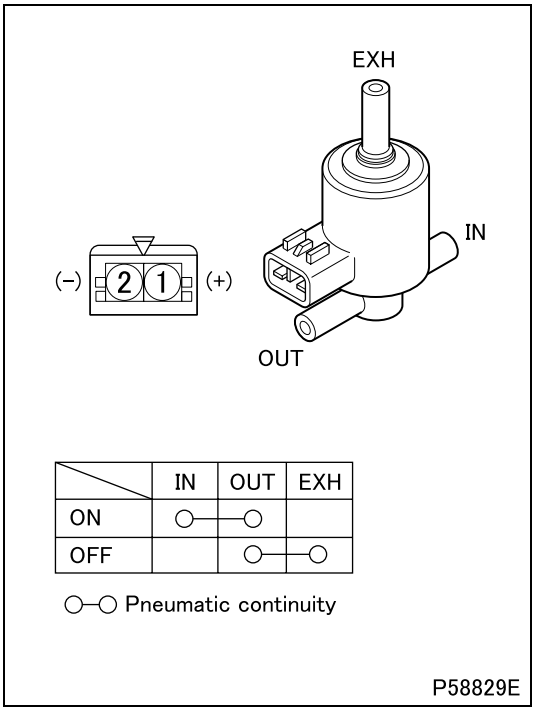
	Accelerator lever position	Output voltage
Standard value	Idling position A	0.85 ± 0.1 V
	Accelerator pedal switch operating position B	1.0 ± 0.24 V
	Full load position C	4.15 ± 0.1 V

A: Position in which accelerator lever is touching stopper
B: Position at which continuity between terminals 2 and 3 disappears as accelerator pedal is pushed downward
C: Position in which accelerator lever is touching stopper bolt

- If any output voltage is out of specification, make an adjustment.
- If any output voltage is still out of specification when you have made an adjustment, replace the sensor.

[Adjustment]

- To adjust the output voltage for the idling position A, loosen the screws and move the accelerator pedal position sensor. Tighten the screws after making the adjustment.
- To adjust the output voltage for the full load position C, loosen the nut and make the adjustment using the stopper bolt. After making the adjustment, lock the stopper bolt in position with the nut.



#565 Inspection of exhaust brake 3-way magnetic valve

- Perform the following checks. If there is any abnormality, replace the exhaust brake 3-way magnetic valve.

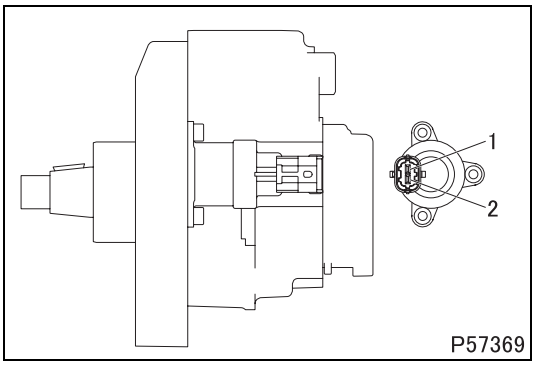
(1) Check of operation

- Gradually increase from zero the voltage applied to terminals 1 and 2.
- Observe the voltage when the exhaust brake 3-way magenetic valve operates.
  (Determine the magnet valve's OFF-ON operation from the operating sound.)

Standard value (min. operating voltage)	11 V or lower

(2) Check of continuity and airtightness

- Vacuum pressure applied during check:
  –100 kPa {–29.5 in.Hg, –750 mmHg}

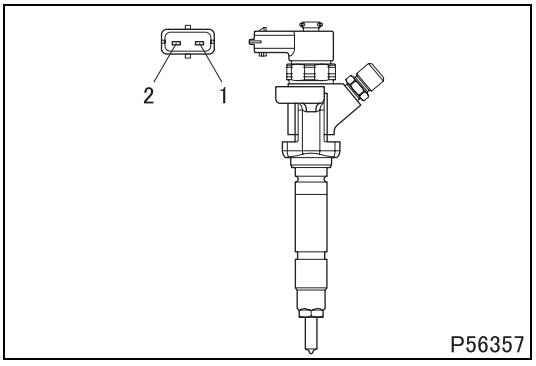


#574 Inspection of MPROP
(injection quantity adjustment valve)

- Measure the resistance between terminals 1 and 2.

Standard value	2.6 to 3.15 Ω

- If the measurement is out of specification, replace the supply pump.

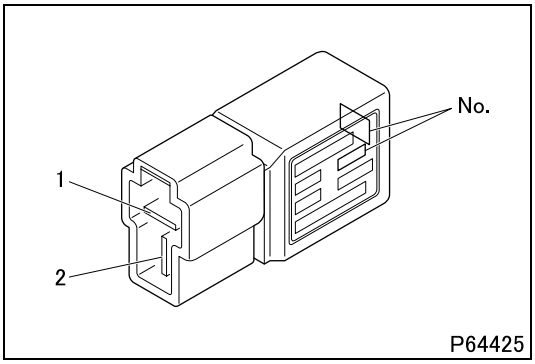


#582 Inspection of injector magnetic valve

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	0.255 ± 0.04 Ω

- If the measurement is out of specification, replace the injector.



#828 Inspection of fuel injection rate adjustment resistor

- Measure the resistance of the resistor number marked on the fuel injection rate adjustment resistor.

Standard value (at 20°C {68°F})	Resistor No.	1	270 ± 13.5 Ω
		2	510 ± 25.5 Ω
		3	820 ± 41 Ω
		4	1300 ± 65 Ω
		5	2000 ± 100 Ω
		6	3300 ± 165 Ω
		7	5600 ± 280 Ω
		8	15000 ± 750 Ω
		9	390 ± 19.5 Ω
		10	4300 ± 215 Ω
		11	9100 ± 455 Ω

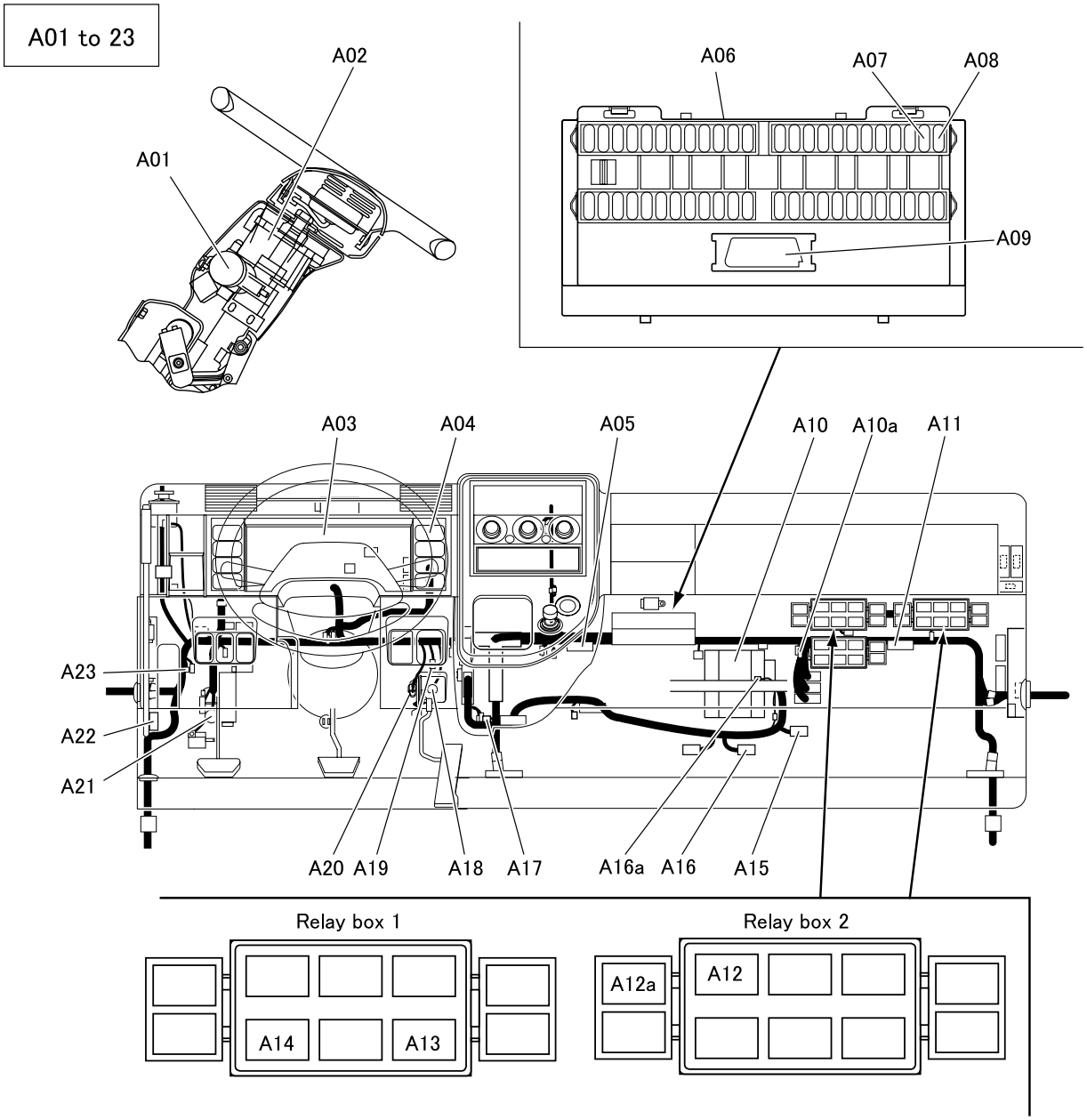
- If the measurement is out of specification, replace the fuel injection rate adjustment resistor with one that has the same resistor number and same specified resistance.

CAUTION ⚠

- **The fuel injection rate adjustment resistor is matched to the engine. If you replace it, be sure to replace it with one that has the same resistor number.**

M E M O

INSTALLED LOCATIONS OF PARTS



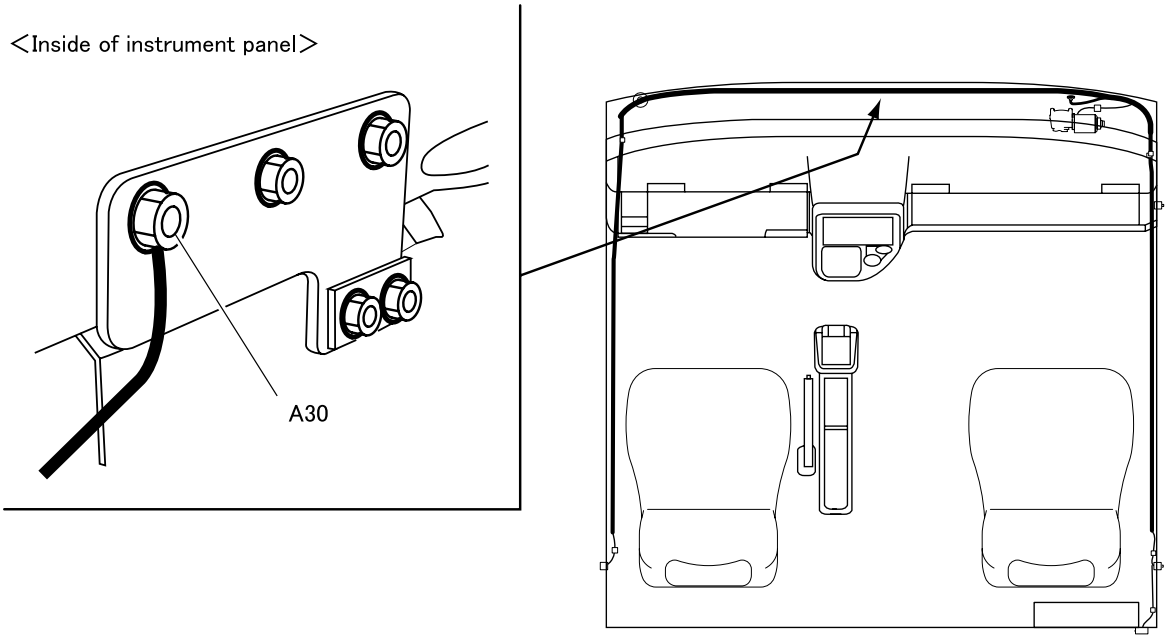
No relevant parts in a missing number

A01 Starter switch
A02 Combination switch
A03 Meter cluster
A04 Warm-up switch
A05 Joint connector (J/C-1)
A06 Fuse box
A07 Diagnosis switch
A08 Memory clear switch
A09 Multi-Use Tester-Ⅲ connector (for recorder)
A10 Engine ECU
A10a Diode
A11 Joint connector (J/C-2, 3)
A12 ABS exhaust brake cut relay
A12a Engine start relay
A13 Exhaust brake cut relay <A/T>
A14 Safety relay
A15 Joint connector (J/C-4)
A16 Resister unit
A16a Ground
A17 Diode
A18 Idling speed adjustment potentiometer
A19 PTO resistor
A20 Accelerator pedal position sensor
A21 Clutch switch
A22 Multi-Use Tester-Ⅲ connector (for inspection)
A23 Fuel injection rate adjustment resistor

ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit
PTO : Power take-off

L00182

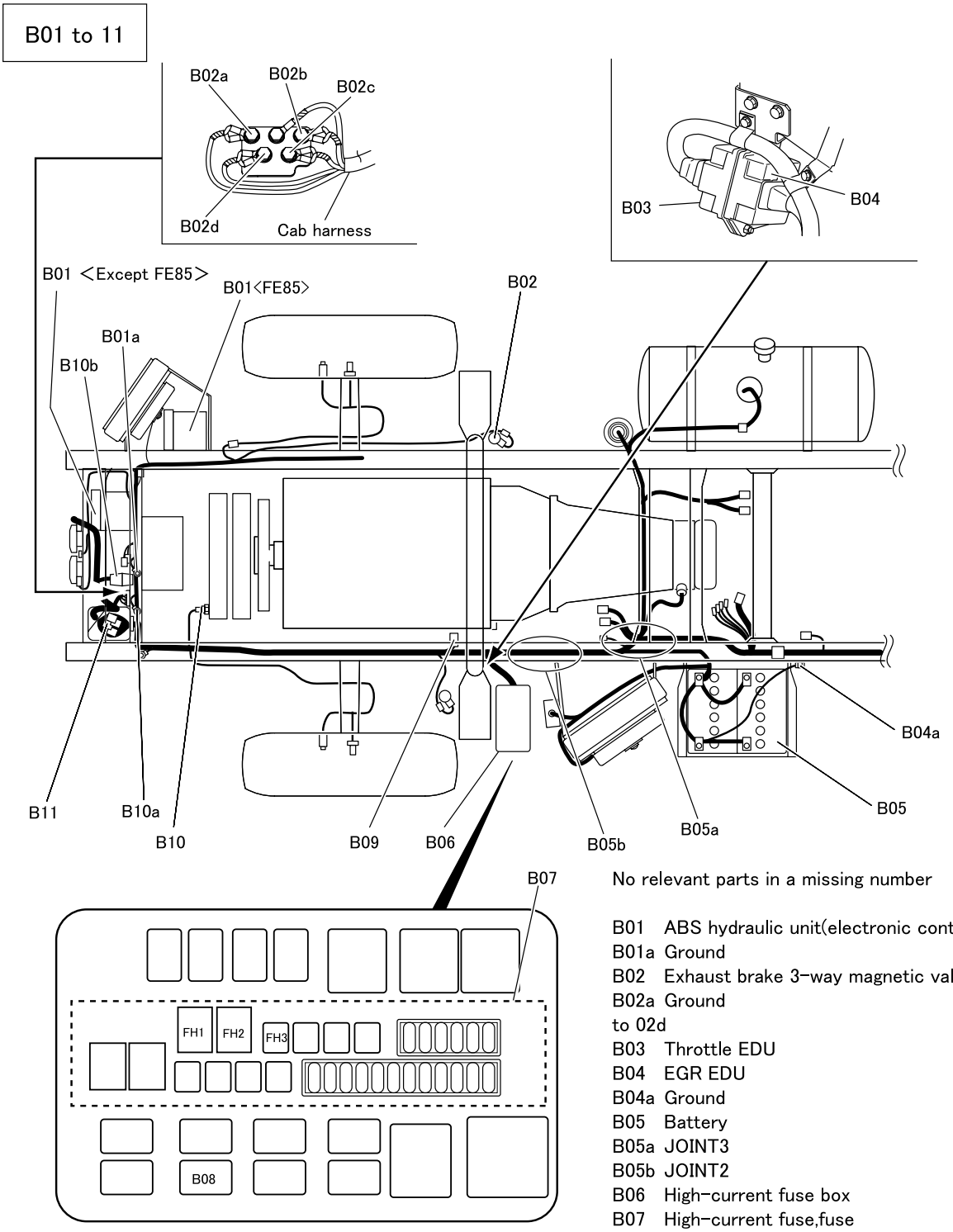
A30



A30 Ground

L00183

INSTALLED LOCATIONS OF PARTS



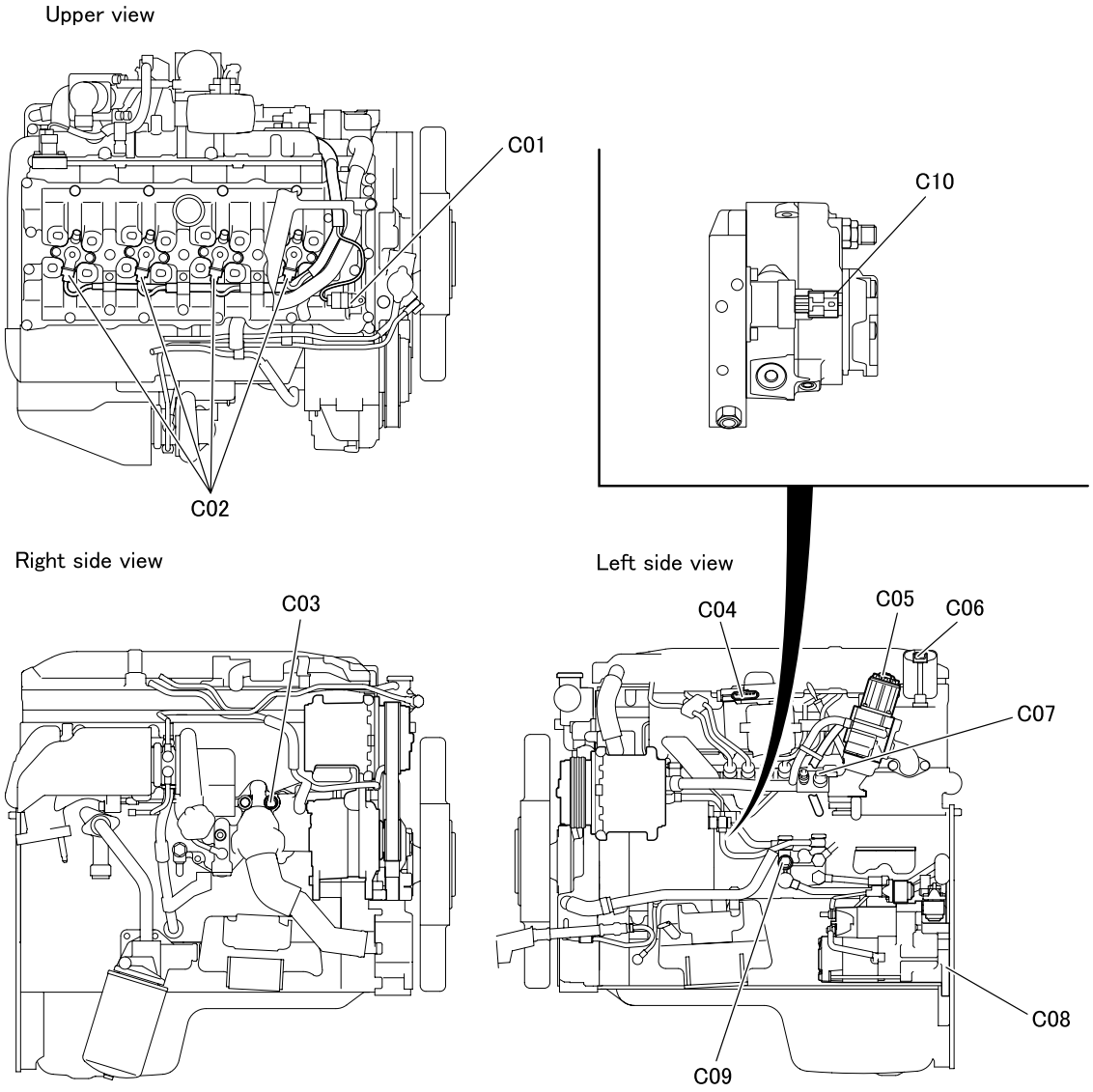
No relevant parts in a missing number

B01 ABS hydraulic unit(electronic control unit)
B01a Ground
B02 Exhaust brake 3-way magnetic valve
B02a Ground
to 02d
B03 Throttle EDU
B04 EGR EDU
B04a Ground
B05 Battery
B05a JOINT3
B05b JOINT2
B06 High-current fuse box
B07 High-current fuse,fuse
B08 EDU relay
B09 Joint connector
B10 Boost air temperature sensor
B10a Ground
B10b Connection of cab harness and engine harness
B11 Connection of chassis harness and cab harness or engine herness

ABS : Anti-lock brake system
EGR : Exhaust-gas recirculation
EDU : Electronic drive unit

L01273

C01 to 10



C01 Cylinder recognition sensor
C02 Injector magnetic valve
C03 Water temperature sensor
(Connects to engine ECU)
C04 Intake throttle
(Building into motor, position sensor)
C05 EGR valve
(Building into motor, position sensor)
C06 Boost pressure sensor
C07 Common rail pressure sensor
C08 Starter
C09 Fuel temperature sensor
C10 MPROP (rail pressure control valve)

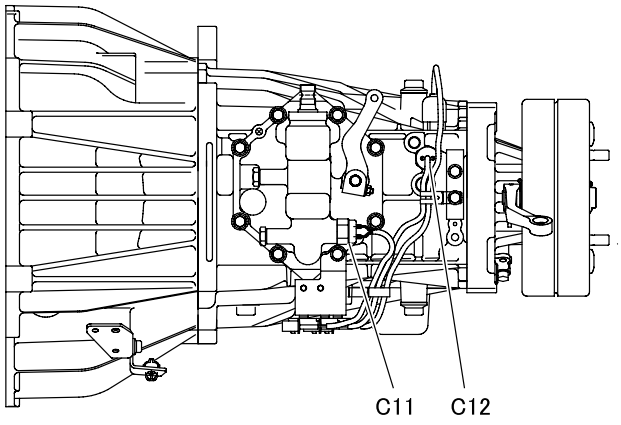
ECU : Electronic control unit

L00185

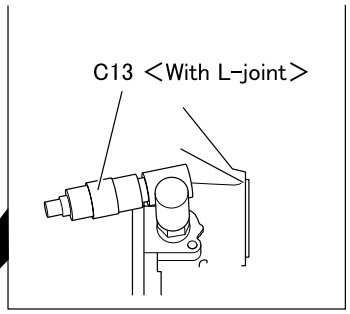
C11 to 14

Manual transmission

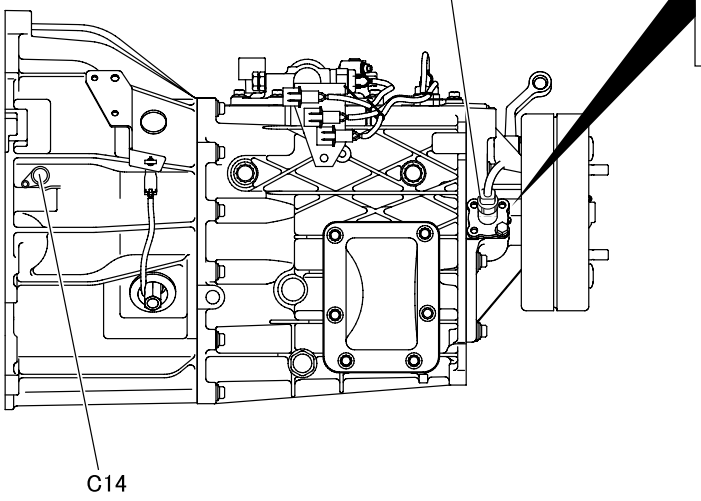
Upper view



C11 Transmission neutral switch
C12 Torque limit switch
C13 Vehicle speed sensor
C14 Engine speed sensor

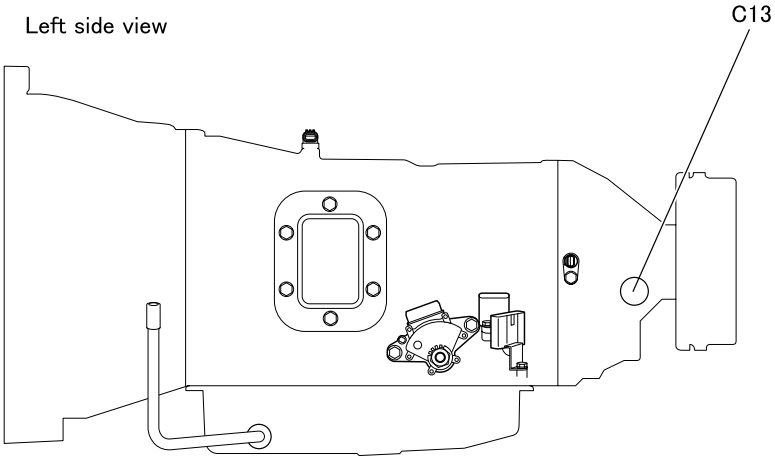


Left side view



Automatic transmission

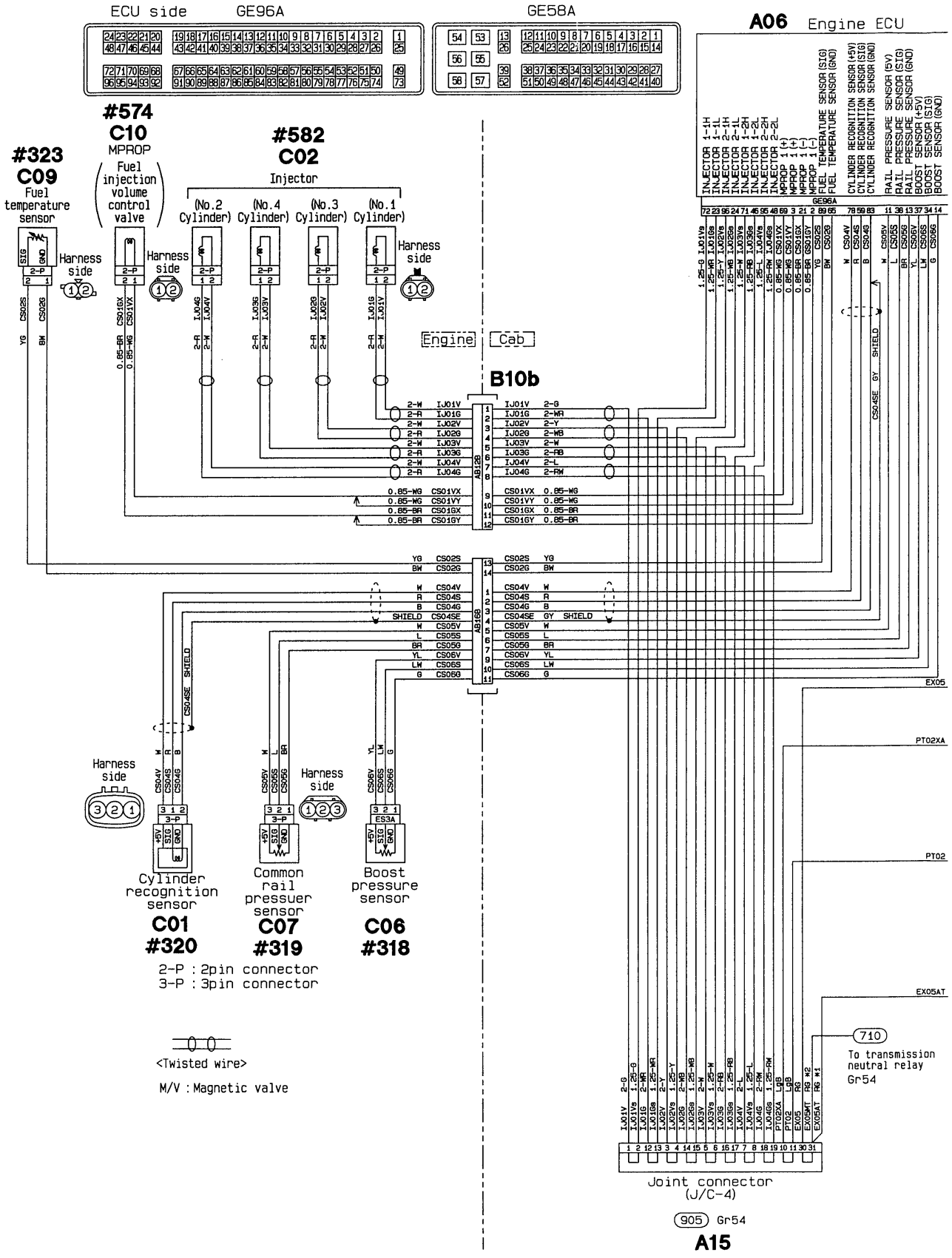
Left side view

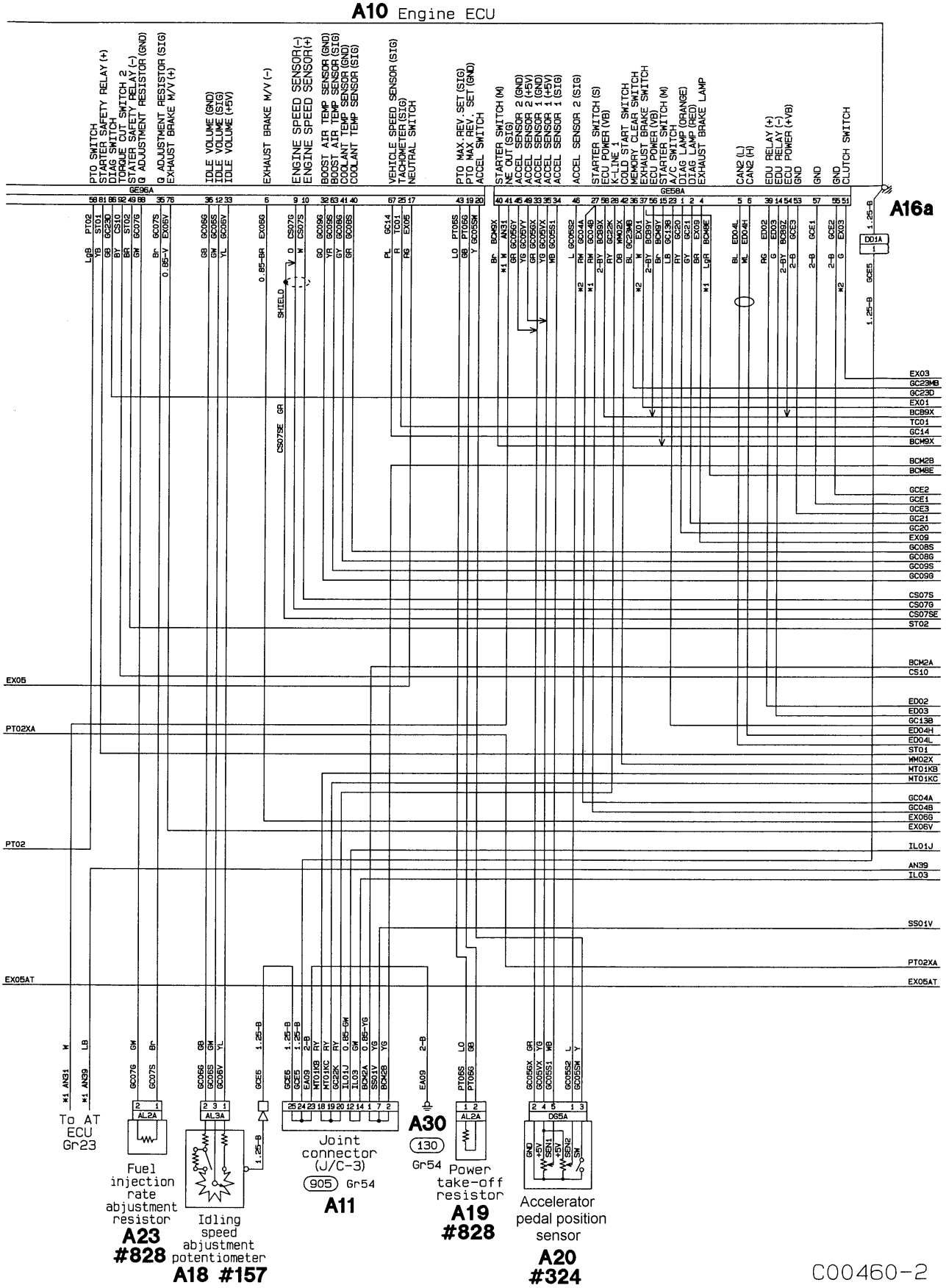


L00186

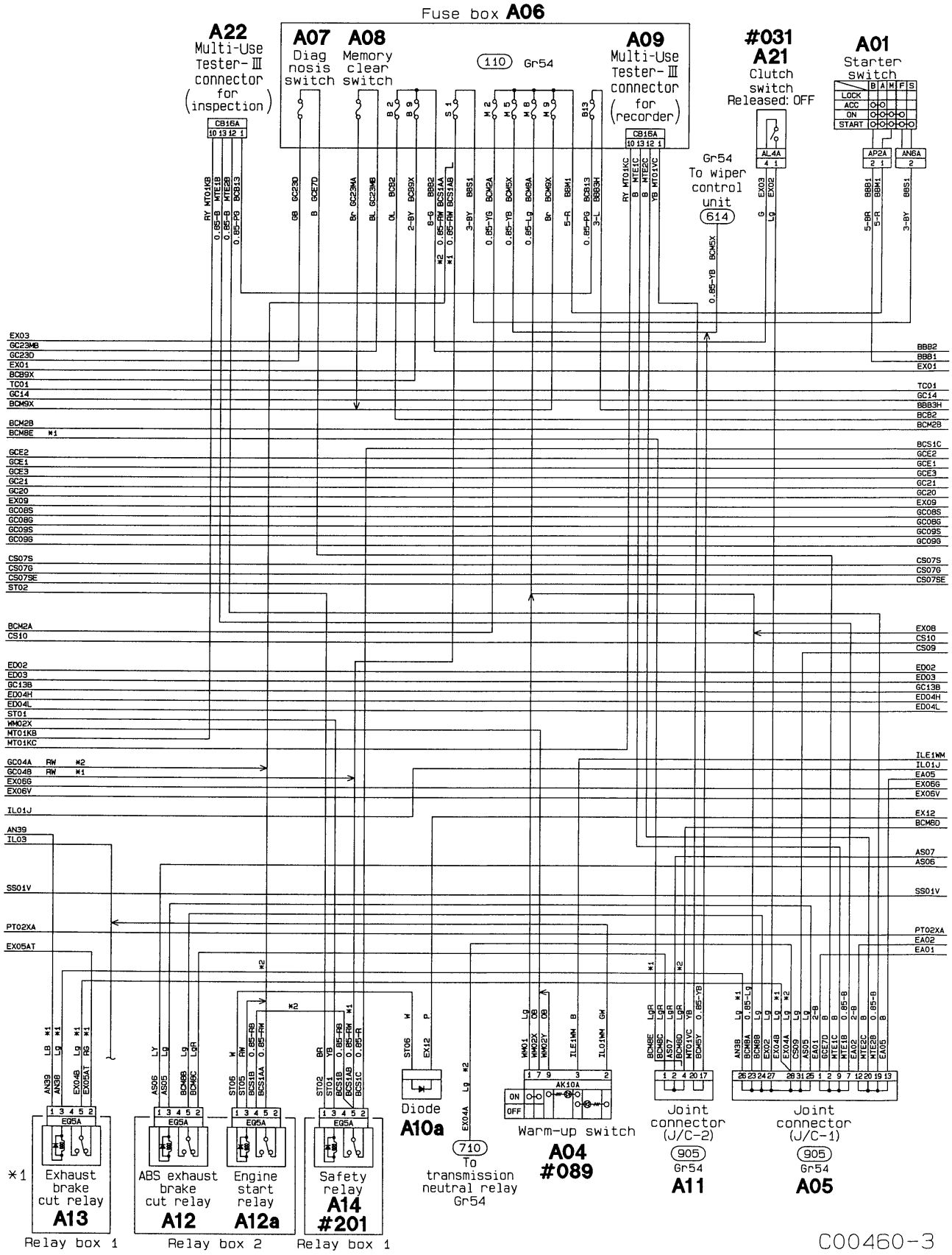
M E M O

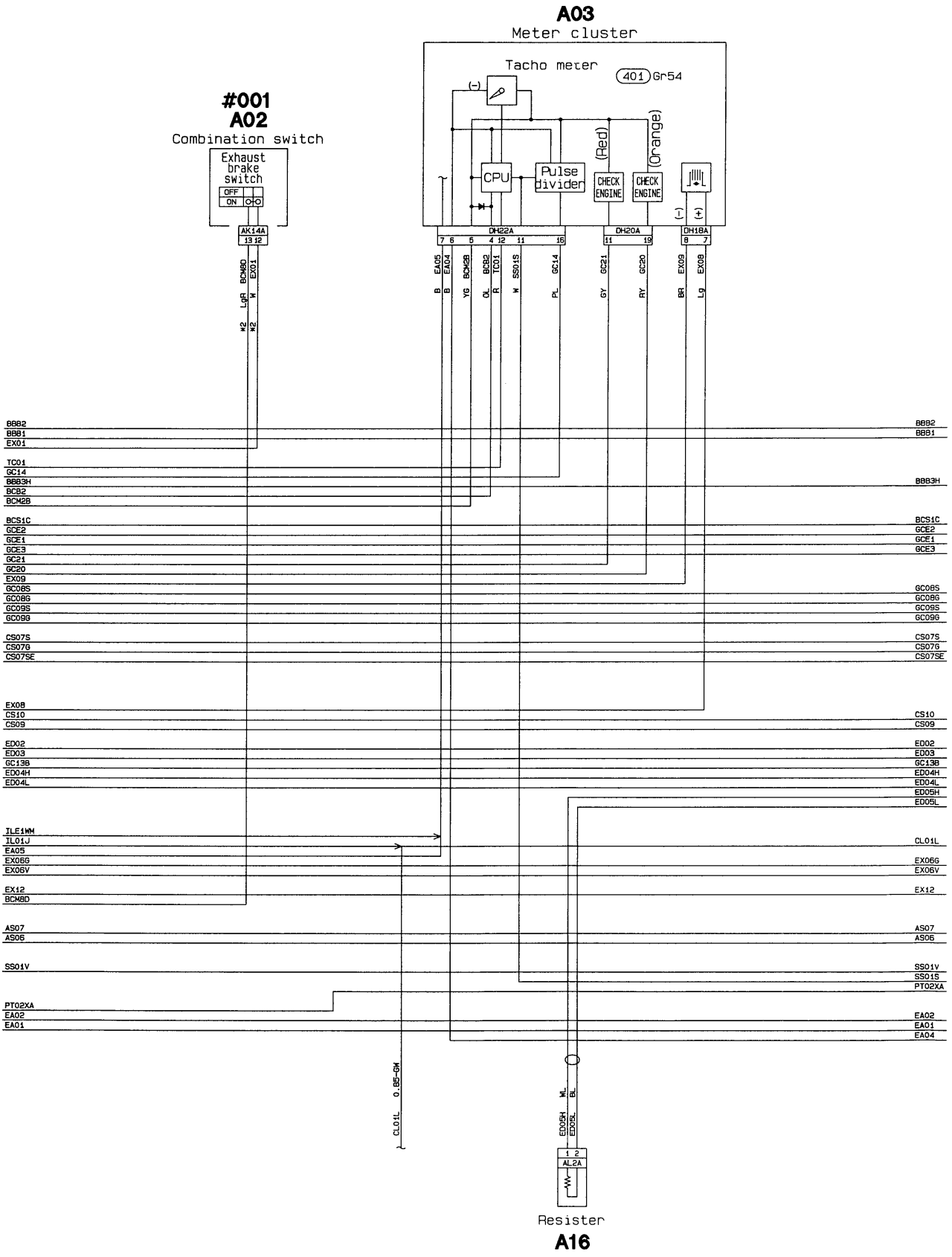
ELECTRIC CIRCUIT DIAGRAM




A10 Engine ECU
GE96A
GE58A
A16a
PTO SWITCH
STARTER SAFETY RELAY (+)
DIAG SWITCH
TORQUE CUT SWITCH 2
STATER SAFETY RELAY(-)
G ADJUSTMENT RESISTOR (GND)
G ADJUSTMENT RESISTOR (SIG)
EXHAUST BRAKE M/V(+)
IDLE VOLUME (GND)
IDLE VOLUME (SIG)
IDLE VOLUME (+5V)
EXHAUST BRAKE M/V (-)
ENGINE SPEED SENSOR(-)
ENGINE SPEED SENSOR(+)
BOOST AIR TEMP SENSOR (GND)
BOOST AIR TEMP SENSOR (SIG)
COOLANT TEMP SENSOR(GND)
COOLANT TEMP SENSOR (SIG)
VEHICLE SPEED SENSOR (SIG)
TACHOMETER(SIG)
NEUTRAL SWITCH
PTO MAX.REV.SET(SIG)
PTO MAX.REV. SET (GND)
ACCEL SWITCH
STARTER SWITCH (M)
NE OUT (SIG)
ACCEL SENSOR 2 (GND)
ACCEL SENSOR 2 (+5V)
ACCEL SENSOR 1 (GND)
ACCEL SENSOR 1 (+5V)
ACCEL SENSOR 1 (SIG)
ACCEL SENSOR 2 (SIG)
STARTER SWITCH (S)
ECU POWER (VB)
K-LINE 1
COLD START SWITCH
MEMORY CLEAR SWITCH
EXHAUST BRAKE SWITCH
ECU POWER (VB)
STARTER SWITCH (M)
A/C SWITCH
DIAG LAMP (ORANGE)
DIAG LAMP (RED)
EXHAUST BRAKE LAMP
CAN2 (L)
CAN2 (H)
EDU RELAY (+)
EDU RELAY (-)
EDU POWER (+VB)
GND
GND
GND
CLUTCH SWITCH
EX03
GC23MB
GC23D
EX01
BCM9X
TC01
GC14
BCM9X
BCM2B
BCM8E
GCE2
GCE1
GCE3
GC21
GC20
EX09
GC08S
GC08G
GC09S
GC09G
CS07S
CS07G
CS07SE
ST02
BCM2A
CS10
EX05
ED02
ED03
GC13B
ED04H
ED04L
ST01
WM02X
MT01KB
MT01KC
PT02XA
GC04A
GC04B
EX06G
EX06V
PT02
IL01J
AN39
IL03
SS01V
PT02XA
EX05AT
EX05AT
To AT ECU Gr23
Fuel injection rate abjustment resistor
A23 #828
Idling speed abjustment potentiometer
A18 #157
Joint connector (J/C-3)
905 Gr54
A11
A30
130
Gr54
Power take-off resistor
A19 #828
Accelerator pedal position sensor
A20 #324
C00460-2

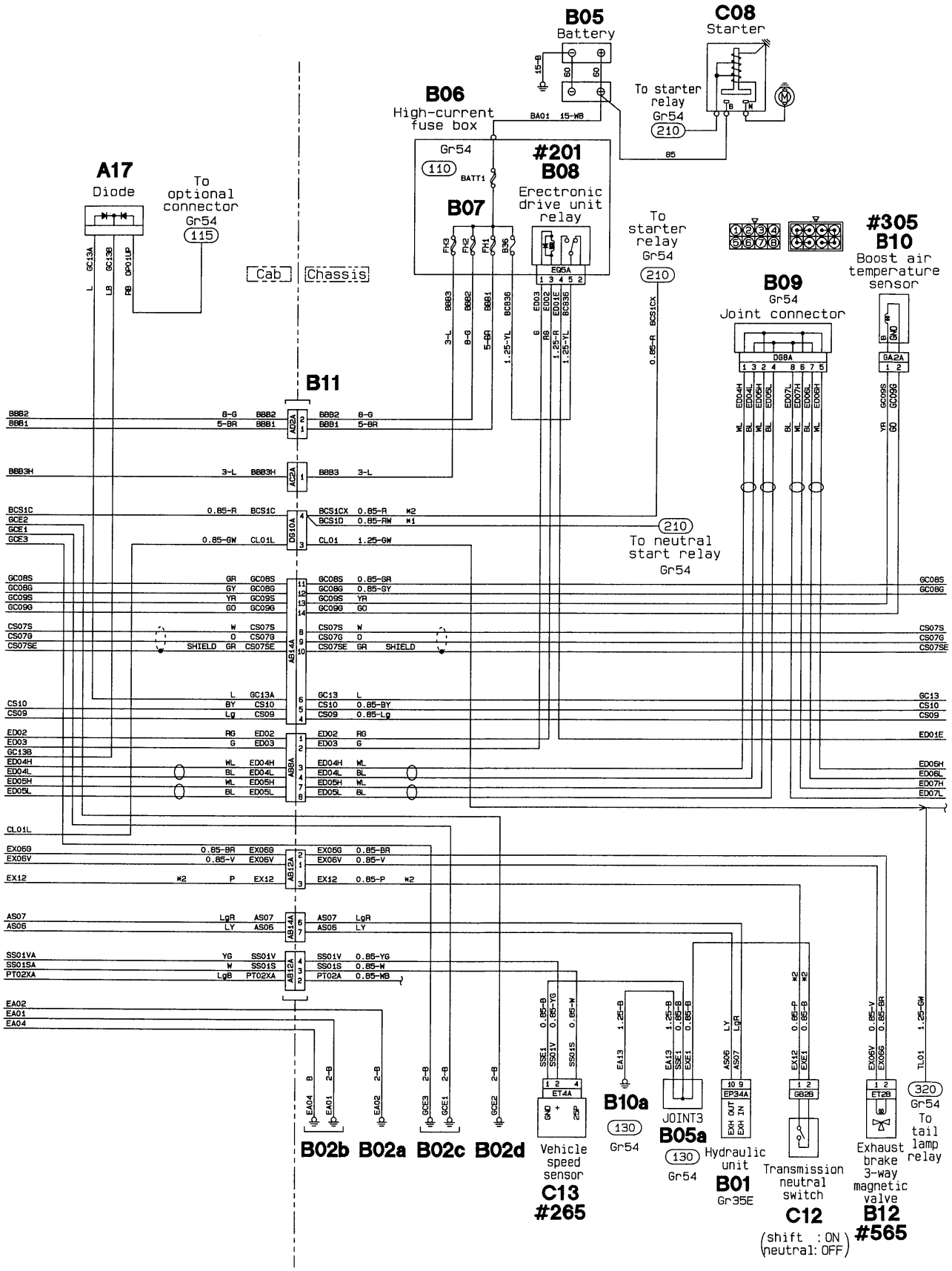
ELECTRIC CIRCUIT DIAGRAM



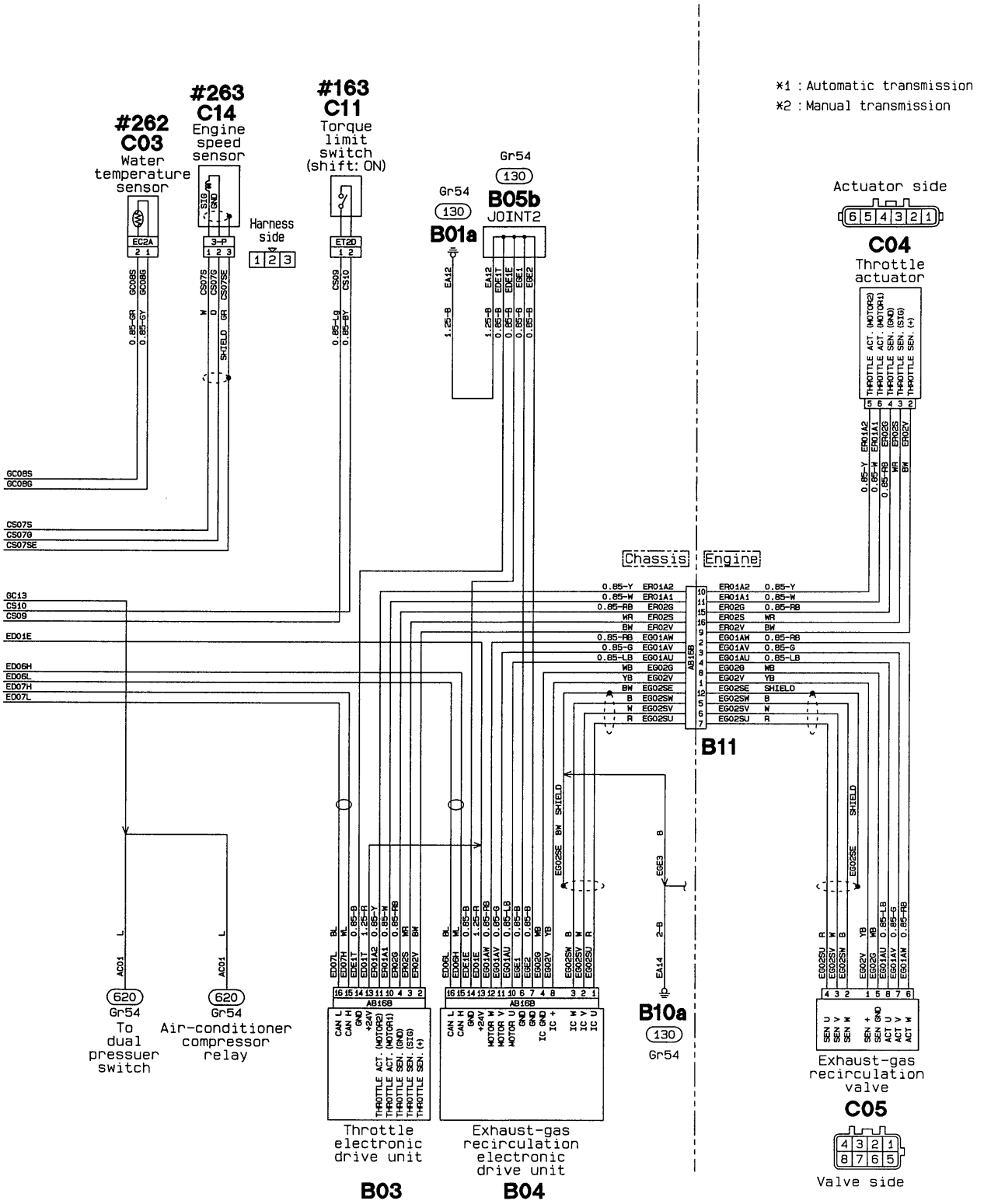

A03
Meter cluster
Tacho meter
401 Gr54
#001
A02
Combination switch
Exhaust brake switch
OFF
ON
AK14A
13 12
CPU
Pulse divider
CHECK ENGINE
CHECK ENGINE
(Red)
(Orange)
DH22A
DH20A
DH18A
BBB2
BBB1
EX01
TC01
GC14
BBB3H
BCB2
BCM2B
BCS1C
GCE2
GCE1
GCE3
GC21
GC20
EX09
GC08S
GC08G
GC09S
GC09G
CS07S
CS07G
CS07SE
EX08
CS10
CS09
ED02
ED03
GC13B
ED04H
ED04L
ED05H
ED05L
ILE1WM
IL01J
EA05
EX06G
EX06V
EX12
BCM8D
AS07
AS06
SS01V
SS01S
PT02XA
EA02
EA01
EA04
CL01L
O.BS-GW
EDOGH
EDOGL
WL
BL
AL2A
1W
Resister
A16

C00460-4

ELECTRIC CIRCUIT DIAGRAM



C00460-5


*1 : Automatic transmission
*2 : Manual transmission
#262
C03
Water temperature sensor
#263
C14
Engine speed sensor
#163
C11
Torque limit switch (shift: ON)
Harness side
Gr54
130
B01a
Gr54
130
B05b
JOINT2
Actuator side
C04
Throttle actuator
Chassis
Engine
B11
B10a
Gr54
130
620
Gr54
To dual pressuer switch
620
Gr54
Air-conditioner compressor relay
Throttle electronic drive unit
B03
Exhaust-gas recirculation electronic drive unit
B04
Exhaust-gas recirculation valve
C05
Valve side

C00460-6

GROUP 14 INDEX

SPECIFICATIONS 14-2

STRUCTURE AND OPERATION
1. Cooling System (Flow of Coolant) 14-4
2. Thermostat 14-5
3. Water Pump 14-5

TROUBLESHOOTING 14-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Coolant Replacement and Cleaning of Cooling System 14-8
2. Air Bleeding of Cooling System 14-10
3. Air/Gas Leakage Test 14-10

DISCONNECTION AND CONNECTION OF HOSES AND PIPES ... 14-12

RADIATOR 14-16

COOLING FAN, V-BELT AND WATER PUMP 14-24

TENSION PULLEY 14-27

THERMOSTAT 14-30

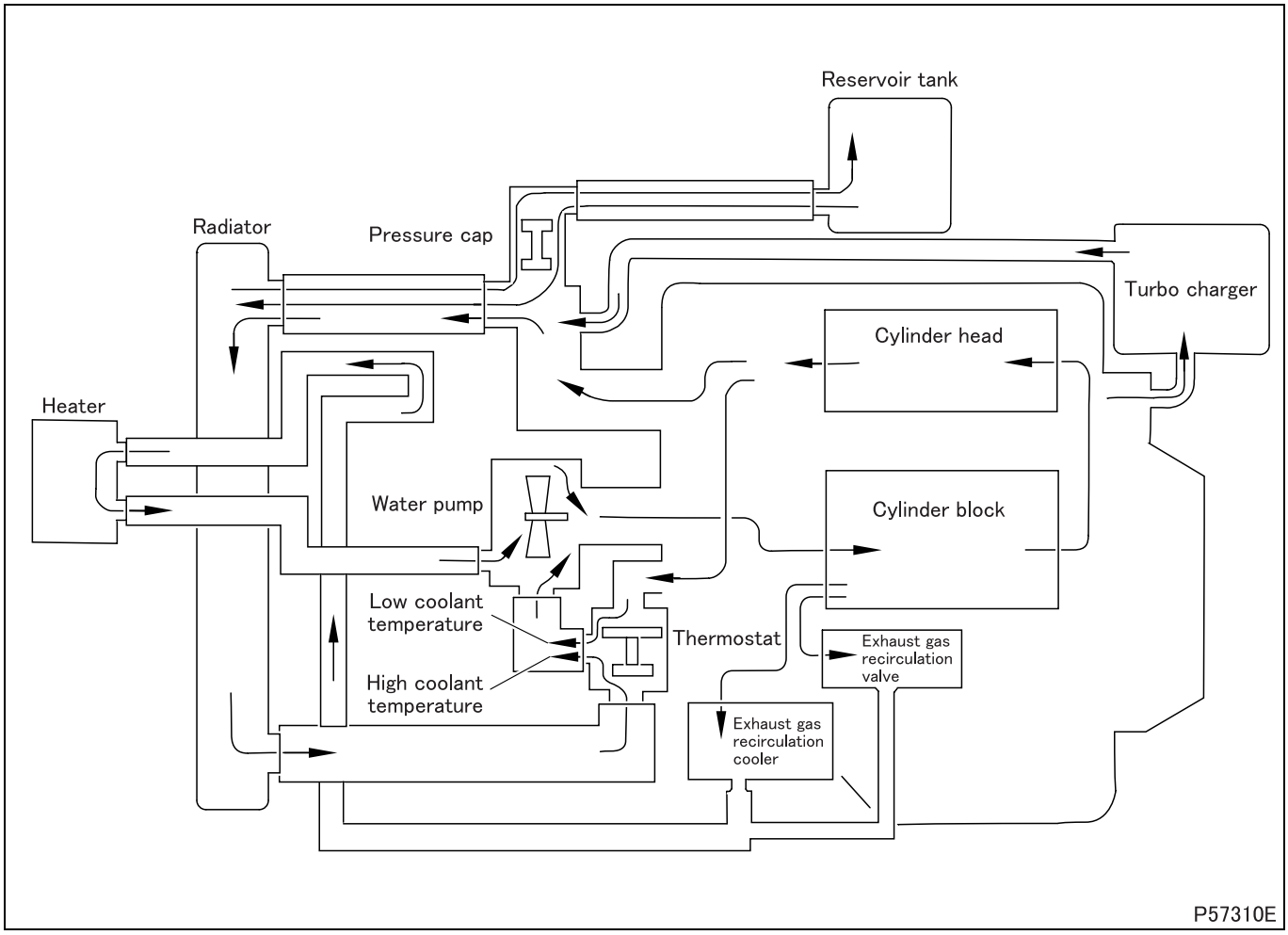
PRESSURE CAP AND WATER OUTLET CASE 14-32

SPECIFICATIONS

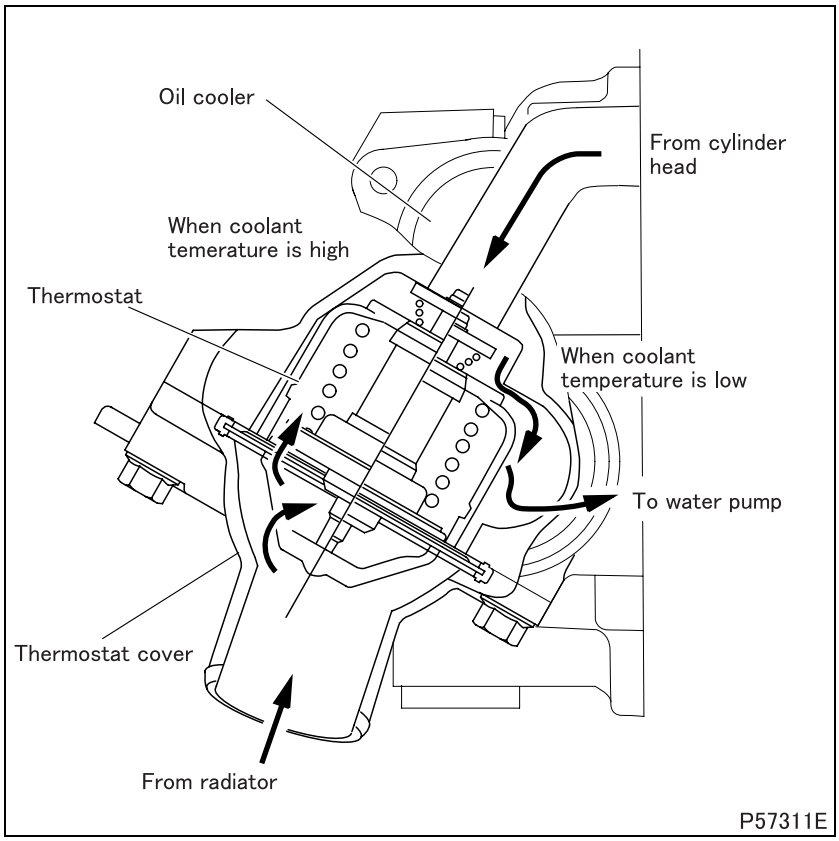
Item	Specifications
Cooling system	Forced water circulation system
Water pump	Belt-driven involute type
Thermostat	Wax pellet, bottom bypass type (with jiggle valve)
Automatic cooling fan coupling	Continuous control type
Radiator	Tube and corrugated fin type
Coolant capacity L {qts}	16.0 {17}

M E M O

1. Cooling System (Flow of Coolant)

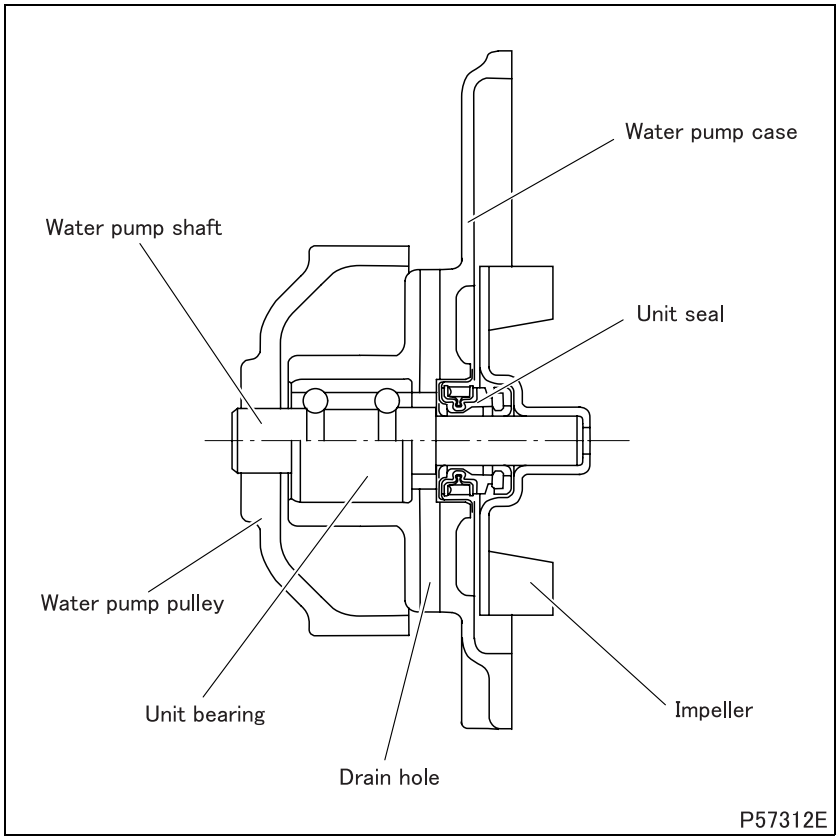


2. Thermostat



- It is a bottom bypass type that uses a wax-filled pellet as its flow-regulating element. When the wax is heated, it melts from solid to liquid, changing its total volume. This allows the valve to open or close in accordance with the coolant temperature, regulating and adjusting the flow of coolant to the radiator and to the cylinder head (bypassing the radiator).

3. Water Pump



- The water pump has a drain hole to prevent coolant from entering the unit bearing in the case of defect of the unit seal.

Possible causes \ Symptoms		Overheating (poor cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Reference Gr
V-belt	Loose or damaged	O		O		
	Excessive tension			O		
	Oil on belt	O				
Water pump	Incorrectly mounted water pump	O			O	
	Defective gasket	O			O	
	Defective unit bearing	O		O		
	Defective impeller	O				
	Defective unit seal	O			O	
	Too loose fit of unit bearing on flange and impeller	O		O		
Thermostat	Incorrectly mounted case	O			O	
	Valve opening temperature too high (valve remains closed)	O				
	Valve opening temperature too low (valve remains open)		O			
Radiator	Clogged core	O				
	Cracked core and/or separation in welds	O			O	
	Cracks in upper tank and/or lower tank	O			O	
	Poor clinching of upper tank and/or lower tank	O			O	
	Defective packing of upper tank and/or lower tank	O			O	
Automatic cooling fan coupling	Defective bearing	O		O		
	Damaged bimetal	O				
	Contaminated bimetal	O	O			
	Silicon oil leakage	O		O		
Cylinder head	Incorrectly mounted cylinder head	O			O	Gr11
	Defective gasket	O			O	
Oil cooler	Incorrectly mounted oil cooler	O			O	Gr12
	Defective gasket	O			O	
	Leakage from coolant temperature sensor	O			O	
Exhaust gas recirculation system	Poor installation of exhaust gas recirculation cooler bracket	O			O	Gr17
	Poor installation of exhaust gas recirculation cooler	O			O	
	Poor installation of connectors	O			O	
	Poor installation of adapter	O			O	
	Damaged O-rings	O			O	

Possible causes \ Symptoms		Overheating (poor cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Reference Gr
Breather cover	Poor installation of breather cover	O			O	Gr17
	Poor installation of gaskets	O			O	
	Damaged O-rings	O			O	
Poorly airtight pressure cap		O				
Insufficient coolant amount		O				
Clogged or scaled coolant passage		O				
Incorrectly connected hoses		O			O	
Poor installation of pipes		O			O	
Excessively low exterior temperature			O			

1. Coolant Replacement and Cleaning of Cooling System

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

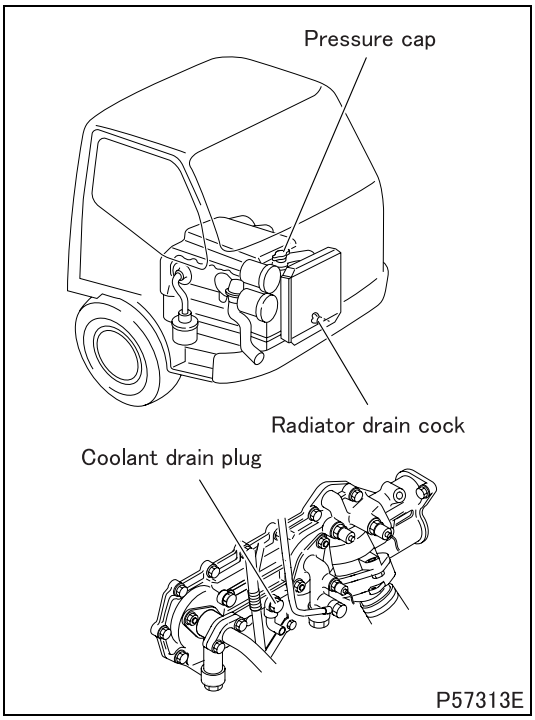
Mark	Parts to be tightened	Tightening torque	Remarks
–	Radiator drain cock	15 ± 0.3 {1.1 ± 0.2, 0.15 ± 0.03}	–
–	Water drain plug	24.5 ± 4.9 {18 ± 3.6, 2.5 ± 0.5}	–

- Using the radiator for extended periods of time without cleaning can increase chance of rust and scale formation, which may cause engine overheating. The cooling system must be cleaned periodically.

NOTE

- **Coolants containing longlife coolant require replacement every two years. This replacement interval can be extended to a maximum of six years by adding longlife coolant additive to the coolant once every year for the four years following the first two-year limit. For instructions on the use of this product, refer to the Owner's Handbook.**

1.1 Draining of coolant



- Before draining the coolant, loosen the pressure cap to reduce the pressure in the cooling system. Remember to drain the coolant out of the reservoir tank as well.

WARNING ⚠

- **Drain the coolant only after it has cooled sufficiently to avoid getting scalded.**
- **Opening the pressure cap while the coolant temperature is still high can cause hot coolant to spray out. Cover the pressure cap with a cloth, and loosen it slowly to let the pressure out before opening it fully.**

1.2 Cleaning procedure

- Keep the coolant temperature at approximately 90°C {195°F} so that the thermostat valve remains open and the coolant continues to circulate in the radiator.
- For the sake of convenience you can raise the coolant temperature quickly by covering the front of the radiator with corrugated cardboard or something similar.
- Set the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- In cases where a great amount of rust has accumulated it often happens that as a result of cleaning the radiator starts leaking. Conduct a thorough check for leakage after cleaning.
- Soft water to be used should have the following properties.

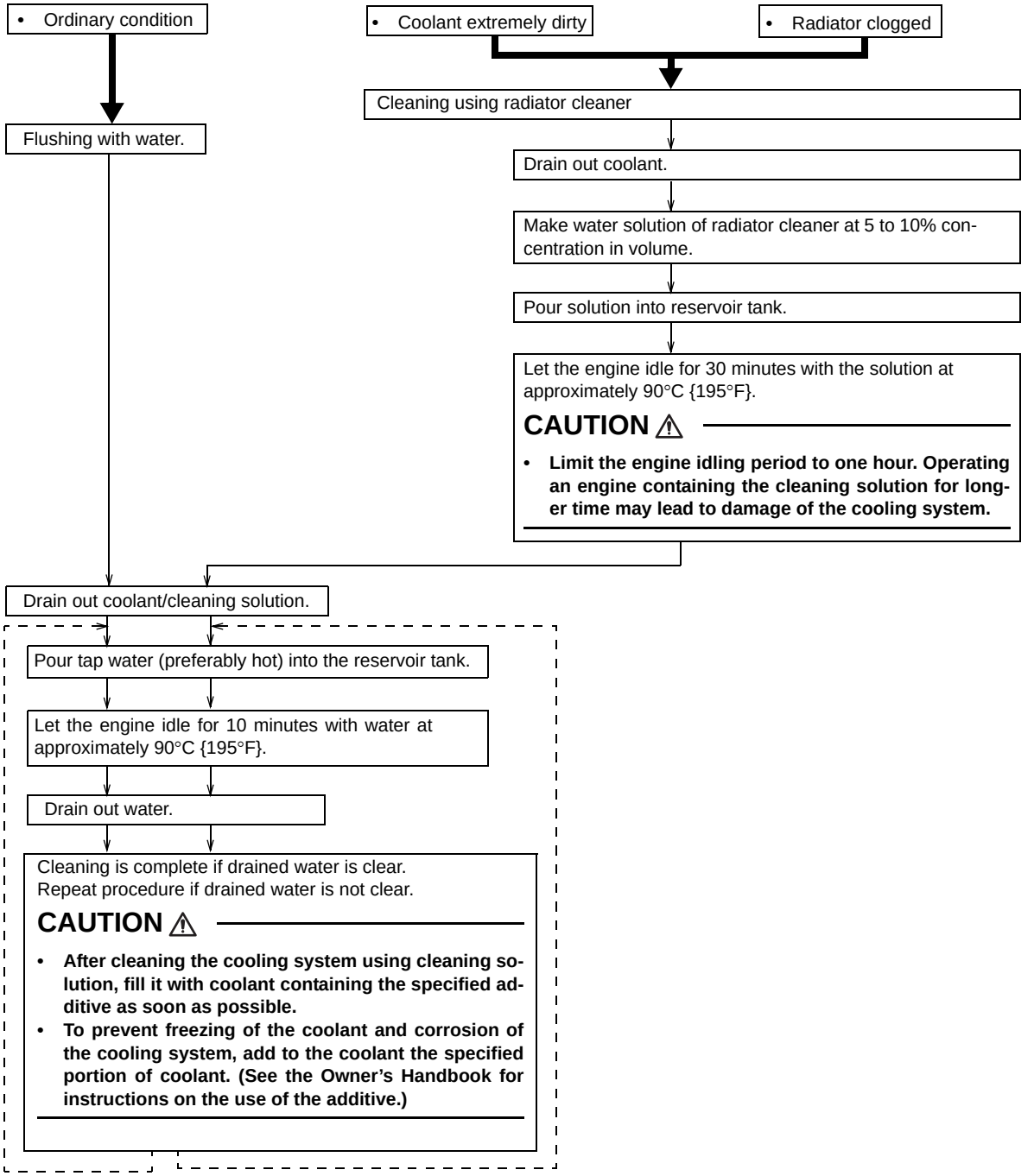
CAUTION ⚠

- **Do not use hard water as it causes scale and rust.**

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^-	100 ppm or less
Chloride Cl^-	100 ppm or less
Total dissolved solids	500 ppm or less
pH	6 to 8

- Select an appropriate cleaning method according to the condition of the cooling system as shown below.



DANGER ⚠

- **If you accidentally splash coolant or antirust treatment products in your eyes, wash it out immediately with water and seek medical attention.**

WARNING ⚠

- **Coolant is flammable. Keep them away from heat and flames.**

2. Air Bleeding of Cooling System

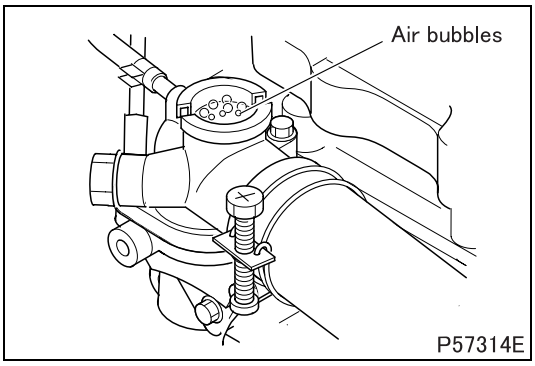
- With the pressure cap removed and the coolant temperature at 90°C {195°F}, let the engine idle in order to bleed air completely out of the cooling system.
- After air bleeding is completed, refill the reservoir tank with coolant as needed.

3. Air/Gas Leakage Test

- Presence of air or exhaust gas in coolant accelerates corrosion of the cooling system components. To prevent this, carry out air/gas leakage tests in accordance with the following procedure.
- Remove the pressure cap.

WARNING ⚠

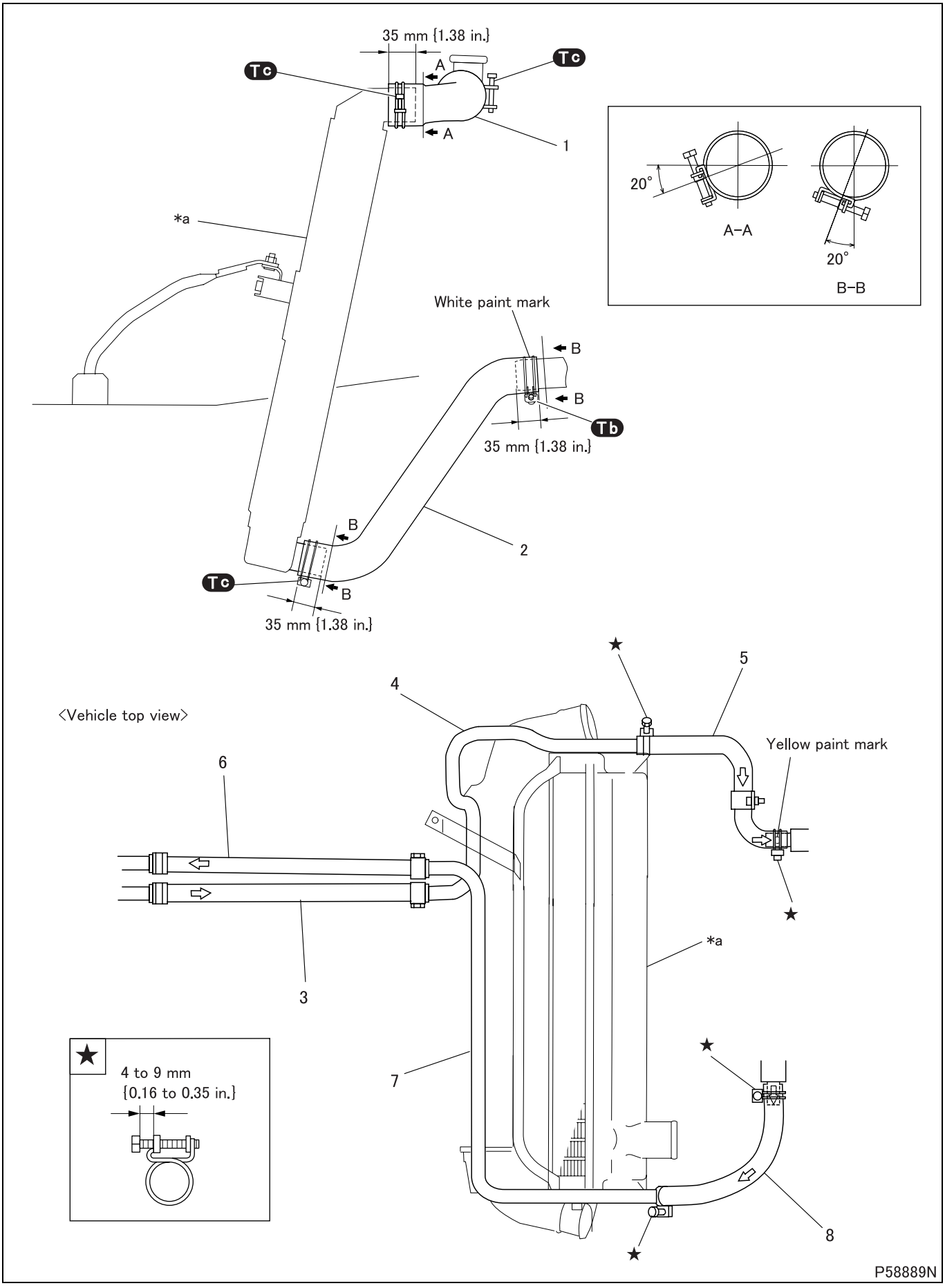
- **If the engine is hot, boiling coolant may spurt out from the filler port when the pressure cap is loosened. To avoid a scold, make sure to remove the pressure cap only when the coolant is cold.**



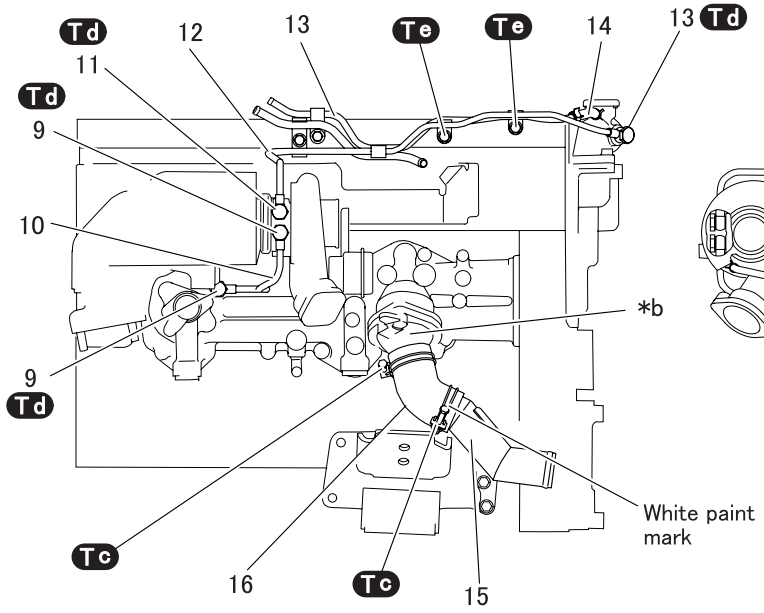
- Run the engine until the coolant temperature rises to approximately 90°C {195°F}.
- If air bubbles appear continuously through the filler port, there is air or exhaust gas penetrating into the cooling system.
- Presence of air in coolant can be an indication of loose cylinder head bolts, loose water pump mounting bolts, loose hose connections, and/or a damaged hose.
- Presence of exhaust gas in coolant can be an indication of a damaged cylinder head gasket and/or cracks in the cylinder head.

M E M O

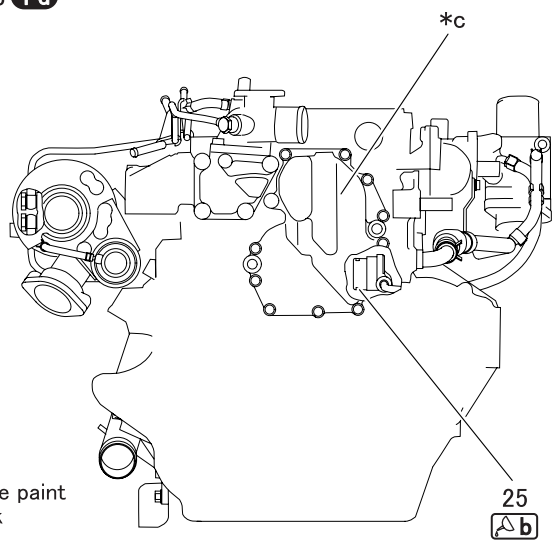
DISCONNECTION AND CONNECTION OF HOSES AND PIPES



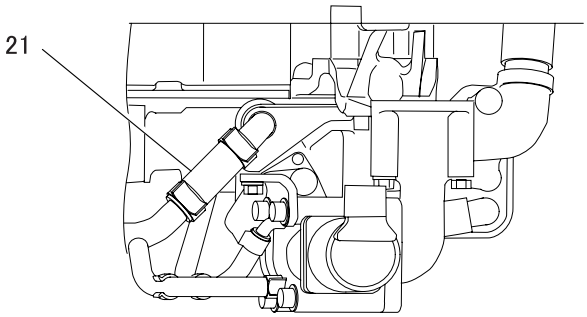
<Engine right side view>



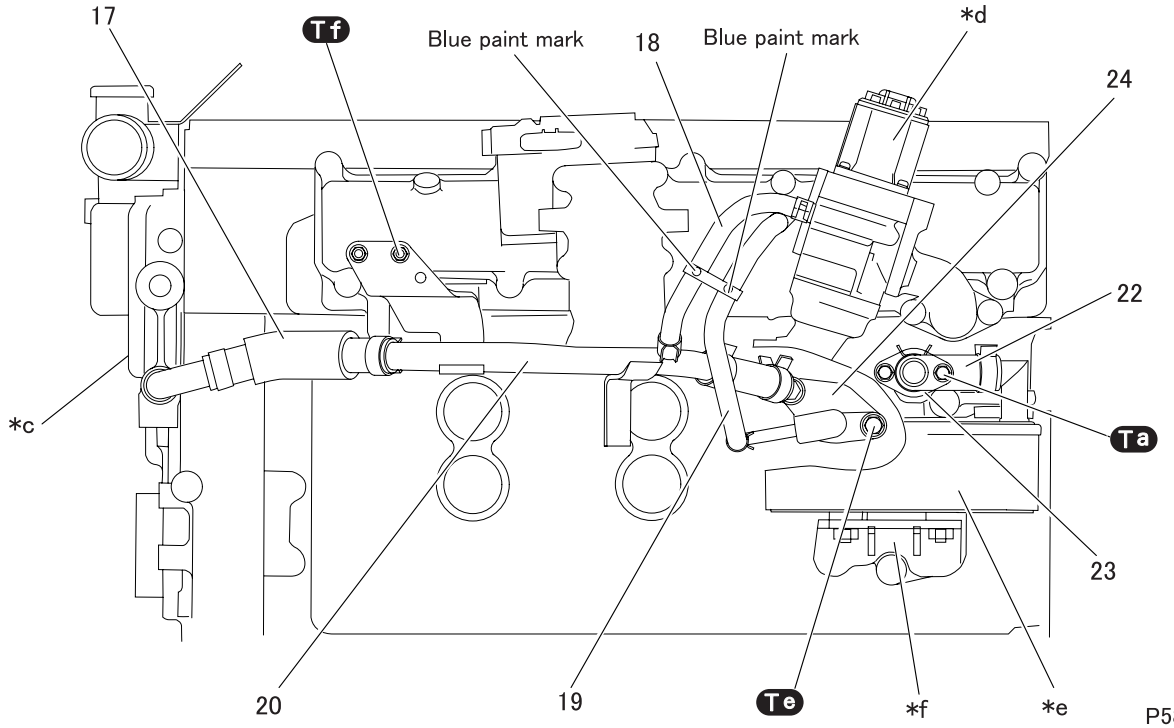
<Engine front view>



<Engine top view>



<Engine left side view>



P58890E

DISCONNECTION AND CONNECTION OF HOSES AND PIPES

● Removal sequence

1 Upper radiator hose
2 Lower radiator hose
3 Heater hose
4 Heater pipe
5 Heater hose
6 Heater hose
7 Heater pipe
8 Heater hose
9 Eyebolt
10 Water pipe
11 Eyebolt
12 Water and vacuum pipe
13 Water pipe
14 Water hose
15 Water pipe
16 Water hose
17 Water hose
18 Water hose
19 Water hose
20 Water pipe
21 Water-out hose
22 Water-in hose
23 Connector
24 Adapter
25 O-ring

∗a: Radiator
∗b: Thermostat cover
∗c: Breather cover
∗d: Exhaust gas recirculation valve
∗e: Exhaust gas recirculation cooler
∗f: Exhaust gas recirculation cooler bracket
⊗: Non-reusable parts

● Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **Install each hose clamp to the angle indicated in the illustration so that sufficient clearance is assured between the hose clamp and its surrounding parts.**
- **Keep the O-ring free of engine oil. Engine oil will make the O-ring swell, which may cause leakage.**

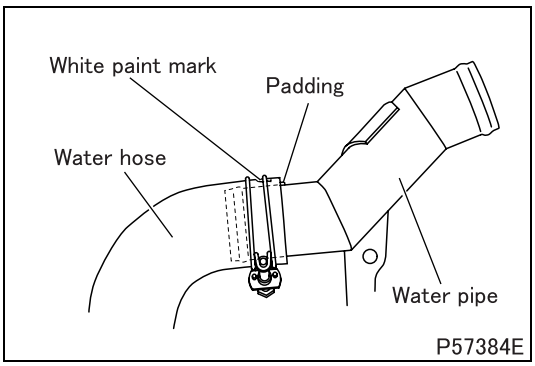
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (connector mounting)	8 {5.9, 0.82}	–
Tb	Clamp	1.5 to 2.0 {1.1 to 1.5, 0.15 to 0.2}	Wet
Tc	Clamp	3.0 to 4.5 {2.2 to 3.3, 0.3 to 0.5}	–
Td	Eyebolt (water pipe mounting)	25.5 {19, 2.6}	–
	Eyebolt (water and vacuum pipe mounting)		
Te	Bolt (water and vacuum pipe mounting)	23.2 {17, 2.4}	–
	Bolt (water pipe mounting)		
	Bolt (adapter mounting)		
Tf	Nut (water pipe mounting)	4.9 {3.6, 0.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
La	Clamp screw threads	Engine oil	As required
Lb	O-ring	Soapy water	As required

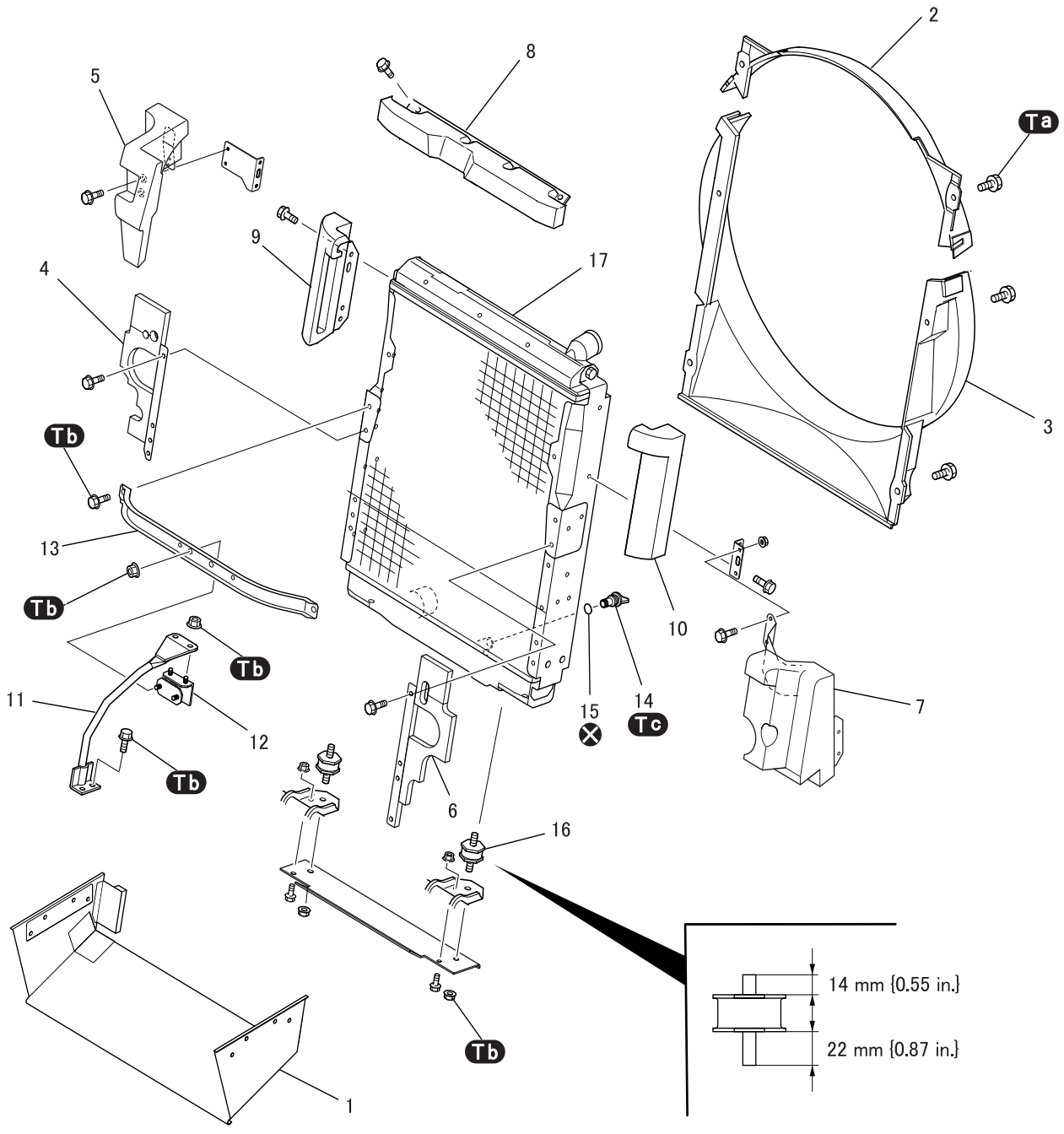
◆Installation procedure◆



■ Installation: Water hose

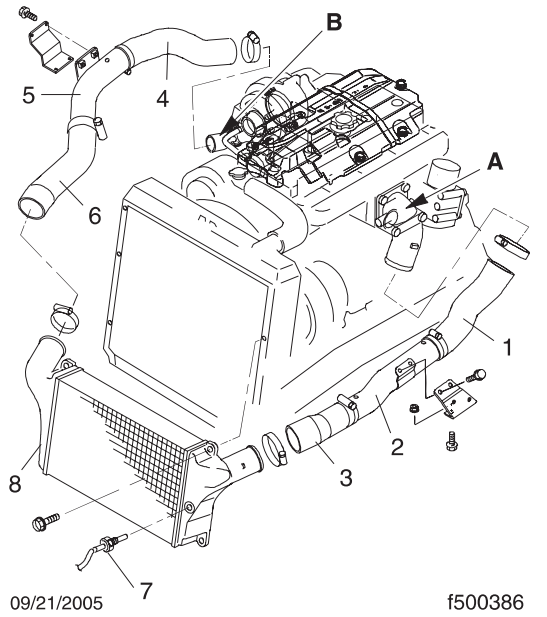
- Install the water hose with the white mark on its end aligned with the padding on the water pipe.

RADIATOR



1 Air scoop
2 Upper shroud
3 Lower shroud
4 Baffle plate RH
5 Baffle plate RH
6 Baffle plate LH
7 Baffle plate LH
8 Baffle plate upper
9 Baffle plate RH
10 Baffle plate LH
11 Support rod
12 Support cushion
13 Upper support
14 Radiator drain cock
15 O-ring
16 Support cushion
17 Radiator
(See later section.)

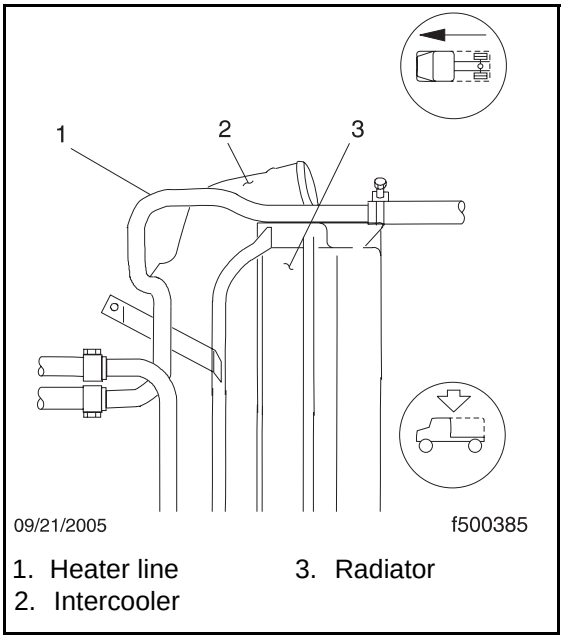
⊗: Non-reusable parts



1. Air inlet hose
2. Air inlet pipe LH
3. Air inlet hose
4. Air inlet hose
5. Air inlet pipe RH
6. Air inlet hose
7. Intake temperature sensor
8. Intercooler

A Air inlet duct

B Turbocharger coupler



1. Heater line
2. Intercooler
3. Radiator

NOTE: The radiator and intercooler must be removed as an assembly then separated as needed.

1. Park the vehicle on a level surface, set the parking brake, chock the tires, and shut down the engine.
2. Tilt the cab.

WARNING ⚠

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

3. Remove the radiator cap and drain the coolant.
4. Remove the air hose (#4) from turbo inlet. See illustration.
9. Detach the metal air inlet pipe (#5) from the support bracket.
10. Remove the air inlet air hose (#6) from intercooler.
11. Remove the air inlet hose (#1) from the intake manifold.
12. Remove the metal air inlet pipe (#2) from the support bracket.
13. Remove the air inlet hose (#3) from the intercooler.
14. Disconnect the connector for the intercooler temp sensor. Remove the temperature sensor from intercooler.
15. Remove the air scoop.
16. From under the truck, remove the following pieces from the radiator:
    - Baffle plate RH (#5) See illustration.
    - Baffle plate RH (#9)
    - Baffle plate LH (#10)
    - Baffle plate LH (#7)
    - Support rod (#11)
    - Upper support (#13)
    - A/C line support bracket (lower right side).
17. Disconnect the heater line that goes around the lower right side of radiator. See illustration.
18. Disconnect the upper radiator hose.
19. Disconnect the lower radiator hose.
20. Disconnect any heater hose or A/C line support brackets in front of radiator.
21. Remove the upper fan shroud.
22. Remove the lower fan shroud.
23. Remove the two nuts securing the radiator to the frame crossmember.
24. Remove the radiator and intercooler.
25. Remove the intercooler from radiator. Keep track of the brackets sandwiched between the intercooler and radiator.

● Installation sequence

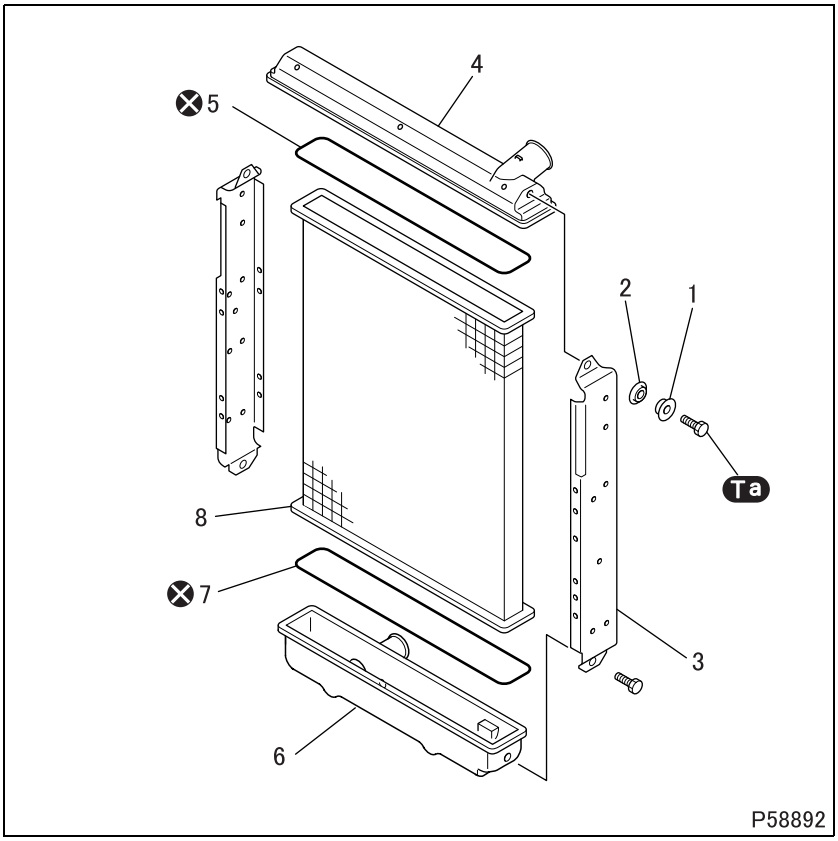
1. Install the intercooler onto the radiator. Make sure the correct brackets are installed between intercooler and radiator.
2. Install the radiator and intercooler into the truck.
3. Align the radiator mounting studs with holes in the frame crossmember. Install, but do not tighten, the nuts at this time.
4. Install the lower fan shroud.
5. Install the upper fan shroud.
6. Attach the heater tube to the lower right side of the radiator. Attach the heater hoses to the tube. See illustration.
7. Install the AC line support bracket on the lower right side of the radiator.
8. **NOTE:** From this point on, install fasteners but do not tighten until all support brackets are installed.
9. Install the hoses from the turbo to the intercooler. See illustration.
10. Attach the metal air inlet pipe #5 to the support bracket.

11. Install the RH baffle plates. See illustration.
12. Install the hoses from the intercooler to the intake manifold.See illustration.
13. Fasten the metal air inlet pipe #2 to the support bracket.
14. Install the heater hose bracket to the radiator.
15. Install the LH baffle plates.
16. Install the upper support on the front of the radiator.
17. Install the support rod.
18. Install all heater hose and AC line support brackets in front of the radiator.
19. Tighten all fasteners.
20. Install the lower radiator hose.
21. Install the upper radiator hose.
22. Install the intercooler temp sensor. Attach the connector.
23. Tighten the 2 nuts that secure the radiator to the frame crossmember.
24. Install the air scoop.
25. Close the radiator drain cock.
26. Fill the system with coolant. Install the radiator cap.
27. Start the engine and check for air and water leaks.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (upper shroud mounting)	5 to 7 {3.7 to 5.2, 0.5 to 0.7}	–
	Bolt (lower shroud mounting)		
Tb	Bolt (support rod mounting)	12 to 15 {8.9 to 11, 1.18 to 1.47}	–
	Nut (support cushion mounting)		
	Bolt (upper support mounting)		
	Nut (support cushion mounting)		
Tc	Radiator drain cock	2.5 ± 0.5 {1.8 ± 0.4, 0.25 ± 0.05}	–

Radiator



● **Disassembly sequence**

1 Pipe
2 Bush
3 Side member
4 Upper tank
5 Packing
6 Lower tank
7 Packing
8 Core

⊗: Non-reusable parts

CAUTION ⚠

- **Do not disassemble the radiator unless defects are evident.**
- **Handle the upper tank and lower tank carefully, as they are made of plastic and may crack under impact.**
- **Check the number of paint marks put near the upper tank and lower tank mounting tabs. The number of paint marks corresponds to the number of times the tabs have been unbent and re-clinched. If the core has already two paint marks, replace it with a new one.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

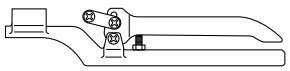
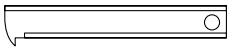
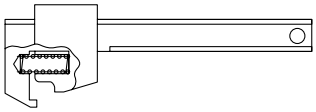
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Air leakage from radiator (air pressure 147 kPa {21 psi, 1.47 kgf/cm^2})	0 cm^3 {0 mL}	–	Repair or replace

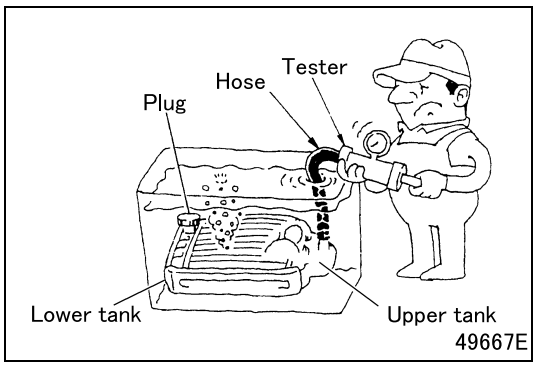
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (side member mounting)	13 {9.6, 1.3}	–

Special tools

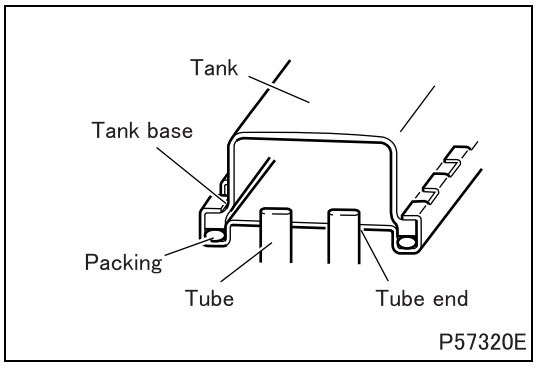
Mark	Tool name and shape	Part No.	Application
a	Overhaul handle  P51240	MH062875	Installation and removal of upper tank and lower tank
b	Claw  P51241	MH062876	
c	Punch assembly  P51242	MH062877	

◆Inspection before removal◆



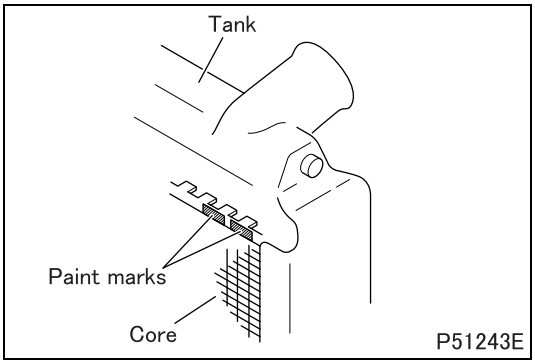
■ Inspection: Radiator air leakage

- Connect a hose and radiator cap tester to the upper tank.
- Plug the lower tank and put the entire radiator into a tank filled with water.
- Use the radiator cap tester to apply an air pressure of 147 kPa {21 psi, 1.47 kgf/cm^2} and check for air leakage.
- If air leakage is found, repair or replace the radiator.



- Replace the following parts according to the area of leakage.

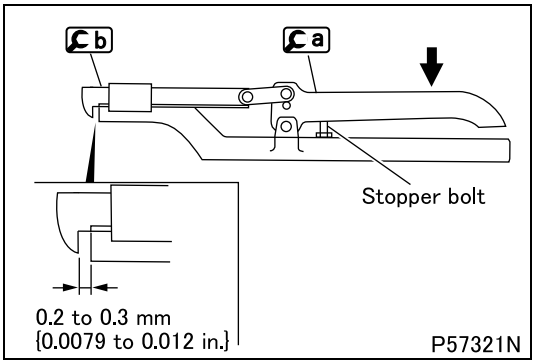
Area of leakage		Cause
Upper tank Lower tank	Tank body	Cracks in tank
	Tank base	Defective tabs Defective packing Cracks in tank
Tube body, tube ends		Cracks in tube



NOTE

- **The core may have paint marks that indicate the number of times the upper tank and lower tank mounting tabs have been unbent and re-clinched. Replace the core if it has already two paint marks.**
- **One paint mark is made every time the tabs are unbent and re-clinched. Upper tank paint marks should be counted separately from lower tank paint marks.**

◆Removal procedure◆

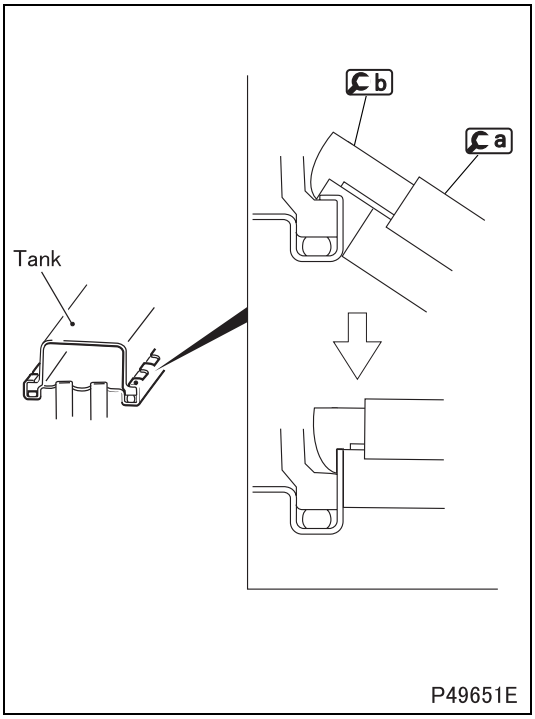


■ Removal: Upper tank and lower tank

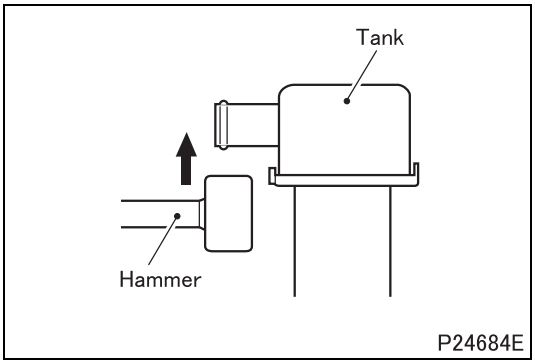
- Attach b onto a.
- Using the stopper bolt on a, adjust the jaw span of b to the dimension indicated in the illustration.

CAUTION ⚠

- **Make sure to adjust the stopper bolt before using the tools. Failure to do so may cause damage to b.**



- Using b, undo the tabs that are holding the tank in place.
- Once each tab is unbent, grip a more tightly to straighten it out completely.
- Undo all the tabs on the entire periphery of the tank, then remove the tank using the inlet hose fitting as a grip.

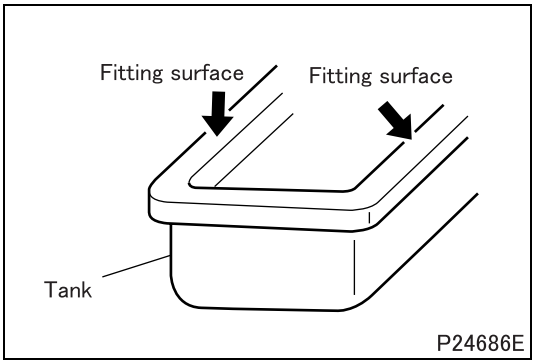


- If the tank does not come off easily, tap it lightly with a soft-face hammer (rubber or plastic hammer) to loosen it.

CAUTION ⚠

- **Handle the tanks carefully, as they are made of plastic and may crack easily under impact.**

◆Inspection procedure◆

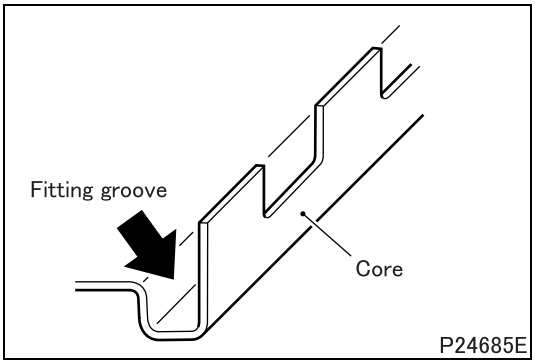


■ Inspection: Core fitting surfaces of tank

- Inspect the core fitting surfaces of the tank for any dirt or damage. If necessary, clean them thoroughly.
- Replace the tank(s) if defective.

CAUTION ⚠

- **Carry out the inspection with your bare hands to avoid putting foreign matter on the fitting surfaces.**

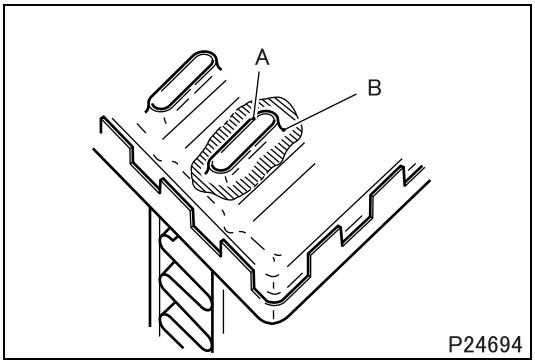


■ Inspection: Tank fitting groove of core

- Check the tank fitting groove of the core for any foreign matter or cracks.
- If foreign matter is found on the groove surfaces, lightly scrub it off with a No.1000 sandpaper taking care not to damage the surfaces, or blow it off with compressed air.
- If a crack is found on the groove surfaces, repair the crack or replace the core.

CAUTION ⚠

- **Installing a packing and tank on the core without removing foreign matter from the groove surfaces can lead to coolant leakage. Make sure to inspect the entire groove surfaces extremely carefully. Even one strand of hair is enough to cause leakage.**

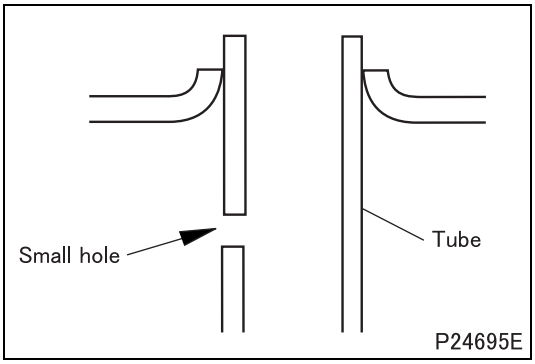


Repair of core

CAUTION ⚠

- **The following core repair procedure involves tungsten inert gas arc welding (TIG arc welding). Only personnel competent for doing this type of welding should carry out the job.**
- **Dry the core completely before performing welding. Welding wet parts could be extremely dangerous.**

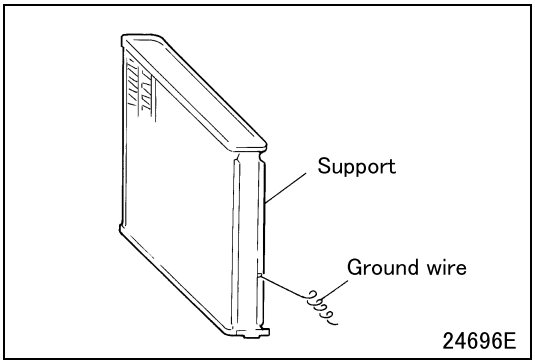
- Scrub both ends **A** of a leaky tube as well as the surrounding areas **B** of each end with a stainless wire brush. Continue scrubbing until the aluminum layer becomes exposed.



- Drill a small hole in the tube to let the air out when both ends of the tube are welded closed.

CAUTION ⚠

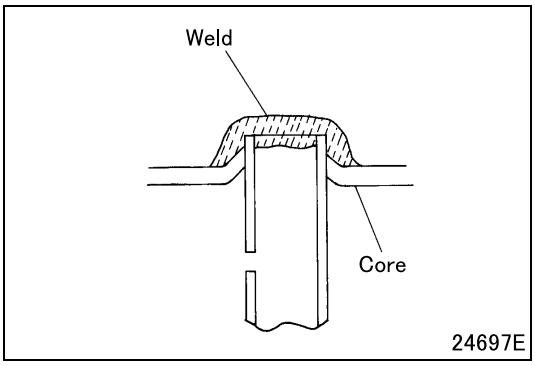
Failure to drill an air release hole in the tube may cause pinholes to form in the welds.



- Connect one of the support edges of the core to ground with a wire.

CAUTION ⚠

- **Inadequate connection of the ground wire can cause a short circuit to a part of the core, which may cause the part to melt.**

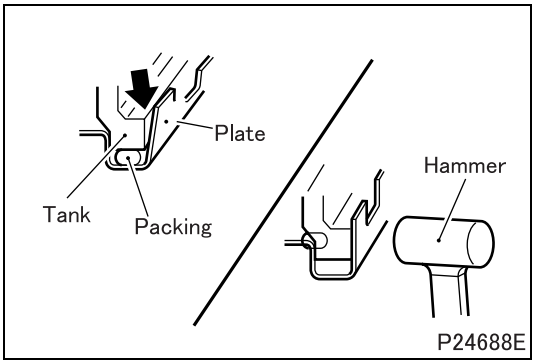


- Close both ends of the tube by TIG arc welding.
  Welding conditions
  - Welding rod: A4043
    (diameter approximately 2 mm {ϕ0.079 in.})
  - Welding current: AC80A
- After the welding is completed, check for the following defects. If any of these defects are spotted, repair the defect or replace the core.
  - Undercuts
  - Cracks in weld bead
  - Cracks in base metal

CAUTION ⚠

- **Make sure that welds are proper. Any defect in welding can lead to recurrence of leakage.**

◆Installation procedure◆

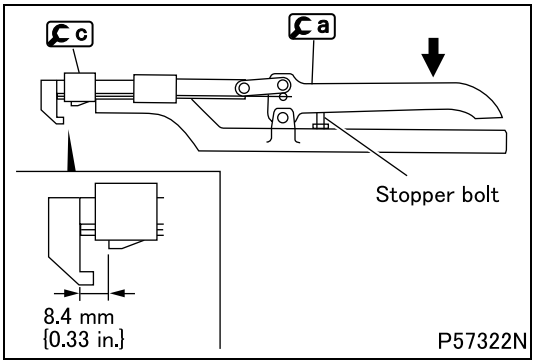


■ Installation: Upper tank and lower tank

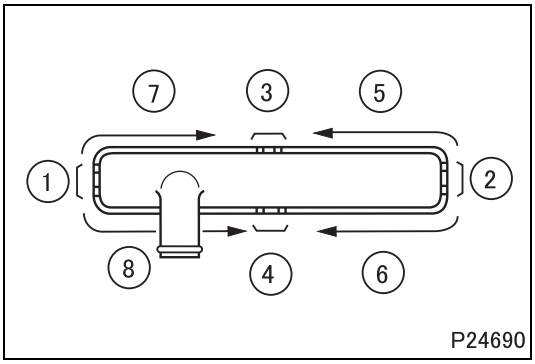
- If there is a gap between the tank and core's tank holding plate when the tank is placed in position, lightly tap the plate with a rubber or plastic hammer to eliminate the gap.

CAUTION ⚠

- **When installing the tank and packing, use your bare hands to avoid putting foreign matter on the parts.**



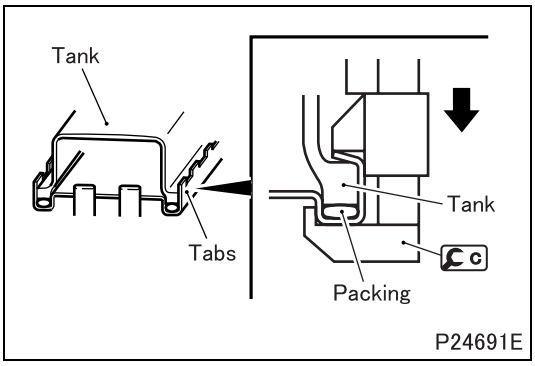
- Attach [c] onto [a].
- Using the stopper bolt on [a], adjust the jaw span of [c] to the dimension indicated in the illustration.



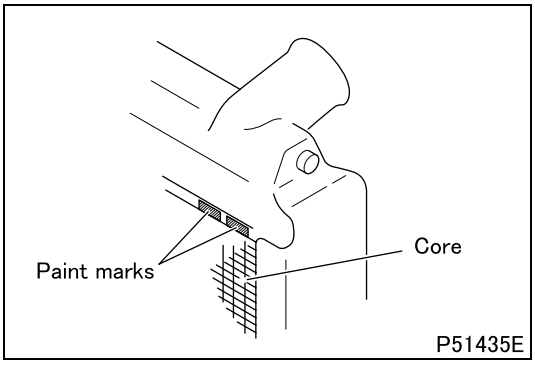
- Bend and clinch the tabs of the core over the brim of the tank in the sequence indicated in the illustration.
  1 to 4: Clinch the two tabs at the center on each side of the tank.
  5 to 8: Clinch the rest of the tabs in the order indicated by the arrows.

CAUTION ⚠

- **The tabs on sides 1 and 2 cannot be clinched using [c]. Use a pair of pliers with the noses wrapped with vinyl tape to clinch these tabs.**



- After clinching all the tabs, check for leakage.



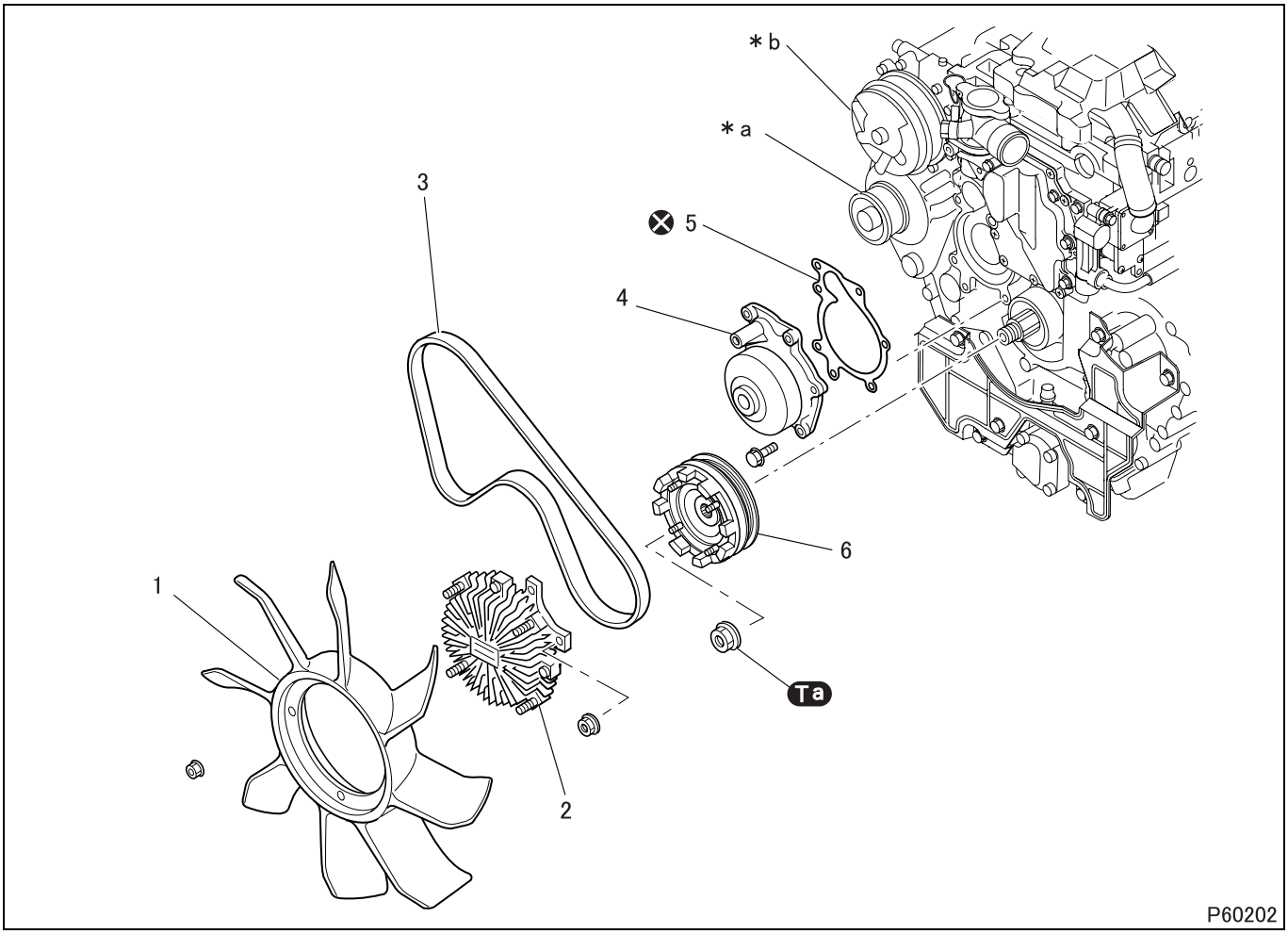
- Put a paint mark on a clearly visible area of the core to indicate the number of times the tabs have been unbent and re-clinched.

CAUTION ⚠

- **One paint mark should be made for each of the upper and lower tanks every time the tabs for it are unbent and re-clinched.**

M E M O

COOLING FAN, V-BELT AND WATER PUMP



● **Removal sequence**

1 Cooling fan
2 Automatic cooling fan coupling
3 V-belt
4 Water pump
5 Gasket
6 Fan pulley

***a**: Alternator
***b**: Compressor
<With air conditioner>
Tension pulley
<Without air conditioner>

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **The automatic cooling fan coupling and the water pump cannot be disassembled. It must be replaced if defective.**
- **Make sure that there is no oil or grease on the V-belts. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
3	V-belt tension	with air conditioner	New	7.5 to 8.5 {0.30 to 0.33}	–	Adjust
			Reused	9.5 to 10.5 {0.37 to 0.41}		
		without air conditioner	New	8 to 10 {0.31 to 0.39}		
			Reused	10 to 12 {0.39 to 0.47}		

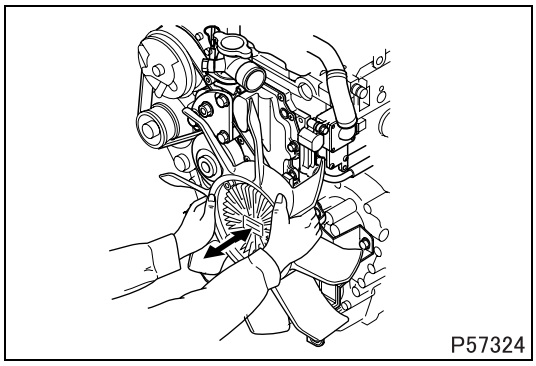
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (fan pulley mounting)	196.1 {145, 20}	–

Special tools

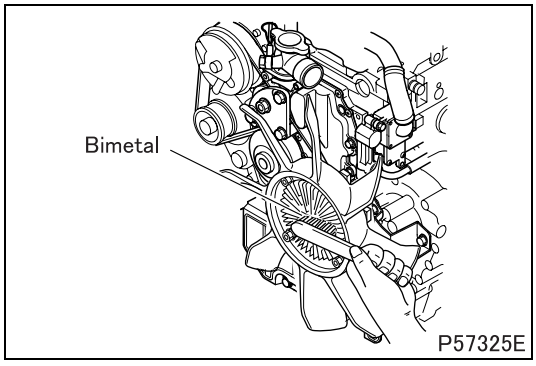
Mark	Tool name and shape	Part No.	Application
Ca	Belt tension gauge P03612	MH062345	Measurement of tension of V-belt

◆Inspection and cleaning procedure◆


P57324

■ Inspection: Automatic cooling fan coupling

- Make an inspection of the following points. Replace the automatic cooling fan coupling if defective.
  Check that:
  - the hydraulic oil sealed inside the coupling is not leaking;
  - the coupling does not make any abnormal noise or rotate unevenly due to defects in the inside bearing when rotated manually; and
  - the automatic cooling fan coupling does not move too much when pushed and pulled in the axial directions when the engine is cold.

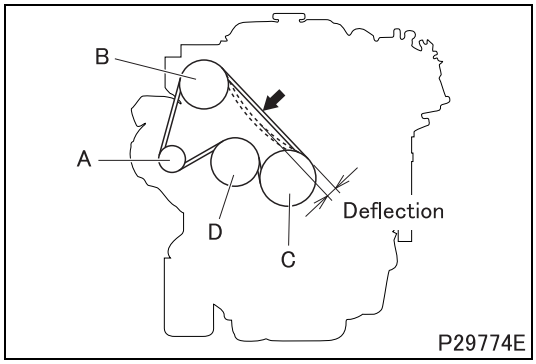


P57325E

■ Cleaning: Automatic cooling fan coupling

- When removing foreign matter from the bimetal, be careful not to press too hard against the bimetal.

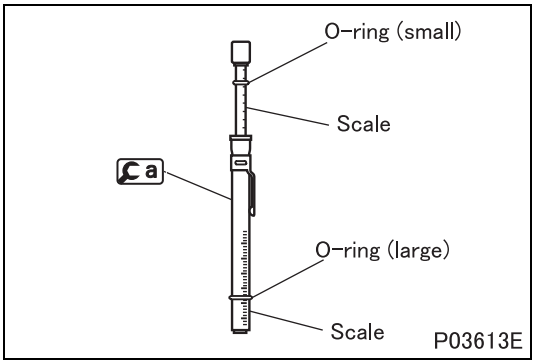
◆Inspection after installation◆



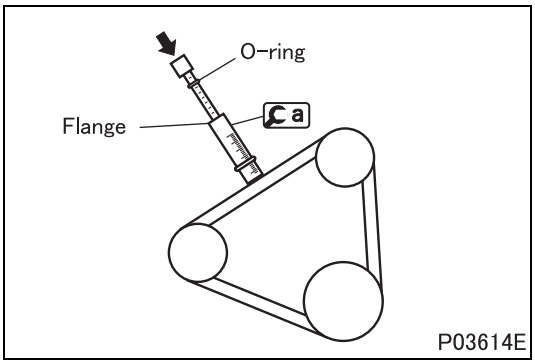
P29774E

■ Inspection: Tension of V-belts

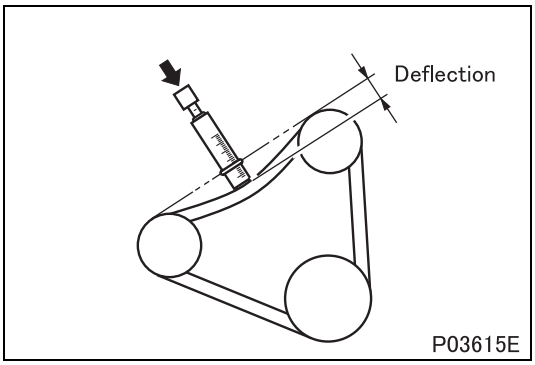
- Press each V-belt at a central portion between pulleys with a force of approximately 98 N {22 lbs, 10 kgf} as shown in the illustration and measure the amount of deflection of the belt.
  - **A:** Alternator pulley
  - **B:** Air conditioner compressor pulley or tension pulley
  - **C:** Fan pulley
  - **D:** Water pump pulley



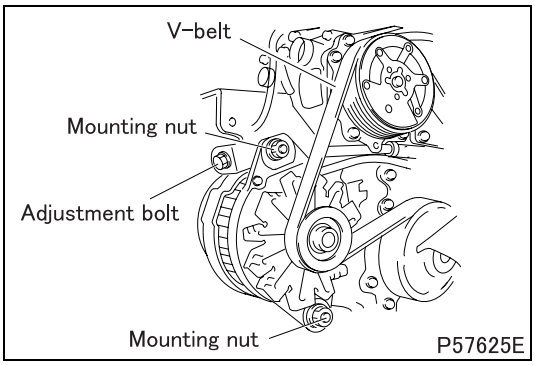
- Place the small O-ring on a at the scale mark corresponding to 98 N {22 lbs, 10 kgf} (press force).
- Place the large O-ring on a at the scale mark corresponding to the maximum permissible deflection value specified for the belt.



- Place a at a central portion between pulleys of the V-belt and push the handle (indicated by the arrow in the illustration) until the O-ring touches the flange.



- Measure the amount of deflection of the V-belt.
- If the measured value deviates from the standard value range, adjust the tension of the belt as follows.



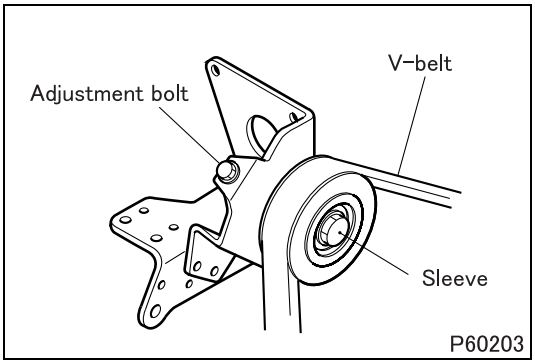
Adjustment of V-belt

(1) Vehicles with air conditioner

- Loosen the alternator mounting nuts (2 locations) and adjust the tension of the V-belt by tightening or loosening the adjustment bolt.
- After the adjustment is completed, retighten the mounting nuts firmly.

CAUTION ⚠

- **Excessive tension in the V-belt may damage not only the belt itself but also the bearings of the related components.**

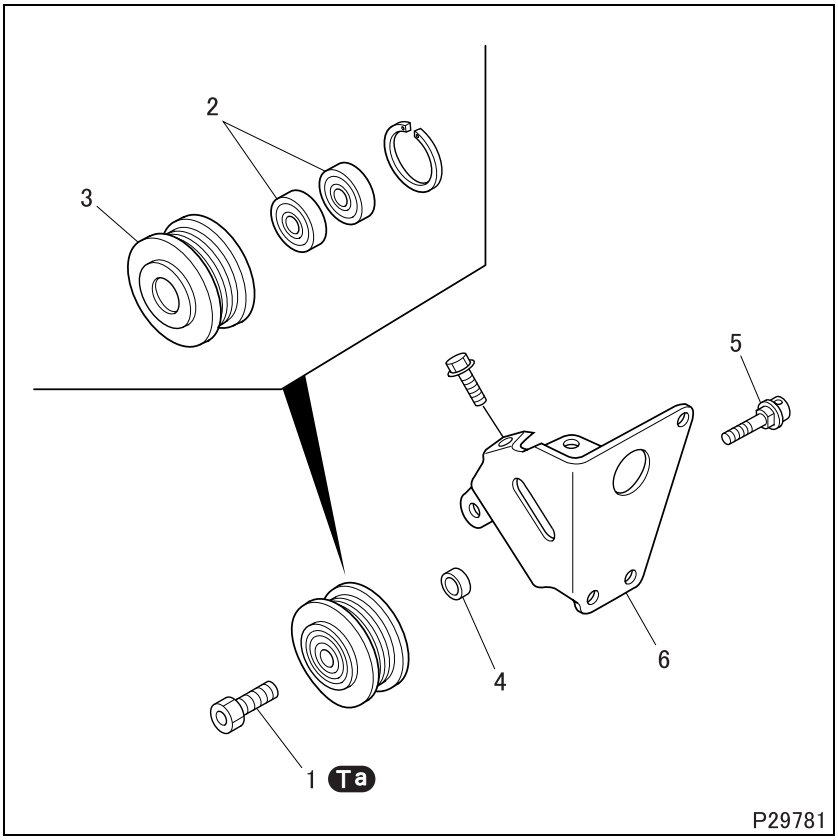


(2) Vehicles without air conditioner

- Loosen the tension pulley mounting sleeve and turn in or out the adjustment bolt to adjust the tension of the V-belt.
- After the adjustment is completed, retighten the mounting sleeve firmly.

CAUTION ⚠

- **Excessive tension in the V-belt may damage not only the belt itself but also the bearings of the related components.**



● Disassembly sequence

1 Sleeve
2 Bearing
3 Tension pulley
4 Spacer
5 Shaft
6 Tension pulley bracket

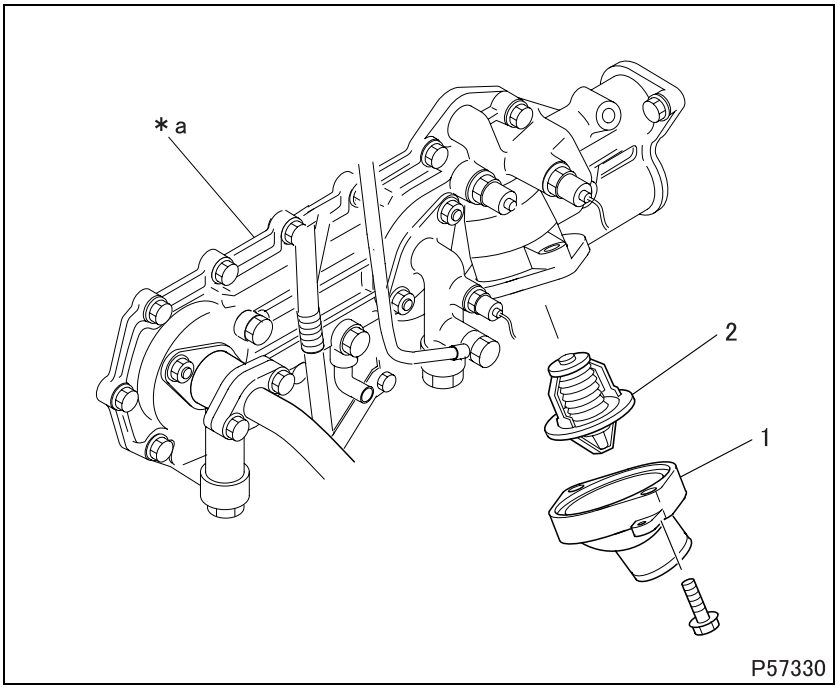
● Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Sleeve	49 {36, 5.0}	–

THERMOSTAT



● Disassembly sequence

1 Thermostat cover
2 Thermostat

***a**: Oil cooler

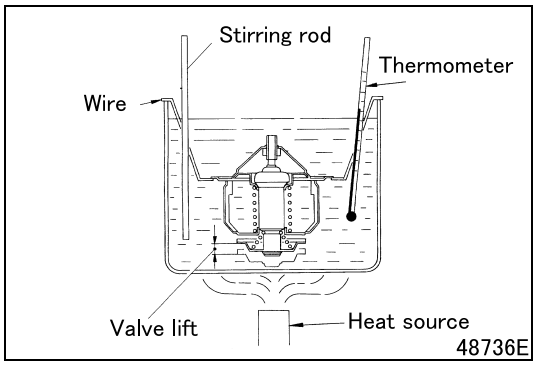
● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
2	Thermostat	Valve opening temperature	82 ± 2°C {180 ± 3.6°F}	–	Replace
		Valve lift / temperature	10 {0.39} or more / 95°C {205°F}		

◆Inspection procedure◆



■ Inspection: Thermostat

- Stir the water using a stirring rod to maintain an even water temperature in the container, then conduct the tests indicated below.
- If the measured values deviate from the standard value ranges, replace the thermostat.

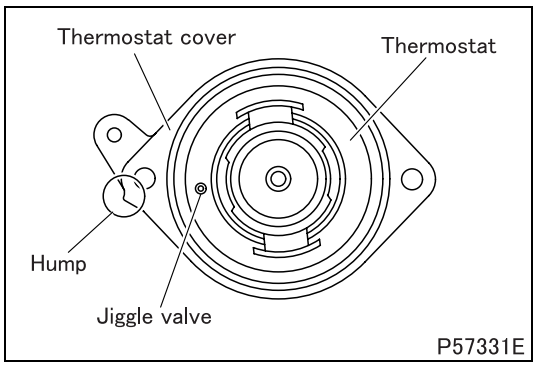
(1) Valve opening temperature

- Hold the thermostat with wire to keep it away from the heat source.
- Heat the water gradually to the valve opening temperature.
- Maintain this temperature for five minutes and make sure that the valve is completely open.
- Make sure that the valve closes completely when the water temperature drops below 65°C {150°F}.

(2) Valve lift

- Heat the water to a temperature slightly higher than the valve opening temperature. Maintain this temperature for five minutes and measure the valve lift.

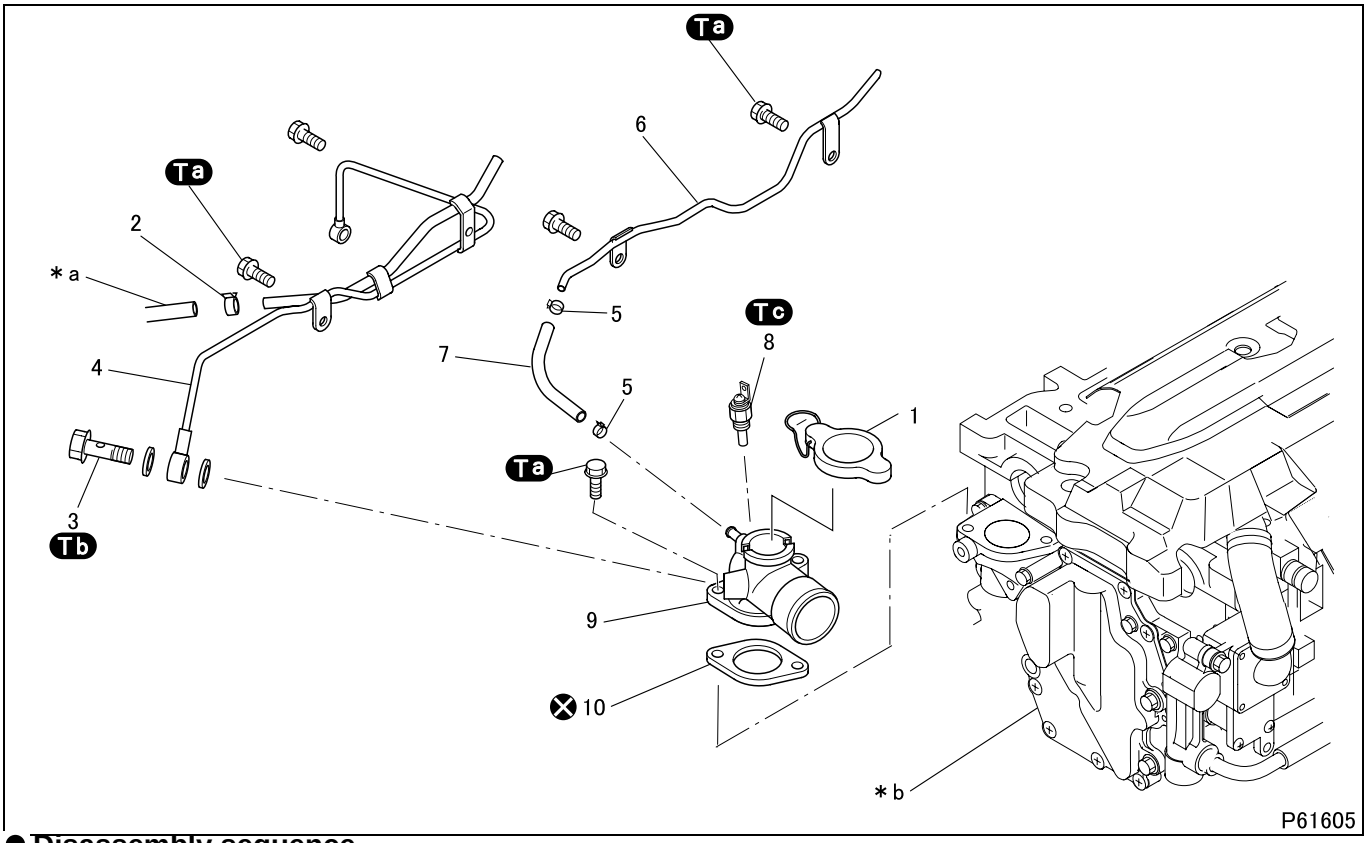
◆Installation procedure◆



■ **Installation: Thermostat**

- Mount the thermostat on the thermostat cover in the illustrated direction.

PRESSURE CAP AND WATER OUTLET CASE



● **Disassembly sequence**

1 Pressure cap
2 Clip
3 Eyebolt
4 Water and vacuum pipe
5 Clip
6 Water pipe
7 Water hose
8 Overheating switch
9 Water outlet case
10 Gasket
***a**: Vacuum hose
***b**: Breather cover
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

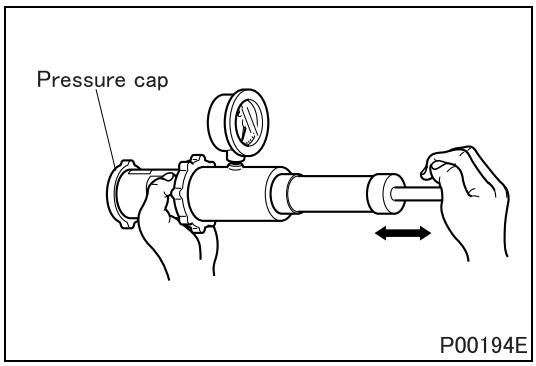
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Pressure cap valve opening pressure	110 ± 15 kPa {16 ± 2.2 psi, 1.1 ± 0.15 kgf/cm^3}	–	Replace

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (water and vacuum pipe mounting)	23.2 {17, 2.4}	–
	Bolt (water pipe mounting)		
	Bolt (water outlet pipe mounting)		
Tb	Eyebolt (water and vacuum pipe mounting)	25.5 {19, 2.6}	–
Tc	Overheating switch	34 ± 6.9 {25 ± 5.1, 3.5 ± 0.7}	–

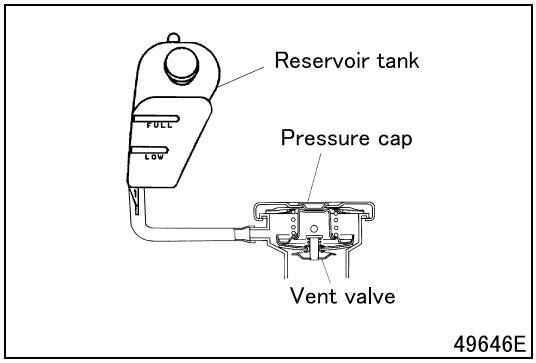
◆Inspection procedure◆



■ **Inspection: Pressure cap**

(1) Pressure valve opening pressure

- Replace the pressure cap if the measured value deviates from the standard value range.



(2) Inspection of vent valve

- Before starting the inspection, check the level of coolant in the reservoir tank.
- Run the engine at full speed. Stop the engine when the level of coolant in the reservoir tank noticeably rises.
- Wait until the coolant temperature drops to the ambient temperature. Then, check if the coolant in the reservoir tank has returned to the same level as that confirmed before the engine was started.
- If the coolant has failed to return to its original level, the vent valve is defective. In this case, replace the pressure cap.

CAUTION ⚠

- **Be aware that removing the pressure cap before the coolant cools down to the ambient temperature will result in loss of vacuum in the radiator, which disables the coolant from being returned to the reservoir tank.**

GROUP 15 INDEX

SPECIFICATIONS 15-2

STRUCTURE AND OPERATION

1. **Air Cleaner 15-2**
2. **Turbocharger 15-3**
3. **Muffler 15-4**

TROUBLESHOOTING 15-5

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. **Measurement of Turbocharger Boost Pressure 15-6**

AIR DUCT AND AIR CLEANER 15-8

TURBOCHARGER 15-12

INTERCOOLER 15-18

INTAKE MANIFOLD 15-22

EXHAUST MANIFOLD 15-23

EXHAUST PIPE 15-24

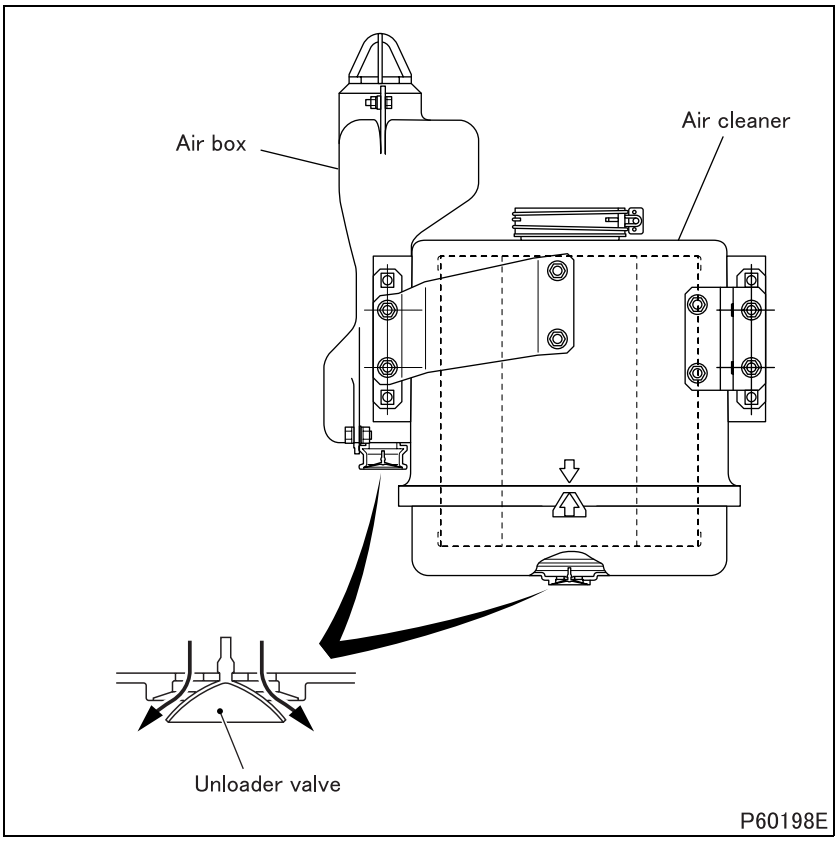
MUFFLER 15-26

SPECIFICATIONS

Item		Specifications
Air cleaner element		Filter paper type
Turbocharger	Model	TD04
	Manufacturer	Mitsubishi Heavy Industries, Ltd.
Intercooler		Tube and corrugated fin type air-to-air heat exchanger

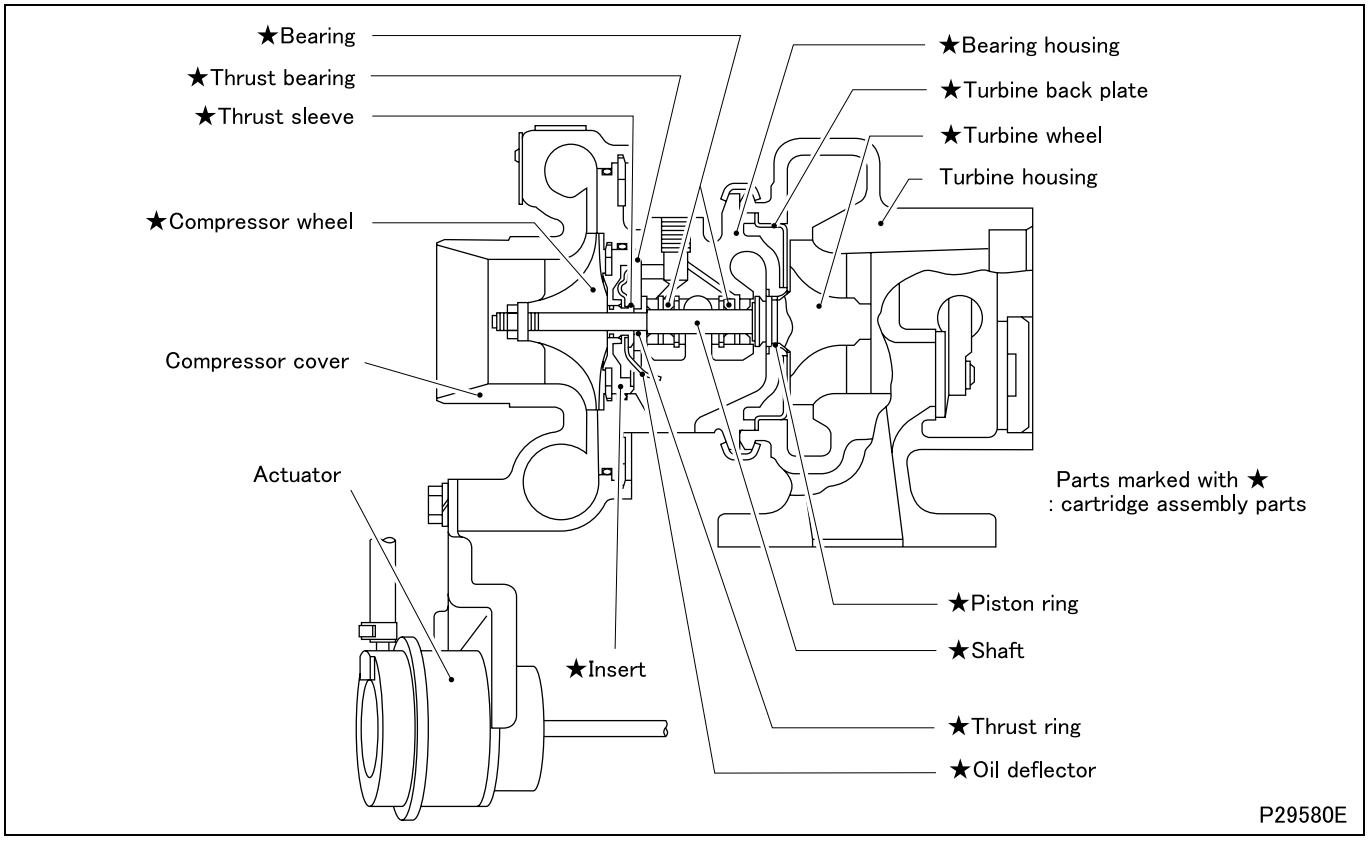
STRUCTURE AND OPERATION

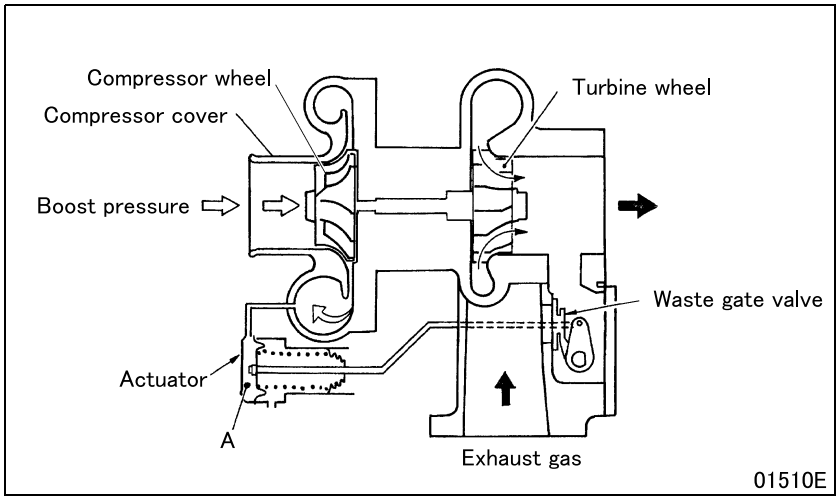
1. Air Cleaner



- The air cleaner is a single element type.
- When the engine slows down below the predetermined speed, the level of vacuum changes and causes the unloader valve to vibrate. Vibration of the unloader valve allows the air cleaner to automatically discharge any water and dust that has accumulated in its inside.

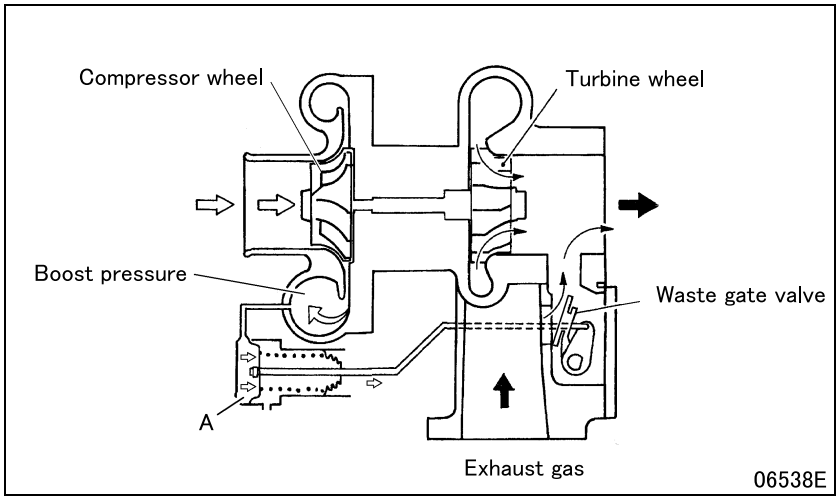
2. Turbocharger





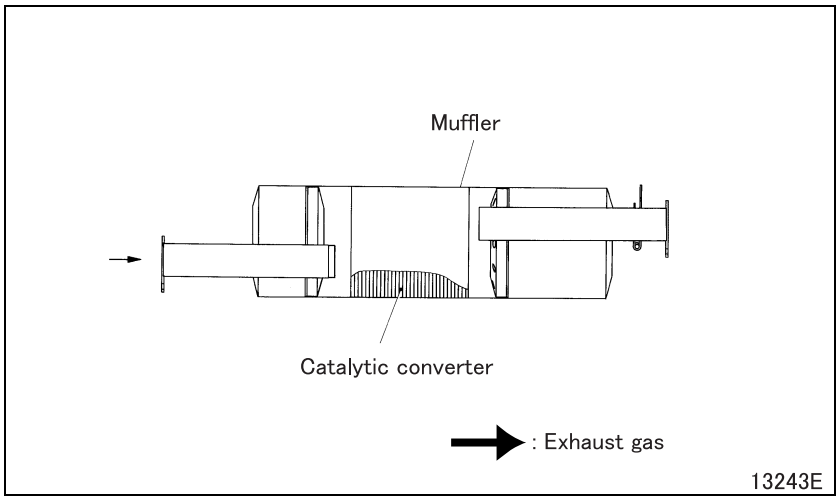
2.1 Waste gate mechanism

- The waste gate mechanism allows excess exhaust gas to escape from the turbocharger by means of an actuator in order to maintain the boost pressure at an appropriate level. This prevents overrunning of the turbocharger and excessive pressure buildups in the intake manifold.
- The boost pressure is led via a rubber hose from the compressor cover to chamber **A** in the actuator. When the boost pressure in chamber **A** is less than the predetermined value, the actuator does not function and the waste gate valve remains closed. All exhaust gas then flows toward the turbine wheel.



- When the boost pressure in chamber **A** exceeds the predetermined value, the waste gate valve opens, reducing the amount of exhaust gas flowing toward the turbine wheel. As a result, the speed of the compressor wheel and thus the boost pressure are reduced.

3. Muffler



- Converter is built into muffler to decrease the amount of particulate matter (PM) in the exhaust gas.

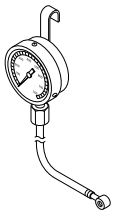
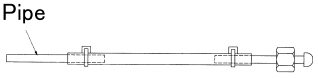
Possible causes \ Symptoms			Engine is difficult to start	Exhaust gas is black	Exhaust gas is white	Engine output is insufficient	Fuel consumption is too high	Intake and exhaust system vibrates and/or makes abnormal noises	Reference Gr
Air cleaner		Clogged air cleaner element	O	O		O			
Turbocharger	Cartridge assembly	Defective bearing		O		O		O	
		Carbon deposits on turbine wheel		O		O			
		Interference between turbine wheel and turbine back plate		O		O		O	
		Interference between turbine wheel and turbine housing		O		O		O	
		Bent shaft		O		O		O	
		Damaged turbine wheel		O		O		O	
		Interference between compressor wheel and compressor cover		O		O		O	
		Seizure of thrust sleeve and/or thrust bearing		O		O		O	
		Damaged compressor wheel		O		O		O	
		Oil leakage due to worn piston ring and/or insert		O	O		O		
		Poorly installed piston ring					O		
		Unsmooth sliding of inner parts due to clogged lubricating oil pipe and/or eyebolt		O		O			
		Damaged oil seals due to clogged oil return pipe			O		O		
	Poorly mounted compressor cover			O		O	O	O	
	Poorly mounted turbine housing					O		O	
Intercooler						O			
Throttle actuator		Butterfly valve stuck in closed position		O	O	O			Gr13E
		Poorly adjusted butterfly valve		O	O	O			
Deformed front pipe, muffler, and/or tail pipe								O	
Poorly installed front pipe, muffler, and/or tail pipe								O	
Inappropriate valve clearance				O					Gr11
Defective cylinder head gasket				O					
Worn valve and valve seat and/or carbon deposits				O					
Weakened valve springs				O					
Worn and/or damaged piston rings					O		O		
Worn and/or damaged piston ring grooves					O		O		
Malfunctioning cooling system				O					Gr14
Excessive engine oil level					O				Gr12
Seizure of main moving parts				O					Gr11
Uneven or excessive fuel injection				O					Gr13E

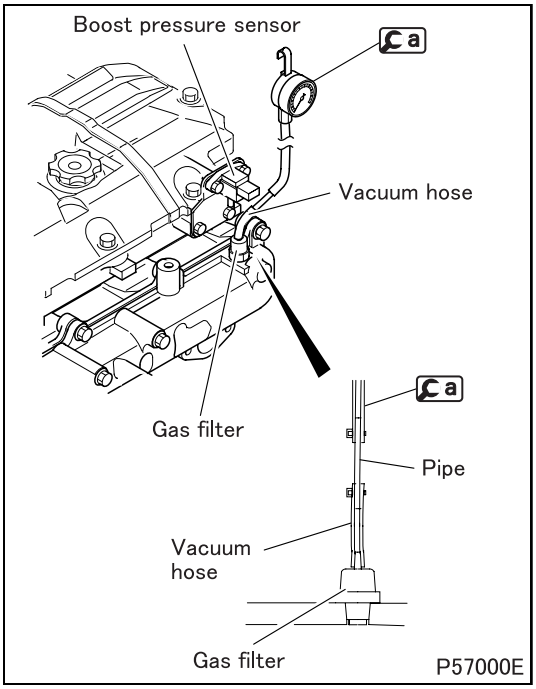
1. Measurement of Turbocharger Boost Pressure

Service standards (Unit: mm {in.})

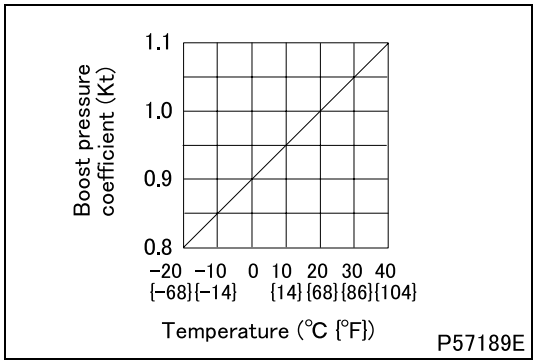
Location	Maintenance item		Standard value	Limit	Remedy
–	Boost pressure (temperature: 20°C {68°F}; air pressure: 100 kPa {29.9 in. Hg, 760 mmHg})	Boost pressure gauge reading	–	67.8 kPa {20 in. Hg, 509 mmHg} /3100 rpm	Inspect or adjust
		Multi-Use Tester reading (See Gr13E.)	–	168.8 kPa {49.9 in. Hg, 1270 mmHg} /3100 rpm	

Special tools

Mark	Tool name and shape	Part No.	Application
a	Boost pressure gauge  P01524	MH061366	Measurement of turbocharger boost pressure
b	Boost pressure gauge adapter  51603E	MH062047 (Only the pipe section will be used.)	



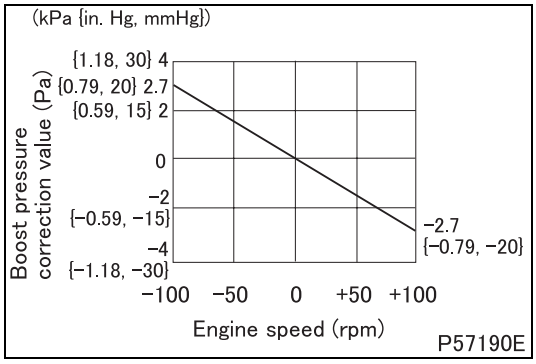
- Before measuring the turbocharger boost pressure, clean or replace the air cleaner element.
- Disconnect the vacuum hose from the boost pressure sensor.
- Connect the pipe b between the vacuum hose connected to the gas filter and a.
- Warm up the engine well, then measure the boost pressure at no-load maximum speed. Also measure the engine speed and atmospheric temperature.



- Adjust the boost pressure to the standard value (boost pressure changes according to the atmospheric temperature and the engine speed).

[Atmospheric temperature correction of boost pressure]

- Based on the current atmospheric temperature, determine the appropriate boost pressure correction coefficient in the graph.



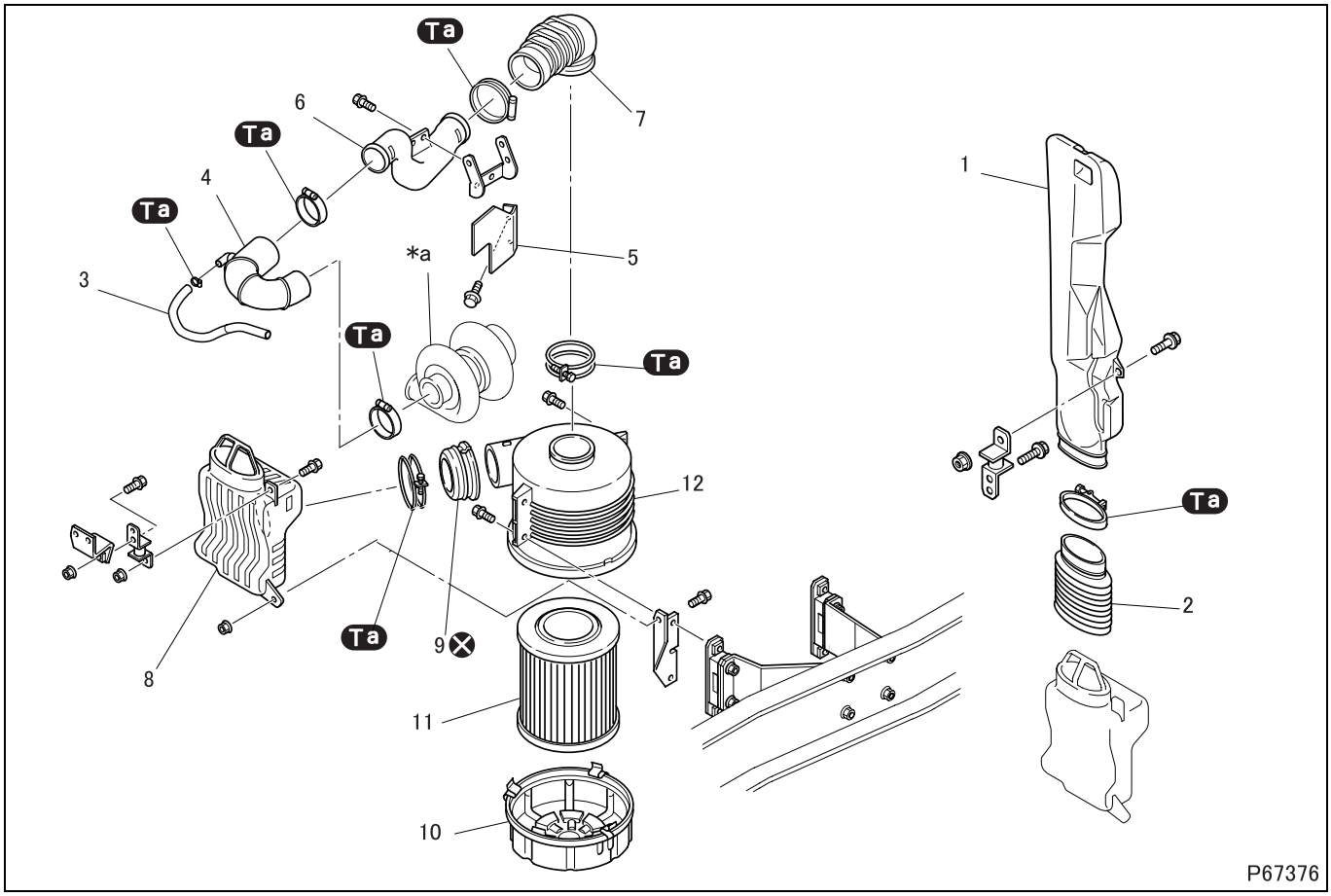
[Engine speed correction of boost pressure]

- Subtract the median of the no-load maximum speed values from the engine speed at the time of boost pressure measurement. Use the difference to determine the necessary boost pressure correction value (Pa) in the graph.
  Median: 3200 rpm

[Calculation of corrected boost pressure]

- With **P** as the measured boost pressure, determine the correctedboost pressure **Pb** using the following equation:
  Pb = **KtP** + **Pa**
  Pb: Corrected boost pressure
  P: Measured boost pressure
  Kt: Ambient temperature correction coefficient for boost pressure
  Pa: Boost pressure correction value
- The turbocharger must be inspected and/or adjusted if **Pb** is below the specified limit.

AIR DUCT AND AIR CLEANER



● **Disassembly sequence**

1 Air inlet duct
2 Connector
3 PCV hose
4 Air hose
5 Insulator
6 Air duct
7 Connector
8 Air box
9 Rubber seal
10 Air cleaner cap
11 Air cleaner element
12 Air cleaner case

***a**: Turbocharger
⊗: Non-reusable parts
PCV: Positive Crankcase Ventilation

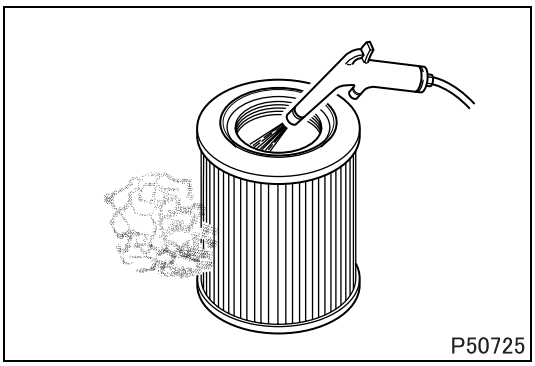
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3.0 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–

◆Cleaning procedure◆



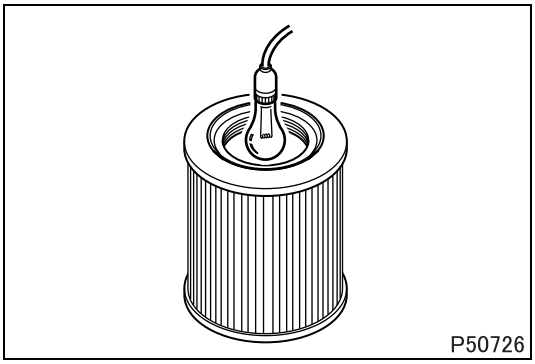
■ **Cleaning: Filter element**

- Blow a jet of compressed air at a pressure not higher than 685 kPa {100 psi, 7 kgf/cm^2} against the inside surfaces of the element.
- Move the compressed air jet up and down along all pleats of the filter paper element.

CAUTION ⚠

- **Do not strike the element or hit it against another object to remove dust.**
- **Do not blow compressed air against outside surfaces of the element.**

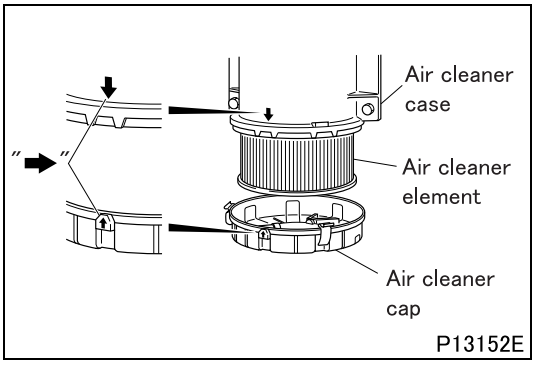
◆Inspection procedure◆



■ **Inspection: Element**

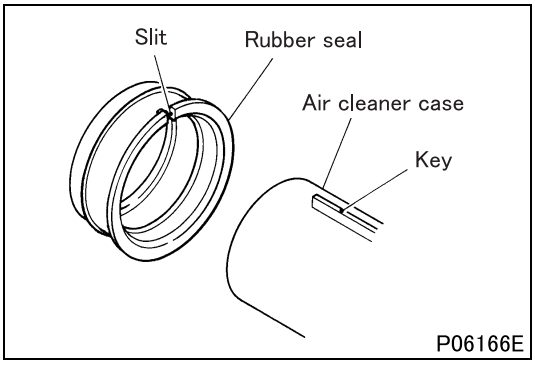
- Shine some electric light inside the element.
- Replace the element if thin spots or broken parts are evident in the filter paper, or if the packing at the top of the element is damaged.
  Also replace the element if the dust on the element is damp with oily smoke or soot, regardless of the replacement schedule.

◆Installation procedure◆



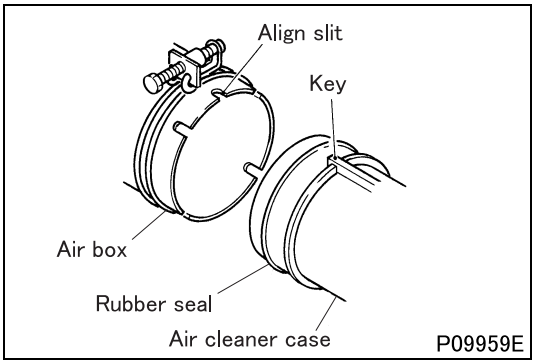
■ **Installation: Air cleaner cap**

➡: Alignment mark



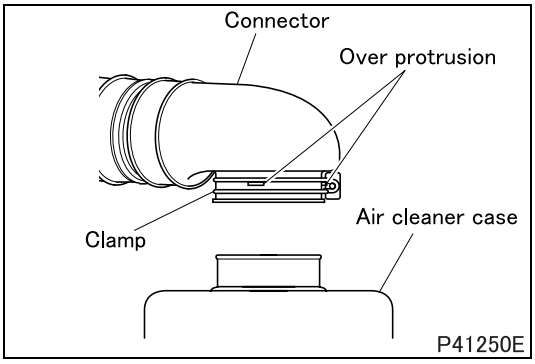
■ **Installation: Rubber seal**

- Align slit of rubber seal with key of air cleaner case.



■ **Installation: Air box**

- Align slit of air box with key of air cleaner case.

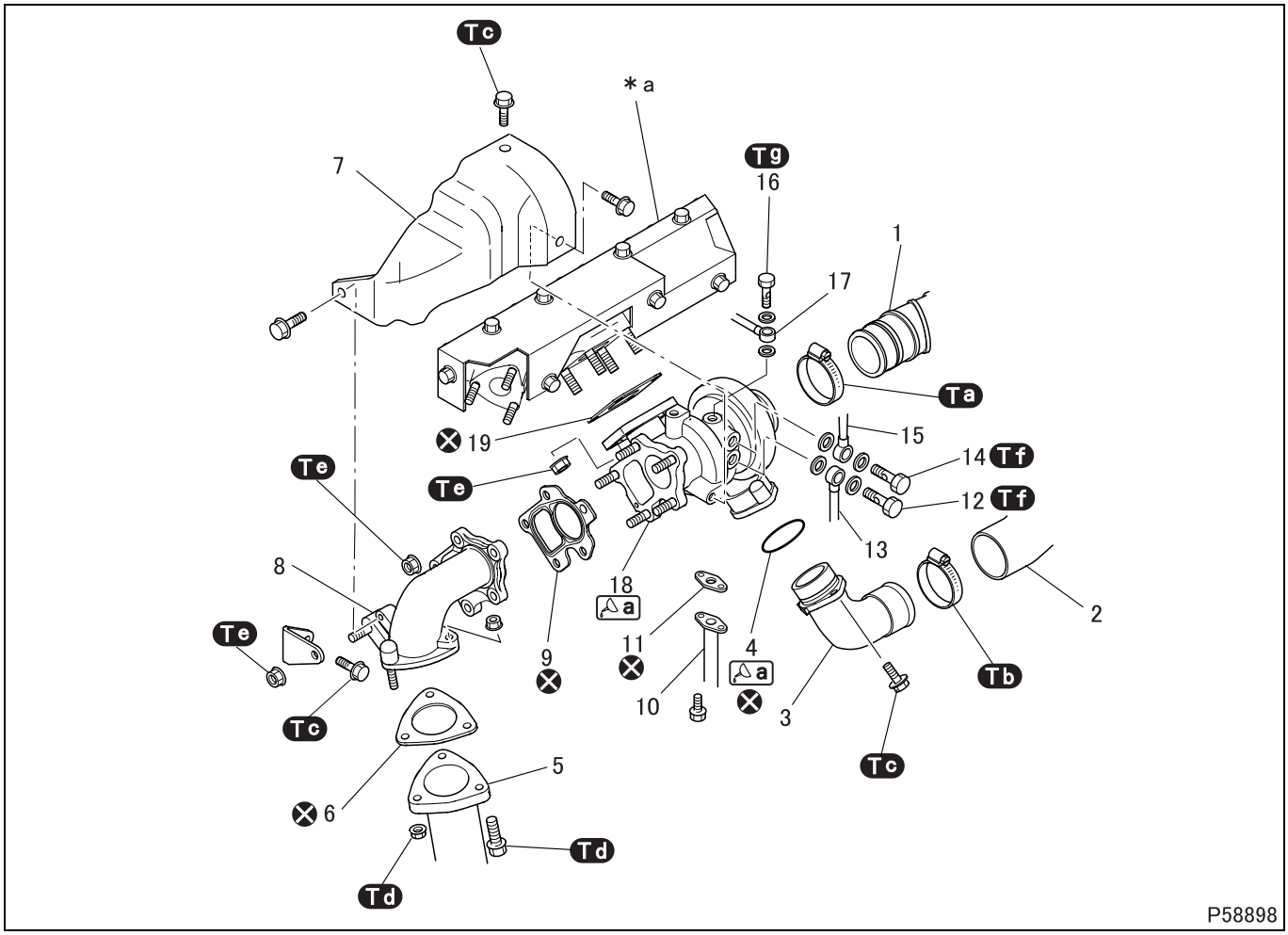


■ **Installation: Air duct**

- Fit clamp over protrusions of connector.
- Push air duct in until it hits air cleaner case.

M E M O

TURBOCHARGER



● **Removal sequence**

1 Air hose
2 Air inlet hose
3 Turbocharger coupler
4 O-ring
5 Front pipe
6 Gasket
7 Insulator
8 Exhaust coupler
9 Gasket
10 Oil return pipe
11 Gasket
12 Eyebolt
13 Water pipe
14 Eyebolt
15 Water and vacuum pipe
16 Eyebolt
17 Oil pipe
18 Turbocharger (See later section.)
19 Gasket

***a**: Exhaust manifold
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

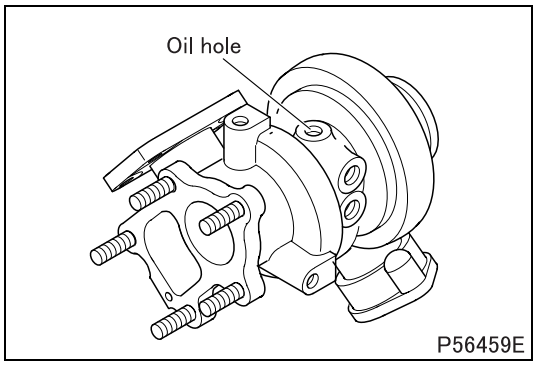
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–
Tb	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–
Tc	Bolt (turbocharger coupler mounting)	23.2 {17, 2.4}	–
	Bolt (insulator mounting)		
	Bolt (exhaust pipe stay mounting)		
Td	Bolt (front pipe mounting)	25 to 30 {18 to 22, 2.5 to 3.1}	–
	Nut (front pipe mounting)		
Te	Nut (exhaust coupler stay mounting)	53 {39, 5.4}	–
	Nut (exhaust coupler mounting)		
	Nut (turbocharger mounting)		
Tf	Eyebolt (water pipe mounting)	25.5 {19, 2.6}	–
	Eyebolt (water and vacuum pipe mounting)		
Tg	Eyebolt (oil pipe mounting)	23.5 {17, 2.4}	–

Lubricant and/or sealant

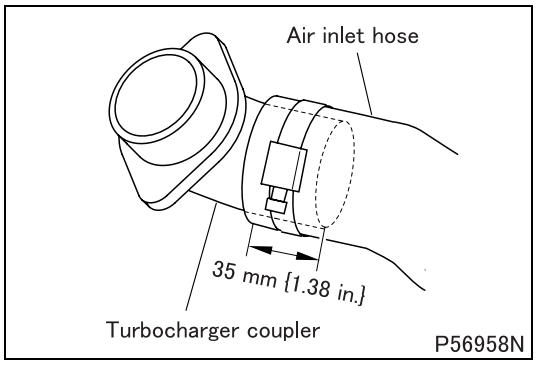
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Turbocharger		

◆Installation procedure◆



■ Installation: Turbocharger

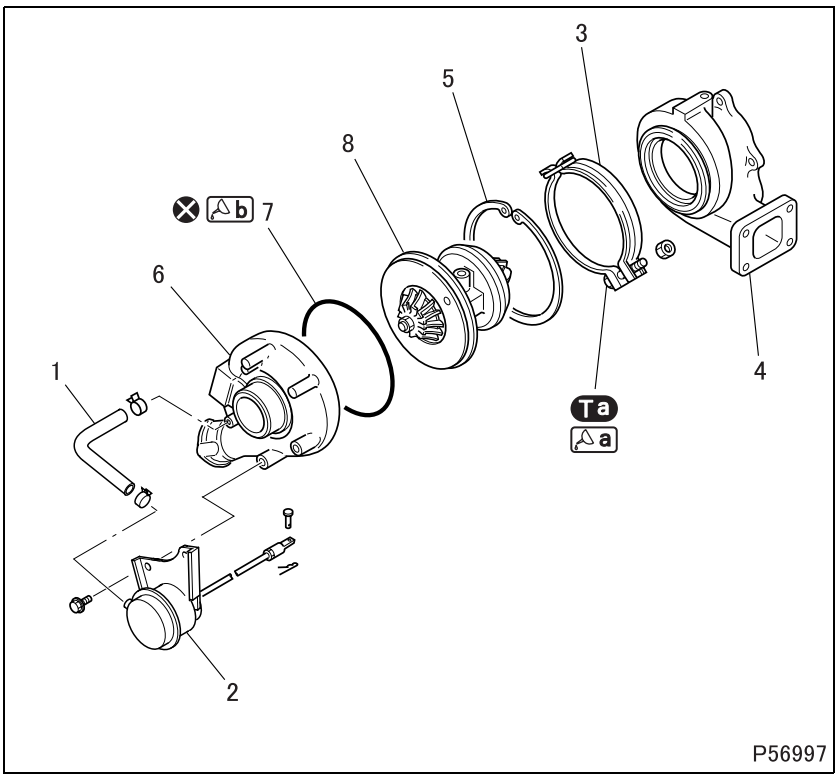
- When installing the turbocharger, fill adequate amount of engine oil through the oil hole for smooth operation.



■ Installation: Air inlet hose

- Install the air inlet hose on the turbocharger coupler to the indicated dimension.

Turbocharger



●Disassembly sequence

1 Hose
2 Actuator
3 Coupling
4 Turbine housing
5 Snap ring
6 Compressor cover
7 O-ring
8 Cartridge assembly

⊗: Non-reusable parts

●Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The cartridge assembly cannot be disassembled. If the turbine wheel or the compressor cover is damaged or does not rotate smoothly, replace the entire cartridge assembly.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
8	Cartridge assembly	Play in axial directions		0.03 to 0.10 {0.0012 to 0.0039}	0.11 {0.0043}	Replace
		Play in radial directions	Turbine wheel end	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	Replace
			Compressor wheel end	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	Replace

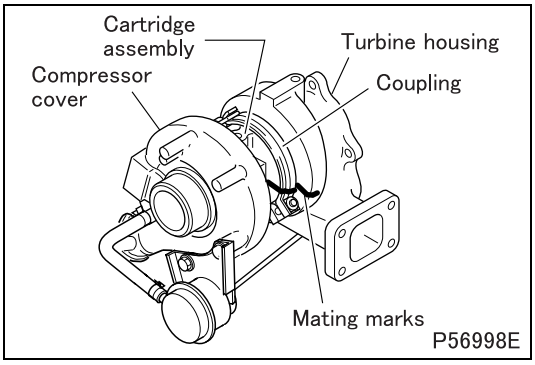
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (coupling fastening)	7.8 to 8.8 {5.8 to 6.5, 0.8 to 0.9}	Wet

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	MoriCoat BR-2 Plus	As required
b	O-ring	Engine oil	As required

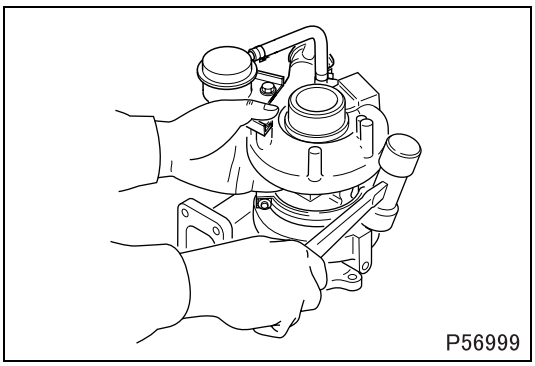
◆Work before removal◆



■ Mating marks

- Draw a line across the coupling, turbine housing, compressor cover, and cartridge assembly. This line will serve as mating marks in the installation procedure.

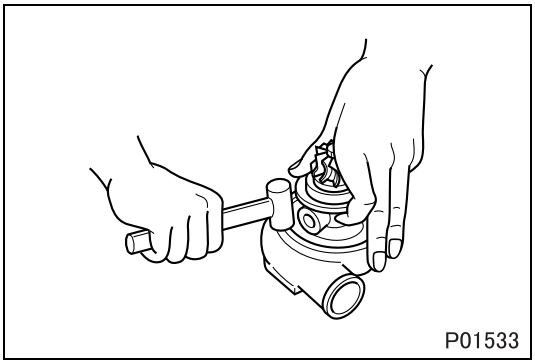
◆Removal procedure◆



■ **Removal: Turbine housing**

CAUTION ⚠

- **Tap all around the end of the turbine housing with a rubber hammer or a similar tool, being careful not damage the turbine housing.**
- **Do not let the blades of the cartridge assembly hit the turbine housing, as they are easily bent.**

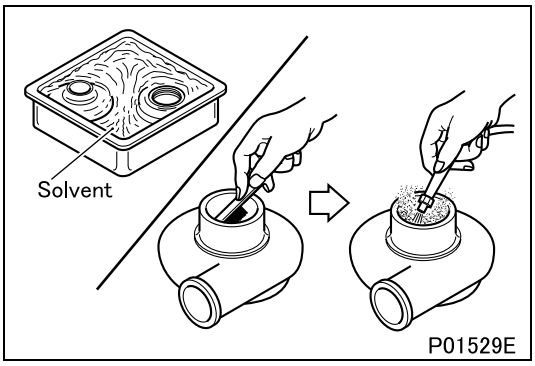


■ **Removal: Compressor cover**

CAUTION ⚠

- **Tap all around the end of the turbine housing with a rubber hammer or a similar tool, being careful not damage the turbine housing.**
- **Do not let the blades of the cartridge assembly hit the turbine housing, as they are easily bent.**

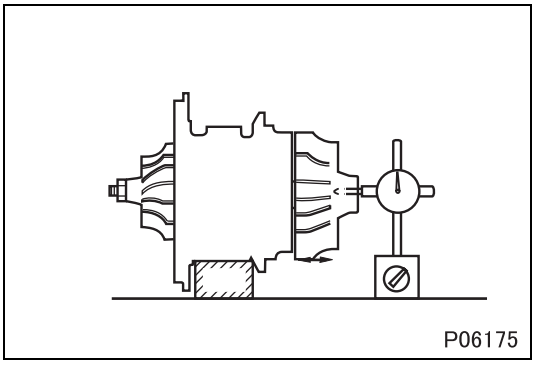
◆Work after disassembly◆



■ **Cleaning**

- Before cleaning the parts, carry out a visual inspection for any marks of burns or wear that may become difficult to find after the cleaning. If any defects are evident, replace the part(s).
- Immerse the disassembled parts in an inflammable solvent (Daicleaner-T-30 by Daido Chemical Industry Co., Ltd.). Remove the parts from the solvent, and dry them with compressed air.
  If there is any solid matter remaining on the parts, remove them with a plastic scraper or a bristle brush.
- Reimmerse the parts in the solvent.
- Dry each part with compressed air.

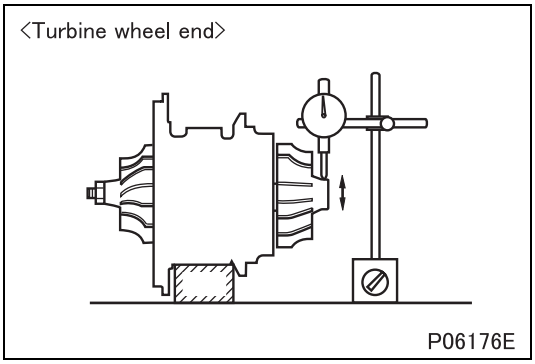
◆Inspection procedure◆

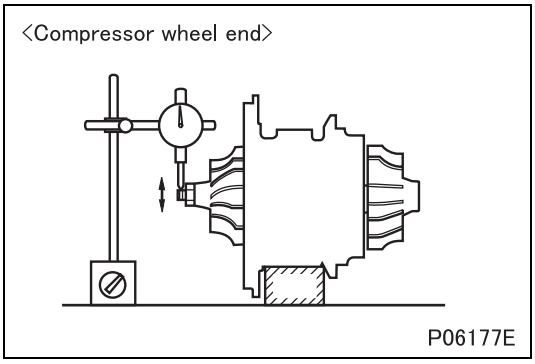


■**Inspection: Cartridge assembly**

(1) Play in axial directions

- If the measurement exceeds the specified limit, replace the cartridge assembly.

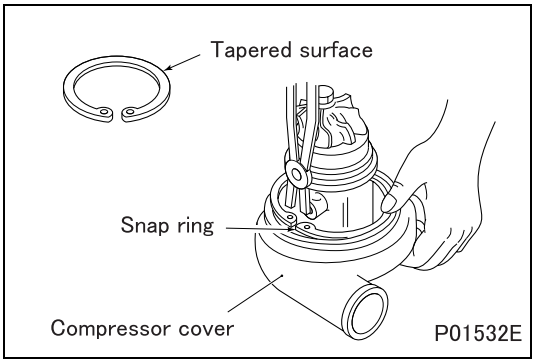




(2) Play in radial directions

- If the measurement exceeds the specified limit, replace the cartridge assembly.

◆Installation procedure◆



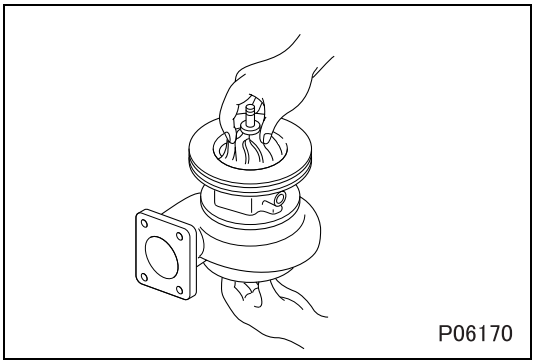
■ Installation: Snap ring

- Fit the snap ring into the compressor cover with the tapered surface on top.

CAUTION ⚠

- **Always keep one hand on the snap ring to prevent it from flying off.**

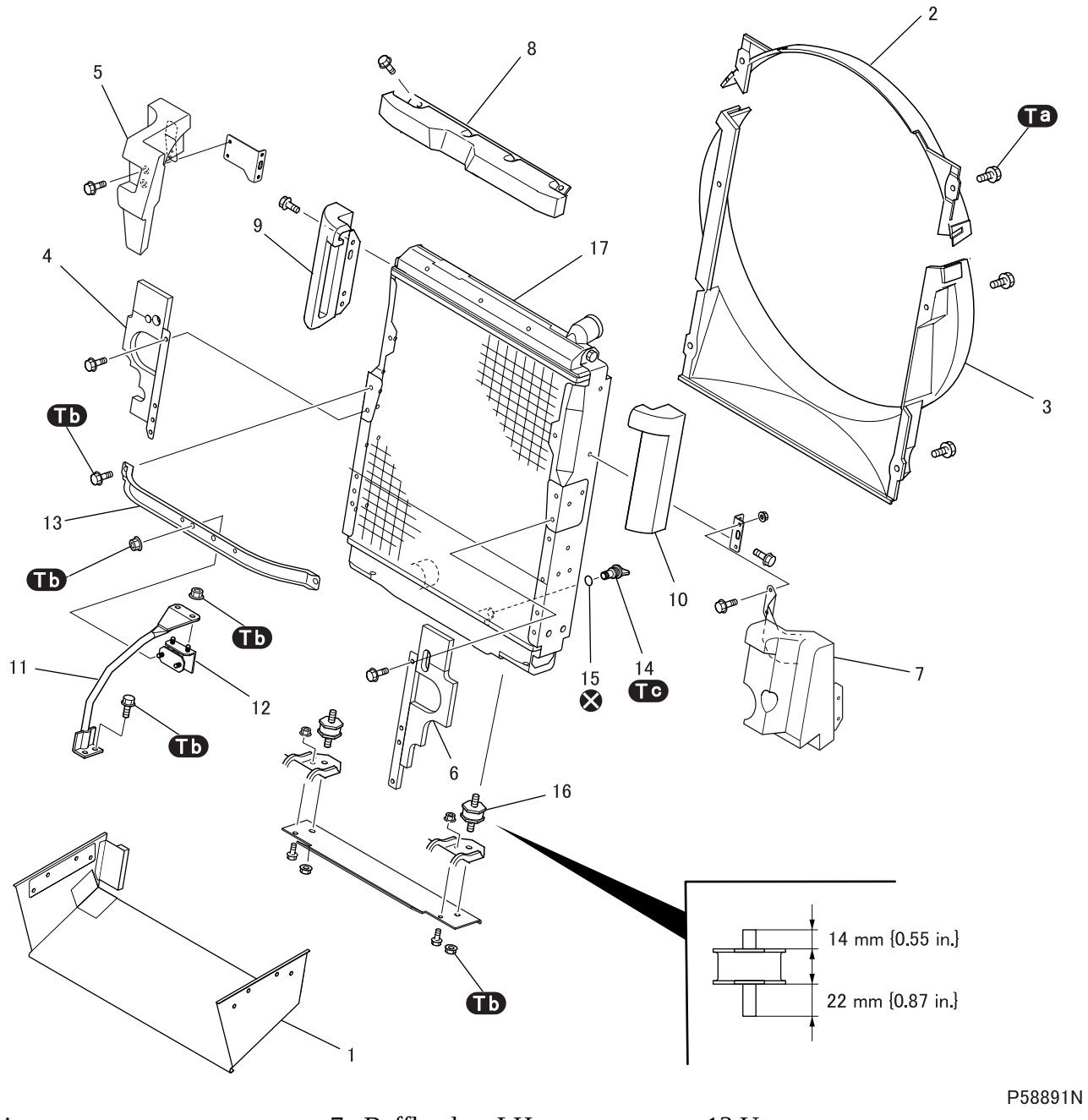
◆Work after installation◆



■ Inspection: Rotation of cartridge assembly

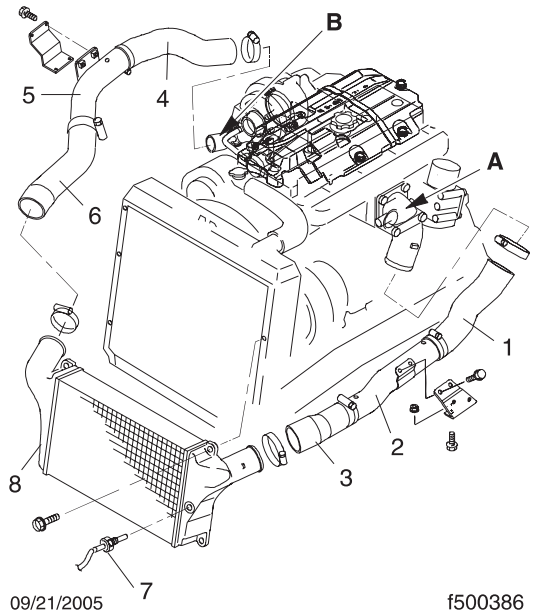
- Turn both wheels of the cartridge assembly to check that they rotate smoothly.
- If anything abnormal is found, disassemble the cartridge assembly and perform necessary service.

M E M O



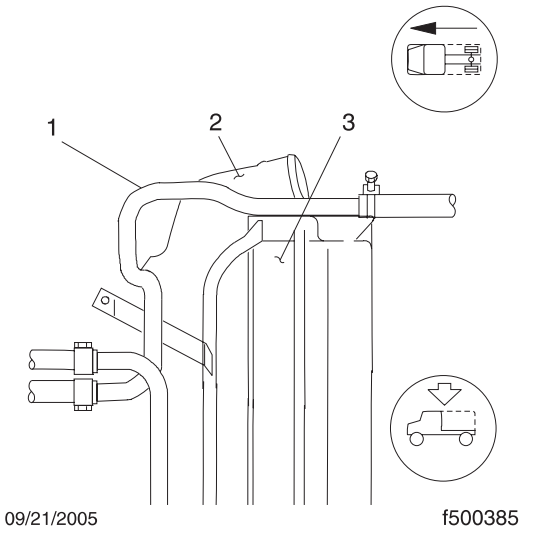
1. Air scoop
2. Upper shroud
3. Lower shroud
4. Baffle plate RH
5. Baffle plate RH
6. Baffle plate LH
7. Baffle plate LH
8. Baffle plate upper
9. Baffle plate RH
10. Baffle plate LH
11. Support rod
12. Support cushion
13. Upper support
14. Radiator drain cock
15. O-ring
16. Support cushion
17. Radiator (See later section.)

⊗: Non-reusable parts



1. Air inlet hose
2. Air inlet pipe LH
3. Air inlet hose
4. Air inlet hose
5. Air inlet pipe RH
6. Air inlet hose
7. Intake temperature sensor
8. Intercooler

A Air inlet duct
B Turbocharger coupler



1. Heater line
2. Intercooler
3. Radiator

● Removal sequence

NOTE: The radiator and intercooler must be removed as an assembly then separated as needed.

1. Park the vehicle on a level surface, set the parking brake, chock the tires, and shut down the engine.
2. Tilt the cab.

WARNING ⚠

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

3. Remove the radiator cap and drain the coolant.
4. Remove the air hose (#4) from turbo inlet.
5. Detach the metal air inlet pipe (#5) from the support bracket.
6. Remove the air inlet air hose (#6) from intercooler.
7. Remove the air inlet hose (#1) from the intake manifold.
8. Remove the metal air inlet pipe (#2) from the support bracket.
9. Remove the air inlet hose (#3) from the intercooler.
10. Disconnect the connector for the intercooler temp sensor. Remove the temperature sensor from intercooler.
11. Remove the air scoop.
12. From under the truck, remove the following pieces from the radiator:
    - Baffle plate RH (#5)
    - Baffle plate RH (#9)
    - Baffle plate LH (#10)
    - Baffle plate LH (#7)
    - Support rod (#11)
    - Upper support (#13)
    - A/C line support bracket (lower right side).
13. Disconnect the heater line that goes around the lower right side of radiator.
14. Disconnect the upper radiator hose.
15. Disconnect the lower radiator hose.
16. Disconnect any heater hose or A/C line support brackets in front of radiator.
17. Remove the upper fan shroud.
18. Remove the lower fan shroud.
19. Remove the two nuts securing the radiator to the frame crossmember.
20. Remove the radiator and intercooler.
21. Remove the intercooler from radiator. Keep track of the brackets sandwiched between the intercooler and radiator.

● Installation sequence

1. Install the intercooler onto the radiator. Make sure the correct brackets are installed between intercooler and radiator.
2. Install the radiator and intercooler into the truck. Align the radiator mounting studs with holes in the frame crossmember. Install, but do not tighten, the nuts at this time.
3. Install the lower fan shroud.

4. Install the upper fan shroud.
5. Attach the heater tube to the lower right side of the radiator. Attach the heater hoses to the tube.
6. Install the A/C line support bracket on the lower right side of the radiator.
   NOTE: From this point on, install fasteners but do not tighten until all support brackets are installed.
7. Install the hoses from the turbo to the intercooler.
8. Attach the metal air inlet pipe #5 to the support bracket.
9. Install the RH baffle plates.
10. Install the hoses from the intercooler to the intake manifold.
11. Fasten the metal air inlet pipe #2 to the support bracket.
12. Install the heater hose bracket to the radiator.
13. Install the LH baffle plates.
14. Install the upper support on the front of the radiator.
15. Install the support rod.
16. Install all heater hose and A/C line support brackets in front of the radiator.
17. Tighten all fasteners.
18. Install the lower radiator hose.
19. Install the upper radiator hose.
20. Install the intercooler temperature sensor. Attach the connector.
21. Tighten the two nuts that secure the radiator to the frame crossmember.
22. Install the air scoop.
23. Close the radiator drain cock.
24. Fill the system with coolant. Install the radiator cap.
25. Start the engine and check for air and water leaks.

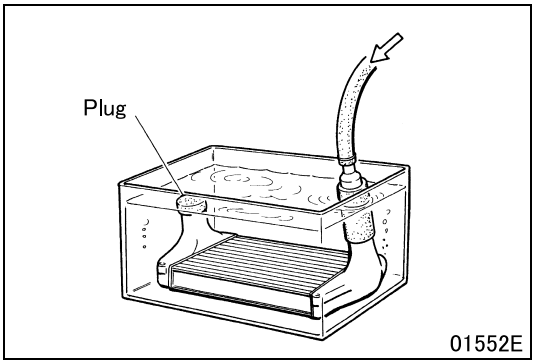
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
8	Intercooler air leakage (air pressure: 200 kPa {29 psi, 2.0 kgf/cm^2} maintained for 30 seconds)	0 cm^3 {0 cu.in.}	–	Replace

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

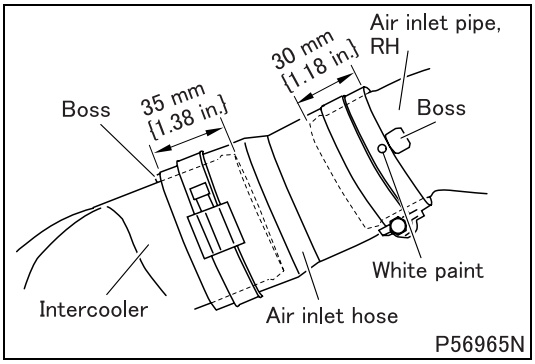
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–
Tb	Intake temperature sensor	24.5 {18, 2.5}	–

◆Inspection procedure◆



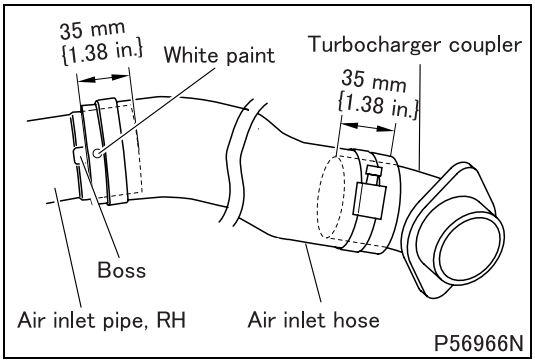
■ Inspection: Intercooler

- Plug one of the air ports on the intercooler and connect an air source to the other port. Place the intercooler in a tank of water and apply air pressure of the specified level (200 kPa {29 psi, 2.0 kgf/cm^2}) to the intercooler and retain the pressure for 30 seconds.
- Replace the intercooler if any air leakage is evident.

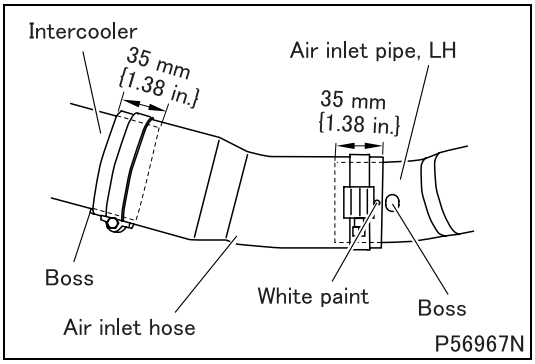


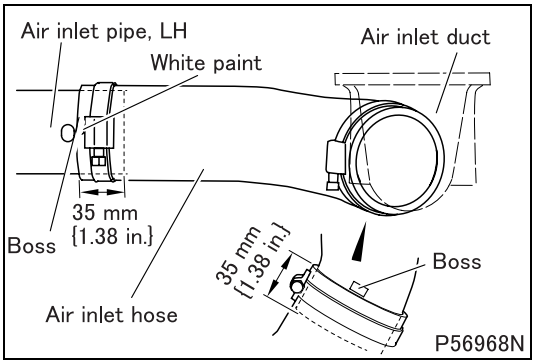
■ Installation: Air inlet hose

- Connect the air inlet hose to the RH air inlet pipe with the white paint on the hose aligned with the boss on the pipe.
- Connect the air inlet hoses to the intercooler, RH air inlet pipe and turbocharger coupler to the dimensions indicated in the illustrations.

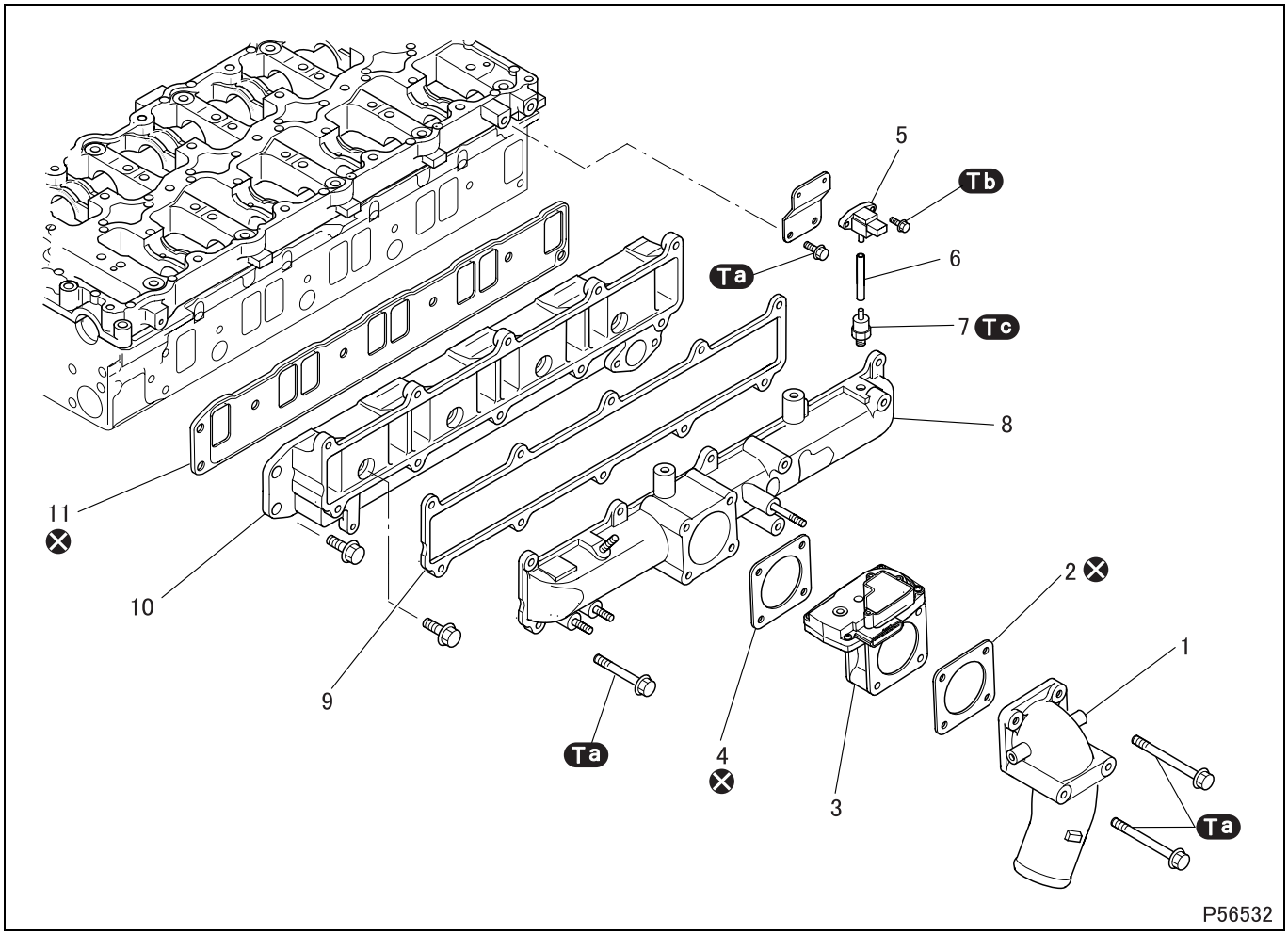


- Connect the air inlet hose to the LH air inlet pipe with the white paint on the hose aligned with the boss on the pipe.
- Connect the air inlet hoses to the intercooler, LH air inlet pipe and air inlet duct to the dimensions indicated in the illustrations.





INTAKE MANIFOLD



● **Disassembly sequence**

1 Air inlet duct
2 Gasket
3 Intake throttle
4 Gasket
5 Boost pressure sensor
6 Vacuum hose
7 Gas filter
8 Intake manifold B
9 Gasket B
10 Intake manifold A
11 Gasket A

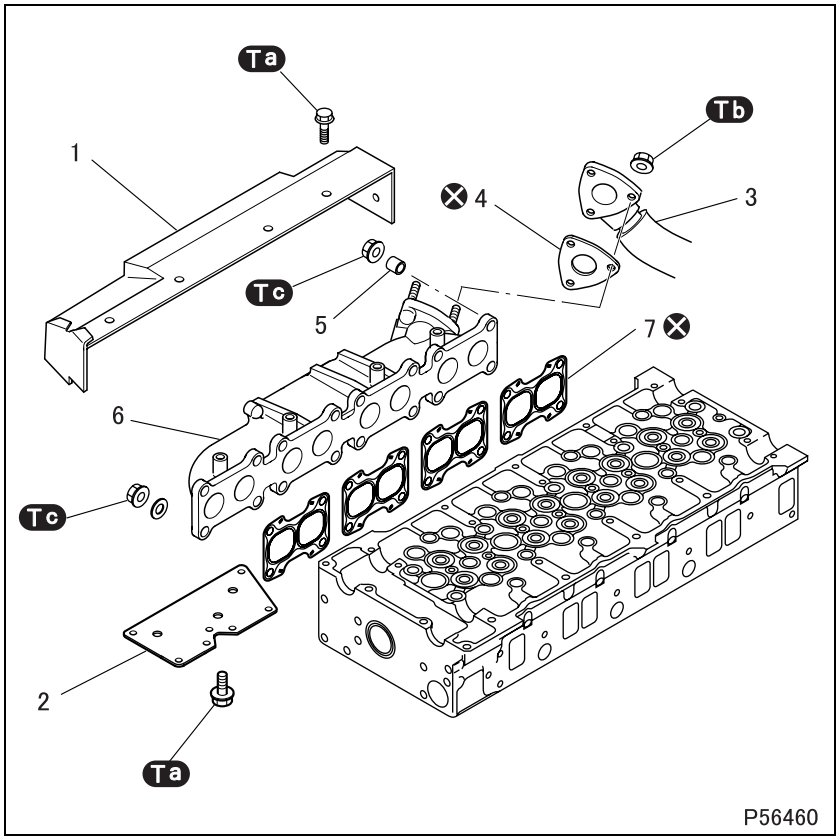
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (air inlet duct and throttle actuator mounting)	23.2 {17, 2.4}	–
	Bolt (boost pressure sensor bracket mounting)		
	Bolt (intake manifold B mounting)		
Tb	Bolt (boost pressure sensor mounting)	12.7 {9.4, 1.3}	–
Tc	Gas filter	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–



● **Disassembly sequence**

1 Insulator
2 Under insulator
3 Exhaust gas recirculation pipe
4 Gasket
5 Distance piece
6 Exhaust manifold
7 Gasket

⊗: Non-reusable parts

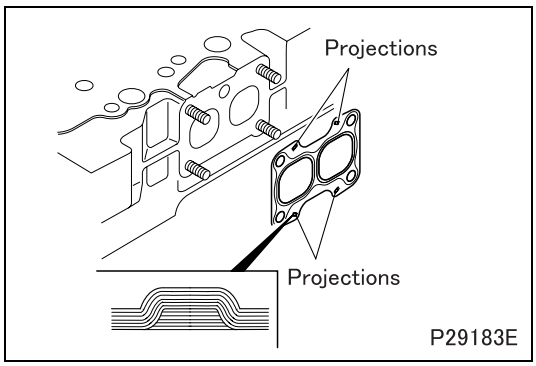
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (insulator mounting)	11.8 {8.7, 1.2}	–
Tb	Nut (exhaust gas recirculation pipe mounting)	20.6 {15, 2.1}	–
Tc	Nut (exhaust manifold mounting)	41.2 {30, 4.2}	–

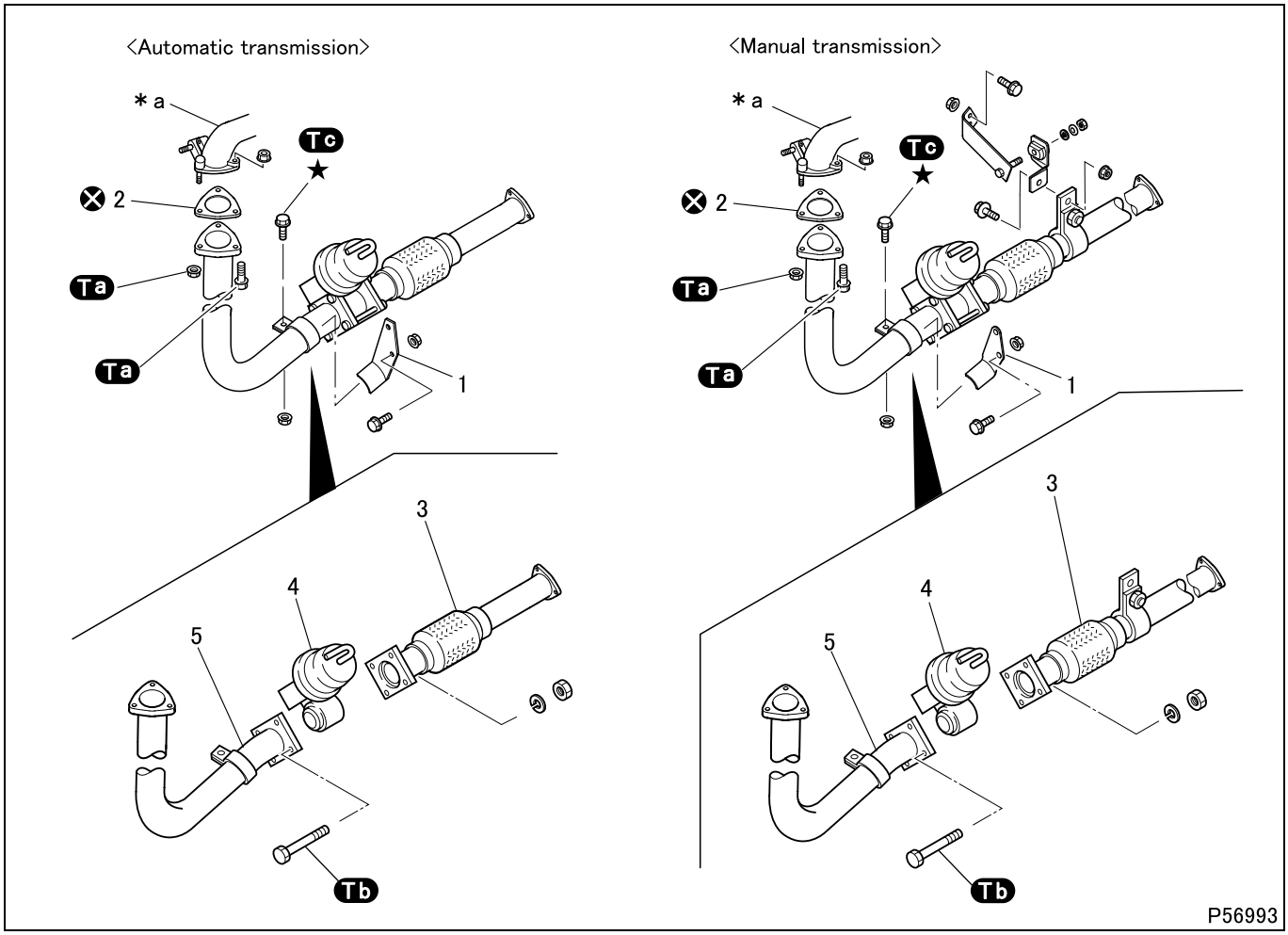
◆**Installation procedure**◆



■ **Installation: Gasket**

- Install the gasket on the cylinder head with their surfaces facing in the illustrated directions.

EXHAUST PIPE



● **Disassembly sequence**

1 Brace bracket
2 Gasket
3 Front pipe
4 Exhaust brake unit
5 Front pipe
***a** Exhaust manifold
⊗: Non-reusable parts

CAUTION ⚠

- **Loosen the ★ marked bolt first to prevent undue forces from being applied to the exhaust pipe.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

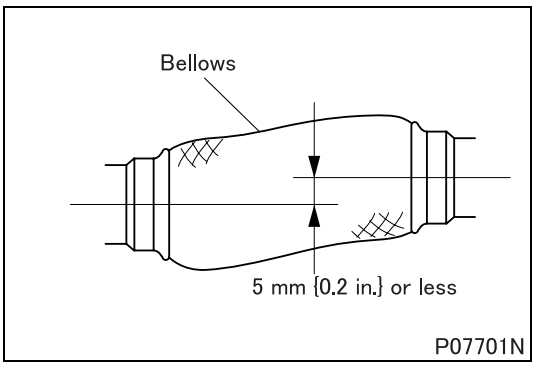
CAUTION ⚠

- **Tighten the ★ marked bolt last to prevent undue forces from being applied to the exhaust pipe.**

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (front pipe mounting)	25 to 30 {18 to 22, 2.5 to 3.1}	–
	Bolt (front pipe mounting)		
Tb	Bolt (exhaust brake unit mounting)	27 {20 to 29, 2.75}	–

◆Installation procedure◆



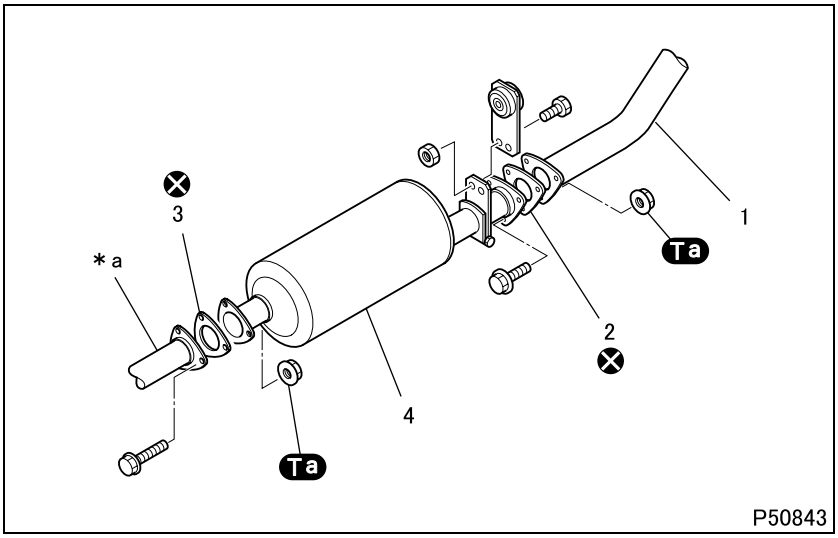
■ **Installation: Front pipe**

- Install the front pipe so that the amounts of offset in both vertical and horizontal directions between the pipes in front of and behind the bellows are smaller than the dimension indicated in the illustration.

CAUTION ⚠

- **The bellows on the front pipe have the purpose of reducing the level of noise from the vehicle. It is not intended for compensating for misalignment that may result from improper installation of the front pipe. Install the front pipe properly to avoid excessive tension or other stress on the bellows.**

MUFFLER



● **Disassembly sequence**

1 Tail pipe
2 Gasket
3 Gasket
4 Muffler

***a**: Front pipe
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Do not touch any of the water that may have accumulated inside the muffler. If you accidentally get some on your skin, wash it off immediately with water.**

CAUTION ⚠

- **Do not kick or strike the muffler, as this can cause damage to the catalyzer inside the muffler.**

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (tail pipe mounting)	26 to 33 {19 to 24, 2.7 to 3.2}	–
	Nut (muffler mounting)		

GROUP 17 INDEX

STRUCTURE AND OPERATION

1. Exhaust Gas Recirculation System 17-2
2. Crankcase Emission Control System 17-7

EXHAUST GAS RECIRCULATION SYSTEM

1. Diagnosis Procedure 17-8
2. Diagnostic Precautions 17-9
3. Inspections Based on Diagnosis Codes 17-10
4. Multi-Use Tester Service Data 17-12
5. Actuator Tests Performed Using Multi-Use Tester 17-12
6. Inspections Performed at Electronic Control Unit Connectors 17-13
7. Inspection of Electrical Equipment 17-14
8. Installed Locations of Parts 17-15
9. Electric Circuit Diagram 17-20

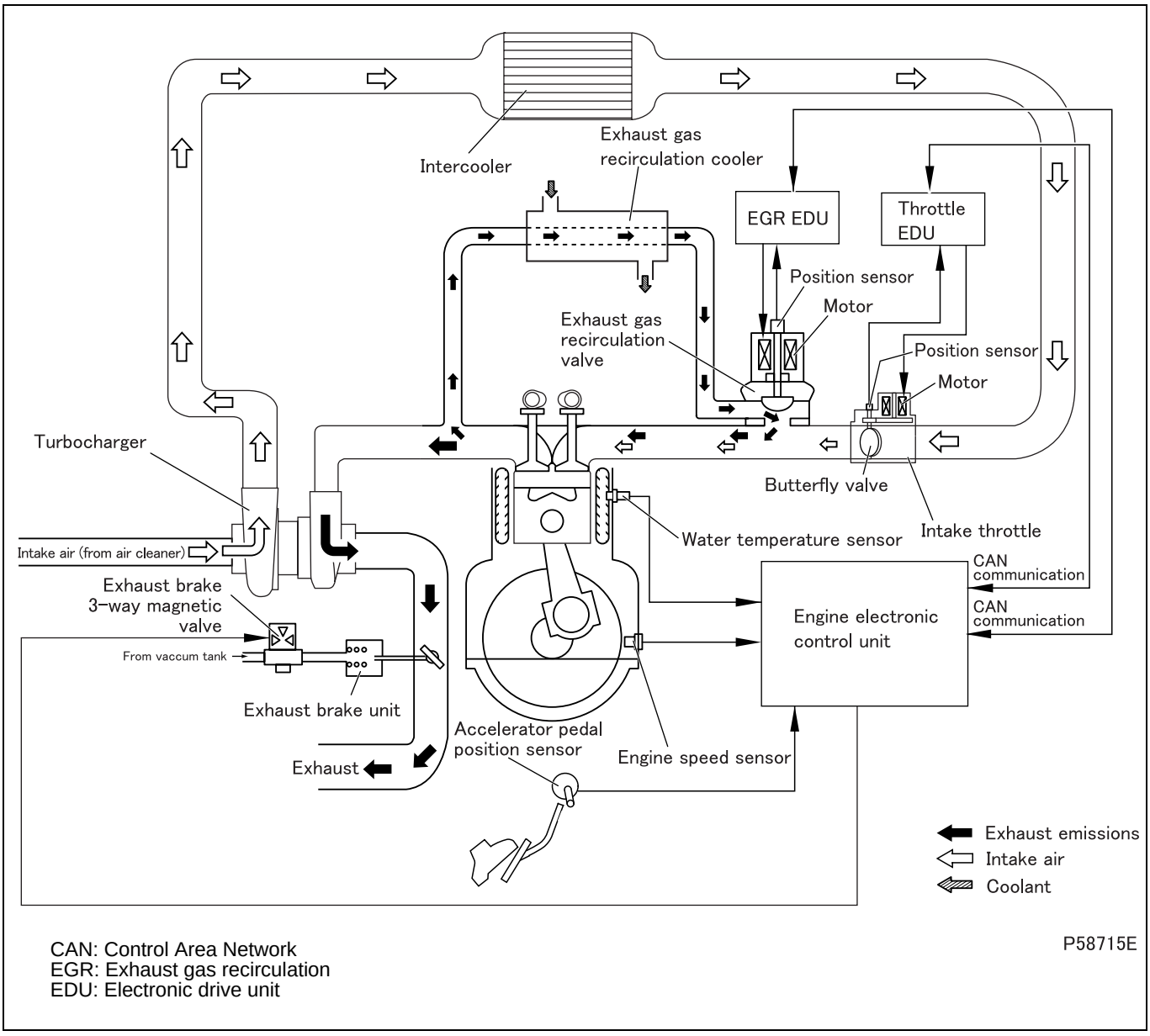
EXHAUST GAS RECIRCULATION VALVE, PIPE AND COOLER 17-24

CRANKCASE EMISSION CONTROL SYSTEM 17-26

1. Exhaust Gas Recirculation System

1.1 Overview

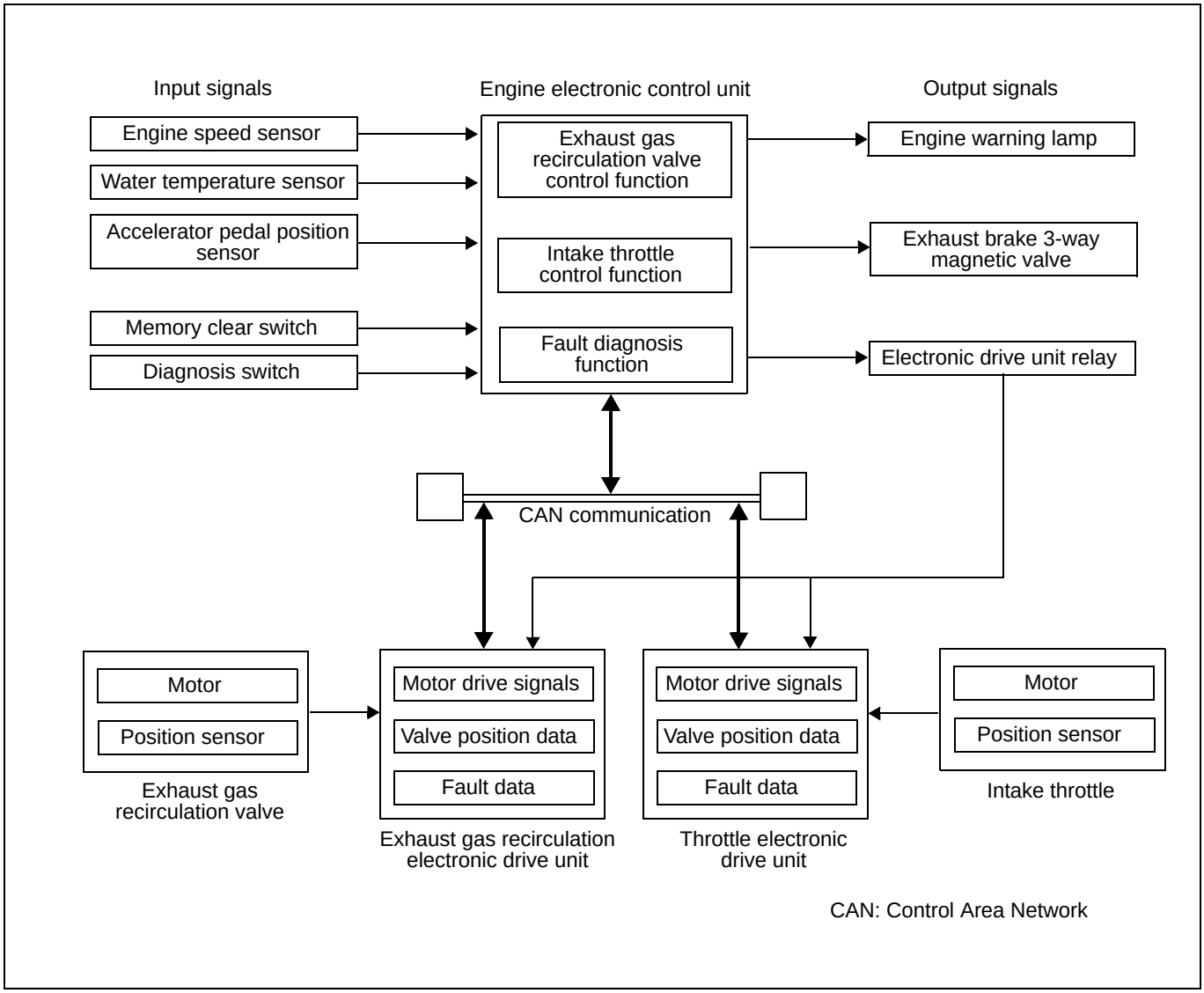
- In the exhaust gas recirculation system, the engine electronic control unit and multiple electronic drive units control the exhaust gas recirculation valve and intake throttle in accordance with information from sensors on various aspects of the engine (engine speed, coolant temperature, throttle opening, etc.).
- Exhaust gas recirculation involves the introduction of inert gases in the post-combustion exhaust emissions into the intake manifold. By reducing the combustion temperature, it reduces the amount of nitrogen oxides (NOx), which are harmful, in the exhaust emissions. Further, an exhaust gas recirculation cooler cools the recirculated exhaust emissions, thereby reducing the peak combustion temperature.
- The intake air quantity is adjusted by means of intake throttle control such that the effectiveness of exhaust gas recirculation is maximized.



CAN: Control Area Network
EGR: Exhaust gas recirculation
EDU: Electronic drive unit

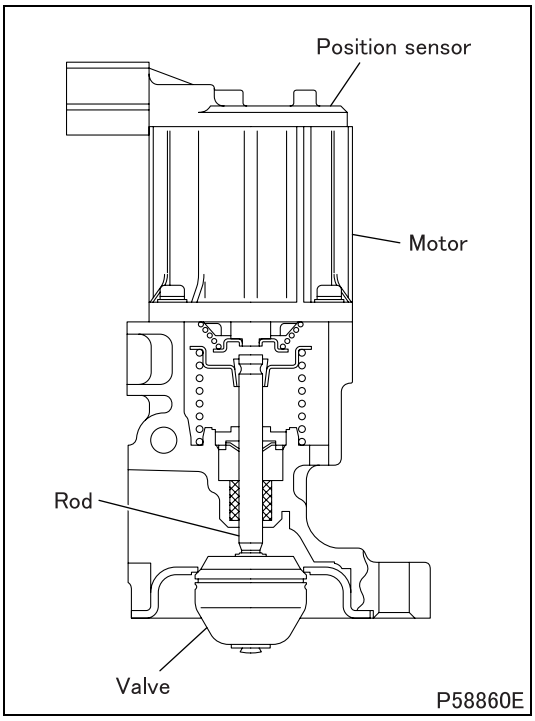
1.2 Electronic control system

(1) System block diagram



(2) Exhaust gas recirculation valve control function

- In accordance with data from sensors, the engine electronic control unit determines the exhaust gas recirculation valve opening that suits the operating condition and sends a control signal (this indicates the target exhaust gas recirculation valve opening) to the exhaust gas recirculation electronic drive unit.
  When necessary to prevent black smoke emissions and engine speed instability (for example, when the engine is heavily loaded, when the engine is lightly loaded, and when the exhaust brake is operating), the engine electronic control unit stops exhaust gas recirculation valve control.
- The exhaust gas recirculation electronic drive unit activates the exhaust gas recirculation valve motor. At the same time, it monitors the extent of valve lift using a position sensor and sends this information (this indicates the actual exhaust gas recirculation valve opening) to the engine electronic control unit.
  This operation makes it possible for the target exhaust gas recirculation valve opening indicated by the engine electronic control unit to be precisely maintained.

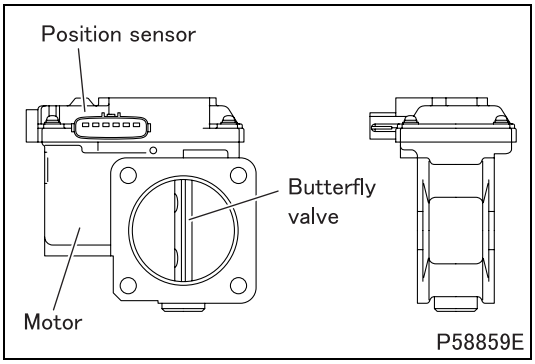


(2.1) Exhaust gas recirculation valve

- A motor in the exhaust gas recirculation valve is driven by control signals from the exhaust gas recirculation electronic drive unit. Via a rod, the motor's operation opens and closes the valve.

(3) Intake throttle control function

- When the engine electronic control unit determines from sensor data on the engine speed and engine loading that the vacuum pressure in the intake manifold is low, it increases the amount of exhaust emissions introduced into the intake manifold by determining an appropriate butterfly valve opening and by sending corresponding control signals (these indicate the target throttle opening) to the throttle electronic drive unit.
- The throttle electronic drive unit activates the valve motor. At the same time, it monitors the valve opening using a position sensor and sends this information (this indicates the actual throttle opening) to the engine electronic control unit.
  This operation makes it possible for the target throttle opening indicated by the engine electronic control unit to be precisely maintained.



(3.1) Intake throttle

- In accordance with signals from the throttle electronic drive unit, the motor opens and closes the butterfly valve, thereby adjusting the intake air amount such that the effectiveness of exhaust gas recirculation is maximized.

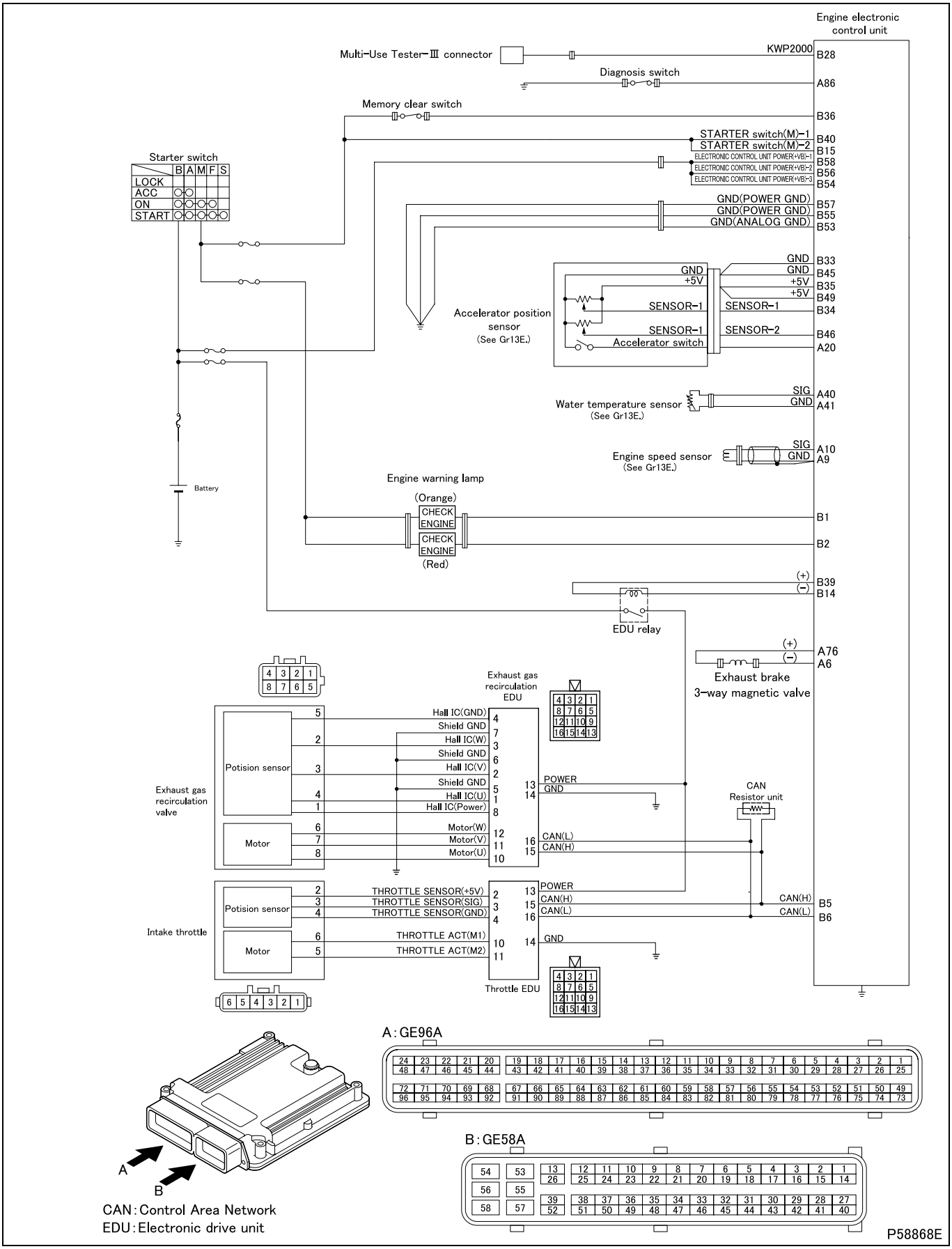
(4) Fault diagnosis function

- While the starter switch is in the ON position, the engine electronic control unit continuously monitors the electronic drive units and sensors for faults. In the event that the engine electronic control unit finds a component faulty, it causes an indication to be made in the meter cluster to alert the driver. At the same time, it memorizes the fault location in the form of a diagnosis code and starts a control during fault.
- While the engine is running, the exhaust gas recirculation electronic drive unit and throttle electronic drive unit continuously monitor communication with the position sensor and motor of the exhaust gas recirculation valve, communication with the position sensor and motor of the intake throttle, and communication with the engine electronic control unit. In the event that they identify a fault, they send fault data to the engine electronic control unit.
- While control necessitated by a fault is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

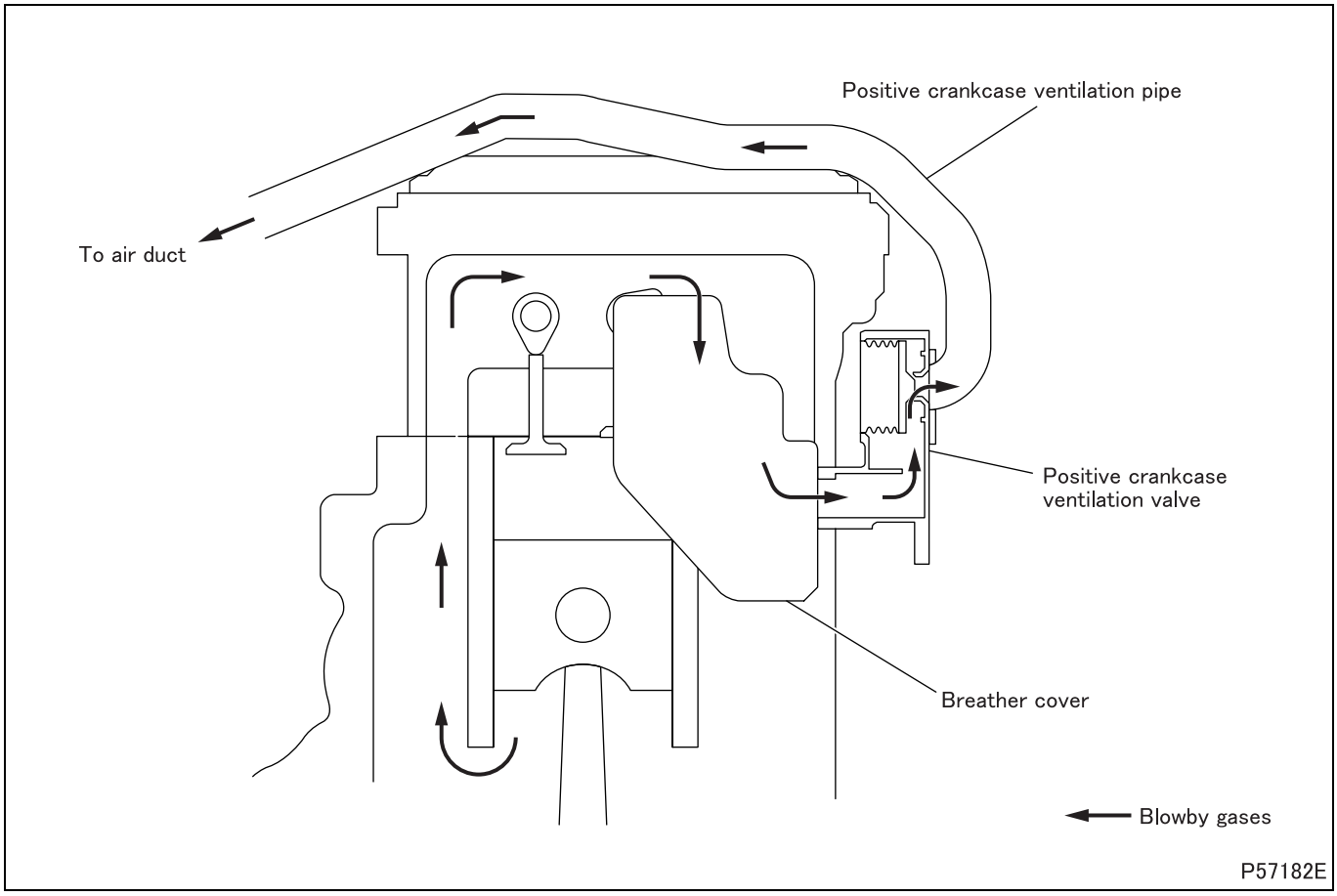
NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

1.3 Electronic control unit connection diagram



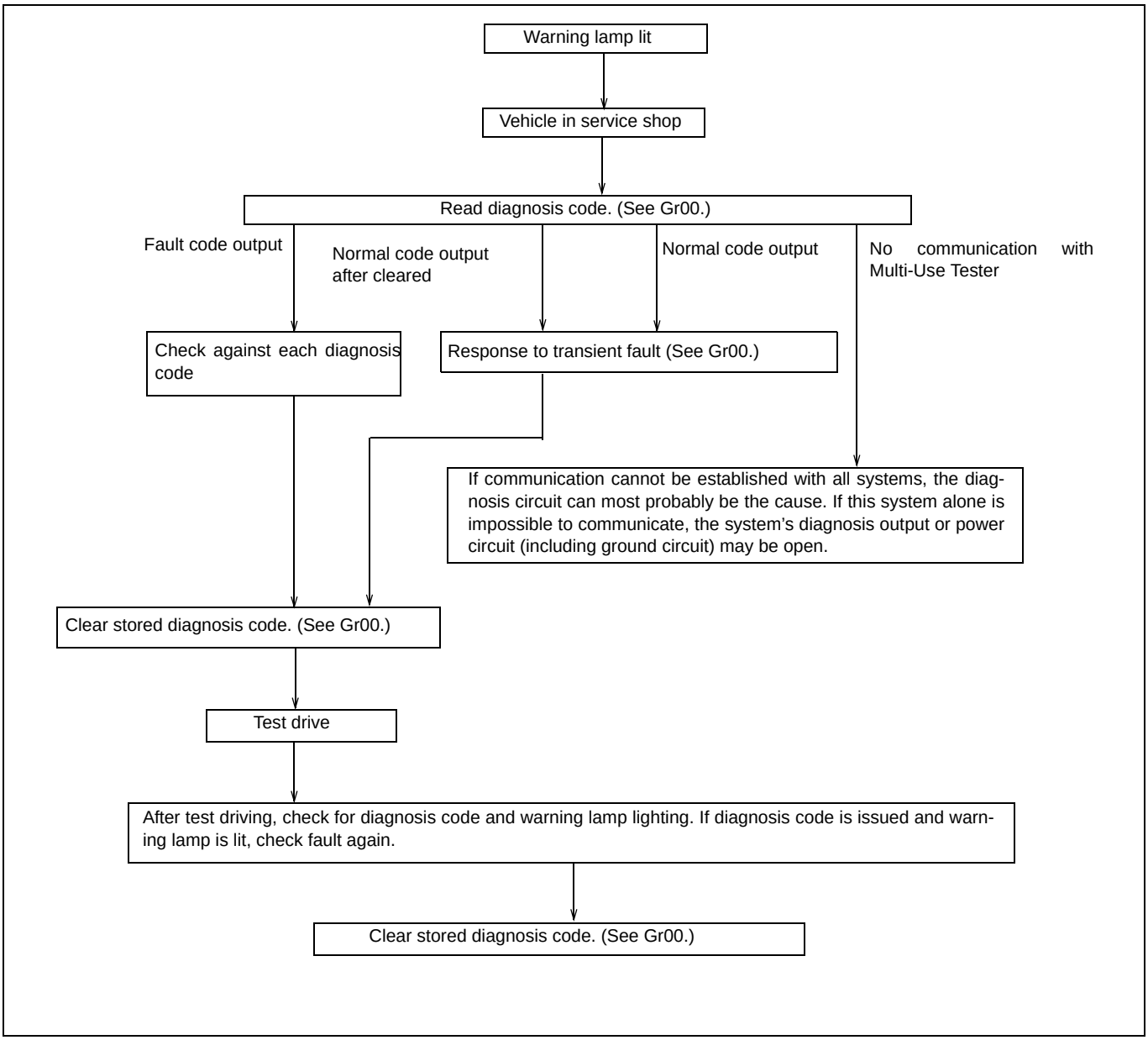
2. Crankcase Emission Control System



- The crankcase emission control system returns blowby gases to an air duct to prevent them from being released to the outside air.
- The positive crankcase ventilation valve keeps constant the pressure inside the crankcase.

1. Diagnosis Procedure

- The system can be efficiently inspected for faults using a Multi-Use Tester-III.
  System inspection can be accomplished basically in two ways according to trouble symptom and diagnosis code as shown below.
  - Check against each diagnosis code stored in memory by the electronic control unit
  - Response to transient fault



2. Diagnostic Precautions

- Before measuring voltage, check the battery for charged condition and specific gravity. If system inspection is performed with the battery uncharged or reduced in specific gravity, accurate measurements cannot be achieved.
- To avoid having electrical parts damaged, set the starter switch and lighting switch to LOCK or OFF before disconnecting and reconnecting battery cables.
- Before disconnecting connectors, set the starter switch to LOCK or OFF, then allow at least 20 seconds. Voltage may remain in electric parts or connected circuit.
- When performing measurement with the tester, handle the test bar carefully so that it does not damage internal circuit and other electrical parts of the electronic control unit to result in a short-circuit failure between terminals in connector or between connector and car body.
- Resistance is affected by temperature. Determine the necessity of resistance measurement following given temperature specification as a guide. Otherwise, use normal temperature (10 to 35°C {50 to 95°F}) as the measuring condition.

3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P0403	EGR 1	67
P0404	EGR System	02
P1121	Intake Throttle 1	28
P1625	EDU Relay	84
P1630	CAN (EGR)	95
P1635	CAN (intake throttle)	96

3.2 Diagnosis code generation conditions and inspection items

P0403: EGR 1 (warning lamp flashes: 67)

Generation condition		• Any of the following items: • Exhaust gas recirculation motor is short-circuited to earth, short-circuited to power supply line, or open-circuited. • Exhaust gas recirculation position sensor is open-circuited. • Abnormality (target position data outside range, data not received, etc.) occurs in communication between electronic drive unit and exhaust gas recirculation valve. • Power supply voltage is abnormal (excessively high or excessively low).
Recoverability		• Motor or sensor abnormality: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. • Communication or power supply voltage abnormality: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control and throttle control are stopped. • Exhaust gas recirculation system error evaluation is stopped. • Engine output lowered.
Inspection	Service data	1F: EGR Position
	Actuator test	A1: EGR 1
	Electrical equipment	• #530: Exhaust gas recirculation valve • Exhaust gas recirculation electronic drive unit • Engine electronic control unit
	Electric circuit diagram	Engine electronic control unit, exhaust gas recirculation electronic drive unit, and exhaust gas recirculation valve systems

P0404: EGR System (warning lamp flashes: 02)

Generation condition		Motor abnormality (permanent)
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Engine output lowered.
Inspection	Service data	1F: EGR Position
	Actuator test	A1: EGR 1
	Electrical equipment	• #530: Exhaust gas recirculation valve • Exhaust gas recirculation electronic drive unit • Engine electronic control unit
	Electric circuit diagram	Exhaust gas recirculation electronic drive unit and exhaust gas recirculation valve systems

P1121: Intake Throttle 1 (warning lamp flashes: 28)

Generation condition		Intake throttle abnormality (motor abnormality, position sensor abnormality, or motor seizure)
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Engine output lowered.
Inspection	Actuator test	A7: Intake Throttle 1
	Electrical equipment	• #529: Intake throttle • Throttle electronic drive unit • Engine electronic control unit
	Electric circuit diagram	Engine electronic control unit, throttle electronic drive unit, and intake throttle systems

P1625: EDU Relay (warning lamp flashes: 84)

Generation condition		Electronic drive unit relay is short-circuited, open-circuited, or overloaded.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control and throttle control are stopped. (Exhaust emissions worsen.) • Engine output lowered.
Inspection	Service data	90: EDU Power Relay
	Actuator test	B2: EDU Relay
	Electronic control unit connector	01 : Electronic drive unit relay
	Electrical equipment	#201: Electronic drive unit relay
	Electric circuit diagram	Electronic drive unit relay system

P1630: CAN (EGR) (warning lamp flashes: 95)

Generation condition		Communication with exhaust gas recirculation electronic drive unit is impossible. (CAN messages are not received for certain period, or CAN bus is off.)
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control and throttle control are stopped. (Exhaust emissions worsen.) • Engine output lowered.
Inspection	Actuator test	A1: EGR 1
	Electronic control unit connector	02 : CAN resistor
	Electrical equipment	• Exhaust gas recirculation electronic drive unit • Engine electronic control unit
	Electric circuit diagram	CAN communication circuitry to engine electronic control unit and exhaust gas recirculation electronic drive unit

P1635: CAN (intake throttle) (warning lamp flashes: 96)

Generation condition		Communication with throttle electronic drive unit is impossible. (CAN messages are not received for certain period, or CAN bus is off.)
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control and throttle control are stopped. (Exhaust emissions worsen.) • Engine output lowered.
Inspection	Actuator test	A7: Intake Throttle 1
	Electronic control unit connector	02 : CAN resistor
	Electrical equipment	• Throttle electronic drive unit • Engine electronic control unit
	Electric circuit diagram	CAN communication circuitry to engine electronic control unit and throttle electronic drive unit

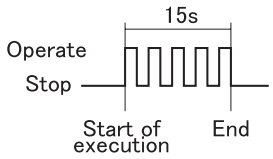
4. Multi-Use Tester Service Data

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
1F	EGR Position	■■■.■ %	Idling	0 %
20	Intake Throttle Position	■■■.■ %	Idling	50 %
90	EDU Power Relay	ON/OFF	Starter switch ON	ON
			Starter switch OFF	OFF
			[Actuator test] B2: EDU relay	

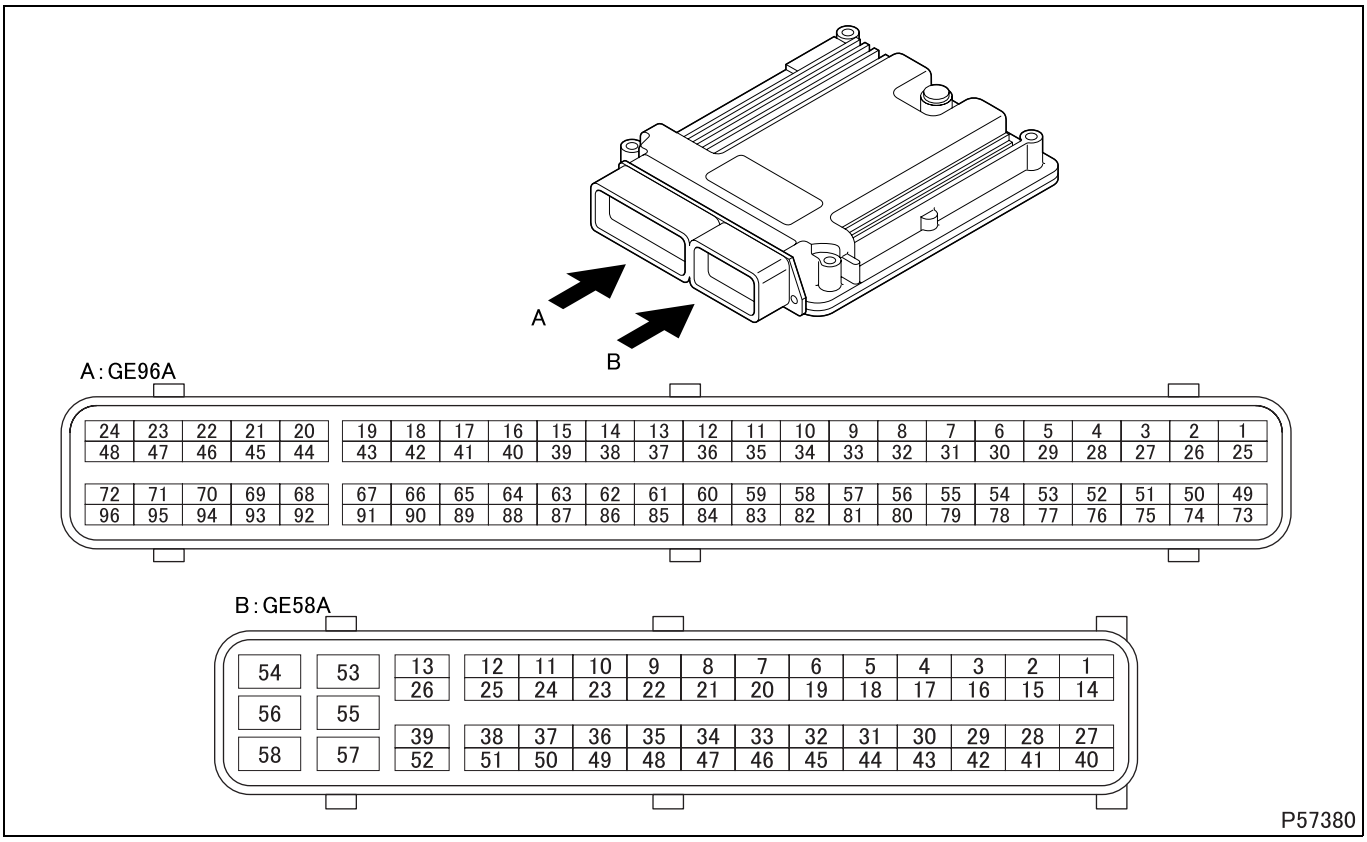
5. Actuator Tests Performed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
A1	EGR 1	Maintain exhaust gas recirculation valve opening indicated by Multi-Use Tester.	[Service data] 1F: EGR Position
A7	Intake Throttle 1	Maintain intake throttle opening indicated by Multi-Use Tester.	[Service data] 20: Intake Throttle position
B2	EDU Relay	Electronic drive unit relay drive signal (Errors related to exhaust gas recirculation and to the intake throttle can be detected when this actuator test is executed.)  P58223E	Relay operating sound [Service data] 90: EDU Power Relay

6. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black number **01** corresponds to the similarly printed reference number in section "**3. Inspections based on diagnosis codes**".

6.1 Electronic control unit connector terminal layout



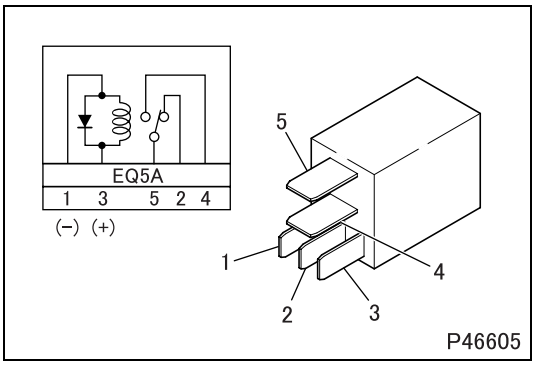
6.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

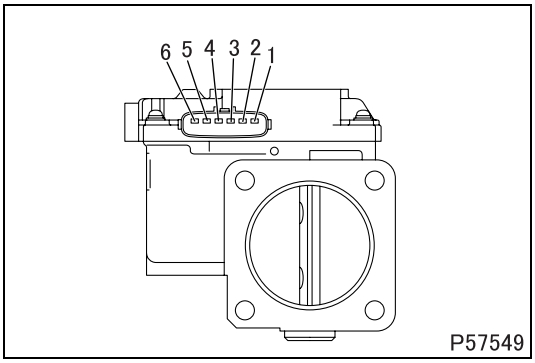
Check item	Measurement method
01 Voltage of electronic drive unit relay	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): B39-B14 • With relay operating: Corresponding to battery voltage • With relay not operating: 0V
02 Resistance of CAN resistor	[Conditions] • Starter switch OFF • Disconnect connecter. Perform inspection on vehicle-side connector. [Requirements] Terminals : B5-B6 • 120 ± 6Ω

7. Inspection of Electrical Equipment



#201 Inspection of relay (normally open, 5 pins)

- Perform a continuity check and an operation check. If there is any abnormality, replace the relay.



#529 Inspection of intake throttle

- Perform the following checks. If there is any abnormality, replace the throttle.

(1) Coil resistance of motor

- Measure the resistance between terminals 5 and 6.

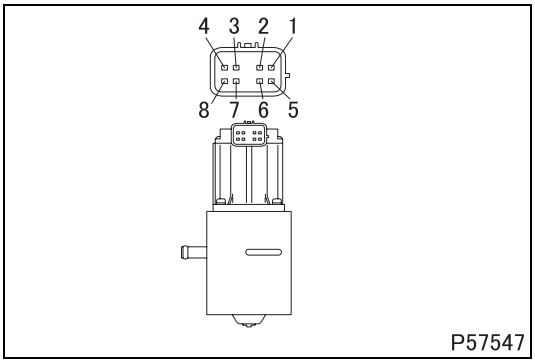
Standard value	0.3 to 80 Ω

NOTE

- **If the measurement deviates from the standard value, measure the resistance again after manually opening and closing the butterfly valve 5 times.**

(2) Position sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the intake throttle.



#530 Inspection of exhaust gas recirculation valve

- Perform the following checks. If there is any abnormality, replace the exhaust gas recirculation valve.

(1) Coil resistance of motor

- Measure the resistance between terminals 8 and 7, the resistance between terminals 8 and 6, and the resistance between terminals 7 and 6.

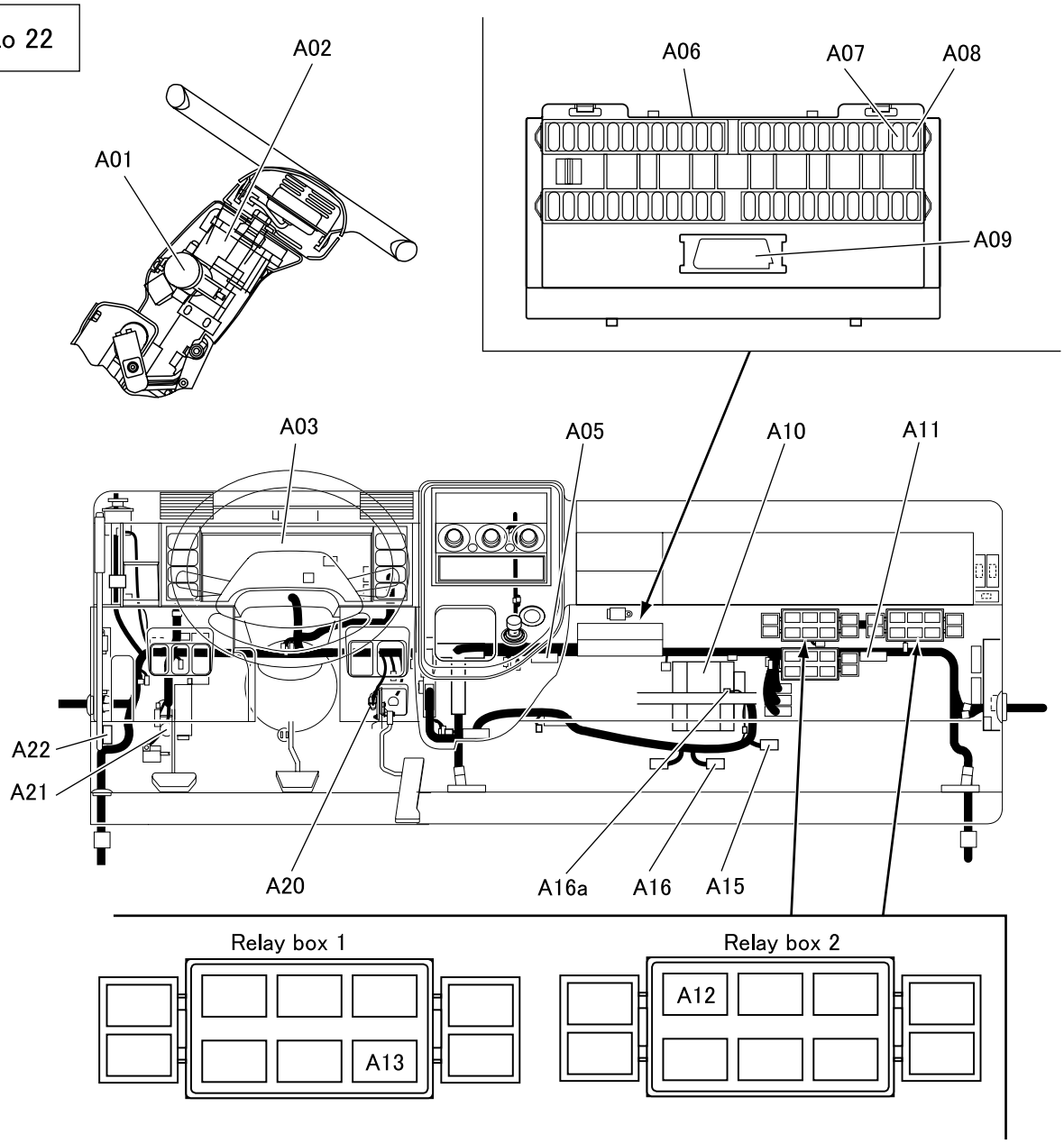
Standard value	2.1 ± 0.3 Ω

(2) Position sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the exhaust gas recirculation valve.

8. Installed Locations of Parts

A01 to 22



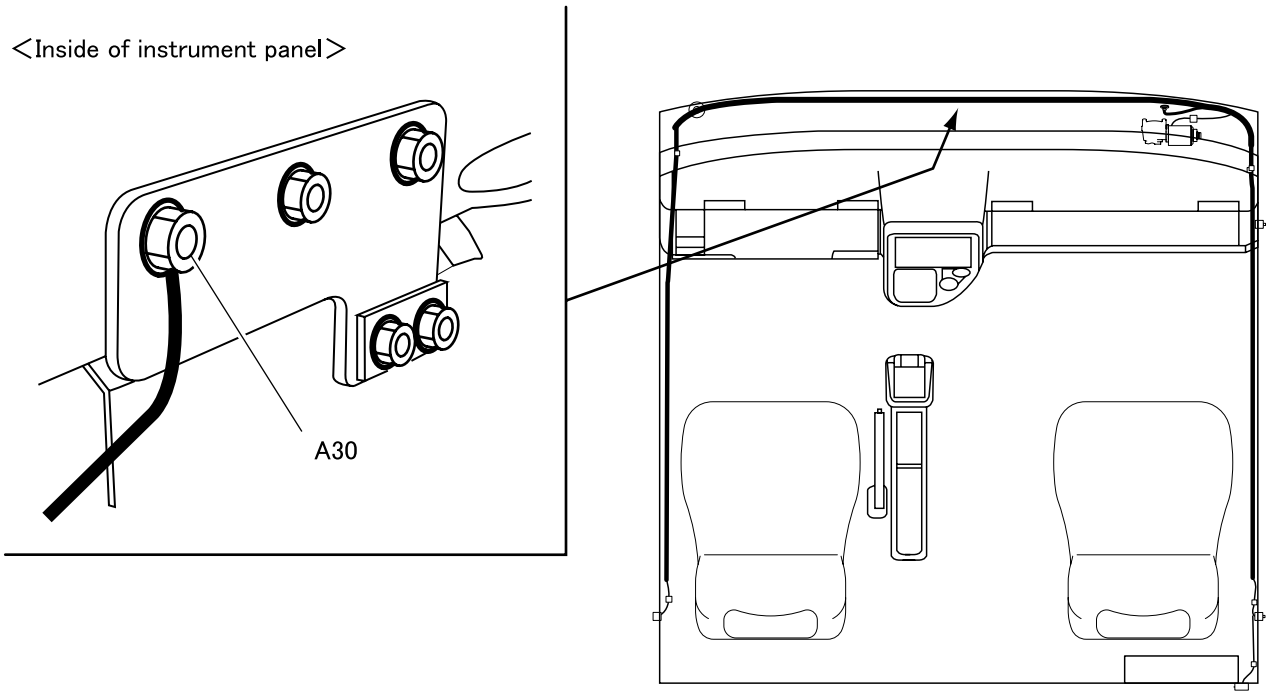
No relevant parts in a missing number

A01 Starter switch
A02 Combination switch
A03 Meter cluster
A05 Joint connector (J/C-1)
A06 Fuse box
A07 Diagnosis switch
A08 Memory clear switch
A09 Multi-Use Tester-Ⅲ connector (for recorder)
A10 Engine ECU
A11 Joint connector (J/C-2, 3)
A12 ABS exhaust brake cut relay
A13 Exhaust brake cut relay <A/T>
A15 Joint connector (J/C-4)
A16 Resister unit
A16a Ground
A20 Accelerator pedal position sensor
A21 Clutch switch
A22 Multi-Use Tester-Ⅲ connector (for inspection)

ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit

L00190

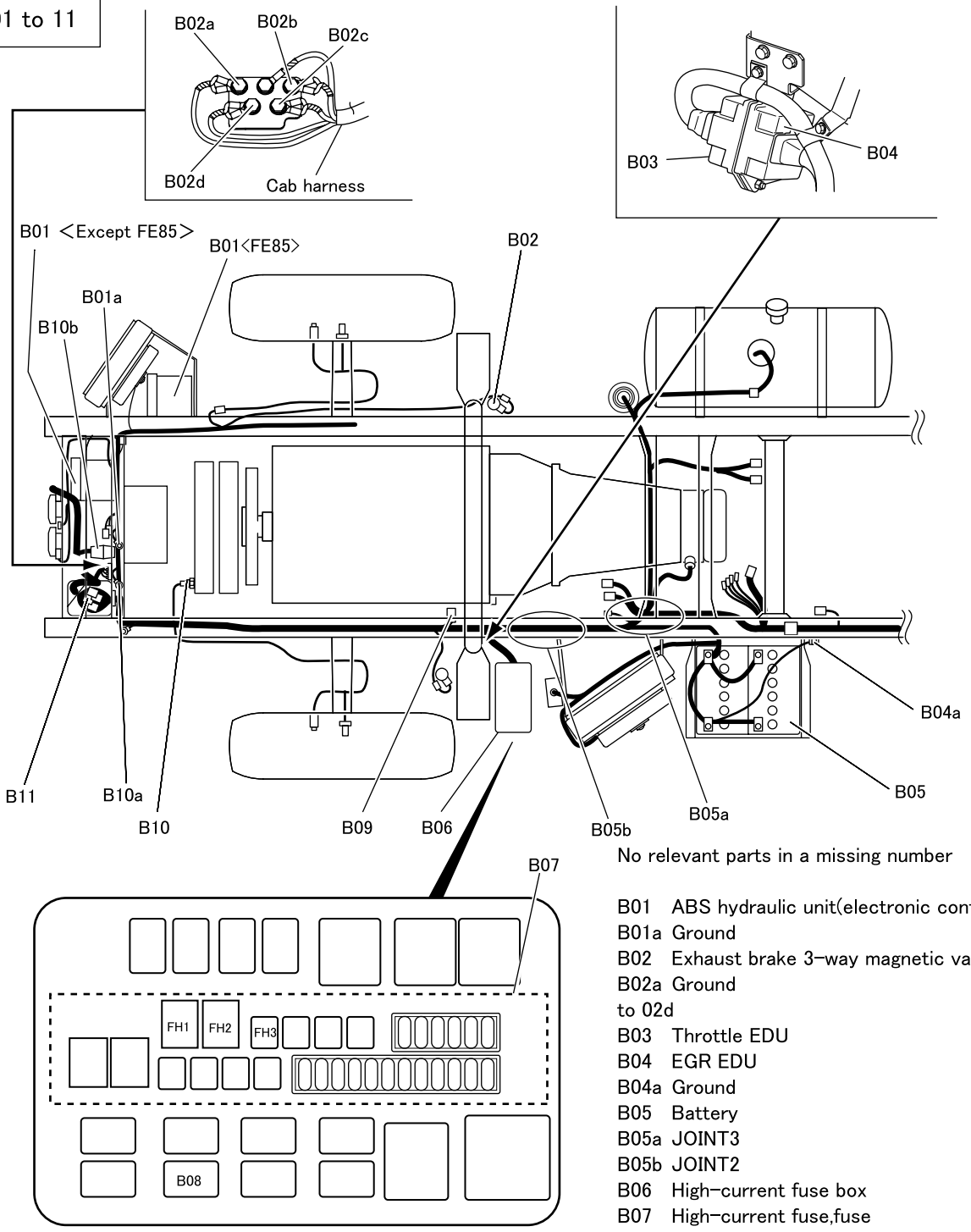
A30



A30 Ground

L00183

B01 to 11



No relevant parts in a missing number

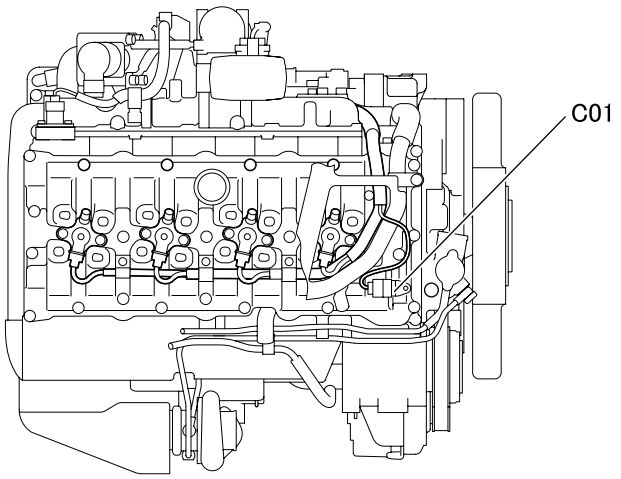
B01 ABS hydraulic unit(electronic control unit)
B01a Ground
B02 Exhaust brake 3-way magnetic valve
B02a Ground
to 02d
B03 Throttle EDU
B04 EGR EDU
B04a Ground
B05 Battery
B05a JOINT3
B05b JOINT2
B06 High-current fuse box
B07 High-current fuse,fuse
B08 EDU relay
B09 Joint connector
B10 Boost air temperature sensor
B10a Ground
B10b Connection of cab harness and engine harness
B11 Connection of chassis harness and cab harness or engine herness

ABS : Anti-lock brake system
EGR : Exhaust-gas recirculation
EDU : Electronic drive unit

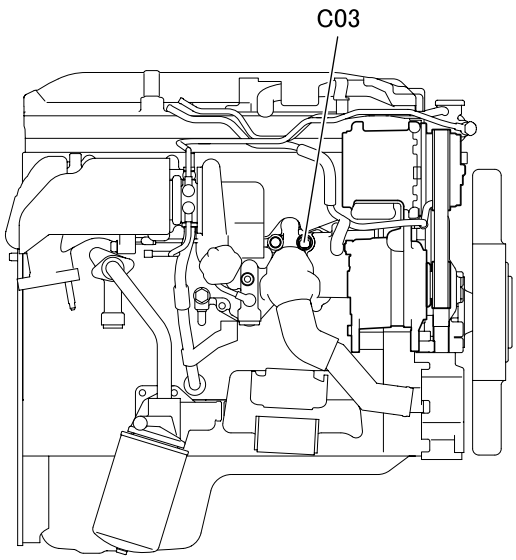
L01273

C01 to 06

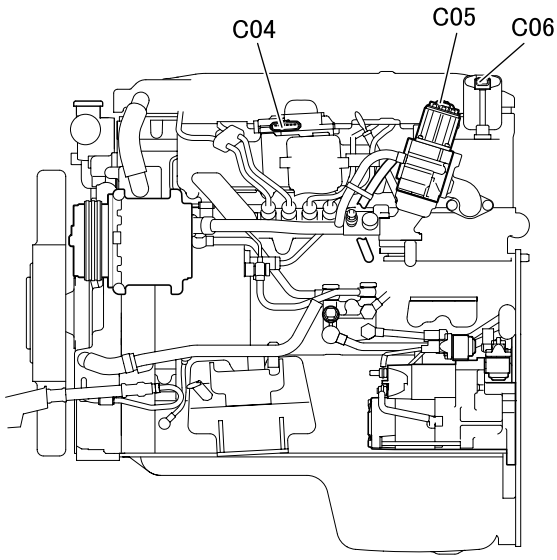
Upper view



Right side view



Left side view



No relevant parts in a missing number

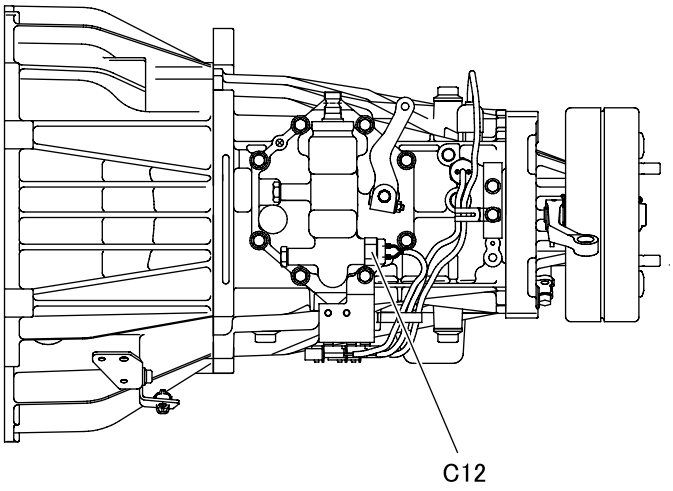
C01 Cylinder recognition sensor
C03 Water temperature sensor
(Connects to engine ECU)
C04 Intake throttle
(Building into motor, position sensor)
C05 EGR valve
(Building into motor, position sensor)
C06 Boost pressure sensor

ECU : Electronic control unit
EGR : Exhaust-gas recirculation

L00191

C12 to 14 Manual transmission

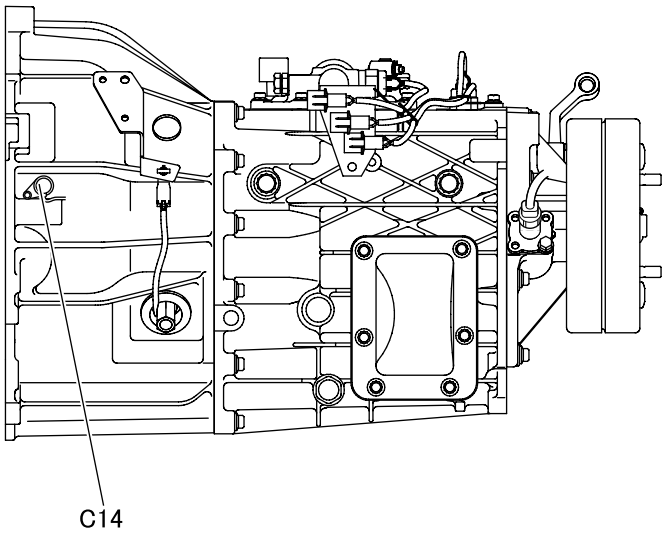
Upper view



No relevant parts in a missing number

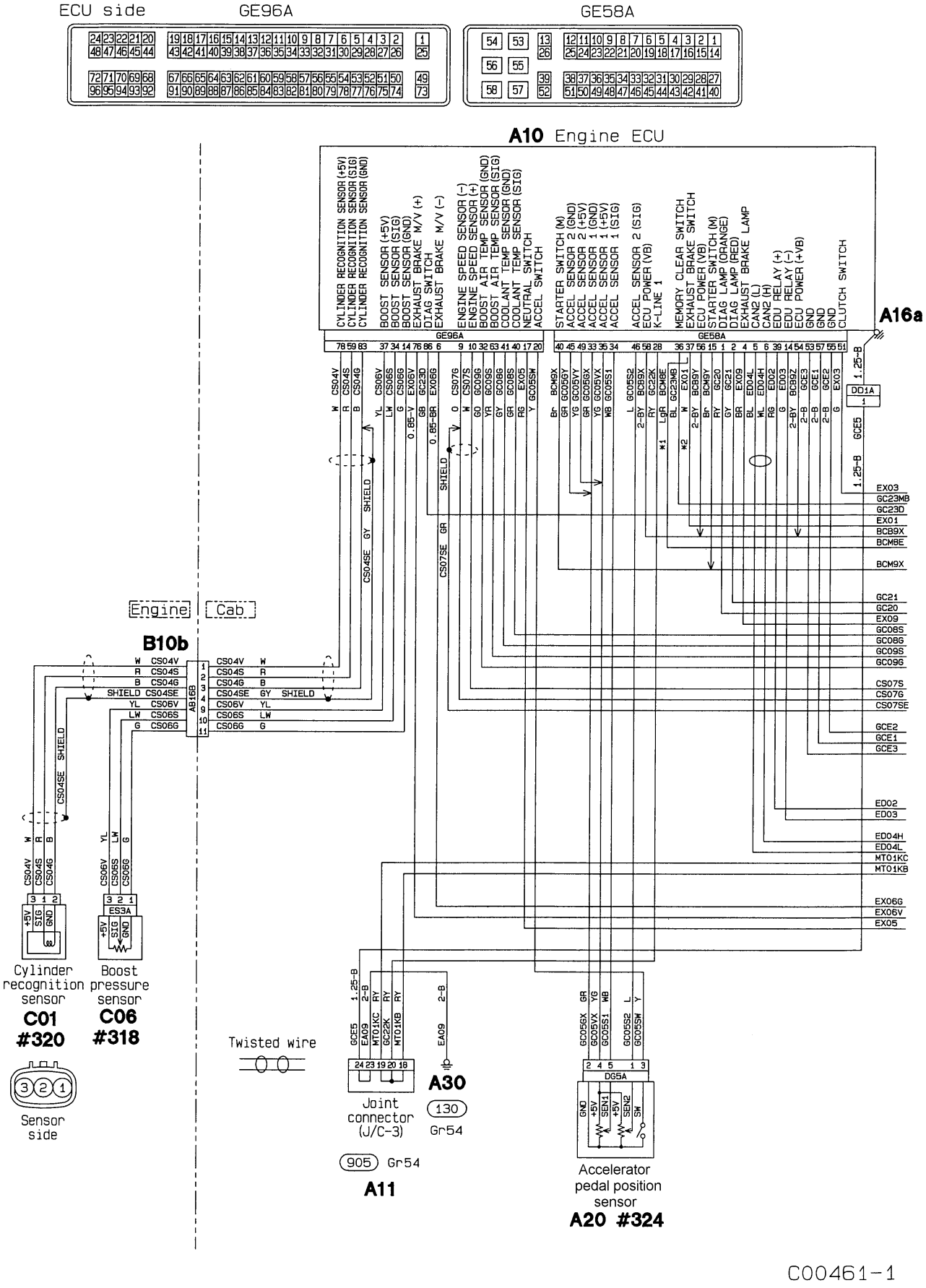
C12 Transmission neutral switch
C14 Engine speed sensor

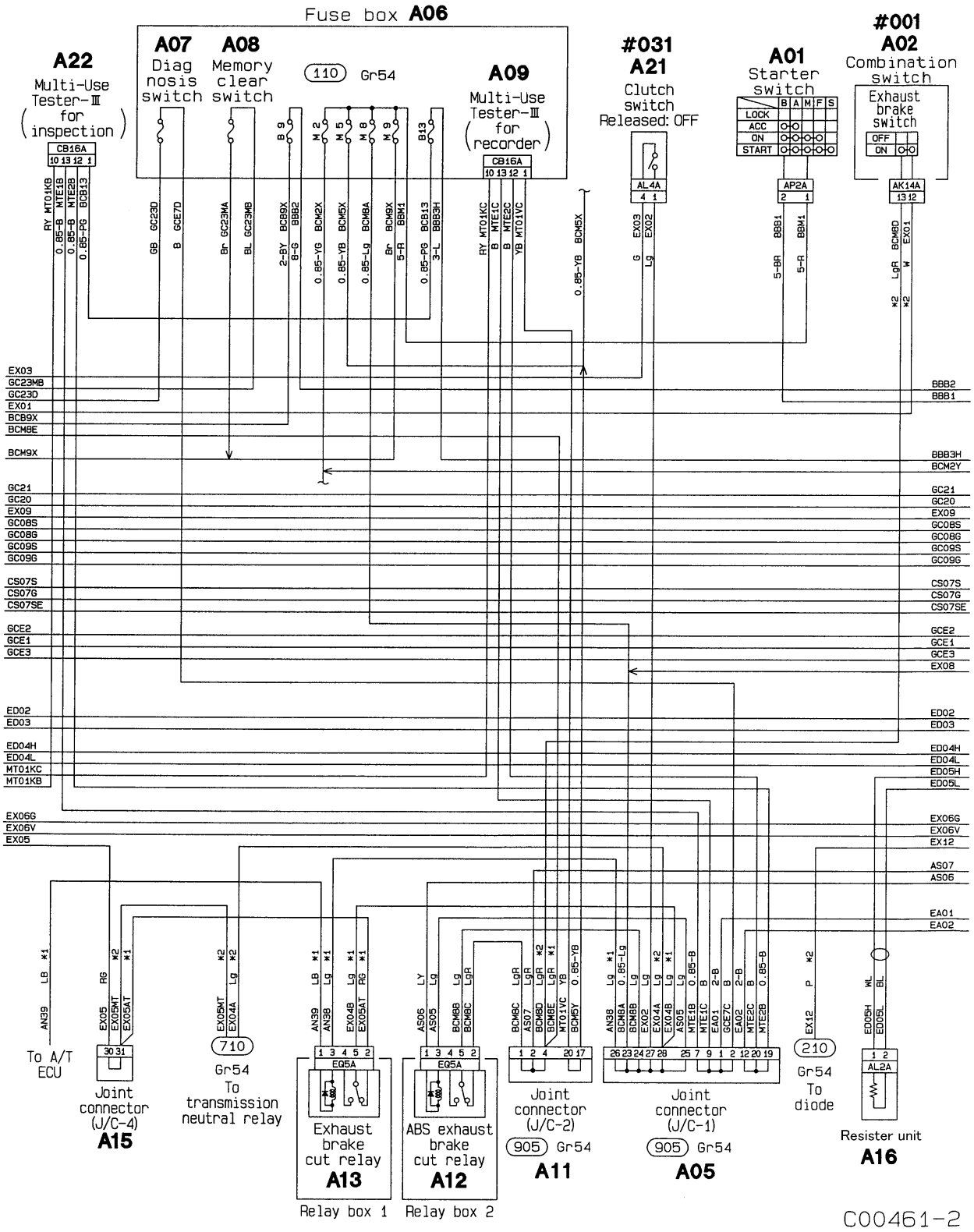
Left side view

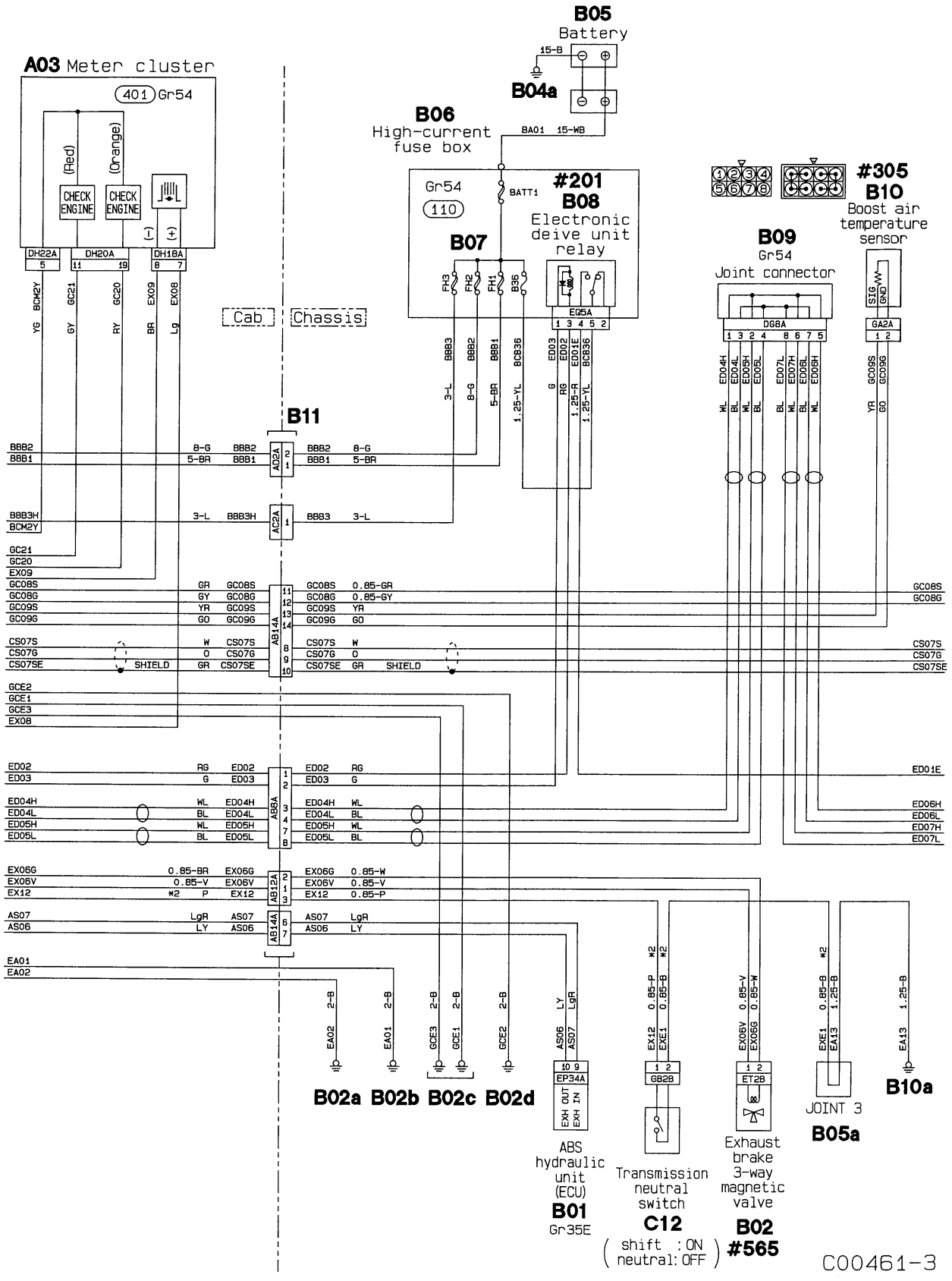


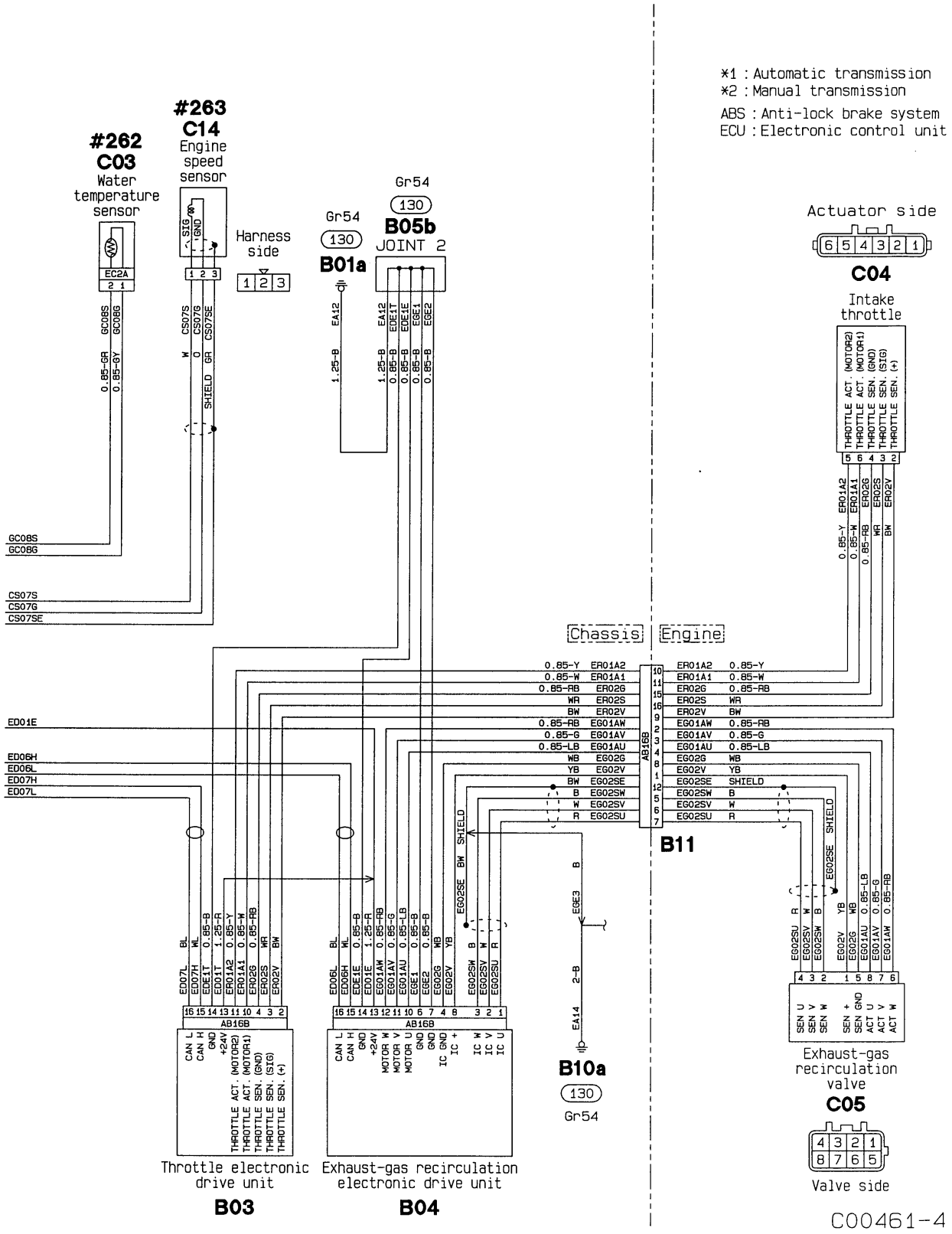
L00192

9. Electric Circuit Diagram

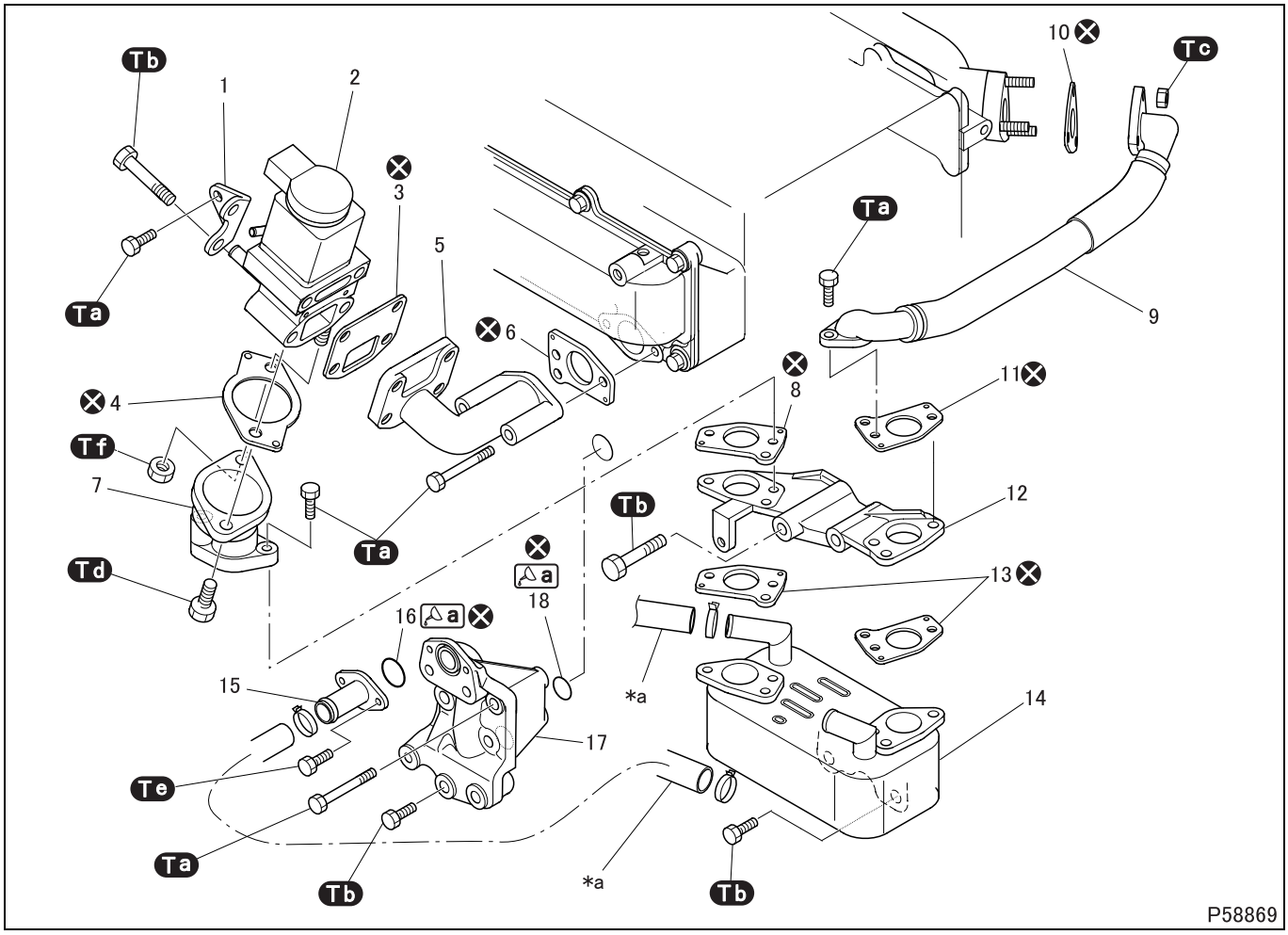



Fuse box A06
A22
Multi-Use Tester-III for inspection
A07
Diag nosis switch
A08
Memory clear switch
110 Gr54
A09
Multi-Use Tester-III for recorder
#031
A21
Clutch switch Released: OFF
A01
Starter switch
#001
A02
Combination switch
Exhaust brake switch
To A/T ECU
Joint connector (J/C-4)
A15
710 Gr54
To transmission neutral relay
Exhaust brake cut relay
A13
ABS exhaust brake cut relay
A12
Relay box 1
Relay box 2
Joint connector (J/C-2)
905 Gr54
A11
Joint connector (J/C-1)
905 Gr54
A05
210 Gr54
To diode
Resister unit
A16
C00461-2


A03 Meter cluster
401 Gr54
(Red)
(Orange)
CHECK ENGINE
CHECK ENGINE
(-)
(+)
DH22A
DH20A
DH18A
BCM2Y
GC21
GC20
EX09
EX08
YG
GY
RY
BR
Lg
Cab
Chassis
B05
Battery
15-B
B04a
B06
High-current fuse box
BA01 15-WB
Gr54
110
BATT1
#201
B08
Electronic deive unit relay
B07
FH3
FH2
FH1
B36
EQ5A
#305
B10
Boost air temperature sensor
B09
Gr54
Joint connector
D68A
GA2A
STG
GND
B11
AD2A
AC2A
AB14A
AB8A
AB12A
BBB2 8-G
BBB1 5-BR
BBB3H 3-L
BBB3 3-L
GC08S GR
GC08G GY
GC09S YR
GC09G GO
CS07S W
CS07G O
CS07SE GR SHIELD
GCE2
GCE1
GCE3
EX08
ED02 RG
ED03 G
ED04H WL
ED04L BL
ED05H WL
ED05L BL
EX06G 0.85-BR
EX06V 0.85-V
EX12 *2 P
AS07 LgR
AS06 LY
EA01
EA02
ED01E
ED06H
ED06L
ED07H
ED07L
CS07S
CS07G
CS07SE
B02a B02b B02c B02d
EP34A
EXH OUT
EXH IN
ABS hydraulic unit (ECU)
B01
Gr35E
GB28
Transmission neutral switch
C12
shift : ON
neutral: OFF
ET28
Exhaust brake 3-way magnetic valve
B02
#565
JOINT 3
B05a
B10a
C00461-3


*1 : Automatic transmission
*2 : Manual transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
#262
C03
Water temperature sensor
#263
C14
Engine speed sensor
Harness side
Gr54
130
B01a
Gr54
130
B05b
JOINT 2
Actuator side
C04
Intake throttle
Chassis
Engine
B11
B10a
Gr54
130
Throttle electronic drive unit
B03
Exhaust-gas recirculation electronic drive unit
B04
Exhaust-gas recirculation valve
C05
Valve side
C00461-4

EXHAUST GAS RECIRCULATION VALVE, PIPE AND COOLER



● **Removal sequence**

- **1** Exhaust gas recirculation bracket
- **2** Exhaust gas recirculation valve
- **3** Exhaust gas recirculation valve gasket B
- **4** Exhaust gas recirculation valve gasket A
- **5** Exhaust gas recirculation cooler adapter B
- **6** Exhaust gas recirculation gasket
- **7** Exhaust gas recirculation cooler adapter A
- **8** Exhaust gas recirculation gasket
- **9** Exhaust gas recirculation pipe
- **10** Exhaust gas recirculation pipe gasket
- **11** Exhaust gas recirculation gasket
- **12** Exhaust gas recirculation cooler bracket B
- **13** Exhaust gas recirculation gasket
- **14** Exhaust gas recirculation cooler
- **15** Connector
- **16** O-ring
- **17** Exhaust gas recirculation cooler bracket A
- **18** O-ring

***a**: Water hose
⊗: Non-reusable parts

NOTE

- **Even when all coolant in the crankcase has been drained out, approximately 1L {1.1qt.} of coolant remains in the exhaust gas recirculation cooler. Before removing the exhaust gas recirculation cooler, make ready a container to catch the coolant.**

● **Installation sequence**

Perform installation by following the removal sequence in reverse.

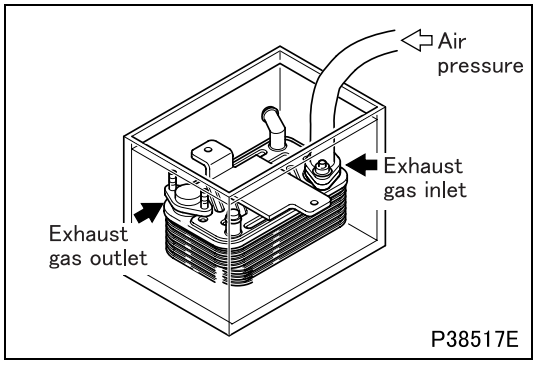
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (mounting of exhaust gas recirculation bracket)	23.2 {17, 2.4}	–
	Bolt (mounting of exhaust gas recirculation cooler adapter A)		
	Bolt (mounting of exhaust gas recirculation cooler adapter B)		
	Nut (mounting of exhaust gas recirculation pipe)		
	M8 bolt (mounting of exhaust gas recirculation cooler bracket A)		
Tb	Bolt (mounting of exhaust gas recirculation valve)	44.5 {33, 4.5}	–
	Bolt (mounting of exhaust gas recirculation cooler)		
	M10 bolt (mounting of exhaust gas recirculation cooler bracket A)		
	Bolt (mounting of exhaust gas recirculation cooler bracket B)		
Tc	Nut (mounting of exhaust gas recirculation pipe)	20.6 {15, 2.1}	–
Td	Bolt (mounting of exhaust gas recirculation valve)	57.5 {42, 5.9}	–
Te	Bolt (mounting of connector)	8 {5.9, 0.82}	–
Tf	Nut (mounting of exhaust gas recirculation valve)	57.5 {42, 5.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Soapy water	As required

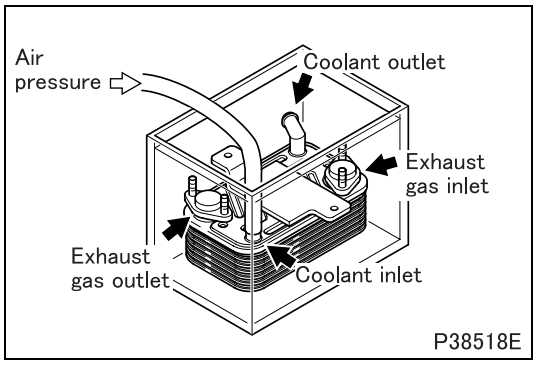
◆Inspection procedures◆



■ Inspection: Exhaust gas recirculation cooler

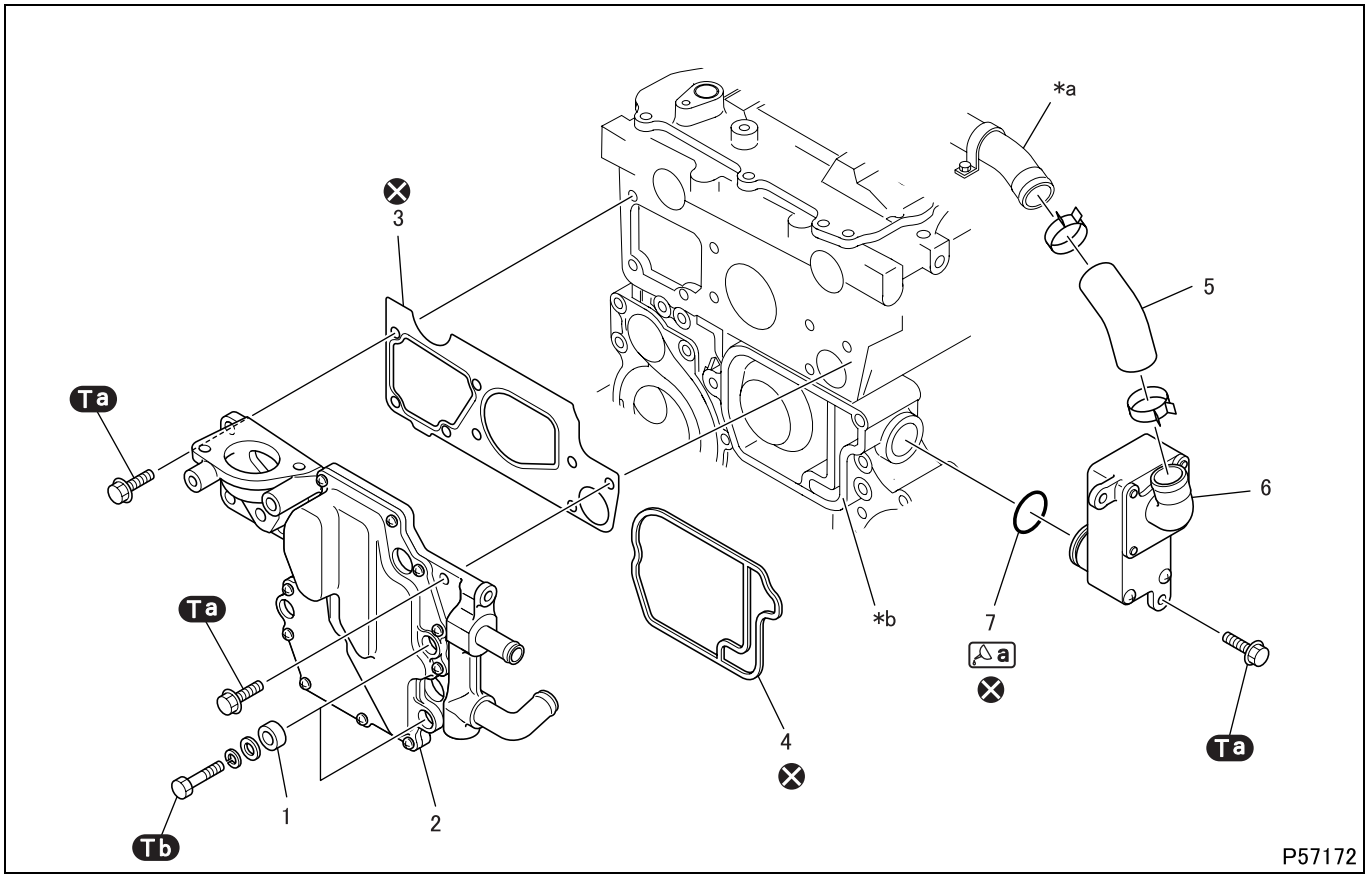
(1) Exhaust gas passage side

- Fit a cover over the exhaust gas outlet of the exhaust gas recirculation cooler, and connect a hose to the exhaust gas inlet. Then, submerge the exhaust gas recirculation cooler in a container of water. Make sure the coolant passage is full of water.
- Apply air pressure of 294 kPa {43 psi, 3 kgf/cm^2} through the hose. Check that air does not leak from any part of the exhaust gas recirculation cooler.
- If there is any abnormality, replace the exhaust gas recirculation cooler.



(2) Coolant passage side

- Fit covers over the exhaust gas recirculation cooler's exhaust gas inlet, exhaust gas outlet, and coolant outlet, and connect a hose to the coolant inlet. Then, submerge the exhaust gas recirculation cooler in a container of water.
- Apply air pressure of 196 kPa {28 psi, 2 kgf/cm^2} through the hose. Check that air does not leak from any part of the exhaust gas recirculation cooler.
- If there is any abnormality, replace the exhaust gas recirculation cooler.



● **Removal sequence**

1 Spacer
2 Breather cover (See later section.)
3 Gasket
4 Breather gasket
5 PCV hose
6 PCV valve
7 O-ring
***a**: PCV pipe
***b**: Front case
⊗: Non-reusable parts
PCV: Positive crankcase ventilation

● **Installation sequence**

Perform installation by following the removal sequence in reverse.

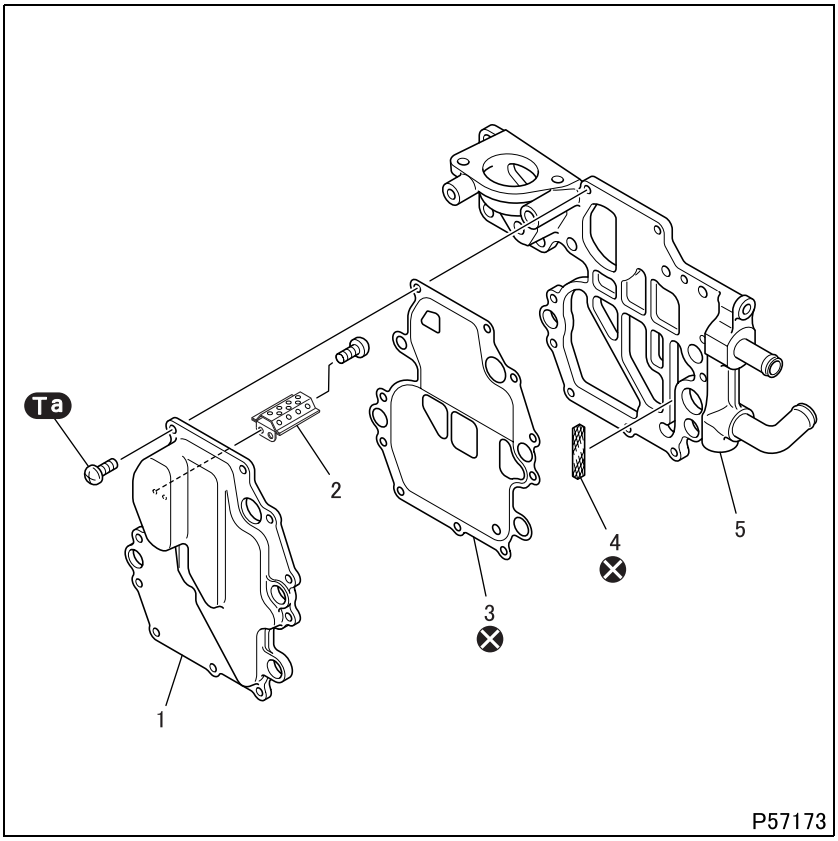
Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (mounting of breather cover)	23.2 {17, 2.4}	–
	Bolt (mounting of PCV valve)		
Tb	Bolt (mounting of breather cover)	9.8 {7.2, 1.0}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	–

Breather cover



● **Removal sequence**

1 Breather cover A
2 Separator plate
3 Gasket
4 Element
5 Breather cover B

⊗:Non-reusable parts

Tightening torque (Unit: N·m {lbf·ft, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (mounting of breather cover)	7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	–

GROUP 21 INDEX

SPECIFICATIONS 21-2

STRUCTURE AND OPERATION

1. **Clutch Control 21-3**
2. **Clutch Master Cylinder 21-4**
3. **Clutch Proper and Clutch Direct Power Cylinder..... 21-6**

TROUBLESHOOTING 21-8

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. **Replacement of Brake Fluid (Clutch System) 21-10**
2. **Air Bleeding of Brake Fluid (Clutch System) 21-12**
3. **Inspection of Clutch Disc Wear Limit 21-14**

CLUTCH PEDAL 21-16

CLUTCH MASTER CYLINDER..... 21-20

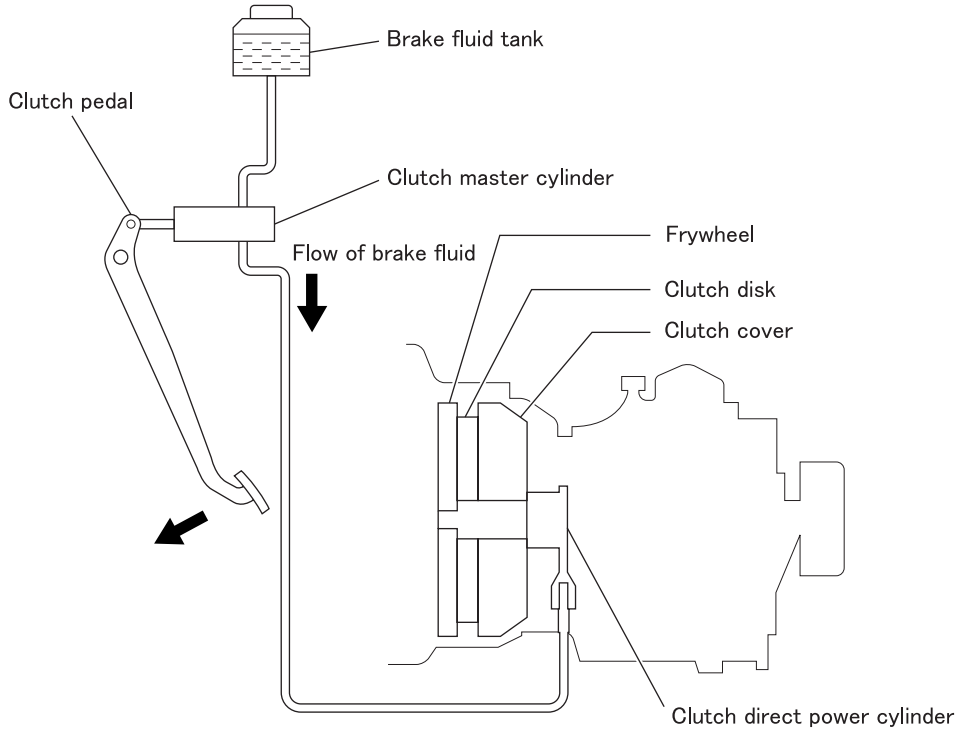
CLUTCH PROPER 21-22

CLUTCH CONTROL..... 21-26

SPECIFICATIONS

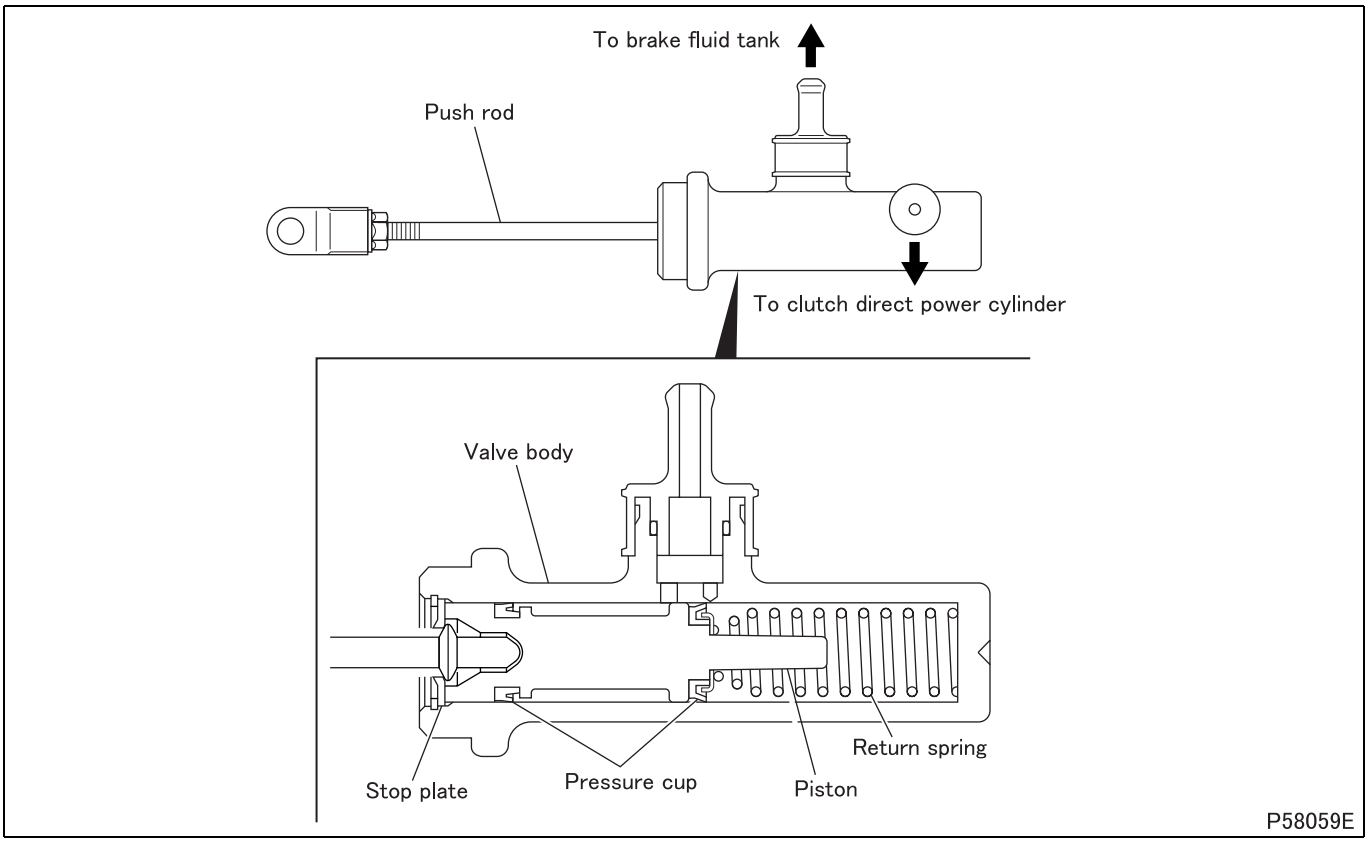
Item	Specifications
Clutch model	C5W33
Drive type	Strap drive
Clutch disc type	Dry, single plate
Pressure plate type	Diaphragm spring
Control system	Fluid pressure
Clutch master cylinder manufacturer	NISSIN KOGYO CO., LTD
Clutch direct power cylinder manufacturer	NISSIN KOGYO CO., LTD

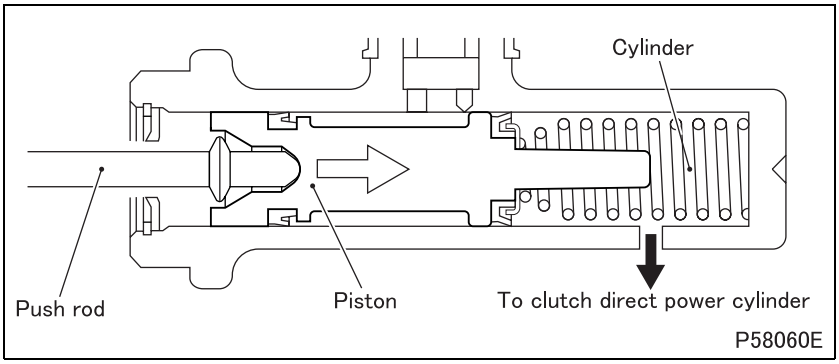
1. Clutch Control



- Fluid pressure is used to control the clutch operation.
- When the clutch pedal is depressed, the boost force is then applied to the clutch master cylinder. This pressurizes the brake fluid inside the clutch master cylinder, pushing the clutch direct power cylinder and disengaging the clutch.

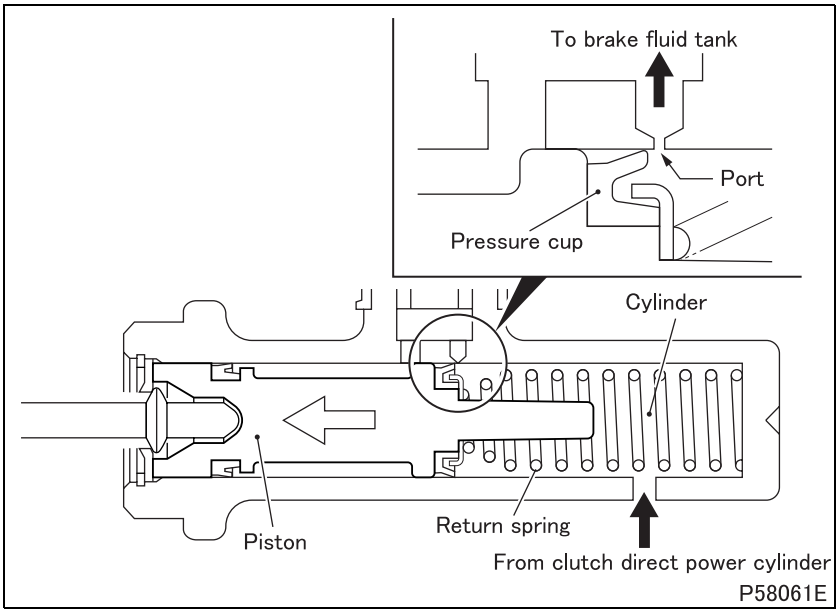
2. Clutch Master Cylinder





2.1 When clutch pedal is depressed

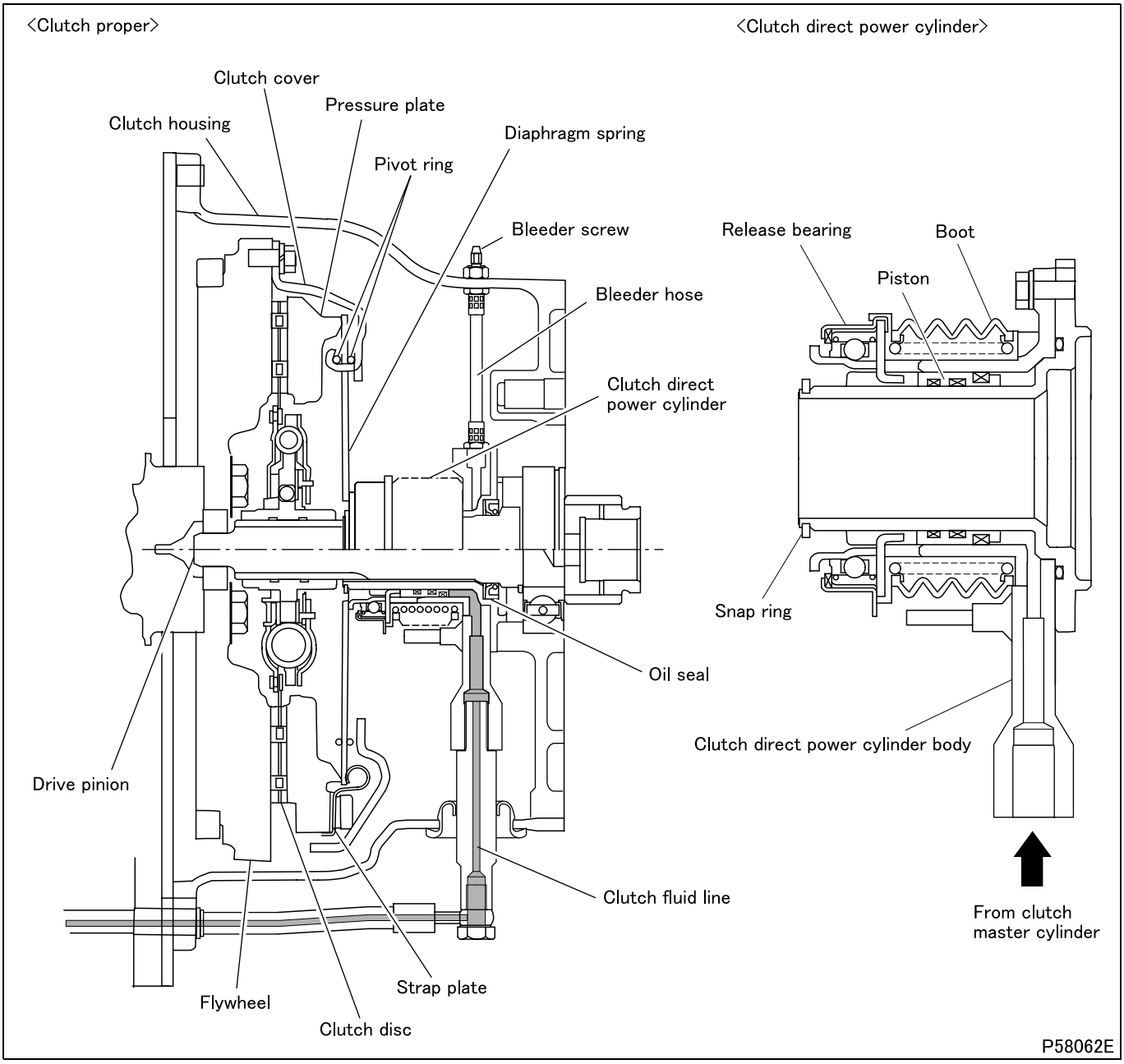
- The piston is pushed to the right by the push rod, pressurizing the brake fluid in the cylinder.
- This brake fluid pressure is transmitted to the clutch direct power cylinder.



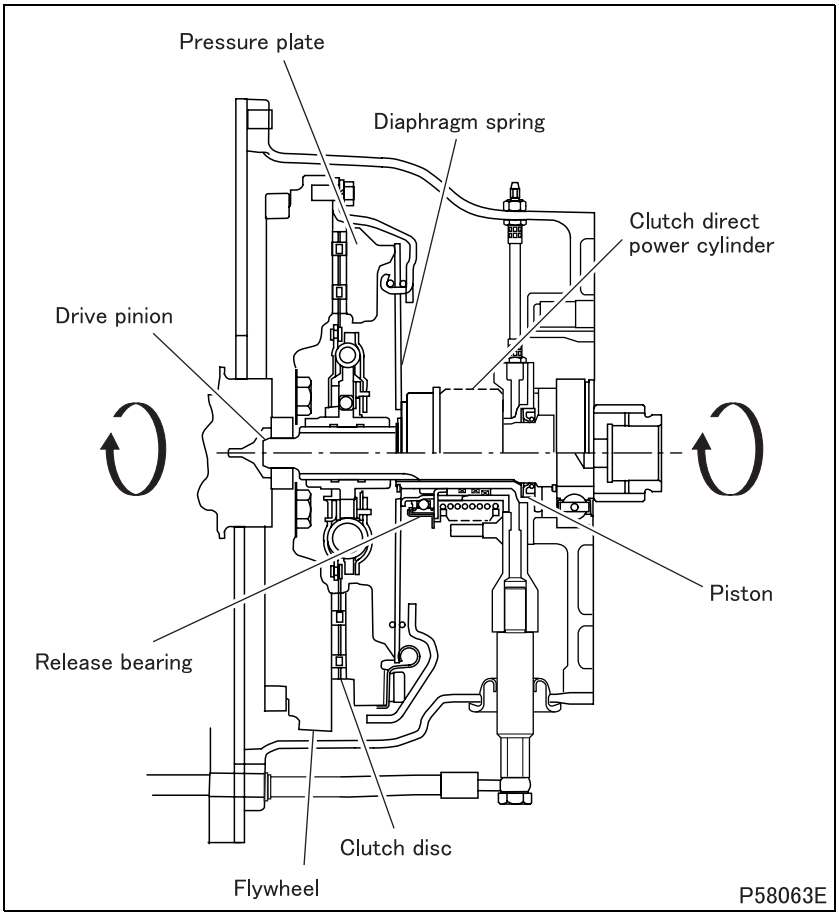
2.2 When clutch pedal is released

- The piston is pushed back to the left by the combined force of oil pressure from the clutch direct power cylinder and the return spring.
- This opens up the port that has been blocked by the pressure cup, connecting the cylinder to the brake fluid tank. This allows the oil pressure to completely drain to the tank.

3. Clutch Proper and Clutch Direct Power Cylinder

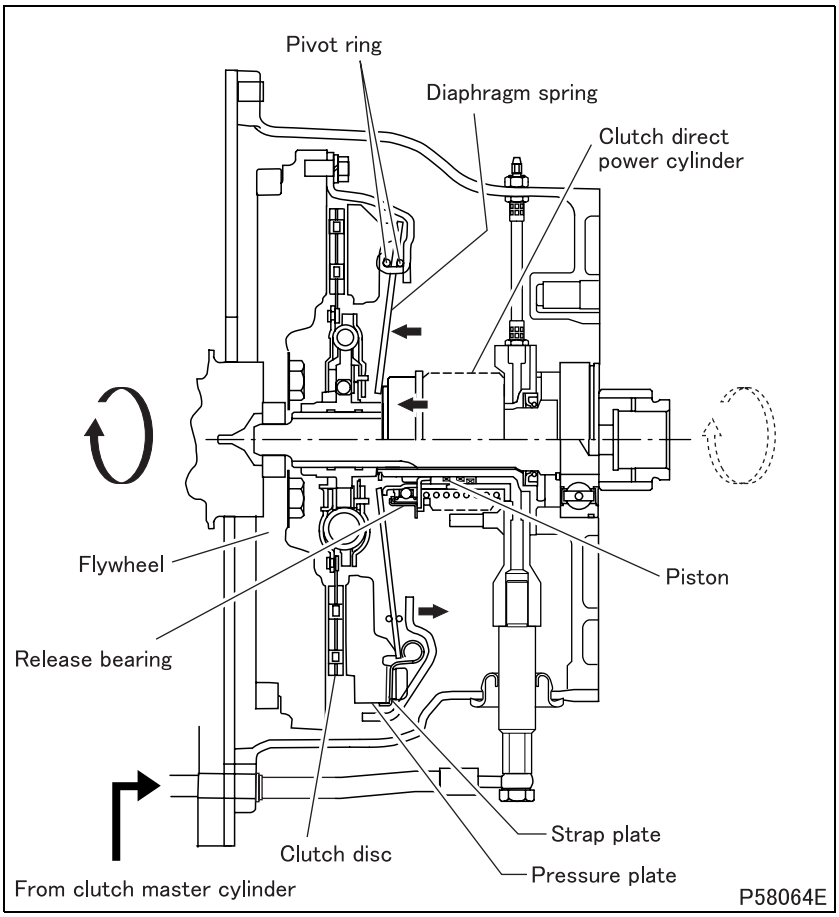


- Clutch engagement and disengagement are controlled by the brake fluid pressure from the clutch master cylinder acting on the piston of the clutch direct power cylinder, and are achieved by the operation of the piston and the release bearing.



3.1 When clutch pedal is released

- There is no brake fluid pressure acting on the clutch direct power cylinder. The piston and release bearing remain in their home positions.
- The force of the diaphragm spring acts on the pressure plate, which in turn keeps the clutch disc pressed against the flywheel.
- Pressed against the flywheel, the clutch disc rotates together with the flywheel and transmits the engine power to the transmission drive pinion.



3.2 When clutch pedal is depressed

- Brake fluid pressure from the clutch master cylinder moves the piston in the clutch direct power cylinder.
- As it moves, the piston pushes the release bearing, which in turn pushes the diaphragm spring.
- The diaphragm spring pivots around the pivot ring. This movement, via the strap plate, causes the pressure plate to retract from the flywheel. As a result, the clutch disc separates from the flywheel, cutting off engine power to the transmission.

Possible causes / Symptoms		Clutch disengaged but drags	Clutch slips	Clutch does not engage smoothly	Clutch makes noise on disengagement	Clutch makes noise on engagement	Judder when vehicle starting	Clutch pedal requires too much effort	Reference Gr
Clutch cover	Diaphragm spring heights uneven	O	O	O			O		
	Diaphragm spring fatigued		O	O					
	Pressure plate warped or faulty	O	O	O			O		
	Loose rivets	O		O			O		
	Strap plate bent	O		O	O		O		
Clutch disc	Disc deformed	O		O			O		
	Disc rivets loose			O			O		
	Disc torsion spring fatigued or damaged					O			
	Spline worn	O		O			O		
	Spline rusted	O		O			O		
	Facing worn		O						
	Facing surface hardened		O	O			O		
	Facing oily or greasy		O	O					
Clutch pedal	Pedal free play insufficient		O	O					
	Pedal free play excessive	O		O					
	Pedal stroke insufficient	O							
	Pedal sliding part faulty			O			O	O	
Clutch master cylinder	Piston and pressure cup sliding movement faulty	O	O	O				O	
	Spring fatigued		O						
	Brake fluid passage port clogged	O	O	O				O	
Clutch direct power cylinder	Piston and piston cup sliding movement faulty	O	O	O				O	
	Brake fluid passage port clogged	O	O	O				O	
	Release bearing faulty	O			O	O			
Transmission drive pinion spline worn		O		O					Gr22
Engine idling speed too low		O				O			Gr13A
Engine mounting fatigued							O		Gr11
Flywheel warped, deformed or worn forming steps		O	O	O			O		
Flywheel pilot bearing faulty		O							
Air mixed in clutch hydraulic system		O							
Clutch hydraulic system leaking		O							

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Replacement of Brake Fluid (Clutch System)

- Clutch fluid (DOT3 brake fluid) is shared by the clutch and brake systems. The brake fluid tank is partitioned to supply fluid to both systems. This section describes the replacement of the clutch fluid (DOT3 brake fluid) for the clutch system. In order to completely replace the clutch fluid (DOT3 brake fluid), the fluid in the brake system should also be replaced. (See Gr35A.)

Torque: N·m (lbf·ft)

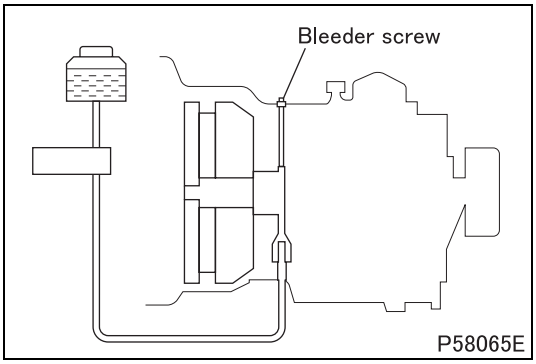
ID	Fastener	Torque value	Remarks
–	Bleed screw	6.8 to 8.8 (5.0 to 6.5)	–

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703f or FMVSS No. 116 DOT3)	As required

CAUTION ⚠

- **DOT3 Brake fluid is corrosive to paint. Be careful not to spill it on painted surfaces.**
- **If DOT3 brake fluid is spilled on paint, wipe it off immediately.**
- **When replacing the clutch fluid, be sure to use new DOT3 brake fluid. Do not mix it with brake fluid of different properties, or with other kinds of oil (diesel fuel, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of the brake fluid, and cause the boiling point to drop and the rubber parts of the clutch to swell. This will result in faulty clutch operation.**
- **Ensure that no foreign matter or water enters into the brake fluid when replacing it. This will cause faulty clutch operation.**
- **Keep DOT3 brake fluid in a designated pressure container. This helps to prevent contamination of the clutch fluid, and the resulting faulty operation of the clutch.**



1.1 Work before replacement

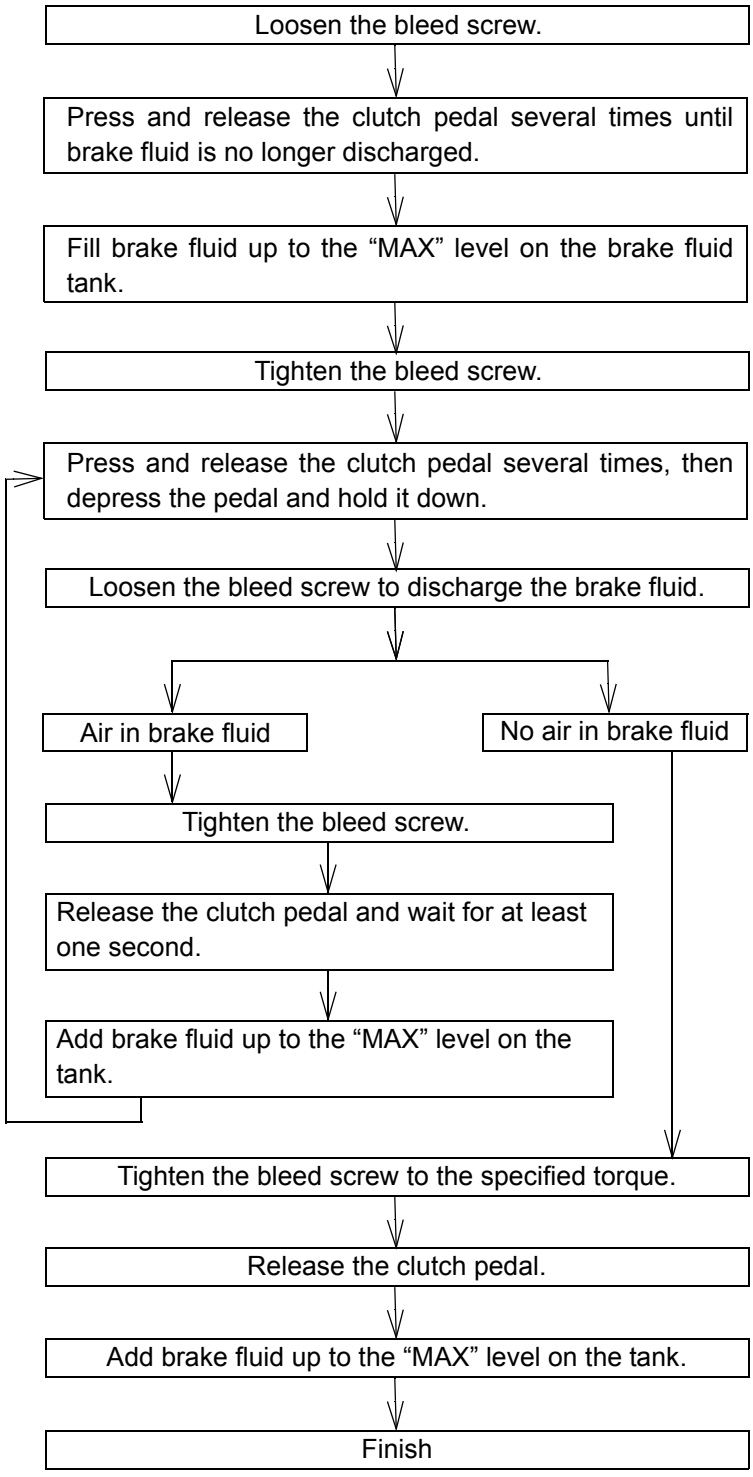
- Install one end of a clear plastic tube onto the bleed screw. Place the loose end into a container.

1.2 Replacement of brake fluid

- Replace the brake fluid. Do these steps in order.

CAUTION ⚠

- **Continue to discharge the old brake fluid until the fluid changes color, indicating clean new fluid is flowing through the clear plastic tube. This will prevent faulty clutch operation.**



2. Air Bleeding of Brake Fluid (Clutch System)

- Clutch fluid (DOT3 brake fluid) is shared by the clutch and brake systems. The brake fluid tank is partitioned to supply fluid to both systems. This section describes the air bleeding procedures for the clutch system. For air bleeding procedures for the brake system, see Gr35A.

Torque: N·m (lbf·ft)

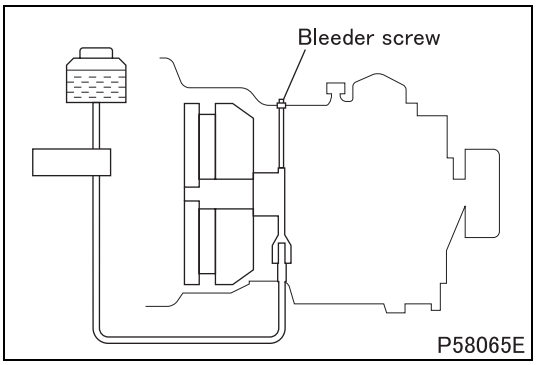
ID	Fastener	Value	Remarks
–	Bleed screw	5.0 to 6.5 (6.8 to 8.8)	–

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required

CAUTION ⚠

- **DOT3 Brake fluid is corrosive to paint. Be careful not to spill it on painted surfaces.**
- **If DOT3 brake fluid is spilled on paint, wipe it off immediately.**
- **When replacing the clutch fluid, be sure to use new DOT3 brake fluid. Do not mix it with brake fluid of different properties, or with other kinds of oil (diesel fuel, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of the brake fluid, and cause the boiling point to drop and the rubber parts of the clutch to swell. This will result in faulty clutch operation.**
- **Ensure that no foreign matter or water enters into the brake fluid when replacing it. This will cause faulty clutch operation.**
- **Keep DOT3 brake fluid in a designated pressure container. This helps to prevent contamination of the clutch fluid, and the resulting faulty operation of the clutch.**

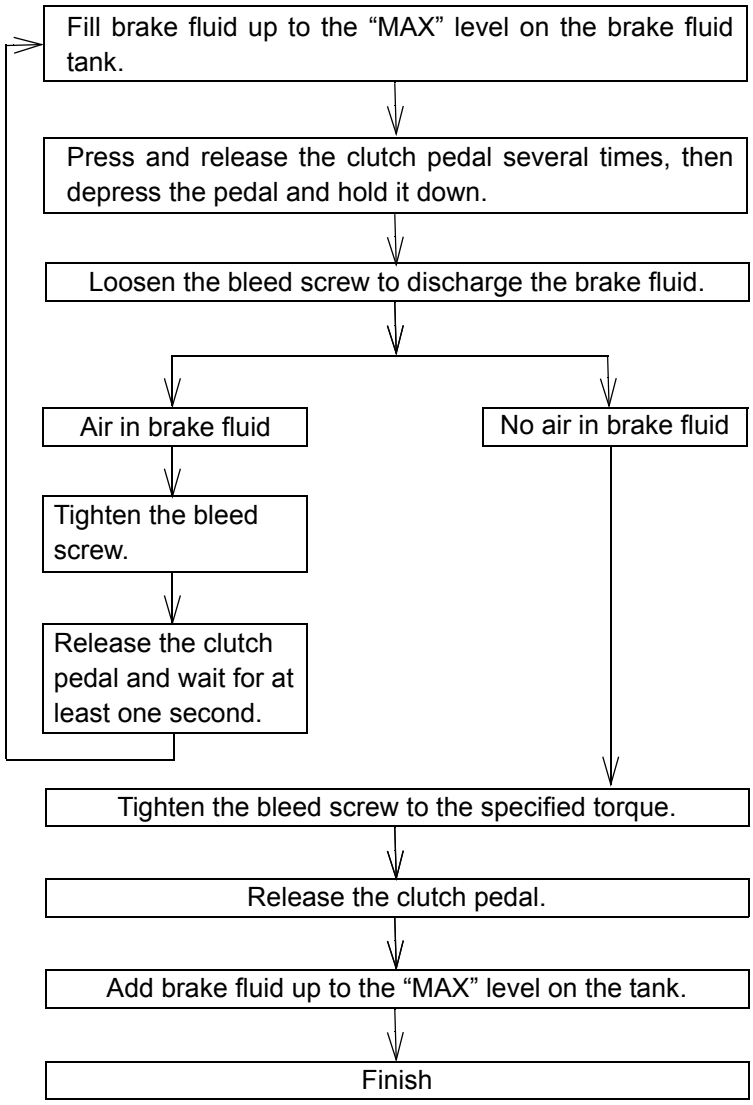


2.1 Work before air bleeding

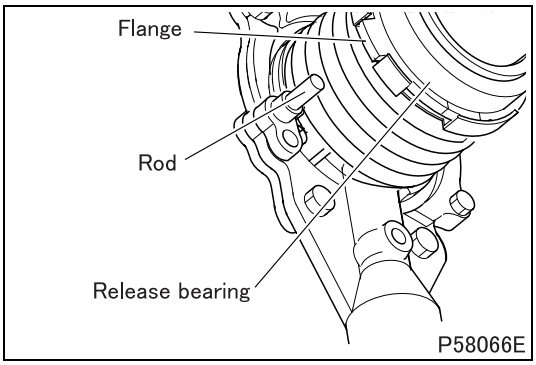
- Install one end of a clear plastic tube onto the bleed screw. Place the loose end into a container.

2.2 Air bleeding of brake fluid

- Bleed the air in the following sequence.



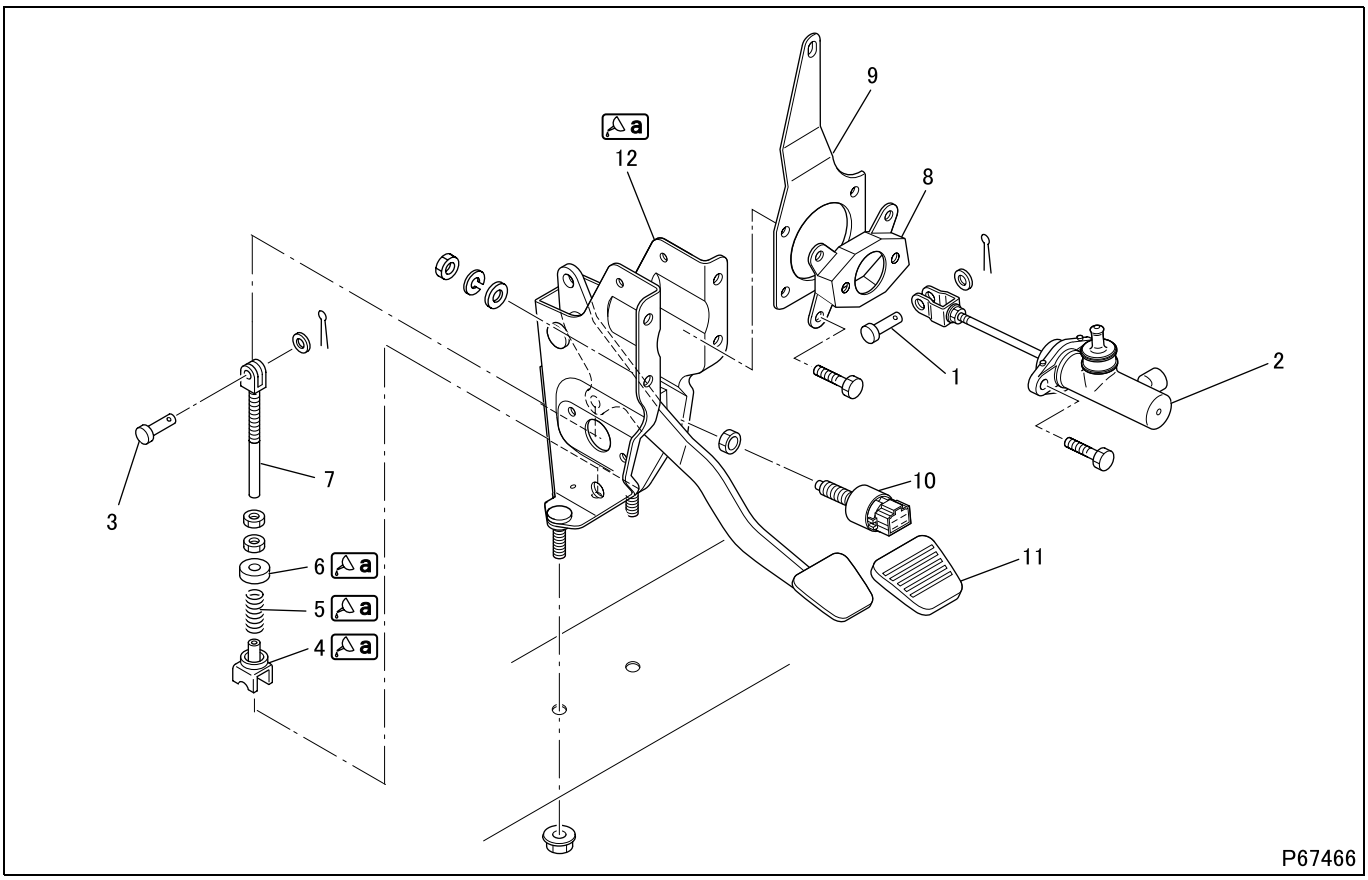
3. Inspection of Clutch Disc Wear Limit



- Remove the grommet from the clutch housing and make sure that the rod of the clutch direct power cylinder does not reach the flange of the release bearing.
- If the rod reaches the flange, replace the clutch disc.

M E M O

CLUTCH PEDAL



● **Removal sequence**

1 Clevis pin, master cylinder push rod
2 Clutch master cylinder (See later section.)
3 Clevis pin, spring assist rod
4 Spring holder
5 Return spring
6 Plate
7 Spring assist rod
8 Cylinder bracket
9 Booster bracket
10 Clutch switch
11 Pedal pad
12 Clutch pedal unit

● **Installation sequence**

Follow the removal sequence in reverse.

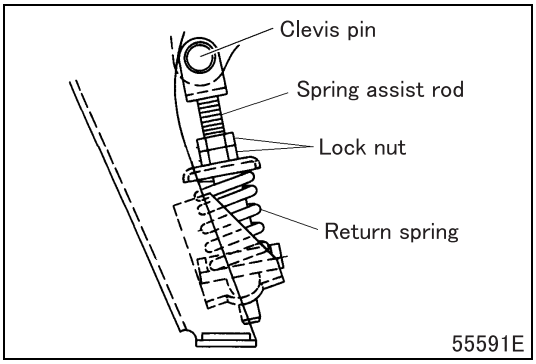
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod to piston clearance (clutch master cylinder)	0.2 to 1.2 {0.0079 to 0.047}	–	Adjust
5	Return spring load (installed length: 35.6 {1.40})	225 N {51 lbf}	205 N {46 labs., 20.8 kgf}	Replace
10	Installed clearance of clutch switch (for exhaust brake)	0.1 to 1.5 {0.0039 to 0.059}	–	Adjust
12	Clutch pedal free play	0.2 to 4.0 {0.0079 to 0.157}	–	Replace

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding surface of spring holder	Chassis grease [NLGI No. 1 (Ca soap)]	As required
	Sliding surface of return spring		
	Sliding surface of plate		
	Clutch master cylinder and spring assist rod mounting clevis-pin hole bushing's inner face of clutch pedal.		

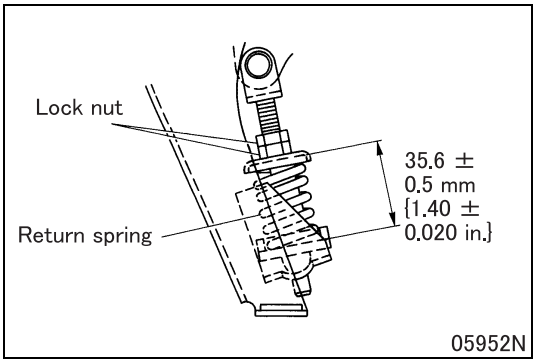
◆Removal procedure◆



■ Removal: Spring assist rod

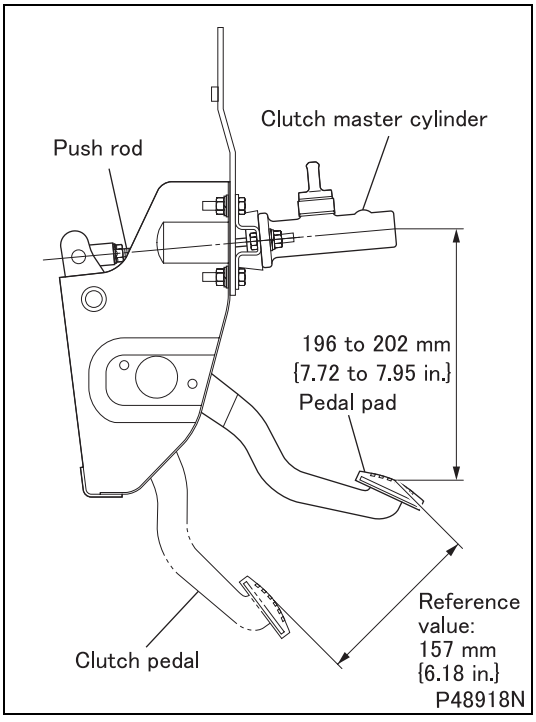
- Loosen the lock nut to release the load on the return spring. Then, remove the clevis pin and remove the spring assist rod.

◆Work after installation◆



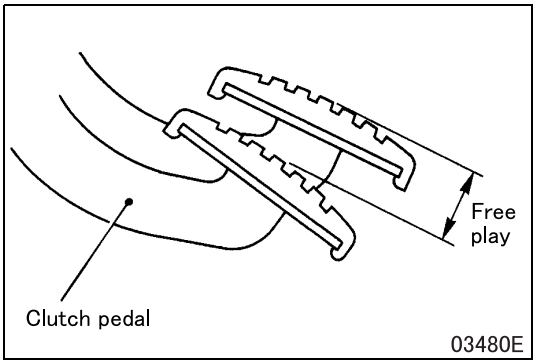
■ Adjustment: Return spring

- Tighten the lock nut until the return spring is set to the correct length as shown in the illustration.



■ Adjustment: Clutch pedal

- Adjust the push rod of the clutch master cylinder until the distance between the center of the clutch pedal pad and the center of the clutch master cylinder is set to the correct measurement as shown in the illustration.



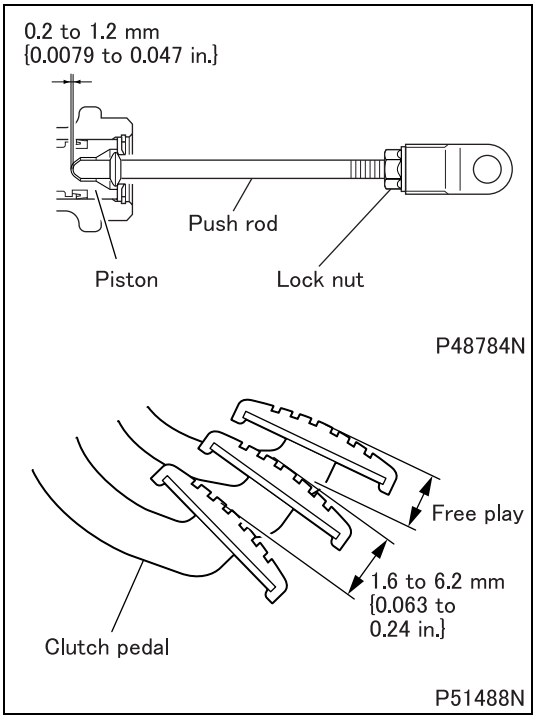
■ **Inspection: Clutch pedal free play**

- After installing the clutch master cylinder, check the clutch pedal free play.
- Use the pressure of one finger to depress the center of the clutch pedal until resistance is felt. Measure the amount of pedal free play to this point.

NOTE

- **When adjusting clutch pedal free play, do not press the clutch pedal until the second point of resistance is felt. This is the point at which the clutch master cylinder push rod contacts the piston.**

- If the measured pedal free play does not conform to the standard value for clutch pedal free play, replace the clutch pedal.



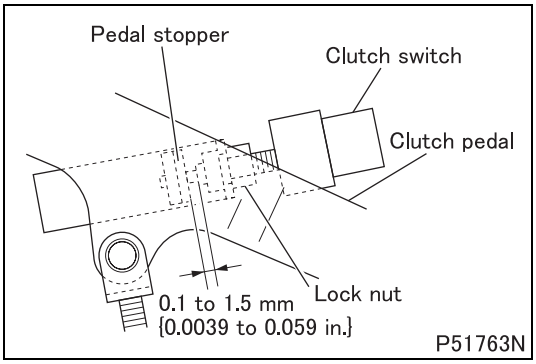
■ **Adjustment: Clearance between the clutch master cylinder push rod and piston**

- Adjust the clearance between the clutch master cylinder push rod and piston by using the clutch pedal as follows.
- Using the pressure of one finger, depress the center of the clutch pedal. Measure the amount of pedal travel from the point of first resistance to the point of second resistance.

NOTE

- **This measurement corresponds to the clearance between the push rod and the piston.**

- If the pedal travel is not within the correct range shown in the illustration, adjust it by turning the push rod in or out as needed.
- With the pedal travel set within the illustrated range, the push rod-to-piston clearance should conform to the standard value.
- After the adjustment, tighten the lock nut 15-20 N·m (11-15 lbf·ft).



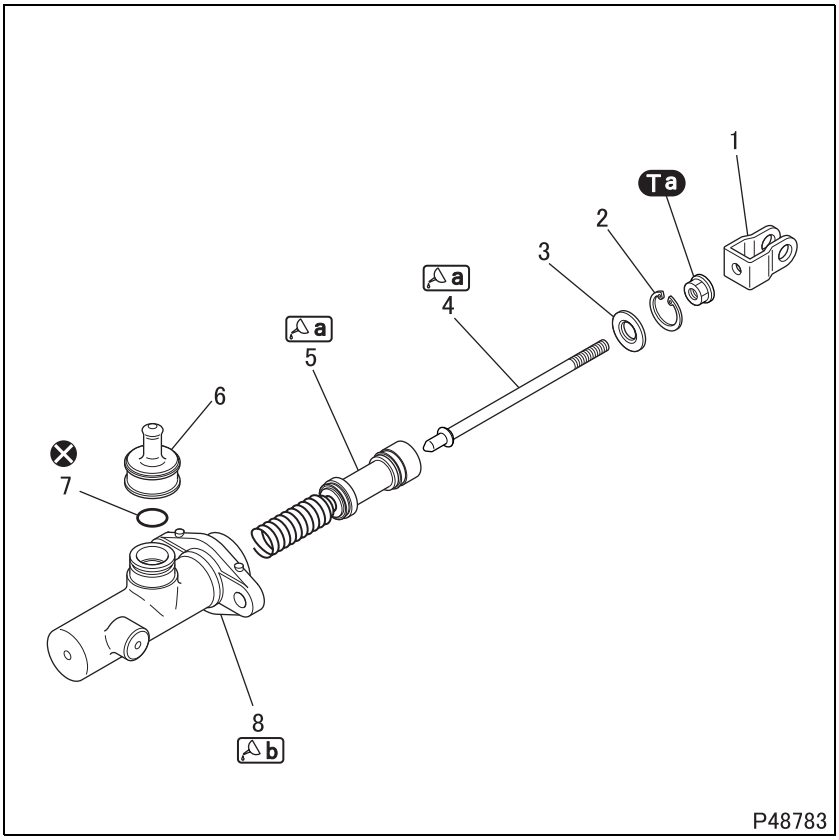
■ **Adjustment: Clearance between clutch switch (for exhaust brake) and pedal**

- With the clutch pedal adjusted as above, set the clearance between the end of the threaded section of the clutch switch and the pedal stopper to the correct value as shown in the illustration. Tighten the locknut 15-20 N·m (11-15 lbf·ft).

CAUTION ⚠

- **Do not allow the threaded end of the clutch switch to come into contact with the clutch pedal stopper during the adjustment operation. This could damage the clutch switch.**

CLUTCH MASTER CYLINDER



● **Disassembly sequence**

1 Clevis
2 Snap ring
3 Stop plate
4 Push rod
5 Piston
6 Union collar
7 O-ring
8 Cylinder body

⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Clutch master cylinder kit

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
5, 8	Clearance between piston and cylinder body	0.02 to 0.10 {0.0008 to 0.0039}	0.2 {0.0079}	Replace

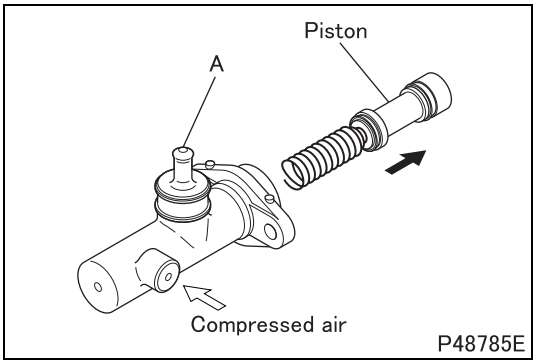
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Lock nut	15 to 20 (11 to 15)	–

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Push rod end contact face with piston	COSMO Rubber Grease	0.1 to 0.3 g {0.0035 to 0.011 oz.}
	Piston cup sliding face against cylinder body		
b	Cylinder body inner face	Metal rubber #20 (rust preventive oil)	As required

◆Removal procedure◆



■ **Removal: Piston**

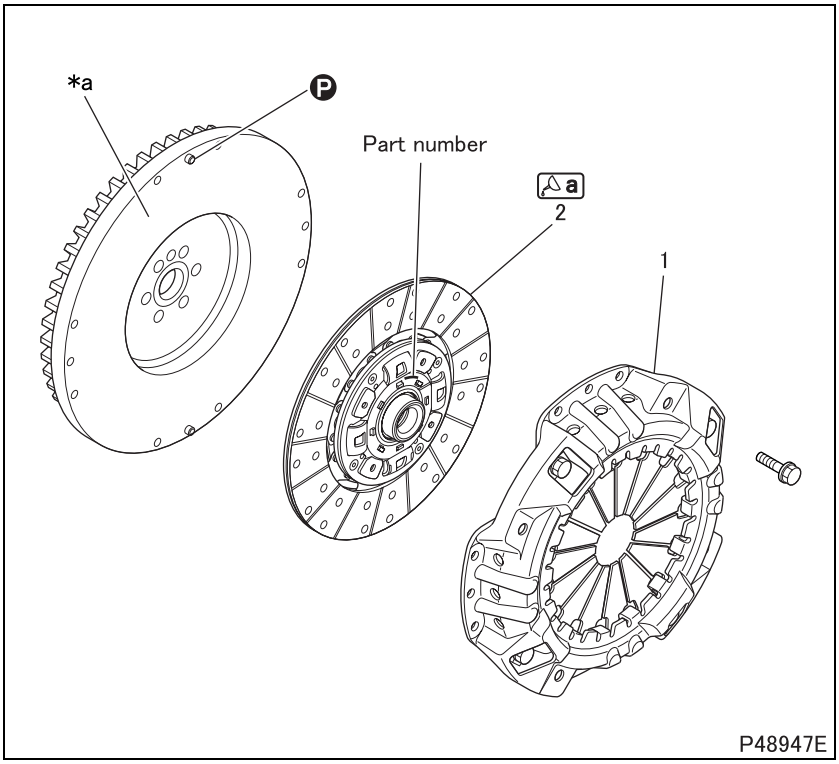
- To remove the piston, block opening **A**. With opening **A** blocked, feed compressed air gradually starting from zero pressure.

WARNING ⚠

- **Do not apply compressed air suddenly at high pressure. The piston will fly out at high speed and could cause a personal injury.**

M E M O

CLUTCH PROPER



● **Removal sequence**

1 Clutch cover
2 Clutch disc

***a**: Flywheel
Ⓟ: Locating pin

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **To prevent clutch slippage, keep the surfaces of the clutch cover, clutch disc and flywheel free from oil and grease.**

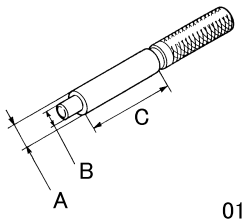
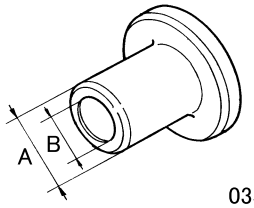
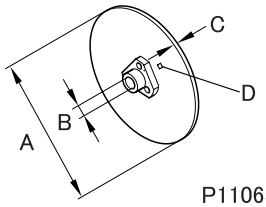
Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
1	Pressure plate peak-to-valley height		–	0.05 {0.0020}	Replace
	Diaphragm spring finger height unevenness		–	1.0 (0.039}	
2	Clutch disc	Depth from facing surface to rivet	1.8 to 2.4 {0.071 to 0.094}	0.2 {0.0079}	Replace
		Play in revolving direction in splines	0.05 to 0.23 {0.0020 to 0.0091}	0.5 {0.020}	
		Vertical runout	1.0 {0.039} or less	1.5 {0.059}	
		Lateral runout	0.8 {0.031} or less	1.5 {0.059}	

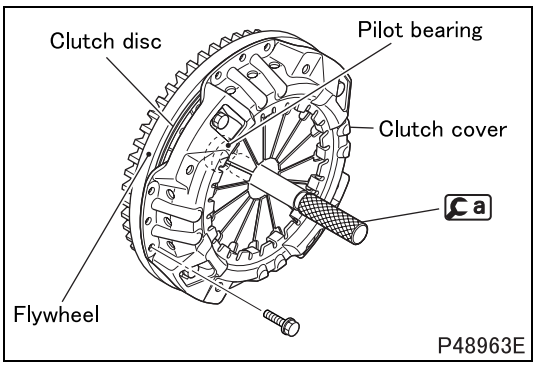
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Entire surface of splines	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	0.8 to 1.1 g {0.028 to 0.039 oz.}
	Fill in the grease grooves of splines		3.2 to 4.2 g {0.11 to 0.15 oz.}

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
a	Clutch alignment arbor A: ϕ28.94 {1.14}, B: ϕ20 {0.79}, C: 120 {4.72}  01270	MH061387	Holding clutch disc
b	Sleeve A: ϕ45 {1.77}, B: ϕ28.94 {1.14}  03509	MH061425	Checking diaphragm spring for installed height
c	Clutch master plate A: ϕ325 {12.8}, B: ϕ32 {1.26}, C: 9.2 {0.36}, D: "5"  P11065	MH062291	Checking diaphragm spring for installed height

◆Removal procedure◆

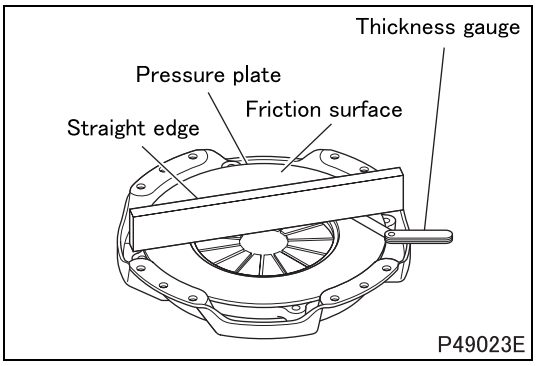


P48963E

■ Removal: Clutch cover

- Insert the clutch alignment arbor a into the flywheel pilot bearing. While supporting the clutch disc with the clutch alignment arbor, a, remove the clutch cover.

◆Inspection procedure◆

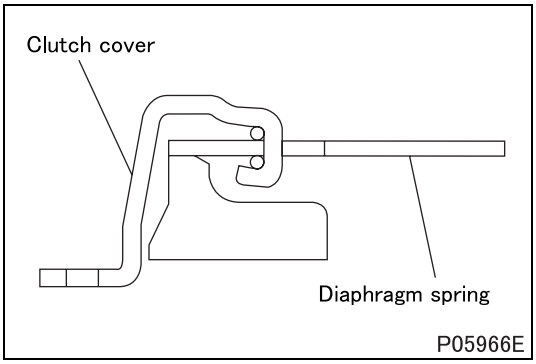


P49023E

■ Inspection: Clutch cover

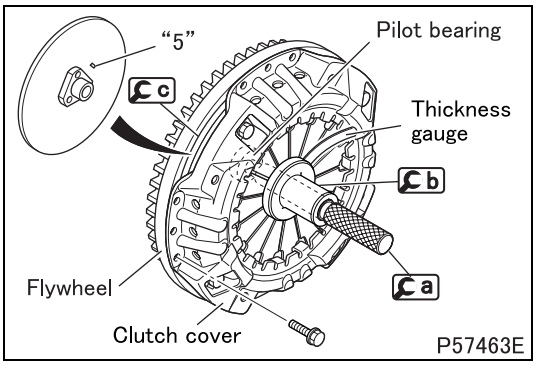
(1) Pressure plate evenness

- Place a straight edge across the friction surface of the pressure plate. Using a thickness gauge, measure the clearance between the gauge and the surface in several locations selected at random.
- Obtain the peak-to-valley height of the pressure plate by subtracting the smallest clearance measured from the greatest clearance measured.
- If the peak-to-valley height is equal to or exceeds the specified limit, replace the clutch cover.



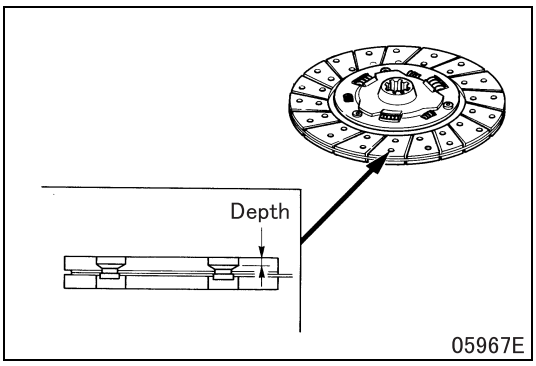
(2) Inspection of diaphragm spring

- Inspect the diaphragm spring for play.
- If there is play in the spring, replace the clutch cover.



(3) Installed height of diaphragm spring

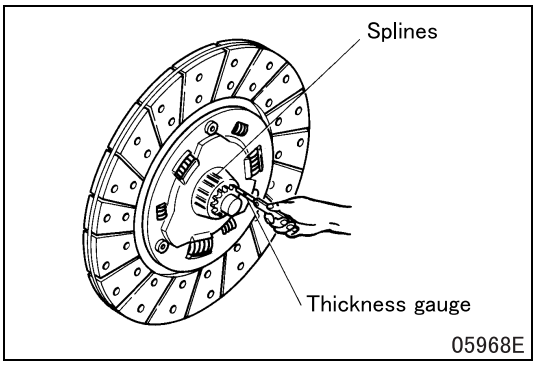
- Using the clutch alignment arbor [a], install the clutch master plate [c] (in place of the clutch disc) and the clutch cover.
- Install the sleeve [b]. Using a thickness gauge, check for unevenness in the height of the spring fingers.
- If the unevenness exceeds the limit, replace the clutch cover.



■ Inspection: Clutch disc

(1) Depth from clutch facing to rivet

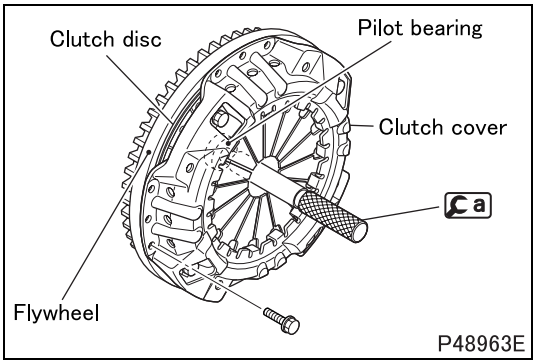
- Measure the depth from the clutch disc facing to the rivet.
- If the measured value is equal to or less than the limit, replace the clutch disc.



(2) Play in revolving direction in splines

- Reshape a thickness gauge such that it can be inserted into the drive pinion splines. Then, using the gauge, measure the splines for play in the direction of revolution.
- If the measured value is equal to or exceeds the limit, replace the faulty part.

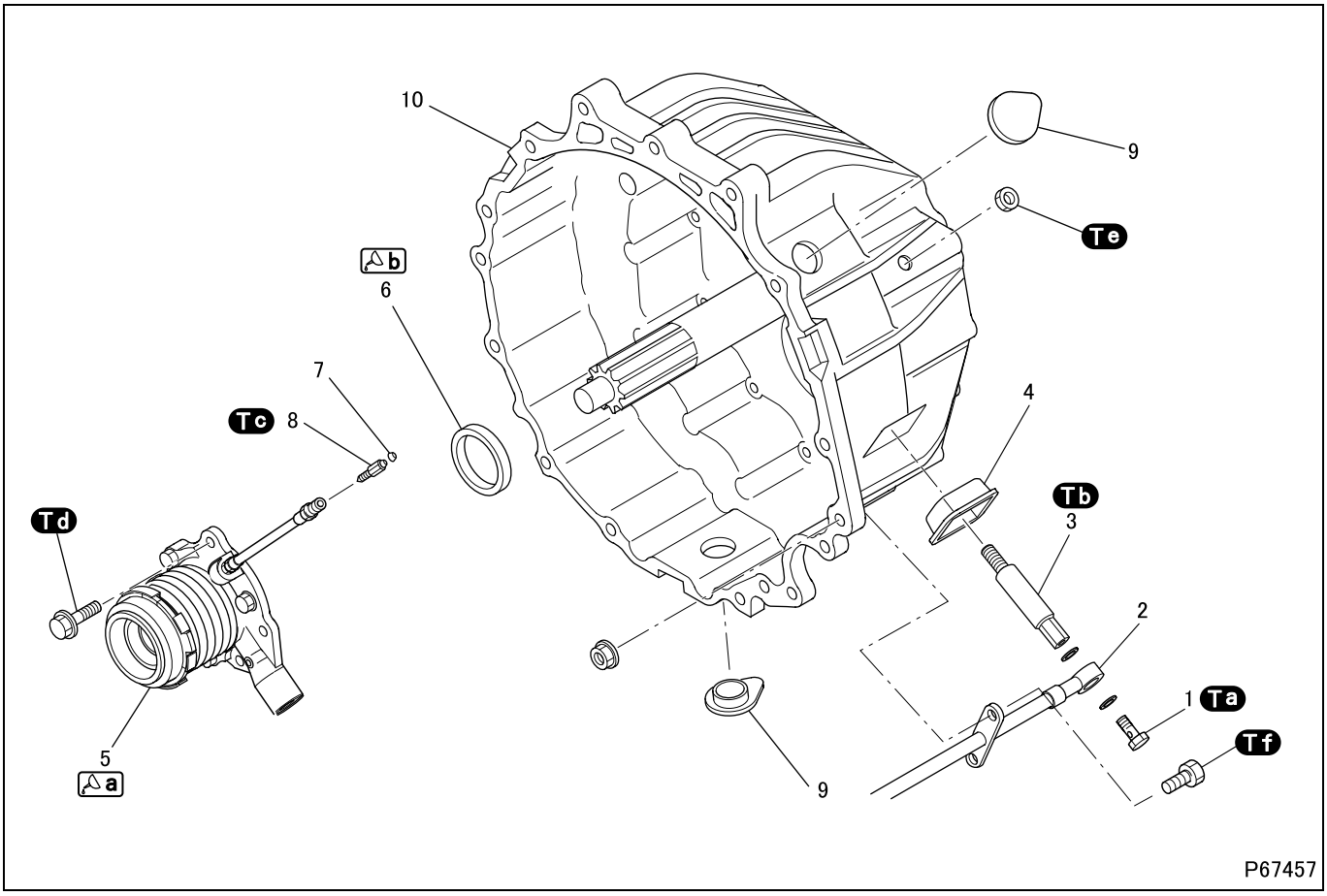
◆Installation procedure◆



■ Installation: Clutch disc

- Insert the clutch alignment arbor [a] into the flywheel pilot bearing to support the clutch disc.
- Install the clutch cover. Tighten the bolts in stages, using a cross-over pattern.

M E M O



● **Removal sequence**

1 Eyebolt
2 Clutch hose
3 Connector
4 Grommet
5 Clutch direct power cylinder (See later section.)
6 Oil seal
7 Bleed screw cap
8 Bleed screw
9 Dust plug
10 Clutch housing

CAUTION ⚠

- **When handling the clutch direct power cylinder, be careful not to contaminate it with petroleum-based products such as engine oil or automatic transmission fluid. DOT3 brake fluid can leak from a contaminated cylinder.**

● **Installation sequence**

Follow the removal sequence in reverse.

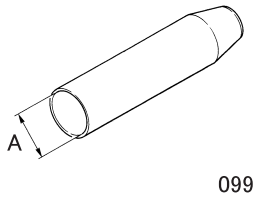
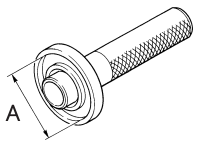
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Eyebolt (clutch hose mounting)	20 to 25 (15 to 18)	–
Tb	Connector	40 (30)	–
Tc	Bleed screw	6.8 to 8.8 (5.0 to 6.5)	–
Td	Bolt (clutch direct power cylinder mounting)	40 (30)	–
Te	Nut (bleeder hose mounting)	51 to 60 (37 to 43)	–
Tf	Bolt (clutch hose mounting)	45 to 55 (33 to 41)	–

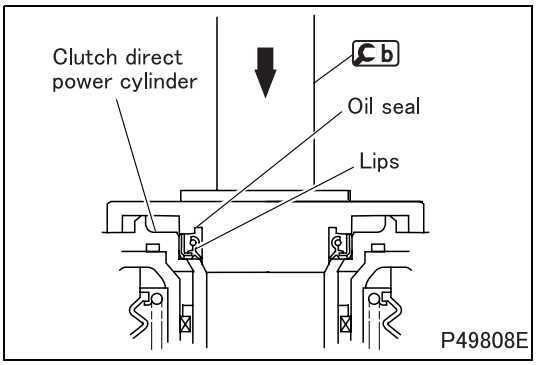
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Clutch direct power cylinder mating face with clutch housing	ThreeBond 1215	As required
b	Oil seal lips	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools (Unit: mm {in})

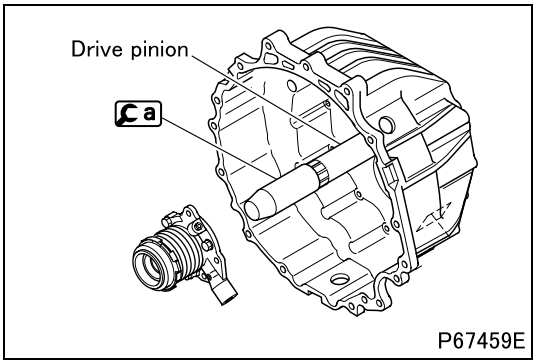
ID	Tool name and shape	Part No.	Application
a	Oil seal guide A: ϕ36.5 {1.44}  09918	MH063322	Protecting oil seal during clutch direct power cylinder installation
b	Oil seal installer A: ϕ89 {3.50}  09917	MH062714	Oil seal installation

◆Installation procedure◆



■ Installation: Oil seal

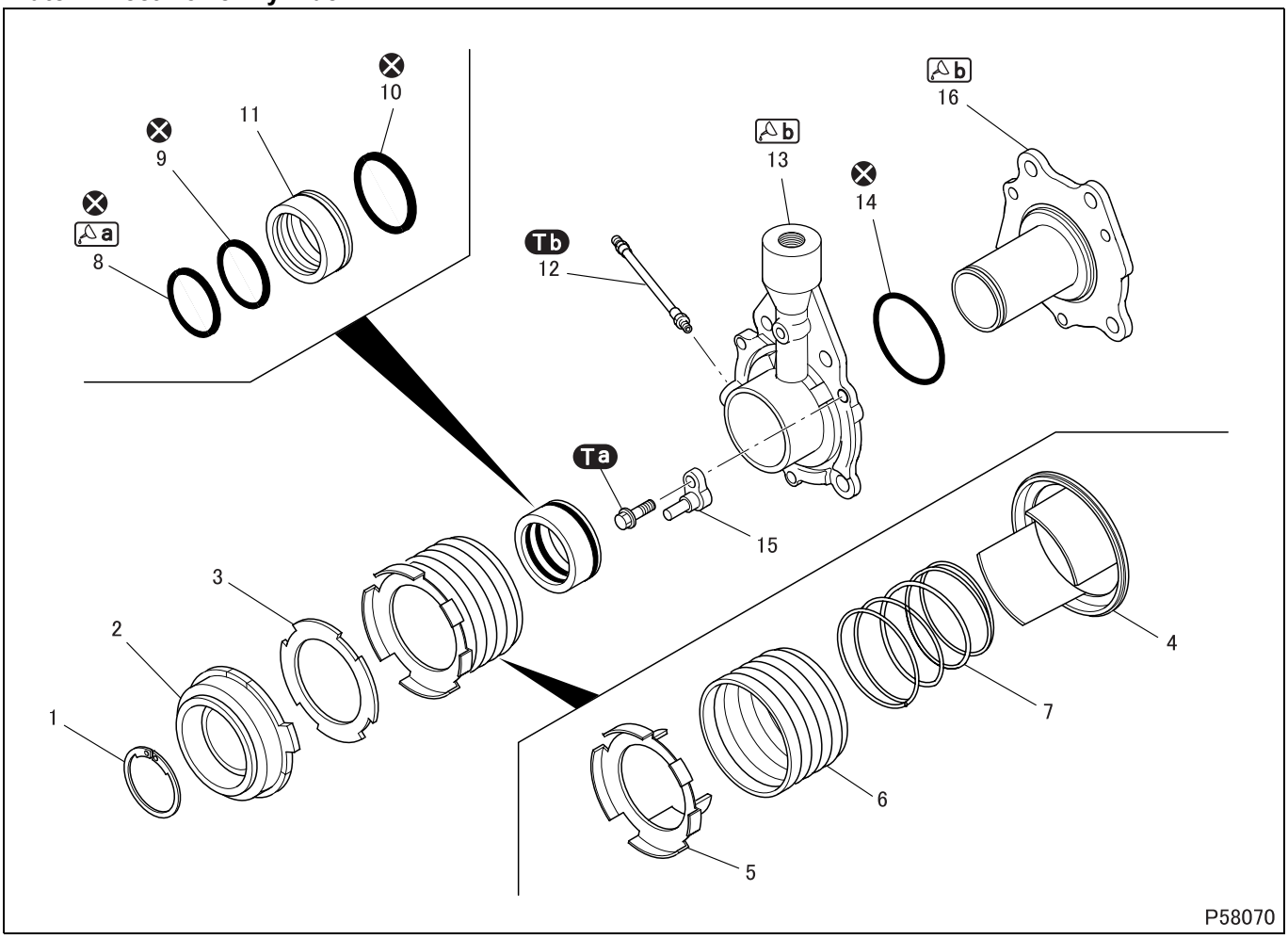
- Apply grease onto the oil seal lips. Then, install the oil seal onto the clutch direct power cylinder. Make sure that the seal faces in the correct direction as shown in the illustration.



■ Installation: Clutch direct power cylinder

- After cleaning the sealant application surfaces, apply sealant as required.
- Install the oil seal guide a onto the drive pinion to protect the oil seal installed in the previous step.

Clutch Direct Power Cylinder



● **Disassembly sequence**

1 Snap ring
2 Release bearing
3 Oil seal
4 Rear spring stopper
5 Front spring stopper
6 Boots
7 Spring
8 Front inner cup
9 Rear inner cup
10 Outer cup
11 Piston
12 Bleeder hose
13 Cylinder body A
14 O-ring
15 Rod
16 Cylinder body B

⊗: Non-reusable parts

CAUTION ⚠

- **Remove the bleeder hose only when cylinder body A is being replaced. If the hose is removed unnecessarily, it can cause brake fluid leakage.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Install the piston correctly. Make sure it is facing in the right direction, and that the cups are installed correctly. An incorrectly installed piston causes brake fluid leakage and clutch drag.**

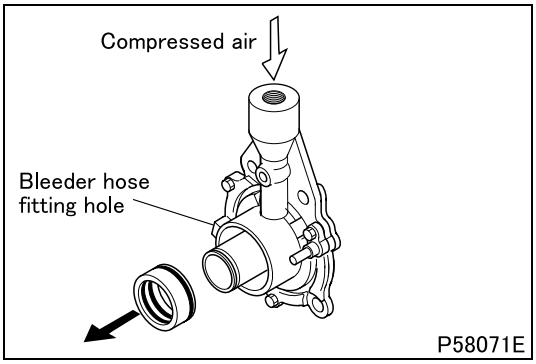
Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Bolt (mounting of cylinder bodies A, B and rod)	6.9 to 8.8 (5.1 to 6.5)	–
Tb	Bleeder hose	16 to 18 (12 to 13)	–

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Front inner cup sliding face with cylinder body B	COSMO Rubber Grease	0.004 to 0.007 oz (0.1 to 0.2 g)
b	Cylinder body A sliding face	Metal rubber #20 (rust preventive oil)	As required
	Cylinder body B sliding face		

◆Removal procedure◆

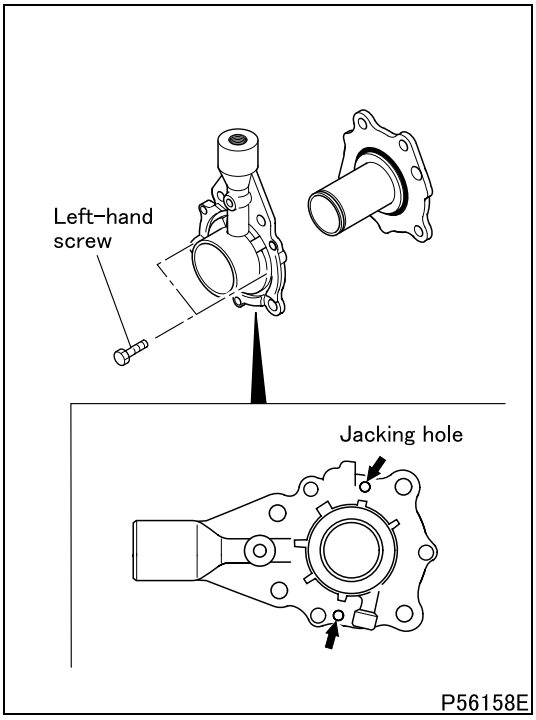


■ Removal: Piston

- To remove the piston, disconnect the bleeder hose and block the opening in the bleeder hose fitting on cylinder body A. Feed compressed air gradually starting at zero pressure until the piston is forced out.

WARNING ⚠

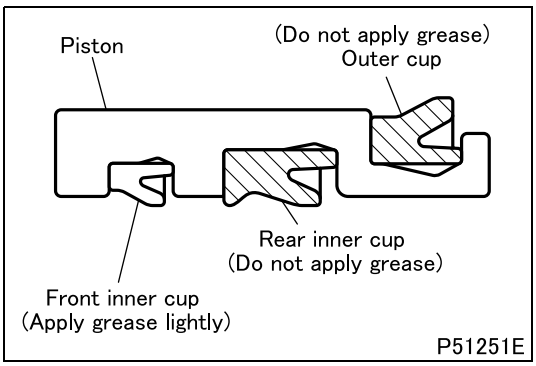
- **Do not apply compressed air suddenly at high pressure. The piston will fly out at high speed and could cause a personal injury.**



■ Removal: Cylinder body A

- Install left-hand threaded screws (M8 × 1.25 mm) evenly into the jacking holes on cylinder body A. Remove the cylinder body.

◆Installation procedure◆

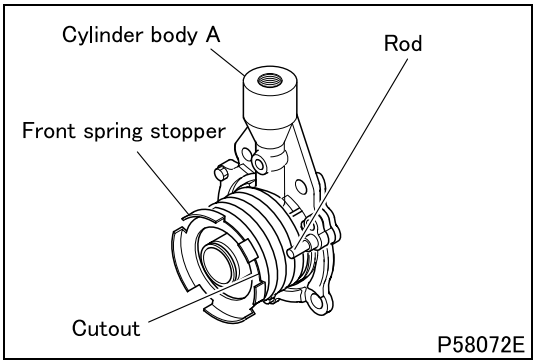


■ Installation: Front inner cup, rear inner cup and outer cup

- Install the front inner cup, rear inner cup, and outer cup onto the piston, facing them as shown in the illustration.

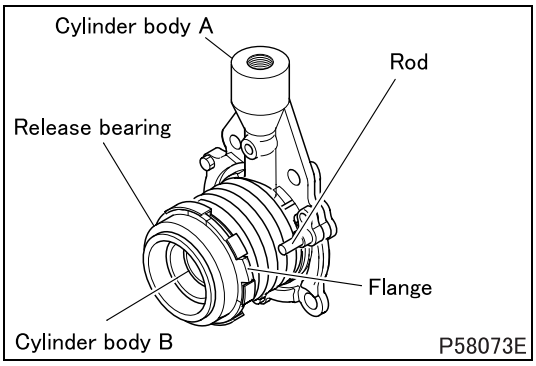
CAUTION ⚠

- **Incorrectly installed cups cause brake fluid leakage and clutch drag.**
- **Do not apply grease to the rear inner cup or the outer cup. Otherwise, brake fluid will leak.**
- **Apply only a thin coating of grease to the front inner cup. Greasing it too much can cause brake fluid to leak.**



■ Installation: Front spring stopper

- Install the front spring stopper onto cylinder body A. Make sure that the cutout aligns with the rod on the body and that it faces in the correct direction as shown in the illustration.



■ Installation: Release bearing

- Install the release bearing onto cylinder body B. Make sure that its flange aligns with the rod on cylinder body A and that it faces in the correct direction as shown in the illustration.

GROUP 22 INDEX

SPECIFICATIONS 22-2

STRUCTURE AND OPERATION
1. Transmission 22-4
2. Synchromesh Mechanism 22-6
3. Interlock Mechanism 22-9
4. Speedometer Gear Bushing 22-9

TROUBLESHOOTING..... 22-10

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Inspection of Transmission Mounting Bolts 22-12
2. Inspection of Companion Flange and Lock Nut 22-12
3. Changing Transmission Oil..... 22-13

REMOVAL AND INSTALLATION OF TRANSMISSION..... 22-14

SHIFT MECHANISM..... 22-18

REAR COVER <S5> AND PARKING BRAKE 22-24

EXTENSION HOUSING <S6> AND PARKING BRAKE 22-28

REVERSE IDLER GEAR..... 22-34

6TH GEAR <S6> 22-38

TRANSMISSION MAIN SECTION 22-44

DRIVE PINION (INPUT SHAFT)..... 22-60

MAIN SHAFT 22-62

COUNTERSHAFT..... 22-72

SHIFT CONTROL 22-74

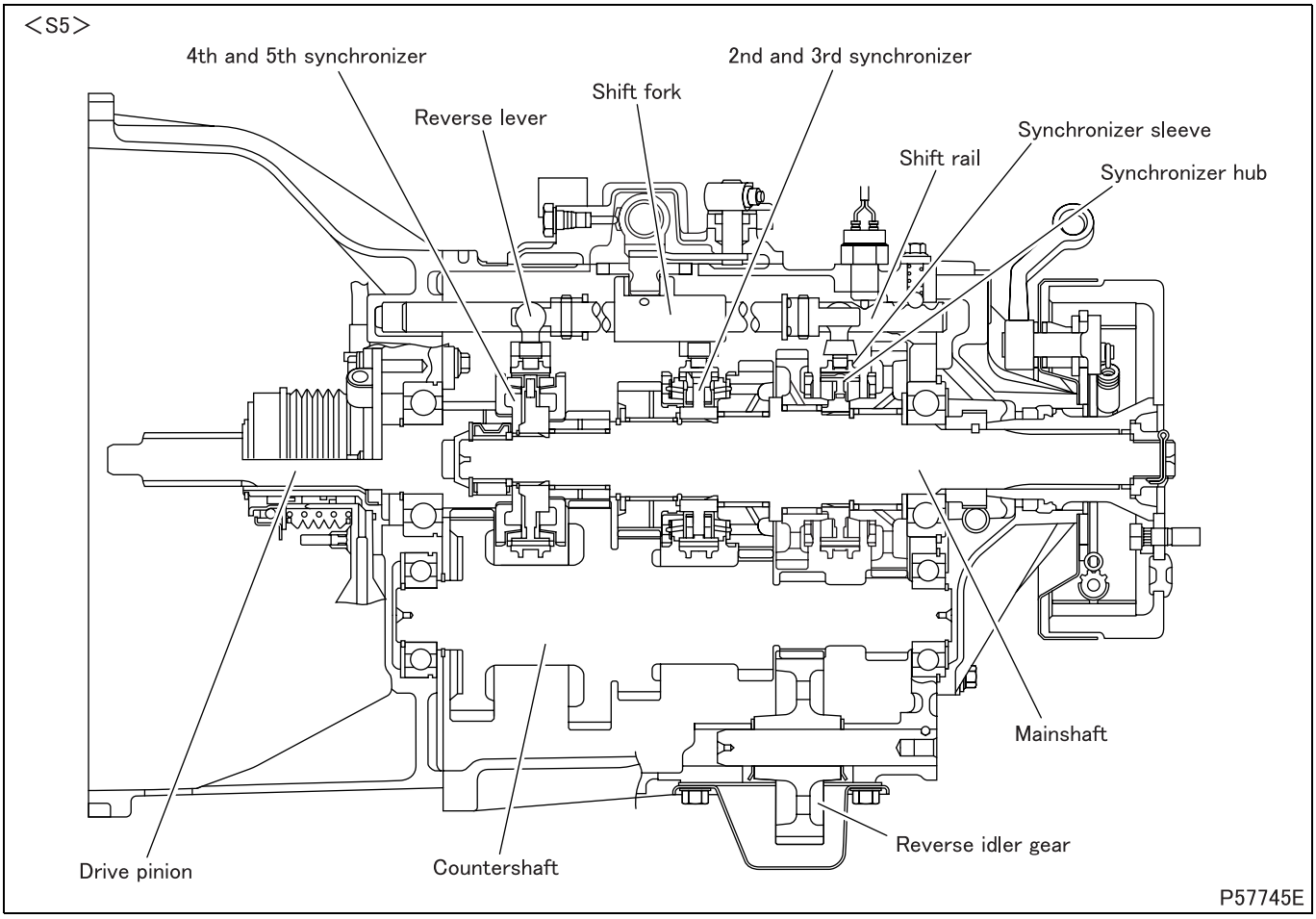
BEARING PULLER AND INSTALLER..... 22-78

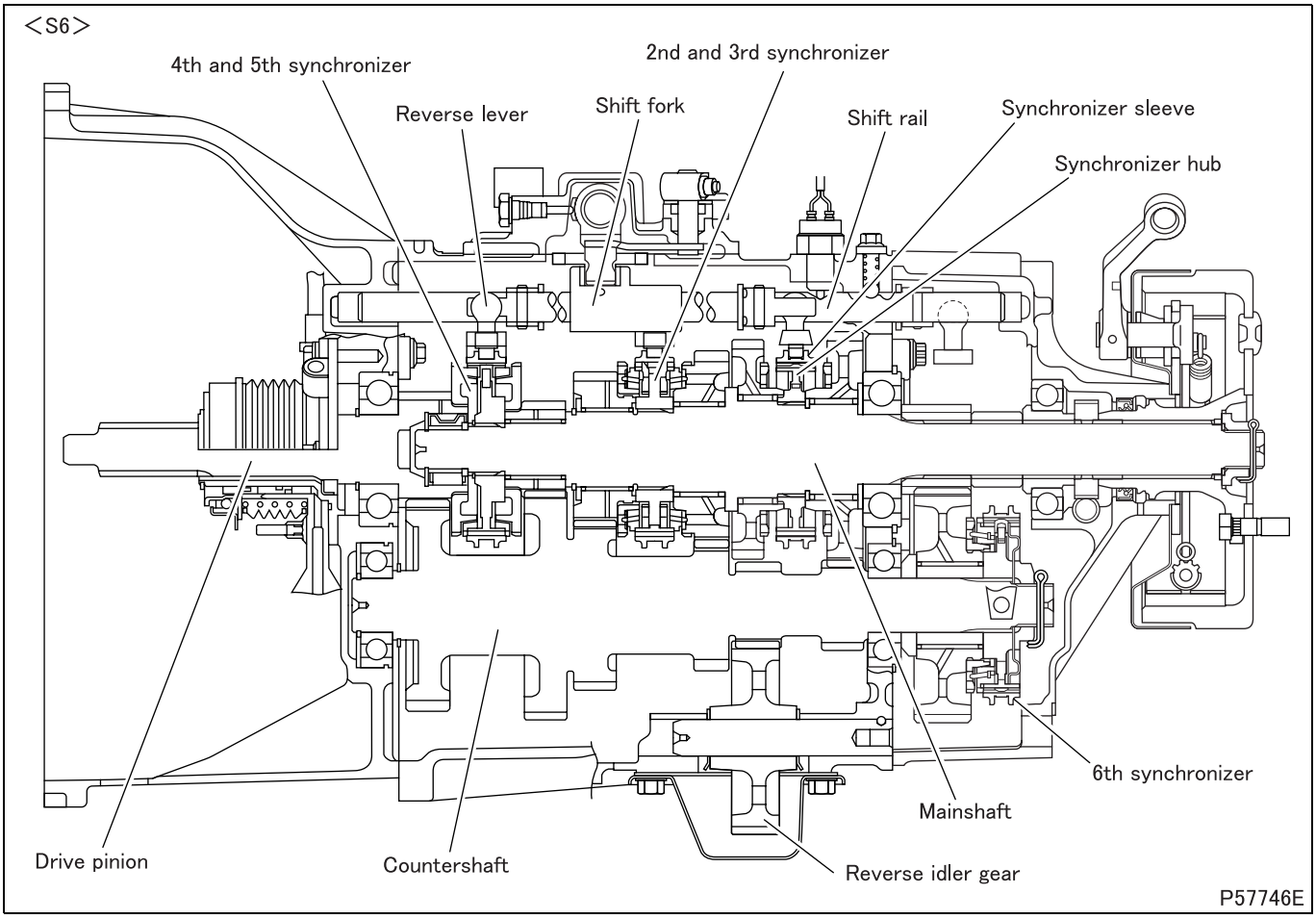
SPECIFICATIONS

Item			Specifications	
Mode of control			Instrument panel shift remote control	
Transmission model			M036S5 (5.175/0.715)	M036S6 (5.175/0.669)
Gear ratio		1st	5.175	5.175
		2nd	2.913	2.913
		3rd	1.682	1.682
		4th	1.000	1.000
		5th	0.715	0.793
		6th	–	0.669
		Rev	5.175	5.175
Transmission oil	Gear oil		Temperate climate: API GL-3 SAE80 Warm climate: API GL-3 SAE90 Tropical climate: API GL-4 SAE90	
	Engine oil		For long periods of high-speed driving API CC SAE30 or SAE40	
	Quantity	L (qt)	3.6 (3.8)	4.4 (4.6)
Mass		kg (lb)	89 (195)	101 (220)

M E M O

1. Transmission





- Two types of transmission are offered: a five-speed version <S5> and a six-speed version <S6>.
- The transmission changes the torque generated by the engine into a torque that matches the vehicle's power requirement (drive force). The power requirement (drive force) can be increased or decreased by selecting from a range of gear sets.
- The transmission uses an interlock mechanism to avoid double engagement.

2. Synchromesh Mechanism

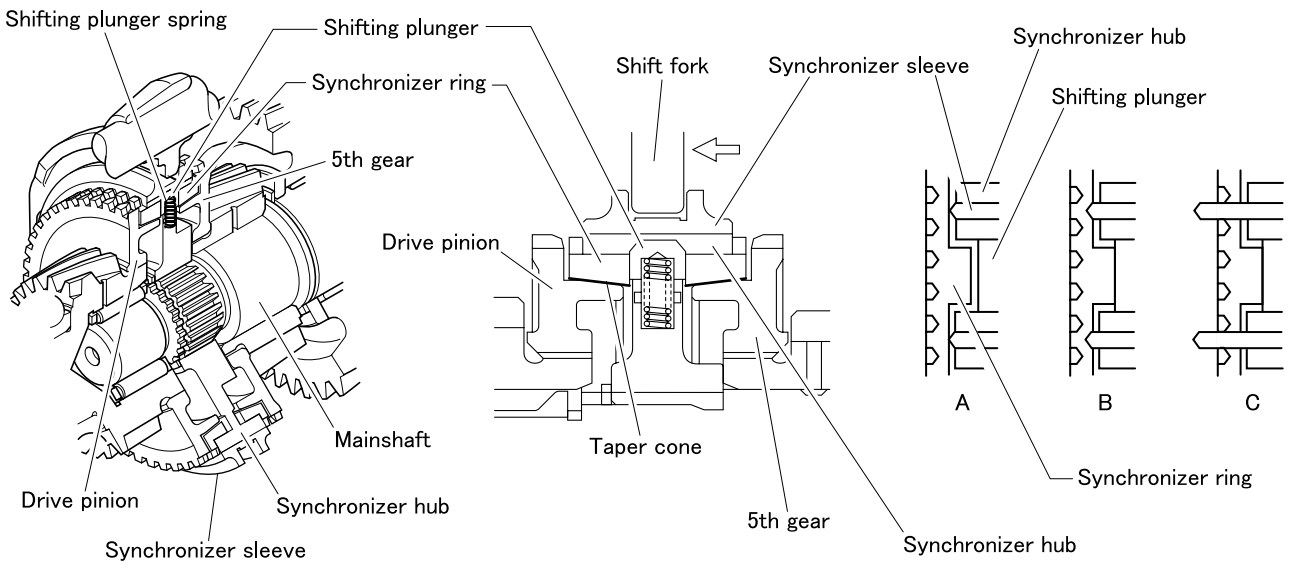
- When a shift change is made, the synchromesh mechanism synchronizes the rotation speed of the main shaft, the drive pinion and the synchronizer hub with the rotation speed of the desired gear. The synchronizer hub rotates integrally with the main shaft.
- This vehicle has two synchromesh mechanisms, a Warner synchromesh type and a lever synchromesh type. The Warner synchromesh type or the lever synchromesh type is used depending on the gear position as shown below:

Synchromesh type \ Transmission type		M036S5	M036S6
Warner synchromesh type	Single cone type	4th, 5th	4th, 5th
	Triple cone type	–	6th
Lever synchromesh type	Triple cone type	2nd, 3rd	2nd, 3rd

2.1 Warner synchromesh type

(1) Single cone type

The following descriptions are for 4th gear on the 4th/5th gear synchronizer assembly.

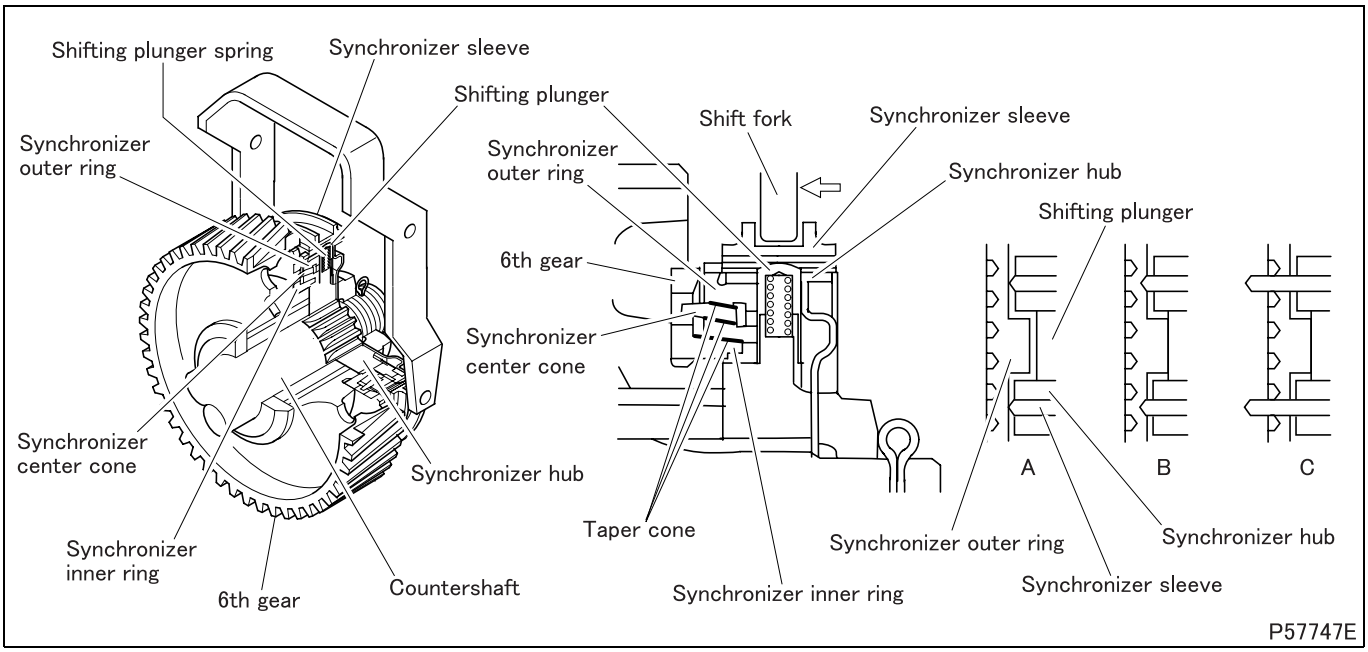


- The inside of the synchronizer hub engages the spline of the main shaft and rotates with it. The outside of the synchronizer hub has a spline that engages the synchronizer sleeve. This spline has three grooves in it.
- Shifting plungers are inserted into these grooves. When the gear shift is in neutral, the shifting plungers engage grooves in the synchronizer sleeve and are pressed against the inside of the synchronizer sleeve by shifting plunger springs.
- Synchronizer rings are inserted into the respective taper cone of each gear.
- The outer splines of the synchronizer rings engage the synchronizer sleeve. On the synchronizer hub are three grooves in which protrusions of the synchronizer rings are inserted. These grooves are wider than the width of protrusions of the synchronizer rings.
- Synchronizer rings rotate relative to the synchronizer sleeve according to the amount of play.
- When the gear shift is in neutral (Figure **A**), moving the shift fork in the direction of the arrow as shown in the illustration moves the synchronizer sleeve slightly to the pinion drive. At the same time, the shifting plunger, the central protrusion of which engages the synchronizer sleeve, moves to the drive pinion and presses the synchronizer ring against the taper cone of the drive pinion (Figure **B**).
- The taper cones of the synchronizer rings, which act as cone clutches, generate friction torque and perform synchronous operation.

- The rotation speed of the synchronizer hub becomes gradually closer to that of the drive pinion gear due to the synchronous operation, and eventually they rotate at the same speed. This allows the synchronizer sleeve to move smoothly to engage the synchronizer hub and gear, completing the shift change (Figure **C**).

(2) Triple cone type

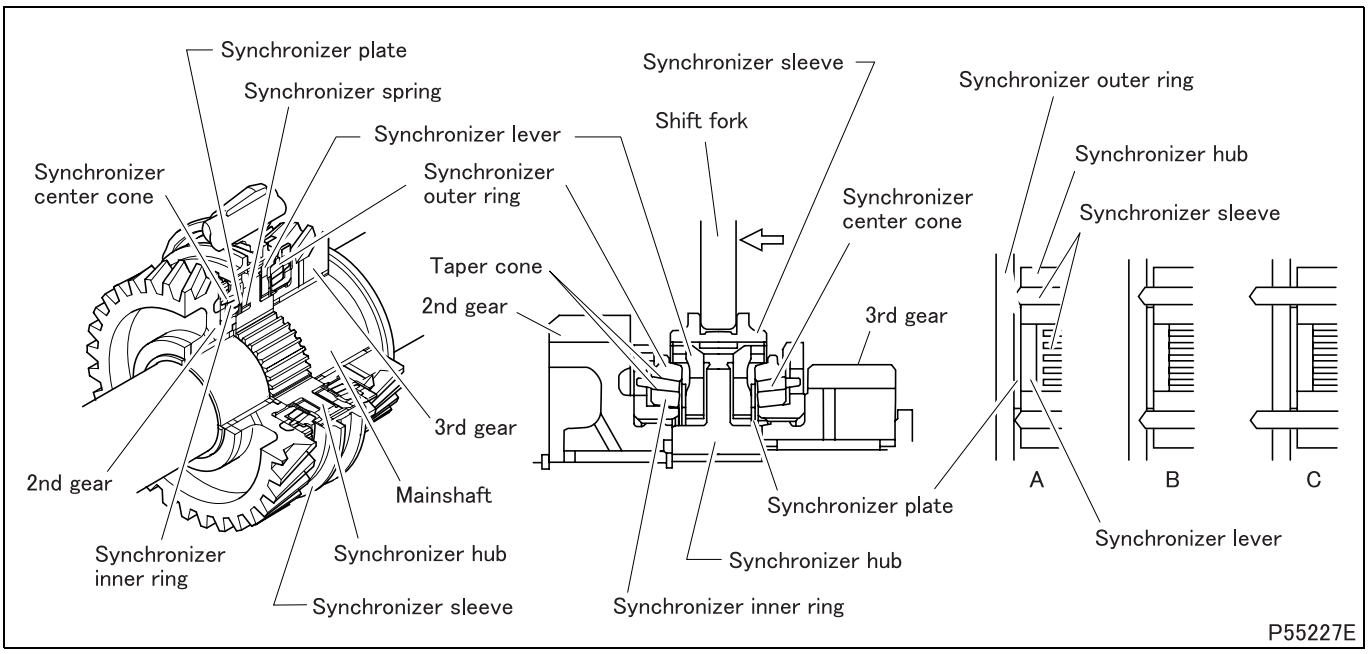
The following descriptions are for the 6th gear synchronizer assembly.



- The synchromesh structure and operation of the triple cone type are basically the same as for the single cone type. The synchronizer ring is divided into three parts (synchronizer inner ring, synchronizer center cone and synchronizer outer ring) and the center cone (both the inside and outside surfaces are tapered) and the inner ring (both the inside and outside surfaces are tapered) are sandwiched between the outer ring and the taper cone of each gear to shorten the time required for synchronization with cone clutches at three locations.
- Six protrusions on the outside of the synchronizer center cone fit into corresponding gear holes. As in the taper cone of the single cone type, the center cone and the gear are installed as if integrated.
- The inside of the synchronizer hub engages the spline of the main shaft and rotates with it. The outside of the synchronizer hub has a spline that engages the synchronizer sleeve and three grooves.
- Shifting plungers are inserted into these keyways. When the gear shift is in neutral, the shifting plungers engage grooves in the synchronizer sleeve and are pressed against the inside of the synchronizer sleeve by shifting plunger springs.
- The synchronizer outer ring and synchronizer inner ring are inserted into synchronizer center cones, respectively.
- The outer spline of the synchronizer outer ring engages the synchronizer sleeve. On the synchronizer hub are three grooves in which protrusions of the synchronizer outer ring are inserted. These grooves are wider than the width of protrusions of the synchronizer outer ring.
- The synchronizer outer ring rotates relative to the synchronizer sleeve according to the amount of play.
- When the gear shift is in neutral (Figure **A**), moving the shift fork in the direction of the arrow as shown in the illustration moves the synchronizer sleeve slightly towards the 6th gear. At the same time, the shifting plunger, the central protrusion of which engages the synchronizer sleeve, moves to the 6th gear and presses the synchronizer outer ring and the center cone against the taper cone of the synchronizer center cone and the synchronizer inner ring, respectively. In addition, it presses the inner ring against the 6th gear (Figure **B**).
- The taper cones of synchronizer rings, which act as cone clutches, generate friction torque and perform synchronous operation.
- The rotation speed of the synchronizer hub becomes gradually closer to that of the gear of the 6th gear due to the synchronous operation, and eventually they rotate at the same speed. This allows the synchronizer sleeve to move smoothly to engage the synchronizer hub and gear, completing the shift change (Figure **C**).

2.2 Lever synchromesh type

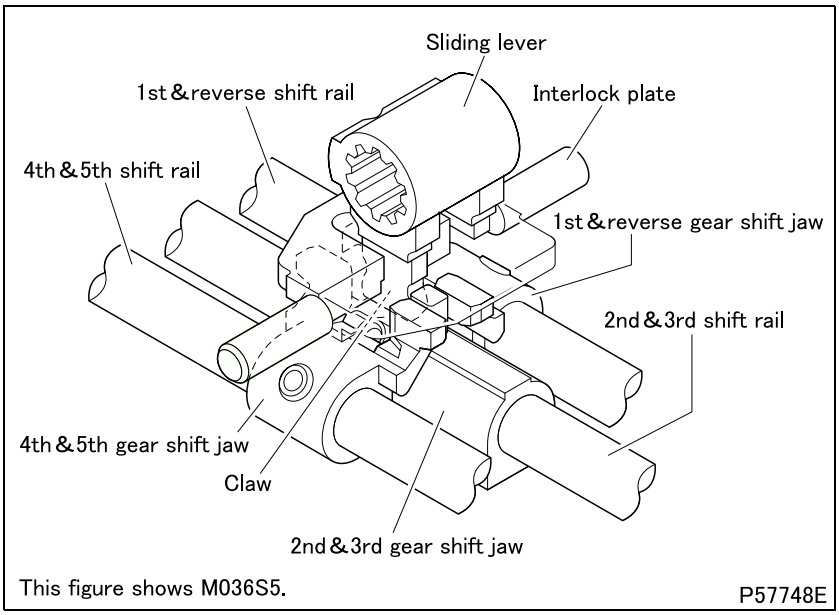
The following descriptions are for the 2nd gear of the 2nd/3rd gear synchronizer assembly.



- The synchronizer ring consists of three elements (synchronizer inner ring, synchronizer center cone and synchronizer outer ring). When a gear is selected, the center cone (having tapered cone surfaces on both inner and outer surfaces) and the inner ring (having tapered cone surfaces on both inner and outer surfaces) are sandwiched between the outer ring and the taper cone portion of the gear. Since cone clutch actions occur at three places, the mechanism can fully synchronize in a short period of time.
- Six protrusions on the outside of the synchronizer center cone fit into corresponding gear holes. As in the taper cone of the single cone type, the center cone and the gear are installed as if integrated.
- The inside of the synchronizer hub engages the spline of the main shaft and rotates with it. The outside of the synchronizer hub has a spline that engages the synchronizer sleeve and four grooves.
- Two arc-shaped synchronizer levers are inserted between the synchronizer outer ring and synchronizer hub, and synchronizer sleeve to double the force pushing the outer ring of the sleeve, shortening the time required for synchronization.
- The synchronizer outer ring and synchronizer inner ring are inserted into synchronizer center cones, respectively.
- When the gear shift is in neutral (Figure **A**), moving the shift fork in the direction of the arrow as shown in the illustration moves the synchronizer sleeve slightly to the 2nd gear. At the same time, because the synchronizer lever top faces the inside angle of the synchronizer sleeve, the sleeve pushes the lever top toward the 2nd gear on this angle as well as it pushes the lever inside the radius direction (Figure **B**).
- The two synchronizer levers, whose forces are doubled by leverage with the synchronizer hub as the fulcrum, push the synchronizer outer ring toward the 2nd gear, and press it against the taper cone of the synchronizer center cone, the center cone against the synchronizer inner ring, and in addition the inner ring against the 2nd gear. The levers are constantly expanded outside the radius direction by the synchronizer springs.
- The taper cones of synchronizer rings, which act as cone clutches, generate friction torque and perform synchronous operation.
- The synchronizer outer ring has protrusions at two locations. These protrusions are sandwiched by the two synchronizer levers, restricting rotation of the synchronizer outer ring. Therefore, the synchronizer outer ring expands the levers outward by friction torque.
- The synchronizer sleeve can’t move unless it pushes in the synchronizer levers. Therefore, while friction torque acts on the synchronizer outer ring, the protrusions of the synchronizer outer ring expand the levers, and the sleeve can’t move and keep pressing on the synchronizer outer ring.

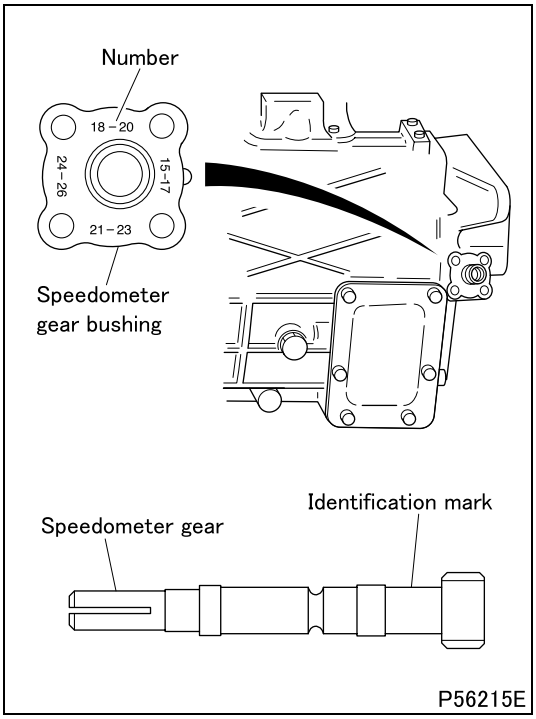
- The rotation speed of the synchronizer hub becomes gradually closer to that of the 2nd gear, due to the synchronous operation, and eventually they rotate at the same speed. This allows the synchronizer sleeve to push in the synchronizer levers on the inside angle and to move smoothly while turning the synchronizer outer ring to engage the synchronizer hub and gear, completing the shift change (Figure **C**).

3. Interlock Mechanism



- The interlock mechanism prevents double engagement of gears.
- When the 2nd and 3rd shift rail is shifted, the finger of the gear shift sliding lever engages with the 2nd & 3rd gear shift jaw, and the rail on the bottom surface of the interlock plate locks the other gear shift jaws.

4. Speedometer Gear Bushing



- The speedometer gear bushing is eccentric, and displacing the installed position allows it to correspond to the different number of teeth on the speedometer gear.
- The numbers marked at four locations on the front show the allowable range of tooth numbers for the corresponding speedometer gear.
  "15-17": Number of teeth 15 to 17
- An identification mark showing the number of teeth is marked on the speedometer gear.

Identification mark	A	B	C	D	L	E
Number of teeth	15	16	17	18	19	20
Gear ratio	3.0	3.2	3.4	3.6	3.8	4.0

Possible causes	Symptoms	Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise when cruising	Noise when changing gear	Reference Gr
Transmission mechanism faulty	Main shaft rear lock nut loose	O	O				
	Main shaft thrust washer worn	O	O				
	Main shaft bearing worn or damaged	O	O				
	Synchronizer ring and synchronizer sleeve spline worn	O					
	Synchronizer ring and gears taper cone area worn		O				
	Main shaft pilot bearing worn or damaged			O	O		
	Drive pinion bearing worn or damaged			O			
	Countershaft bearing worn or damaged			O			
	Needle bearings of gears worn or damaged			O	O		
	Main shaft and countershaft gears worn or damaged				O		
	Main shaft and countershaft gears backlash excessive				O		
	Spline of gears worn					O	
	Gears damaged				O		
	Transmission oil insufficient				O		
Control mechanisms faulty	Control cable adjustment faulty		O				
	Control cable routing inadequate		O				
	Control cable length inadequate		O				
	Bushings worn	O	O				
	Steel ball and groove of shift rail worn	O					
	Poppet spring of shift rail fatigued or damaged	O					
	Shift rail sliding movement faulty		O				
	Shift fork fingers worn		O				
	Shift fork bent		O				

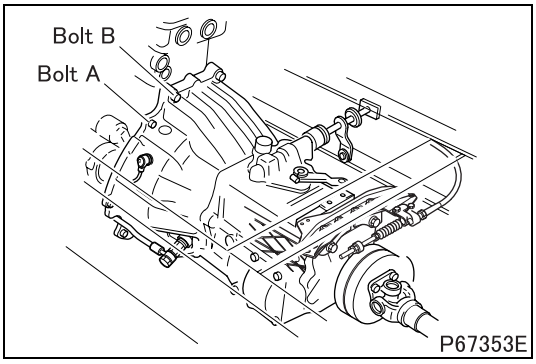
Possible causes \ Symptoms				Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise when cruising	Noise when changing gear	Reference Gr
Clutch faulty	Clutch disengagement faulty				O			O	Gr21
	Clutch pedal play faulty				O				
Synchronizer faulty	Warner synchromesh type	Single cone type	Contact surface of synchronizer ring and gear taper cone worn		O			O	
		Triple cone type	Contact surface of synchronizer inner and outer rings and center cone worn		O			O	
			Contact surface of synchronizer inner ring and gear taper cone worn		O			O	
	Lever synchromesh type		Synchronizer lever worn or damaged		O			O	
			Contact surface of synchronizer inner and outer rings and center cone worn		O			O	
			Contact surface of synchronizer inner ring and gear taper cone worn		O			O	
	Synchronizer ring spline chamfer worn <Warner synchromesh type>							O	
	Shifting plunger worn <Warner synchromesh type>							O	
	Shifting plunger spring deteriorated or damaged <Warner synchromesh type>							O	
	Synchronizer spring deteriorated or damaged <Lever synchromesh type>							O	
	Synchronizer sleeve worn or damaged						O	O	

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection of Transmission Mounting Bolts

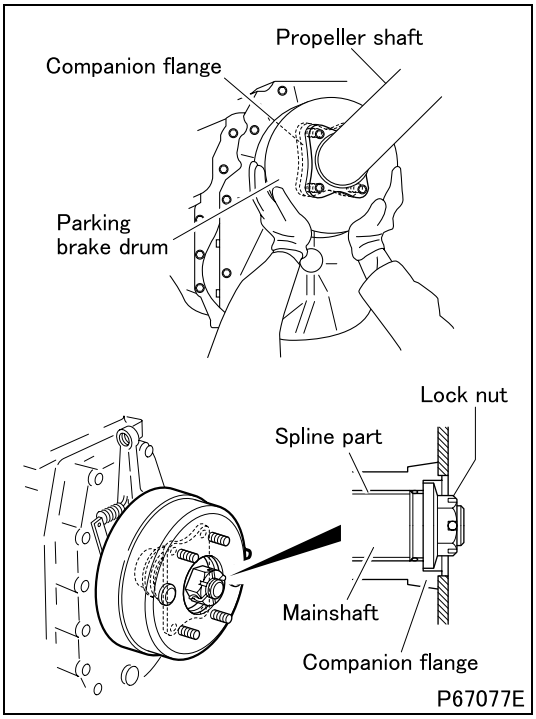
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
–	Bolt A (transmission mounting)	47 (35)	M10
	Bolt B (transmission mounting)	82 (61)	M12



- Check the transmission mounting bolts for correct torque.
- Retighten any loose bolt to the specified value.

2. Inspection of Companion Flange and Lock Nut



- Move the parking brake drum in both axial and vertical directions. Check for excessive play between the companion flange and main shaft.
- If excessive play is found, remove the propeller shaft. Check the lock nut for correct torque and the splines of the companion flange and main shaft for signs of damage. If any part is found to be damaged, replace that part. (See the following sections: “REAR COVER <S5> AND PARKING BRAKE” or “EXTENSION HOUSING <S6> AND PARKING BRAKE”.)

3. Checking and Changing Transmission Oil

Torque: N·m (lbf·ft))

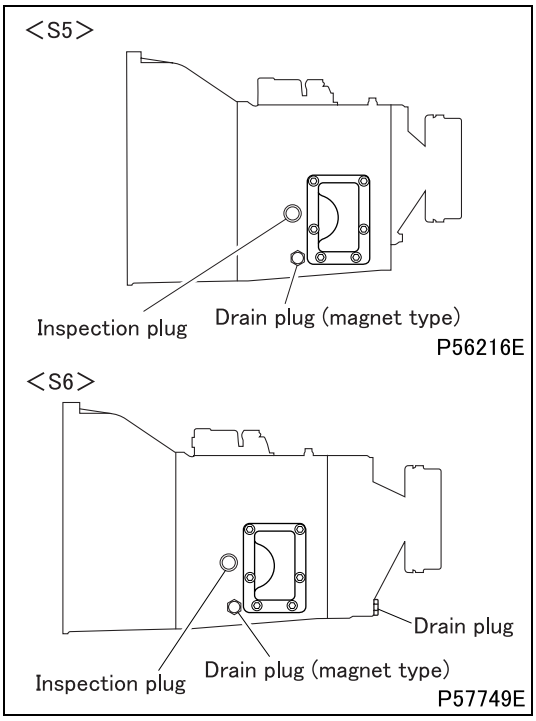
ID	Component	Torque value	Remarks
–	Fill plug (inspection plug)	54-82 (40-62)	–
	Drain plug		

Lubricant and/or sealant

ID	Points of application		Specified lubricant and/or sealant	Quantity
–	Threaded area of fill plug		ThreeBond 1105	As required
	Threaded area of drain plug			
–	Gear case and extension housing (auxiliary case)	M036S5	Gear oil Temperate climate: API GL-3 SAE80 Warm climate: API GL-3 SAE90 Tropical climate: API GL-4 SAE90 Engine oil For long periods of high-speed driving: API CC SAE30 or SAE40	3.6 L (3.8 qt)
		M036S6		4.4 L (4.6 qt)

WARNING ⚠

- **Transmission oil is extremely hot after vehicle operation. Hot transmission oil can cause burns.**



[Checking oil]

(1) Check oil level

- Remove the fill plug (inspection plug), and check that oil is filled up to the neck.
- If oil is not sufficient, add oil through the fill plug hole until it is level with the lower edge of the fill opening.
- After filling, apply sealant to the fill plug and tighten it as specified.

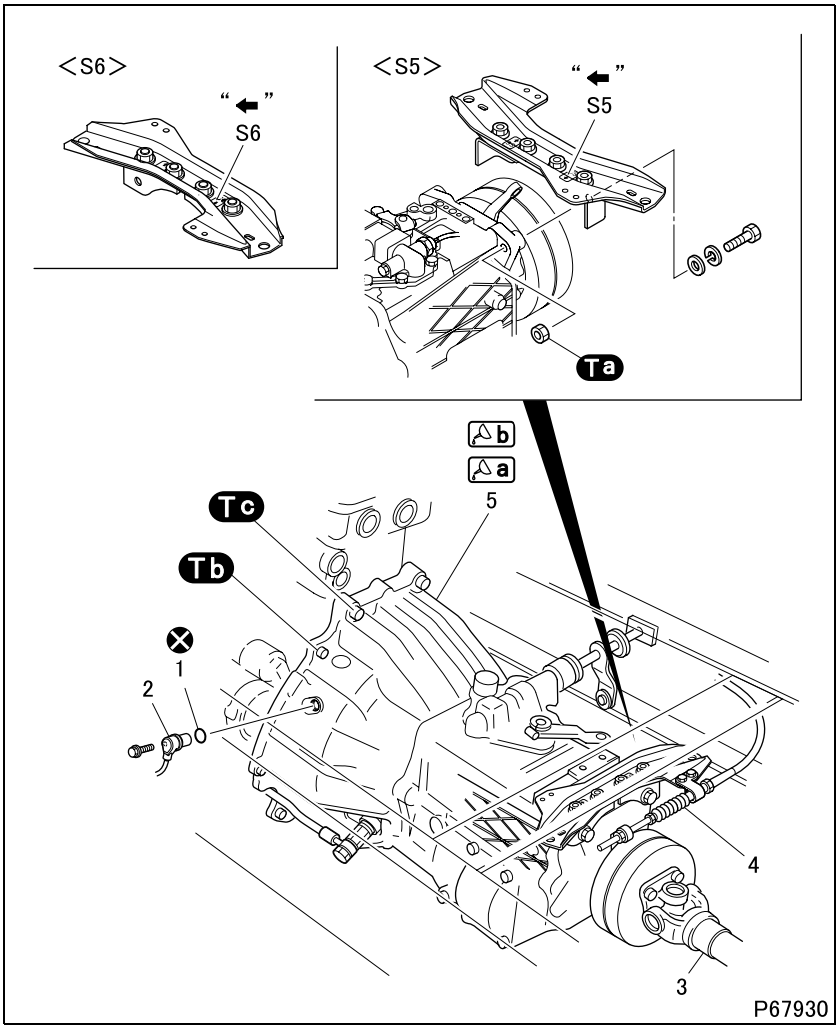
(2) Check oil quality

- When draining the transmission oil, check the oil and magnetic drain plug for metal chips and powdered metal.
- If an abnormally large amount of metal chips and metal powder is found, the transmission is damaged.

[Changing oil]

- Remove the fill plug and magnetic drain plug. Drain the oil while it is still warm. Catch the used transmission oil in a suitable container and dispose of it properly.
- Clean the magnetic drain plug before installing it. Use a piece of key stock, or other convenient steel slug, to short the two magnetic poles and divert the magnetic field.
- Add oil through the fill plug hole until it is level with the lower edge of the fill opening.
- After filling, check the oil level. If oil is not sufficient, replenish it.
- Apply sealant to the fill and drain plugs and tighten them as specified.

REMOVAL AND INSTALLATION OF TRANSMISSION



● **Removal sequence**

1 O-ring
2 Engine speed sensor
3 Propeller shaft
4 Parking brake cable
5 Transmission

● **Installation sequence**

Follow the removal sequence in reverse.

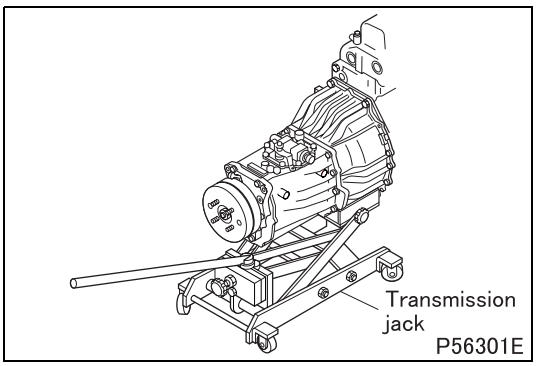
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Nut (transmission mounting)	130 to 180 (96 to 130)	–
Tb	Bolt (transmission mounting)	47 (35)	M10
Tc	Bolt (transmission mounting)	82 (61)	M12

Lubricant and/or sealant

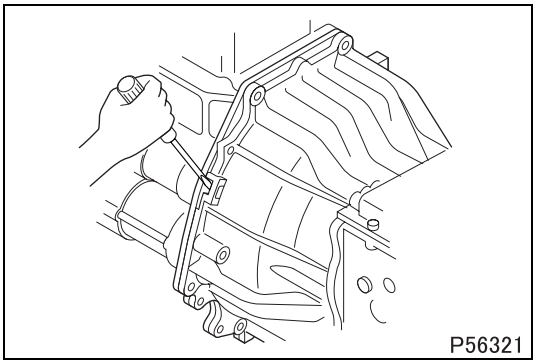
ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Drive pinion spline	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
b	Engine mounting surface of clutch housing	ThreeBond 1215	As required

◆Removal procedure◆



■ **Removal: Transmission**

- Support the transmission on a transmission jack and remove the transmission mounting bolts.

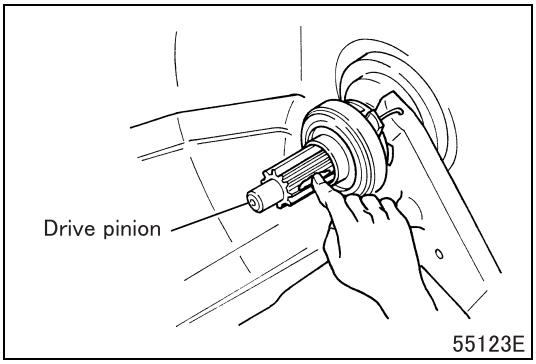


- Insert a screwdriver into the three removal grooves. Remove the transmission from the engine.
- Move the transmission backward until the spline of the drive pinion is detached from the clutch.

CAUTION ⚠

- **Make sure that you pull the transmission out in a straight line. If you move the transmission from side to side, you will damage the splines of the drive pinion (input shaft).**

◆Installation procedure◆



■ **Installation: Transmission**

- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Use your hand to apply grease evenly onto the clutch disc sliding surface of the drive pinion.

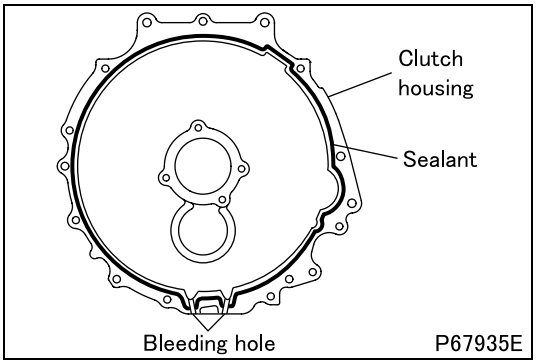
CAUTION ⚠

- **Apply only a minimum amount of grease. Too much grease could cause the clutch to slip.**

- There are various ways to apply sealant, using a gun applicator or spatula. Follow the procedures given below.

CAUTION ⚠

- **Sealant that is not applied properly can cause oil leaks.**
  - **Clean all dust, oil, grease, and other contaminants from the mating surfaces.**
  - **Apply sealant in an even bead of uniform width.**
  - **Apply sealant in a continuous bead, without breaks.**
  - **Do not allow sealant to cover the bleed hole in the clutch housing or any engine flywheel parts.**

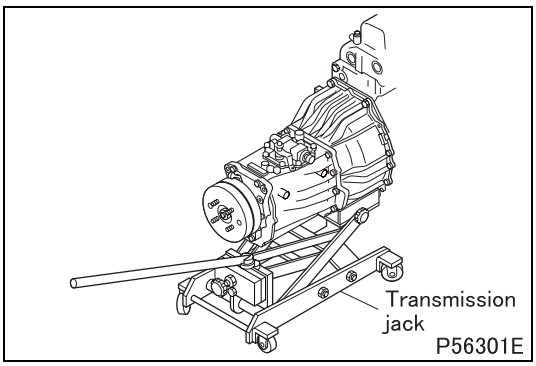


[Applying sealant using a gun applicator]

- Clean the mating surfaces of each part.
- Apply sealant in a uniform bead to the center of the mating surface. The diameter of the bead should be the same as the diameter of the gun nozzle. For an example, see the illustration.

[Applying sealant using a spatula or other hand tool]

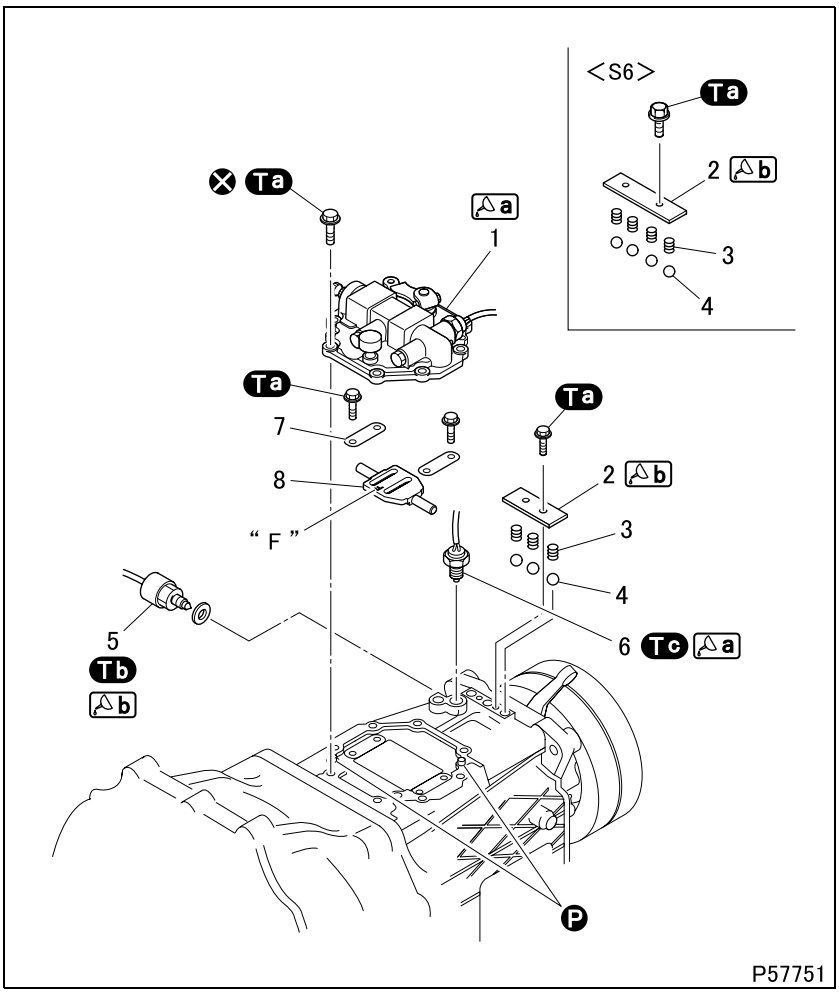
- Clean the mating surfaces of each part.
- Apply sealant evenly to the entire mating surface.



- Support the transmission on the transmission jack. Guide the splined drive pinion (input shaft) of the transmission slowly into the pilot bearing of the flywheel.
- Tighten the transmission mounting bolts as specified.

M E M O

SHIFT MECHANISM



● **Removal sequence**

1 Shift rod housing
(See below for details)
2 Poppet spring plate
3 Poppet spring
4 Steel ball
5 Back-up alarm switch
6 Torque limit switch
7 Plate
8 Interlock plate

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards: N (lbf)

Location	Maintenance item	Standard value	Limit	Remedy
3	Poppet spring installed load (installed length 21.7 {0.85})	61.2 (13.8)	43.0 (9.7)	Replace

Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Bolt (shift housing)	23 (17)	–
	Bolt (poppet spring plate mounting)		
	Bolt (plate mounting)		
Tb	Back-up alarm switch	29 to 39 (22 to 29)	–
Tc	Torque limit switch	46 to 52 (34 to 38)	–

Lubricant and/or sealant

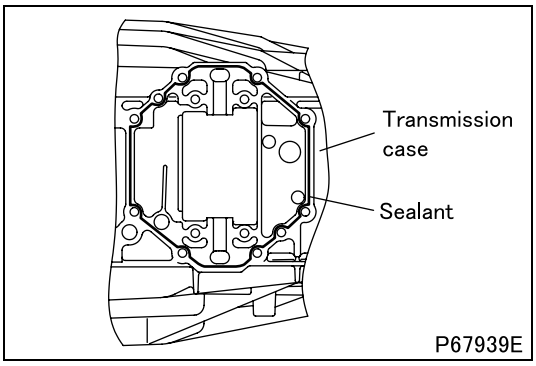
ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Mating surface of shift housing and transmission case	ThreeBond 1104	As required
	Threaded area of torque limit switch		
b	Mating surface of poppet spring plate and transmission case	ThreeBond 1215	As required
	Threaded area of backup lamp switch		

■ **Installation: Shift rod housing**

- There are various ways to apply sealant, using a gun applicator or spatula. Follow the procedures given below.

CAUTION ⚠

- **Sealant that is not applied properly can cause oil leaks.**
  - **Clean all dust, oil, grease, and other contaminants from the mating surfaces.**
  - **Apply sealant in an even bead of uniform width.**
  - **Apply sealant in a continuous bead, without breaks.**



[Applying sealant using a gun applicator]

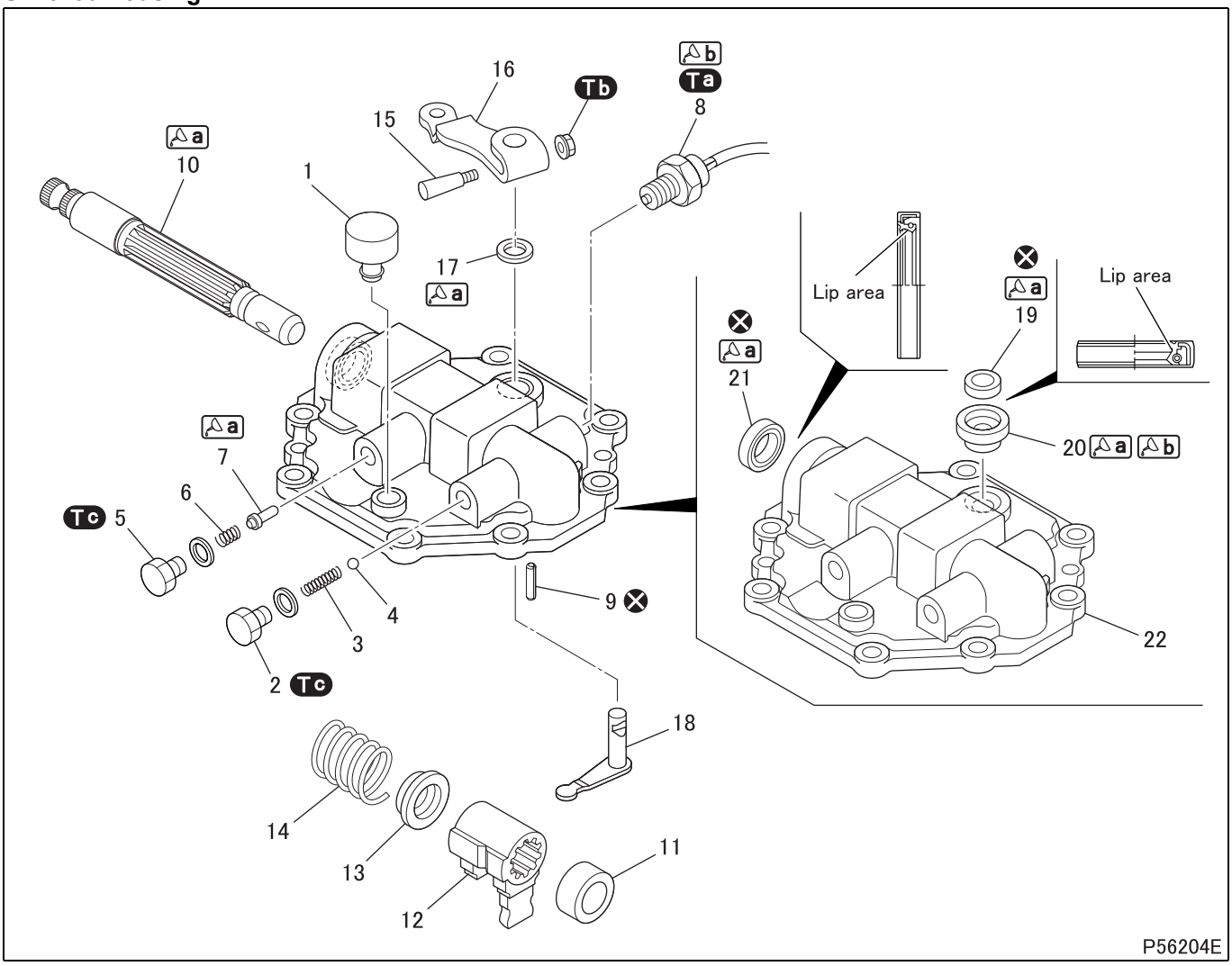
- Clean the mating surfaces of each part.
- Apply sealant in a uniform bead to the center of the mating surface. The diameter of the bead should be the same as the diameter of the gun nozzle. For an example, see the illustration.

[Applying sealant using a spatula or other hand tool]

- Clean the mating surfaces of each part.
- Apply sealant evenly to the entire mating surface.

SHIFT MECHANISM

Shift rod housing



● Disassembly sequence

1 Air breather
2 Poppet capscrew, neutral
3 Neutral poppet spring
4 Steel ball
5 Poppet capscrew, select
6 Select poppet spring
7 Select poppet pin
8 Neutral start switch
9 Spring pin
10 Torsion shaft (shift rod)
11 Spacer <S5>
12 Gear shift slide lever
13 Spring retainer
14 Return spring
15 Lock pin
16 Gear selector lever, top
17 Washer
18 Gear selector lever, bottom
19 Oil seal, gear selector
20 Bushing
21 Oil seal, shift rod
22 Selector lever case

⊗: Non-reusable parts

NOTE

- **If the bushing is removed, it must be replaced.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards: N (lbf)

Location	Maintenance item	Standard value	Limit	Remedy
3	Neutral poppet spring installed load (installed length 1.10 in {27.9 mm})	71 (16)	50 (11)	Replace
6	Select poppet spring installed load (installed length 0.43 in {11.0 mm})	19.6 (4.4)	14.0 (3.1)	Replace
14	Return spring installed load (installed length 1.06 in {26.9 mm})	71 (16)	50 (11)	Replace

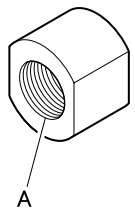
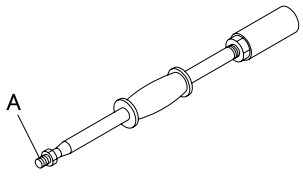
Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Neutral start switch	46 to 52 (34 to 38)	–
Tb	Nut (lock pin mounting)	6.9 (5.1)	–
Tc	Poppet capscrew	33 to 49 (24 to 36)	–

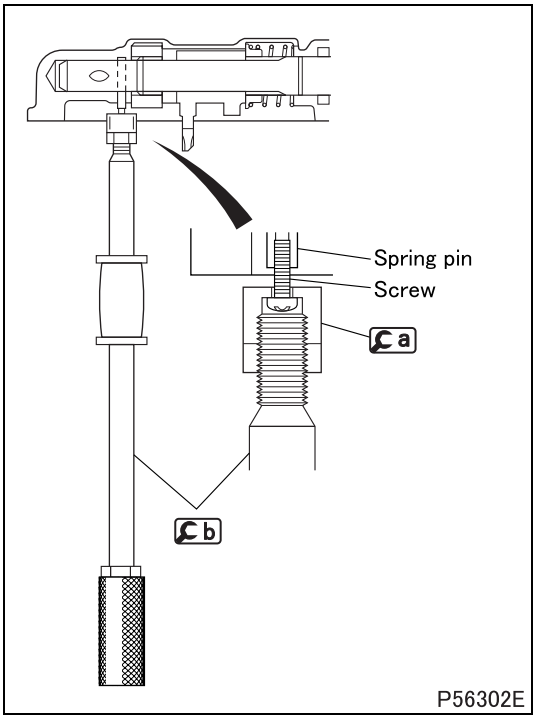
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding area of select poppet pin	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Neutral switch of torsion shaft and steel ball mounting groove		
	Sliding area of washer		
	Lip area of oil seal		
	Bushing interior friction surface and gear selector lever shaft		
b	Thread area of neutral start switch	ThreeBond 1104	As required
	Bushing exterior contact surface and selector lever case		

Special tools (Unit: mm)

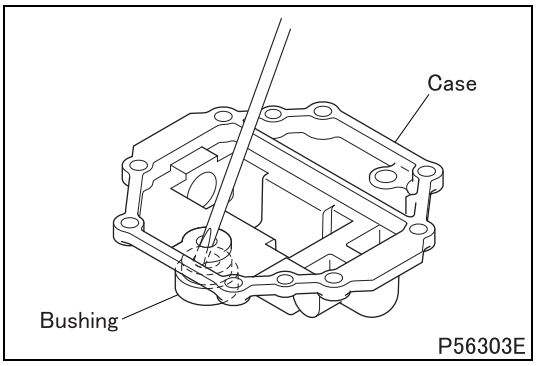
ID	Tool name and shape	Part No.	Application
a	Spring pin puller A: M12 × 1.25  P02399	MH062445	Removing the spring pin
b	Reverse shaft puller A: M12 × 1.25  P02118	03726-82000	

◆Removal procedure◆



■ **Removal: Spring pin**

- Tap the spring pin using an M4 tap.
- Insert the spring pin puller a with an M4 screw of appropriate length into the spring pin, and remove the spring pin using the reverse shaft puller b.



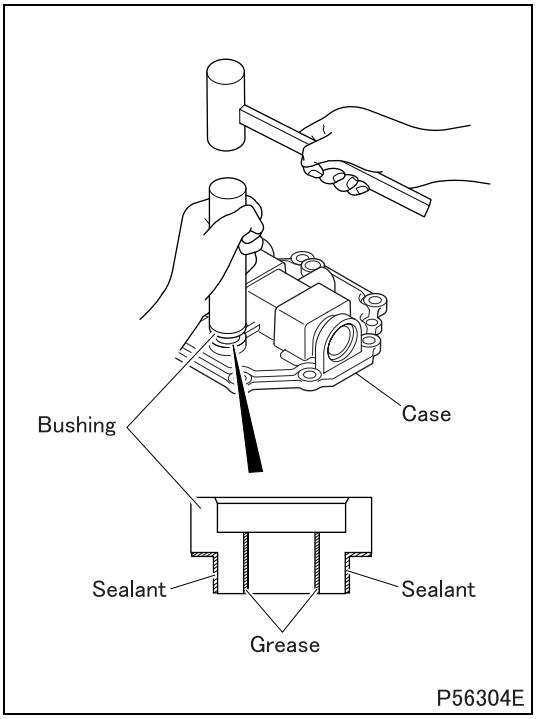
■ **Removal: Bushing**

- Remove the bushing using a screwdriver.

CAUTION ⚠

- **Be careful not to damage the selector lever case.**

◆Installation procedure◆



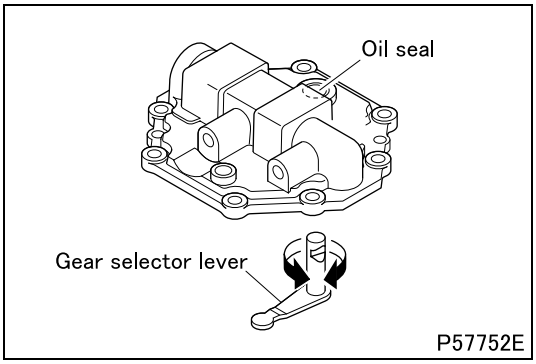
■ **Installation: Bushing**

- Clean the bushing and bushing mounting surface of the selector lever case.
- Apply grease to the inner surface of the bushing and sealant to its outer surface.

NOTE

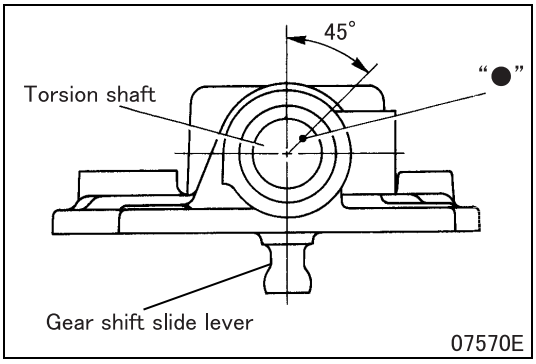
- **Do not allow sealant to adhere to the inner surface of the bushing.**

- To mount the bushing, tap it in using a cylindrical bar with an outer diameter of approximately 30 mm {1.18 in}.



■ **Installation: Gear selector lever**

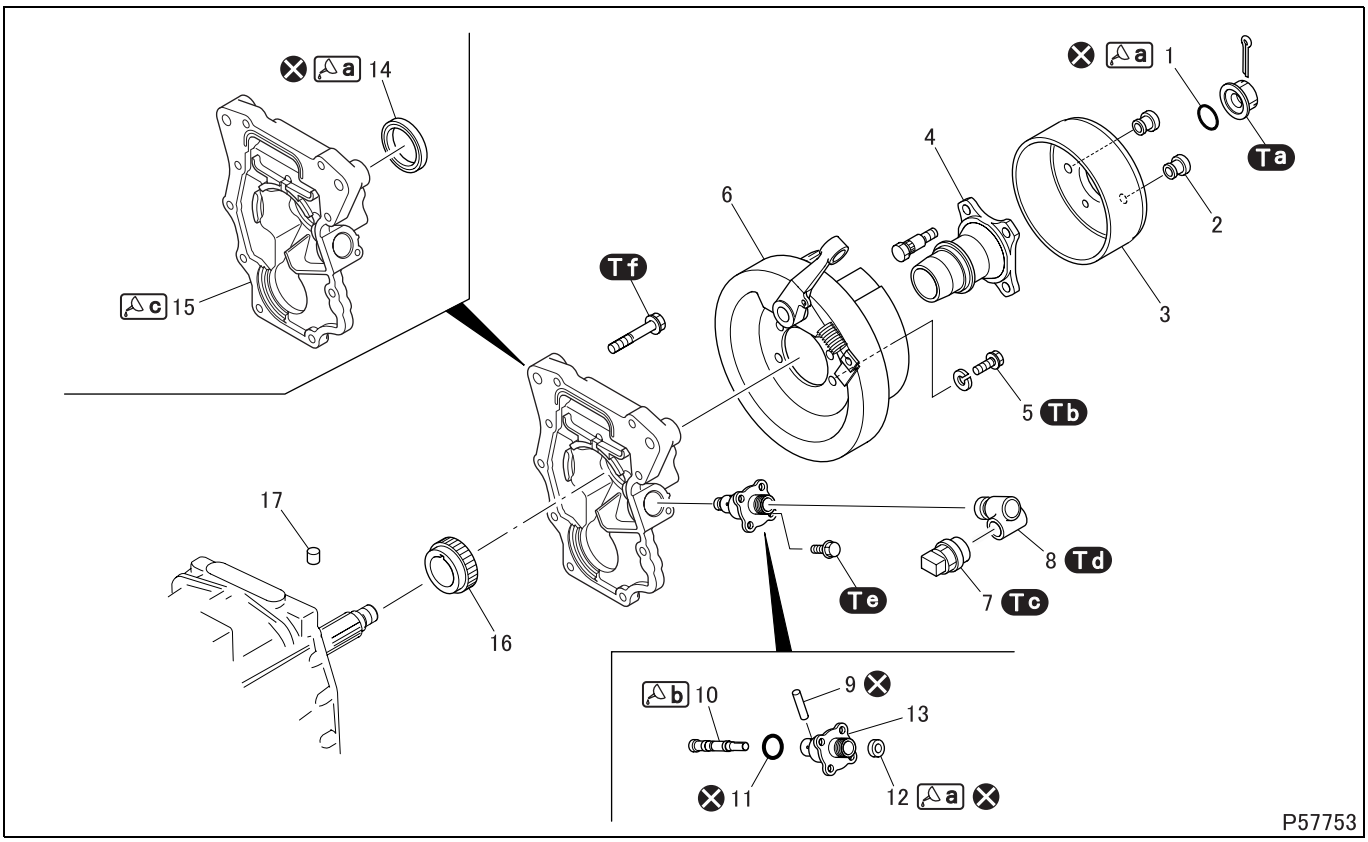
- Turn the gear selector lever when installing it in order to avoid damage to the lip of the oil seal.



■ **Installation: Torsion shaft (shift rod)**

- Install the torsion shaft (shift rod) so that the punch mark "●" at the tip of the shaft forms an angle of 45 degrees with the gear shift slide lever, as shown in the illustration.

REAR COVER <S5> AND PARKING BRAKE



● **Disassembly sequence**

1 O-ring, lock nut
2 Dust plug
3 Parking brake drum
4 Companion flange
5 Reamer bolt
6 Driveline parking brake (See Gr36.)
7 Vehicle speed sensor
8 L-joint
9 Spring pin
10 Speedometer gear
11 O-ring, speedometer gear
12 Oil seal, speedometer gear
13 Speedometer gear bushing
14 Oil seal, rear cover
15 Rear cover
16 Speedometer worm
17 Pin

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards: in (mm)

Location	Maintenance item		Standard value	Limit	Remedy
3	Parking brake drum	Inner diameter	$\phi 203.2\ ^{+0.3}_{0}$ ($8.00\ ^{+0.012}_{0}$)	ϕ205 (8.07)	Replace
		Squareness	0.05 {0.002) or less	–	
		Concentricity	0.20 (0.008) or less	–	
		Cylindricity	0.05 (0.002) or less	–	
		Static rotation imbalance	0.0049 N·m (0.004 lbf·ft) or less	–	
4	Runout at socket portion of companion flange		0.006 (0.15) or less	0.5 (0.020)	Replace
10, 13	Clearance between speedometer gear and speedometer gear bushing		0.04 to 0.09 (0.0016 to 0.0035)	0.15 (0.006)	Replace

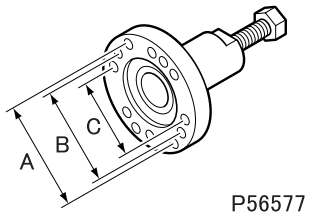
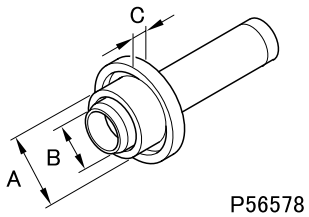
Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Lock nut	245 to 343 (180 to 250)	–
Tb	Reamer bolt	52 to 67 (38 to 49)	–
Tc	Vehicle speed sensor	15 to 29 (11 to 22)	–
Td	L-joint	34 to 49 (25 to 36)	–
Te	Bolt (speedometer gear bushing mounting)	23 (17)	–
Tf	Bolt (rear cover mounting)	45 (33)	–

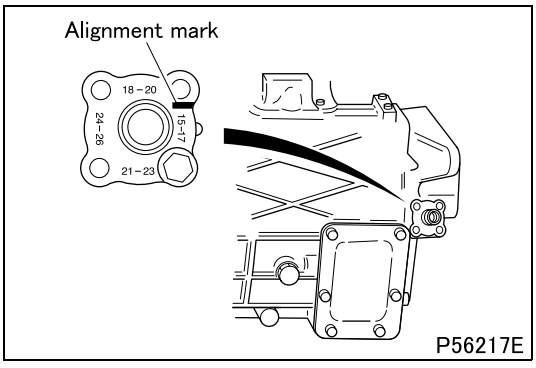
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	O-rings	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Lip area of oil seals		
b	Friction surface of speedometer gear and speedometer gear bushing	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
c	Contact surface of gear case and rear cover	ThreeBond 1215	As required

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
a	Flange puller A: ϕ95 {3.74} B: ϕ100 {3.94} C: ϕ90 {3.54}  P56577	MH061848	Removing the companion flange
b	Oil seal installer A: ϕ64 {2.52} B: ϕ50 {1.97} C: 17 {0.67}  P56578	MH062691	Installing the oil seal

◆Work before removal◆

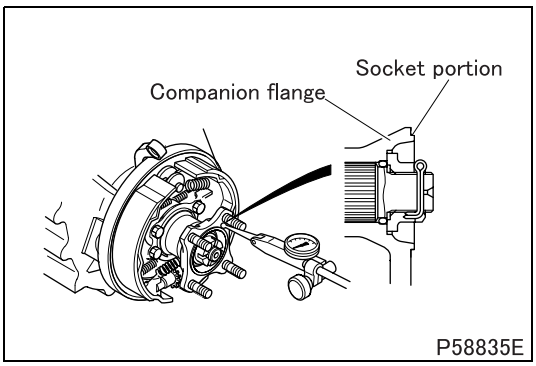


P56217E

■ Alignment marks: Speedometer gear bushing

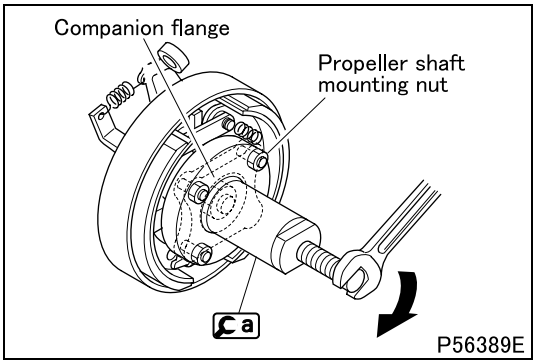
- The installed direction of the speedometer gear bushing is determined by the number of the speedometer gear teeth.
- Make alignment marks with a paint pen for ease of installation.

◆Removal procedure◆



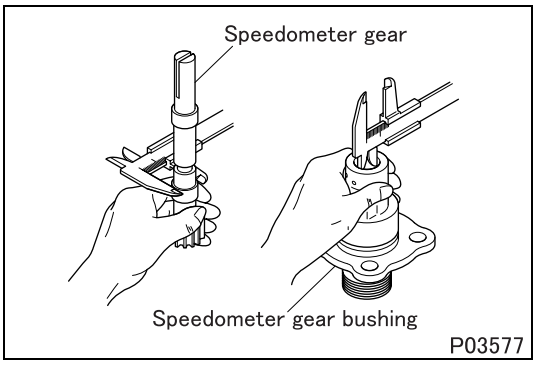
■ Inspection: Runout at socket portion of companion flange

- After removing the parking brake drum, measure runout of the companion flange at its socket portion.
- If the measurement exceeds the specified limit, replace the companion flange.



■ Removal: Companion flange

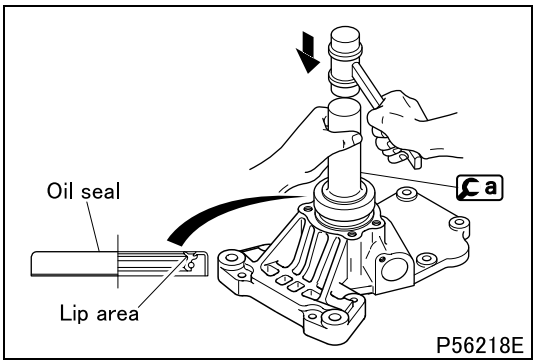
◆Inspection procedure◆



■ Inspection: Clearance between speedometer gear and speedometer gear bushing

- If the measured value exceeds the limit, replace the parts that are defective.

◆Installation procedure◆



■ Installation: Oil seal

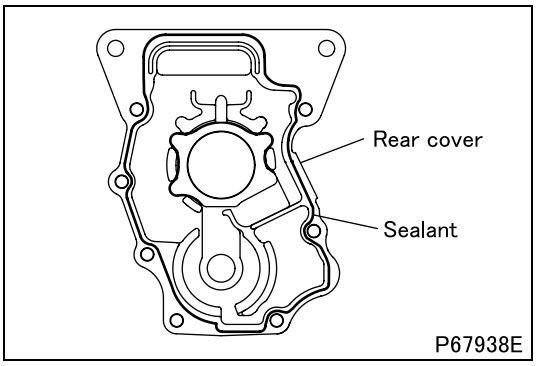
- Apply grease to the lip area of the oil seal, and install it as shown in the illustration.

■ **Installation: Rear cover**

- There are various ways to apply sealant, using a gun applicator or spatula. Follow the procedures given below.

CAUTION ⚠

- **Sealant that is not applied properly can cause oil leaks.**
  - **Clean all dust, oil, grease, and other contaminants from the mating surfaces.**
  - **Apply sealant in an even bead of uniform width.**
  - **Apply sealant in a continuous bead, without breaks.**

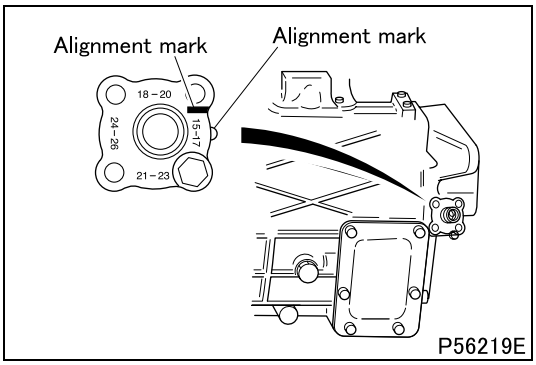


[Applying sealant using a gun applicator]

- Clean the mating surfaces of each part.
- Apply sealant in a uniform bead to the center of the mating surface. The diameter of the bead should be the same as the diameter of the gun nozzle. For an example, see the illustration.

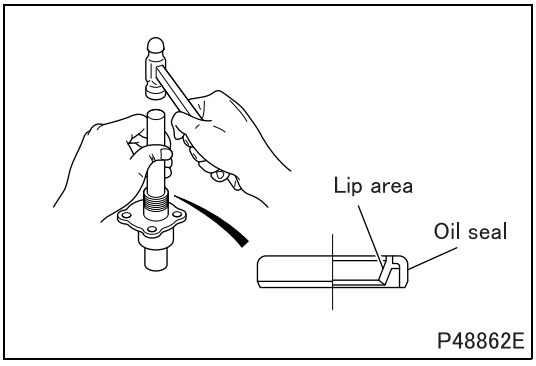
[Applying sealant using a spatula or other hand tool]

- Clean the mating surfaces of each part.
- Apply sealant evenly to the entire mating surface.



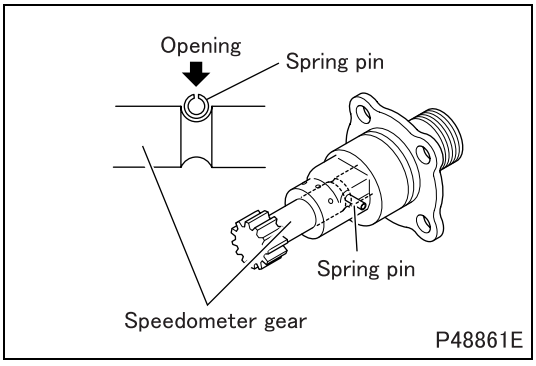
■ **Installation: Speedometer gear bushing**

- When replacing the speedometer gear bushing, check the alignment marks made on the old part and on the rear cover to determine the right orientation for the new part.



■ **Installation: Oil seal**

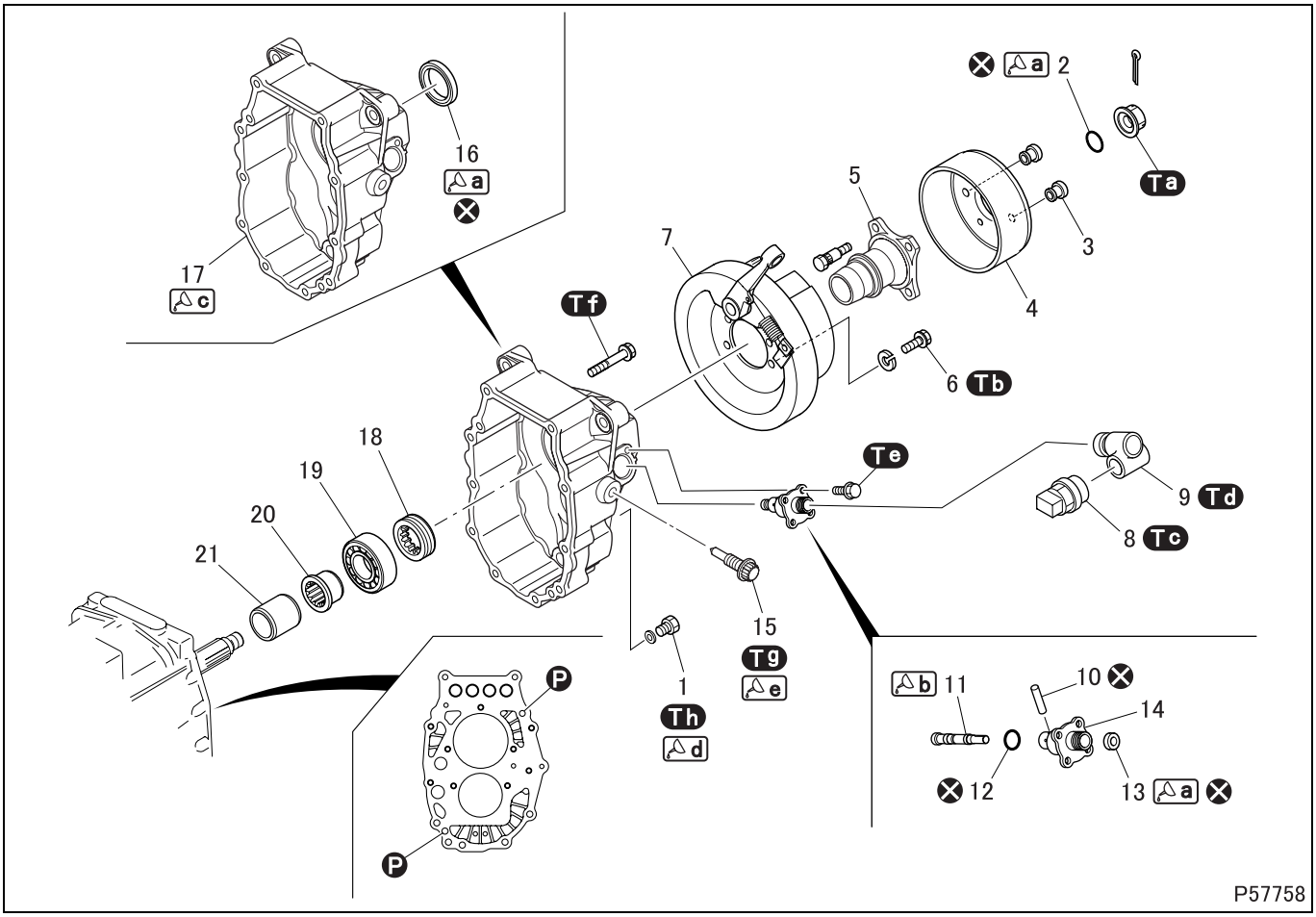
- Apply grease to the lip area of the oil seal.
- Install the oil seal evenly in the illustrated direction using a cylindrical bar of outer diameter of approx. 14 mm {0.55 in}.



■ **Installation: Spring pin**

- Install the spring pin in the illustrated direction to prevent the speedometer gear from slipping off.

EXTENSION HOUSING <S6> AND PARKING BRAKE



● **Disassembly sequence**

1 Drain plug
2 O-ring, lock pin
3 Dust plug
4 Parking brake drum
5 Companion flange
6 Reamer bolt
7 Driveline parking brake (See Gr36.)
8 Vehicle speed sensor
9 L-joint
10 Spring pin
11 Speedometer gear
12 O-ring, speedometer gear
13 Oil seal, speedometer gear
14 Speedometer gear bushing
15 Lever set bolt
16 Oil seal, auxiliary housing
17 Extension housing (auxiliary case)
18 Speedometer worm
19 Bearing, output shaft
20 Bearing retainer
21 Spacer
Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards: mm (in)

Location	Maintenance item		Standard value	Limit	Remedy
4	Parking brake drum	Inner diameter	$\phi 203.2\ ^{+0.3}_{0}$ ($8.00\ ^{+0.012}_{0}$)	ϕ205 (8.07)	Replace
		Squareness	0.05 {0.002) or less	–	
		Concentricity	0.20 (0.008) or less	–	
		Cylindricity	0.05 (0.002) or less	–	
		Static rotation imbalance	0.0049 N·m (0.004 lbf·ft) or less	–	
5	Runout at socket portion of companion flange		0.006 (0.15) or less	0.5 (0.020)	Replace
11, 14	Clearance between speedometer gear and speedometer gear bushing		0.04 to 0.09 (0.0016 to 0.0035)	0.15 (0.006)	Replace

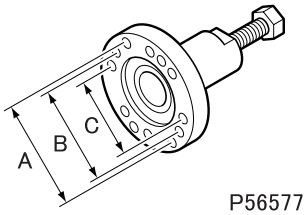
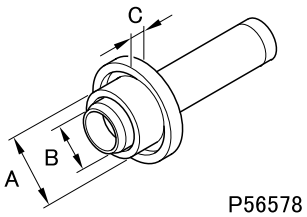
Torque: N·m (lbf·ft))

ID	Component	Torque value	Remarks
Ta	Lock nut	245 to 343 {180 to 250}	–
Tb	Reamer bolt	52 to 66.7 {38 to 49}	–
Tc	Vehicle speed sensor	14.7 to 29.4 {11 to 22}	–
Td	L-joint	34 to 49 {25 to 36}	–
Te	Bolt (speedometer gear bushing mounting)	23.5 {17}	–
Tf	Bolt (extension housing mounting)	44.5 {33}	–
Tg	Lever set bolt	160 {120}	–
Th	Drain plug	68.6 ± 14.7 {50.6 ± 10.8}	–

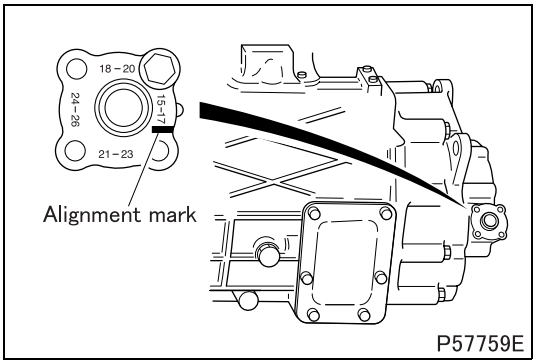
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Wheel bearing grease	As required
	Lip area of oil seal		
b	Sliding surface of speedometer gear and speedometer gear bushing	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
c	Mating surface of extension housing and gear case	ThreeBond 1215	As required
d	Thread area of drain plug	ThreeBond 1105	As required
e	Thread area of lever set bolt	Loctite 271	As required

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
Ca	Flange puller A: ϕ95 {3.74}, B: ϕ100 {3.94}, C: ϕ90 {3.54}  P56577	MH061848	Removing the companion flange
Cb	Oil seal installer A: ϕ64 {2.52}, B: ϕ50 {1.97}, C: 17 {0.67}  P56578	MH062691	Installing the oil seal

◆Work before removal◆

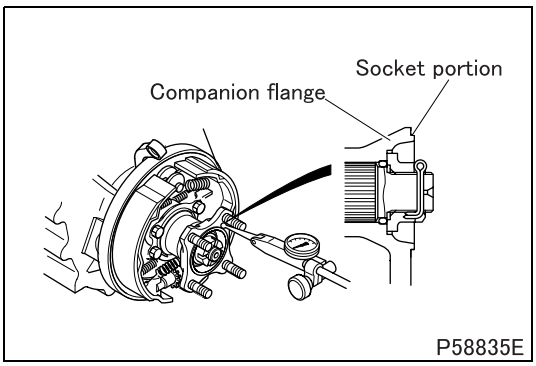


P57759E

■ Alignment marks: Speedometer gear bushing

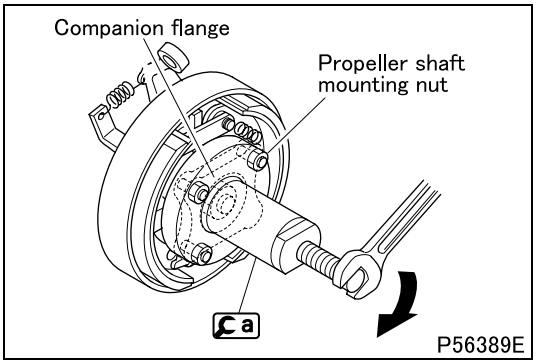
- The installed direction of the speedometer gear bushing is determined by the number of the speedometer gear teeth.
- Make alignment marks with a paint pen for ease of installation.

◆Removal procedure◆



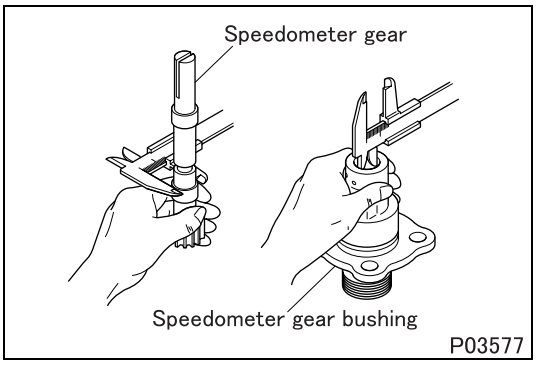
■ Inspection: Runout at socket portion of companion flange

- After removing the parking brake drum, measure the runout of the companion flange at its socket portion.
- If the measurement exceeds the specified limit, replace the companion flange.



■ Removal: Companion flange

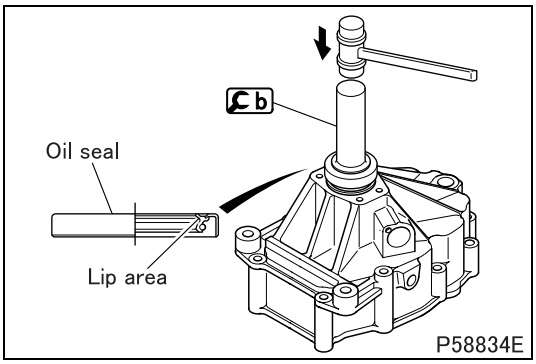
◆Inspection procedure◆



■ Inspection: Clearance between speedometer gear and speedometer gear bushing

- If the measured value exceeds the limit, replace the parts that are defective.

◆Installation procedure◆



■ Installation: Oil seal

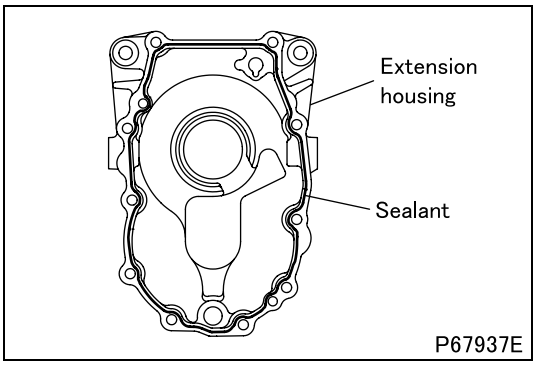
- Apply grease to the lip area of the oil seal, and install it on the extension housing (auxiliary case) as shown in the illustration.

■ **Installation: Extension housing (auxiliary case)**

- There are various ways to apply sealant, using a gun applicator or spatula. Follow the procedures given below.

CAUTION ⚠

- **Sealant that is not applied properly can cause oil leaks.**
  - **Clean all dust, oil, grease, and other contaminants from the mating surfaces.**
  - **Apply sealant in an even bead of uniform width.**
  - **Apply sealant in a continuous bead, without breaks.**

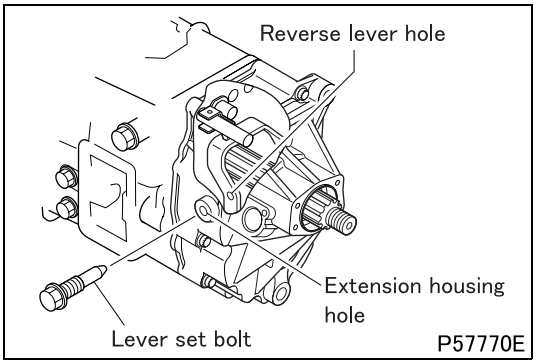


[Applying sealant using a gun applicator]

- Clean the mating surfaces of each part.
- Apply sealant in a uniform bead to the center of the mating surface. The diameter of the bead should be the same as the diameter of the gun nozzle. For an example, see the illustration.

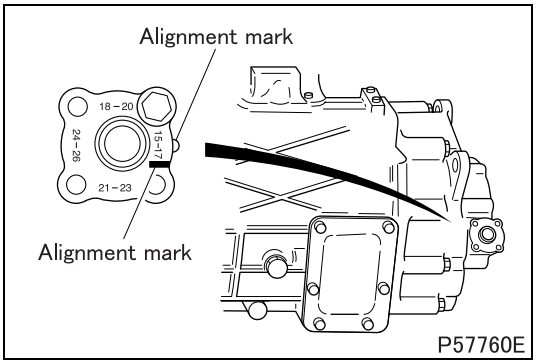
[Applying sealant using a spatula or other hand tool]

- Clean the mating surfaces of each part.
- Apply sealant evenly to the entire mating surface.



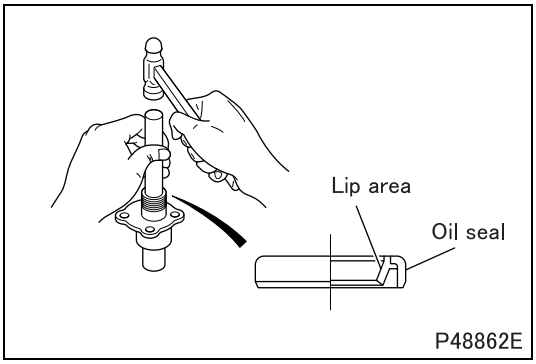
■ **Installation: Lever set bolt**

- Apply sealant to the threaded areas of the lever set bolts. Install them into the extension housing (auxiliary case) and into the opening in the reverse lever.



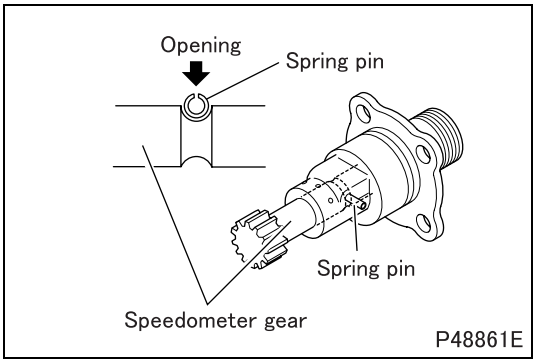
■ **Installation: Speedometer gear bushing**

- When replacing the speedometer gear bushing, check the alignment marks made on the old part and on the extension housing to determine the right orientation for the new part.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal.
- Install the oil seal evenly in the illustrated direction using a cylindrical bar with an outer diameter of approx. 14 mm {0.55 in}.

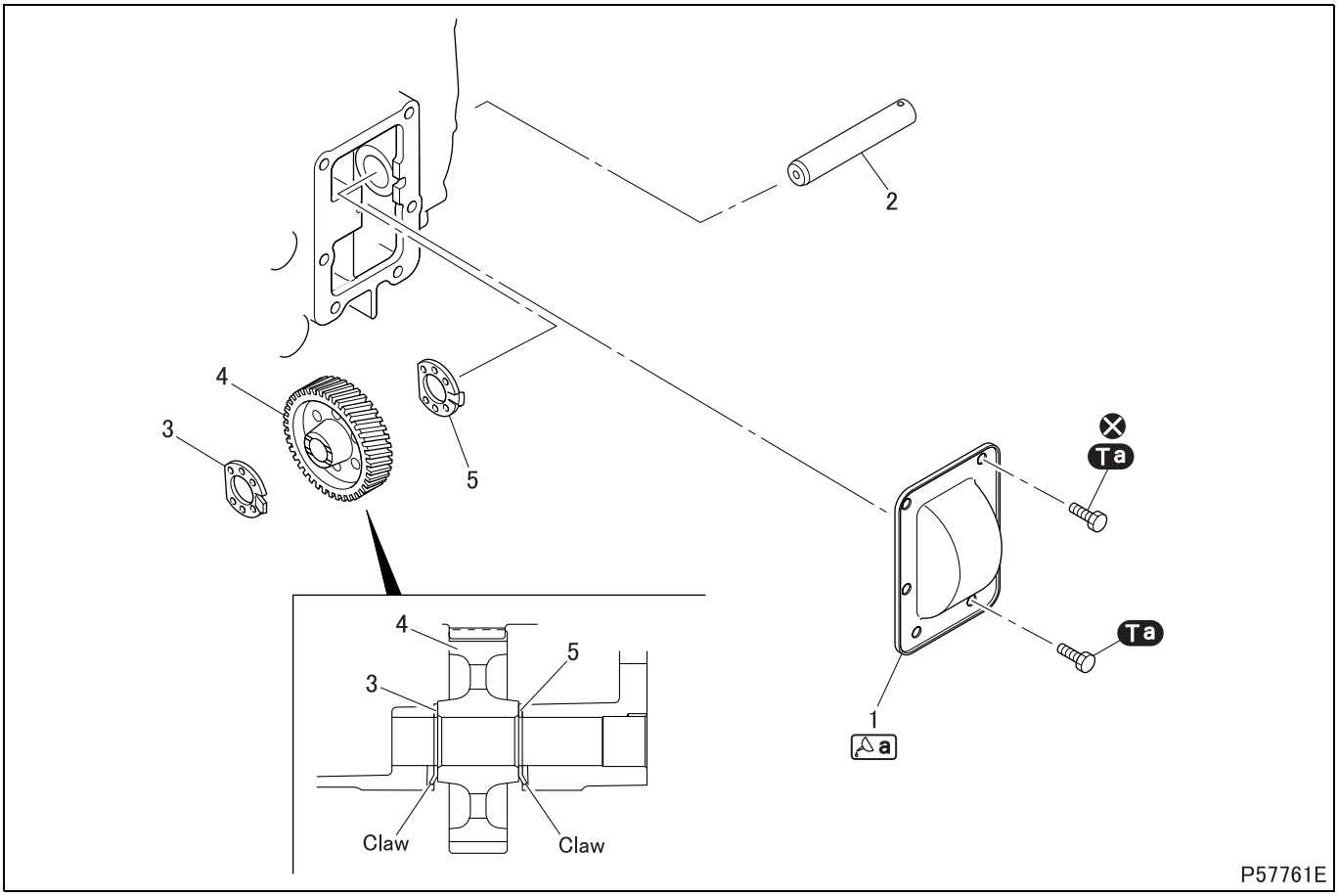


■ **Installation: Spring pin**

- Install the spring pin as shown in the illustration to prevent the speedometer gear from slipping off.

M E M O

REVERSE IDLER GEAR



● **Disassembly sequence**

1 PTO cover
2 Reverse idler gear shaft
3 Lockring, inner
4 Reverse idler gear
5 Lockring, outer

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
2, 4	Axial play of reverse idler gear	0.045 to 0.107 {0.0018 to 0.0042}	0.4 {0.016}	Replace

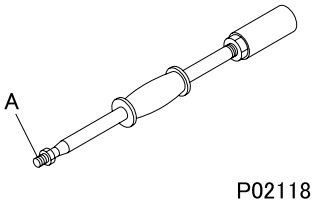
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Bolt (PTO cover)	44.5 {33}	–

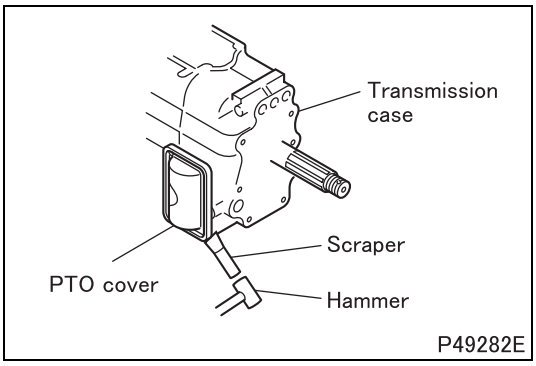
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact surface of PTO cover with gear case	Loctite 5999	As required

Special tools (Unit: mm)

ID	Tool name and shape	Part No.	Application
a	Reverse shaft puller A: M12 × 1.25  P02118	03726-82000	Removing the reverse idler gear shaft

◆Removal procedure◆



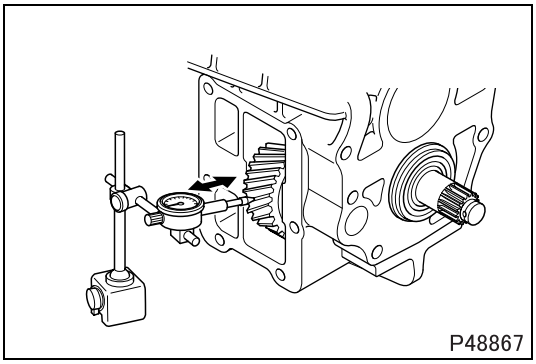
P49282E

■ **Removal: PTO cover**

- Insert a scraper into the lower right or lower left corner of the PTO cover where it meets the gear case. Tap gently with a hammer to loosen the edges of the PTO cover. When the PTO cover is loose all around, remove it.

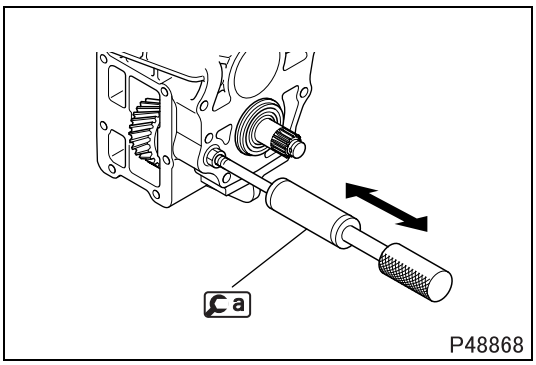
CAUTION ⚠

- **Do not attempt to pry out the PTO cover until it is loose all the way around. To do so could damage the PTO cover or the gear case.**


P48867

■ **Inspection: Axial play of reverse idler gear**

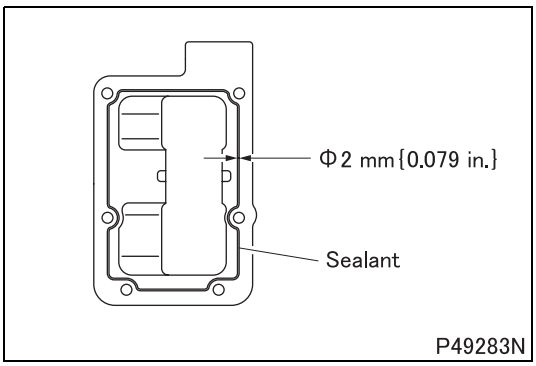
- If the measured value exceeds the limit of 0.4 mm (0.016 in), replace the reverse idler gear.
- After installation of the new gear, check the axial play again. Make sure it does not exceed the limit.



P48868

■ **Removal: Reverse idler gear shaft**

◆Installation procedure◆



■ **Installation: PTO cover sealant**

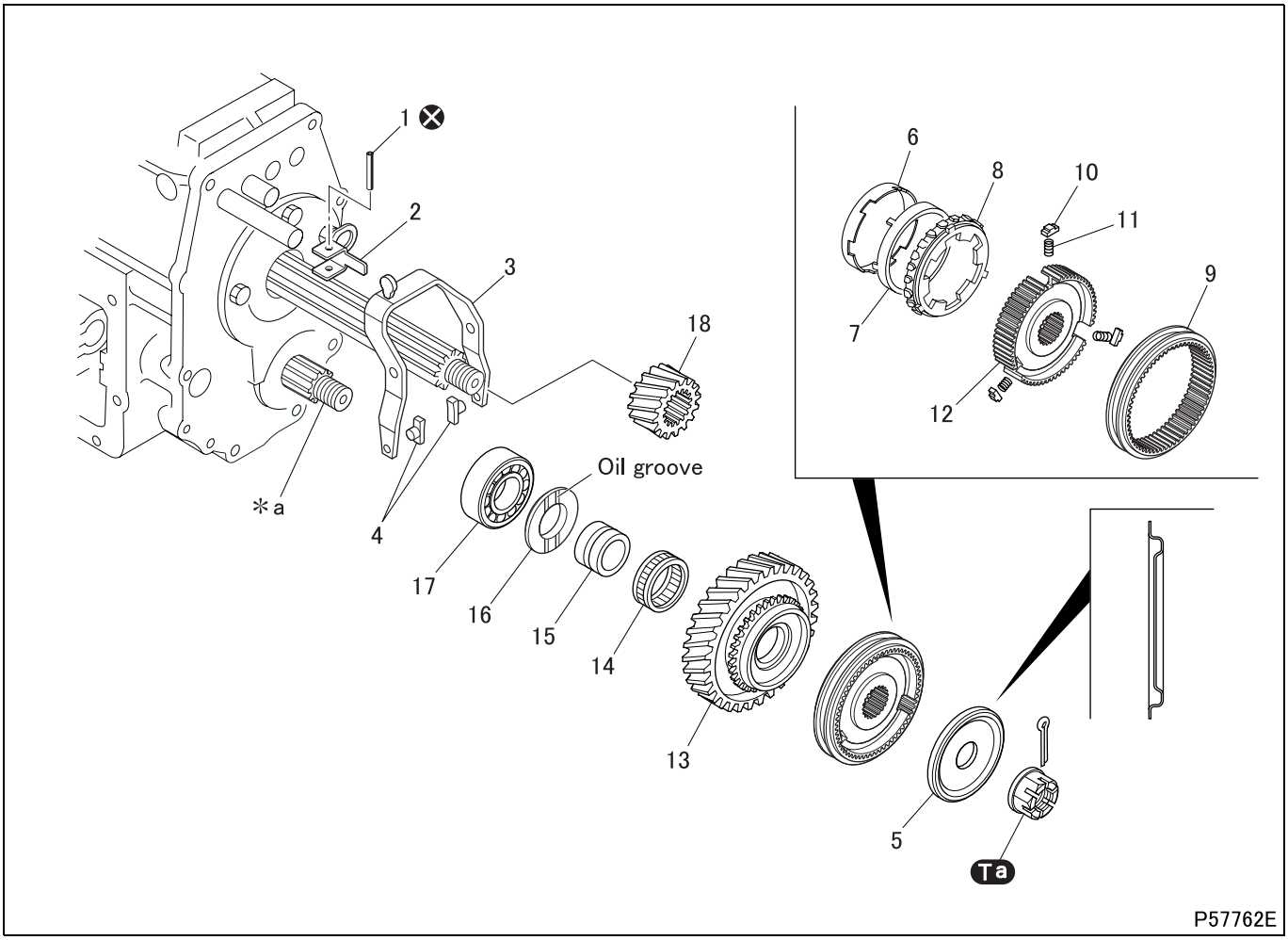
- Clean the contact surface of each part.
- Apply the sealant to the gear case contact surface of the PTO cover in an even bead, without breaks.
- Install the PTO cover within three minutes after applying the sealant. Make sure the sealant remains in place and does not leak out the edges of the PTO cover.

CAUTION ⚠

- **Wait one hour before starting the engine after installing the PTO cover.**
- **Any time the PTO cover mounting bolts are loosened or removed, reapply the sealant.**

M E M O

6TH GEAR <S6>



● **Disassembly sequence**

1 Spring pin
2 6th shift rail jaw B
3 6th reverse lever
4 Gear shift fork piece
5 Shifting key retainer
6 Synchronizer inner ring
7 Synchronizer center cone
8 Synchronizer outer ring
9 Synchronizer sleeve
10 Shifting plunger
11 Shifting plunger spring
12 Synchronizer hub
13 Countershaft 6th gear
14 Needle bearing
15 Countershaft 6th gear sleeve
16 Thrust washer
17 Countershaft rear bearing
18 Main shaft 6th gear

***a**: Countershaft
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

- **Place the synchronizer sleeve in neutral position before installing the 6th reverse lever.**

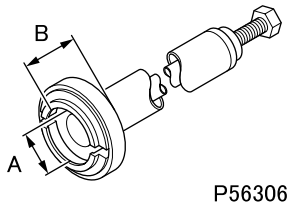
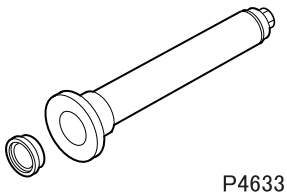
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
4, 9	Clearance between gear shift fork piece and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
8, 12	Clearance between synchronizer outer ring and synchronizer hub	3.0 to 3.3 {0.12 to 0.13}	4.0 {0.16}	Replace
8, 13	Clearance between synchronizer outer ring and countershaft 6th gear	0.96 to 1.54 {0.038 to 0.061}	0.5 {0.020}	Replace
13	End play of countershaft 6th gear	0.25 to 0.35 {0.0098 to 0.014}	0.7 {0.028}	Replace
13 to 15	Axial play of countershaft 6th gear	0.08 to 0.14 {0.0031 to 0.0055}	0.2 {0.0079}	Replace

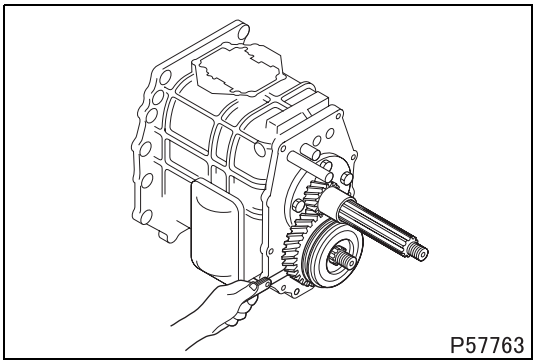
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Lock nut	295 to 392 {215 to 290}	–

Special tools (Unit: mm {in})

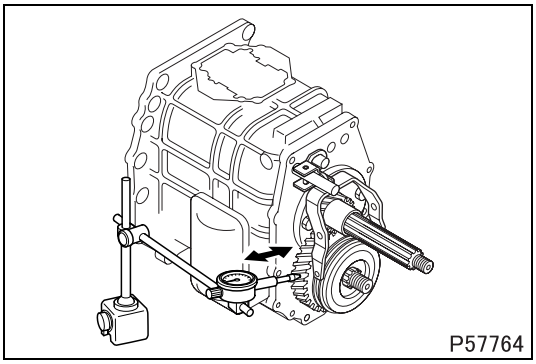
ID	Tool name and shape	Part No.	Application
a	Rear bearing puller, countershaft A: ϕ68 {2.68} B: 73.5 {2.89}  P56306	MH062697	Removing the countershaft 6th gear sleeve, thrust washer and countershaft rear bearing
b	Rear bearing installer, countershaft  P46331	MH062696	Installing the countershaft 6th gear sleeve, thrust washer and countershaft rear bearing

◆Work before removal◆


P57763

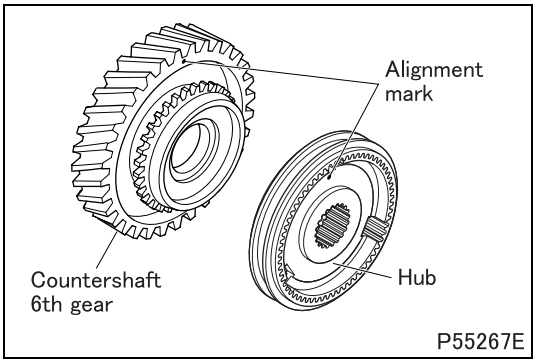
■ Inspection: End play of countershaft 6th gear

- If the measured value exceeds the limit, replace the parts that are defective.



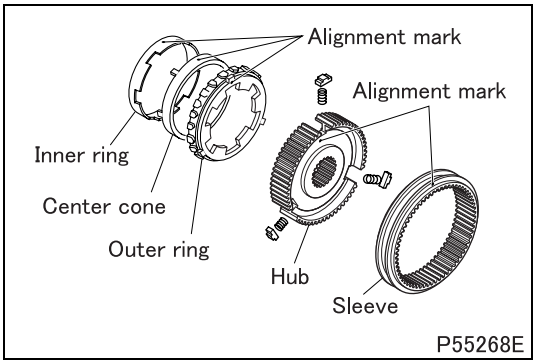
■ **Inspection: Axial play of countershaft 6th gear**

- If the measured value exceeds the limit, replace the parts that are defective.

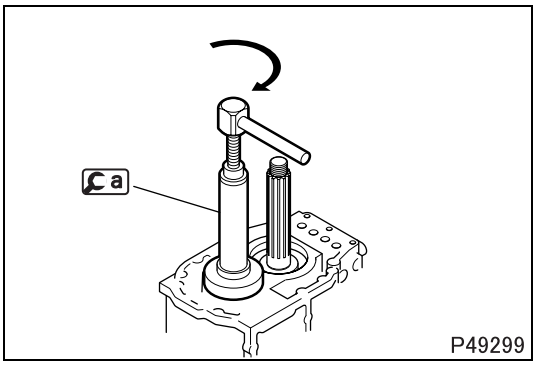


■ **Alignment marks: Synchronizer hub and countershaft 6th gear**

- Using a paint pen, make an alignment mark on both the synchronizer hub and the countershaft 6th gear.
- In a similar way, make an alignment mark on each of the following: synchronizer inner ring, center cone, outer ring and sleeve. Make one mark on each component, and align the marks with the mark already made on the synchronizer hub.



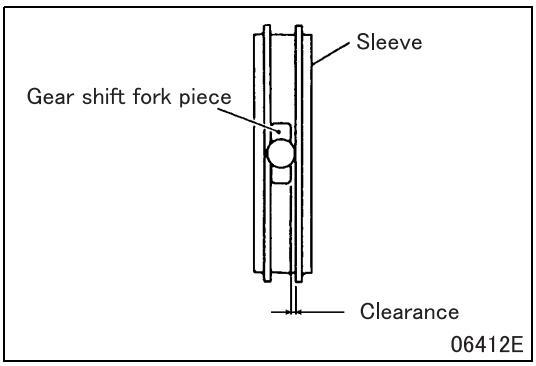
◆Removal procedure◆



■ **Removal: Countershaft 6th gear sleeve, thrust washer and countershaft rear bearing**

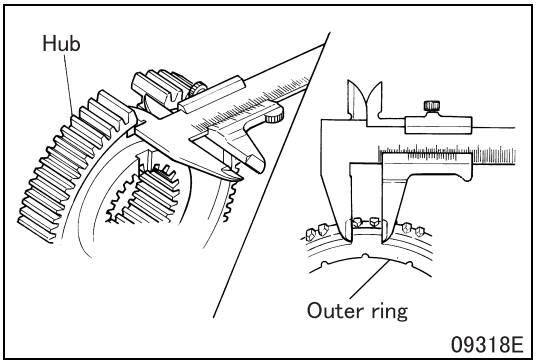
- Using the countershaft rear bearing puller, remove the countershaft rear bearing together with the sleeve and washer.

◆Inspection procedure◆



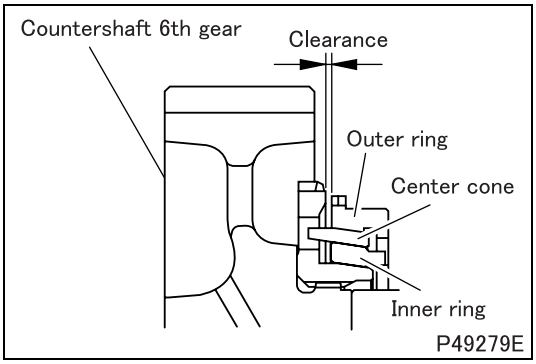
■ **Inspection: Clearance between gear shift fork piece and synchronizer sleeve of main shaft**

- If the measured value exceeds the limit, replace the parts that are defective.



■ **Inspection: Clearance between synchronizer outer ring and synchronizer hub**

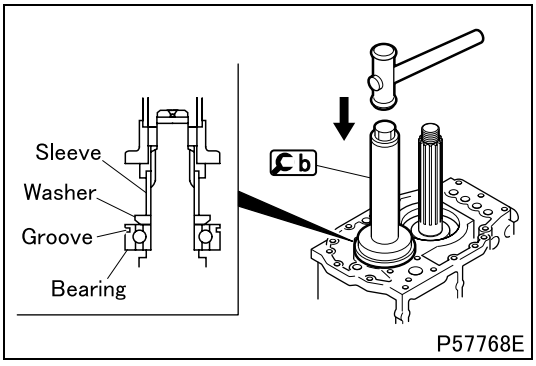
- If the measured value exceeds the limit, replace the parts that are defective.



■ **Inspection: Clearance between synchronizer outer ring and countershaft 6th gear**

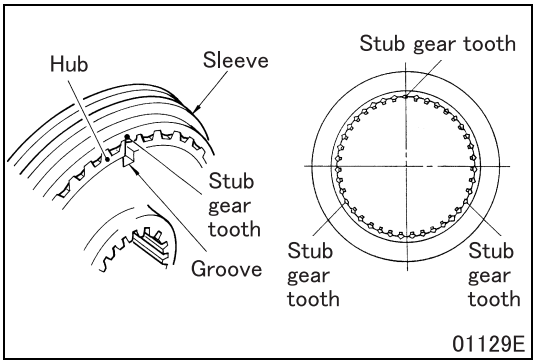
- When measuring the clearance, press each synchronizer ring and center cone evenly against the gear and measure all around the circumference.
- If the measured value exceeds the limit, replace the parts that are defective.

◆Installation procedure◆



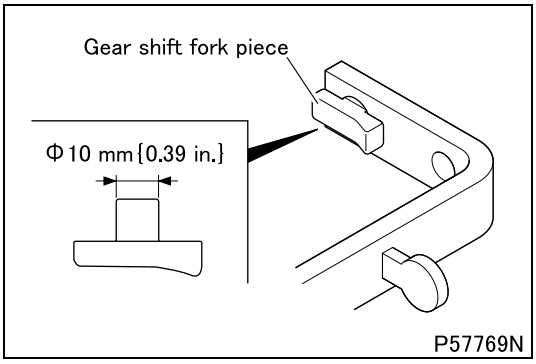
■ **Installation: Countershaft 6th gear sleeve, thrust washer and countershaft bearing**

- Using the countershaft rear bearing installer, press in the countershaft bearing with the sleeve and washer installed as shown in the illustration.



■ **Installation: Synchronizer sleeve and synchronizer hub**

- When replacing the synchronizer sleeve or synchronizer hub, align each of three keyways in the synchronizer hub with the corresponding stub gear tooth of the synchronizer sleeve as shown in the illustration.

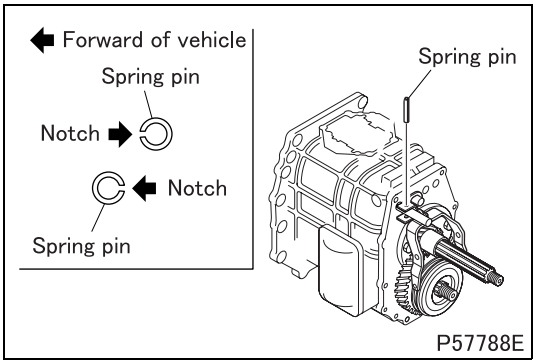


■ **Installation: Gear shift fork piece**

- Check that the shaft diameter of the gear shift fork piece is larger than 10mm (0.39 in) as shown in the illustration. Install the gear shift fork piece on the reverse lever.

CAUTION ⚠

- **Always check the shaft diameter before installation. It is not permissible to install any gear shift fork piece with a smaller diameter shaft.**



■ **Installation: Spring pin**

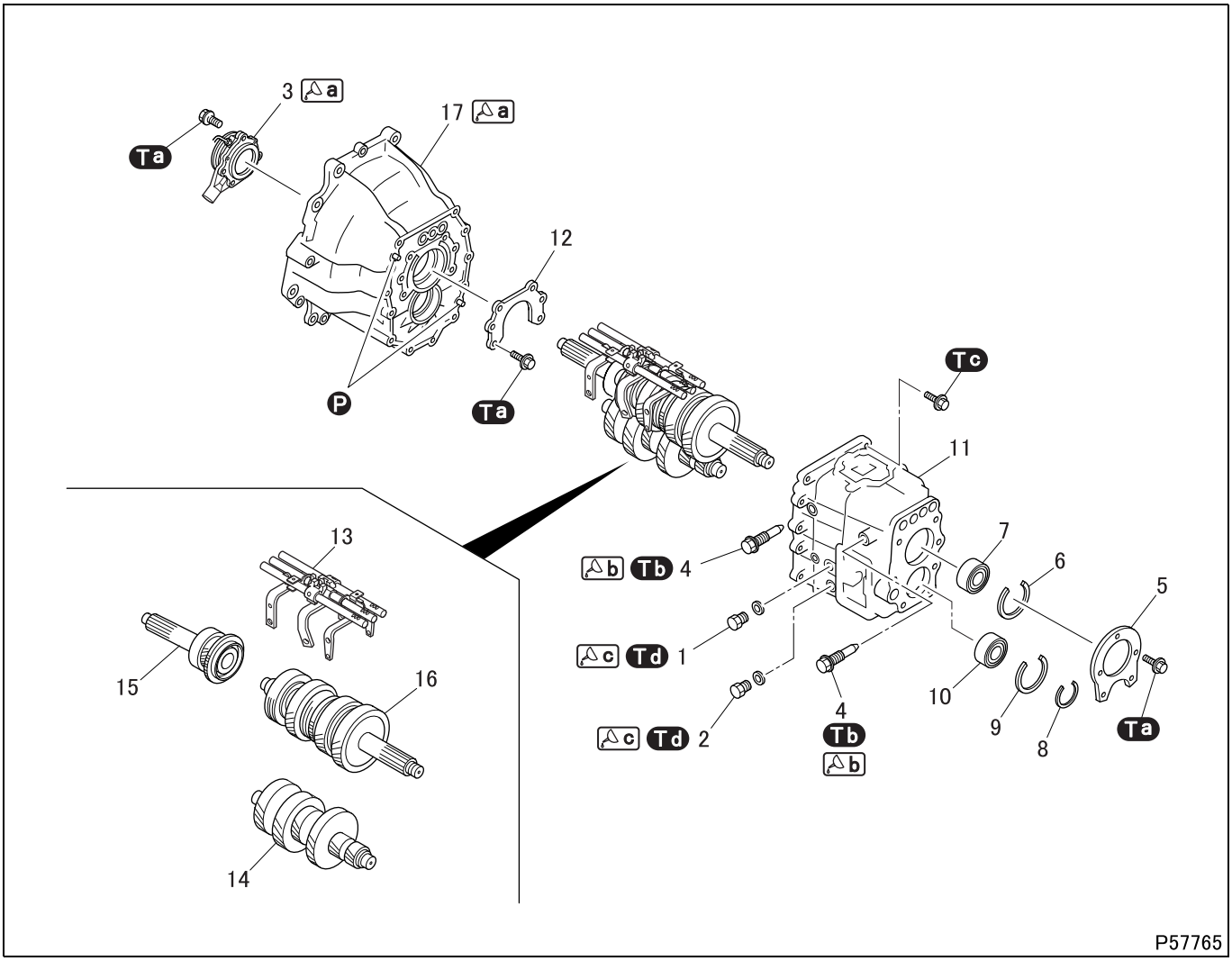
- Install the spring pin as shown in the illustration. The notch in the spring pin can be positioned to face either forward or aft on the vehicle. When installing the spring pin, leave a clearance of 0 to 0.5 mm {0 to 0.020 in} to the outside of the transmission shift rail.

CAUTION ⚠

- **Drive the spring pin carefully. Do not put too much load on the transmission shift rail.**

M E M O

TRANSMISSION MAIN SECTION



● **Disassembly sequence**

1 Fill plug
2 Drain plug
3 Direct power cylinder (see Gr21)
4 Lever set bolt
5 Rear bearing retainer <S6>
6 Snap ring, main shaft
7 Main shaft rear bearing
8 Snap ring, countershaft <S5>
9 Snap ring, countershaft
10 Countershaft rear bearing <S5>
11 Transmission case
12 Front bearing retainer
13 Shift rail and shift fork (see later section)
14 Countershaft (see later section)
15 Drive pinion (see later section)
16 Main shaft (see later section)
17 Clutch housing (bell housing)

Ⓟ: Locating pin

NOTE

- **After removing the direct power cylinder, set the transmission down on the clutch housing (output end up).**
- **It is not necessary to disassemble the countershaft, drive pinion (input shaft), and main shaft in order to remove the shift rail and shift fork.**
- **For removal and installation procedures of the countershaft bearings on the M036S6 transmission, see under the heading "6TH GEAR <S6>."**

● Assembly sequence

Follow the disassembly sequence in reverse.

NOTE

- **Place the synchronizer sleeve of the main shaft in the neutral position before installing the shift rail and shift fork on the main shaft.**

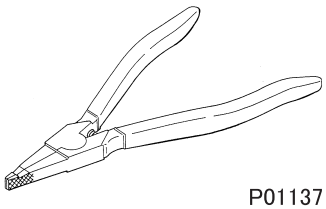
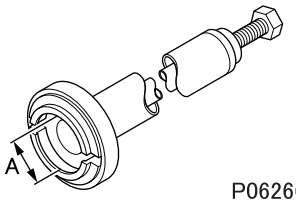
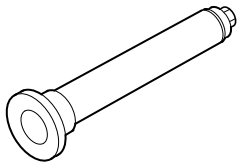
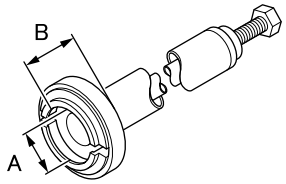
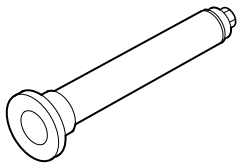
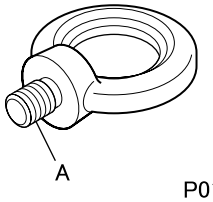
Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Bolt (front bearing retainer)	44.5 {33}	–
	Bolt (rear bearing retainer)		
	Bolt (direct power cylinder)		
Tb	Lever set bolt	160 {118}	–
Tc	Bolt (transmission case)	54 {40}	–
Td	Fill plug	68.6 ± 14.7 {51 ± 11}	–
	Drain plug		

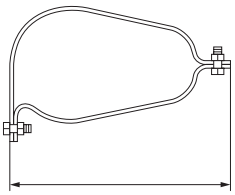
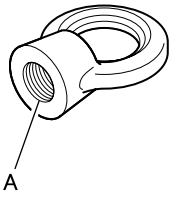
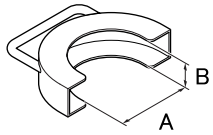
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Direct power cylinder, clutch housing mounting surface	ThreeBond 1215	As required
	Clutch housing, transmission case mounting surface		
b	Threaded area of lever set bolt	Loctite 271	As required
c	Threaded area of fill plug	ThreeBond 1105	As required
	Threaded area of drain plug		

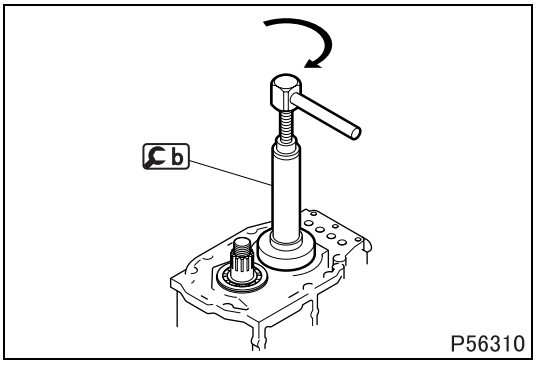
Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
a	Snap ring expander  P01137	MH061268	Removing and installing snap rings
b	Rear bearing puller. main shaft A: ϕ96.8 {3.81}  P06266	MH062697	Removing and installing the main shaft rear bearing
c	Rear bearing installer, main shaft  P49555		
d	Rear bearing puller, countershaft A: ϕ76.8 {3.02}, B: 25 {0.98}  P56306	MH062696	Removing the countershaft rear bearing
e	Rear bearing installer, countershaft  P49555	MH062696	Installing the countershaft rear bearing
f	Eyebolt A: M10 × 1.5  P01140	MH062340	Lifting the transmission case

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
g	Steel lifting band A: 251 {9.88}  P22884	MH063410	Removing and installing the countershaft, main shaft and drive pinion
h	Eye nut A: M24 × 1.5  P01142	MH063308	
i	Synchromesh guard S5: A 98 {3.86}, B 30 {1.18} S6: A 98 {3.86}, B 31 {1.22}  P51250	<S5> MH062888 <S6> MH062889	For preventing synchromesh from sticking when main shaft is driven

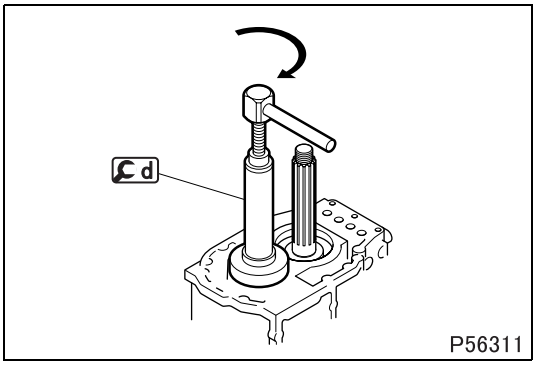
◆Removal procedure◆



P56310

■ **Removal: Main shaft rear bearing**

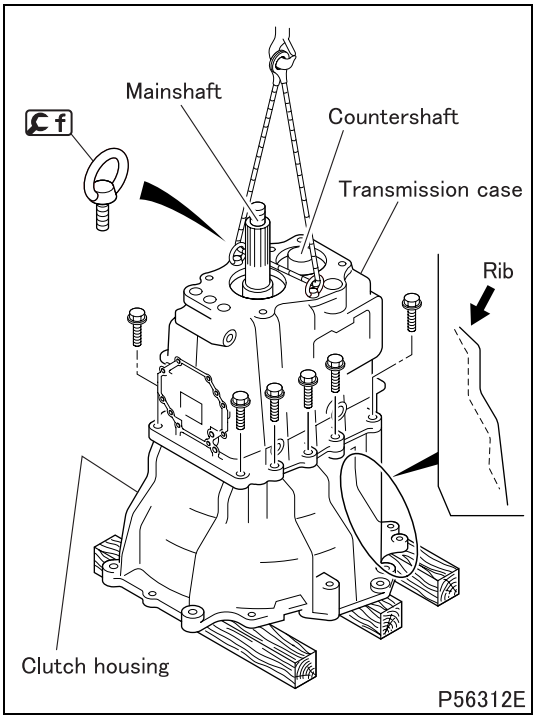
- Using the main shaft rear bearing puller and a socket wrench, remove the main shaft rear bearing as shown in the illustration.



P56311

■ **Removal: Countershaft rear bearing**

- Using the countershaft rear bearing puller and a socket wrench, remove the countershaft rear bearing as shown in the illustration.

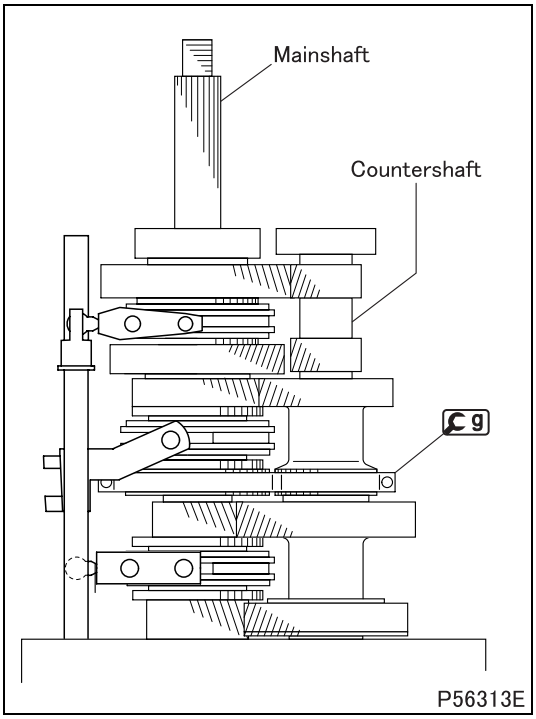


■ **Removal: Transmission case (gear case)**

- Install the eyebolt [f] on the transmission case and make preparations to lift it with a crane.
- After removing the transmission case bolts, lift up the transmission case. If necessary, tap the output ends of the countershaft and main shaft and/or the rear ribs of the clutch housing with a plastic hammer to dislodge the transmission case from the clutch housing (bell housing).

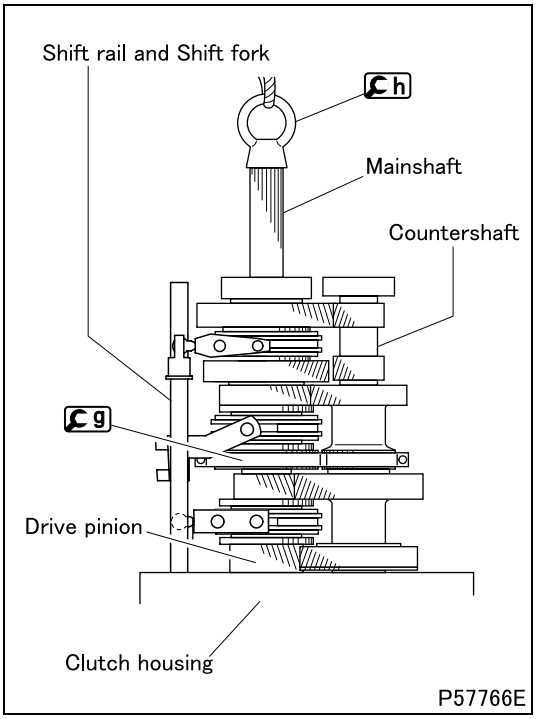
CAUTION ⚠

- **Be careful to tap only the ribs of the transmission case. Hitting other areas may damage the clutch housing.**



■ **Removal: Shift rail and shift fork, countershaft, drive pinion and main shaft**

- Secure the countershaft and the 2nd gear area of the main shaft with the steel lifting band [g] for safety. Tighten the steel lifting band until it is firmly fastened, but be careful not to overtighten it.

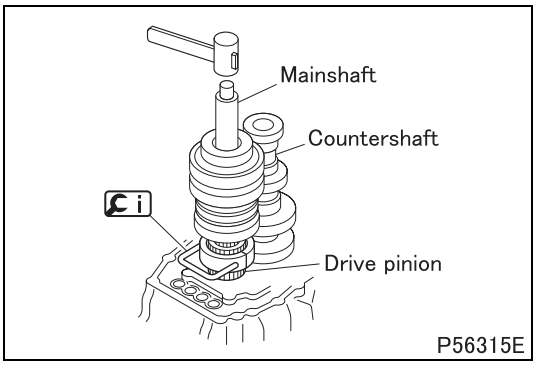


- Leave the countershaft and main shaft secured with the steel lifting band g.
- Install the eyebolt h on the main shaft and make preparations to lift it with a crane.
- Secure the shift rail and shift fork assembly with a rubber band to prevent it from coming undone as the main shaft is lifted.
- To remove the clutch housing, attach a block of wood and hit the wood block with a plastic hammer to dislodge the clutch housing from the transmission main section. Do not hit the clutch housing directly.

CAUTION ⚠

- **When lifting, support the drive pinion (input shaft) with your hand to prevent it from falling.**

◆Installation procedure◆

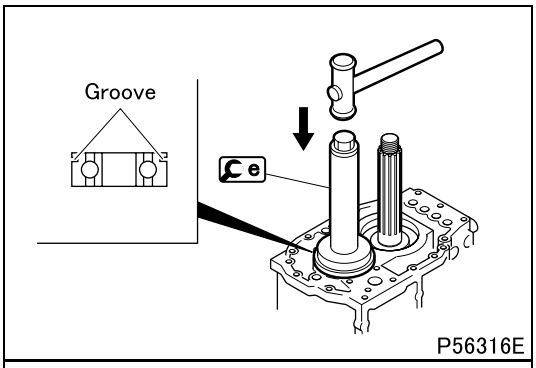


■ Installation: Shift rail and shift fork, countershaft, drive pinion and main shaft

- When driving in the drive pinion, main shaft and countershaft, install the synchromesh guard i to prevent the drive pinion (input shaft) and synchronizer of the main shaft from sticking.

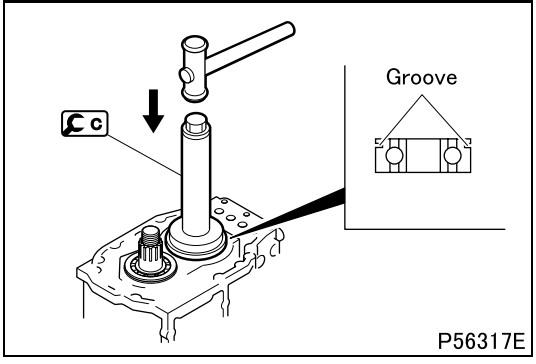
NOTE

- **Be sure to remove all the special tools used.**



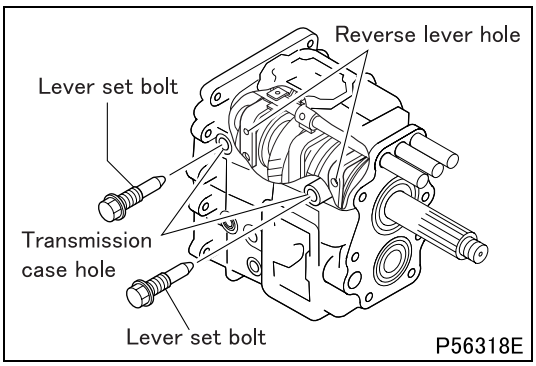
■ Installation: Countershaft rear bearing

- Using the countershaft rear bearing installer, press in the countershaft bearing as shown in the illustration.



■ Installation: Main shaft rear bearing

- Using the main shaft rear bearing installer, press in the main shaft bearing as shown in the illustration.

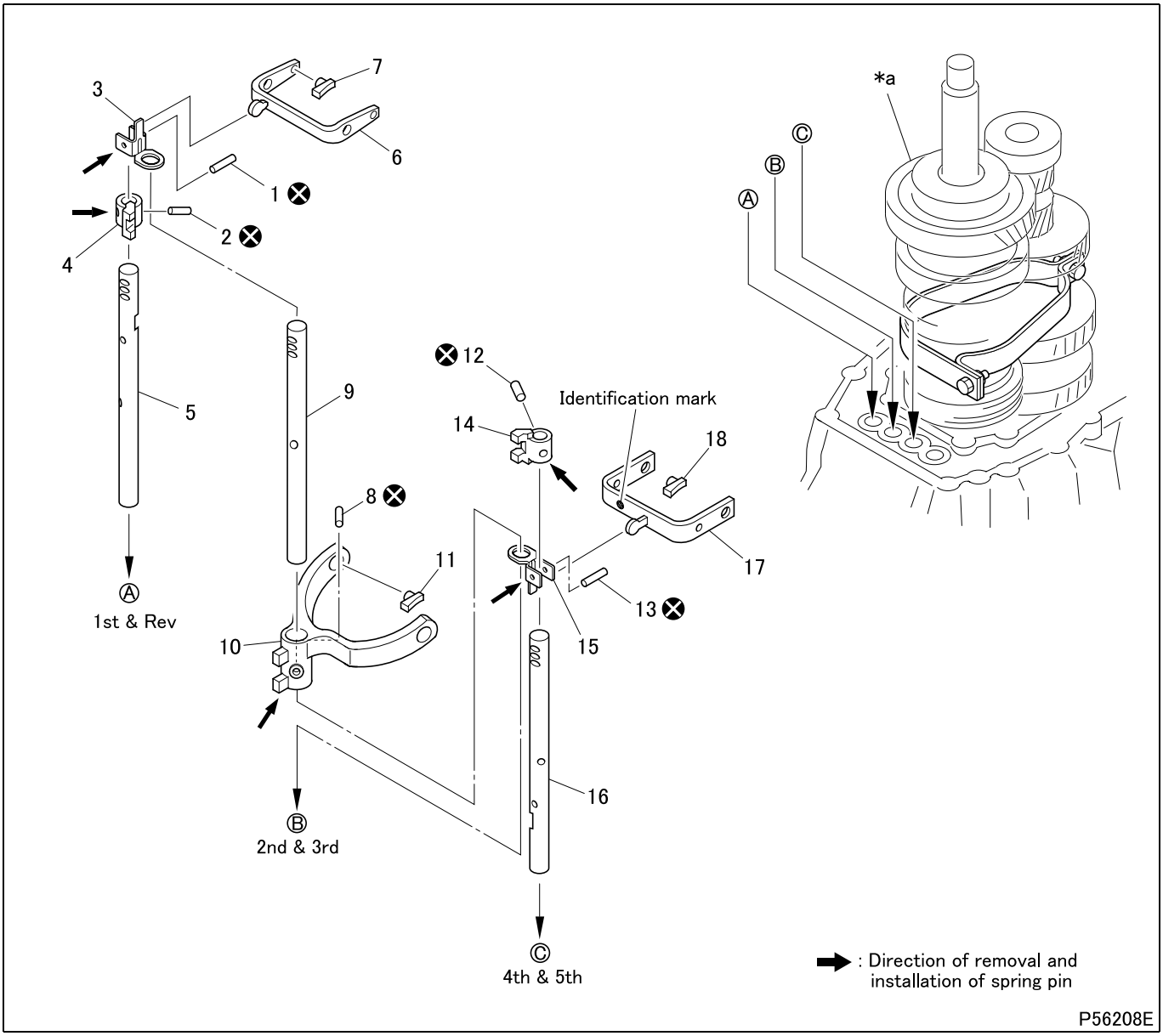


■ **Installation: Lever set bolt**

- Apply sealant to the threaded areas of the lever set bolts. Install them as shown in the illustration. Tighten them 160 N·m (118 lbf·ft).

M E M O

Shift rail and shift fork <S5>



● Disassembly sequence

1 Spring pin, jaw B (1st/reverse)
2 Spring pin, jaw A (1st/reverse)
3 Shift rail jaw B (1st/reverse)
4 Shift rail jaw A (1st/reverse)
5 Shift rail (1st/reverse)
6 Reverse lever (1st/reverse)
7 Gear shift fork piece (1st/reverse)
8 Spring pin (2nd/3rd)
9 Shift rail (2nd/3rd)
10 Shift fork (2nd/3rd)
11 Gear shift fork piece (2nd/3rd)
12 Spring pin, jaw A (4th/5th)
13 Spring pin, jaw B (4th/5th)
14 Shift rail jaw A (4th/5th)
15 Shift rail jaw B (4th/5th)
16 Shift rail (4th/5th)
17 Reverse lever (4th/5th)
18 Gear shift fork piece (4th/5th)

***a**: Main shaft
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

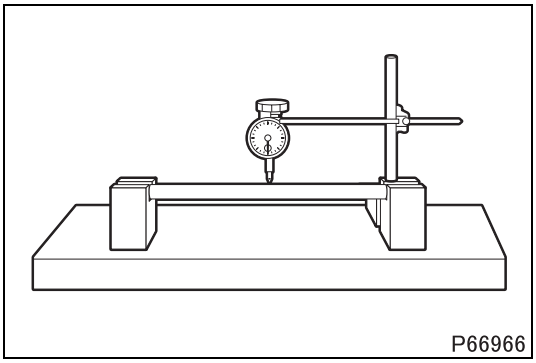
NOTE

- **Place the synchronizer sleeve of the main shaft in the neutral position before installing the reverse lever on the main shaft.**

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
5, 9, 16	Shift rail deviation from true	0.04 {0.0016} or less	0.05 {0.0020}	Repair or replace
7, 11, 18, *a	Clearance between gear shift fork piece and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace

◆Inspection procedure◆

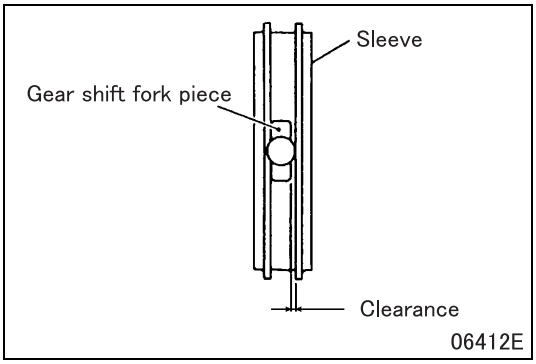

P66966

■ **Inspection: Shift rail deviation from true**

- Measure the extent of deviation at the middle of each of shift rail.
- If any measured value exceeds the limit, repair or replace the shift rail.

NOTE

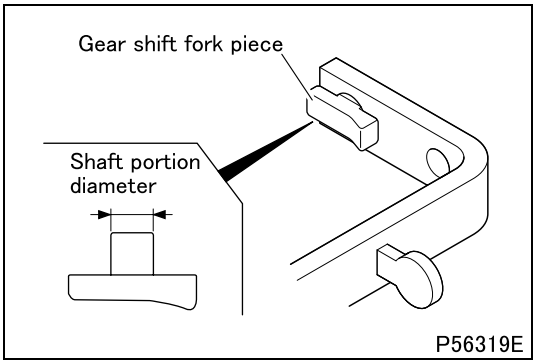
- **Give each shift rail one complete turn and read the dial gauge at the end of that time. The deviation from true is half of the dial reading.**



■ **Inspection: Clearance between the gear shift fork piece and the synchronizer sleeve on the main shaft**

- If the measured value exceeds the limit, replace the parts that are defective.

◆Installation procedure◆



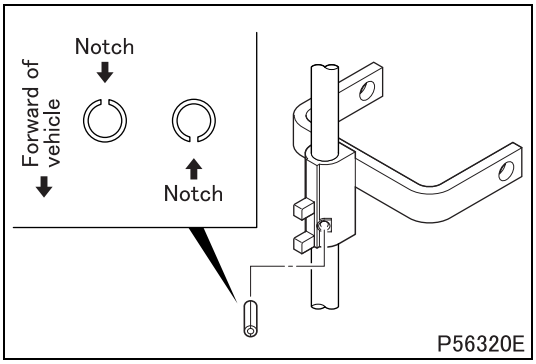
■ **Installation: Gear shift fork piece**

- Check that the shaft diameter of each gear shift fork piece is larger than the value given in the table. Install the gear shift fork piece on the reverse lever.

Gear set	Shaft diameter (mm {in})
1st & Rev	10 {0.39}
2nd & 3rd, 4th & 5th	15 {0.59}

CAUTION ⚠

- **Always check the shaft diameter before installation. It is not permissible to install any gear shift fork piece with a smaller diameter shaft.**



■ **Installation: Spring pin**

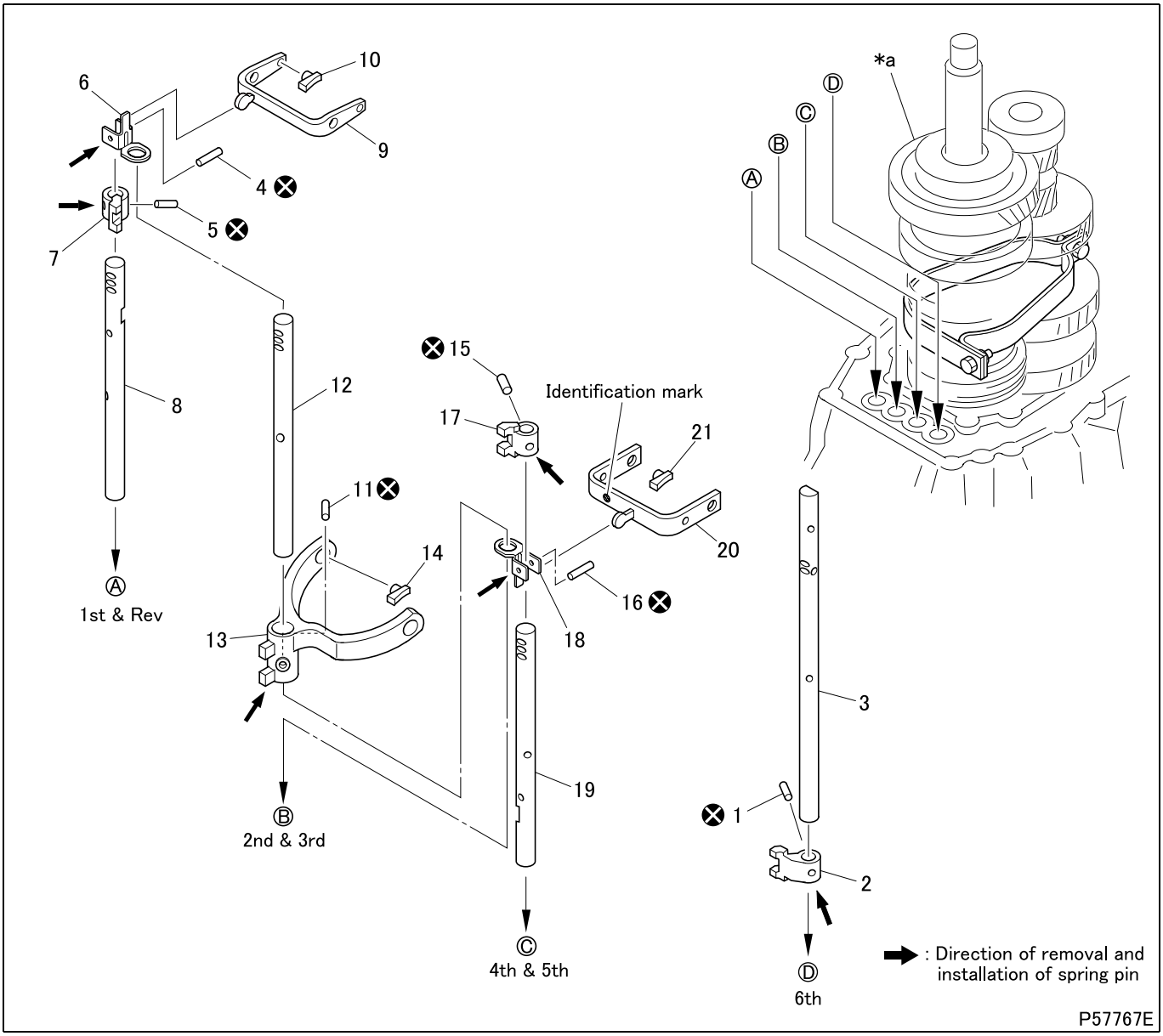
- Install the spring pin as shown in the illustration. The notch in the spring pin can be positioned to face either forward or aft on the vehicle. When installing the spring pin, leave a clearance of 0 to 0.5 mm {0 to 0.020 in} to the outside of the transmission shift rail.

CAUTION ⚠

- **Drive the spring pin carefully. Do not put too much load on the transmission shift rail.**

M E M O

Shift rail and shift fork <S6>



● Disassembly sequence

1 Spring pin (6th)
2 Shift rail jaw (6th)
3 Shift rail (6th)
4 Spring pin, jaw B (1st/reverse)
5 Spring pin, jaw A (1st/reverse)
6 Shift rail jaw B (1st/reverse)
7 Shift rail jaw A (1st/reverse)
8 Shift rail (1st/reverse)
9 Reverse lever (1st/reverse)
10 Gear shift fork piece (1st/rev)
11 Spring pin (2nd/3rd)
12 Shift rail (2nd/3rd)
13 Shift fork (2nd/3rd)
14 Gear shift fork piece (2nd/3rd)
15 Spring pin, jaw A (4th/5th)
16 Spring pin, jaw B (4th/5th)
17 Shift rail jaw A (4th/5th)
18 Shift rail jaw B (4th/5th)
19 Shift rail (4th/5th)
20 Reverse lever (4th/5th)r
21 Gear shift fork piece (4th/5th)

***a**: Main shaft
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

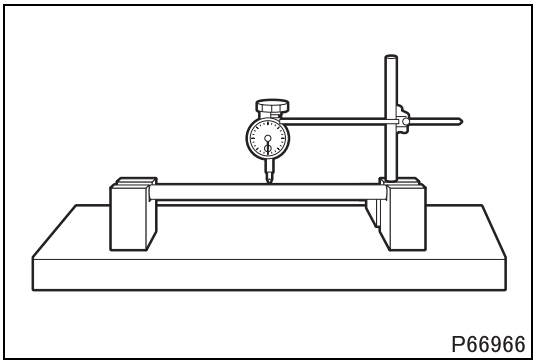
NOTE

- **Place the synchronizer sleeve of the main shaft in the neutral position before installing the reverse lever on the main shaft.**

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
3, 8, 12, 19	Shift rail deviation from true	0.04 {0.0016} or less	0.05 {0.0020}	Repair or replace
10, 14, 21, *a	Clearance between gear shift fork piece and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace

◆Inspection procedure◆

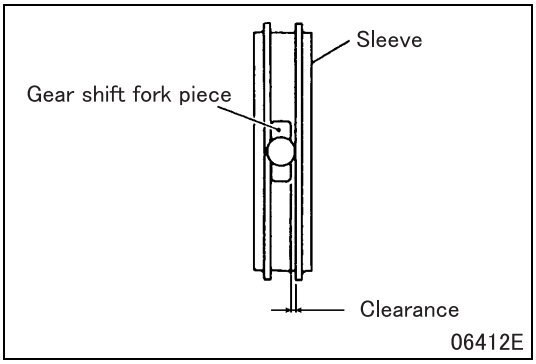

P66966

■ **Inspection:** Shift rail deviation from true

- Measure the deviation at the middle of each of shift rail.
- If any measured value exceeds the limit, repair or replace the faulty shift rails.

NOTE

- **Give each shift rail one complete turn and read the dial gauge at the end of that time. The deviation from true is half of the dial reading.**

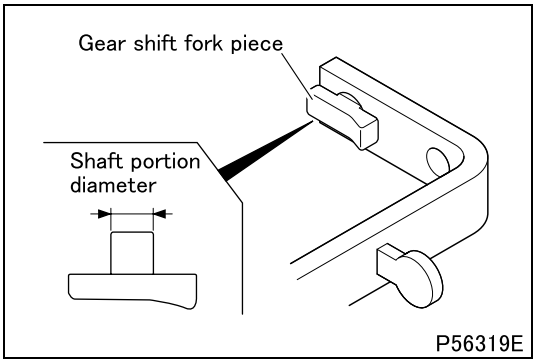


06412E

■ **Inspection: Clearance between the gear shift fork piece and the synchronizer sleeve on the main shaft**

- If the measured value exceeds the limit, replace the parts that are defective.

◆Installation procedure◆



P56319E

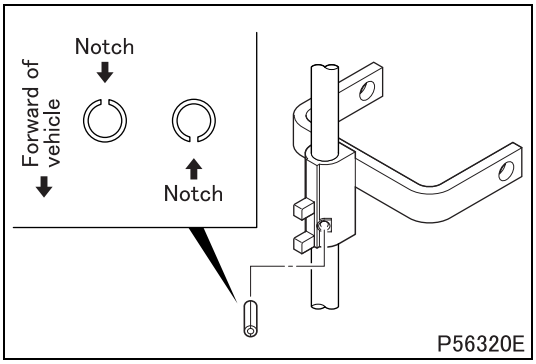
■ **Installation: Gear shift fork piece**

- Check that the shaft diameter of each gear shift fork piece is larger than the value given in the table. Install the gear shift fork piece on the reverse lever.

Gear set	Shaft diameter (mm {in})
1st & Rev	10 {0.39}
2nd & 3rd, 4th & 5th	15 {0.59}

CAUTION ⚠

- **Always check the shaft diameter before installation. It is not permissible to install any gear shift fork piece with a smaller diameter shaft.**



■ **Installation: Spring pin**

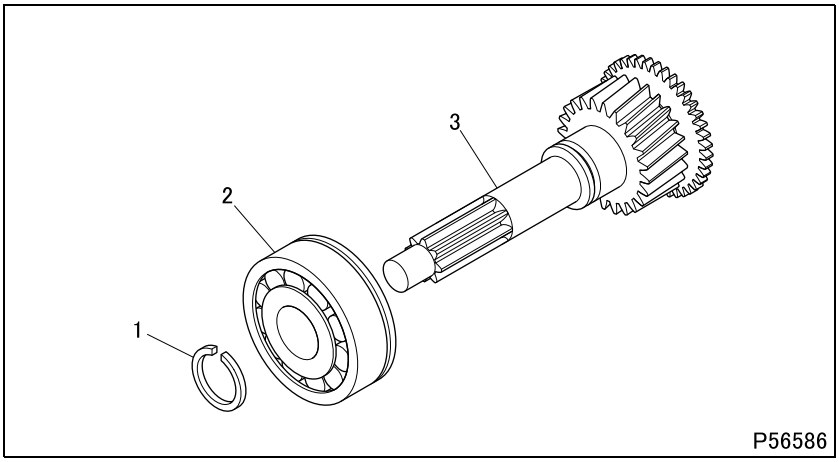
- Install the spring pin as shown in the illustration. The notch in the spring pin can be positioned to face either forward or aft on the vehicle. When installing the spring pin, leave a clearance of 0 to 0.5 mm {0 to 0.020 in} to the outside of the transmission shift rail.

CAUTION ⚠

- **Drive the spring pin carefully. Do not put too much load on the transmission shift rail.**

M E M O

DRIVE PINION (INPUT SHAFT)



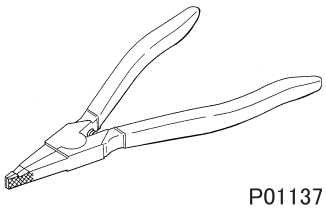
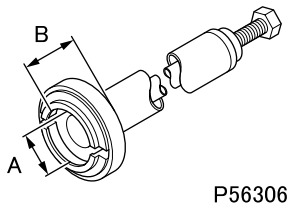
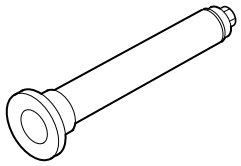
● **Disassembly sequence**

1 Snap ring
2 Drive pinion bearing
3 Drive pinion

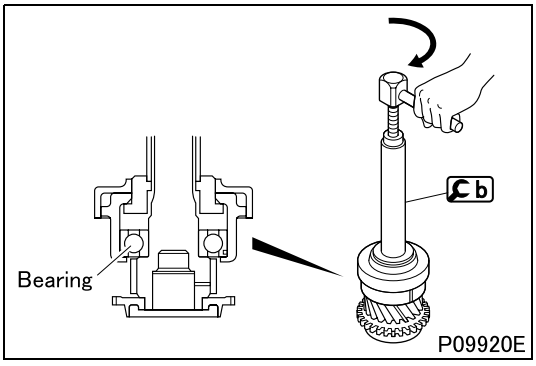
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
a	Snap ring expander  P01137	MH061268	Removing and installing snap rings
b	Drive pinion bearing puller A: ϕ92.5 {3.64} B: 57.5 {2.26}  P56306	MH062697	Removing and installing the drive pinion (input shaft) bearing
c	Drive pinion bearing installer  P49555		

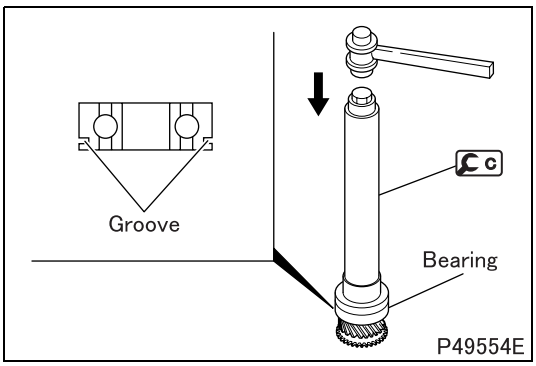
◆**Removal procedure**◆



■ **Removal: Drive pinion bearing**

- Using the drive pinion bearing puller and a socket wrench, remove the drive pinion bearing as shown in the illustration.

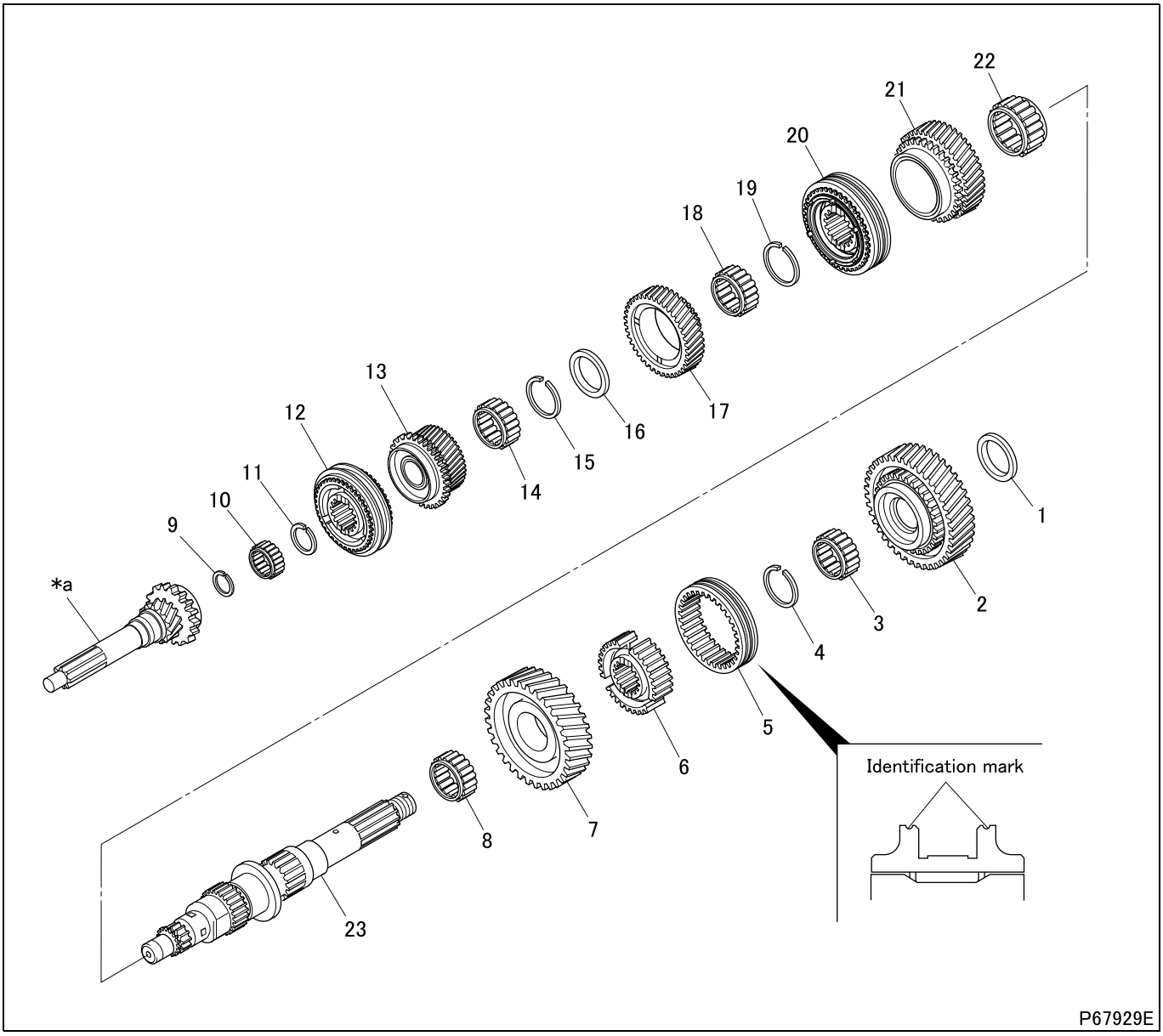
◆Installation procedure◆



■ **Installation: Drive pinion bearing**

- Using the drive pinion bearing installer and a socket wrench, install the drive pinion bearing as shown in the illustration.

MAIN SHAFT



● **Disassembly sequence**

1 1Thrust washer, 1st gear
2 1st gear wheel
3 Needle bearing, 1st gear
4 Snap ring, 1st gear
5 1st/reverse gear synchronizer sleeve
6 1st/reverse gear synchronizer hub
7 Reverse gear wheel
8 Needle bearing, reverse gear
9 Snap ring, pilot bearing
10 Pilot bearing
11 Snap ring, 4th gear
12 4th/5th gear synchronizer (see later section)
13 5th gear wheel
14 Needle bearing, 5th gear
15 Snap ring, 5th gear
16 Thrust washer, 3rd gear
17 3rd gear wheel
18 Needle bearing, 3rd gear
19 Snap ring, 3rd gear
20 2nd/3rd gear synchronizer (see later section)
21 2nd gear wheel
22 Needle bearing, 2nd gear
23 Main shaft

***a**: Drive pinion (input shaft)

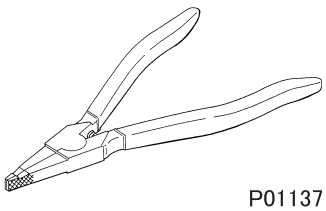
● **Assembly sequence**

Follow the disassembly sequence in reverse.

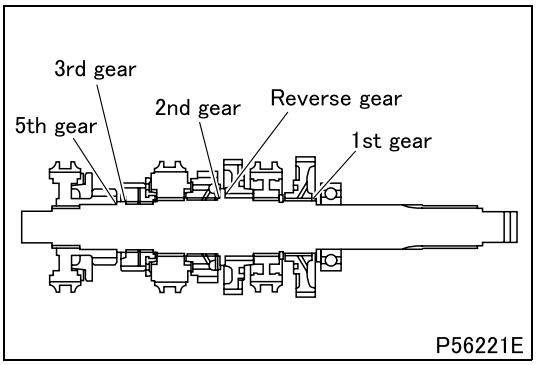
Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	End play	1st gear	0.15 to 0.46 {0.0059 to 0.018}	0.7 {0.028}	Replace
		2nd gear	0.15 to 0.61 {0.0059 to 0.024}	0.8 {0.031}	
		3rd gear	0.15 to 0.46 {0.0059 to 0.018}	0.7 {0.028}	
		5th gear	0.2 to 0.56 {0.0079 to 0.022}	0.8 {0.031}	
		Reverse gear	0.15 to 0.46 {0.0059 to 0.018}	0.7 {0.028}	
–	Axial play	1st gear	0.02 to 0.05 {0.0079 to 0.0020}	0.12 {0.0047}	Replace
		2nd gear	0.02 to 0.05 {0.0079 to 0.0020}	0.12 {0.0047}	
		3rd gear	0.02 to 0.06 {0.0079 to 0.0024}	0.12 {0.0047}	
		5th gear	0.05 to 0.09 {0.0020 to 0.0035}	0.2 {0.0079}	
		Reverse gear	0.04 to 0.07 {0.0016 to 0.0028}	0.12 {0.0047}	
12, 13	Clearance between 4th/5th synchronizer ring and 5th gear wheel		1.23 to 1.47 {0.048 to 0.058}	0.5 {0.020}	Replace
12, *a	Clearance between 4th/5th synchronizer ring and drive pinion		1.23 to 1.47 {0.048 to 0.058}	0.5 {0.020}	Replace
17, 20	Clearance between 3rd gear wheel and 2nd/3rd synchronizer outer ring		1.16 to 1.74 {0.046 to 0.069}	0.7 {0.028}	Replace
20, 21	Clearance between 2nd/3rd synchronizer outer ring and 2nd gear wheel		1.16 to 1.74 {0.046 to 0.069}	0.7 {0.028}	Replace

Special tools

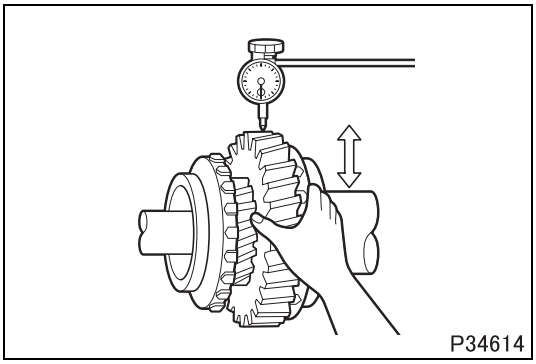
ID	Tool name and shape	Part No.	Application
a	Snap ring expander  P01137	MH061268	Removing and installing snap rings

◆Work before removal◆



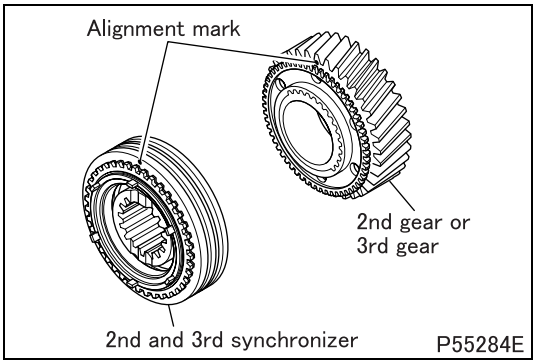
■ Inspection: End play of gears

- If the measured value exceeds the limit, replace the parts that are defective.



■ **Inspection: Axial play of gears**

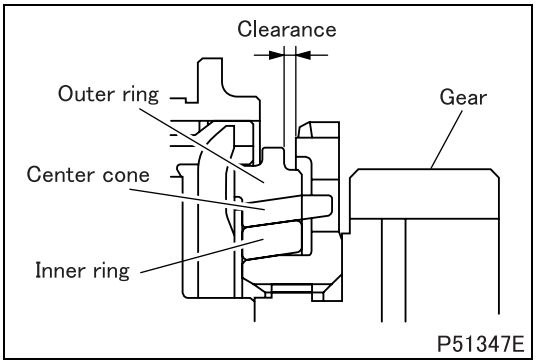
- If the measured value exceeds the limit, replace the parts that are defective.



■ **Alignment marks: 2nd gear, 2nd and 3rd synchronizer and 3rd gear**

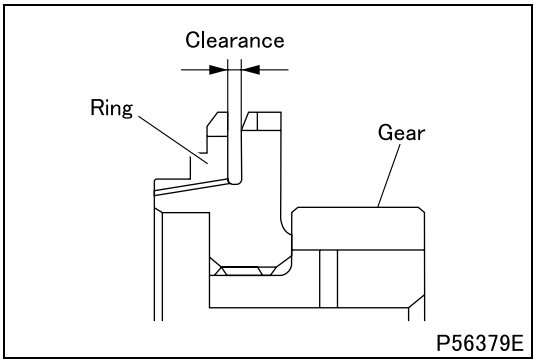
- Using a paint pen, make alignment marks on the synchronizer sleeve of the 2nd/3rd gear synchronizer, the 2nd gear wheel, and the 3rd gear wheel. Put one mark on each component before disassembly.

◆Inspection procedure◆



■ **Inspection: Clearance between the 2nd/3rd synchronizer outer ring and the 2nd gear wheel (or 3rd gear wheel)**

- To measure the clearance, press each ring and the center cone evenly against the gear and measure all around the circumference of the wheel.
- If the measured value exceeds the limit, replace the parts that are defective.

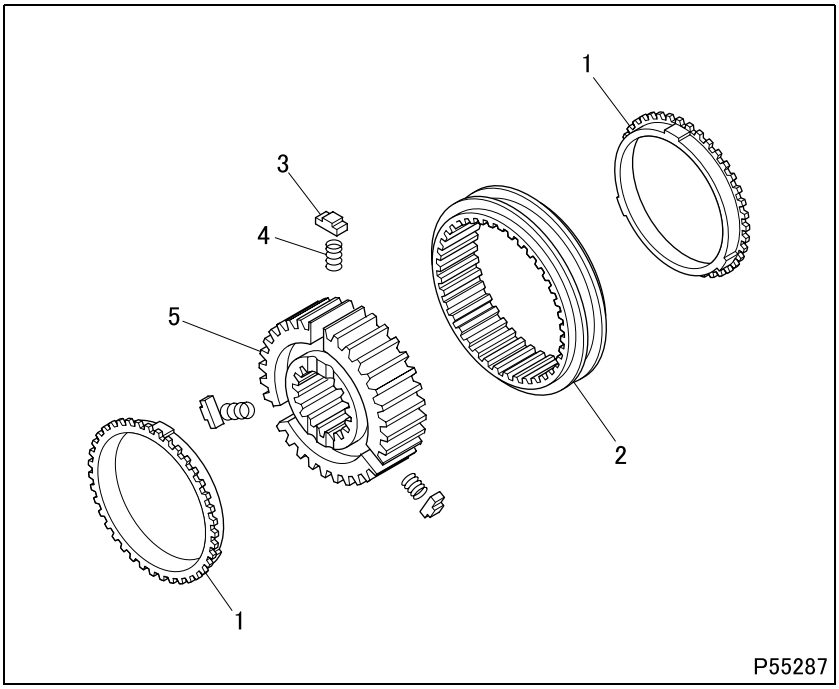


■ **Inspection: Clearance between 4th/5th synchronizer ring r and 5th gear wheel (or drive pinion wheel)**

- To measure the clearance, press each ring evenly against the gear and measure all around the circumference of the wheel.
- If the measured value exceeds the limit, replace the parts that are defective.

M E M O

4th/5th synchronizer



● Disassembly sequence

1 Synchronizer ring
2 Synchronizer sleeve
3 Spring holder
4 Compression spring
5 Synchronizer hub

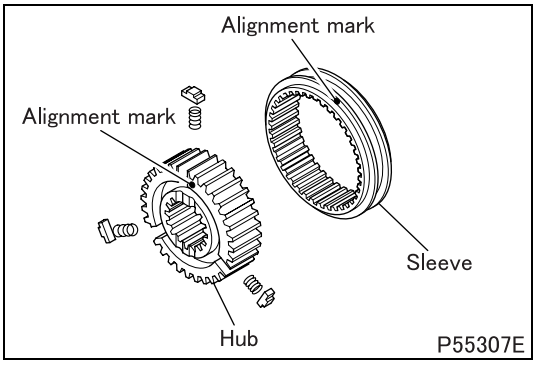
● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
1, 5	Clearance between protrusions of synchronizer ring and synchronizer hub groove	3.0 to 3.3 {0.12 to 0.13}	4.0 {0.16}	Replace

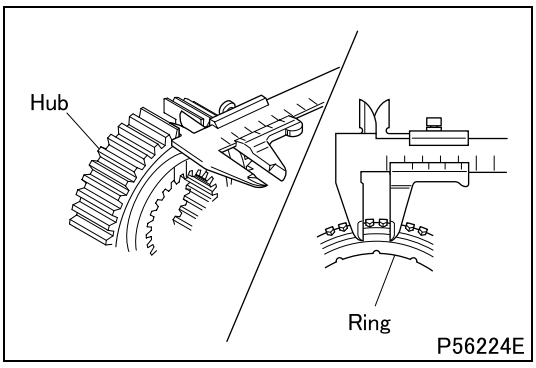
◆Work before removal◆



■ Alignment marks: Synchronizer sleeve and synchronizer hub

- Using a paint pen, make alignment marks on the synchronizer ring and synchronizer hub. Put one mark on each component before disassembly.

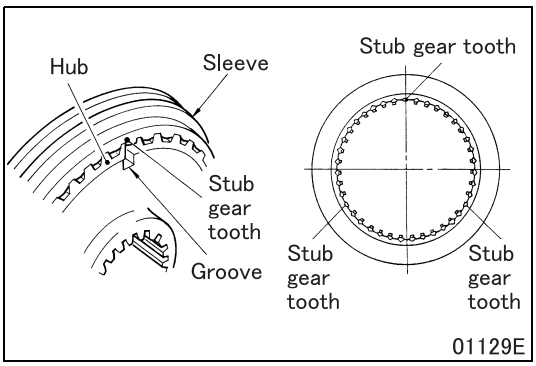
◆Inspection procedure◆



■ Inspection: Clearance between synchronizer ring (or synchronizer outer ring) and synchronizer hub

- If the measured value exceeds the limit, replace the parts that are defective.

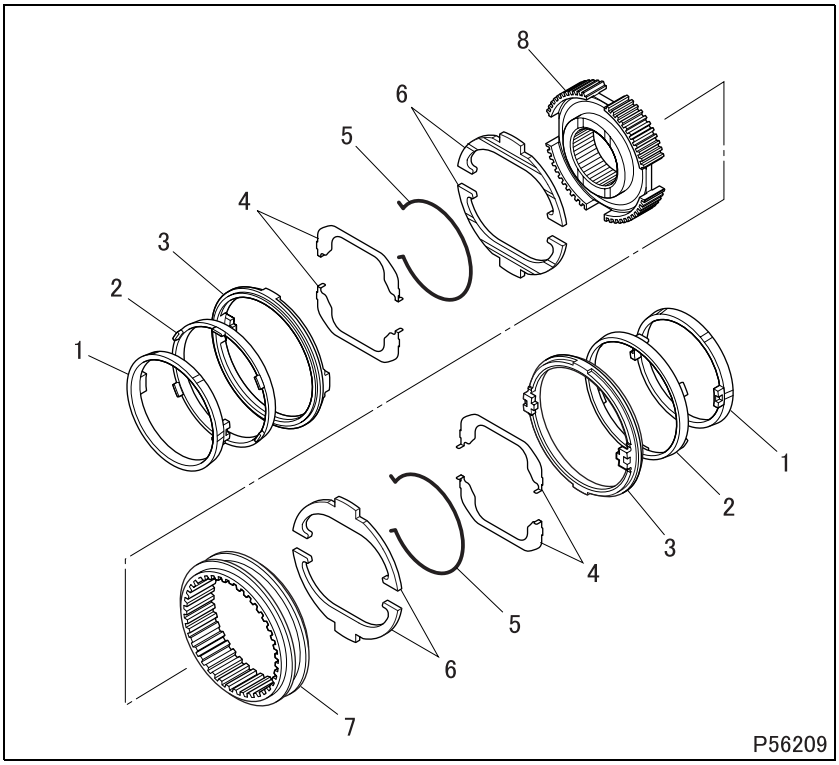
◆Installation procedure◆



■ Installation: Synchronizer sleeve and synchronizer hub

- When replacing the synchronizer sleeve or synchronizer hub, align each of three keyways in the synchronizer hub with the corresponding stub gear tooth of the synchronizer sleeve as shown in the illustration.

2nd/3rd synchronizer



● Disassembly sequence

1 Synchronizer inner ring
2 Synchronizer center cone
3 Synchronizer outer ring
4 Synchronizer plate
5 Synchronizer spring
6 Synchronizer lever
7 Synchronizer sleeve
8 Synchronizer hub

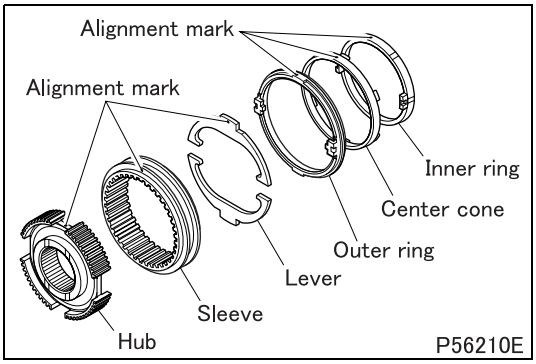
● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
3	Width of mounts on synchronizer outer ring	13.8 to 14.0 {0.54 to 0.55}	13 {0.51}	Replace

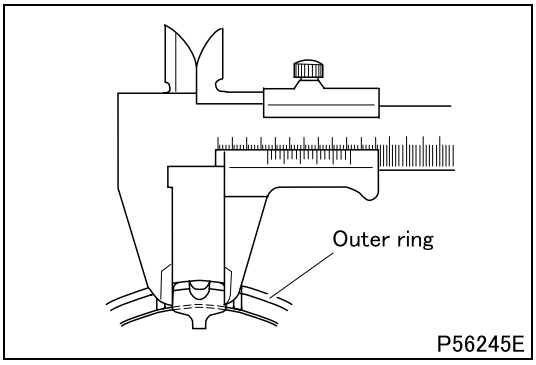
◆Work before removal◆



■ Alignment marks: Synchronizer inner ring, center cone, outer ring, lever and hub

- Using a paint pen, make alignment marks on the synchronizer inner ring, center cone, outer ring, lever, and hub. Put one mark on each component. Each mark should line up with the alignment mark on the synchronizer sleeve before disassembly.

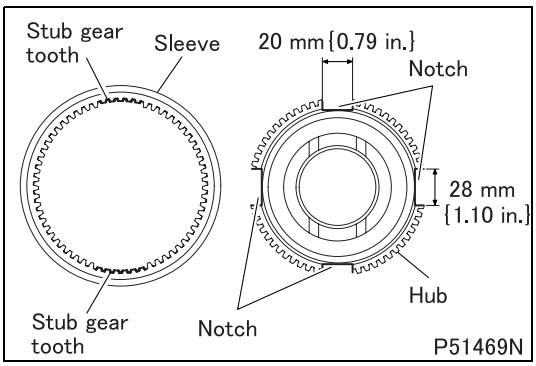
◆Inspection procedure◆



■ Inspection: Width of mounts on synchronizer outer ring

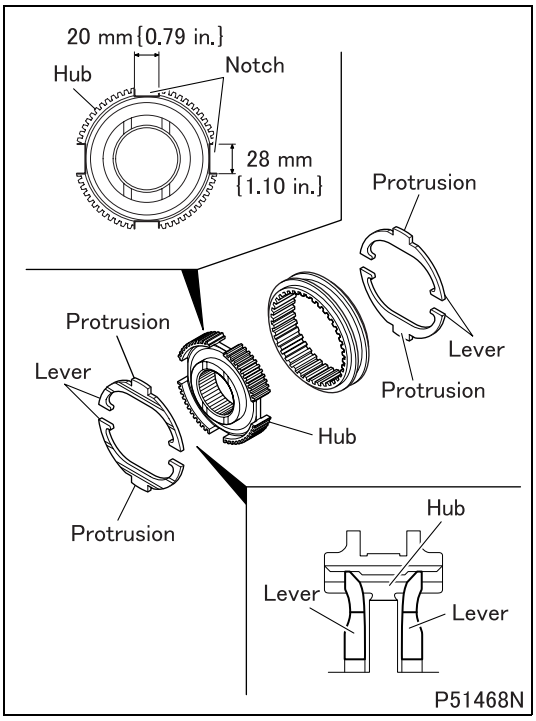
- If the measured value exceeds the limit, replace the parts that are defective.

◆Installation procedure◆



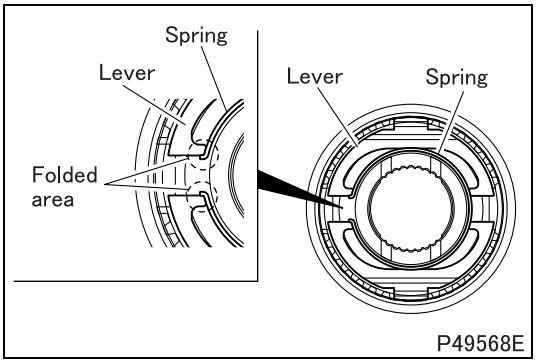
■ Installation: Synchronizer sleeve and synchronizer hub

- When replacing the synchronizer sleeve or synchronizer hub, align each of two notches in the synchronizer hub with the corresponding stub gear tooth of the synchronizer sleeve as shown in the illustration.
- When installing the synchronizer sleeve, align the stub gear teeth with the notches of narrow width (20 mm {0.79 in}) on the synchronizer hub.



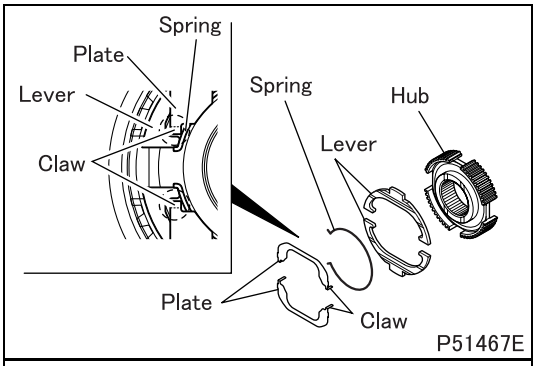
■ Installation: Synchronizer lever

- Install the synchronizer lever on the synchronizer hub as shown in the illustration.
- Install the stop lugs of the synchronizer lever into the notches of narrow width (20 mm {0.79 in}) on the synchronizer hub.



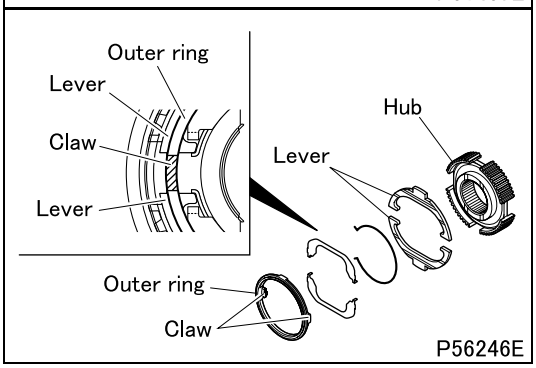
■ Installation: Synchronizer spring

- Hang the folded area on the synchronizer lever to install the synchronizer spring.



■ **Installation: Synchronizer plate**

- Install the synchronizer plate with the mounts facing toward the synchronizer hub. Insert the synchronizer plate between the synchronizer lever and synchronizer spring.

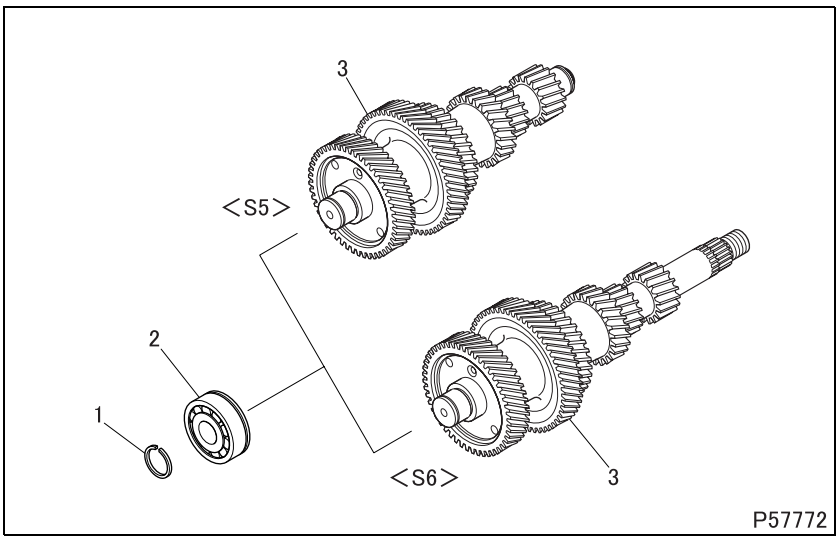


■ **Installation: Synchronizer outer ring**

- Install the synchronizer outer ring with the mounts facing toward the synchronizer hub. Insert the outer ring between the two parts of the synchronizer lever.

M E M O

COUNTERSHAFT



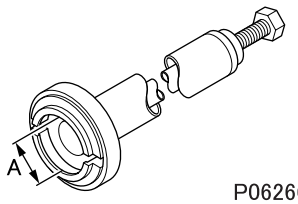
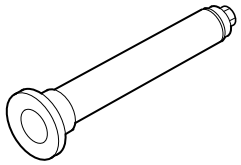
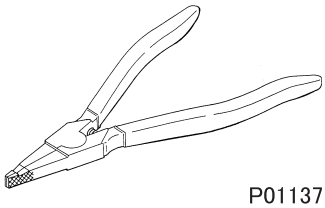
● **Disassembly sequence**

1 Snap ring
2 Countershaft front bearing
3 Countershaft gear

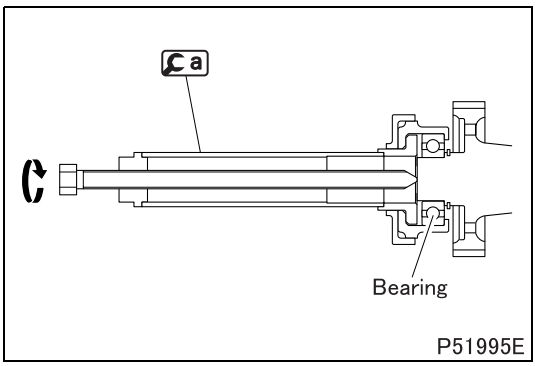
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
a	Countershaft front bearing puller A: φ72 {2.83}  P06266	MH062696	Removing the countershaft front bearing
b	Countershaft front bearing installer  P49555		Installing the countershaft front bearing
c	Snap ring expander  P01137	MH061268	Removing and installing snap rings

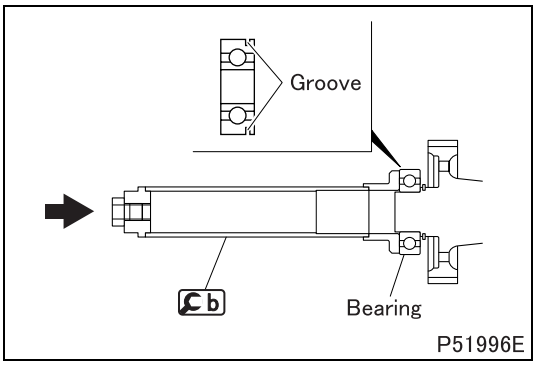
◆Removal procedure◆



■ **Removal: Countershaft front bearing**

- Remove the countershaft front bearing from the countershaft as shown in the illustration.

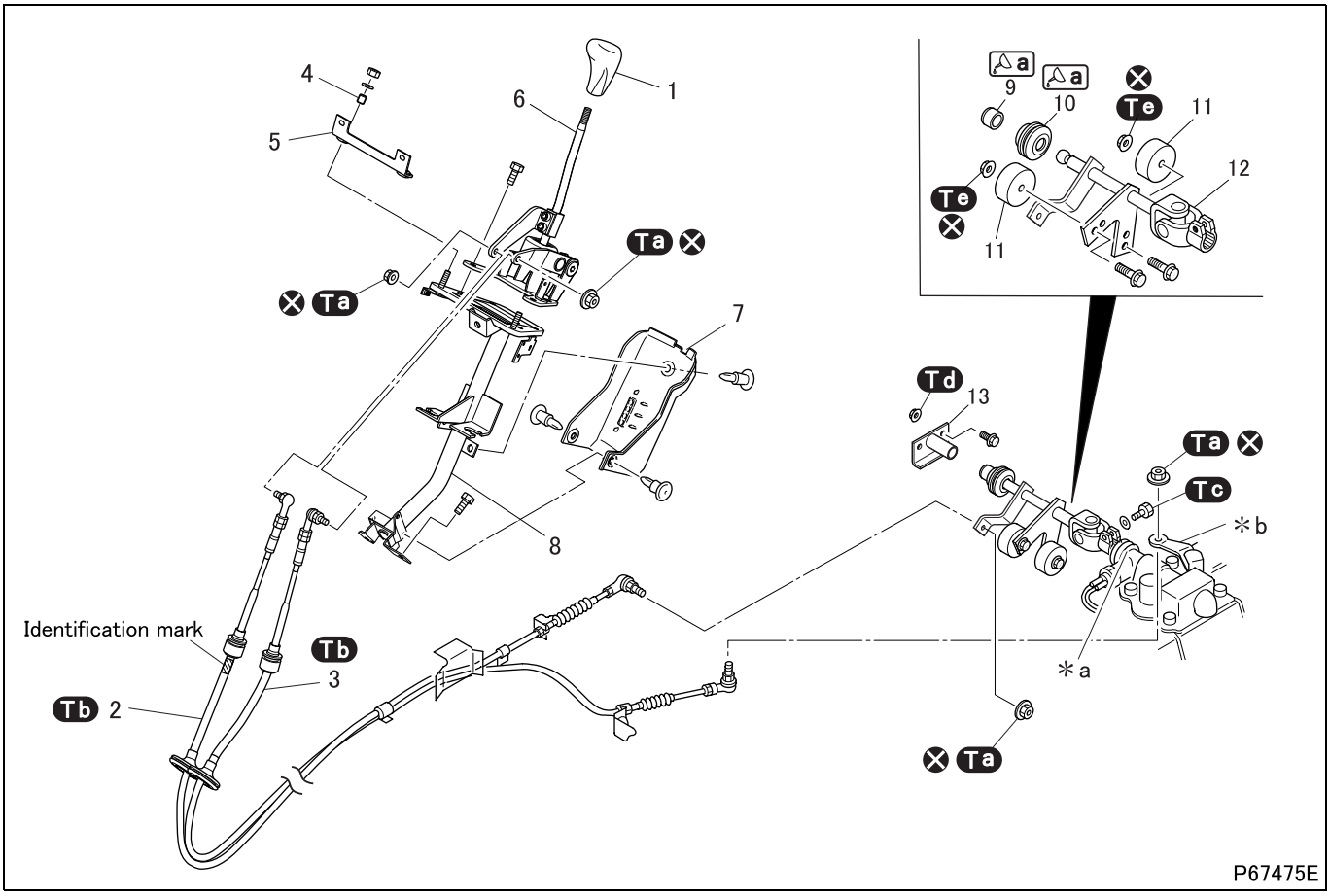
◆Installation procedure◆



■ **Installation: Countershaft front bearing**

- Install the countershaft front bearing on the countershaft as shown in the illustration.

SHIFT CONTROL



● **Removal sequence**

1 Shift knob
2 Shift selector cable
3 Gear selector cable
4 Collar
5 Instrument panel bracket
6 Shift lever (see later section)
7 Shift lever cover
8 Shift lever bracket
9 Cross-shaft bushing
10 Cross-shift boot
11 Counterweight
12 Cross-shaft
13 Cross-shaft bracket

***a**: Torsion shaft
***b**: Gear selector lever
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

- **All the nuts used on the shift and gear selector cables are coated with thread-locking compound. Replace these nuts must be replaced with new ones whenever they are loosened or removed.**
- **The counterweight mounting nut is coated with thread-locking compound. Replace this nut with a new one whenever it is loosened or removed.**

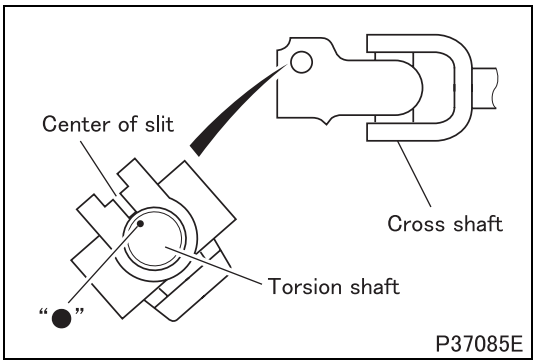
workshop manual: N·m (lbf·ft)

ID	Fastener		Torque value	Remarks
Ta	Nut (shift selector cable)		19 to 24 {14 to 18}	–
	Nut (gear selector cable)			
Tb	Shift selector cable	Lock nut on transmission side	59 to 83 {44 to 61}	–
	Gear selector cable	Lock nut on transmission side		
Tc	Bolt (cross-shaft)		15 to 20 {11 to 15}	–
Td	Nut (cross-shaft bracket)		59 to 78 {44 to 61}	
Te	Nut (cross-shaft weight)		9 to 14 {6.6 to 10}	

Lubricant and/or sealant

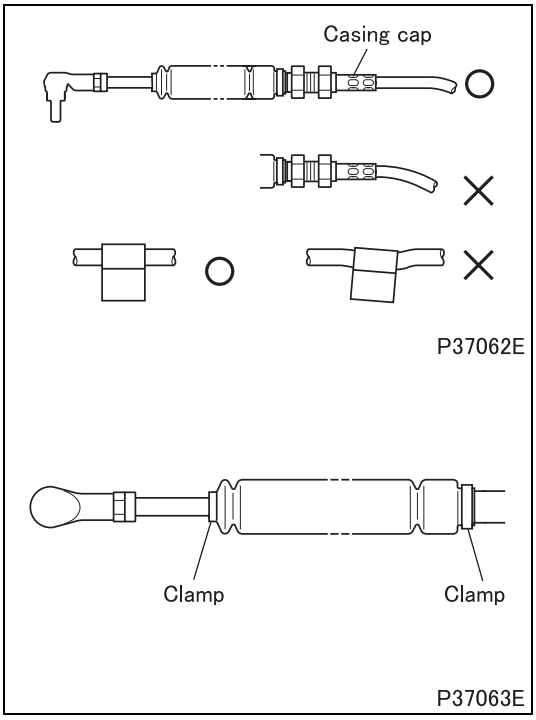
ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Internal circumference and circumference of cross-shaft bushing	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Filling in cross-shaft boot		

◆Installation procedure◆



■ Installation: Cross-shaft

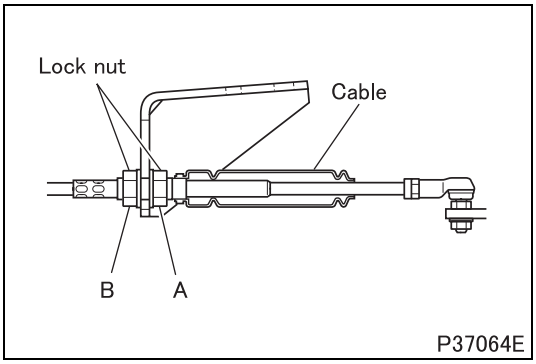
Insert the cross-shaft into the cross-shaft bracket. Make sure that the punch mark "●" on the torsion shaft is positioned at the center of the slit on the cross-shaft.



■ Installation: Shift selector cable and gear selector cable

CAUTION ⚠

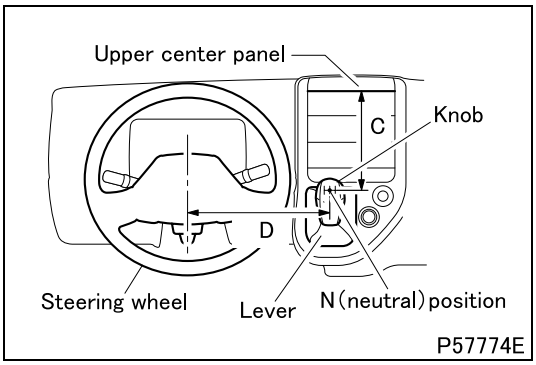
- **Install the casing cap as a straight line.**
- **The radius of the cable bend shall be 200 mm {7.87 in} or more.**
- **Make sure that there is no obstruction in movement of the cables.**
- **Install the clamp at right angles to the cable.**
- **Do not twist the clamps at either end of the boot.**
- **Check on the shift selector cable for the identification mark.**
- **The turning angle of the ball joints at each end of the cables shall be 15 degrees or less.**
- **Make sure that the ball joints face the correct direction. Installing them in the wrong direction can reduce the service life of the cables.**



- Connect the shift selector cable and the gear selector cable. Install all the clamps but do not tighten them yet.
- Permanently tighten the lock nuts and each cable clamp in this order with no excessive force applied to the shift cable and select cable.

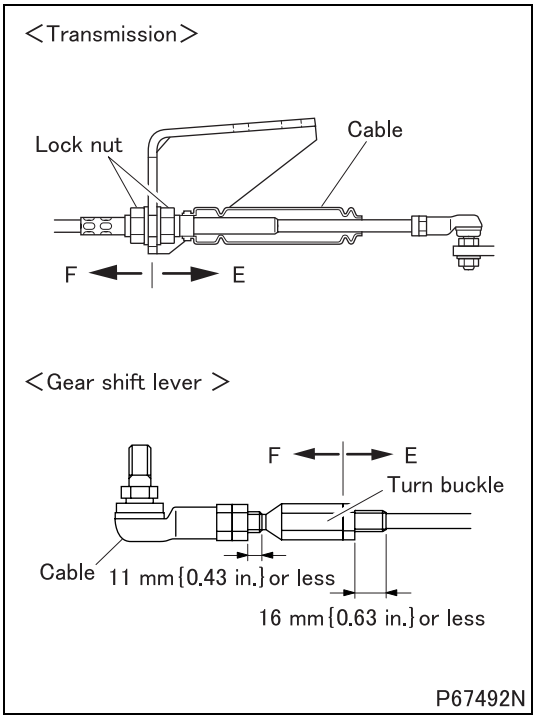
NOTE

- **When tightening lock nuts, tighten B without moving A on the transmission.**



- When operating the shift lever, make sure that it shifts smoothly from one position to another.
- Adjust the gear shift lever with the lock nut on the transmission and turnbuckle or clevis on the gear shift lever.
  Fore-and-aft direction **C:** Distance from the upper center panel
  Right-and-left direction **D:** Distance from the steering wheel center
  N (neutral) position on the 2nd-3rd line of the shift lever <S5>
  N (neutral) position on the 4th-5th line of the shift lever <S6>

	Fore-and-aft direction **C** (mm {in})	Right-and-left direction **D** (mm {in})
S5	274 ± 15 {10.8 ± 0.59}	303 ± 5 {11.9 ± 0.20}
S6		333 ± 5 {13.1 ± 0.20}



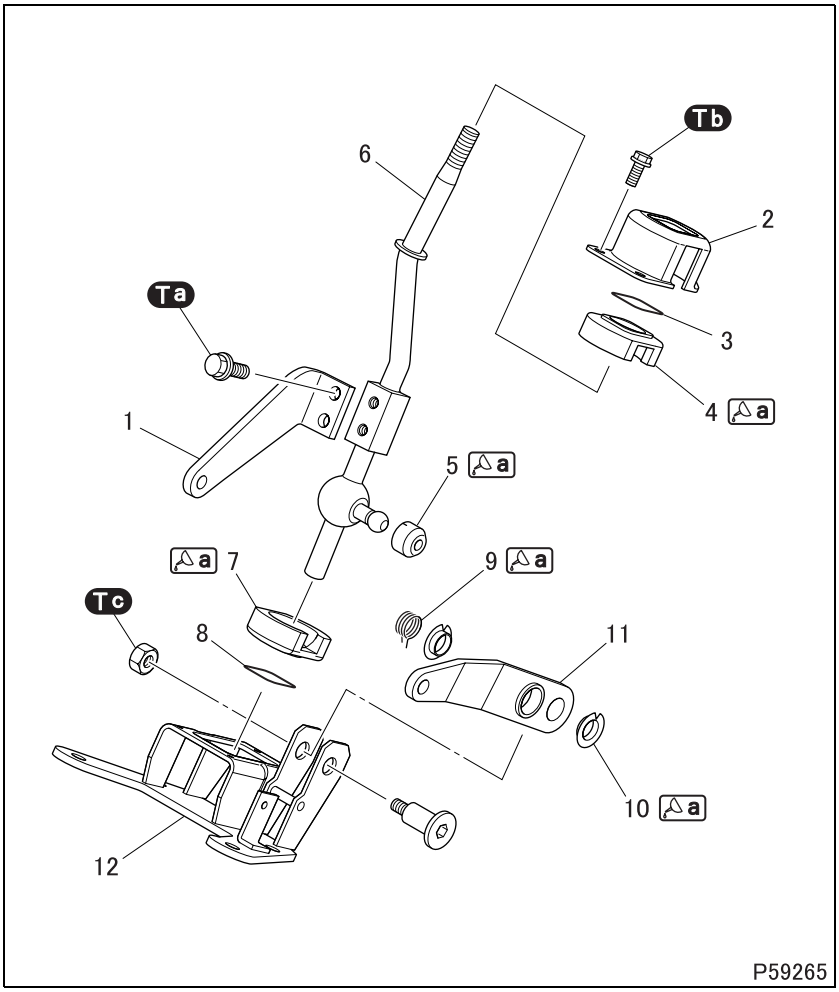
Position	Shift selector cable	Gear selector cable
Tilt forward	E	–
Tilt backward	F	–
Tilt to the right	–	F
Tilt to the left	–	E

E Move the lock nut and turnbuckle in the direction of the transmission.
F Move the lock nut and turnbuckle in the direction of the gear shift lever.

NOTE

- **When adjusting cable length, do not move the torsion shaft and gear selector lever from neutral.**
- **When adjusting selector cable position, align the N (neutral) position of the transmission with the N (neutral) position of the shift lever.**

Shift lever



● Disassembly sequence

1 Shift lever
2 Lever support
3 Insulator
4 Case
5 Shift rod bushing
6 Shift rod
7 Casing
8 Insulator
9 Return spring
10 Selector lever bushing
11 Selector lever
12 Plate

● Assembly sequence

Follow the disassembly sequence in reverse.

workshop manual: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Bolt (shift lever)	19 to 28 {14 to 20}	–
Tb	Bolt (lever support)	4 to 6 {3.0 to 4.4}	–
Tc	Nut (selector lever)	10 to 15 {7.4 to 11}	–

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Friction surfaces of casing and shift rod	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
	Internal and external circumference of shift rod bushing		
	Entire return spring		
	Internal and external circumference of selector lever bushing		

BEARING PULLER AND INSTALLER

- Bearing pullers and installers are special tools used for removing and installing bearings listed in the table below which are used in this group.
- For each puller (for removing) and each installer (for installing), use the components of the bearing pullers and installers in combination.

Component \ Application			Drive pinion bearing		Main shaft rear bearing		Countershaft front bearing		Countershaft rear bearing <S5>		Countershaft rear bearing and 6th gear sleeve <S6>	
Bearing puller and installer	Component	Part No.	Puller	Installer	Puller	Installer	Puller	Installer	Puller	Installer	Puller <S6>	Installer <S6>
MH062696	Adaptor	MH062590										O
	Plug	03726-81017						O		O		O
	Bolt	MH062700					O		O			
	Body	MH062701					O	O	O	O		O
	Protector	MH061306					O		O			
	Countershaft bearing claw	03726-81012							O			
	Bearing claw	MH062707					O					
	Main shaft bearing claw	MH061305										
	Bearing claw	MH062706										
MH062697	Bearing claw	MH062589									O	
	Plug	03726-81017		O		O						
	Bolt	MH062700	O		O						O	
	Body	MH062702	O	O	O	O					O	
	Protector	ME624229	O		O						O	
	Main shaft bearing claw	ME624226			O							
	Bearing claw	MH062636	O									

GROUP 23 INDEX

SPECIFICATIONS 23-2

STRUCTURE AND OPERATION
1. Overview 23-3
2. Electronic Control System 23-14
3. TCU Connector Diagram 23-20

TROUBLESHOOTING
1. Diagnosis Procedure.....23-22
2. Diagnostic Precautions 23-23
3. Inspections Based on Diagnosis Codes.....23-24
4. Multi-Use Tester Service Data 23-33
5. Inspections Performed at Electronic Control Unit Connectors 23-36
6. Likely Causes of Symptoms 23-39

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Inspection of Transmission Mounting Bolts.....23-44
2. Inspection of the Companion Flange and Lock Nut 23-44
3. Stall Test 23-45
4. Time Lag Test 23-46
5. Line Pressure Test 23-47
6. Road Test 23-49
7. Inspection of Automatic Transmission Fluid (ATF) 23-50
8. Changing ATF 23-51
9. Dealer Adjustment 23-53

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION 23-56

AUTOMATIC TRANSMISSION CONTROL 23-64

ATF COOLER 23-74

REPLACEMENT OF PARTS, AUTOMATIC TRANSMISSION MAIN SECTION 23-76

INSPECTION OF ELECTRICAL EQUIPMENT 23-80

INSTALLED LOCATIONS OF PARTS 23-84

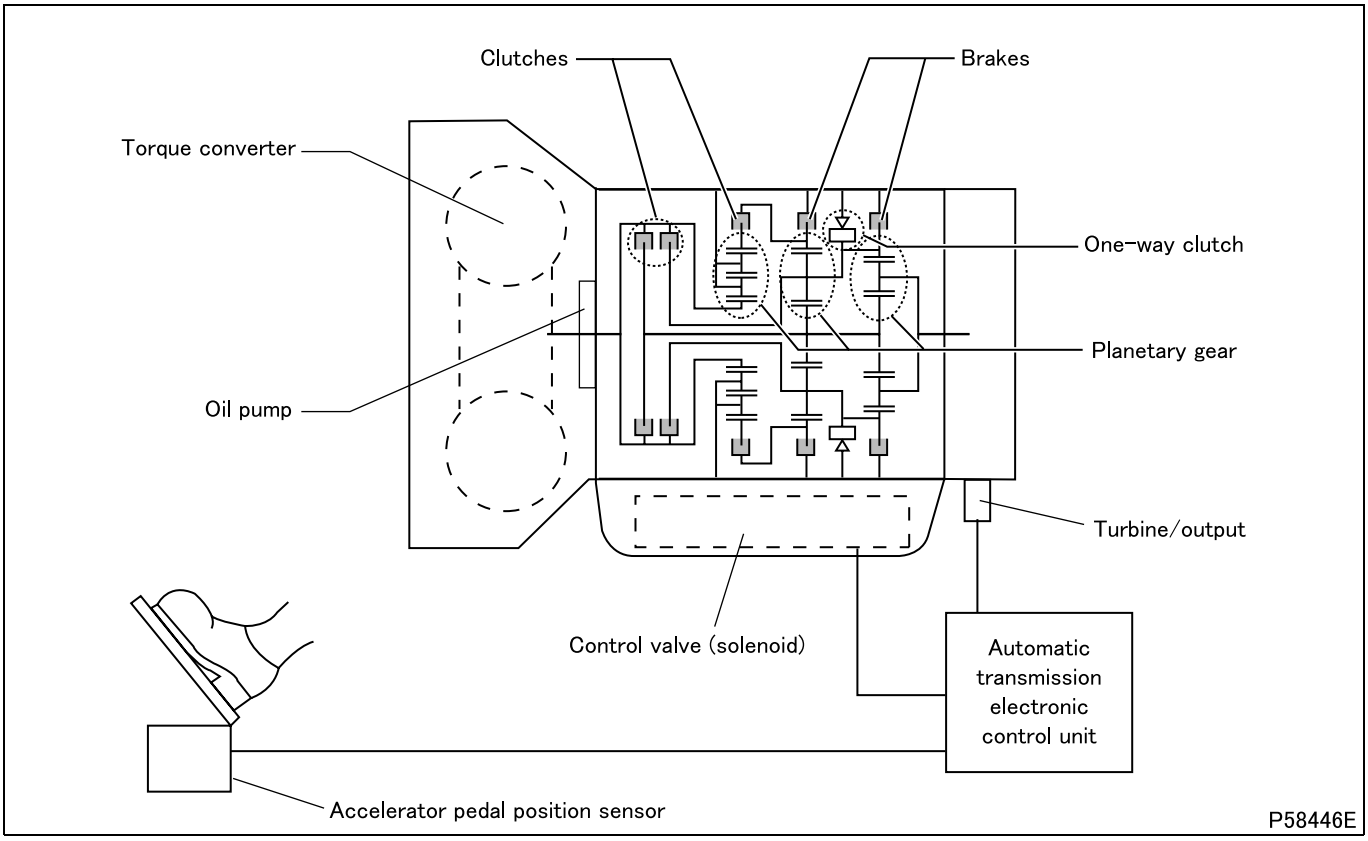
ELECTRIC CIRCUIT DIAGRAM 23-88

SPECIFICATIONS

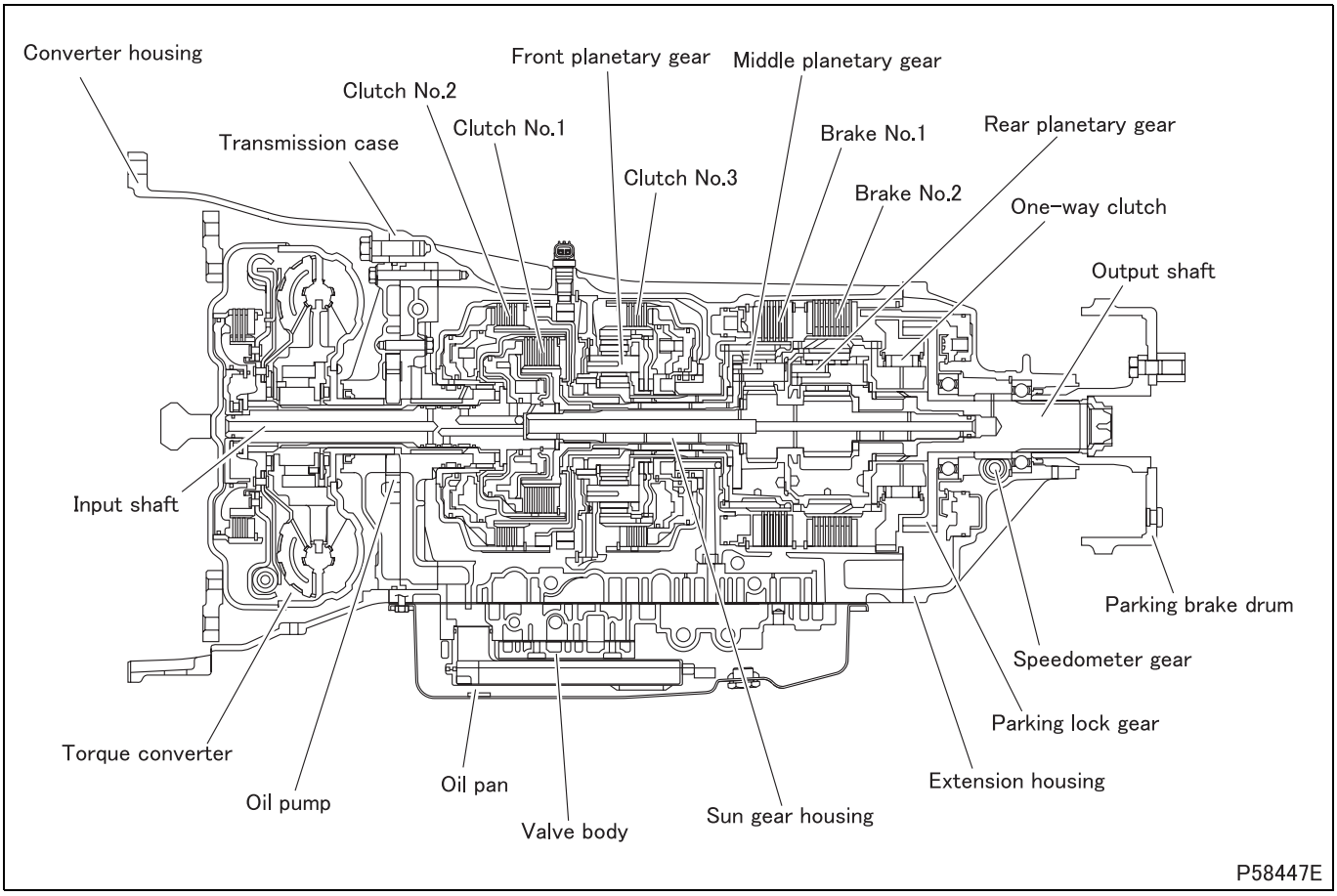
Item			Specifications
Manufacturer			Aisin Seiki Co., Ltd.
Transmission model			M036A6
Torque converter	Type		3-element, single-stage, 2-phase (with lockup clutch)
	Stall torque ratio		1.60
Transmission	Type		Planetary gear type; 6 forward gears, 1 reverse gear
	Gear ratios	1st	3.742
		2nd	2.003
		3rd	1.343
		4th	1.000
		5th	0.773
		6th	0.634
		Rev	3.539
Range selection pattern			P-R-N-D-3-2 (engine startup possible in P and N only)
Automatic transmission fluid	Type		Mobil ATF3309
	Total quantity L {qt}		13 {14}
	Quantity at time of replacement L {qt}	Replaced with drain plug removed	Approx. 6.4 {6.8}
		Replaced with oil pan removed	Approx. 8.4 {8.9}

1. Overview

- The automatic transmission forms a system in which gearshifts are automatically accomplished by directing automatic transmission fluid into different paths, using solenoid valves in conjunction with sensor information about the vehicle speed, throttle opening, and other aspects of vehicle operation.
- The automatic transmission electronic control unit provides certain control functions. These include a diagnosis function (the automatic transmission electronic control unit monitors the main components and warns the driver of any abnormality), a shutdown function (the automatic transmission electronic control unit stops control of the automatic transmission when required by an abnormality), and a failsafe function (the automatic transmission electronic control unit changes the control method to allow continued driving under conditions of uncertainty).
- The system consists mainly of electronically controlled control valves (solenoid valves), a torque converter, planetary gears, brakes, clutches, the automatic transmission electronic control unit, and associated sensors that form part of the control apparatus.



1.1 Automatic transmission



- The automatic transmission combines a torque converter (with a lockup mechanism) and a fully automatic 6-speed gear system.

(1) Torque converter

- The torque converter serves as the input device for the transmission. It functions as a fluid coupling that increases the torque transmitted from the engine and absorbs the shock of standing starts and gearshifts. At higher vehicle speeds, a lockup mechanism in the torque converter eliminates slippage and improves transmission efficiency.

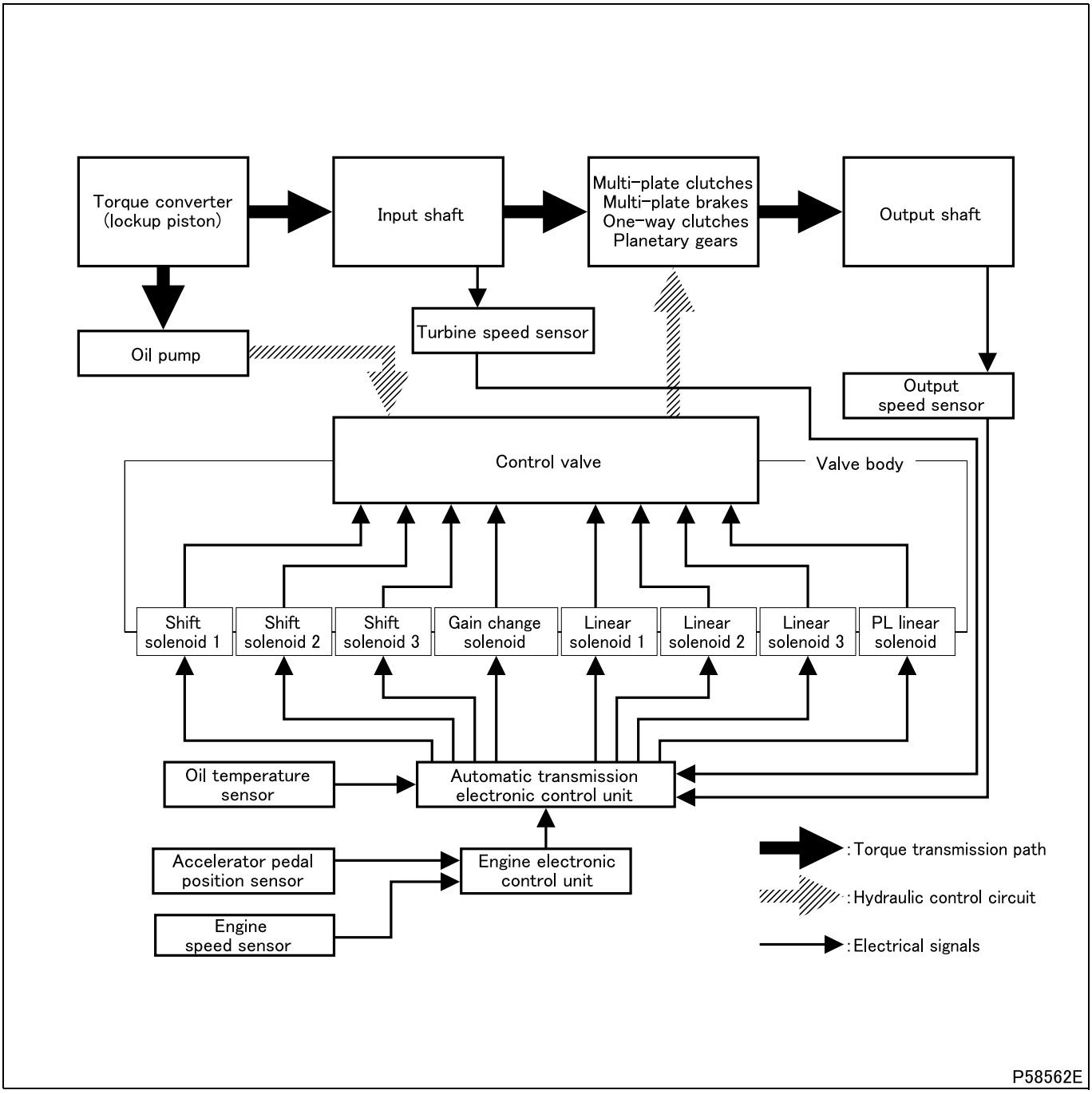
(2) Transmission

- The transmission consists of a gear system with 6 forward gears and 1 reverse gear. To shift gears, it employs a one-way clutch, three planetary gear sets (each of these consists of a sun gear, pinion gears, and a ring gear), three hydraulically activated, wet, multi-plate clutches, and two hydraulically activated, wet, multi-plate brakes.

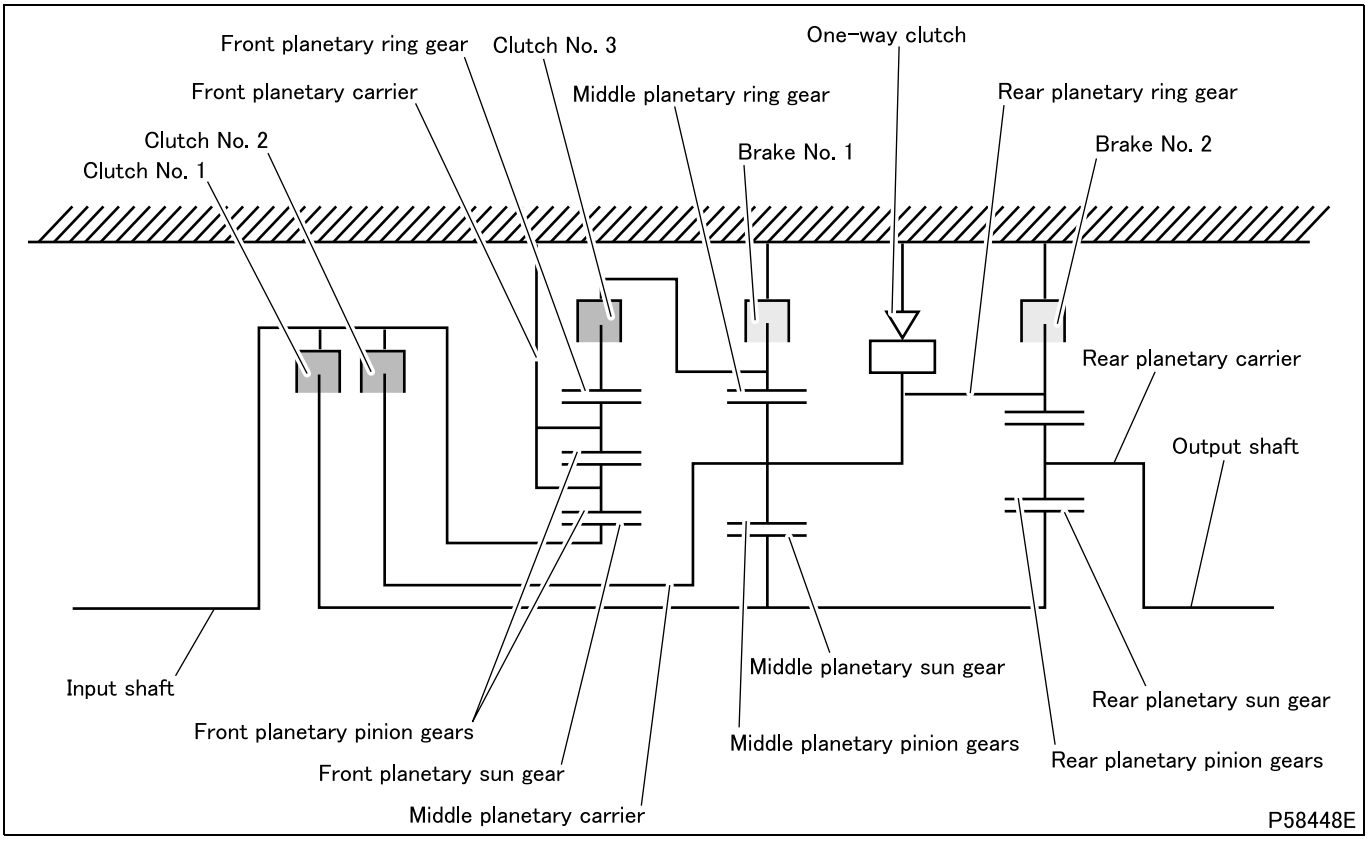
(3) Hydraulic control arrangement

- A microcomputer (the automatic transmission electronic control unit) extends its electronic control over the hydraulic system to enable precision control of gearshifts.

1.2 Automatic transmission block diagram



1.3 Transmission



(1) Functions of clutches and brakes

Component	Function
Clutch No. 1	Engages input shaft with middle and rear planetary sun gears
Clutch No. 2	Engages input shaft with middle planetary carrier and rear planetary ring gear
Clutch No. 3	Engages front planetary ring gear with middle planetary ring gear
Brake No. 1	Locks middle planetary ring gear
Brake No. 2	Locks front planetary carrier and rear planetary ring gear
One-way clutch	Locks front planetary carrier and rear planetary ring gear against counterclockwise rotation (only allowing them to rotate clockwise)

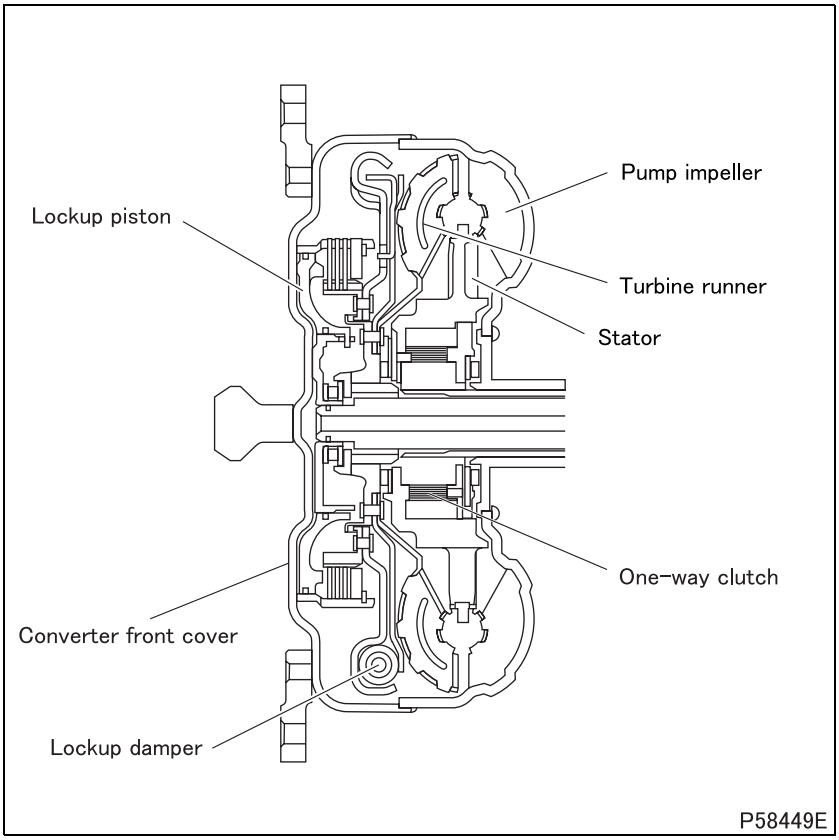
(2) Operation timing of clutches, brakes and solenoids

Shifter position		Shift solenoid			Linear solenoid			Clutch No.			Brake No.		One-way clutch
		1	2	3	1	2	3	1	2	3	1	2	
P	Parking		O	O		O						O	
R	Rev (high torque)	O		O		O	O			O		O	
	Rev (low torque)	O	O	O		O	O			O		O	
N	Neutral		O	O		O						O	
D	1st			O		O		O				O	●
	2nd				O			O			O		
	3rd	O				O		O		O			
	4th	O	O		O			O		O			
	5th		O			O			O	O			
	6th		O		O				O		O		

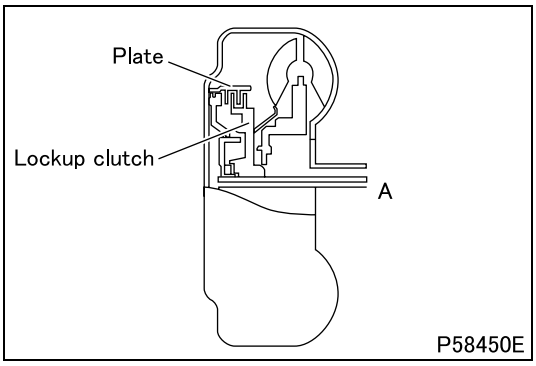
O :In operation

● :Only in operation when driven

(3) Torque converter

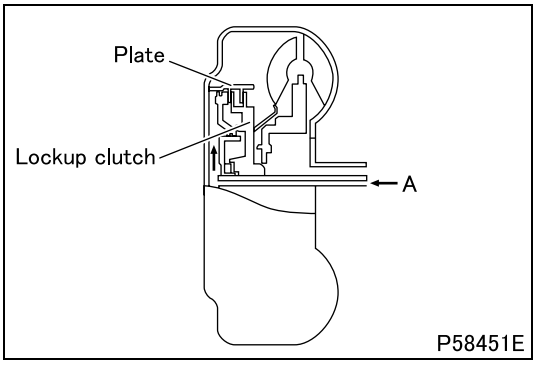


- The torque converter transmits the engine torque to the transmission. Under normal operation (when it is not locked up), the torque is transmitted through a bath of oil. When it is locked up, the torque is transmitted through the lockup piston.
- The lockup damper is designed to soften the impact when the torque converter locks up.
- The torque converter is a 3-element, single-stage, 2-phase type.
- The term ‘single-stage’ indicates that there is 1 turbine runner (output element). The term ‘2-phase’ indicates that the mechanism works as a torque converter when the turbine runner is turning slowly relative to the pump impeller, and as a fluid coupling when the turbine runner is turning quickly relative to the pump impeller.



(3.1) When not locked up

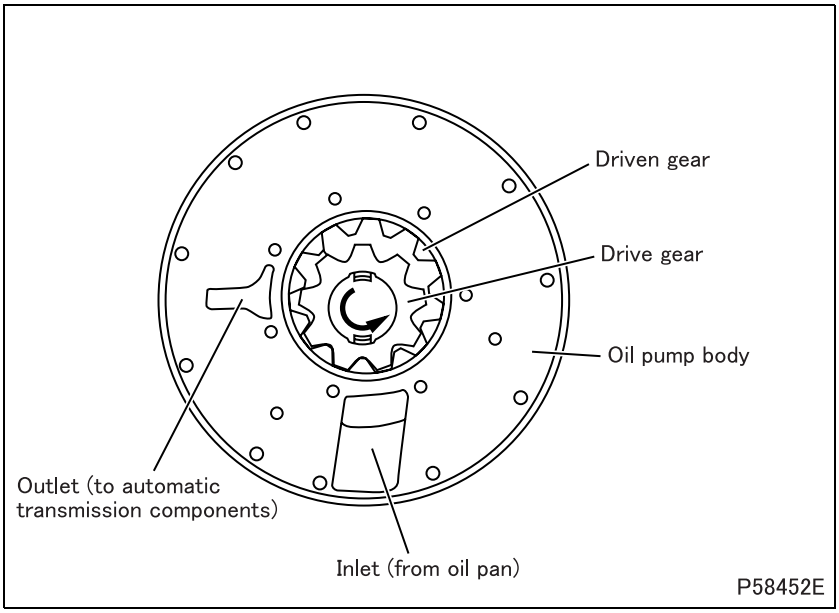
- There is no torque converter activation pressure between the converter front cover and the lockup piston. Passage **A** is not is use. The lockup clutch and the plate are disengaged and the lockup function is inactive.



(3.2) When locked up

- There is torque converter activation pressure supplied via passage **A** between the converter front cover and lockup piston. The lockup clutch and the plate are therefore engaged and the lockup function is active.

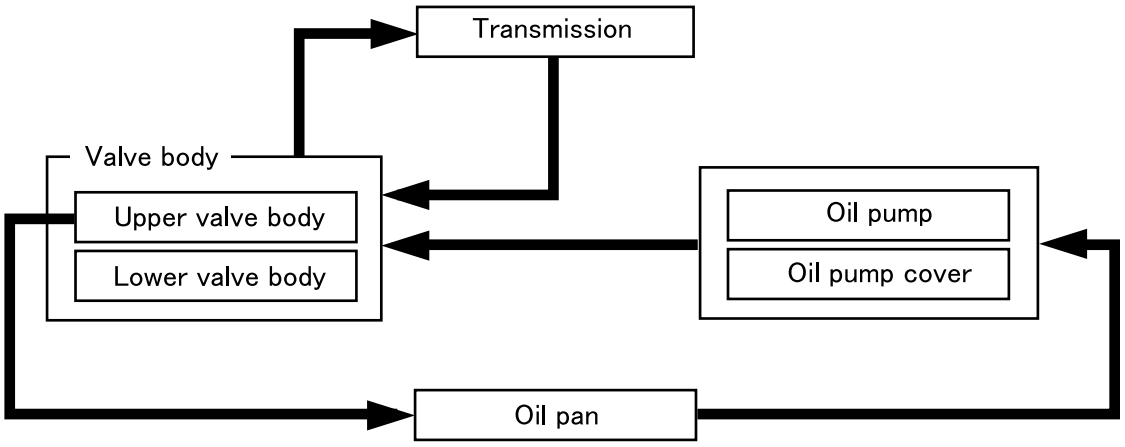
(4) Oil pump



- The oil pump is a high-performance gear-type pump with a small number of specially designed gear teeth.
- The drive gear is fitted onto the extension sleeve of the torque converter, so it turns in the direction of the arrow (the same direction as the engine output). Oil drawn into the pump is compressed and then expelled.

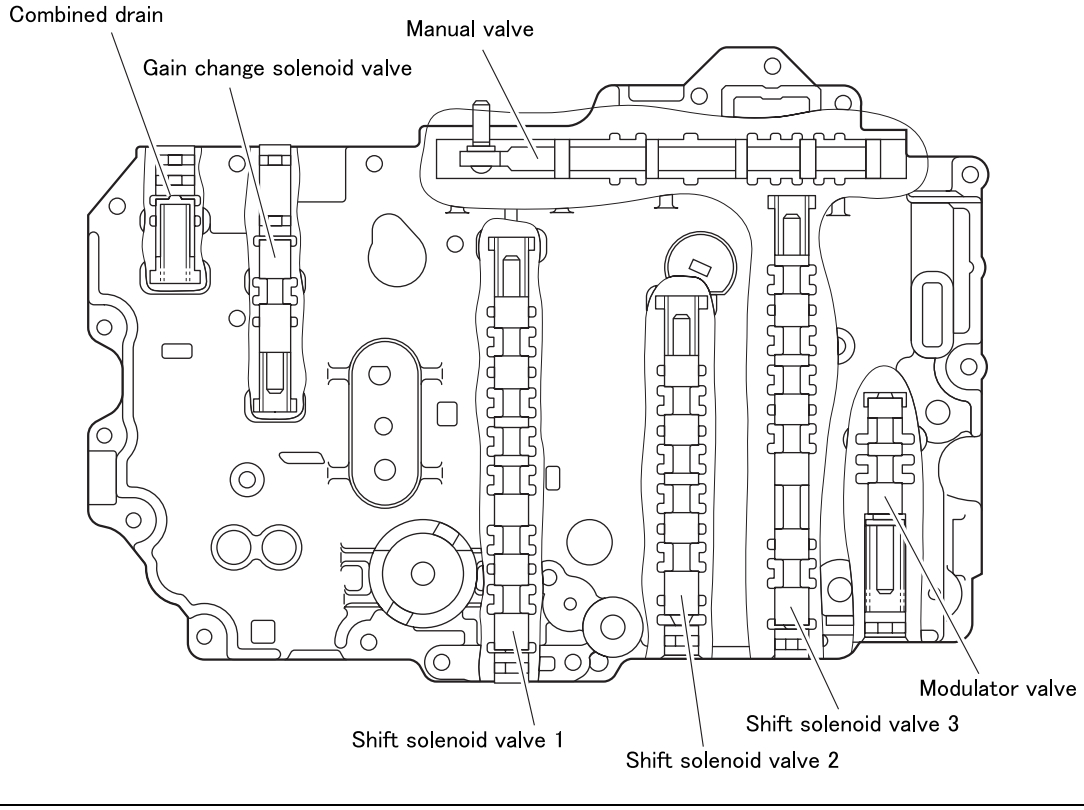
1.4 Hydraulic control components

(1) Overview



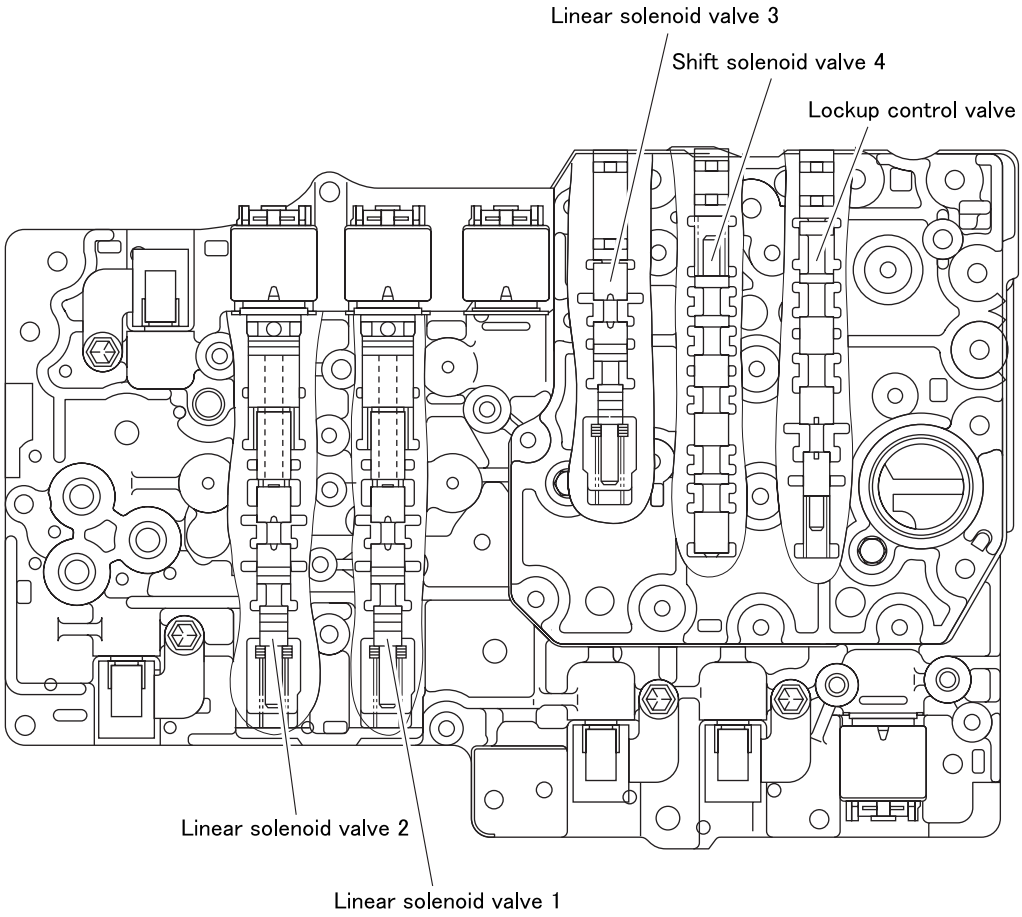
(2) Valve layout drawings

(2.1) Upper valve body



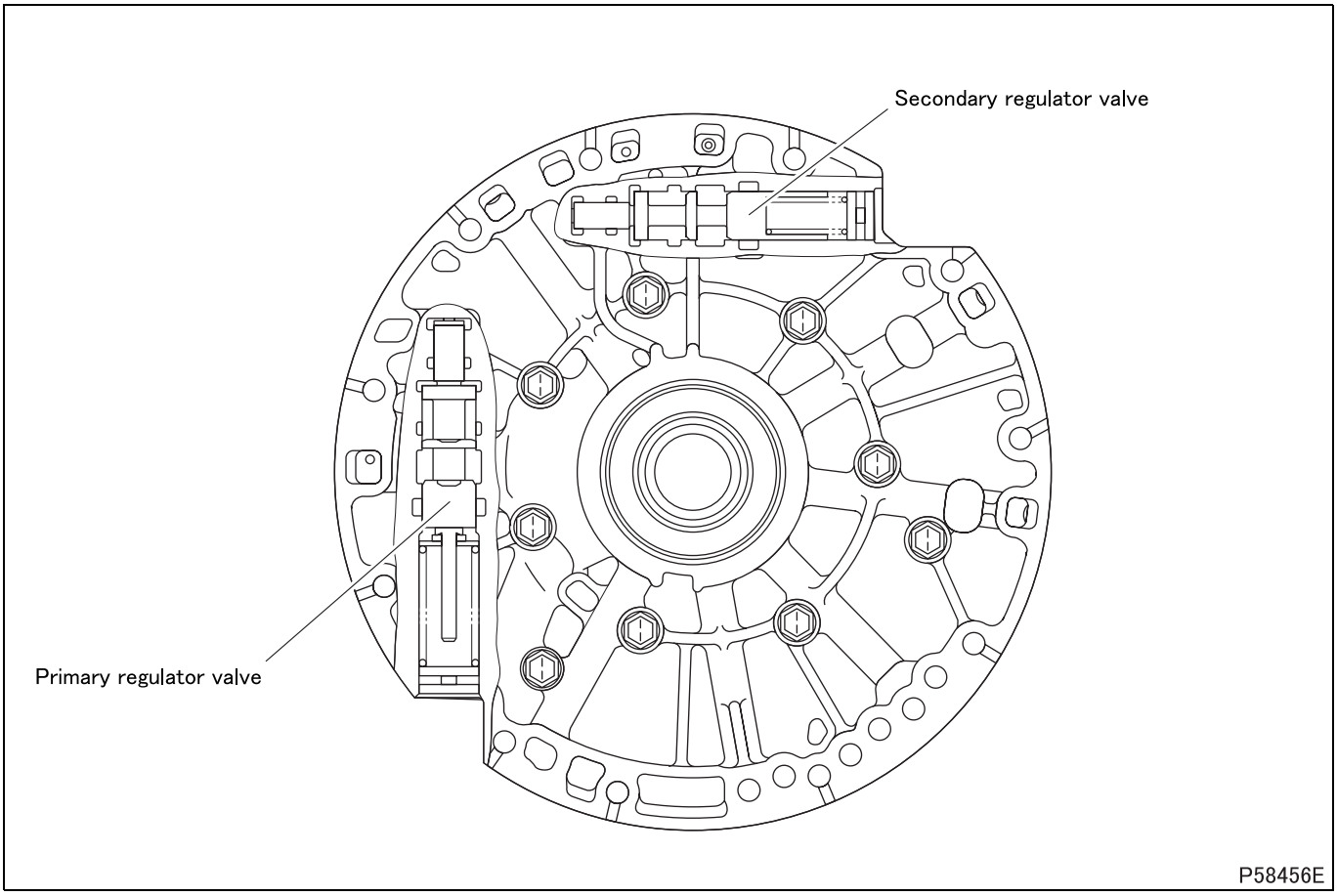
Valve	Function
Manual valve	Selects N, R, and D passages in accordance with driver's movement of shift lever.
Modulator valve	Regulates line pressure and supplies it to linear solenoids and shift solenoids.
Shift solenoid valve 1	Directs line pressure and control pressure for clutch and brake engagement.
Shift solenoid valve 2	Directs line pressure and control pressure for clutch and brake engagement.
Shift solenoid valve 3	Directs line pressure and control pressure for clutch and brake engagement.
Gain change solenoid valve	Changes pressure from control pressure to line pressure.
Combined drain	Enables fluid emerging from clutch passages and brake passages to drain away.

(2.2) Lower valve body



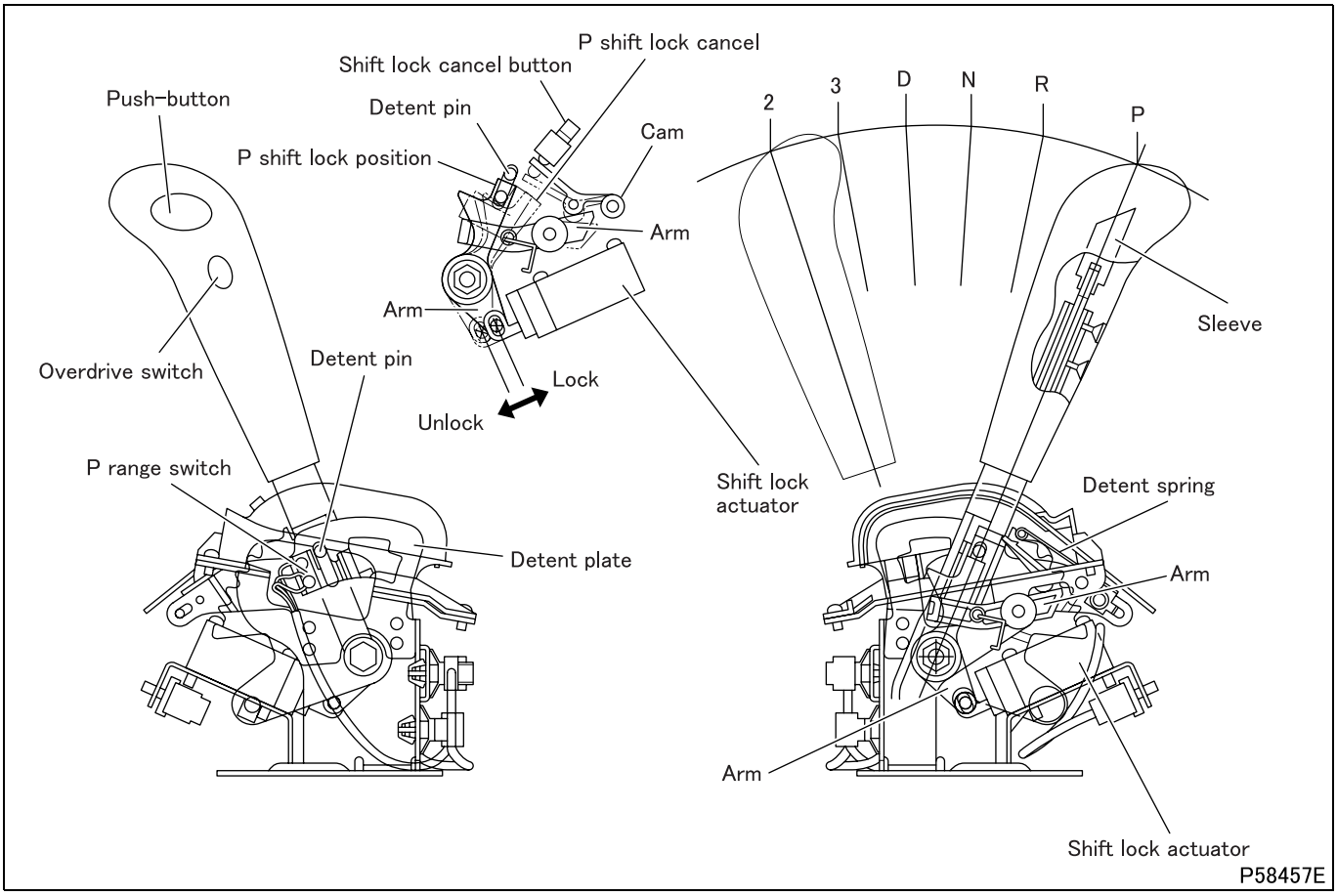
Valve	Function
Lockup control valve	Controls pressure (lockup pressure) fed to torque converter.
Linear solenoid valve 1	Controls pressure (control pressure) fed to clutches No. 1 and No. 2 and brake No. 1
Linear solenoid valve 2	Controls pressure (control pressure) fed to clutch No. 3 and brake No. 2
Linear solenoid valve 3	Controls pressure (control pressure) fed to clutches No. 1 and No. 3
Shift solenoid valve 4	Directs line pressure and control pressure for clutch and brake engagement.

(2.3) Oil pump cover



Valve	Function
Primary regulator valve	Controls pressure (line pressure) fed to elements.
Secondary regulator valve	Controls pressure fed from primary regulator valve to torque converter, and controls lubrication pressure for various parts.

1.5 Shift selector



- The P range switch indicates whether P (park) is selected. It is used for the key interlock function.
- The shift lock actuator is used to control the P shift lock function.
- The shift lock cancel button cancels the P shift lock function in a way that bypasses the shift lock actuator. It is used in the event of a fault.

(1) Key interlock function

(1.1) Locked condition

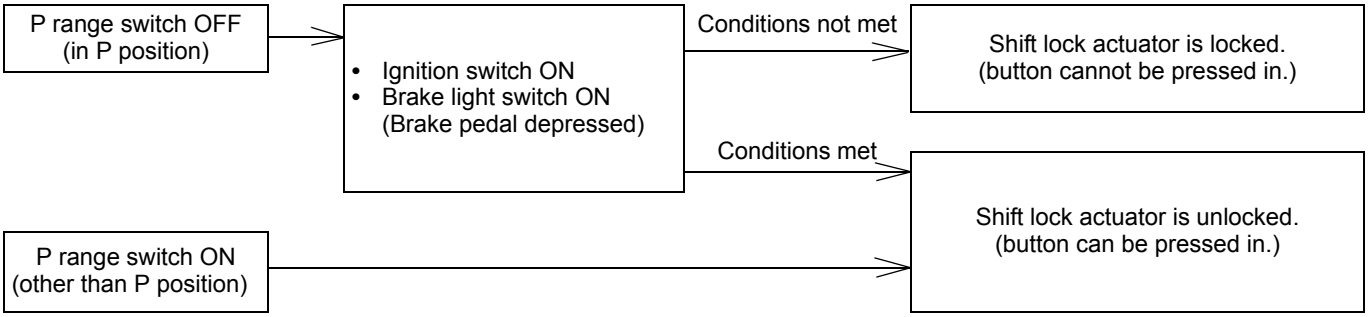
Input signal	Key interlock electronic control unit	Output signal
P Range switch ON (shift selector in position except P)	Key interlock activation	Key interlock solenoid ON (key cannot be turned to LOCK position)

(1.2) Lock cancellation

Input signal	Key interlock electronic control unit	Output signal
P Range switch OFF (shift selector in P position)	Key interlock cancellation	Key interlock solenoid OFF (key can be turned to LOCK position)

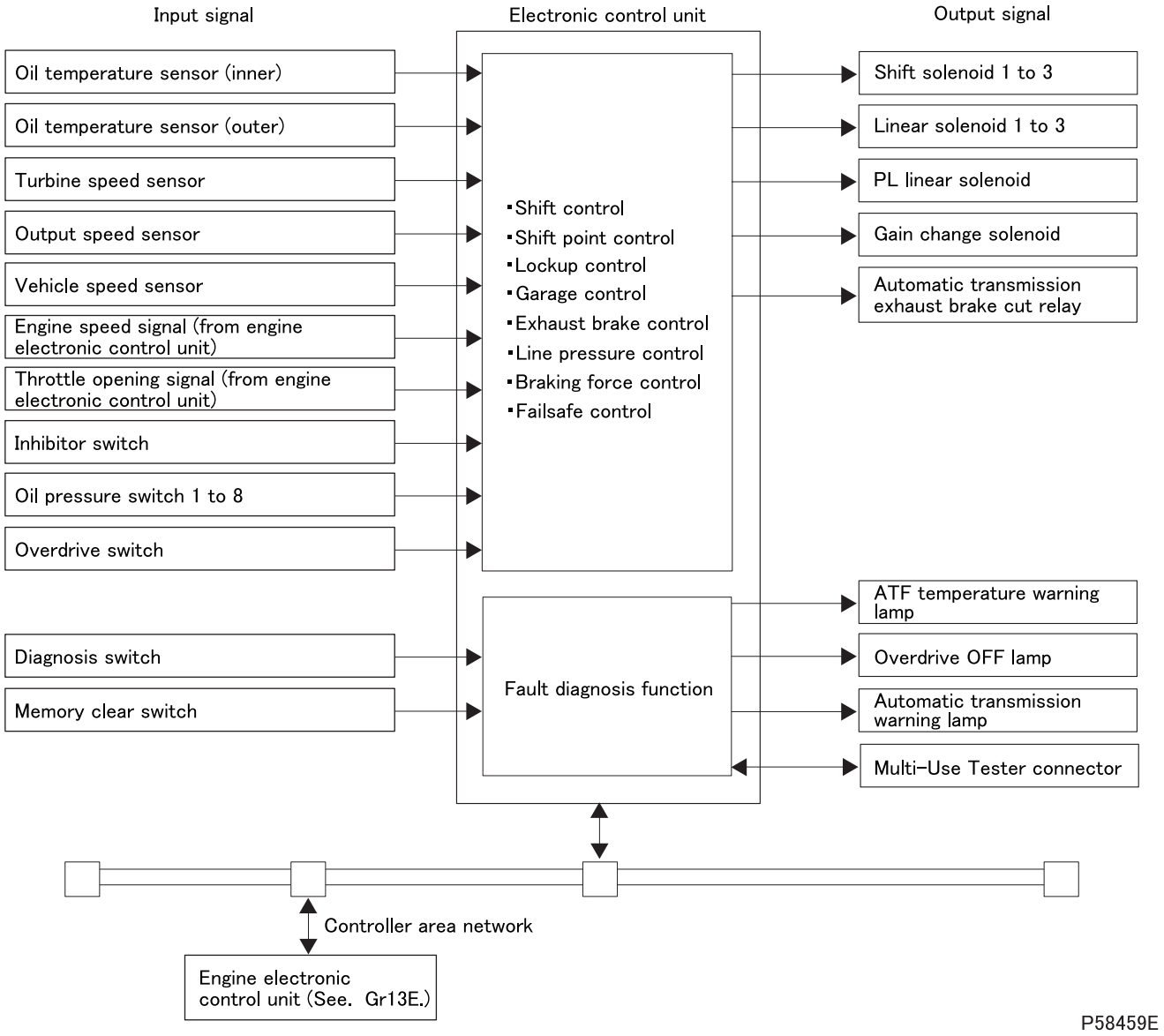
(2) P shift lock function

- When the necessary conditions are not met, the shift lock actuator operates to prevent the button from being pushed, preventing movement of the lever from P (park).



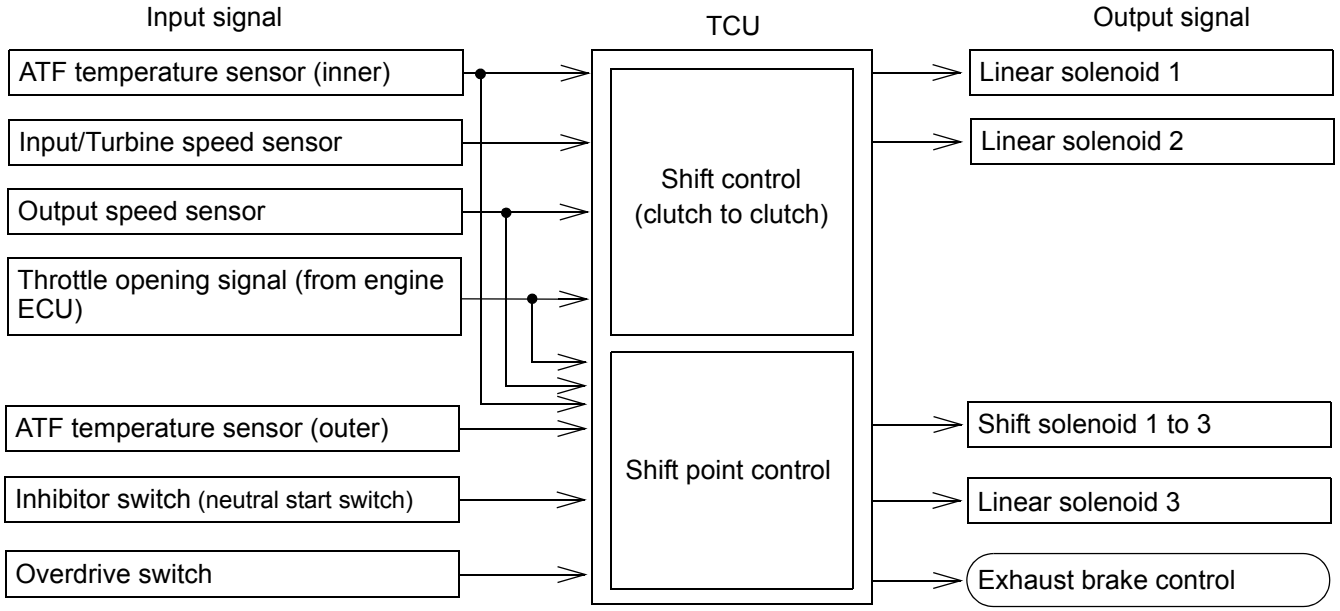
2. Electronic Control System

2.1 System block diagram



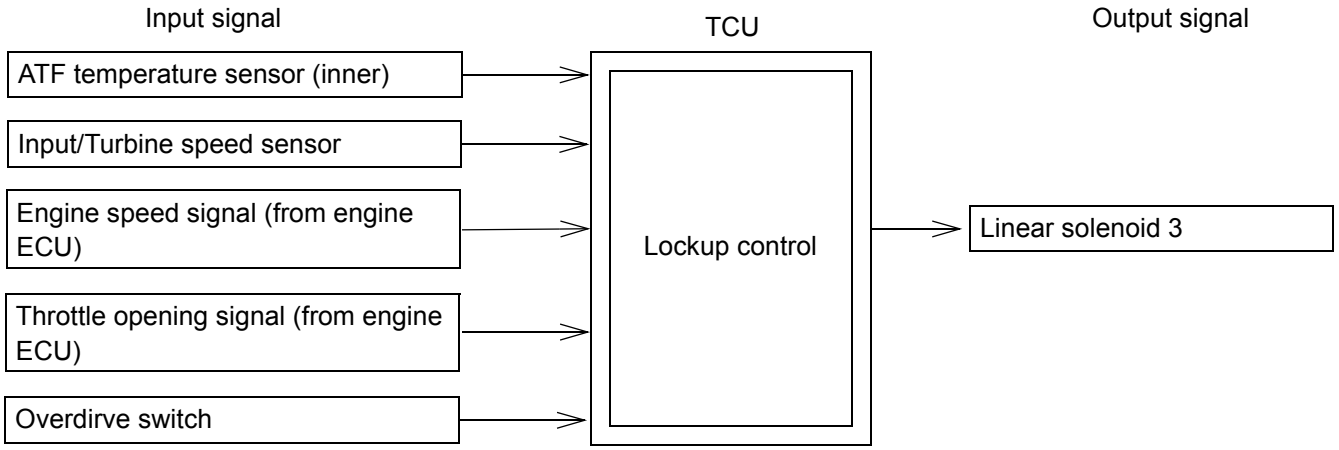
Part name	Major function or operation
ATF temperature sensor (inner and outer)	Detection of automatic transmission fluid temperature
Input/Turbine speed sensor	Detection of input shaft speed
Output speed sensor	Detection of output shaft speed
Vehicle speed sensor	Detection of vehicle speed
Engine electronic control unit [engine ECU] (engine speed signal)	Detection of engine speed
Engine ECU (throttle opening signal)	Detection of throttle opening angle
Inhibitor switch (neutral start switch)	Detection of shift selector position
Oil pressure switches 1 to 8	Detection of oil pressure
Overdrive switch	Detection of overdrive OFF condition
Diagnosis switch	Displaying diagnosis codes
Memory clear switch	Erasing diagnosis codes
Automatic transmission exhaust brake cut relay	Cut-off of exhaust brake
ATF temperature warning	Display of abnormal ATF temperature
Overdrive OFF indicator	Display of overdrive OFF
Automatic transmission warning	Display of system fault and diagnosis codes
Multi-Use Tester (MUT) connector	Communication with MUT; displaying and erasing diagnosis codes

2.2 Shift control and shift point control



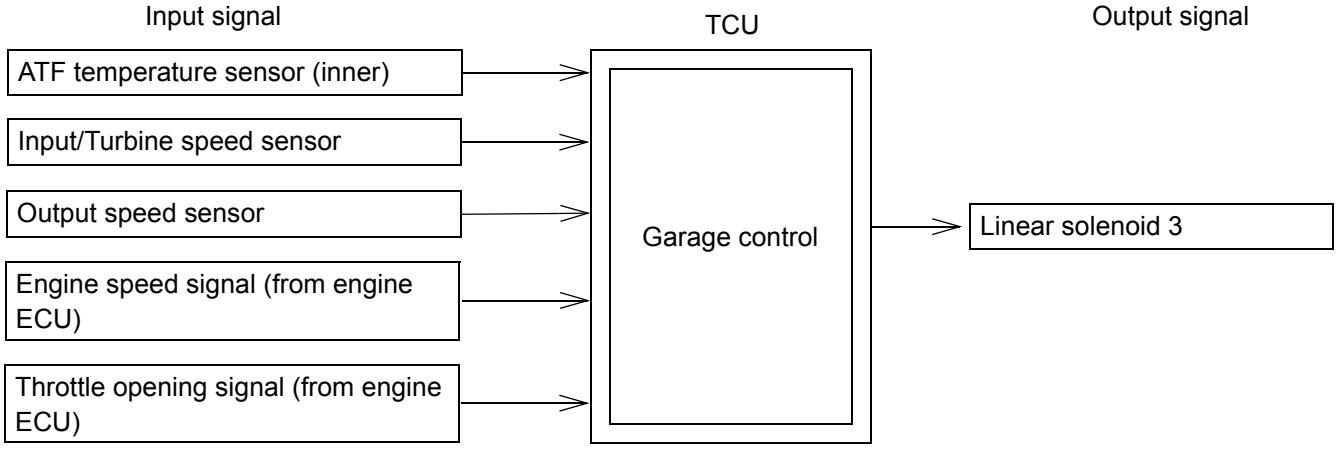
- For automatic selection of the optimal gear, the throttle opening signal and the output speed sensor signals cause the automatic transmission electronic control unit (TCU) to issue a signal to shift solenoid 1-3 and linear solenoid 1 and 2, which are mounted on the valve body.
- Clutch selection for shift control is performed by means of clutch-to-clutch control, whereby one clutch is disengaged as another is engaged.

2.3 Lockup control



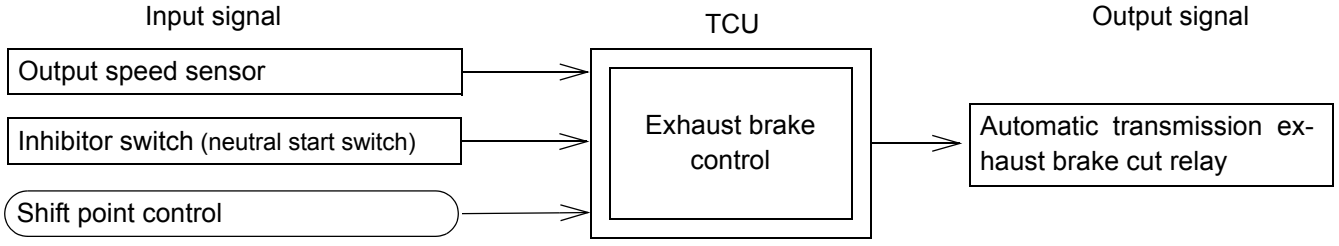
- Lockup control allows slippage in the torque converter to be eliminated, increasing transmission efficiency. The throttle opening signal and the output speed sensor signals cause the automatic transmission electronic control unit to activate linear solenoid 3 (mounted on the valve body) for lockup.

2.4 Garage control



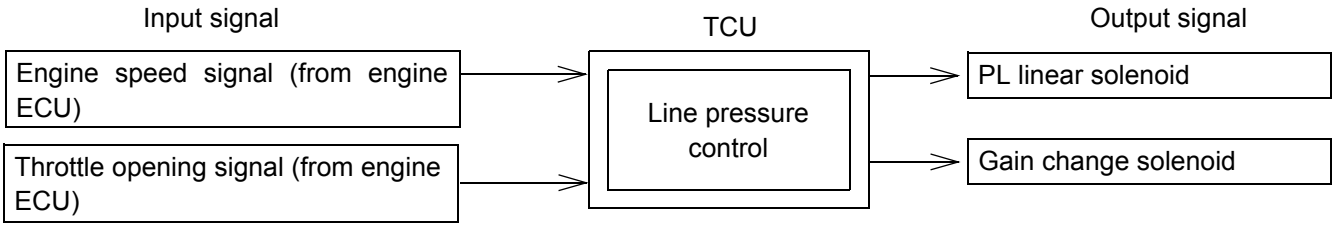
- When the inhibitor switch signal changes from N to an active range (D or R), the automatic transmission electronic control unit issues a signal to linear solenoid 3 (mounted on the valve body) to shift into forward or reverse gear.

2.5 Exhaust brake control



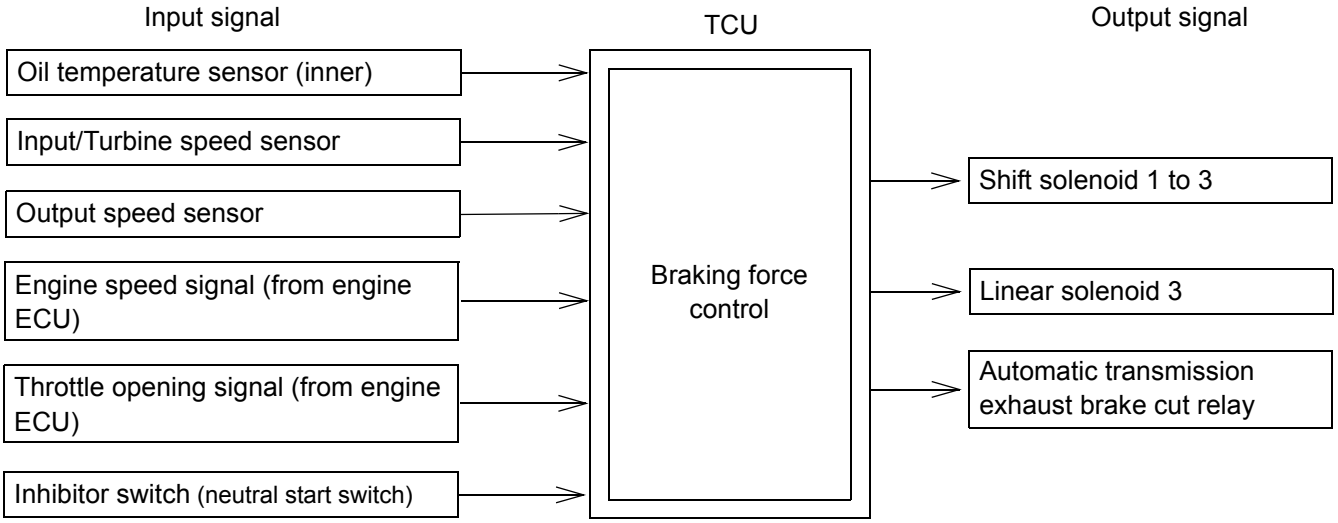
- The exhaust brake is released under any of the following conditions.
  - The shift selector is in P or N
  - When driving at low speed
  - While shifting the automatic transmission
  - High automatic transmission fluid (ATF) temperature

2.6 Line pressure control



- The line pressure control optimizes the automatic transmission line pressure according information from the throttle opening signal and engine speed signal.

2.7 Braking force control



- If the accelerator pedal is released when the vehicle speed is higher than a preset level, a gear is selected in keeping with the road grade and load conditions to activate the optimal degree of engine braking.

2.8 Failsafe control

- Failsafe control is designed to maintain the highest possible level of driveability in case of a problem in either output speed sensor, in the engine speed signal, throttle opening signal, oil temperature sensor, inhibitor switch, or in any solenoid or mechanical valve.

(1) Inhibitor switch (neutral start switch)

If, with the vehicle either stationary or moving, an inhibitor switch problem occurs, and the TCU receives no range signal, the TCU selects 3rd gear, and remains locked in 3rd gear until the signal is restored. If the TCU receives multiple range signals, the TCU accepts signals according to the following priorities: P > N > any other range signal. The selected hydraulic circuit in the valve body is determined by the manual valve in accordance with the shift selector position. See the table below.

Actual shift selector position	Inhibitor switch input signals	Vehicle operating condition
P	P and another range signal	P
R	R and another range signal (except P or N range signal)	R
N	N and another range signal	N
D	D and another range signal (except P or N range signal)	3rd gear
3	3 and another range signal (except P or N range signal)	3rd gear
2	2 and another range signal (except P or N range signal)	3rd gear

2.9 Fault diagnosis function

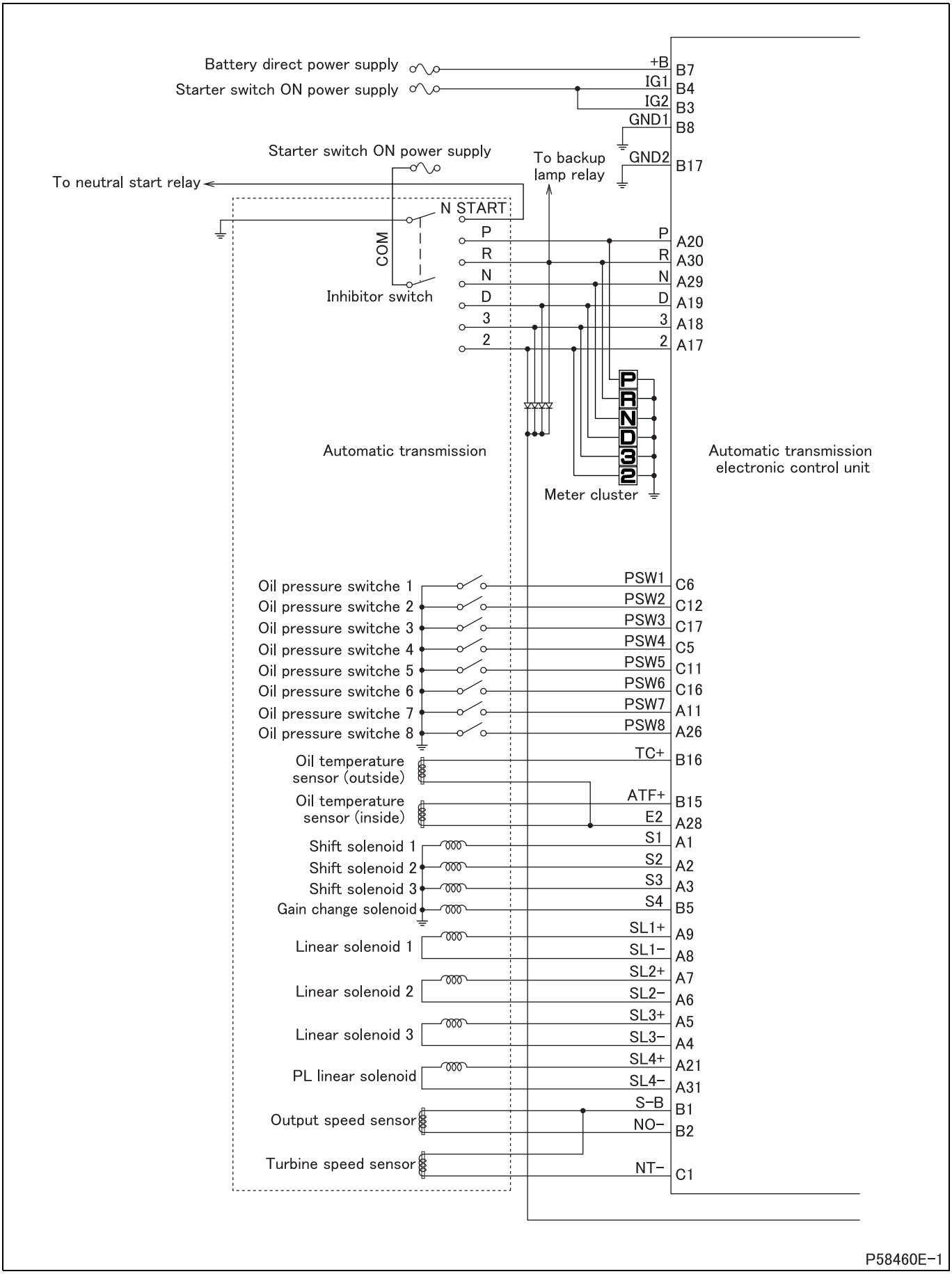
- While the ignition switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found to be faulty, the instrument cluster alerts the driver, the fault location is added to memory in the form of a diagnosis code, and any special programming is initiated.
- While the special programming is in effect, the system is limited in its functionality in order to ensure the safety of the vehicle and its driver. To read the diagnosis code, use the Multi-Use Tester (MUT) or flash the diagnostic light.

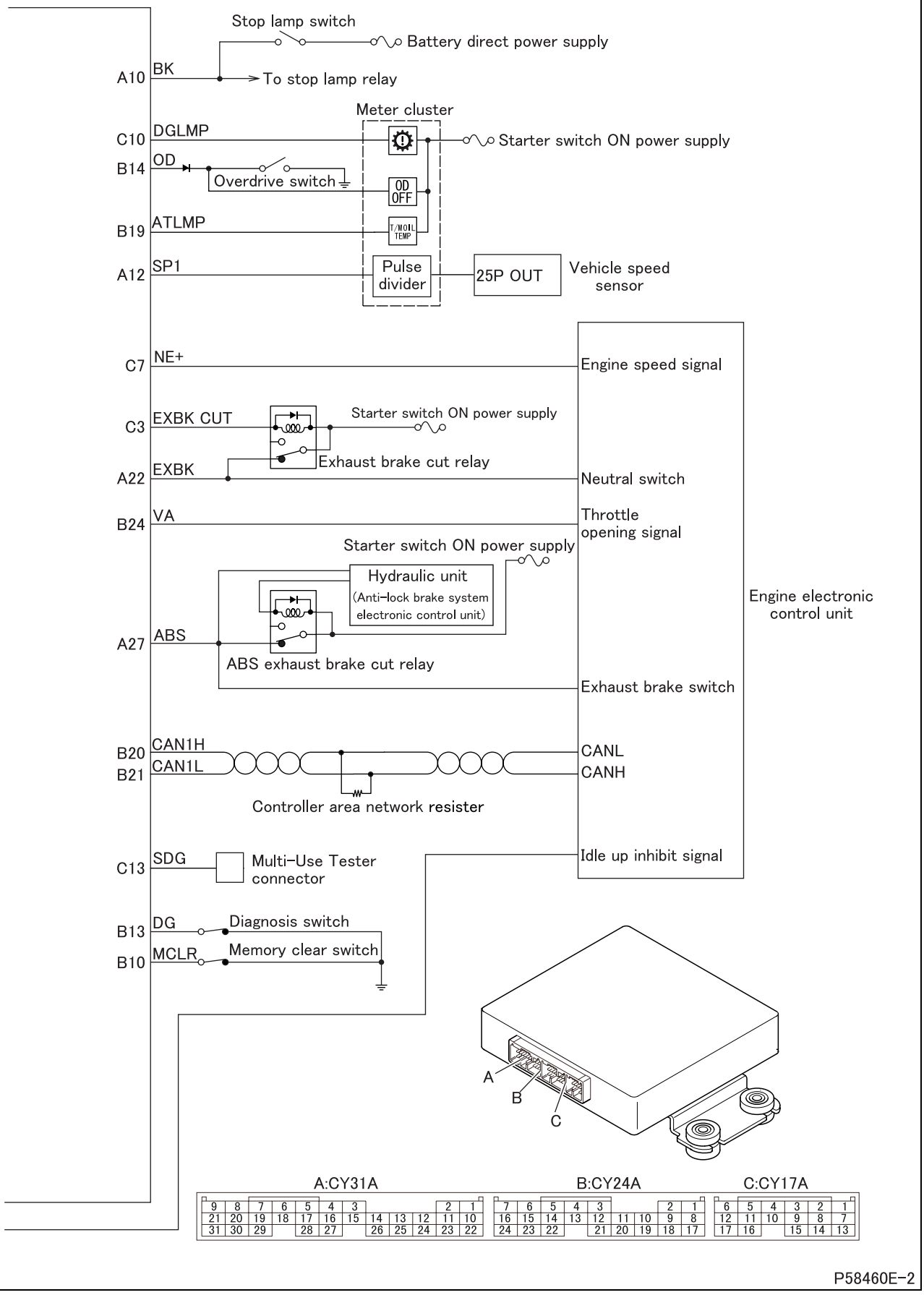
NOTE

- **The MUT uses different diagnosis codes from those obtained by flashing the diagnostic light.**
- **The MUT is capable of showing more detailed diagnosis codes.**

M E M O

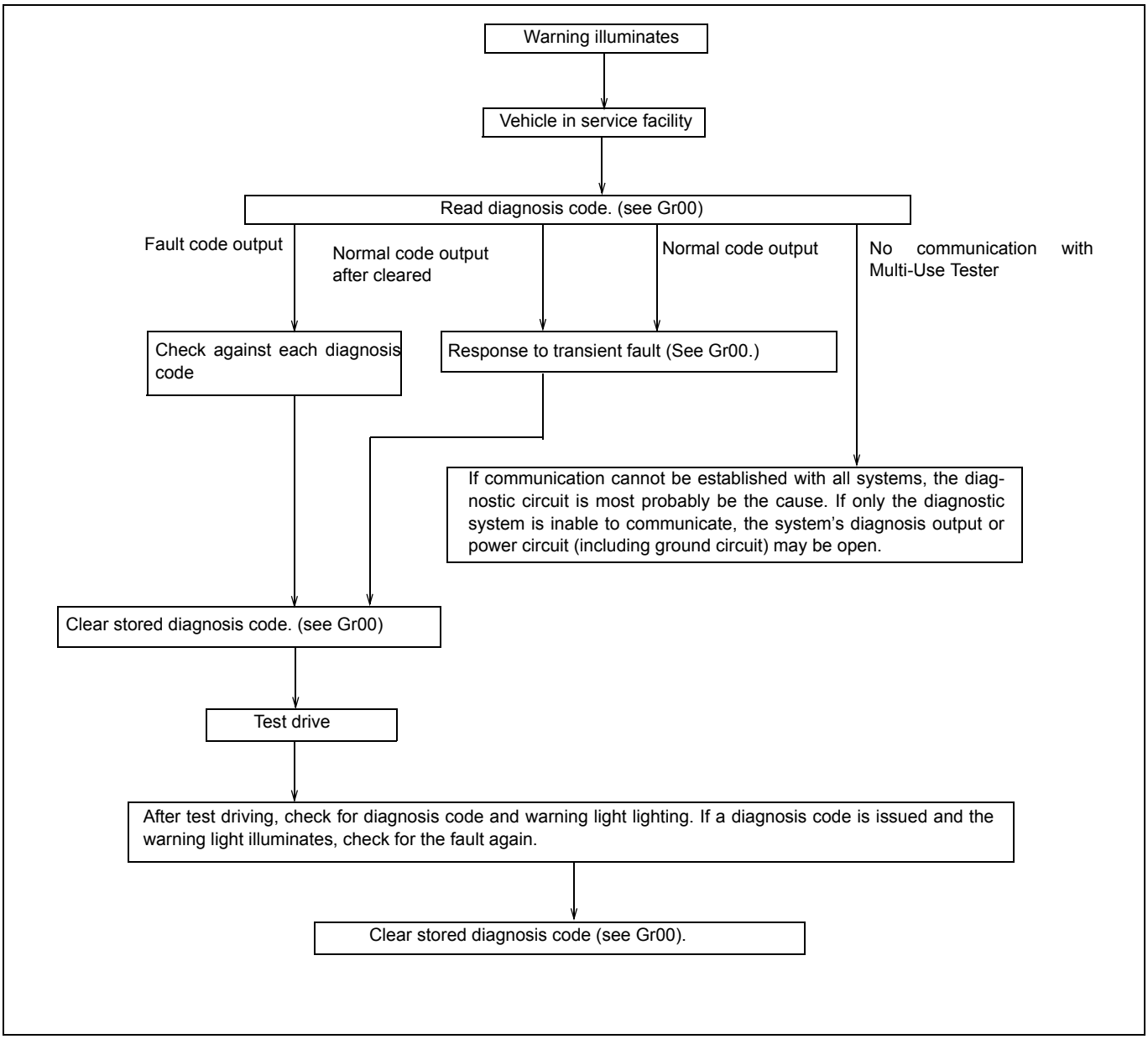
3. TCU Connector Schematic




Stop lamp switch
Battery direct power supply
A10 BK
To stop lamp relay
Meter cluster
C10 DGLMP
Starter switch ON power supply
B14 OD
Overdrive switch
OD OFF
B19 ATLMP
T/MOIL TEMP
A12 SP1
Pulse divider
25P OUT
Vehicle speed sensor
C7 NE+
Engine speed signal
C3 EXBK CUT
Starter switch ON power supply
Exhaust brake cut relay
A22 EXBK
Neutral switch
B24 VA
Throttle opening signal
Starter switch ON power supply
Hydraulic unit
(Anti-lock brake system electronic control unit)
A27 ABS
ABS exhaust brake cut relay
Exhaust brake switch
Engine electronic control unit
B20 CAN1H
B21 CAN1L
CANL
CANH
Controller area network resister
C13 SDG
Multi-Use Tester connector
Idle up inhibit signal
B13 DG
Diagnosis switch
B10 MCLR
Memory clear switch
A
B
C
A:CY31A
B:CY24A
C:CY17A
P58460E-2

1. Diagnosis Procedure

- The system can be efficiently inspected for faults using the MUT.
  There are two ways to troubleshoot this system, as shown below: (1) starting with the symptom; (2) starting with the diagnosis code.
  - Check each diagnosis code in the memory of the TCU.
  - Respond to the symptom.



2. Diagnostic Precautions

- Before measuring voltage, check the battery charge and specific gravity. If this inspection is performed with the battery uncharged or reduced in specific gravity, To obtain accurate measurements, the battery must be fully charged and the specific gravity must be within specifications.
- To avoid damage to electrical parts, disconnect all electrical loads. Make sure the ignition switch and the headlight switch are turned off before disconnecting and reconnecting the battery cables.
- Before disconnecting the batteries, set the ignition switch to LOCK or OFF, and wait at least 20 seconds. Voltage may remain in electrical components or connected circuits.
- When performing measurements with the tester, handle the test bar carefully so that it does not damage internal circuits or other electrical parts of the TCU, cause terminals to short-circuit, between connectors or between a connector and the vehicle chassis.
- Resistance is affected by temperature. Use the temperature specifications given as a guide. Under most conditions, resistance values given for normal temperatures of 50 to 95°F (10 to 35°C) will apply.

3. Inspections Based on Diagnosis Codes

3.1 List of diagnosis codes

NOTE

- **The Multi-Use Tester (MUT) uses different diagnosis codes from those obtained by flashing the diagnostic light (transmission warning light).**
- **The MUT is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
–	Normal	01
P0078	EXH Brake Cut Signal	54
P0500	Vehicle Speed Sensor	12
P0562	Power Supply Voltage	11
P0705	Shift Position SW	43
P0706	Oil Pressure SW8	44
P0710	Oil Temperature Sensor “OP”	13
P0715	Input/Turbine Speed Sensor	16
P0720	Output Speed Sensor	25
P0725	Engine Speed Sensor	15
P0730	Incorrect Gear Ratio	37
P0746	Oil Pressure SW1	41
P0748	Linear Solenoid Valve1	26
P0751	Oil Pressure SW3	45
P0756	Oil Pressure SW4	46
P0761	Oil Pressure SW5 or SW6	47
P0776	Oil Pressure SW2	42

Code	Message	Flashes
P0778	Linear Solenoid Valve2	27
P0796	Oil Pressure SW7	48
P0863	Can Communication	88
P0973	Shift Solenoid1-Low	31
P0974	Shift Solenoid1-High	31
P0976	Shift Solenoid2-Low	32
P0977	Shift Solenoid2-High	32
P0979	Shift Solenoid3-Low	33
P0980	Shift Solenoid3-High	33
P0985	Shift Solenoid4-Low	52
P0986	Shift Solenoid4-High	52
P1604	Accel Sensor	24
P1911	PTO Solenoid-Low	51
P2716	Linear Solenoid Valve4	34
P2740	Oil Temperature Sensor “TC”	17
P2757	Lockup Clutch	61
P2759	Linear Solenoid Valve3	35

3.2 Diagnosis code generation conditions and inspection items

P0078: EXH Brake Cut Signal (diagnostic light flashes: 54)

Generation condition		Exhaust brake operation signal input occurs during exhaust brake cut signal output.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		Braking force control is inhibited.
Inspection	Service data	54: Exh Brake Cut SIG
	Electrical equipment	#201: Exhaust brake cut relay
	Electric circuit diagram	Exhaust brake cut relay system

P0500: Vehicle Speed Sensor (diagnostic light flashes: 12)

Generation condition		Input from vehicle speed sensor is missing while output speed sensor is broadcasting.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		Normal control is effected using output speed sensor.
Inspection	Service data	12: VEH Speed1
	Electronic control unit connector	01: Vehicle speed sensor
	Electric circuit diagram	Vehicle speed sensor system (between vehicle speed sensor, pulse divider, and electronic control unit)
	Other	Vehicle speed sensor (see Gr54)

P0562: Power Supply Voltage (diagnostic light flashes: 11)

Generation condition		Engine speed does not become 0 rpm within 15s after ignition switch has been placed in OFF position.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		Shift solenoid 3 and linear solenoid 2 are turned OFF to maintain driveability. (Fixed to 3rd)
Inspection	Electronic control unit connector	02: Power supply voltage of electronic control unit
	Electric circuit diagram	Ignition switch ON power supply system
	Other	Ignition switch (see Gr54)

P0705: Shift Position SW (diagnostic light flashes: 43)

Generation condition		No signal exists; or duplicate signals exist from inhibitor switch.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		<No signal exists.> • If oil pressure switch 8 is ON, range signal that existed before signal disappeared is recognized and the gear is fixed to 3rd in forward driving. • If oil pressure switch 8 has been OFF for 2 seconds, N range is selected. <Duplicate signals exist.> • Solenoid pattern is fixed; shift selector operation yields R, N, and 3rd gear.
Inspection	Service data	19: P Pos. SW, 20: R Pos. SW, 21: N Pos. SW, 22: D Pos. SW, 24: 3 Pos. SW, 55: Selector Pos., 78: 2 Pos. SW, 79: L Pos. SW
	Electronic control unit connector	03: Inhibitor switch
	Electrical equipment	#159: Inhibitor switch
	Electric circuit diagram	Inhibitor switch system

P0706: Oil Pressure SW8 (diagnostic light flashes: 44)

Generation condition		Input from oil pressure switch 8 (feedback) is inconsistent with inhibitor switch output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		Refer to inhibitor switch failsafe control.
Inspection	Service data	68: Oil Press SW8
	Electronic control unit connector	04: Oil pressure switch 8
	Electrical equipment	#140: Oil pressure switch 8
	Electric circuit diagram	Oil pressure switch 8 system

P0710: Oil Temperature Sensor "OP" (diagnostic light flashes: 13)

Generation condition		Resistance of oil temperature sensor (inside) is out of specified range.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		• Control is effected on basis of low oil temperature for 5 minutes after ignition switch has been placed in ON position. • Braking force control is inhibited
Inspection	Service data	13: A/T Oil Temp (OP)
	Electronic control unit connector	05: Oil temperature sensor (inside)
	Electrical equipment	#312: Oil temperature sensor (inside)
	Electric circuit diagram	Oil temperature sensor (inside) system

P0715: Input/Turbine Speed Sensor (diagnostic light flashes: 16)

Generation condition		Turbine speed sensor pulse input is missing during vehicle operation.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		• Shift control and garage control are effected on open-loop basis. • Lockup control and braking force control is inhibited.
Inspection	Service data	16: Turbine Speed
	Electrical equipment	#293: Turbine speed sensor
	Electric circuit diagram	Turbine speed sensor system

P0720: Output Speed Sensor (diagnostic light flashes: 25)

Generation condition		Output speed sensor pulse input is missing during vehicle speed sensor pulse output.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		• Control is effected using vehicle speed sensor. • Shift control and garage control are effected on open-loop basis. • Braking force control is inhibited.
Inspection	Service data	25: VEH Speed 2
	Electrical equipment	#293: Output speed sensor
	Electric circuit diagram	Output speed sensor system

P0725: Engine Speed Sensor (diagnostic light flashes: 15)

Generation condition		Pulse input from engine speed sensor is missing.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		• Control is performed based on the specified engine speed. (Specified engine speed varies by the types of the control.) • Lockup control and braking force control is inhibited.
Inspection	Service data	15: Engine Speed
	Electric circuit diagram	Engine ECU (engine speed signal)
	Other	Engine speed sensor (see Gr13E)

P0730: Incorrect Gear Ratio (diagnostic light flashes: 37)

Generation condition		Relationship between engine speed and vehicle speed in each gear is incorrect.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• PL linear solenoid is turned OFF. (Line pressure becomes maximum.) • Gear ratio is fixed.
Inspection	Service data	16: Turbine Speed, 25: VEH Speed2, 31: Shift Valve1, 32: Shift Valve2, 33: Shift Valve3, 56: Gear Pos, 61: Oil Press SW1, 62: Oil Press SW2, 63: Oil Press SW3, 64: Oil Press SW4, 65: Oil Press SW5, 66: Oil Press SW6.
	Other	Replace the transmission.

P0746: Oil Pressure SW1 (diagnostic light flashes: 41)

Generation condition		Input from oil pressure switch 1 (feedback) is inconsistent with linear solenoid 1 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	61: Oil Press SW1
	Electronic control unit connector	04: Oil pressure switch 1
	Electrical equipment	#140: Oil pressure switch 1
	Electric circuit diagram	Oil pressure switch 1 system

P0748: Linear Solenoid Valve1 (diagnostic light flashes: 26)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of linear solenoid 1.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	26: Linear Sol Press1
	Electronic control unit connector	06: Linear solenoid 1
	Electrical equipment	#585: Linear solenoid 1
	Electric circuit diagram	Linear solenoid 1 system

P0751: Oil Pressure SW3 (diagnostic light flashes: 45)

Generation condition		Input from oil pressure switch 3 (feedback) is inconsistent with shift solenoid 1 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	63: Oil Press SW3
	Electronic control unit connector	04: Oil pressure switch 3
	Electrical equipment	#140: Oil pressure switch 3
	Electric circuit diagram	Oil pressure switch 3 system

P0756: Oil Pressure SW4 (diagnostic light flashes: 46)

Generation condition		Input from oil pressure switch 4 (feedback) is inconsistent with shift solenoid 2 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	64: Oil Press SW4
	Electronic control unit connector	04: Oil pressure switch 4
	Electrical equipment	#140: Oil pressure switch 4
	Electric circuit diagram	Oil pressure switch 4 system

P0761: Oil Pressure SW5 or SW6 (diagnostic light flashes: 47)

Generation condition		Input from oil pressure switch 5 or 6 (feedback) is inconsistent with shift solenoid 3 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lock up is turned OFF. • Gear ratio is fixed.
Inspection	Service data	65: Oil Press SW5, 66: Oil Press SW6
	Electronic control unit connector	04: Oil pressure switches 5 and 6
	Electrical equipment	#140: Oil pressure switches 5 and 6
	Electric circuit diagram	Oil pressure switches 5 and 6 system

P0776: Oil Pressure SW2 (diagnostic light flashes: 42)

Generation condition		Input from oil pressure switch 2 (feedback) is inconsistent with linear solenoid 2 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	62: Oil Press SW2
	Electronic control unit connector	04: Oil pressure switch 2
	Electrical equipment	#140: Oil pressure switch 2
	Electric circuit diagram	Oil pressure switch 2 system

P0778: Linear Solenoid Valve2 (diagnostic light flashes: 27)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of linear solenoid 2.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	27: Linear Sol Press 2
	Electronic control unit connector	06: Linear solenoid 2
	Electrical equipment	#585: Linear solenoid 2
	Electric circuit diagram	Linear solenoid 2 system

P0796: Oil Pressure SW7 (diagnostic light flashes: 48)

Generation condition		Input from oil pressure switch 7 (feedback) is inconsistent with linear solenoid 3 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		Faulty solenoid is turned OFF.
Inspection	Service data	67: Oil Press SW7
	Electronic control unit connector	04: Oil pressure switch 7
	Electrical equipment	#140: Oil pressure switch 7
	Electric circuit diagram	Oil pressure switch 7 system

P0863: CAN Communication (diagnostic light flashes: 88)

Generation condition		Data check abnormality
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Inspection	Electronic control unit connector	⓫⓬: Controller area network resistor
	Electric circuit diagram	Controller area network resistor line

P0973: Shift Solenoid1-Low (diagnostic light flashes: 31)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 1.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	31: Shift Valve 1, 71: Shift Valve Press 1
	Electronic control unit connector	⓫⓪: Shift solenoid 1
	Electrical equipment	#585: Shift solenoid 1
	Electric circuit diagram	Shift solenoid 1 system

P0974: Shift Solenoid1-High (diagnostic light flashes: 31)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 1.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	31: Shift Valve 1, 71: Shift Valve Press 1
	Electronic control unit connector	⓫⓪: Shift solenoid 1
	Electrical equipment	#585: Shift solenoid 1
	Electric circuit diagram	Shift solenoid 1 system

P0976: Shift Solenoid2-Low (diagnostic light flashes: 32)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 2.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	32: Shift Valve 2, 72: Shift Valve Press 2
	Electronic control unit connector	⓫⓪: Shift solenoid 2
	Electrical equipment	#585: Shift solenoid 2
	Electric circuit diagram	Shift solenoid 2 system

P0977: Shift Solenoid2-High (diagnostic light flashes: 32)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 2.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	32: Shift Valve 2, 72: Shift Valve Press 2
	Electronic control unit connector	06: Shift solenoid 2
	Electrical equipment	#585: Shift solenoid 2
	Electric circuit diagram	Shift solenoid 2 system

P0979: Shift Solenoid3-Low (diagnostic light flashes: 33)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 3.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	33: Shift Valve 3, 73: Shift Valve Press 3
	Electronic control unit connector	06: Shift solenoid 3
	Electrical equipment	#585: Shift solenoid 3
	Electric circuit diagram	Shift solenoid 3 system

P0980: Shift Solenoid3-High (diagnostic light flashes: 33)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 3.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	33: Shift Valve 3, 73: Shift Valve Press 3
	Electronic control unit connector	06: Shift solenoid 3
	Electrical equipment	#585: Shift solenoid 3
	Electric circuit diagram	Shift solenoid 3 system

P0985: Shift Solenoid4-Low (diagnostic light flashes: 52)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of gain change solenoid.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		Request is made to engine ECU to omit output.
Inspection	Service data	52: Shift Valve 4, 74: Shift Valve Press 4
	Electronic control unit connector	06: Gain change solenoid
	Electrical equipment	#585: Gain change solenoid
	Electric circuit diagram	Gain change solenoid system

P0986: Shift Solenoid4-High (diagnostic light flashes: 52)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of gain change solenoid.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		Request is made to engine ECU to omit output.
Inspection	Service data	52: Shift Valve 4, 74: Shift Valve Press 4
	Electronic control unit connector	06: Gain change solenoid
	Electrical equipment	#585: Gain change solenoid
	Electric circuit diagram	Gain change solenoid system

P1604: Accel Sensor (diagnostic light flashes: 24)

Generation condition		Abnormal throttle opening signal
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		• Oil pressure is controlled on basis of throttle opening of 100%. • Shift point is controlled on basis of throttle opening of 0%. • Braking force control is inhibited.
Inspection	Service data	58: Accel Percent
	Electric circuit diagram	Engine ECU (throttle opening signal system)
	Other	Accelerator pedal position sensor (See Gr13E.)

P1911: PTO Solenoid-Low (diagnostic light flashes: 51)

Generation condition		PTO M/V short circuit is detected.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		PTO M/V is turned OFF (PTO inoperative)
Inspection	Service data	50: PTO Valve
	Electric circuit diagram	PTO M/V system
	Other	PTO M/V (See Gr54.)

P2716: Linear Solenoid Valve4 (diagnostic light flashes: 34)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of PL linear solenoid.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		Faulty solenoid is turned OFF. (Line pressure rises to max.)
Inspection	Service data	34: Linear Sol Press4
	Electronic control unit connector	06: PL linear solenoid
	Electrical equipment	#585: PL linear solenoid
	Electric circuit diagram	PL linear solenoid system

P2740: Oil Pressure Sensor "TC" (diagnostic light flashes: 17)

Generation condition		Resistance of oil pressure sensor (outside) is out of specified range.
Recoverability		System recovers if signal becomes normal with ignition switch in ON position.
Control effected by electronic control unit		• Control is effected on basis of oil temperature of 80°C {175°F}. • Braking force control is inhibited.
Inspection	Service data	17: A/T Oil Temp (TC)
	Electronic control unit connector	05: Oil temperature sensor (outside)
	Electrical equipment	#312: Oil temperature sensor (outside)
	Electric circuit diagram	Oil temperature sensor (outside) system

P2757: Lockup Clutch (diagnostic light flashes: 61)

Generation condition		During lockup, engine speed and turbine speed do not match.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		Lockup is turned OFF.
Inspection	Service data	15: Engine Speed, 16: Turbine Speed
	Other	Replace the transmission.

P2759: Linear Solenoid Valve3 (diagnostic light flashes: 35)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of linear solenoid 3.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when ignition switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Gear ratio is fixed.
Inspection	Service data	35: Linear Sol Press3
	Electronic control unit connector	06: Linear solenoid 3
	Electrical equipment	#585: Linear solenoid 3
	Electric circuit diagram	Linear solenoid 3 system

4. Multi-Use Tester Service Data

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
12	VEH Speed 1	■■■. ■MPH	Vehicle being driven	Value corresponds to speedometer indication.
13	A/T Oil Temp (OP)	■■■° F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
15	Engine Speed	■■■■rpm	Racing (engine running)	Value corresponds to tachometer indication.
16	Input/Turbine Speed	■■■■rpm	Vehicle stationary with shift lever in D position	0 rpm
			Vehicle driven from above mentioned condition	Value increases.
17	A/T Oil Temp (TC)	■■■° F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
19	P Pos. SW	ON/OFF	Shift lever in P position	ON
			Shift lever in position except P	OFF
20	R Pos. SW	ON/OFF	Shift lever in R position	ON
			Shift lever in position except R	OFF
21	N Pos. SW	ON/OFF	Shift lever in N position	ON
			Shift lever in position except N	OFF
22	D Pos. SW	ON/OFF	Shift lever in D position	ON
			Shift lever in position except D	OFF
24	3 Pos. SW	ON/OFF	Shift lever in 3 position	ON
			Shift lever in position except 3	OFF
25	VEH Speed 2	■■■. ■MPH	Vehicle being driven	Value corresponds to speedometer indication.
26	Linear Sol Press 1	■■■. ■lbf/in2	When shifting (1→2, 3→4, 5→6)	Increase
			When shifting (2→3, 4→5)	Decrease
27	Linear Sol Press 2	■■■. ■lbf/in2	When shifting (2→3, 4→5)	Increase
			When shifting (1→2, 3→4, 5→6)	Decrease
28	OD-OFF SW	ON/OFF	Overdrive switch ON	ON
			Overdrive switch OFF	OFF
31	Shift Valve 1	ON/OFF	In 3rd gear and in 4th gear	ON
			In any gear except above	OFF
32	Shift Valve 2	ON/OFF	In 4th gear, in 5th gear and in 6th gear	ON
			In any gear except above	OFF
33	Shift Valve 3	ON/OFF	In 1st gear	ON
			In any gear except above	OFF
34	Linear Sol Press 4	■■■. ■lbf/in2	In R range and 1st gear (large throttle opening)	260 lbf/in2
			In any range/gear except above	100 lbf/in2
35	Linear Sol Press 3	■■■. ■lbf/in2	Shift from N to D	Value changes
			During lockup	100 lbf/in2

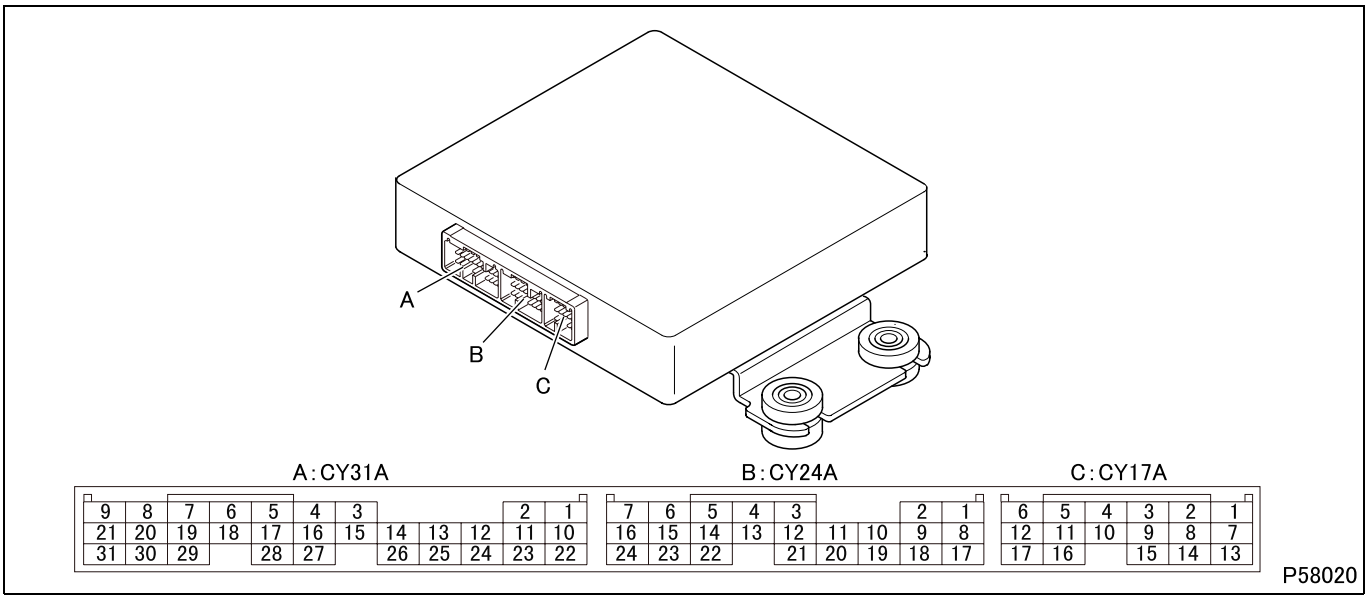
No.	Item	Data	Inspection condition	Requirement
36	Oil Temp Light	ON/OFF	Oil temperature abnormal (excessively high)	ON
			Oil temperature normal	OFF
37	Brake SW	ON/OFF	Brake pedal depressed	ON
			Brake pedal not depressed	OFF
38	Exh. Brake SIG	ON/OFF	Decelerating (engine braking in progress)	ON
			Accelerating	OFF
47	ABS SW	ON/OFF	Anti-lock brake system operating	ON
			Anti-lock brake system not operating	OFF
48	M Clear SW	ON/OFF	Memory clear switch fuse removed	ON
			Memory clear switch fuse fitted	OFF
49	Diagnosis SW	ON/OFF	Diagnosis switch fuse removed	ON
			Diagnosis switch fuse fitted	OFF
50	PTO Valve	ON/OFF	PTO operating (accelerator pedal not depressed; shift lever in P or N position)	ON
			PTO not operating	OFF
52	Shift Valve 4	ON/OFF	In R range (large throttle opening)	ON
			In R range (small throttle opening)	OFF
53	Diagnostic Light	ON/OFF	Warning light illuminated	ON
			Warning light not illuminated	OFF
54	Exh Brake Cut SIG	ON/OFF	Decelerate and stop	OFF → ON
			Accelerating	OFF
55	Selector Pos.	P-Range/R-Range/ N-Range/D-Range/ 3-Range/2-Range	Shift lever in P position	P-Range
			Shift lever in R position	R-Range
			Shift lever in N position	N-Range
			Shift lever in D position	D-Range
			Shift lever in 3 position	3-Range
			Shift lever in 2 position	2-Range
56	Gear Pos.	1ST/2ND/3RD/ 4TH/5TH/6TH/N/R	In 1st gear	1ST
			In 2nd gear	2ND
			In 3rd gear	3RD
			In 4th gear	4TH
			In 5th gear	5TH
			In 6th gear	6TH
			In neutral (shift lever in P or N position)	N
			In reverse	R
58	Accel Percent	■■■%	Accelerator pedal not depressed (throttle fully closed)	0%
			Accelerator pedal depressed (throttle wide open)	100%
61	Oil Press SW1	ON/OFF	In 1st gear, in 2nd gear, in 5th gear and in 6th gear	ON
			In 3rd gear and in 4th gear	OFF

No.	Item	Data	Inspection condition	Requirement
62	Oil Press SW2	ON/OFF	In 1st gear, in 2nd gear and in 3rd gear	ON
			In 4th gear, in 5th gear and in 6th gear	OFF
63	Oil Press SW3	ON/OFF	In 2nd gear, in 3rd gear, in 4th gear, in 5th gear and in 6th gear	ON
			In 1st gear	OFF
64	Oil Press SW4	ON/OFF	In 1st gear, in 3rd gear and in 5th gear	ON
			In 2nd gear, in 4th gear and in 6th gear	OFF
65	Oil Press SW5	ON/OFF	In 1st gear, in 2nd gear, in 4th gear and in 6th gear	ON
			In 3rd gear and in 5th gear	OFF
66	Oil Press SW6	ON/OFF	In 1st gear	ON
			In 2nd gear, in 3rd gear, in 4th gear, 5th gear and in 6th gear	OFF
67	Oil Press SW7	ON/OFF	Shift from N to D	OFF → ON → OFF
68	Oil Press SW8	ON/OFF	In D range	ON
			In P, R, N range	OFF
71	Shift Valve Press 1	HIGH/LOW	In 3rd gear and in 4th gear	HIGH
			In any gear except above	LOW
72	Shift Valve Press 2	HIGH/LOW	In 4th gear, in 5th gear and 6th gear	HIGH
			In any gear except above	LOW
73	Shift Valve Press 3	HIGH/LOW	In 1 gear	HIGH
			In any gear except above	LOW
74	Shift Valve Press 4	HIGH/LOW	In R range (large throttle opening)	HIGH
			In R range (small throttle opening)	LOW
78	2 Pos. SW	ON/OFF	Shift lever in 2 position	ON
			Shift lever in position except 2	OFF
79	L Pos. SW	ON/OFF	All times	OFF

5. Inspections Performed at Electronic Control Unit Connectors

- These inspections allow you to check whether TCU signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black numbers (**01**, **02**, etc.) correspond to the similarly printed reference number in section "**3. Inspections are based on diagnosis codes**".

5.1 TCU connector terminal layout



5.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors attached. Observe the following cautions:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
01 Voltage of vehicle speed sensor	[Conditions] • ignition switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) • Slowly rotate the wheels using a chassis dynamometer, etc. [Requirements] Terminals (+)-(–): A12-B8 • Hi: Approx. 8V • Lo: 0.5V or lower
02 Power supply voltage of electronic control unit	[Conditions] • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] <Power supply directly from the battery> Terminals (+)-(–): B7-B8: 12V <ignition switch ON power> Terminals (+)-(–): B4-B8, B3-B17 • ignition switch OFF: 0V • ignition switch ON: 12V

Check item	Measurement method
⓪③ Voltage of inhibitor switch	[Conditions] • ignition switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] <P range system> Terminals (+)-(–): A20-B8 • P range: 12V • Ranges except P: 0V <R range system> Terminals (+)-(–): A30-B8 • R range: 12V • Ranges except R: 0V <N range system> Terminals (+)-(–): A29-B8 • N range: 12V • Ranges except N: 0V <D range system> Terminals (+)-(–): A19-B8 • D range: 12V • Ranges except D: 0V <3 range system> Terminals (+)-(–): A18-B8 • 3 range: 12V • Ranges except 3: 0V <2 range system> Terminals (+)-(–): A17-B8 • 2 range: 12V • Ranges except 2: 0V
⓪④ Continuity of oil pressure switch	[Conditions] • ignition switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: C6-chassis ground (oil pressure switch 1) C12-chassis ground (oil pressure switch 2) C17-chassis ground (oil pressure switch 3) C5-chassis ground (oil pressure switch 4) C11-chassis ground (oil pressure switch 5) C16-chassis ground (oil pressure switch 6) A11-chassis ground (oil pressure switch 7) A26-chassis ground (oil pressure switch 8) • No continuity
⓪⑤ Resistance of oil temperature sensors	<Oil temperature sensor (inside)> [Conditions] • ignition switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B15-A28 • 10°C {50° F}: 6445 ± 645 Ω • 110°C {230° F}: 247 ± 16 Ω <Oil temperature sensor (outside)> [Conditions] • ignition switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B16-A28 • 120°C {250° F}: 585 to 645 Ω • 145°C {295° F}: 340 to 375 Ω

Check item	Measurement method
06 Resistance of solenoids	[Conditions] • ignition switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A1-chassis ground (shift solenoid 1): 13 ± 2 Ω A2-chassis ground (shift solenoid 2): 13 ± 2 Ω A3-chassis ground (shift solenoid 3): 13 ± 2 Ω B5-chassis ground (gain change solenoid): 13 ± 2 Ω A9-A8 (linear solenoid 1): 5.5 ± 0.5 Ω A7-A6 (linear solenoid 2): 5.5 ± 0.5 Ω A5-A4 (linear solenoid 3): 5.5 ± 0.5 Ω A21-A31 (PL linear solenoid): 5.5 ± 0.5 Ω
07 Resistance of Controller area network resistor	[Conditions] • ignition switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B20-B21: 120 ± 6 Ω

6. Likely Causes of Symptoms

Symptom / Likely source of problem	Unexpected movement						Improper shifting					
	Vehicle can be driven in N range.	Transmission stays in P range when lever is moved out of P position.	Vehicle moves with lever in P position.	Vehicle does not move in any range.	Vehicle does not move in R range.	Vehicle does not move in D, 3, and 2 ranges.	Lockup point is excessively high or low.	Lockup does not occur.	Engine braking does not occur in 3 range.	Engine braking does not occur in 2 range.	Kickdown does not occur.	Shift point is excessively high or low.
Automatic transmission fluid level and condition				O	O	O						
Automatic transmission control	O	O	O	O		O						
Inhibitor switch (neutral start switch)									O	O		
Throttle opening signal							O	O	O	O	O	O
Input/Turbine speed sensor								O				
Output speed sensor							O	O	O	O	O	O
Engine speed signal								O				
Linear solenoid 1											O	
Linear solenoid 2											O	
Linear solenoid 3				O	O	O	O	O				
Shift solenoid 1											O	
Shift solenoid 2				O	O	O					O	
Shift solenoid 3								O			O	
TCU							O	O	O	O	O	O
Torque converter				O	O	O		O				
Automatic transmission-main section	O	O	O	O	O	O	O	O	O	O	O	

Symptom / Likely source of problem	Improper shifting													
	Downshifts from 6th gear to 5th gear do not take place.	Downshifts from 5th gear to 4th gear do not take place.	Downshifts from 4th gear to 3rd gear do not take place.	Downshifts from 3rd gear to 2nd gear do not take place.	Downshifts from 2nd gear to 1st gear do not take place.	Upshifts from 5th gear to 6th gear do not take place.	Upshifts from 4th gear to 5th gear do not take place.	Upshifts from 3rd gear to 4th gear do not take place.	Upshifts from 2nd gear to 3rd gear do not take place.	Upshifts from 1st gear to 2nd gear do not take place.	Engine revs during shifts from 2nd gear to 3rd gear.	Engine revs during shifts from 3rd gear to 4th gear.	Engine revs during shifts from 4th gear to 5th gear.	Engine revs during shifts from 5th gear to 6th gear.
Inhibitor switch (neutral start switch)								O	O					
Throttle opening signal											O	O	O	O
Vehicle speed sensor	O	O	O	O	O	O	O	O	O	O				
Engine speed sensor											O	O	O	O
Linear solenoid 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Linear solenoid 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Shift solenoid 1	O	O	O	O	O	O	O	O	O	O				
Shift solenoid 2	O	O	O	O	O	O	O	O	O	O				
Shift solenoid 3	O	O	O	O	O	O	O	O	O	O				
Oil pressure switch 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Oil pressure switch 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Oil pressure switch 3	O	O	O	O	O	O	O	O	O	O				
Oil pressure switch 4	O	O	O	O	O	O	O	O	O	O				
Oil pressure switch 5	O	O	O	O	O	O	O	O	O	O				
Oil pressure switch 6	O	O	O	O	O	O	O	O	O	O				
Overdrive lockout switch						O	O							
TCU	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Automatic transmission-main section	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Symptom / Likely source of problem	Excessive shift shock													
	During lockup	During shifts from 6th gear to 5th gear	During shifts from 5th gear to 4th gear	During shifts from 4th gear to 3rd gear	During shifts from 3rd gear to 2nd gear	During shifts from 2nd gear to 1st gear	During shifts from 5th gear to 6th gear	During shifts from 4th gear to 5th gear	During shifts from 3rd gear to 4th gear	During shifts from 2nd gear to 3rd gear	During shifts from 1st gear to 2nd gear	During shifts from N range to R range and from N range to D range	During shifts from N range to R range	During shifts from N range to D range
Throttle opening signal	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Input/Turbine speed sensor	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Engine speed sensor	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Linear solenoid 1		O	O	O	O	O	O	O	O	O	O			
Linear solenoid 2		O	O	O	O		O	O	O					
Linear solenoid 3	O											O	O	O
Oil pressure switch 1											O			
TCU	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Torque converter	O													
Automatic transmission-main section	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Symptom / Likely source of problem	Clutch slippage, judder							Other				
	In 6th gear	In 5th gear	In 4th gear	In 3rd gear	In 2nd gear	In 1st gear	In R range	During forward movement and during reverse movement	Transmission overheats; oil emerges from breather.	Engine stalls when R, D, or 3, 2 range is selected or when vehicle is stationary.	Engine can be started in range except N and P.	Engine cannot be started in N and P ranges.
Automatic transmission fluid level and condition									O			
Control linkage											O	O
Inhibitor switch (neutral start switch)											O	O
Throttle opening signal	O	O	O	O	O	O	O	O				
Input/Turbine speed sensor	O	O	O	O	O	O	O	O				
Linear solenoid 1	O	O	O	O	O							
Linear solenoid 2	O	O	O	O	O		O	O				
Linear solenoid 3						O	O	O		O		
PL linear solenoid	O	O	O	O	O	O	O	O	O			
Shift solenoid 3										O		
Gain change solenoid	O	O	O	O	O	O	O	O				
TCU	O	O	O	O	O	O	O	O	O			
Torque converter									O	O		
Automatic transmission-main section	O	O	O	O	O	O	O	O	O	O		

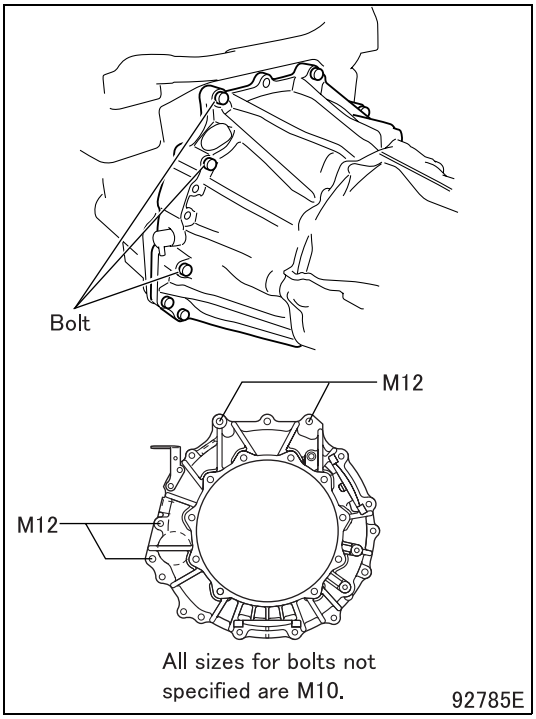
M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection of Transmission Mounting Bolts

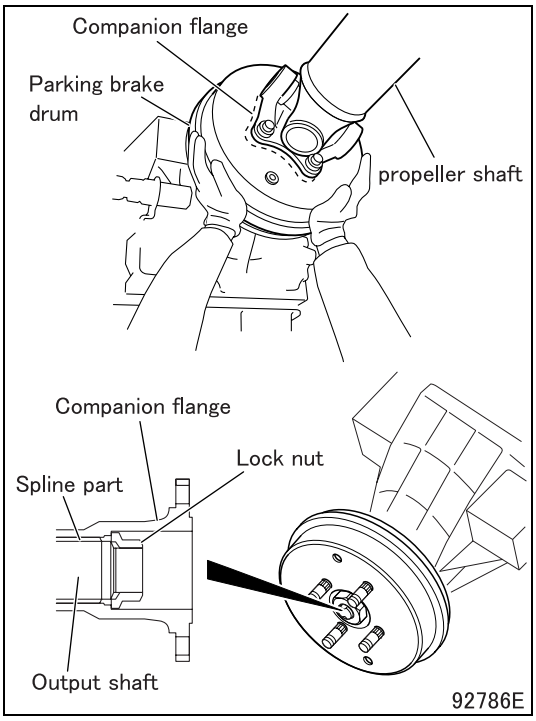
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
–	Bolt (automatic transmission mounting)	47 {35, 4.8}	M10
		82 {60, 8.4}	M12



- Check the transmission mounting bolts for tightness.
- If any are loose, tighten them to the specified torque.

2. Inspection of the Companion Flange and Lock Nut



- Move the parking brake drum or companion flange in axial and vertical directions to check for excessive play between the companion flange and output shaft.
- If excessive play is detected, remove the propeller shaft. Check the lock nut for looseness and the splines on the companion flange and output shaft for damage.
- If the companion flange is found to be damaged, replace it. (See under the heading “REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION.”)
- If no damage is found on the companion flange, replace the output shaft.

3. Stall Test

Service standards

ID	Maintenance item	Standard value	Limit	Remedy
–	Stall speed	1850 to 2150 rpm	–	Inspection

3.1 Purpose of the stall test

- The stall test is performed to check for slippage of the frictional elements in the transmission and of the one-way clutch in the torque converter. It gives an indication of the torque converter's operating condition and of the engine's overall performance.

3.2 Test procedure

- Before performing a stall test, check the engine coolant, engine oil, and automatic transmission fluid levels. Allow the engine and transmission to warm up.
- To prevent the vehicle from moving, set the parking brake and place chocks both fore and aft on the front and rear wheels.
- Start the engine and move the shift selector to the D position.
- Hold down the brake pedal firmly while depressing the accelerator pedal during the test.
- Gradually depress the accelerator pedal until it reaches the end of its stroke. When the engine speed stabilizes, promptly read the engine speed (this is the stall speed) and release the accelerator pedal.

CAUTION ⚠

- **The period during which the accelerator pedal is fully depressed must be shorter than 5 seconds. Complete the measurement within this period.**
- **If the engine speed does not stabilize (if the engine speed continues to gradually increase or the engine suddenly revs), immediately stop the test.**

- Move the shift selector to the N position. Allow the engine to cool by running it at 1200 rpm for one minutes or longer.
- Move the shift selector to the R position. Perform the stall test again for the R range.

3.3 Evaluation of test results

Test result	Main causes
Stall speed is lower than standard value in each range.	Engine output is insufficient.
	The one-way clutch in the torque converter is malfunctioning.
Stall speed is higher than standard value in D range.	Clutch No. 1 is slipping.
	The one-way clutch is malfunctioning.
	The line pressure is too low.
Stall speed is higher than standard value in R range.	Clutch No. 3 is slipping.
	Brake No. 2 is slipping.
	The line pressure is too low.

- If problems are found in the automatic transmission unit itself, replace the transmission.

4. Time Lag Test

Service standards

ID	Maintenance item		Standard value	Limit	Remedy
–	Time lag	When shifting from N to D	0.7 sec. or shorter	–	Inspection
		When shifting from N to R	1.2 sec. or shorter		

4.1 Purpose of time lag test

- The time lag test is performed to check the one-way clutch, clutch No. 1, clutch No. 3, and brake No. 2.

4.2 Test procedure

- Allow the engine to run until the ATF reaches normal operating temperature of 120 to 175°F (50 to 80°C).
- Start the engine and check the idle speed.
- Move the shift selector from N to D. Use a stopwatch to measure the time lag between lever motion and shift shock.
- In a similar manner, measure the time lag for the shift from N to R.

4.3 Evaluation of results

Test result	Conceivable cause
Time lag is too long when shifting from N to D.	Line pressure is too low.
	Clutch No. 1 is slipping.
	One-way clutch is malfunctioning.
Time lag is too long when shifting from N to R.	Line pressure is too low.
	Clutch No. 3 is slipping.
	Brake No. 2 is slipping.

- If problems are found in the automatic transmission unit itself, replace the transmission.

5. Line Pressure Test

Service standards

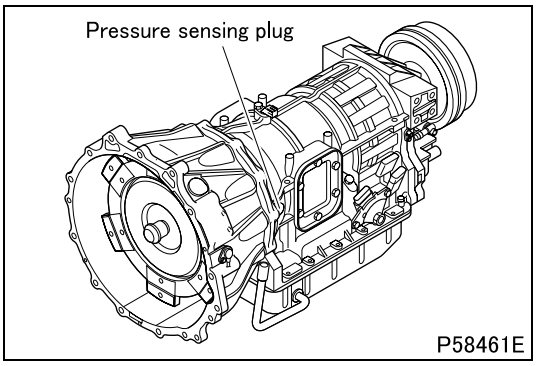
ID	Maintenance item			Standard value	Limit	Remedy
–	Line pressure	At idle speed	D range	560 to 870 kPa {81 to 125 psi, 5.7 to 8.9 kgf/cm^2}	–	Inspect the suspected faulty sections.
			R range			
		At stalling speed	D range	1660 to 2010 kPa {240 to 290 psi, 17 to 20 kgf/cm^2}		
			R range			

Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
–	Pressure sensing plug	27 {20}	1/2-20 UNF

5.1 Purpose of line pressure test

- The line pressure test is performed to check the performance of the oil pump, to check the functionality of the control valve, and to check for oil leaks.



5.2 Test procedure

CAUTION ⚠

- **Two persons are needed to perform the line pressure test. One person backs away from the vehicle and checks the condition of the tires and wheel chocks. The other person performs the test.**

- Set the parking brake. Make sure it is fully applied.
- Chock the front and rear tires.
- Remove the pressure sensing plug and fit the oil pressure gauge.
- Start the engine. Allow the engine to run until the ATF reaches normal operating temperature of 120 to 175°F (50 to 80°C).
- Check the idle speed.
- Depress the brake pedal firmly with your left foot. While holding down the brake pedal, shift to the D range. Then, measure the oil pressure while the engine is idling.
- Fully depress the accelerator pedal. Quickly measure the oil pressure at the stall speed.

CAUTION ⚠

- **If the engine speed does not reach the stall level and the rear wheels start to turn, ease off the accelerator pedal and stop the test.**

- Move the shift selector to the R position. Perform the line pressure test again for the R range.
- If any measured value does not conform to the standard value, locate the possible cause in the following table and correct the problem.

5.3 Locating possible causes

Test result	Conceivable cause
Measured value is higher than standard value in all ranges.	Regulator valve is sticking.
Measured value is lower than standard value in all ranges.	Regulator valve is sticking.
	Oil pump is worn.
Measured value is lower than standard value in D range only.	ATF leak exists in D range system.
	Clutch No. 1 is malfunctioning.
Measured value is lower than standard value in R range only.	ATF leak exists in R range system.
	Clutch No. 3 is malfunctioning.
	Brake No. 2 is malfunctioning.

- After taking the measurements, fit the pressure sensing plug and tighten it to the specified torque value.
- If problems are found in the automatic transmission unit itself, replace the transmission.

6. Road Test

6.1 Test procedure

- Before performing the road test, check the ATF level and condition. Make sure the shift selector cable and accelerator control cable are correctly adjusted.
- During the road test, operate the automatic transmission in each range. Check the shift feel and other changes during shifts.
- Check whether the shift feel gets firmer and softer.
- Check the shift points where upshifts and downshifts occur.
- Check the vehicle speeds at which shifts occur under various driving conditions.
- The data in this table are valid for a differential ratio of 5.285 and to a tire radius of 0.387 m (215/85R16).
- If the differential ratio or tire radius is different, the speeds will be accordingly slower or higher. Adjust the values in the table accordingly.

6.2 Vehicle speeds during shifts (D range) (Unit: Km/h {mph})

Throttle opening of accelerator pedal position	Shift	Vehicle speed
Half open (Accelerator pedal position: 4/8)	1st → 2nd	8 to 10 {4.97 to 6.21}
	2nd → 3rd	23 to 25 {14.3 to 15.5}
	3rd → 4th	36 to 38 {22.4 to 23.6}
	4th → 5th	47 to 49 {29.2 to 30.4}
	5th → 6th	59 to 61 {36.7 to 37.9}
Fully open (Accelerator pedal position: 8/8)	1st → 2nd	15 to 17 {9.32 to 10.6}
	2nd → 3rd	34 to 36 {21.1 to 22.4}
	3rd → 4th	53 to 55 {32.9 to 34.2}
	4th → 5th	73 to 75 {45.4 to 46.6}
	5th → 6th	95 to 96 {59.0 to 59.7}
Fully closed (Accelerator pedal position: 0/8)	1st → 2nd	8 to 10 {4.97 to 6.21}
	2nd → 3rd	18 to 20 {11.2 to 12.4}
	3rd → 4th	28 to 30 {17.4 to 18.6}
	4th → 5th	39 to 41 {24.2 to 25.5}
	5th → 6th	55 to 57 {34.2 to 35.4}

6.3 Vehicle speeds during lockup (Unit: Km/h {mph})

Throttle opening of accelerator pedal position	Shift	Vehicle speed
Half open (Accelerator pedal position: 4/8)	2nd gear ON	15 to 17 {9.32 to 10.6}
	3rd gear ON	23 to 25 {14.3 to 15.5}
	4th gear ON	33 to 35 {20.5 to 21.7}
	5th gear ON	40 to 42 {24.9 to 26.1}
	6th gear ON	49 to 51 {30.4 to 31.7}
Fully open (Accelerator pedal position: 8/8)	2nd gear ON	22 to 24 {13.7 to 14.9}
	3rd gear ON	34 to 36 {21.1 to 22.4}
	4th gear ON	46 to 48 {28.6 to 29.8}
	5th gear ON	60 to 62 {37.3 to 38.5}
	6th gear ON	73 to 75 {45.4 to 46.6}
Fully closed (Accelerator pedal position: 0/8)	2nd gear OFF	14 to 16 {8.70 to 9.94}
	3rd gear OFF	21 to 23 {13.0 to 14.3}
	4th gear OFF	28 to 30 {17.4 to 18.6}
	5th gear OFF	37 to 39 {23.0 to 24.2}
	6th gear OFF	45 to 47 {28.0 to 29.2}

7. Inspection of Automatic Transmission Fluid (ATF)

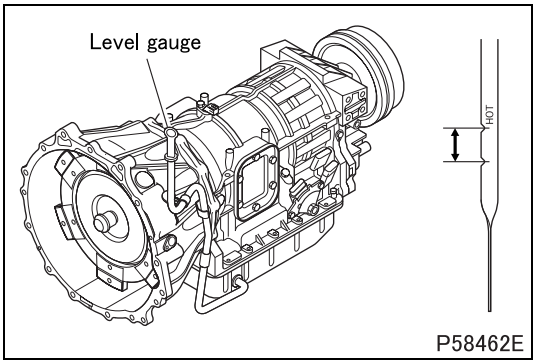
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
–	Automatic transmission	Mobil ATF3309	–

- If the ATF level is too low, the pump can draw in air. Air in the ATF reduces the fluid pressure and can cause the clutches in the automatic transmission to slip.
- If the ATF level is too high, the spinning shafts can agitate it and create a frothy mixture of air and fluid. Air in the ATF reduces the fluid pressure and can cause the clutches in the automatic transmission to slip.
- Whether the ATF level is too low or too high, air bubbles lead to overheating, oxidation of the ATF, and varnish formation. This will impede proper operation of the valves and clutches.
- Air in the ATF can also cause foam to escape from the vent hole and filler tube of the automatic transmission. This phenomenon can be mistaken for ATF leakage.
- Do an accurate check of the ATF level and inspect the condition of the fluid.

7.1 Inspection of automatic transmission fluid condition

- If the automatic transmission fluid smells burned and contains particles of metal and friction material, a complete overhaul of the automatic transmission is necessary. Carefully inspect any ATF that adheres to the dipstick. If you have any doubts about the condition of the automatic transmission fluid, take a sample and perform another inspection.



7.2 Checking the ATF level

- Drive the vehicle until the ATF reaches a temperature of 160 to 175°F (70 to 80°C).
- Stop the vehicle on a level surface, set the parking brake, and chock the front and rear tires. Make sure the parking brake is fully applied.
- With the engine idling, slowly move the shift selector from the P position to each position through L, and then back to P. This will ensure that the hydraulic circuit is filled with automatic transmission fluid.
- With the engine still idling, withdraw the ATF dipstick, wipe it clean, and insert it again. Withdraw the dipstick slowly and check the ATF level.
- The ATF level is acceptable if the gauge reads in the HOT range.

WARNING ⚠

- **With the engine running, vehicle components will be extremely hot and could cause burns.**
- **A moving drive belt can cause a serious injury or loss of life.**

- Be sure to check the ATF level with vehicle parked on a level surface, the engine idling, and the shift selector in N (neutral). If the engine is not running during the inspection, the automatic transmission fluid level will appear higher than it actually is.
- Remove all dirt from the top of the filler tube before withdrawing the level gauge.
- If the ATF level is too low, add approved automatic transmission fluid through the filler tube until the dipstick reads in the HOT range.
- Keep the engine idling until you have finished adjusting the ATF level. Do not increase the engine speed.

CAUTION ⚠

- **To prevent transmission damage, use only approved ATF.**

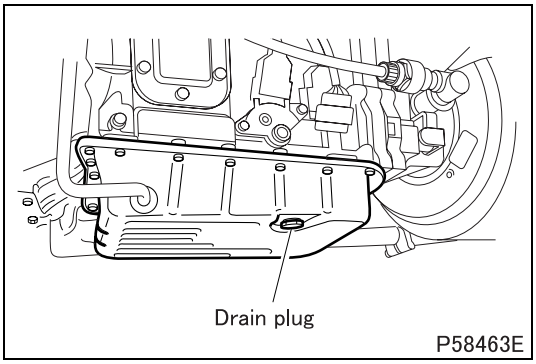
8. Changing ATF

Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
–	Drain plug	27 {20}	–

Lubricant and/or sealant

ID	Points of application		Specified lubricant and/or sealant	Quantity
–	Automatic transmission	Replaced with oil pan removed	Mobil ATF3309	Approx. 8.4 L {8.9 qt}
		Replaced with drain plug removed		Approx. 6.4 L {6.8 its}



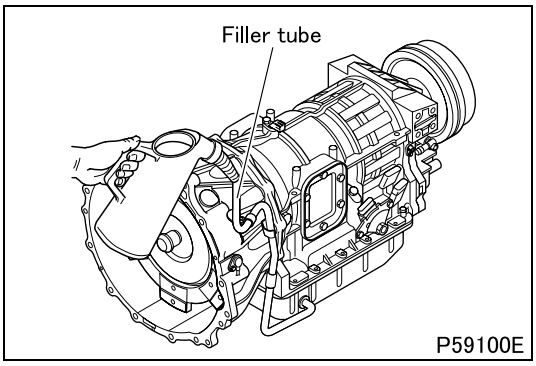
8.1 Draining

- Place a container under the transmission oil pan. Remove the drain plug near the front of the oil pan and allow the ATF to drain out.

CAUTION ⚠

- **ATF is extremely hot immediately after driving. To avoid the risk of burns, wait for the ATF to cool to a safe temperature before starting work.**
- **To prevent transmission damage, inspect the drained ATF for the presence of dirt and metallic particles.**

- Drain the ATF while it is still warm. The ATF drains more quickly when it is warm.
- It is not possible to drain the ATF in the hydraulic circuit, torque converter, and oil cooler.
- At this point, approximately 2 L {2.1 qt} of ATF remains in the oil pan. If you wish to replace this fluid, remove the oil pan.



8.2 Filling

- Obtain a sufficient quantity of new ATF.
- Install the oil pan drain plug and gasket, as removed.
- Add new ATF through the filler tube (dipstick guide tube).

CAUTION ⚠

- **To prevent transmission damage, use only approved ATF.**
- **Do not allow dirt and other foreign matter to enter the transmission.**

- Place the shift selector in P (park). Start the engine and allow it to idle for at least 2 minutes.
- Move the shift selector through each gear position, and then return it to P. Keep the engine idling. Do not rev the engine.
-
- Check the ATF level. Correct the fluid level as needed.

8.3 Fluid leakage

- Check the torque converter housing for fluid leaks. If leakage is found, locate the origin of the leaks.
  - If leaks are found on the torque converter or in the surrounding area, check the color of the fluid.
  - ATF is red in color. This distinguishes it from engine oil.
  - If ATF leaks are found, check carefully for the source of the leaks. Leaks could be coming from the torque converter, the gear case, the oil seal of the oil pump housing, or at the mating surface of the oil pump housing and the gear case.

9. Dealer Adjustment (Calibration)

• What is Dealer Adjustment (Calibration)?

Each automatic transmission has different characteristics. By carrying out steps 1 to 4 of the dealer adjustment (calibration) procedure, the TCU will familiarize itself with the specific characteristics of the automatic transmission that it controls. This will improve the speed and efficiency of gear shifts on each vehicle.

Calibrate the transmission under the following conditions:
- The automatic transmission has been replaced.
- The TCU has been replaced.

NOTE
- **Until the calibration procedure is performed, the ATF temperature warning illuminates.**
- **To ensure safety, chock both the front and rear tires and set the parking brake firmly.**
- **During the calibration process, the clutches will be activated, generating shock loads and/or clutch noise.**
- **When the engine speed is set at 1000 to 1500 rpm during calibration, firmly depress the brake pedal with your left foot.**

9.1 Dealer Adjust (calibration) procedure

- Turn off all electrical loads, including the air conditioner and headlights.
- Ensure that the parking brake is applied firmly and that all tires are chocked.
- Ensure that ATF level is OK.
- Start the engine and run it at idle for 5 minutes for warm-up.
- Move the shift selector form N to D, and from N to R. Repeat this 3 to 5 times.

↓

Enter Calibration Mode
ATF temperature warning flashes (at intervals of 0.2 sec.)

Conditions for entering Calibration Mode
- Diagnosis switch: Open
- Output shaft speed: 0 rpm (vehicle stationary)
- Brake pedal: Depressed
- Automatic transmission fluid temperature: 40 to 100°C {105 to 210°F}
- Engine speed: 500 rpm or above
- Move the lever from D to 3, three times within 10 seconds.

If the ATF temperature warning comes on, this means that the temperature of automatic transmission fluid in the oil pan is too low. Warm up the transmission and try entering Calibration Mode again.

↓

Ensure that the engine speed remains stable within the specified idle speed range.

↓

Prepare for Calibration Steps 1 and 2

Conditions for Calibration Steps 1 and 2
- Shift selector: In D range
- Overdrive lockout switch: ON → OFF (5th and 6th gears disabled)
- Brake pedal: Depressed

NOTE
- **If the vehicle moves after calibration has started, stop the calibration process. While in calibration mode, the ATF temperature warning flashes ON for 2 seconds and then flashes OFF for 1 second, and repeats this cycle. Shut down the engine and try the procedure again from the start.**

↓

(Continued to next page)

(Continued from previous page)

↓

Start Calibration Step 1
ATF temperature warning flashes (intervals: 0.2 sec. → 0.5 sec.)

- Succeeded: ATF temperature warning light flashes (at intervals of 0.2 seconds).
- Failed: ATF temperature warning light comes on steady.

If Calibration Step 1 fails, ensure that the engine is running within the specified idle speed range. Go back to the beginning and prepare to do Calibration Steps 1 and 2 over.

↓

Within 30 sec. from the time when Calibration Step 1 has successfully started, depress the accelerator pedal to maintain the engine speed between 1000 and 1500 rpm.

↓

Start Calibration Step 2
ATF temperature warning continues to flash (at intervals of 0.2 sec.)

Maintain the current conditions (engine running at 1000 to 1500 rpm)

- Succeeded: ATF temperature warning goes out.
- Failed: ATF temperature warning light stays on.

If failed, ensure that the engine is running within the specified idle speed range. Prepare for Adjust Steps 1 and 2 again.

↓

Ensure that the engine speed remains stable within the specified idle speed range.

↓

Prepare for Calibration Steps 3 and 4

Conditions for Calibration Steps 3 and 4

- Shift selector: In R range
- Overdrive switch: ON → OFF (5th and 6th gears disabled)
- Brake pedal: Depressed

↓

Start Calibration Step 3
ATF temperature warning light extinguishes → flashes (at intervals of 0.5 sec.)

- Succeeded: ATF temperature warning light flashes (at intervals of 0.2 sec.)
- Failed: ATF temperature warning light illuminates

If failed, prepare for Calibration Steps 3 and 4 again.

↓

Within 30 seconds of the start of Calibration Step 3, depress the accelerator pedal to maintain the engine speed between 1000 to 1500 rpm.

↓

(Continued to next page)

(Continued from previous page)

↓

Start Calibration Step 4
ATF temperature warning continues to flash (at intervals of 0.2 sec.)

Maintain the current conditions (engine running at 1000 to 1500 rpm)
- Succeeded: ATF temperature warning goes out.
- Failed: When the light has illuminated or extinguished, release the accelerator pedal and return the engine to idle speed.

If failed, prepare for Adjust Steps 3 and 4 again.

↓

End of calibration procedure
ATF temperature warning flashes
(goes out for 2 sec., then comes on for 1 sec., and repeats this cycle)

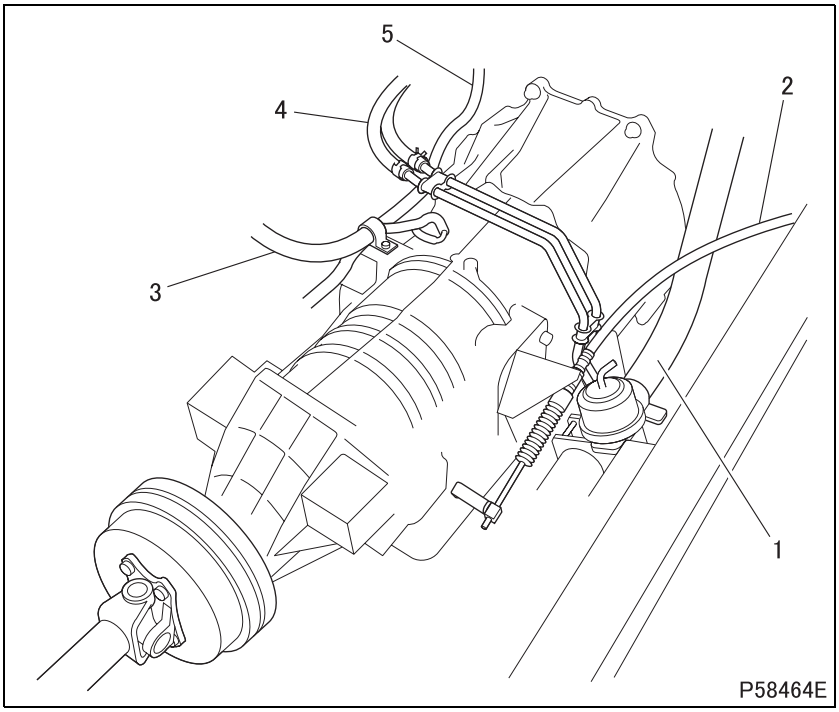
↓

Move the shift selector to P (park).

↓

Shut down the engine. This is the end of the calibration procedure.
The ATF temperature warning goes out.

Preparatory work



● **Removal sequence**

1 Exhaust pipe
2 Selector cable (see later section)
3 Electrical harness
4 ATF cooler hose (see later section)
5 Dipstick filler tube

● **Installation sequence**

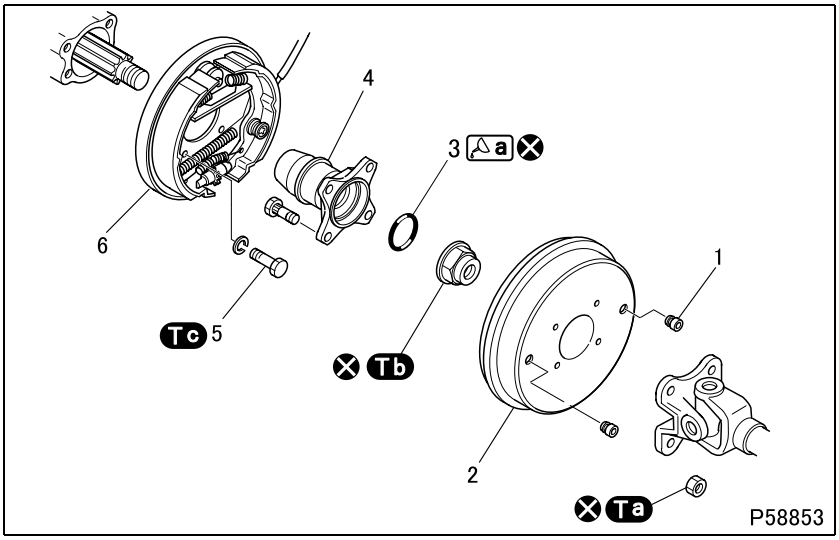
Follow the removal sequence in reverse.

CAUTION ⚠

- **Check the ATF for impurities when you replace the fluid. If bits of metal, metal filings, and other contaminants are found, flush the ATF cooler circuit.**

M E M O

Driveline parking brake



● **Removal sequence**

1 Dust plug
2 Parking brake drum
3 O-ring
4 Companion flange
5 Reamer bolt
6 Parking brake cover (see Gr36)

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After removing the propeller shaft (driveshaft), attach it to the frame up and out of the way. This will to prevent damage to the shaft and prevent the driveline from becoming unbalanced.**
- **Do not allow oil or grease to contaminate the inner surface of the brake drum or on the brake linings. Clean all brake parts thoroughly if contamination occurs.**

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
2	Parking brake drum	Inner diameter	$\phi 190\ ^{+0.2}_{0}$ {$7.48\ ^{+0.0079}_{0}$}	ϕ191 {7.52}	Replace
		Squareness	0.05 {0.0020} or less	–	
		Concentricity	0.1 {0.0039} or less	–	
		Cylindricity	0.05 {0.0020} or less	–	
		Static rotation imbalance	0.0049 N·m {0.004 lbf·ft} or less	–	
4	Runout at socket portion of companion flange		0.15 {0.0059} or less	0.5 {0.020}	

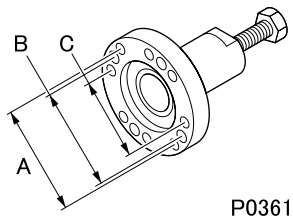
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Nut (propeller shaft mounting)	100 to 120 {74 to 89}	–
Tb	Lock nut (companion flange mounting)	190 {140}	After tightening, crimp at two places.
Tc	Reamer bolt	52 to 66.7 {38 to 49}	–

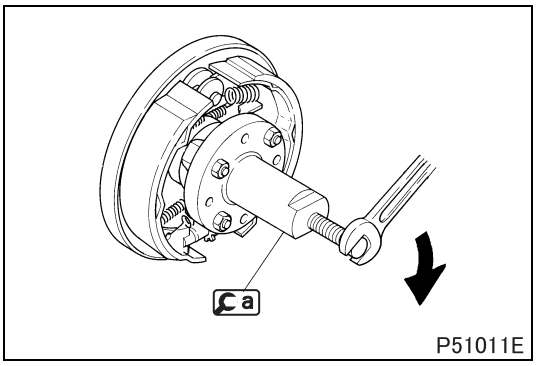
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Mobil ATF3309	As required

Special tools (Unit: mm {in})

ID	Tool name and shape	Part No.	Application
ⓒa	Flange puller A: ϕ95 {3.74} B: ϕ100 {3.94} C: ϕ90 {3.54}  P03618	MH061848	Removal of companion flange

◆Removal procedure◆

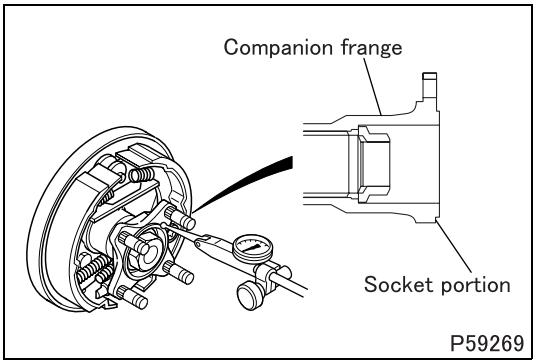


P51011E

■ **Removal: Companion flange**

- Attach the flange puller ⓒa to the companion flange with the propeller shaft mounting nut. Using a socket wrench on the flange puller, ⓒa, remove the companion flange.

◆Work before removal◆

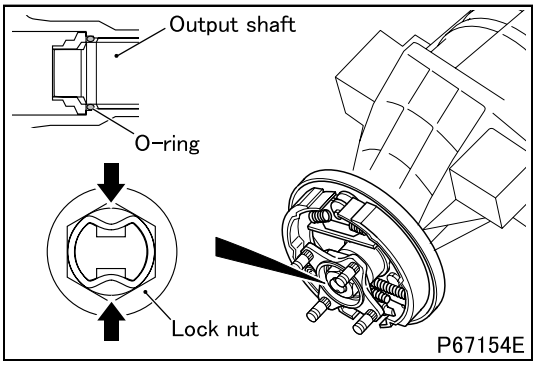


P59269

■ **Inspection: Runout of companion flange**

- Using a dial gauge, measure the runout of the companion flange socket. If the measured valve exceeds the limit, replace the companion flange.

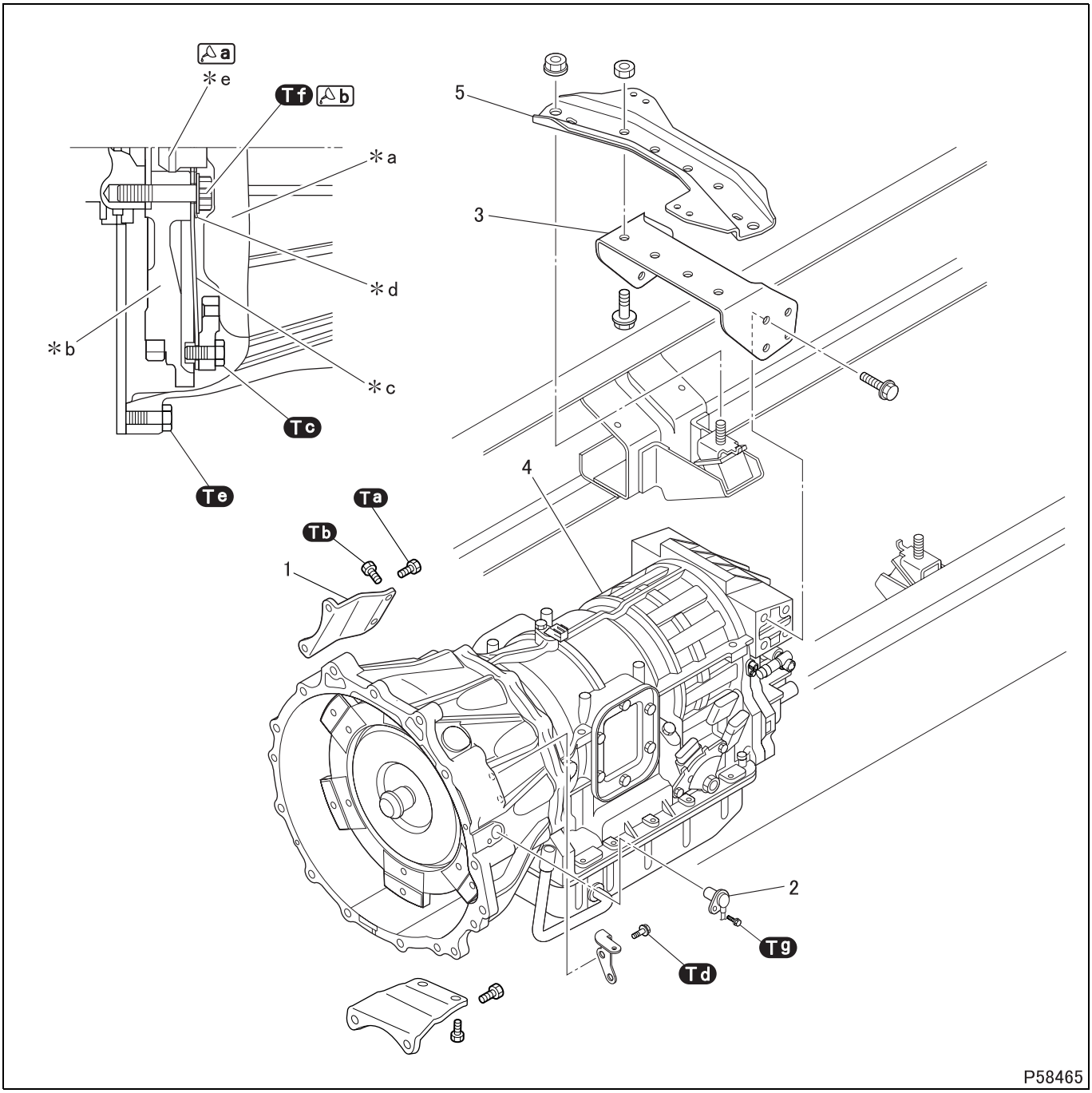
◆Installation procedure◆



P67154E

■ **Inspection: Companion flange**

- Installing the O-ring on the output shaft. Tighten the lock nut to the specified torque and crimp the tabs of the lock nut at two locations.
- Move the parking brake drum or companion flange (1) around in a circle, and (2) up and down. Check for excessive play between the companion flange and output shaft.
- If excessive play is detected, remove the propeller shaft. Check the lock nut for looseness and the splines on companion flange and output shaft for damage.
- If the companion flange is found to be damaged, replace it.
- If no damage is found on the companion flange, replace the output shaft.



● **Removal sequence**

1 Dust cover
2 Engine speed sensor (see Gr13E)
3 Mounting bracket
4 Automatic transmission
5 Mounting support

***a**: Torque converter
***b**: Flywheel
***c**: Drive plate
***d**: Wear plate
***e**: Pilot

● **Installation sequence**

Follow the removal sequence in reverse.

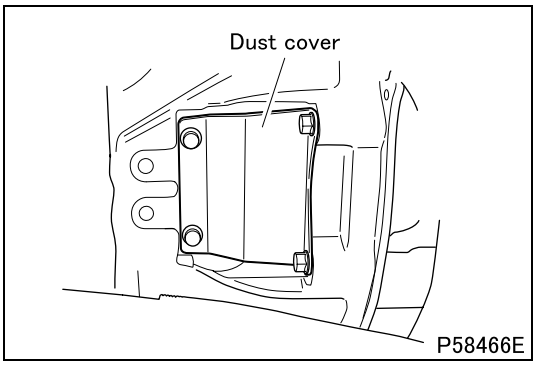
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Bolt (dust cover and automatic transmission mounting)	47 {35}	–
Tb	Bolt (dust cover mounting)	13 {9.6}	–
Tc	Bolt (flywheel and drive plate mounting)	50 {37}	–
Td	Bolt (bracket mounting)	40 {30}	–
Te	Bolt (automatic transmission mounting)	82 {60}	M12
		47 {35}	M10
Tf	Bolt (drive plate mounting)	118 {87} +90°	WET
Tg	Bolt (engine speed sensor mounting)	8 {5.9}	–

Lubricant and/or sealant

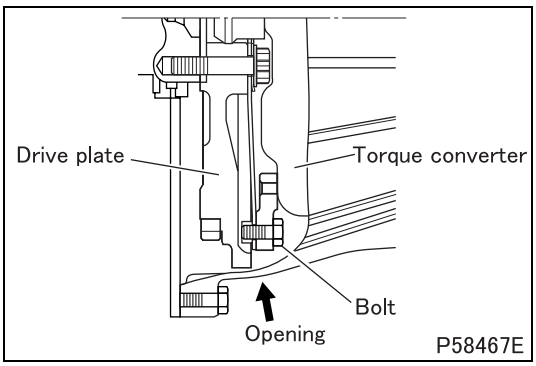
ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Pilot of torque converter	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
b	Bolt threads	Engine oil	As required

◆Removal procedure◆

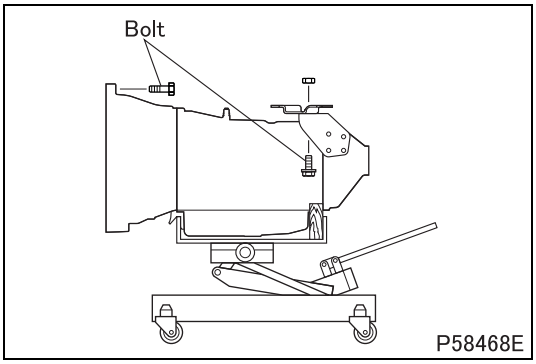


■ **Removal: Automatic transmission**

- Remove the dust cover.



- Crank the engine until one of the drive plate mounting bolts is visible through the opening.
- Remove the bolt that is accessible through the opening. In this way, remove each of the six bolts, cranking the engine to bring each one to the opening in turn.



- Support the automatic transmission with a jack and remove each of the transmission mounting bolts.
- Move the automatic transmission rearward to remove it.

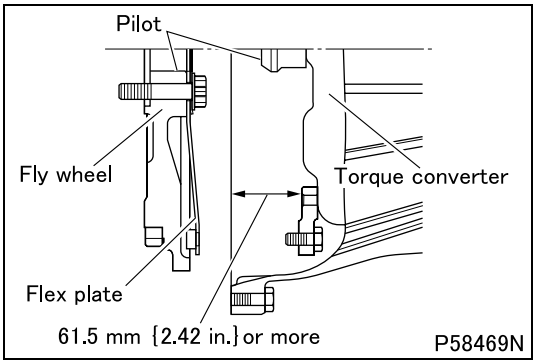
CAUTION ⚠

- **Do not place the jack under the oil pan. The weight of the transmission could damage the oil pan and the oil pan gasket.**
- **Attach a safety strap to the torque converter cover. Do not allow it to drop.**

NOTE

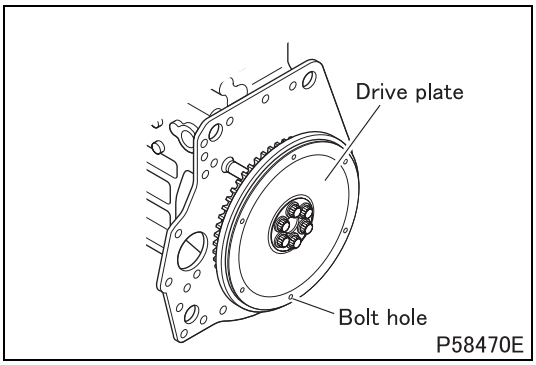
- **The transmission mounting bolts that fasten the automatic transmission to the engine are not all the same length. Make a note of the position of each one as you remove it.**

◆Installation procedure◆

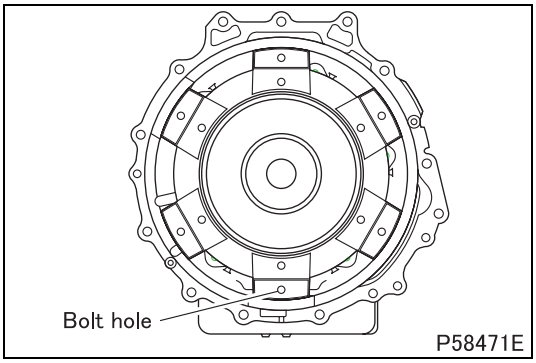


■ Installation: Automatic transmission

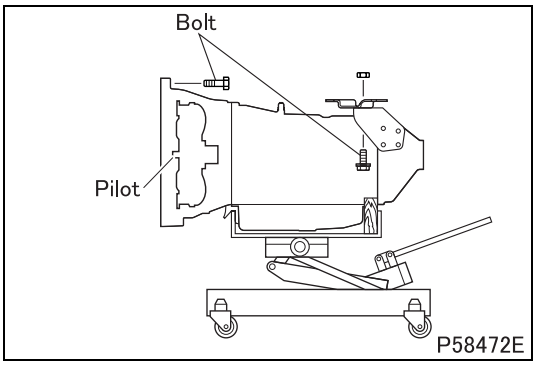
- Make sure the torque converter is correctly installed on the automatic transmission. With the torque converter correctly installed, the dimension from the drive plate surface to the case mounting surface is as shown in the diagram.
- Apply grease to the pilot.



- Position the drive plate with one of the mounting bolt holes at the very bottom.



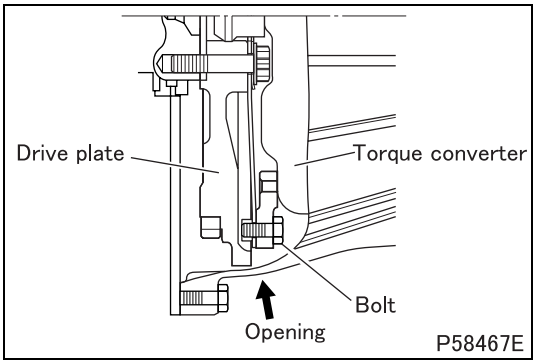
- Position the torque converter likewise, with one of the mounting bolt holes at the very bottom.



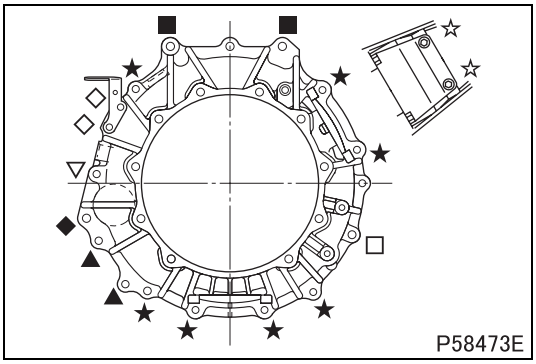
- With the pilot of the torque converter and the dowel pin of the rear plate aligned with each other, slowly move the assembly onto the engine.
- Install several of the transmission mounting bolts. Tighten the rear mounting bolt to the specified torque.

NOTE

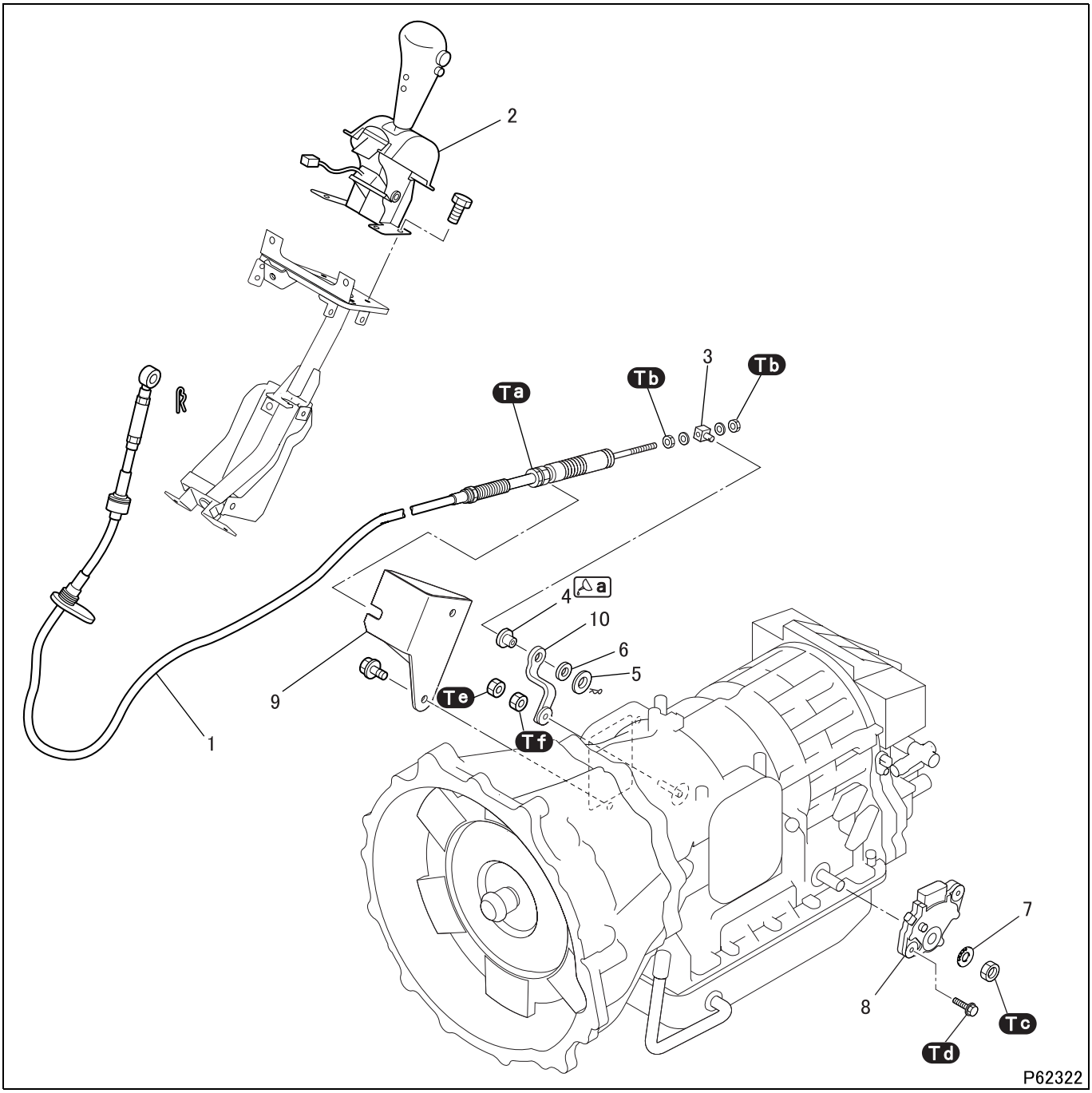
- **To prevent the torque converter from dropping, lower the rear of the automatic transmission slightly to keep the torque converter correctly positioned.**
- **Wipe all oil and grease from the inside wall of the torque converter housing before installing the automatic transmission.**



- Through the opening, align the holes for one of the drive plate mounting bolts. Install that bolt.
- In the same way, install each of the six bolts. Crank the engine to bring the holes to the opening for each one. Next, tighten each bolt to specification, cranking the engine to being each bolt to the opening in turn.



- With the dust cover and bracket mounted using the same bolts, tighten all of the bolts that attach the automatic transmission to the engine.
  - ▲: M10 × 1.25 - 55
  - ★: M10 × 1.25 - 80
  - □: M10 × 1.25 - 95
  - ◇: M10 × 1.5 - 20 (for bracket)
  - ◆: M12 × 1.75 - 45
  - ■: M12 × 1.75 - 60
  - ▽: M12 × 1.75 - 100
- Tighten the remaining mounting bolts on the dust cover (marked ☆) to the specified torque.



● **Removal sequence**

1 Selector cable
2 Shift selector (see later section)
3 Adjuster
4 Bushing
5 Plane washer
6 Spacer
7 Lock washer
8 Inhibitor switch (neutral start switch)
9 Bracket
10 Control lever

● **Installation sequence**

Follow the removal sequence in reverse.

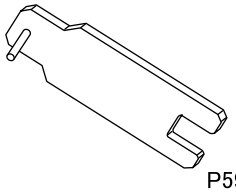
Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Selector cable (mounting on bracket)	30 to 38 {22 to 28}	–
Tb	Nut (adjuster mounting)	4 to 6 {3.0 to 4.4}	–
Tc	Nut (inhibitor switch mounting)	7 {5.2}	–
Td	Bolt (inhibitor switch mounting)	12.5 {9.2}	–
Te	Outside nut (control lever mounting)	15 {11}	Inside nut must be tightened first
Tf	Inside nut (control lever mounting)	13 {9.6}	Hold while tightening outside nut

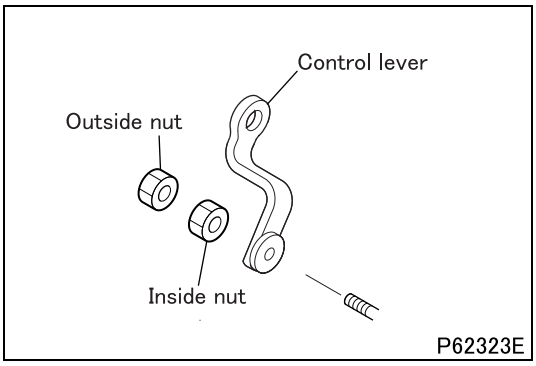
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
La	Friction surface of bushing	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

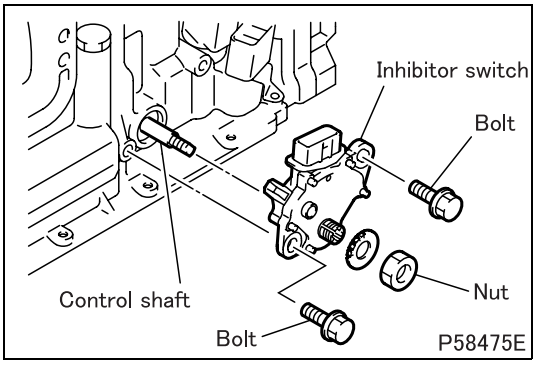
ID	Tool name and shape	Part No.	Application
Ca	Inhibitor switch installer  P59101	MH063642	Installing inhibitor switch

◆Installation procedure◆



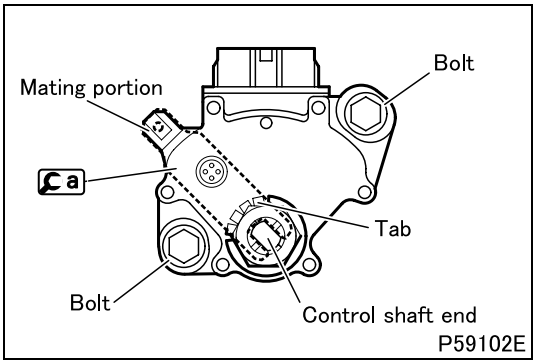
■ Installation: Control lever

- Tighten the inside nut to the specified torque. While holding the inside nut with a wrench to prevent it from moving, tighten the outside nut to the specified torque.



■ Installation: Inhibitor switch (neutral start switch)

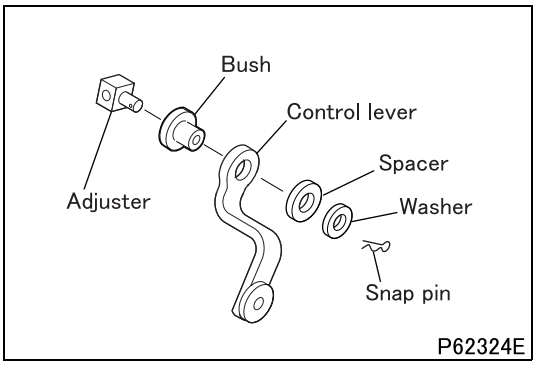
- Position the inhibitor switch on the control shaft.
- Install the two inhibitor switch mounting bolts, but do not tighten them yet.
- Install the lockwasher and inhibitor switch mounting nut. Tighten the nut.



- Loosen the inhibitor switch mounting bolts enough to allow placement of the inhibitor switch installer a with the pin end of the tool inserted into the slot in the inhibitor switch and the claw end of the tool holding the control shaft, as shown in the illustration.
- Hold the inhibitor switch in place with one hand. With the other hand, tighten the inhibitor switch mounting bolts.
- Bend back two of the tabs on the lockwasher to lock the inhibitor switch mounting nut in place.

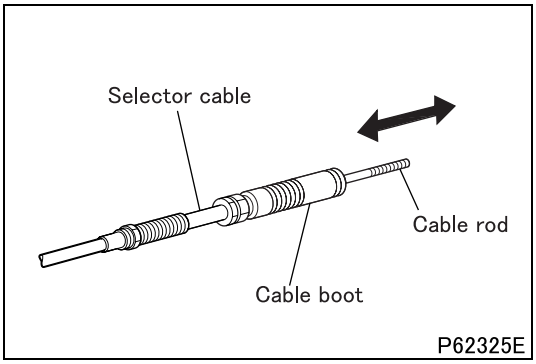
CAUTION ⚠

- **If the inhibitor switch is not properly installed, the gears will not shift properly and the transmission could be damaged.**



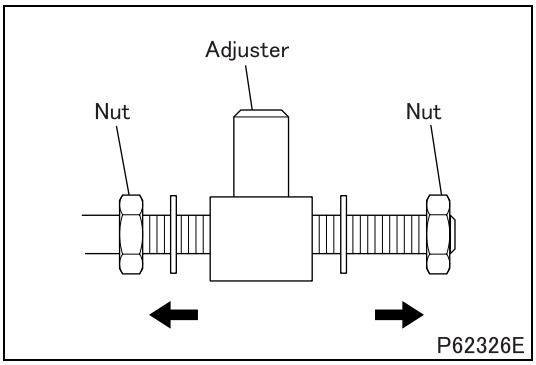
■ Installation: Adjuster

- Install the adjuster on the control lever and fasten it with the snap pin.
- Check that the adjuster turns smoothly on the control lever.
- If the adjuster does not turn smoothly, replace the adjuster, washer, snap pin, and control lever.
- Inspect the bushing and the spacer for signs of loosening, bending, twisting, abrasion, or damage.
  Clean any accumulation of dust and replace any damaged parts.

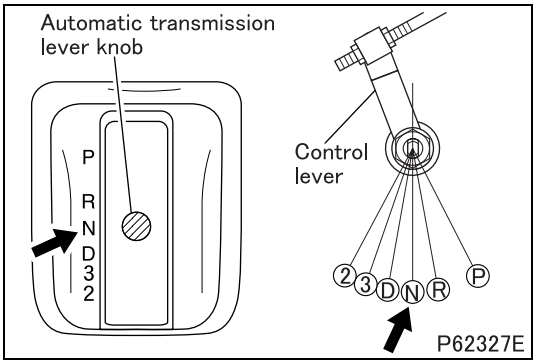


■ Installation: Selector cable

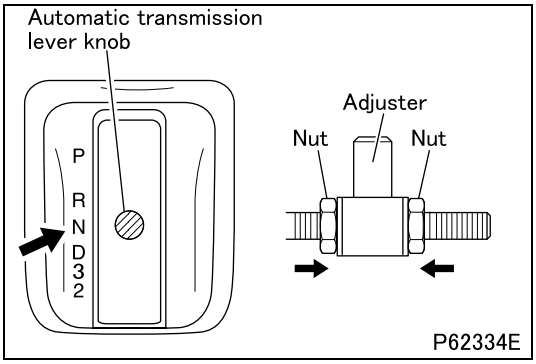
- Check the stroke of the selector cable. If the stroke is not smooth, replace the selector cable.
- Check the cable boot and the cable rod for signs of loosening, bending, twisting, or damage. Clean any accumulation of dust and replace the selector cable if necessary.



- Loosen the adjuster mounting nuts on the both ends of the threaded section of the cable rod.



- Place the shift selector inside the cab in N (neutral). Then place the control lever on the side of the gear case in N (neutral).

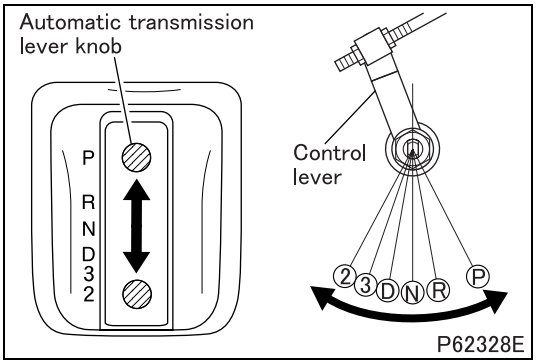


- Confirm that the shift selector inside the cab remains in N (neutral). Tighten the adjuster mounting nuts.

CAUTION ⚠

- **Be careful not to move the adjuster from its set position when tightening the nuts. If the adjuster is moved, the gears will not shift properly and the transmission could be damaged.**

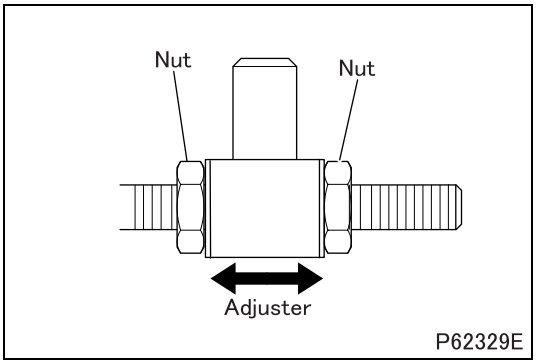
◆Operational check◆



■ Shift selector operational check

[Inspection]

- Chock all the tires, set the parking brake, and move the shift selector to P (park).
- Starting with P, move the shift selector through each range to the 2 position and back again to P. Do this two or three times while checking the shift functions as follows:
  - **1** The shift selector inside the cab and the control lever on the gear case must correctly enter each range between 2 and P.
  - **2** On the instrument cluster, the range indicator light illuminates for the range selected.
  - **3** The shift selector operates smoothly and clicks into each range.
  - **4** The ignition key can be removed from the key cylinder at the P position.
  - **5** If there are any problems, adjust the selector cable according to the procedure below.
- Check the shift interlocks as follows:
  - **1** Move the shift selector to R (reverse). Make sure the backup lights illuminate and the buzzer sounds.
  - **2** Move the shift selector to N (neutral), and then to P (park). Make sure the engine will start in both N and P.
  - **3** If there are any problems, check the backup light circuit and the engine starting circuit (see Group 54) and make the necessary repairs.

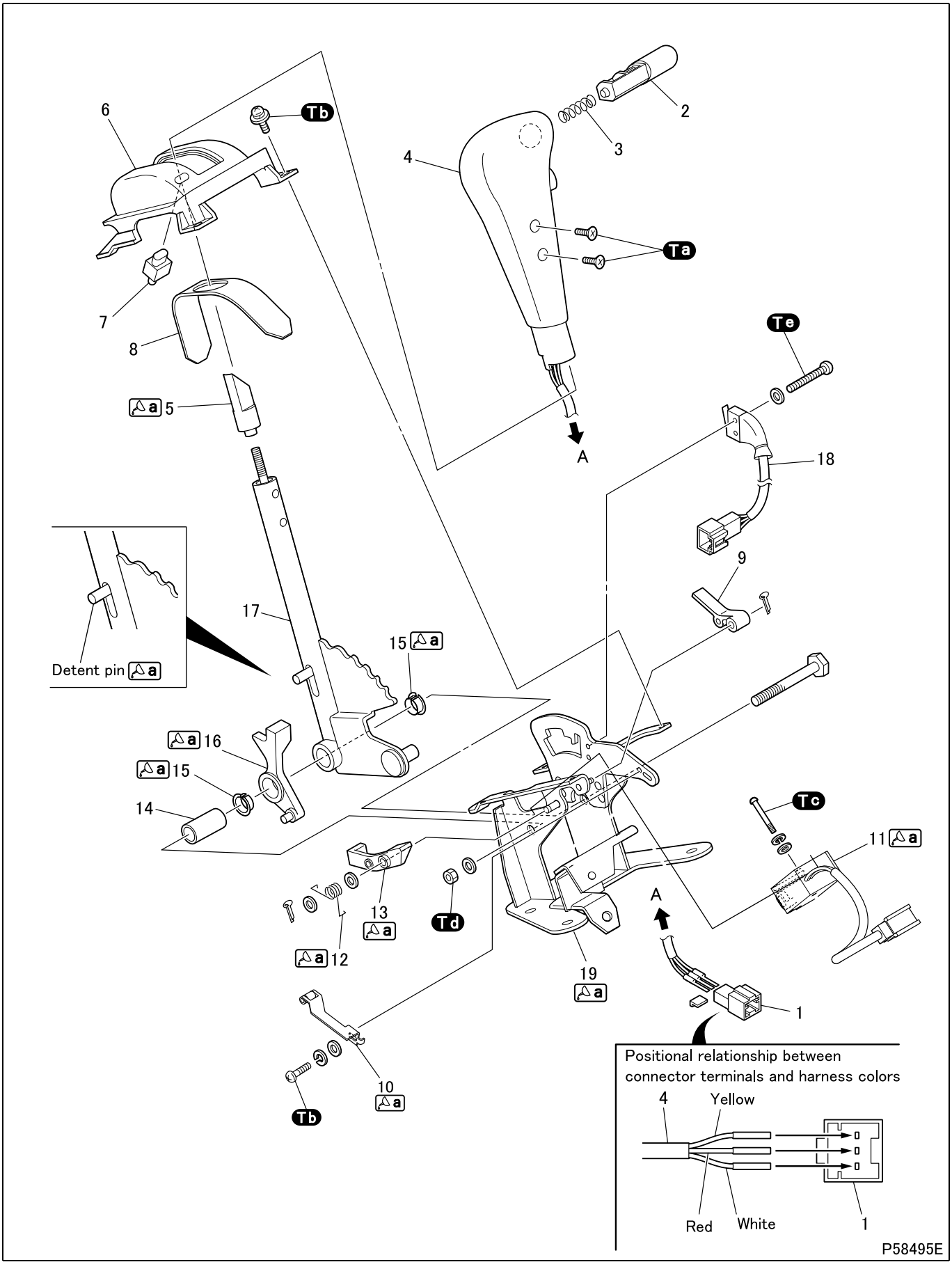


[Selector cable adjustment]

- Loosen the adjuster mounting nuts. Correct the adjuster position as needed. For more information, see the procedure under the heading: "■**Installation: Selector cable**".
- If the control lever is shifted toward the "2" range, move the adjuster toward the end of the selector cable rod. If the lever is shifted toward "P" position, move the adjuster in the opposite direction, toward the cable boot.
- After adjustment, redo the operational check of the shift functions and make sure there is no problem.
- If the problem has not been corrected, check the indicator light circuit in the instrument cluster (see Group 54) and the P range switch.

M E M O

Shift selector



● Removal sequence

1 Connector housing (for overdrive lockout switch)
2 Shift selector button
3 Spring
4 Shift selector knob
5 Shift selector sleeve
6 Indicator panel
7 Shift lock cancel switch
8 Slider
9 Cam
10 Detent spring
11 Shift lock actuator
12 Spring
13 Spring arm
14 Tube
15 Bushing
16 Lever arm
17 Shift selector lever
18 P range switch
19 Shift selector bracket

● Installation sequence

Follow the removal sequence in reverse.

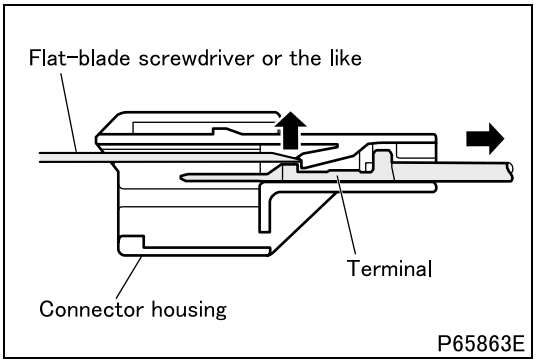
Torque: N·m (lbf·ft)

ID	Fastener	Torque value	Remarks
Ta	Screw (knob mounting)	1.5 to 2 {1.1 to 1.5}	–
Tb	Screw (indicator panel mounting)	1 to 1.5 {0.7 to 1.1}	–
	Screw (detent spring mounting)		
Tc	Screw (shift lock actuator mounting)	1 to 2 {0.7 to 1.5}	–
Td	Nut (lever arm mounting)	9 to 14 {6.6 to 10}	–
Te	Screw (P range switch mounting)	0.1 to 0.15 {0.074 to 0.11}	–

Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Friction surface of detent spring	Chassis grease [NLGI No. 1 (Ca soap)]	As required
	Friction surfaces of shift lock actuator and lever arm		
	Friction surfaces of spring and spring arm		
	Bushing		
	Detent pin on selector lever		
	Contact surface of bracket at the detent pin		
	Contact surface of the shift selector sleeve and the button, and friction surface of sleeve		

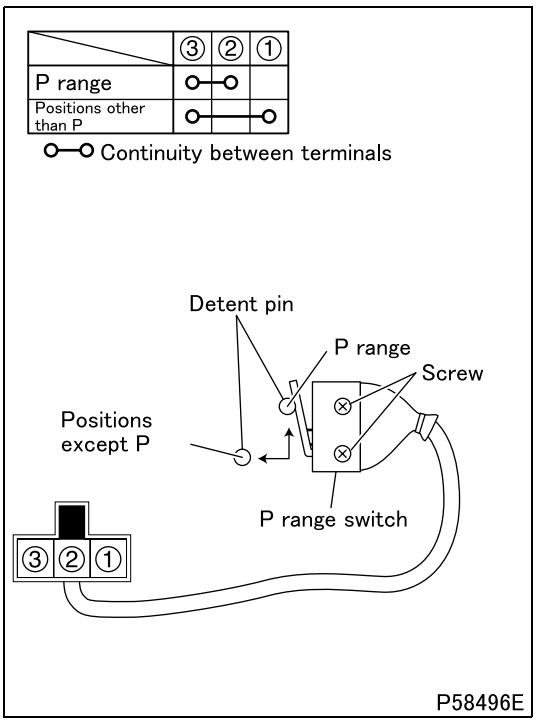
◆Removal procedure◆



■ Removal: Connector housing

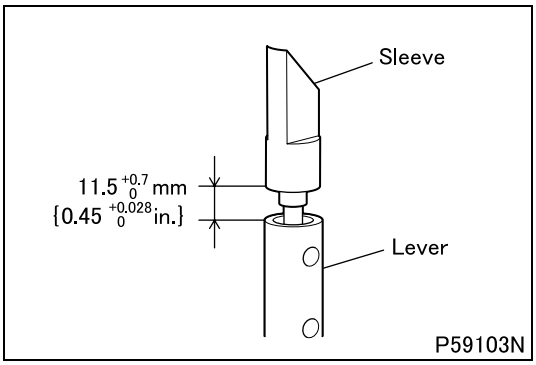
- Using a flat-blade screwdriver, or similar tool, press down the terminal in the connector and remove the connector housing.

◆Installation procedure◆



■ Installation: P range switch

- Position the P range switch as shown in the illustration.
- Check the continuity of the P range switch. If it is as shown in the illustration, go to the next step.
- Tighten the P range switch mounting screws. Make sure the continuity of P range switch remains as shown.

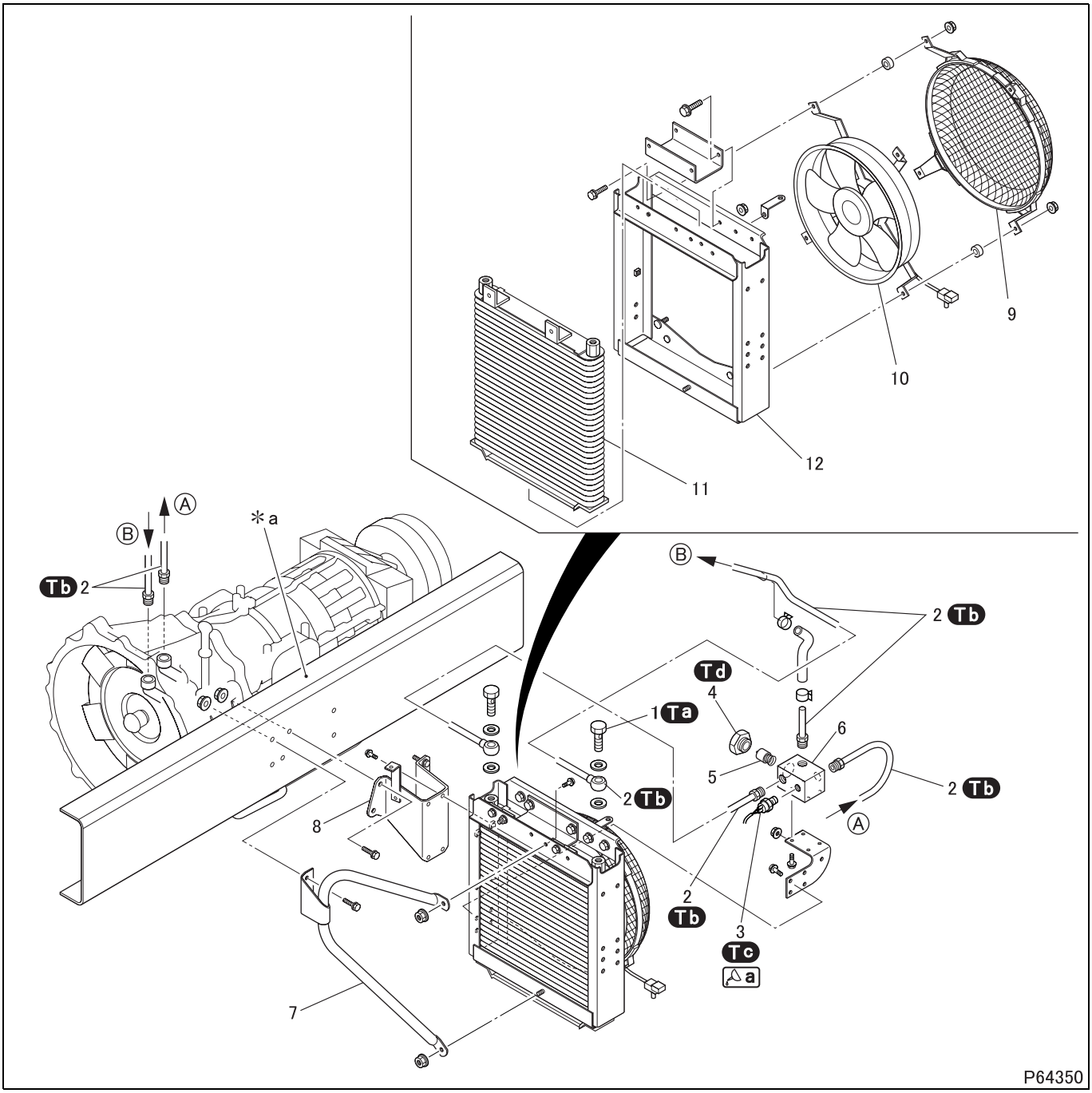


■ Installation: Sleeve

- Turn the sleeve to install it. Make sure the space between the sleeve and the end of the lever is as shown in the illustration with the lever in the R position.
- Install the sleeve with its tapered part on the same side as the shift selector button.

M E M O

ATF COOLER



● **Removal sequence**

1 Eye bolt
2 ATF cooler tube
3 ATF thermo switch
4 Plug
5 Thermo valve
6 Connector
7 ATF cooler stay
8 ATF cooler bracket
9 Fan cover
10 ATF cooler fan motor
11 ATF cooler
12 ATFcooler mount

***a**: Frame

CAUTION ⚠

- **Before disconnecting a cooler line, sure to check the automatic transmission fluid level.**

● **Installation sequence**

Follow the removal sequence in reverse.

Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Eye bolt	29 to 34 {21 to 25}	–
Tb	ATF cooler tube (flare nut)	53 {39}	WET
Tc	ATF thermo switch	29 to 39 {21 to 29}	–
Td	Plug	167 ± 20 {125 ± 15}	WET

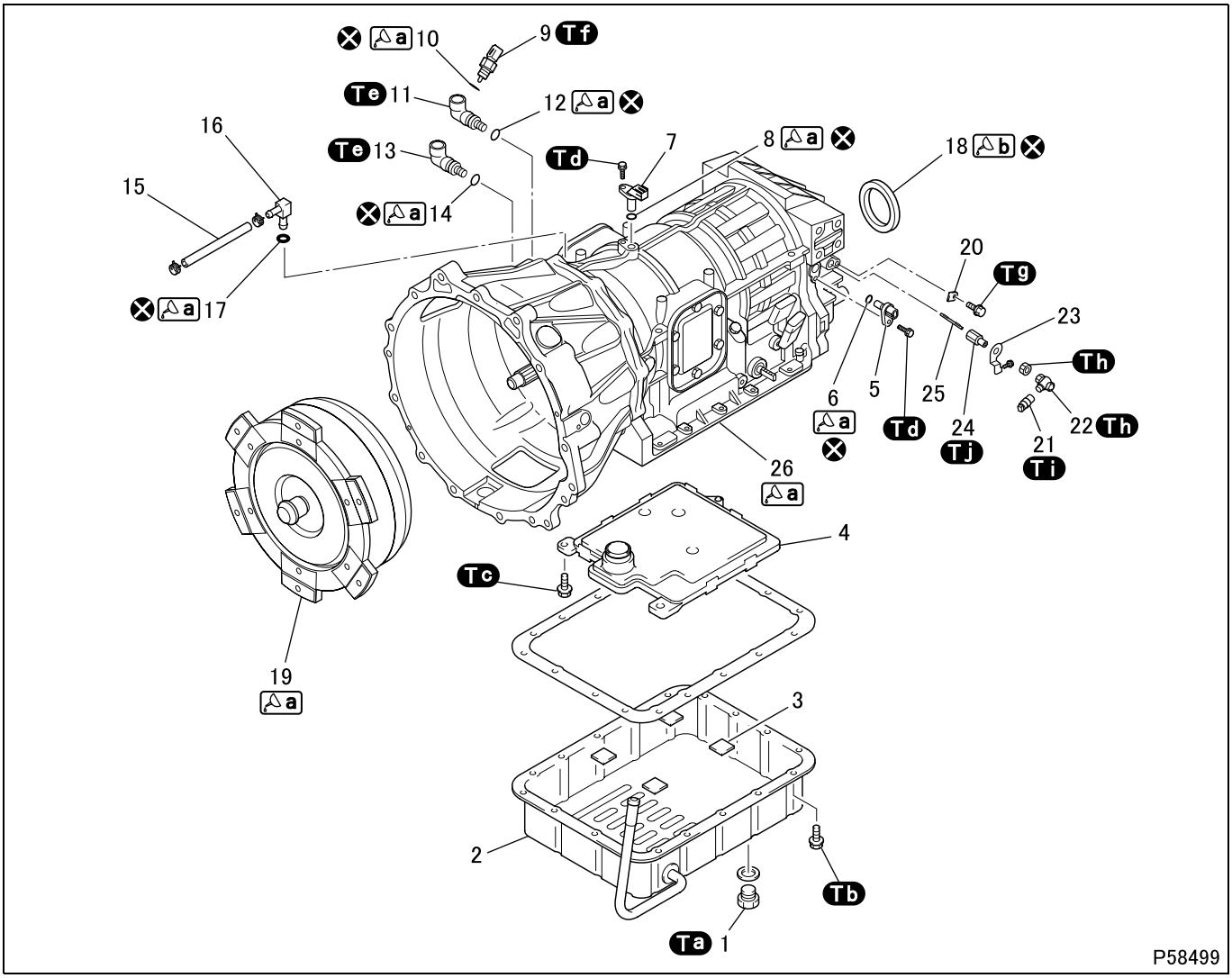
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Threaded portion of ATF thermo switch	ThreeBond 1110B	As required

◆Work before installation◆

■ Flushing: Oil cooler circuit

- If the oil cooler circuit contains a large amount of impurities, flush the cooler circuit.
- Remove the cooler lines from the automatic transmission and oil cooler.
- Blow compressed air into the ATF cooler and cooler lines to clean them.



● **Removal sequence**

1 Drain plug
2 Oil pan
3 Oil cleaner magnet
4 Oil strainer
5 Output speed sensor
6 O-ring, output speed sensor
7 Input/Turbine speed sensor
8 O-ring, turbine speed sensor
9 ATF temperature sensor
10 O-ring, temperature sensor
11 Elbow, ATF line
12 O-ring, ATF line
13 Elbow, ATF line
14 O-ring, ATF line
15 Breather hose
16 Breather plug
17 O-ring, breather
18 Rear oil seal
19 Torque converter
20 Lock plate
21 Vehicle speed sensor
22 L-joint
23 Bracket
24 Speedometer joint
25 Speedometer shaft
26 Gear case

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

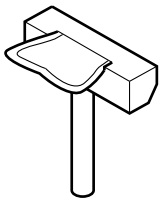
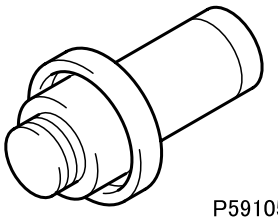
Torque: N·m (lbf·ft)

ID	Component	Torque value	Remarks
Ta	Drain plug	27 {20}	Magnet attached
Tb	Bolt (oil pan)	7 {5.2}	–
Tc	Bolt (oil strainer mounting)	10 {7.4}	–
Td	Bolt (output speed sensor and input/turbine speed sensor)	8 {5.9}	–
Te	Elbow pipe threads	32 {24}	–
Tf	Oil temperature sensor (outside)	34 {25}	–
Tg	Bolt (lock plate mounting)	12.5 {9.2}	–
Th	L-joint	34 to 39 {25 to 29}	–
	Nut (speedometer joint)		
Ti	Vehicle speed sensor	14.7 to 29.4 {11 to 22}	–
Tj	Speedometer joint	20 to 30 {15 to 22}	–

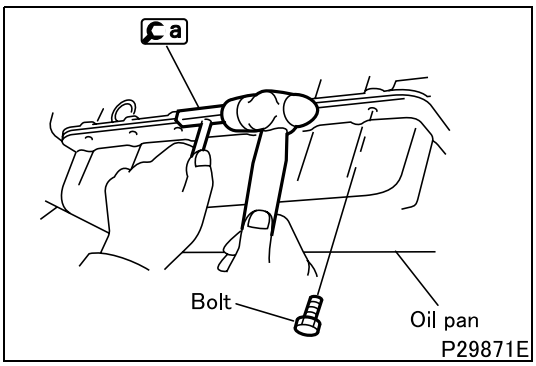
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Mobil ATF3309	As required
	Torque converter		2 L {2.1 qt}
	Front oil seal (automatic transmission)		As required
b	Lips of rear oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

ID	Tool name and shape	Part No.	Application
a	Oil pan remover  P29856	MD998727	Removal of oil pan
b	Oil seal installer  P59105	MH063641	Installing rear oil seal

◆Removal procedure◆



■ **Removal: Oil pan**

- Loosen the oil pan bolts. To prevent the oil pan from falling, leave every third bolt installed finger-tight. Remove the rest of the bolts.

CAUTION ⚠

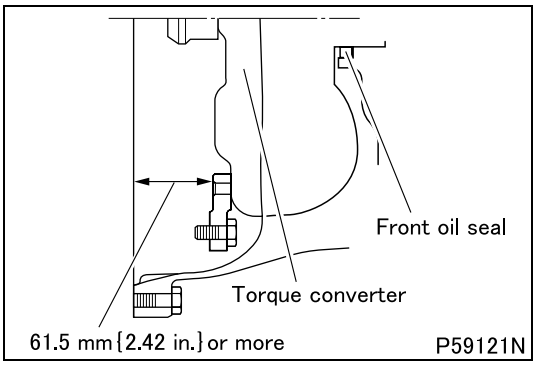
- **To prevent damage to the oil pan, make sure the oil pan is secured from falling.**

- Using the oil pan remover a as shown in the illustration, remove the oil pan from the gear case. Start the special tool at one corner of the oil pan, and gradually work your way around, removing the remaining bolts as you go.

CAUTION ⚠

- **When tapping in the oil pan remover a, be careful not to damage or dent the oil pan.**
- **There will be oil left in the oil pan. To prevent a spill, do not tip the oil pan while removing it.**

◆Installation procedure◆



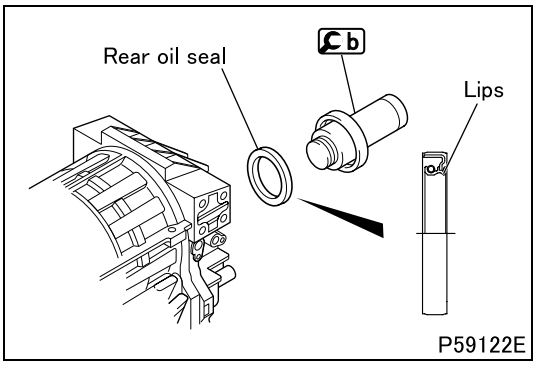
■ **Installation: Torque converter**

- If the torque converter is new, add the specified amount of new automatic transmission fluid (ATF) through the fill tube.
- Apply ATF to the front oil seal. Install the torque converter on the oil pump.

CAUTION ⚠

- **Do not damage the oil seal when installing the torque converter.**

- Measure the distance from the torque converter housing to the torque converter set block. It should not exceed 2.42 in (61.5 mm).



■ **Installation: Rear oil seal**

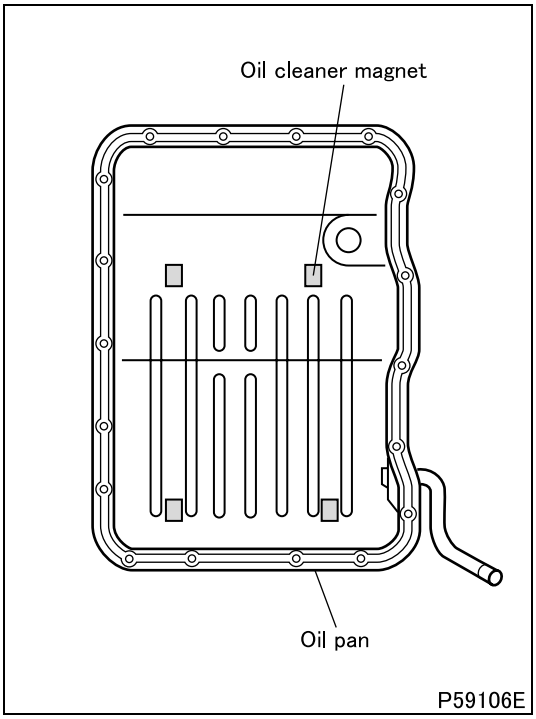
NOTE

- **Before installing the rear oil seal, clean the seal mounting face of the auxiliary housing.**

- Apply grease to the lips of the rear oil seal.
- Using the rear oil seal installer b, press in the rear oil seal until it seats in the mounting face of the auxiliary housing.

CAUTION ⚠

- **When installing the rear oil seal, press down evenly to avoid twisting or cocking the seal.**

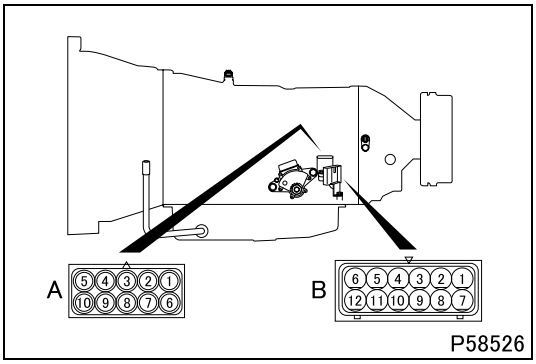


■ **Installation: Oil pan**

- Remove any traces of gasket material clinging to the mating surfaces of the gear case and oil pan. Insure that both mating surfaces are clean and dry. Wipe away any spilled liquid**.**
- Clean the oil cleaner magnet and install it onto the oil pan.
- Install a new gasket on the oil pan. Install the oil pan on the gear case.
- Install the oil pan bolts and tighten them in stages. In each stage, alternate the bolts in the same sequence. Tighten the oil pan bolts to the specified torque.

CAUTION ⚠

- **To prevent leaks and damage to the oil pan, make sure the oil pan is even all the way around when installed.**



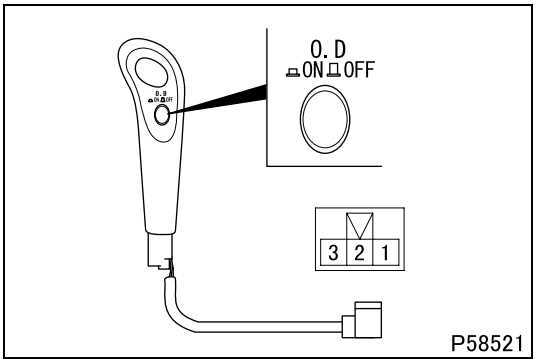
#140 Inspection of oil pressure switch

- Check for continuity between the indicated terminals.

Standard value	Oil pressure switch 1	B1-*	No continuity (When ignition switch is OFF)
	Oil pressure switch 2	B7-*	
	Oil pressure switch 3	B8-*	
	Oil pressure switch 4	A7-*	
	Oil pressure switch 5	A2-*	
	Oil pressure switch 6	B2-*	
	Oil pressure switch 7	A1-*	
	Oil pressure switch 8	A6-*	

*: Automatic transmission gear case

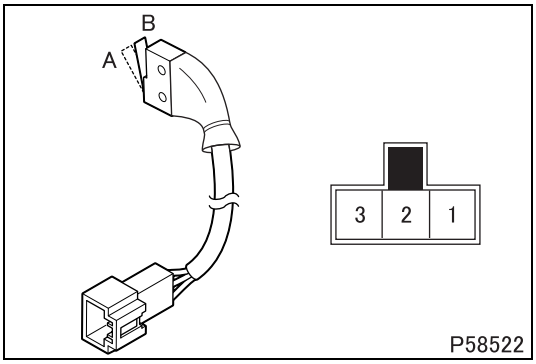
- If continuity is found, replace the affected switch.



#150 Inspection of overdrive switch

Switch position	Terminals with continuity
OFF	1-3
ON	2-3

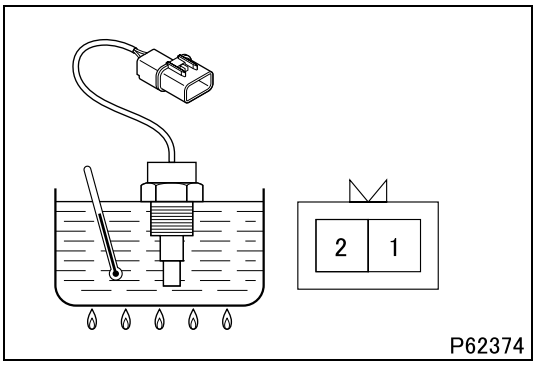
- If there is any problem, replace the shift selector.



#151 Inspection of P range switch

Switch position	Terminals with continuity
A	1-3
B	2-3

- If there is any problem, replace the P range switch.



#153 Inspection of ATF thermo switch

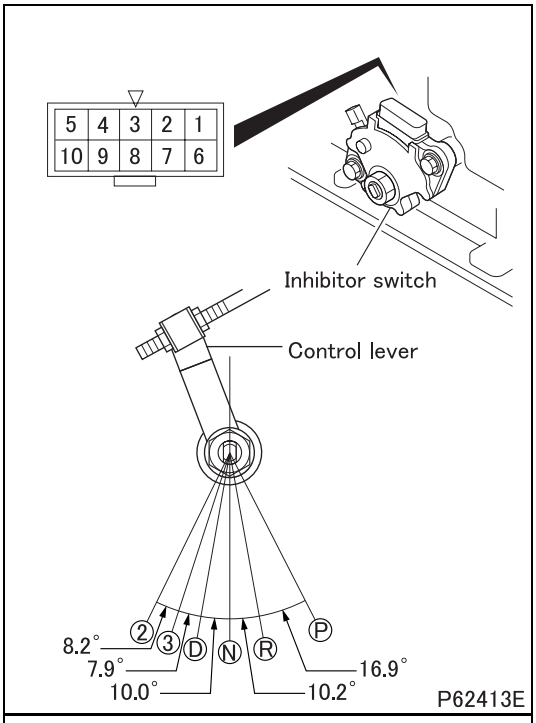
- Place the ATF thermo switch in a container filled with automatic transmission fluid and use a heater to raise the temperature of the fluid.
- Measure the temperature of the fluid at which continuity becomes established between terminals 1 and 2. and check that the measurement is within the standard value range.

Standard value (OFF to ON temperature)	97 ± 3°C

- Allow the ATF to cool. Measure the temperature of the fluid at which the continuity is lost between terminals 1 and 2. Check that the measurement is within the standard value range.

Standard value (ON to OFF temperature)	90°C or higher

- If either of the above measurements is not within the standard value range, replace the ATF thermo switch.

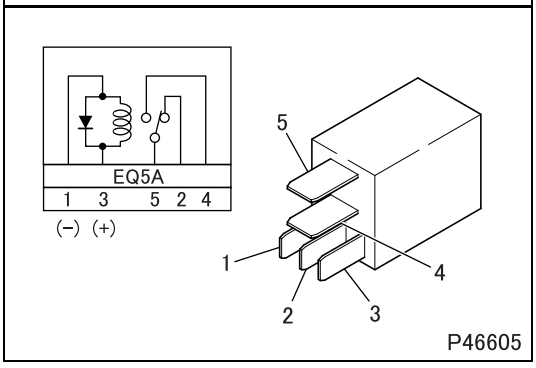


#159 Inspection of Inhibitor switch (neutral start switch)

- Install the inhibitor switch on the gear case and connect the control lever. Check for continuity as shown in the table below:

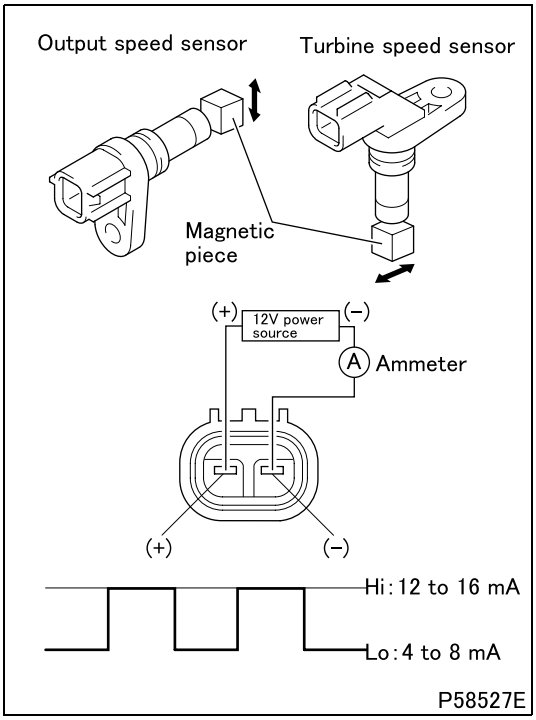
Transmission control lever position	Terminals with continuity
P	4-5, 6-10
R	4-9
N	1-4, 6-10
D	4-8
3	2-4
2	4-7

- If there is any problem, replace the inhibitor switch.



#201 Inspection of exhaust brake cut relay (normally open, 5-pin type)

- Check the relay for continuity. If there is continuity, install the relay and turn the ignition switch to ON. If the exhaust brake does not operate, replace the relay.

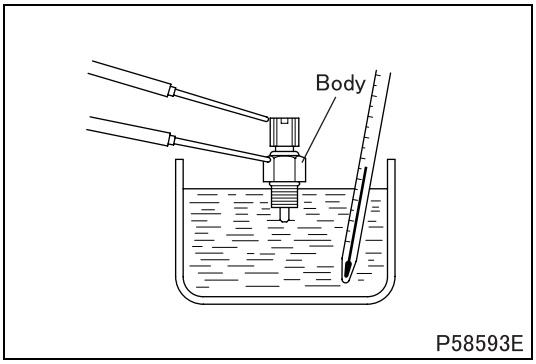


#293 Inspection of speed sensors

- Connect the speed sensor to the power source and an ammeter as illustrated.
- While moving a screwdriver blade or other object made of iron near the end of the speed sensor (as shown in the illustration), read the ammeter. When the distance between the sensor and iron object is less than 5 mm {0.20 in}, the ammeter reading should switch from the HI to the LO range

Standard range (at normal temperature)	Hi	12 to 16 mA
	LO	4 to 8 mA

- If there is any problem, replace the speed sensor.



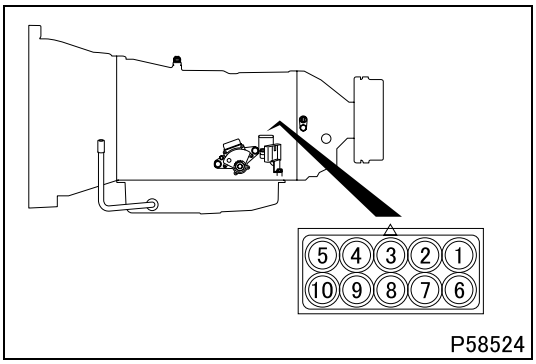
#312 Inspection of oil temperature sensor

<Outside>

- Immerse the oil temperature sensor in a container filled with automatic transmission fluid.
- Measure the resistance at the temperatures listed below. (To obtain the correct reading, the sensor needs to be exposed to the specified temperature for at least 5 minutes.)

Standard value	115°C {240°F}	655 to 730 Ω
	120°C {250°F}	585 to 645 Ω
	145°C {295°F}	340 to 375 Ω
	155°C {310°F}	280 to 305 Ω

- If there is any abnormality, replace the oil temperature sensor.

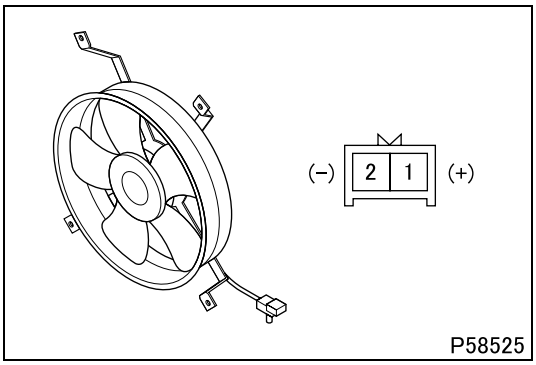


<Inside>

- Measure the resistance between terminals 3 and 8 on the A/T solenoid connector A.

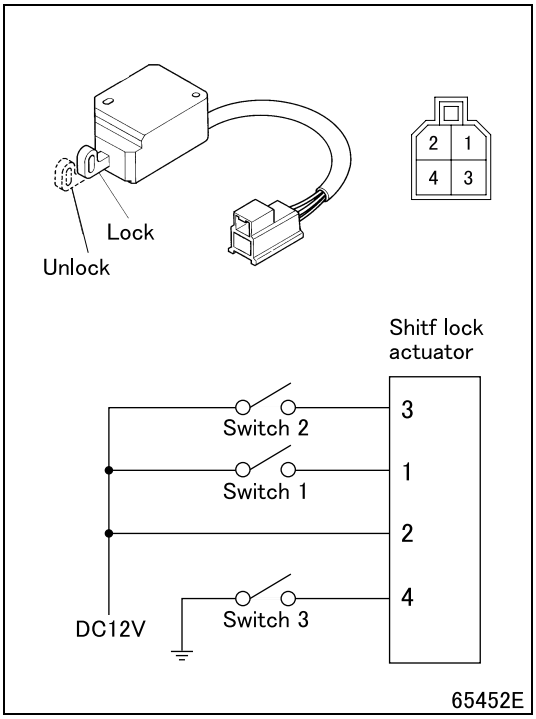
Standard value	–30°C {–24°F}	44 ± 6.6 kΩ
	10°C {50°F}	6445 ± 645 Ω
	110°C {230°F}	247 ± 16 Ω
	145°C {295°F}	111 ± 6 Ω

- If a measured value differs greatly from the standard value or the resistance does not change when the temperature is changed, replace the oil temperature sensor.



#489 Inspection of ATF cooler fan motor

- Check that the ATF cooler fan motor runs when battery voltage is applied to terminals 1 and 2.
- If there is any problem, replace the ATF cooler fan motor.

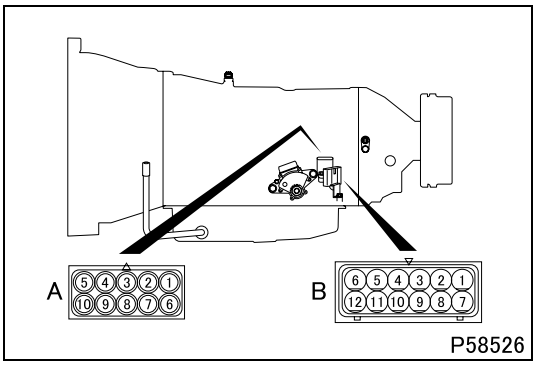


#535 Inspection of shift lock actuator

- Wire the shift lock actuator as illustrated.
- Check the lever position with each combination of switch conditions shown in the following table.

Switch 1	Switch 2	Switch 3	Lever position
ON	ON	ON	Unlock
ON	OFF	ON	Lock
ON	ON	OFF	Unlock
ON	OFF	OFF	Unlock
OFF	ON	ON	Lock
OFF	OFF	ON	Lock
OFF	ON	OFF	Unlock
OFF	OFF	OFF	Unlock

- If there is any problem, replace the shift lock actuator.



#585 Inspection of solenoid valves

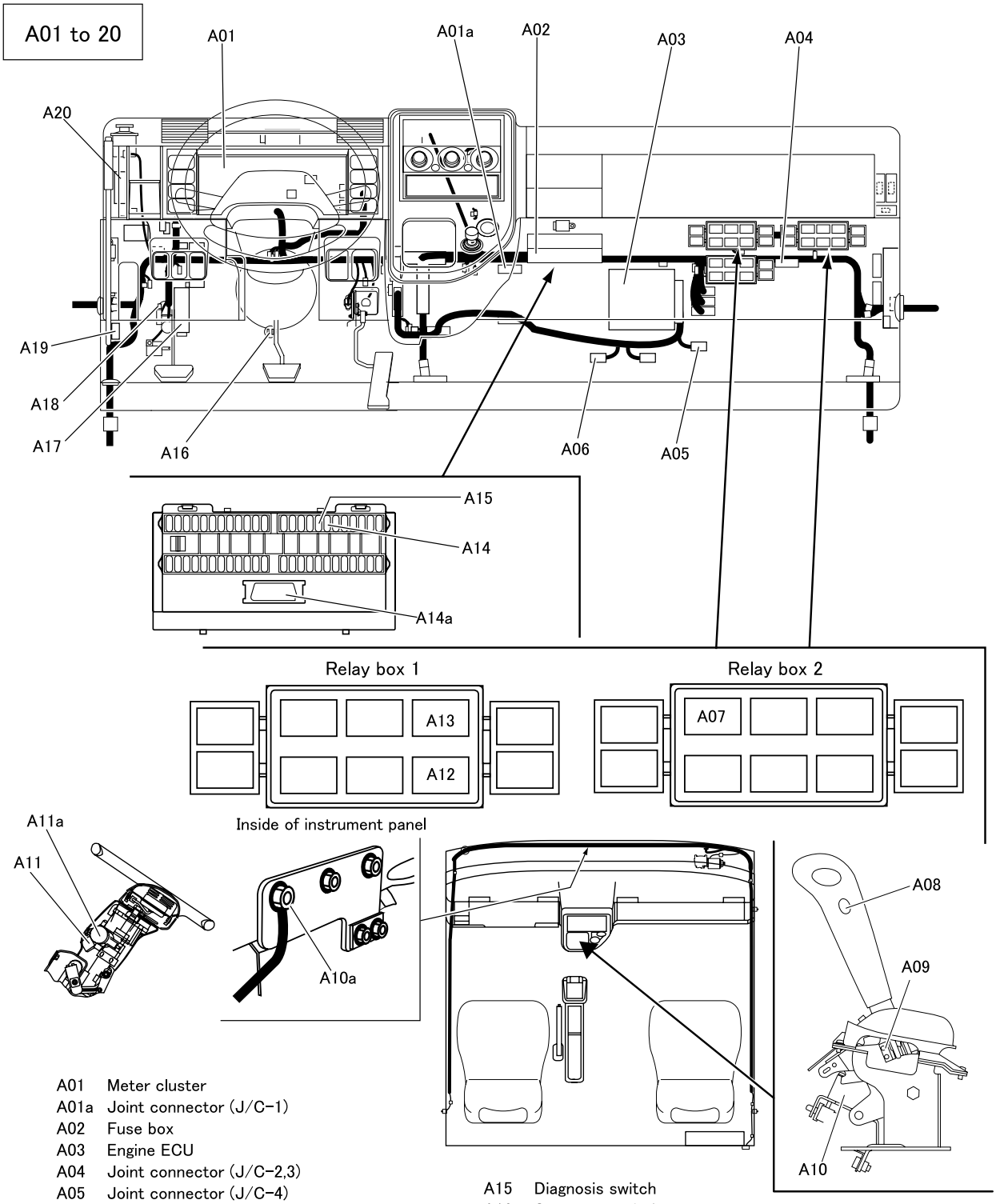
- Measure the resistance between the indicated terminals on the solenoid connectors.

Standard range (at normal temperature)	Shift solenoid 1	B10-*	13 ± 2 Ω
	Shift solenoid 2	B3-*	
	Shift solenoid 3	B9-*	
	Gain change solenoid	B4-*	
	Linear solenoid 1	A5-A10	5.5 ± 0.5 Ω
	Linear solenoid 2	B6-B12	
	Linear solenoid 3	A4-A9	
	PL linear solenoid	B5-B11	

*: Automatic transmission gear case

- If any measured value is not within the standard range, replace the relevant solenoid valve.

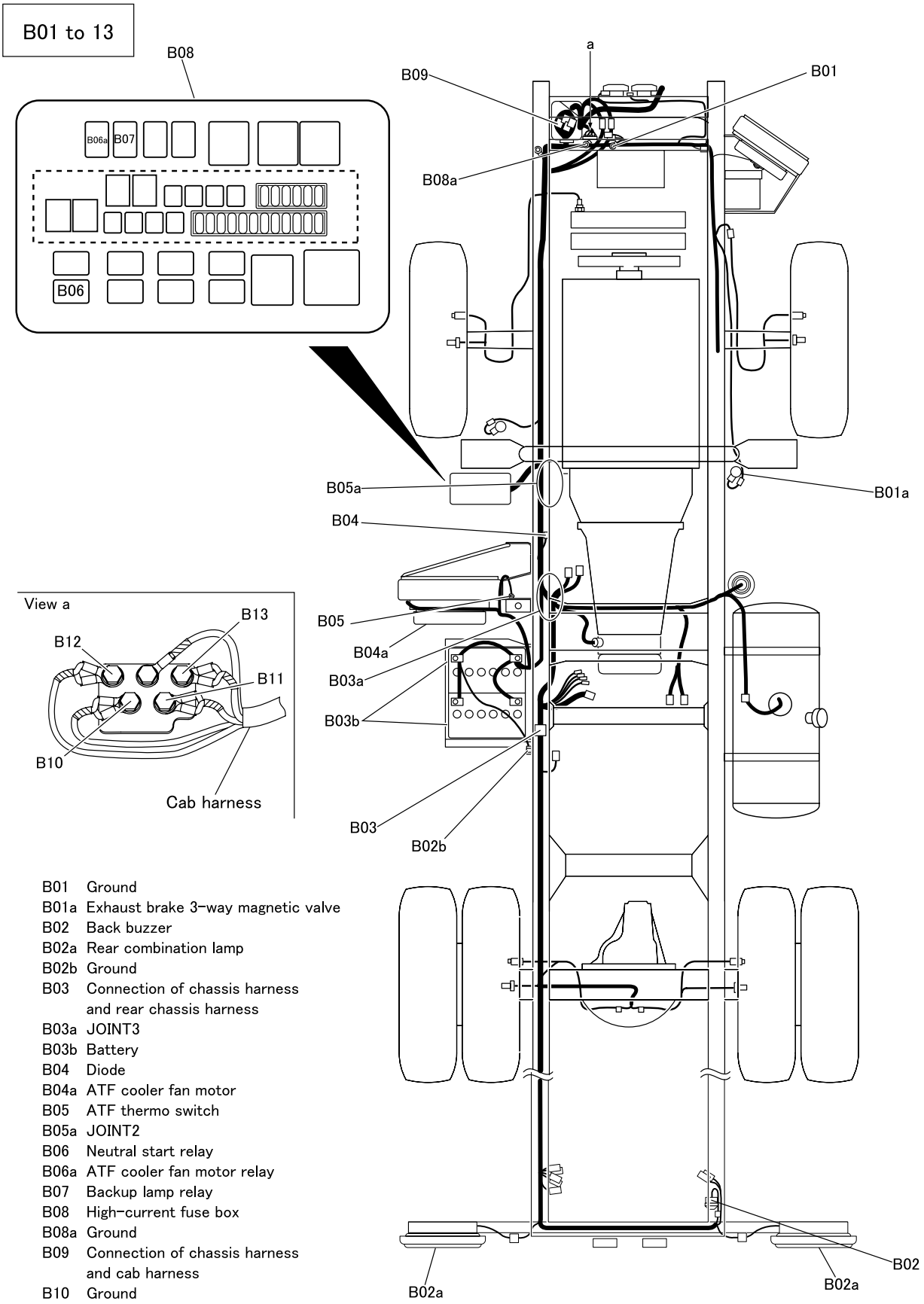
INSTALLED LOCATIONS OF PARTS



A01 Meter cluster
A01a Joint connector (J/C-1)
A02 Fuse box
A03 Engine ECU
A04 Joint connector (J/C-2,3)
A05 Joint connector (J/C-4)
A06 CAN resister
A07 ABS exhaust brake cut relay
A08 O/D switch
A09 P range switch
A10 Shift lock actuator
A10a Ground
A11 Key-interlock solenoid
A11a Starter switch
A12 Exhaust brake cut relay
A13 Stop lamp relay
A14 Memory clear switch
A14a Multi-Use Tester connector (for recorder)
A15 Diagnosis switch
A16 Stop lamp switch
A17 A/T ECU
A18 Diode
A19 Multi-Use Tester connector (for inspection)
A20 Key interlock electronic control unit

ECU: Electronic control unit
ABS: Anti-lock brake system
A/T: Automatic transmission
ATF: Automatic transmission fluid
O/D: Overdrive
CAN: Control area network

L00176



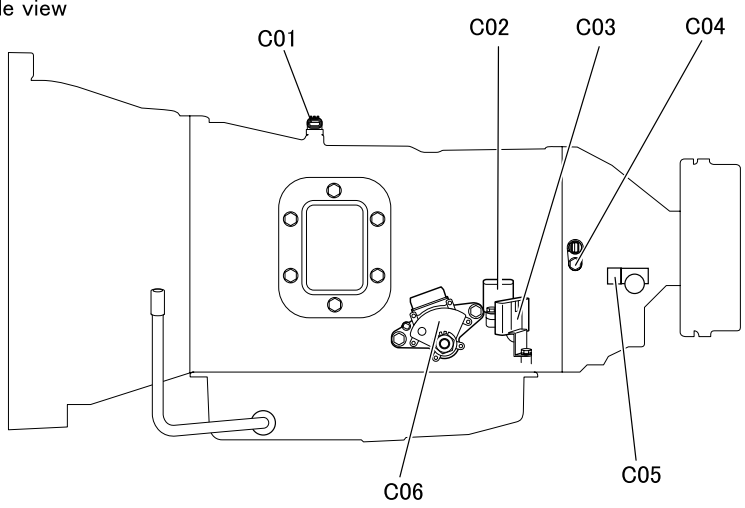
B01 Ground
B01a Exhaust brake 3-way magnetic valve
B02 Back buzzer
B02a Rear combination lamp
B02b Ground
B03 Connection of chassis harness and rear chassis harness
B03a JOINT3
B03b Battery
B04 Diode
B04a ATF cooler fan motor
B05 ATF thermo switch
B05a JOINT2
B06 Neutral start relay
B06a ATF cooler fan motor relay
B07 Backup lamp relay
B08 High-current fuse box
B08a Ground
B09 Connection of chassis harness and cab harness
B10 Ground
to 13

ATF : Autonatic transmission fluid

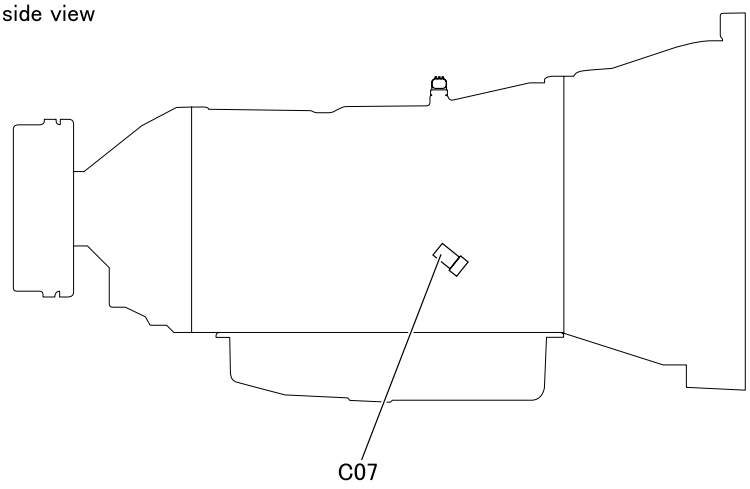
L01275

C01 to 07 Automatic transmission

Left side view



Right side view



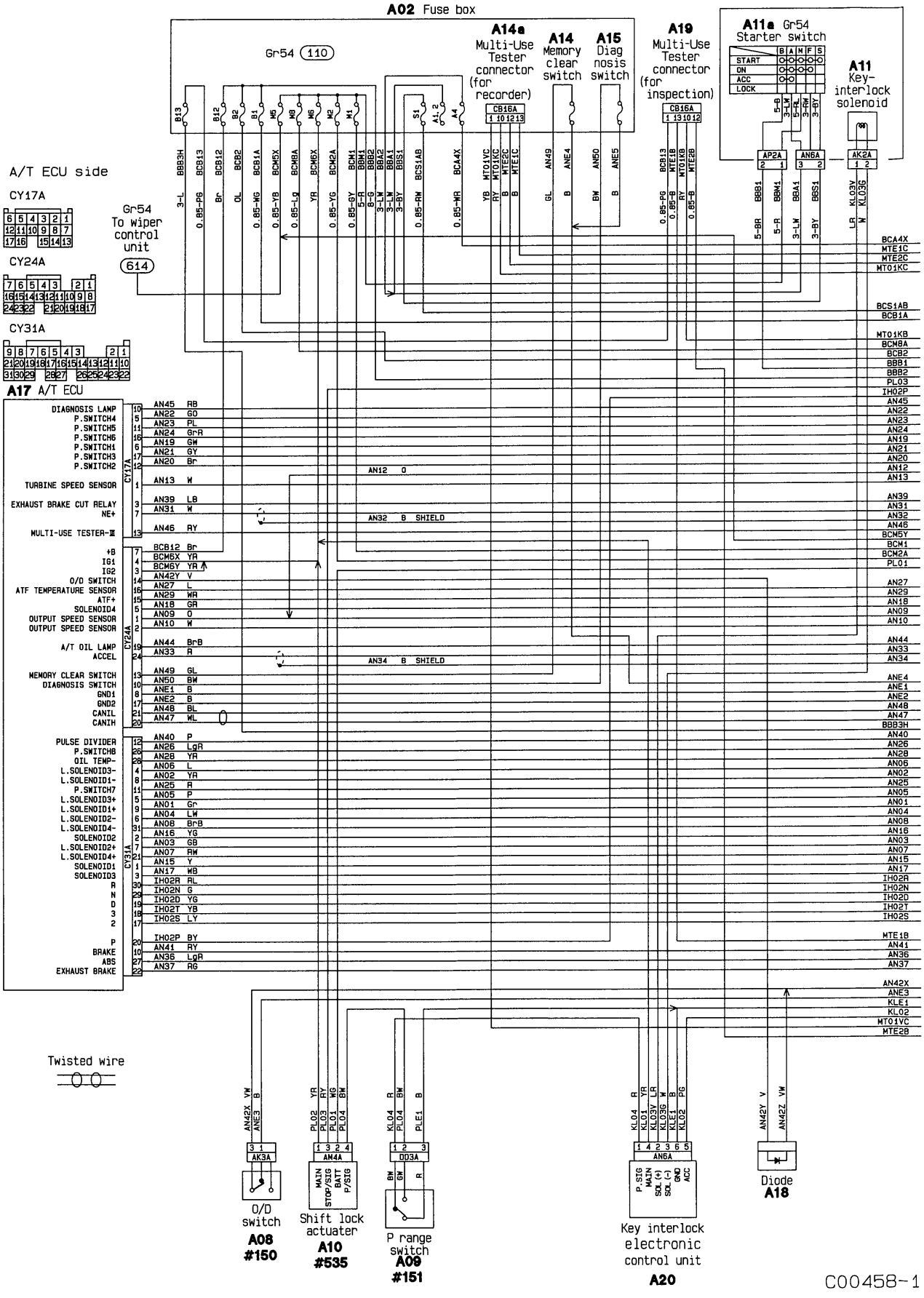
C01 Turbine speed sensor
C02 A/T solenoid connector [ET10A]
C03 A/T solenoid connector [DC12A]
C04 Output speed sensor
C05 Vehicle speed sensor
C06 Inhibitor switch
C07 Oil tenperature sensor (outside)

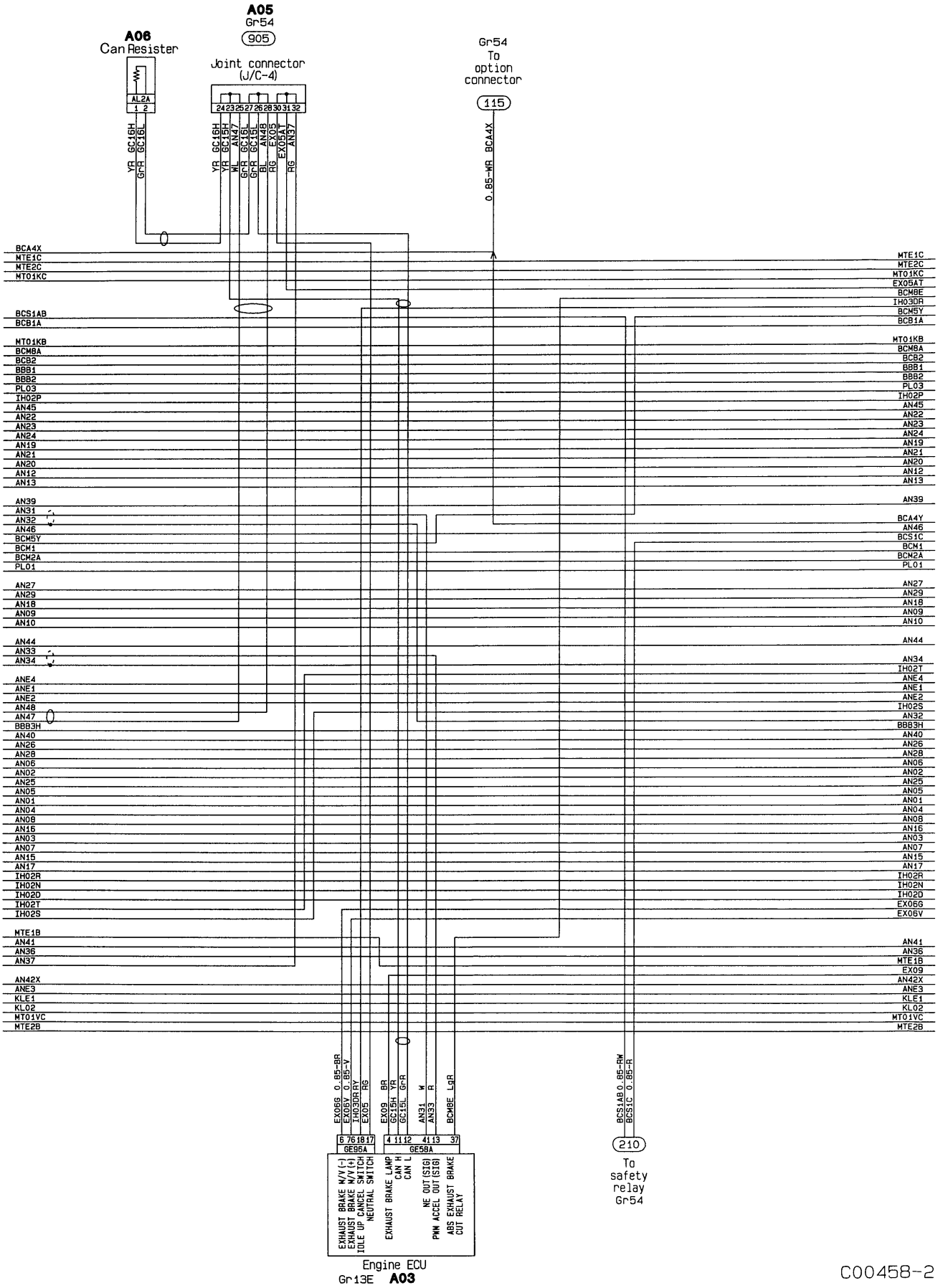
A/T : Automatic transmission

L00177

M E M O

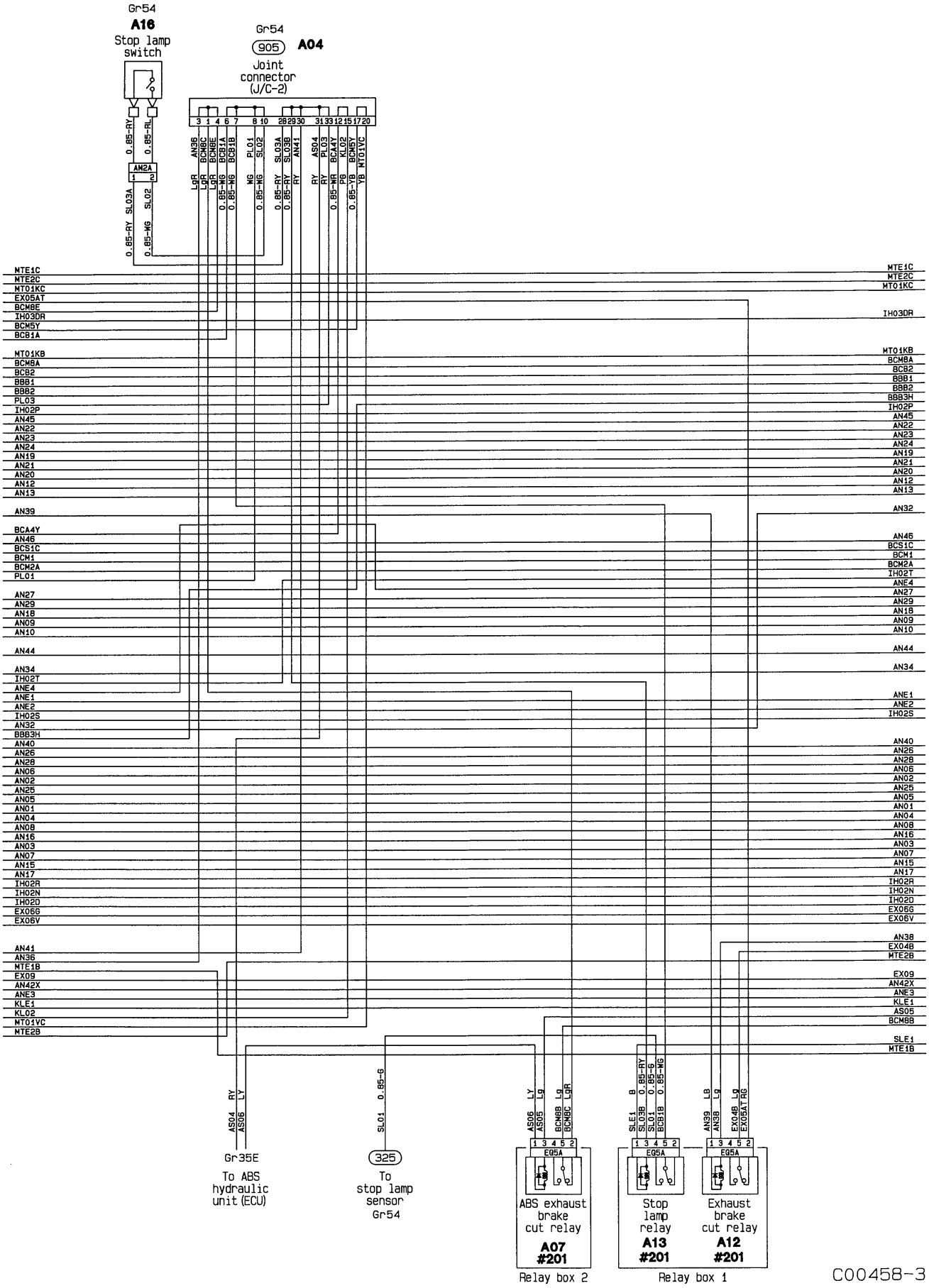
ELECTRIC CIRCUIT DIAGRAM

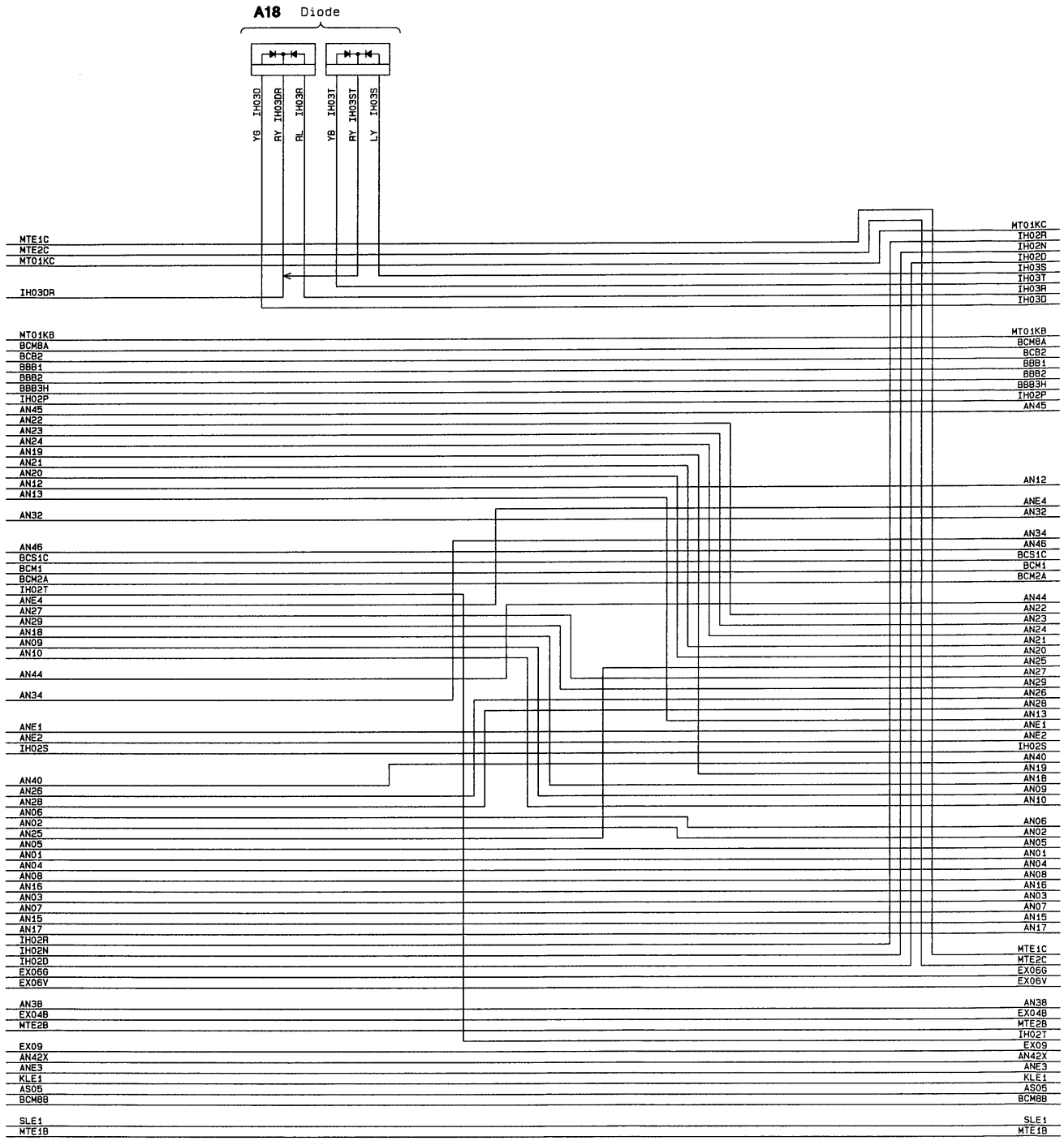



A05
Gr54
905
A06
Can Resister
AL2A
Joint connector
(J/C-4)
Gr54
To
option
connector
115
0.85-WR BCA4X
BCA4X
MTE1C
MTE2C
MTO1KC
BCS1AB
BCB1A
MTO1KB
BCM8A
BCB2
BBB1
BBB2
PL03
IH02P
AN45
AN22
AN23
AN24
AN19
AN21
AN20
AN12
AN13
AN39
AN31
AN32
AN46
BCM5Y
BCM1
BCM2A
PL01
AN27
AN29
AN18
AN09
AN10
AN44
AN33
AN34
ANE4
ANE1
ANE2
AN48
AN47
BBB3H
AN40
AN26
AN28
AN06
AN02
AN25
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
IH02R
IH02N
IH02D
IH02T
IH02S
MTE1B
AN41
AN36
AN37
AN42X
ANE3
KLE1
KL02
MTO1VC
MTE2B
EXHAUST BRAKE N/V (-)
EXHAUST BRAKE N/V (+)
IDLE UP CANCEL SWITCH
NEUTRAL SWITCH
EXHAUST BRAKE LAMP
CAN H
CAN L
NE OUT (SIG)
PWM ACCEL OUT (SIG)
ABS EXHAUST BRAKE
CUT RELAY
GE96A
GE58A
Engine ECU
Gr13E A03
BCS1AB 0.85-RW
BCS1C 0.85-R
210
To
safety
relay
Gr54

C00458-2

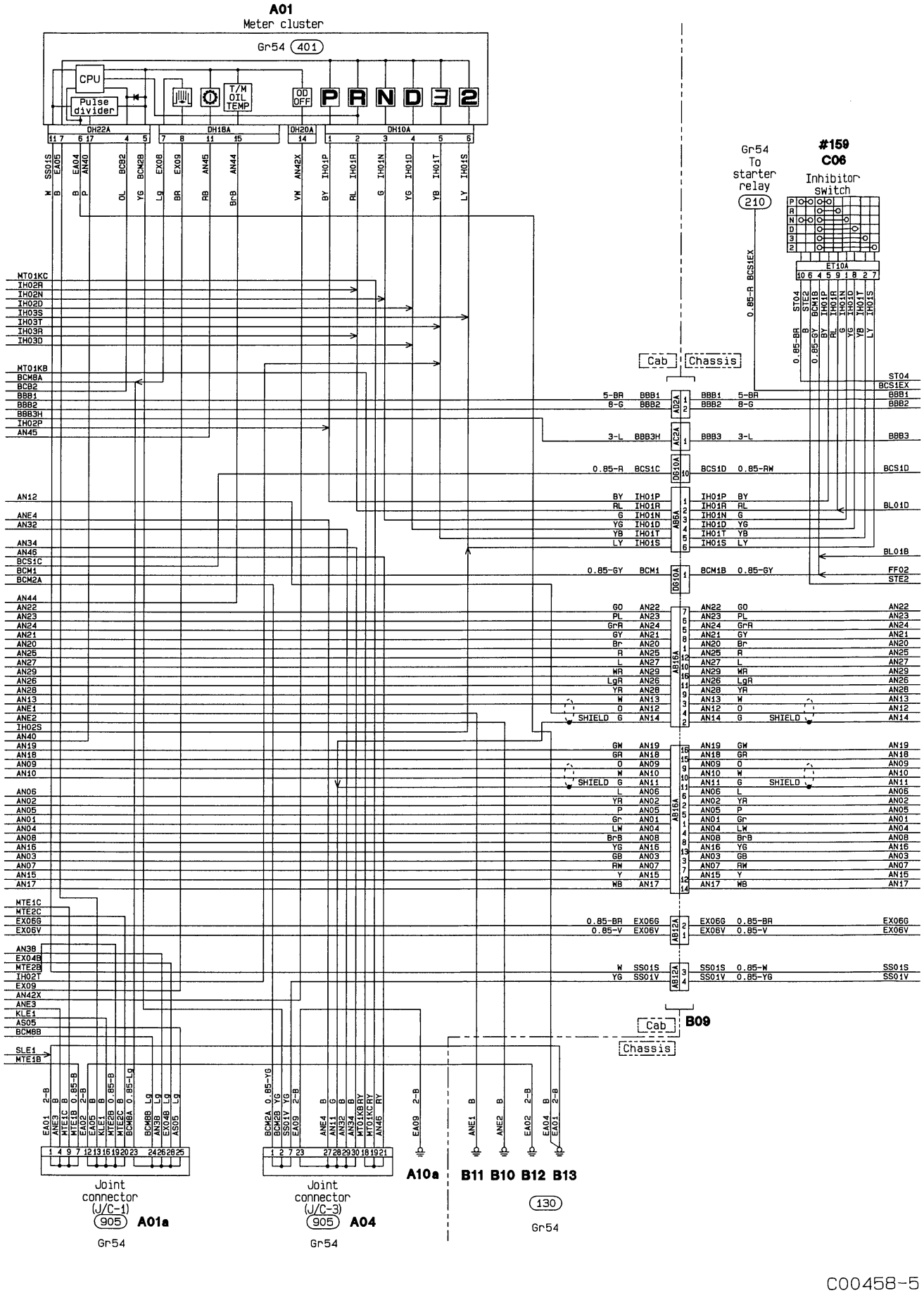
ELECTRIC CIRCUIT DIAGRAM



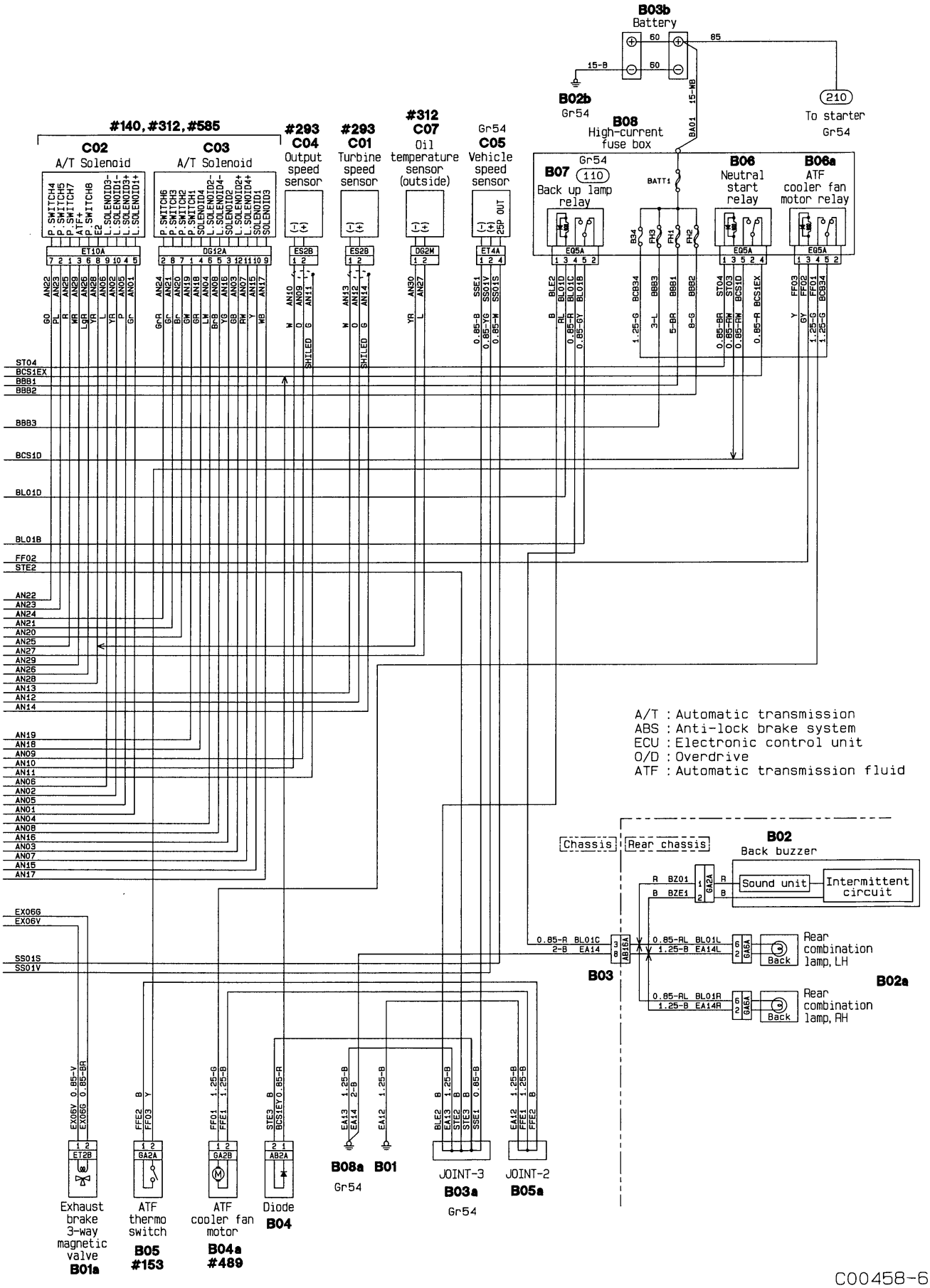

A18 Diode
YG IH03D
RY IH03DR
RL IH03R
YB IH03T
RY IH03ST
LY IH03S
MTE1C
MTE2C
MT01KC
IH03DR
MT01KB
BCM8A
BCB2
BBB1
BBB2
BBB3H
IH02P
AN45
AN22
AN23
AN24
AN19
AN21
AN20
AN12
AN13
AN32
AN46
BCS1C
BCM1
BCM2A
IH02T
ANE4
AN27
AN29
AN18
AN09
AN10
AN44
AN34
ANE1
ANE2
IH02S
AN40
AN26
AN28
AN06
AN02
AN25
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
IH02R
IH02N
IH02D
EX06G
EX06V
AN38
EX04B
MTE2B
EX09
AN42X
ANE3
KLE1
AS05
BCM8B
SLE1
MTE1B
MT01KC
IH02R
IH02N
IH02D
IH03S
IH03T
IH03R
IH03D
MT01KB
BCM8A
BCB2
BBB1
BBB2
BBB3H
IH02P
AN45
AN12
ANE4
AN32
AN34
AN46
BCS1C
BCM1
BCM2A
AN44
AN22
AN23
AN24
AN21
AN20
AN25
AN27
AN29
AN26
AN28
AN13
ANE1
ANE2
IH02S
AN40
AN19
AN18
AN09
AN10
AN06
AN02
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
MTE1C
MTE2C
EX06G
EX06V
AN38
EX04B
MTE2B
IH02T
EX09
AN42X
ANE3
KLE1
AS05
BCM8B
SLE1
MTE1B

C00458-4

ELECTRIC CIRCUIT DIAGRAM



C00458-5


B03b
Battery
60
60
85
15-B
15-WB
B02b
Gr54
210
To starter
Gr54
B08
High-current
fuse box
BA01
Gr54
B07
110
Back up lamp
relay
BATT1
B06
Neutral
start
relay
B06a
ATF
cooler fan
motor relay
EQ5A
#140,#312,#585
C02
A/T Solenoid
C03
A/T Solenoid
#293
C04
Output
speed
sensor
#293
C01
Turbine
speed
sensor
#312
C07
Oil
temperature
sensor
(outside)
Gr54
C05
Vehicle
speed
sensor
ET10A
DG12A
ES2B
DG2M
ET4A
ST04
BCS1EX
BBB1
BBB2
BBB3
BCS1D
BL01D
BL01B
FF02
STE2
AN22
AN23
AN24
AN21
AN20
AN25
AN27
AN29
AN26
AN28
AN13
AN12
AN14
AN19
AN18
AN09
AN10
AN11
AN06
AN02
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
EX06G
EX06V
SS01S
SS01V
A/T : Automatic transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
O/D : Overdrive
ATF : Automatic transmission fluid
Chassis
Rear chassis
B02
Back buzzer
Sound unit
Intermittent
circuit
B03
B02a
Rear
combination
lamp, LH
Rear
combination
lamp, RH
Back
B08a
B01
Gr54
JOINT-3
B03a
Gr54
JOINT-2
B05a
Exhaust
brake
3-way
magnetic
valve
B01a
ATF
thermo
switch
B05
#153
ATF
cooler fan
motor
B04a
#489
Diode
B04

C00458-6

GROUP 25 INDEX

SPECIFICATIONS 25-2

STRUCTURE AND OPERATION

1. **Configuration of Propeller Shaft (Driveshaft) Connection 25-2**
2. **Propeller Shaft <Without Center (Midship) Bearing> 25-3**
3. **Propeller Shaft <With Center (Midship) Bearing> 25-3**

TROUBLESHOOTING 25-4

REMOVAL AND INSTALLATION OF PROPELLER SHAFT <BETWEEN T/M AND REAR AXLE> 25-6

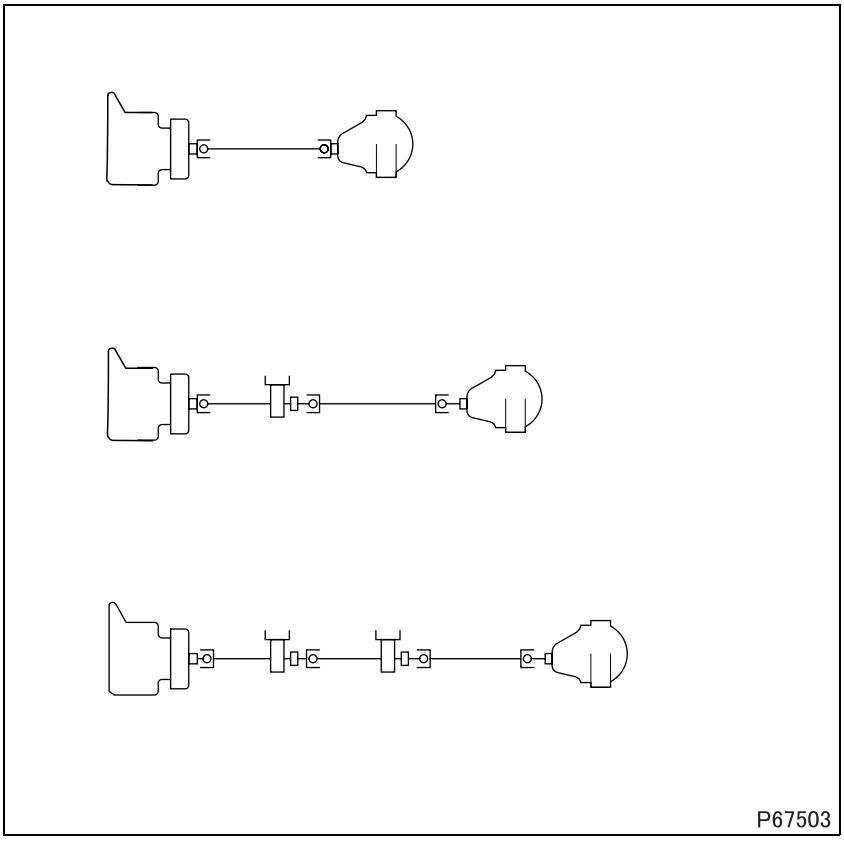
PROPELLER SHAFT 25-10

SPECIFICATIONS

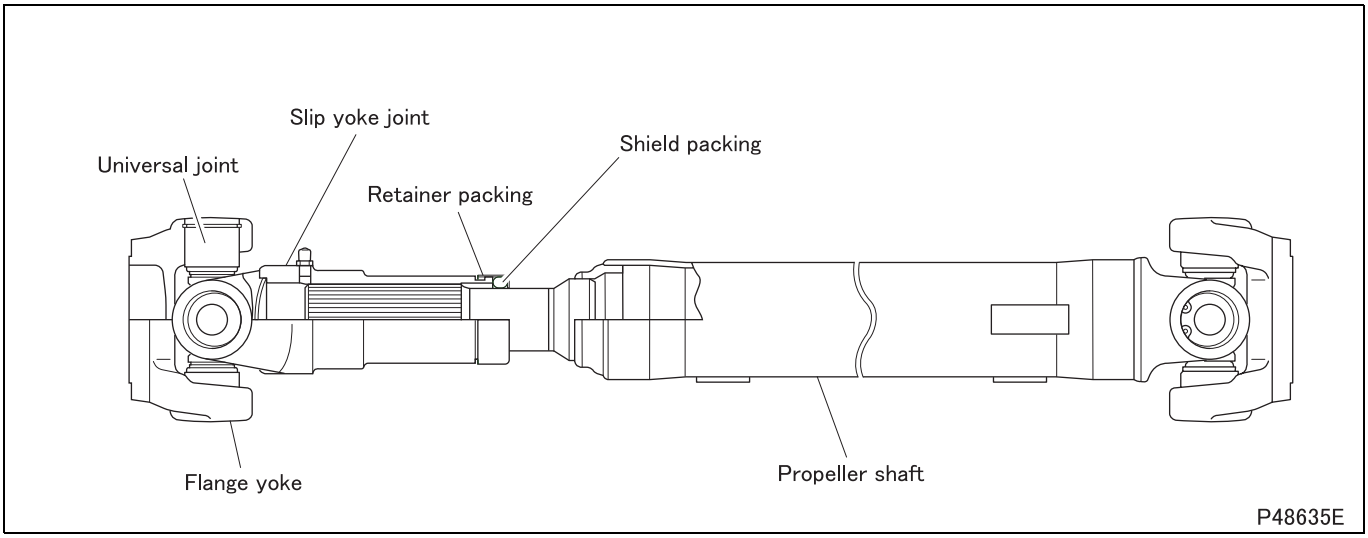
Item		Specifications
Propeller shaft (driveshaft)	Model	P3

STRUCTURE AND OPERATION

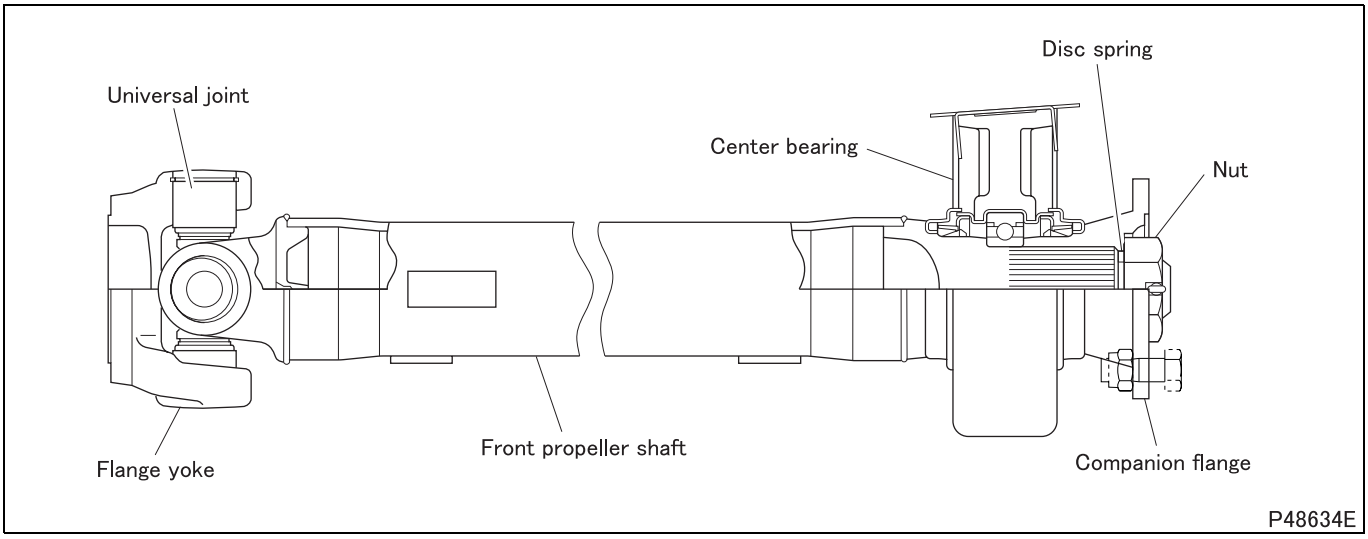
1. Configuration of Propeller Shaft (Driveshaft) Connection



2. Propeller Shaft <Without Center (Midship) Bearing>



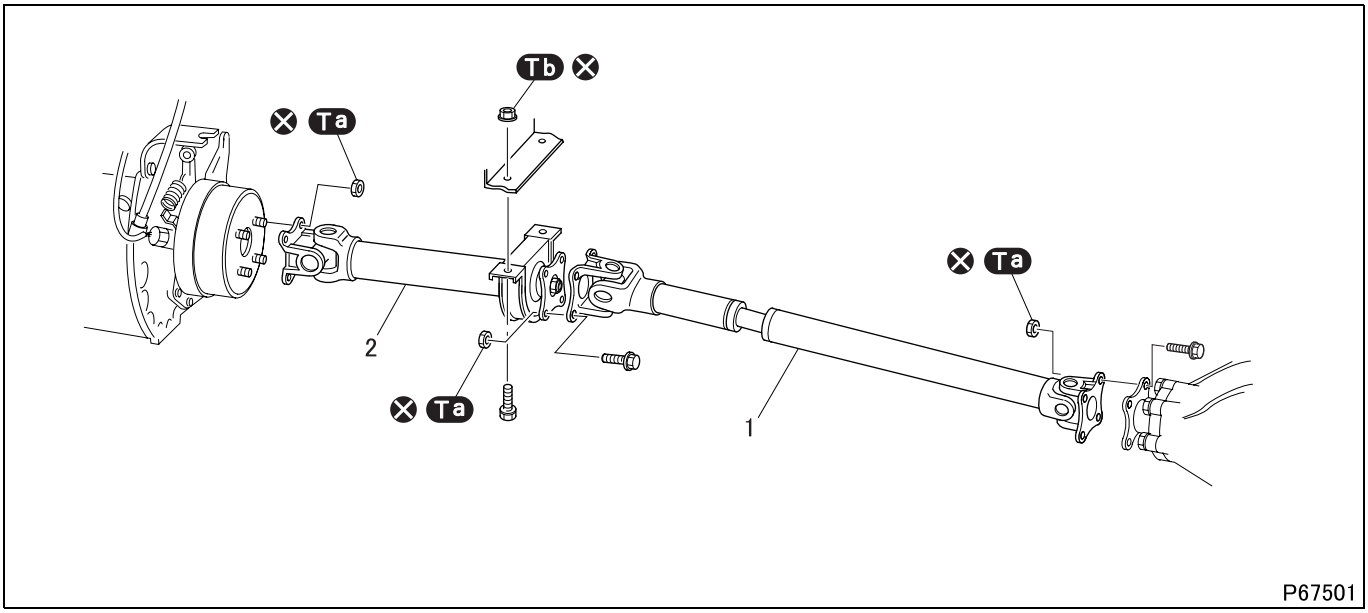
3. Propeller Shaft <With Center (Midship) Bearing>



Symptoms / Possible causes		Propeller shaft vibrates		Abnormal noise from propeller shaft	
		Vibration at high speed	Vibration at low speed	Abnormal noise at acceleration from zero or at coasting	Abnormal noise at normal running
Wrong combination of flange yoke directions		O			
Slip yoke joint	Insufficient grease				O
	Excessive play at spline		O	O	
Universal joint	Excessive clearance in axial direction of spider shaft		O		O
	Insufficient grease on needle bearing				O
	Worn out needle bearing	O		O	O
Center bearing	Insufficient grease				O
	Seizure, wear or improper rotation	O			O
	Deteriorated or deformed cushion rubber			O	
	Loose hanger mounting bolt			O	
Propeller shaft	Loose mounting bolts	O		O	
	Bent	O			
	Dynamic balance improper	O			
T/M in high speed gear			O		

M E M O

REMOVAL AND INSTALLATION OF PROPELLER SHAFT <BETWEEN T/M AND REAR AXLE>



● **Removal sequence**

1 Propeller shaft <Without center (midship) bearing> (see later section)
2 Propeller shaft <With center (midship) bearing> (see later section)

⊗: Non-reusable parts

CAUTION ⚠

- **Chock the tires fore and aft to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

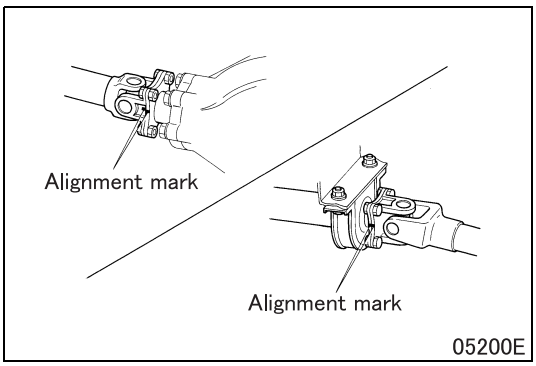
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Permissible amount of imbalance for propeller shaft <Without center bearing>	10 g (0.35 oz} max./3000 rpm (periphery of pipe portion of shaft)	–	Adjust
2	Permissible amount of imbalance for propeller shaft <With center bearing>	5 g (0.18 oz} max./3000 rpm (periphery of pipe portion of shaft)	–	Adjust

Torque: N·m (lbf·ft)

ID	Fastener	Value	Remarks
Ta	Nut (propeller shaft mounting)	100 to 120 (74 to 89)	–
Tb	Nut (front propeller shaft bracket mounting)	47 to 65 (35 to 48)	–

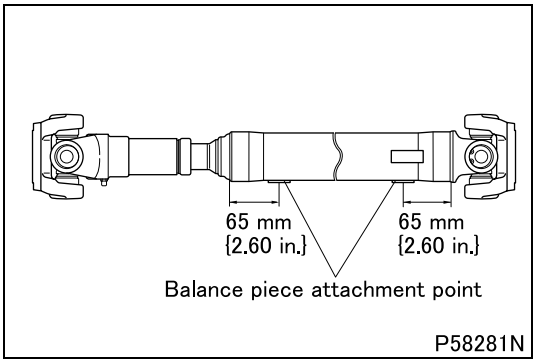
◆Work before removal◆



■ Alignment mark: Propeller shaft

- Before removing the U-joints, make alignment marks on the end yokes for ease of installation.

◆Inspection procedure◆



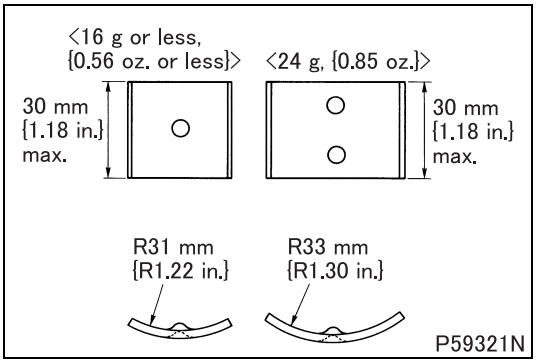
■ Inspection: Propeller shaft <Without center bearing>

[Inspection]

- Measure the amount of dynamic balance on a balancing machine.
- If the measured value exceeds the standard value, make adjustment as follows.

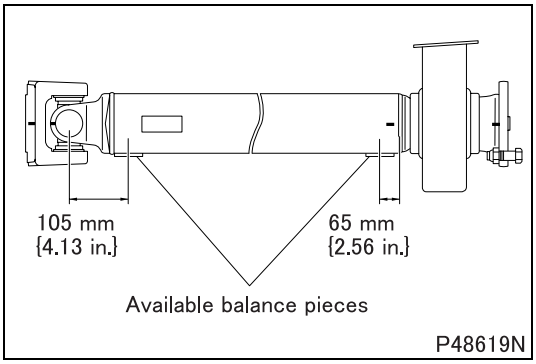
[Adjustment]

- Attach appropriate balance pieces (shims) at the illustrated points to reduce the imbalance to within the standard range.
- Maximum allowance for one point is 3.53 oz (100 g).
- Use a combination that keeps the number of balance pieces to a minimum.



Available balance pieces (shims)

Mass
2 g (0.07 oz)
4 g (0.14 oz)
6 g (0.21 oz)
8 g (0.28 oz)
10 g (0.35 oz)
12 g (0.42 oz)
16 g (0.56 oz)
24 g (0.85 oz)



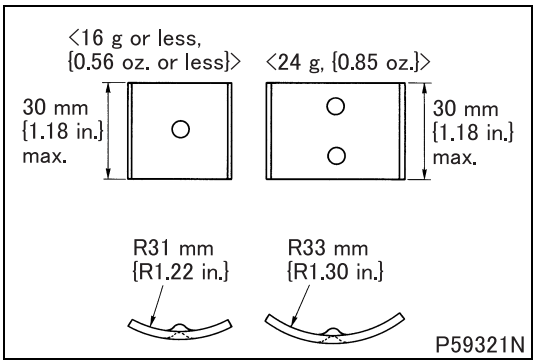
■ **Inspection: Propeller shaft <With center bearing>**

[Inspection]

- Measure the amount of dynamic balance on a balancing machine.
- If the measured value exceeds the standard value, make adjustment as follows.

[Adjustment]

- Attach appropriate balance pieces (shims) at the illustrated points to reduce the imbalance to within the standard range.
- Maximum allowance for one point is 100 g {3.53 oz}.
- Use a combination that keeps the number of balance pieces to a minimum.

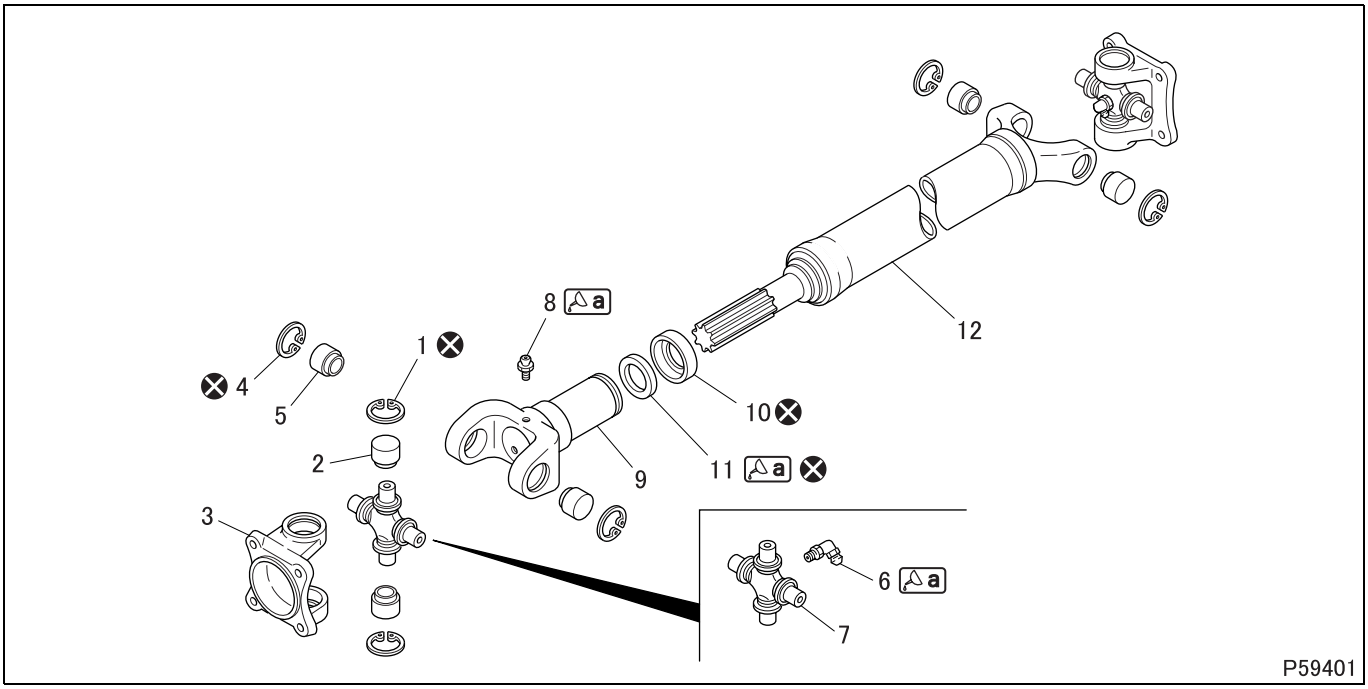


Available balance pieces (shims)

Mass
2 g (0.07 oz)
4 g (0.14 oz)
6 g (0.21 oz)
8 g (0.28 oz)
10 g (0.35 oz)
12 g (0.42 oz)
16 g (0.56 oz)
24 g (0.85 oz)

M E M O

<Without center bearing>



● Disassembly sequence

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Snap ring
5 Needle bearing
6 Grease fitting
7 Spider
8 Grease fitting
9 Slip yoke joint
10 Retainer packing
11 Shield packing
12 Propeller shaft (driveshaft)

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse, excepting:
12→10→11→9

Repair kit: Universal joint spider kit

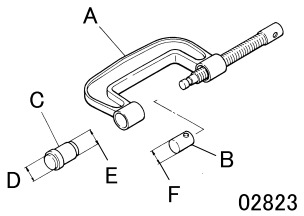
Service standards: mm (in)

Location	Maintenance item	Standard value	Limit	Remedy
–	Axial clearance of spider	0 to 0.06 (0 to 0.0024)	–	Adjust
2, 3	Clearance between needle bearing and flange yoke	0.008 to –0.033 (0.00031 to –0.0013) "–" means interference	0.1 (0.004)	Replace
2, 5, 6	Play between needle bearing and spider	0.01 to 0.06 (0.0004 to 0.0024)	0.1 (0.004)	Replace
5, 9	Clearance between needle bearing and slip joint	0.008 to –0.033 (0.00031 to –0.0013) "–" means interference	0.1 (0.004)	Replace
9, 12	Play in direction of rotation between the slip yoke joint and the propeller shaft spline	0.01 to 0.09 (0.00039 to 0.0035)	0.3 (0.012)	Replace
	Play in the opposite direction between the slip yoke joint and the propeller shaft spline	0.02 to 0.16 (0.0008 to 0.0063)	0.3 (0.012)	Replace
12	Bend of propeller shaft	–	0.4 (0.016)	Correct or replace

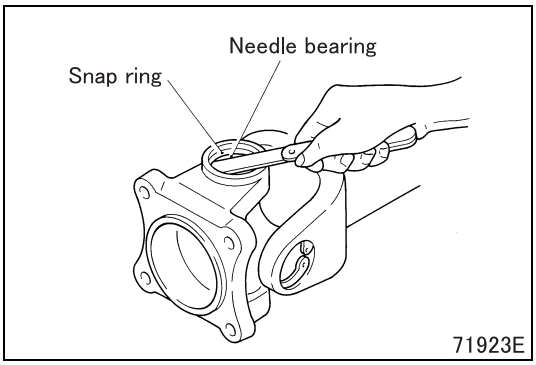
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply through grease fitting	Wheel bearing grease [NGLI No. 2 (Li soap)]	As required
	Lips 0f shield packing		

Special tools: mm (in)

ID	Tool name and shape	Part No.	Application
a	Universal joint tool set **A:** Yoke assembly **B:** Push rod **C:** Guide D: ϕ29 {1.14}, E: ϕ29 {1.14}, F: ϕ27.7 {1.09} 	MB999024 A: MB999025 B: MB999026 C: MB999010	Removal and installation of needle bearing

◆Work before removal◆

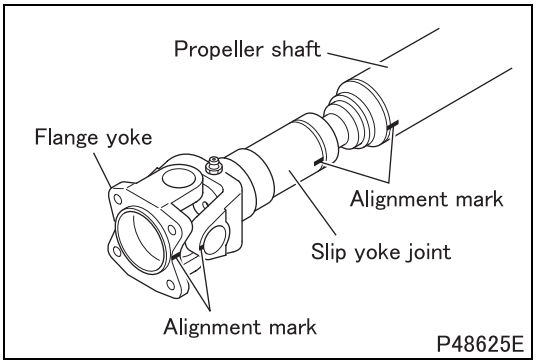


■ Inspection: Axial clearance of spider

- Press down on the needle bearing, and measure clearance between the snap ring and the needle bearing.
- If the measured value exceeds the standard value, correct by changing the snap ring thickness.
  To adjust, use snap rings for both ends with the same thickness. If necessary, use the table below to select the best combination of snap rings.

Table of snap rings (solid line indicates best combination)

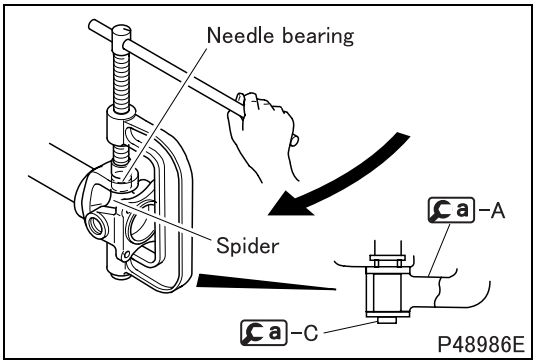
Thickness	Identification color	Combination	Thickness	Identification color
0.059 in (1.49 mm)	None		0.059 in (1.49 mm)	None
0.060 in (1.52mm)	Black		0.060 in (1.52mm)	Black
0.061 in (1.55 mm)	Blue		0.061 in (1.55 mm)	Blue
0.062 in (1.58 mm)	Yellow		0.062 in (1.58 mm)	Yellow
0.063 in (1.61 mm)	Purple		0.063 in (1.61 mm)	Purple
0.065 in (1.64 mm)	None		0.065 in (1.64 mm)	None
0.066 in (1.67 mm)	Black		0.066 in (1.67 mm)	Black
0.067 in (1.70 mm)	Blue		0.067 in (1.70 mm)	Blue



■ **Alignment mark: Propeller shaft**

- For ease of installation, make alignment marks on the flange yoke, slip yoke joint, and propeller shaft.

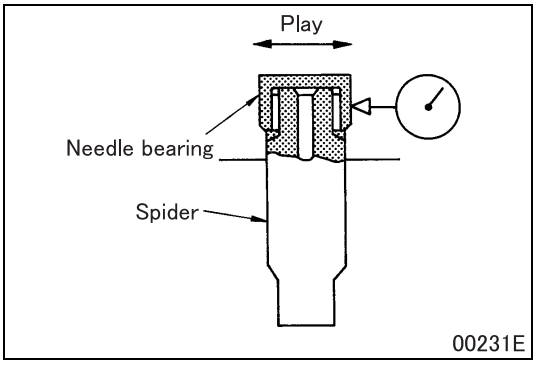
◆Removal procedure◆



■ **Removal: Needle bearing**

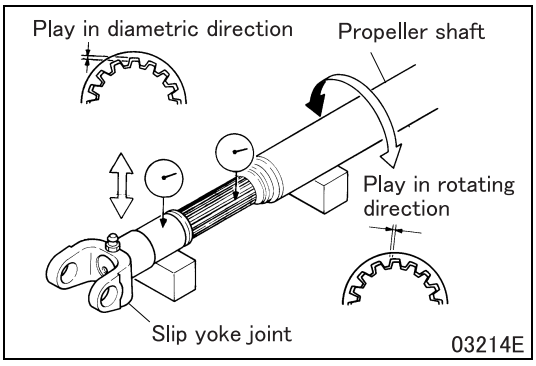
- Fit the needle bearing guide Ca**-C** into the yoke assembly Ca**-A** from outside.
- Applying the needle bearing guide Ca**-C** to the spider, operate the yoke assembly Ca**-A** to force out the spider and remove the needle bearing.

◆Inspection procedure◆



■ **Inspection: Clearance between needle bearing and spider**

- If the clearance is above the limit, replace the needle bearing out of the universal joint spider kit.

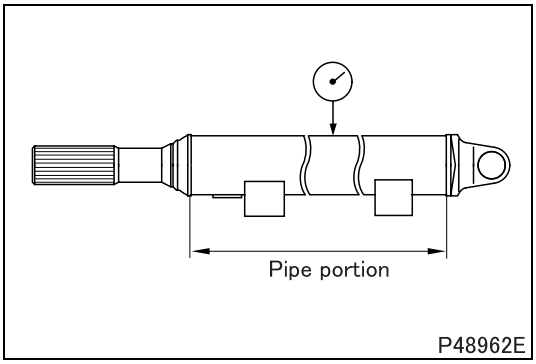


■ **Inspection: Play between slip yoke joint and propeller shaft spline**

- Check the following, and if the measurement is higher than the limit, replace the faulty part.

(1) Play of spline in the direction of rotation

(2) Play of spline in the opposite direction



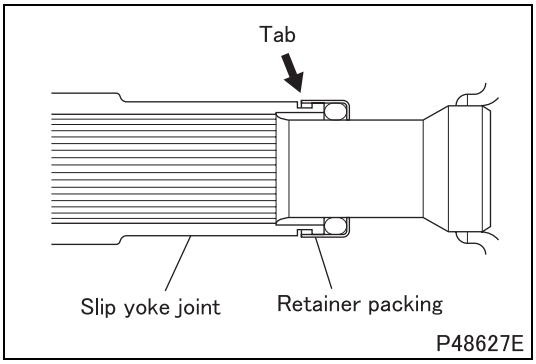
■ **Inspection: Bend in propeller shaft**

- Measure the bend in the propeller shaft at the center of its pipe portion.
- If the measurement is higher than the limit, correct the bend with a press or replace the propeller shaft.

NOTE

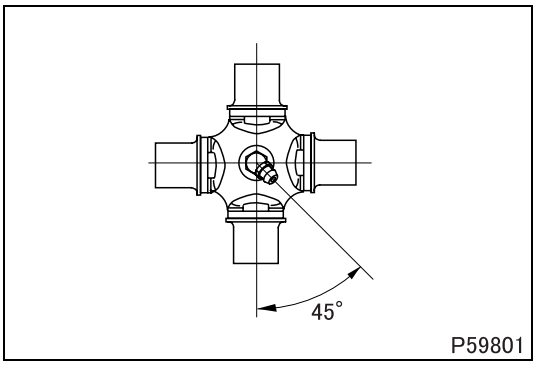
- **To measure the bend in the propeller shaft, turn it fully once and read the dial gauge indicator. The bend is one-half of the indicated value.**
- **Check the propeller shaft for cracks in the welded area after using a press to correct the bend. If cracks are found, replace the propeller shaft.**

◆Installation procedure◆



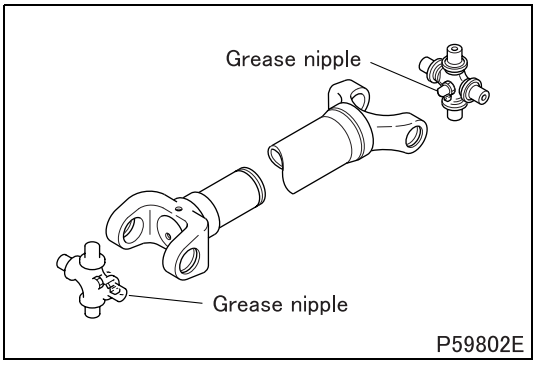
■ **Installation: Retainer packing**

- Hold the retainer packing against the slip yoke joint and caulk the tabs (at eight places).

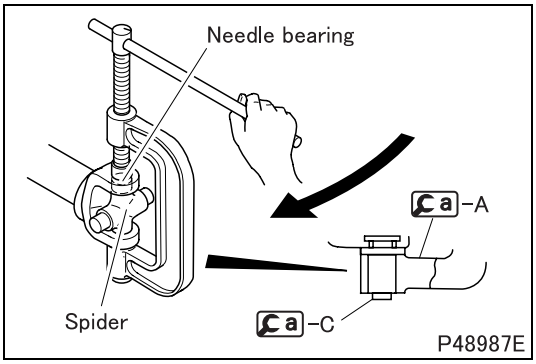


■ **Installation: Spider**

- Install the grease fitting on the spider at the angle shown in the illustration.



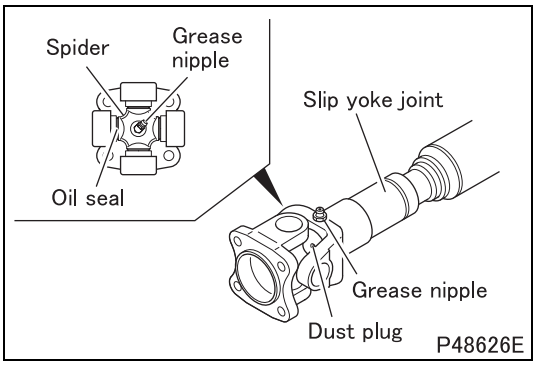
- Install the spiders on the both ends of propeller shaft. so that the direction of grease fittings must be the same.



■ **Installation: Needle bearing**

- Fit the needle bearing guide Ⓐ**-C** into the yoke assembly Ⓐ**-A** from inside.
- Operating the yoke assembly Ⓐ**-A**, install the needle bearing.

◆**Work after installation**◆



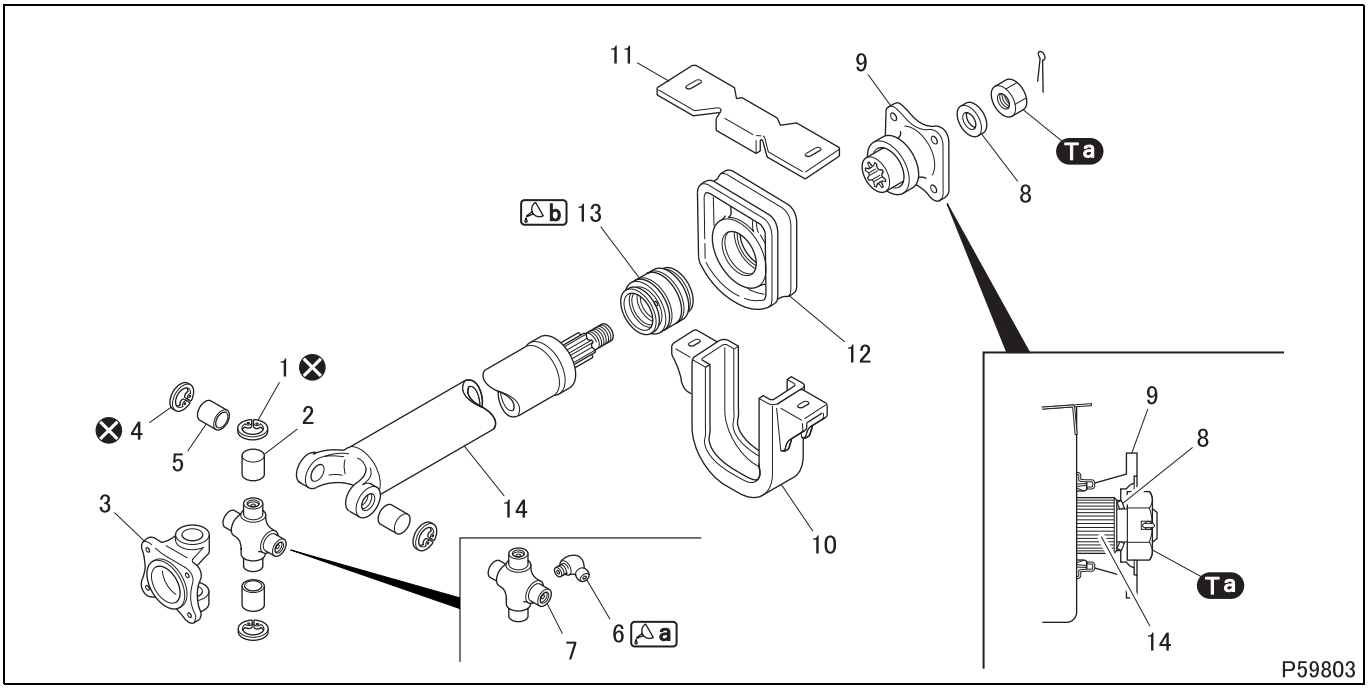
■ **Lubrication: Grease fittings**

- Add grease through the grease fitting until clean grease overflows from the oil seal of the spider.
- Add grease through the grease fitting until clean grease overflows from the hole in the dust plug of the slip yoke joint.

M E M O

PROPELLER SHAFT

<With center (midship) bearing>



● Disassembly sequence

1 Snap ring, spider
2 Needle bearing
3 Flange yoke
4 Snap ring, end yoke
5 Needle bearing
6 Grease fitting
7 Spider
8 Washer
9 Companion flange
10 Center bearing bracket
11 Center bearing hanger
12 Center bearing housing
13 Center (midship) bearing
14 Propeller shaft (driveshaft)

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Universal joint spider kit

Service standards: mm (in)

Location	Maintenance item	Standard value	Limit	Remedy
–	Axial clearance of spider	0 to 0.06 {0 to 0.0024}	–	Adjust
2, 3	Clearance between needle bearing and flange yoke	0.008 to –0.033 {0.00031 to –0.0013} "–" means interference.	0.1 {0.0039}	Replace
2, 5, 6	Play between needle bearing and spider	0.01 to 0.06 {0.00039 to 0.0024}	0.1 {0.0039}	Replace
5, 14	Clearance between needle bearing and propeller shaft	0.008 to –0.033 {0.00031 to –0.0013} "–" means interference.	0.1 {0.0039}	Replace
14	Bend of propeller shaft	–	0.4 {0.016}	Correct or replace

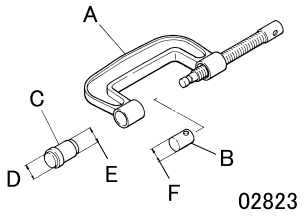
Torque: N·m (lbf·ft)

ID	Fastener	Value	Remarks
Ta	Nut (companion flange mounting)	290 to 390 (215 to 285)	–

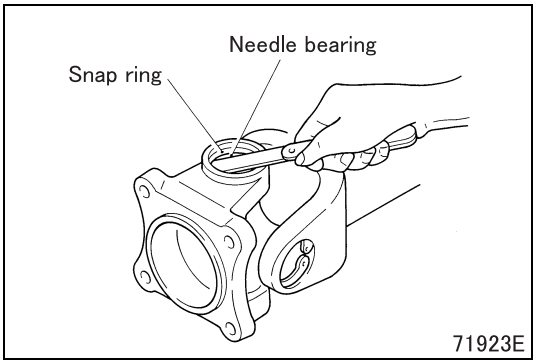
Lubricant and/or sealant

ID	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply through grease fitting	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
b	Fill space in center bearing housing	Heat-resisting grease [NLGI No. 3]	70 to 100% of space capacity: 0.71 to 1.0 oz (20 to 29 g)
	Lips of the center bearing seal		As required

Special tools: mm (in)

ID	Tool name and shape	Part No.	Application
a	Universal joint tool set **A:** Yoke assembly **B:** Push rod **C:** Guide D: ϕ29 {1.14}, E: ϕ29 {1.14}, F: ϕ27.7 {1.09} 	MB999024 A: MB999025 B: MB999026 C: MB999010	Removal and installation of needle bearing

◆Work before removal◆

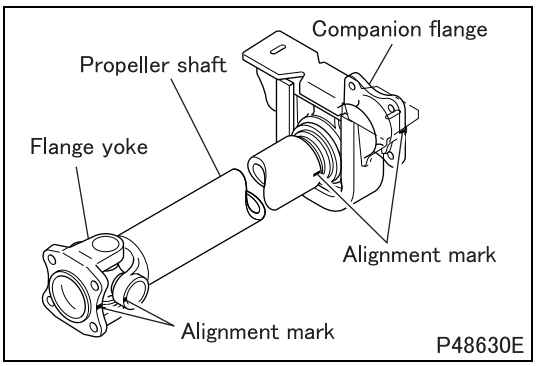


■ Inspection: Axial clearance of spider

- Press down on the needle bearing, and measure clearance between the snap ring and the needle bearing.
- If the measured value exceeds the standard value, correct by changing the snap ring thickness.
  To adjust, use snap rings for both ends with the same thickness. If necessary, use the table below to select the best combination of snap rings.

Table of snap rings (solid line indicates best combination).

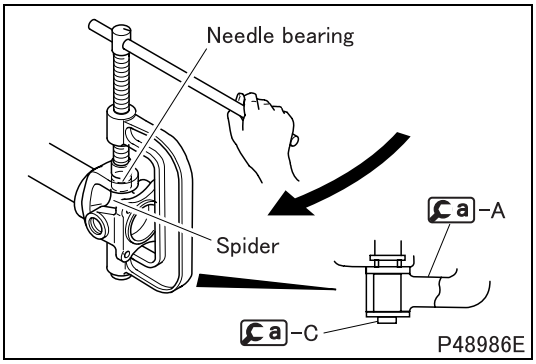
Thickness	Identification color	Combination	Thickness	Identification color
0.059 in (1.49 mm)	None		0.059 in (1.49 mm)	None
0.060 in (1.52mm)	Black		0.060 in (1.52mm)	Black
0.061 in (1.55 mm)	Blue		0.061 in (1.55 mm)	Blue
0.062 in (1.58 mm)	Yellow		0.062 in (1.58 mm)	Yellow
0.063 in (1.61 mm)	Purple		0.063 in (1.61 mm)	Purple
0.065 in (1.64 mm)	None		0.065 in (1.64 mm)	None
0.066 in (1.67 mm)	Black		0.066 in (1.67 mm)	Black
0.067 in (1.70 mm)	Blue		0.067 in (1.70 mm)	Blue



■ **Alignment mark: Propeller shaft**

- For ease of installation, make alignment marks on the flange yoke, companion flange and propeller shaft.

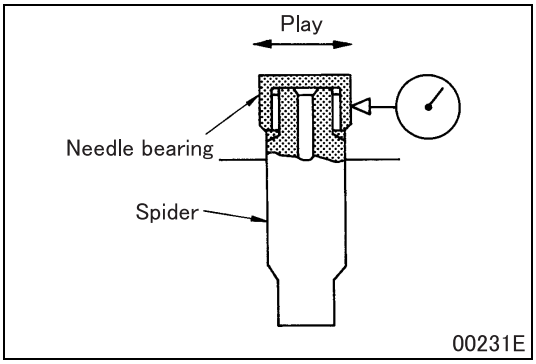
◆Removal procedure◆



■ **Removal: Needle bearing**

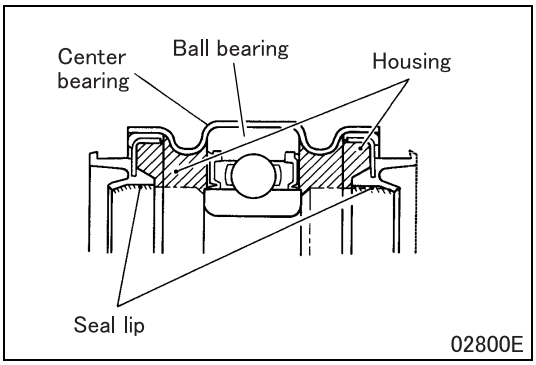
- Fit the needle bearing guide Ca **-C** into the yoke assembly Ca **-A** from outside.
- Applying the needle bearing guide Ca **-C** to the spider, operate the yoke assembly Ca **-A** to force out the spider and remove the needle bearing.

◆Inspection procedure◆



■ **Inspection: Clearance between needle bearing and spider**

- If the clearance is above the limit, replace the needle bearing out of the universal joint spider kit.

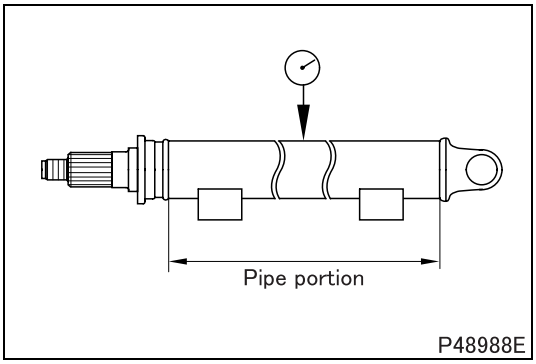


■ **Inspection: Center (midship) bearing**

- Check the bearing every 31,070 miles (50 000 km) or at the nearest regular maintenance interval. If excessive grease outflow is evident, pack grease into the center bearing housing up to 70 to 100% of capacity: 0.71 to 1.02 oz (20 to 29 g).
- Apply grease to the lips of the bearing seal.

NOTE

- **The ball bearing portion of the center bearing is provided with an oil seal and requires no lubrication.**



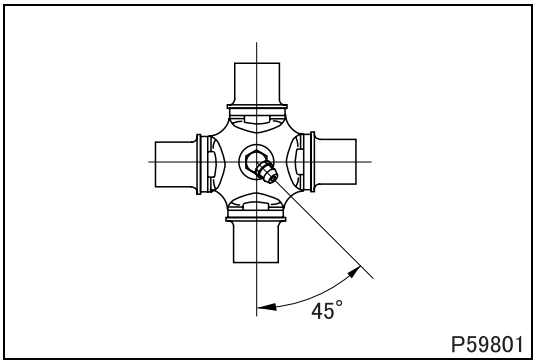
■ **Inspection: Bend in propeller shaft**

- Measure the bend in the propeller shaft at the center of its pipe portion.
- If the measurement is higher than the limit, correct the bend with a press or replace the propeller shaft.

NOTE

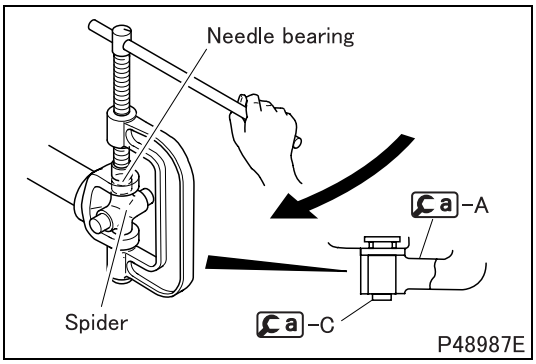
- **To measure the bend in the propeller shaft, turn it fully once and read the dial gauge indicator. The bend is one-half of the indicated value.**
- **Check the propeller shaft for cracks in the welded area after using a press to correct the bend. If cracks are found, replace the propeller shaft.**

◆Installation procedure◆



■ **Inspection: grease fitting**

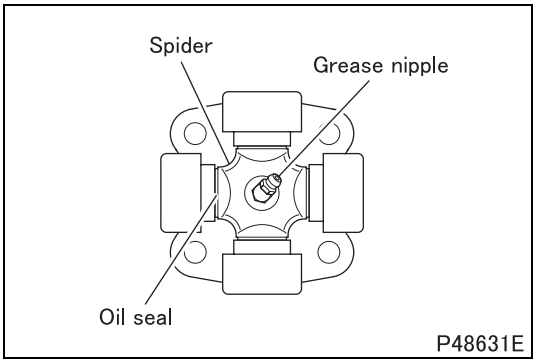
- Install the grease fitting on the spider at the angle shown in the illustration.



■**Installation: Needle bearing**

- Fit the needle bearing guide a **-C** into the yoke assembly a **-A** from inside.
- Operating the yoke assembly a **-A**, install the needle bearing.

◆Work after installation◆



■ **Lubrication: grease fitting**

- Add grease through the grease fitting until clean grease overflows from the oil seal of the spider.

GROUP 26 INDEX

SPECIFICATIONS 26-2

STRUCTURE AND OPERATION
1. **Wheel Hub and Rotor 26-3**
2. **Knuckle and King Pin, Front Axle 26-4**

TROUBLESHOOTING 26-5

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspection and Adjustment of Wheel Alignment 26-6**
2. **Inspection and Adjustment of Steering Angle 26-10**
3. **Inspection of Side Slip 26-11**
4. **Inspection of Tie Rod End Ball Joint 26-11**

WHEEL HUB AND ROTOR 26-12

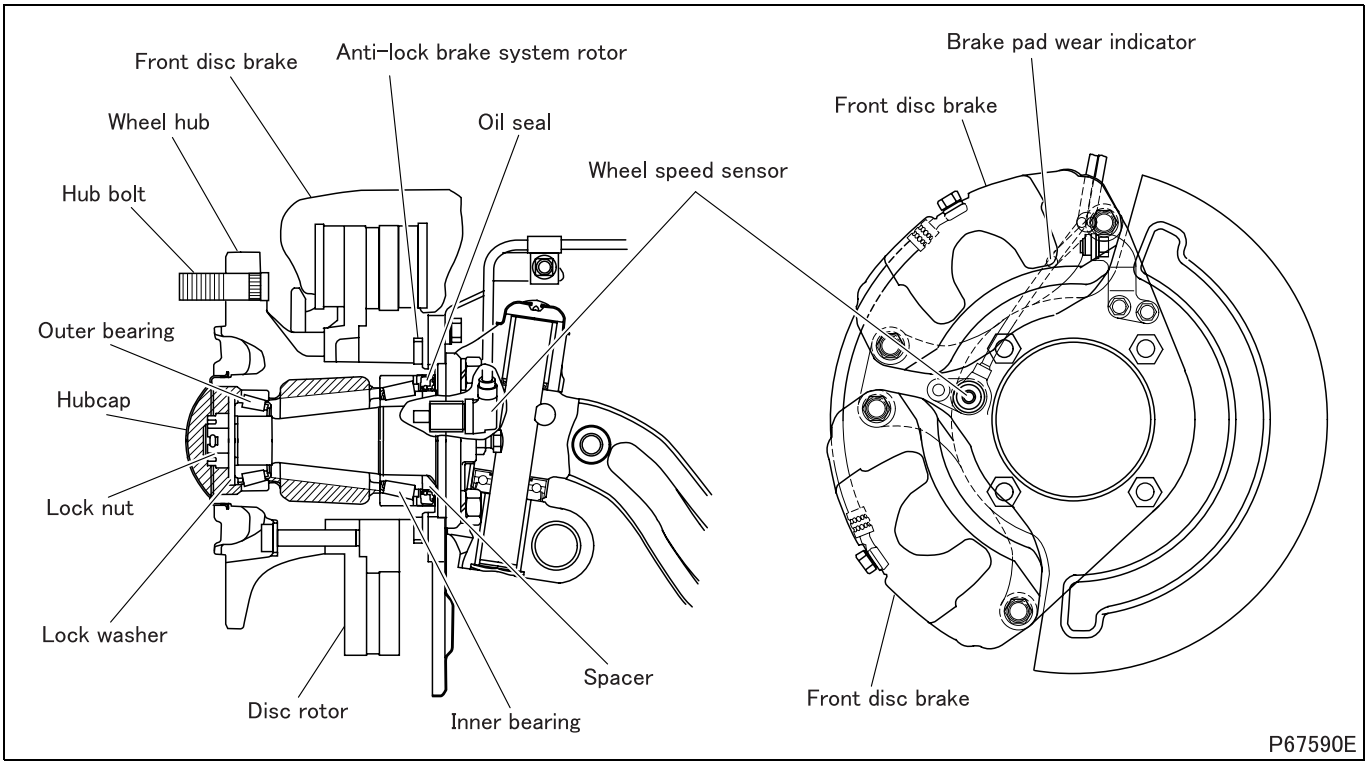
KNUCKLE AND KING PIN, FRONT AXLE 26-20

TIE ROD 26-28

SPECIFICATIONS

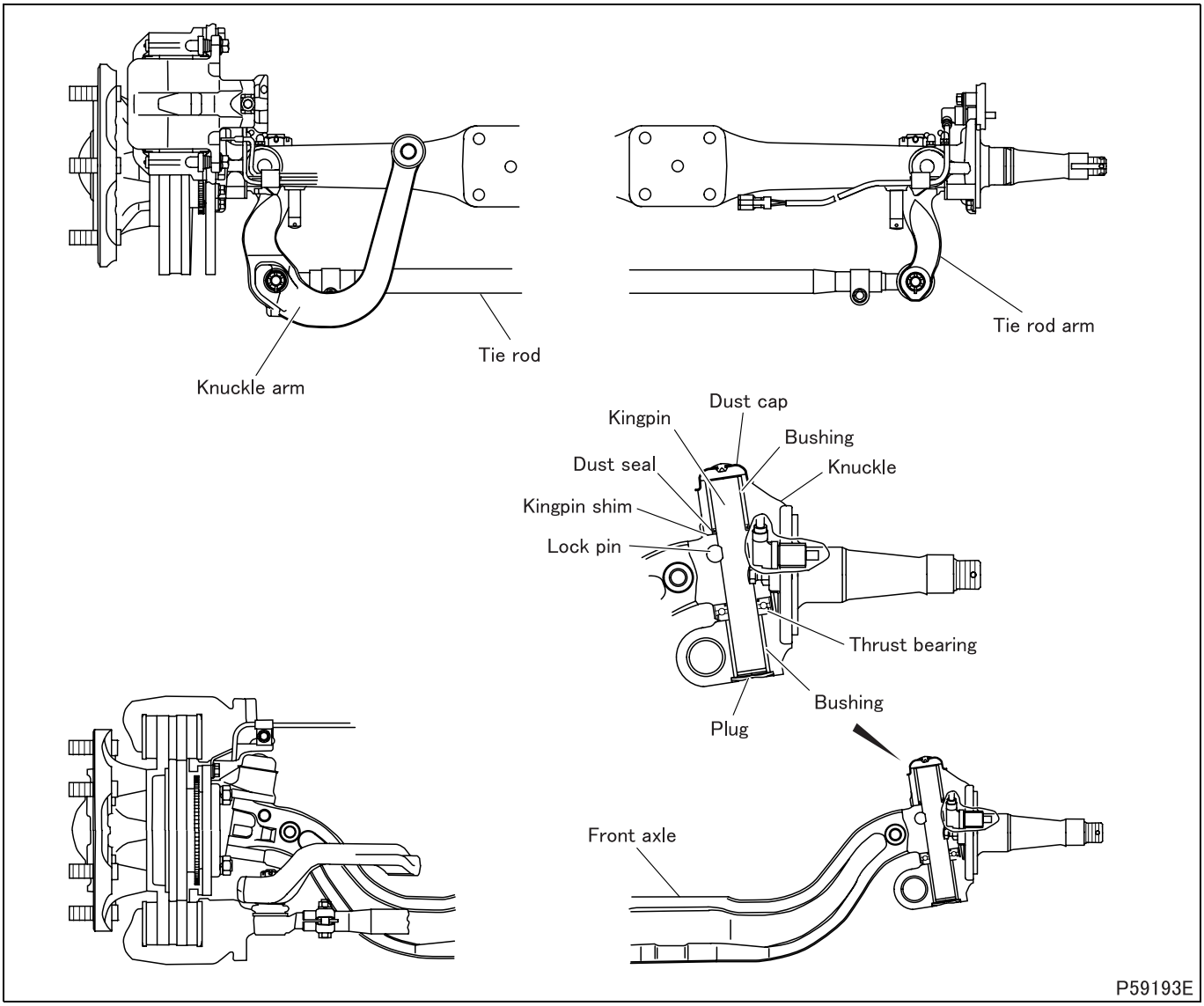
Item			Specifications		
			COE 40	COE 45	COE 50
Front axle	Model		F200T	F300T	F350T
	Type		Reverse Elliot, “I” beam		
King pin Outer diameter × Length		mm {in}	28 × 180 {1.10 × 7.09}		
Tread (dimension notified to the authorities)		mm {in}	1665 {65.6}		
Mass (with disc brakes)		kg {lb}	Approx. 150 {331}	Approx. 155 {342}	Approx. 165 {365}

1. Wheel Hub and Rotor



- The brake pad wear indicator is installed on the right wheels or on both the right and left wheels.

2. Knuckle and king pin, front axle



Possible causes	Symptoms	Continuous noise while cruising	Intermittent noise while cruising	Steering wheel shakes	Steering feels stiff	Steering wheel return poor	Unable to steer the steering wheel	Steering pulls to one side	Uneven wear or early wear of front tires	Reference Gr
Wheel hub, knuckle and king pin, front axle	Wheel alignment misaligned			O	O	O			O	
	Steering angle adjustment faulty						O			
	Wheel hub bearing seized, worn or rotation faulty	O		O						
	Wheel hub bearing broken		O							
	King pin worn			O						
	Clearance between king pin and king pin bushing excessive			O	O					
	Greasing to king pin insufficient				O					
	king pin thrust bearing seized, worn or rotation faulty				O					
	Vertical clearance between knuckle and front axle excessive			O						
	Knuckle arm and tie rod arm tightening nuts loose			O						
	Ball stud tightening nut of tie rod end loose			O						
	Tie rod end ball stud worn			O						
	Tie rod bent						O			
	Knuckle bent							O		
	Front axle bent							O		
	Various parts of front axle tightened excessively					O				
Front suspension	U-bolt nut of front suspension loose			O						Gr33
	One of front springs worn-out or broken							O		
Tire	Tire inflation pressure uneven			O					O	Gr31
	Tire inflation pressure too little				O					
	Inflation pressure uneven for right and left tires							O		
	Size and type of right and left tires different							O	O	
	Outer diameters of right and left tires remarkably different							O		
	Handling of tires inadequate								O	

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Wheel Alignment

Before performing a wheel alignment, do the following:

- Park the vehicle unloaded on a level surface.
- Make sure that the tires are the proper size and inflated to the proper pressure.
- If tire wear is noticeably different on one side of the vehicle, replace the tires.
- Check the vehicle body for tilt to either side, and correct if necessary.
- Service all parts of the front axle and correct any problems, including the following.
  - King pin play or loose king pin
  - Loose front wheel hub
  - Loose bolts used for tightening various parts of tie rod arm, knuckle arm and tie rod
  - Bend of knuckle and front axle
- Make sure steering wheel free play is correct.
- Both wheel alignment and side slip must conform to the standard values.

Service standards: mm {in}

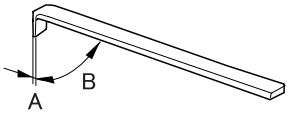
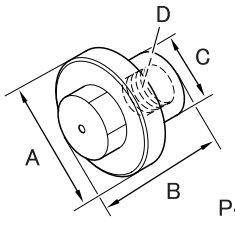
Location	Maintenance item	Standard value	Limit	Remedy
–	Toe-in	0 to 6 (3 ± 3) {0 to 0.24}	–	Adjust
	Camber	1°00 ± 30’	–	*
	Caster	1°15’ ± 1°00’	–	Replace
	King pin inclination angle	8°	–	Replace

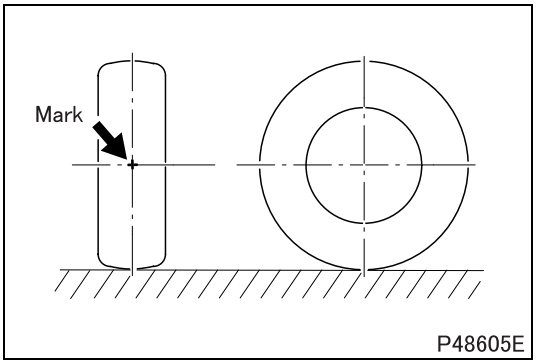
*: If the measured value deviates from the standard value, problems such as wear of the king pin and the king pin bushing, loose hub bearing, and bend of knuckle and front axle are suspected. Inspect each part and replace defective parts.

Torque Value: N·m (lbf·ft)

Mark	Component	Torque value	Remarks
–	Clamp nut (tie rod end clamp fastening)	25 ± 5 (18 ± 3.6)	–
–	Alignment gauge adapter	113 ± 15 (83 ± 11)	–

Special tools: mm {in}

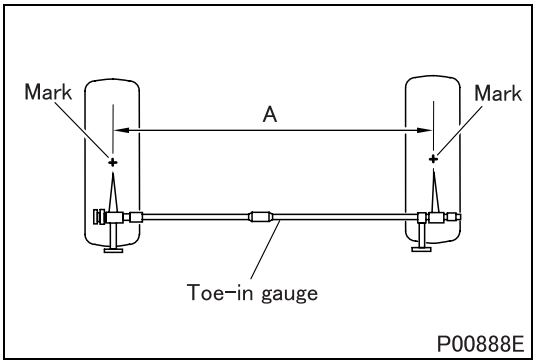
Mark	Tool name and shape	Part No.	Application
a	Hubcap wrench  P49261 **A**: 0.5 {0.020}; **B**: 78°	MB999108	Removal of hubcap
b	Alignment gauge adapter  P48604 **A**: ϕ80 {3.15}; **B**: 69 {2.72}; **C**: ϕ45 {1.77}; **D**: M24 × 1.5	MH063428	Measurement of camber, caster and king pin inclination angle



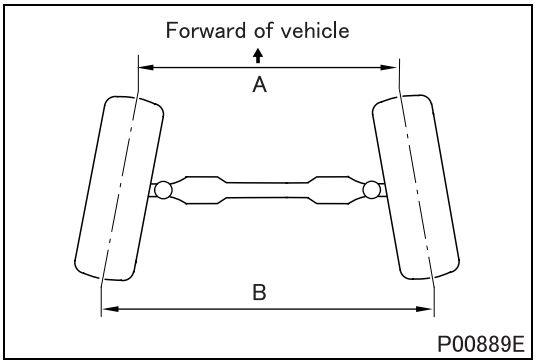
1.1 Inspection and adjustment of toe-in

[Inspection]

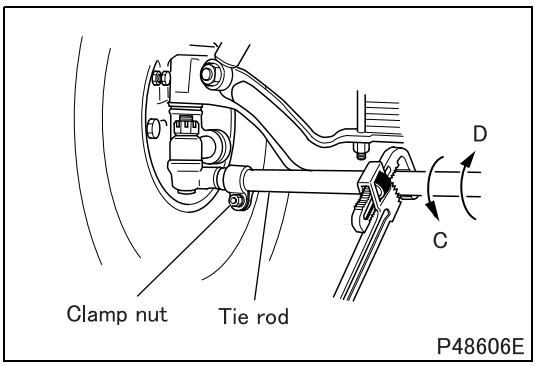
- Put the front wheels exactly in forward running position.
- Put a mark on each tire, right and left, at the height of front wheel axis and in the middle of tire width.



- Align the two points of the toe-in gauge with respective marks and measure distance **A** between the marks.

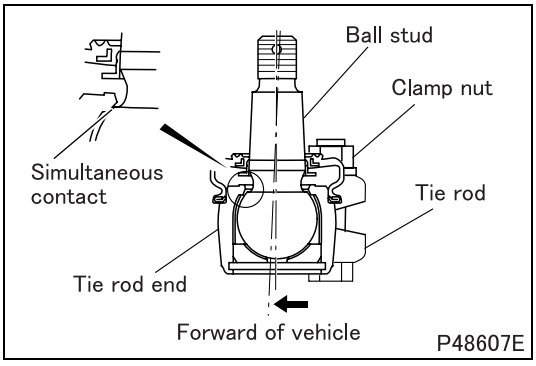


- Push the vehicle to roll the tires 180 degrees.
- Measure distance **B** between the marks that have moved to the rear of the vehicle.
- If toe-in (difference between **A** and **B**) deviates from the standard value, adjust.



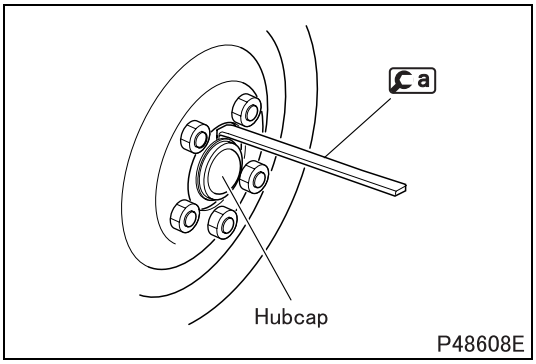
[Adjustment]

- Loosen the clamp nuts on the right and left.
- Turn the tie rod with a pipe wrench to adjust the toe-in.
  C: When adjusting to the toe-out direction
  D: When adjusting to the toe-in direction
- After adjustment, tighten the clamp nut to the specified torque.



CAUTION ⚠

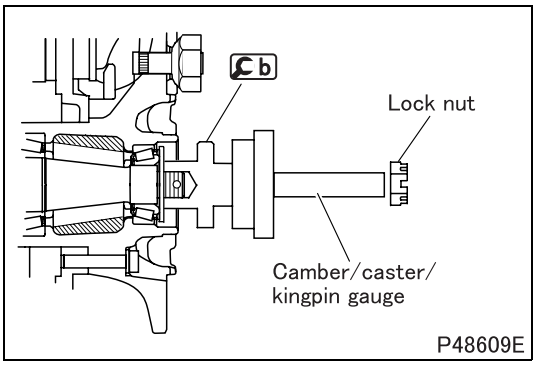
- **Hold down the tie rod end toward the front of the vehicle with the front wheels directed to forward running position so that the right and left tie rod ends are in contact with the ball studs at the same time. In this state adjust so that the specified toe-in is achieved and tighten the clamp nut to secure the tie rod.**



P48608E

1.2 Inspection of camber

- Direct the front wheels exactly to forward running position.
- Remove the hubcap using the hubcap wrench a.



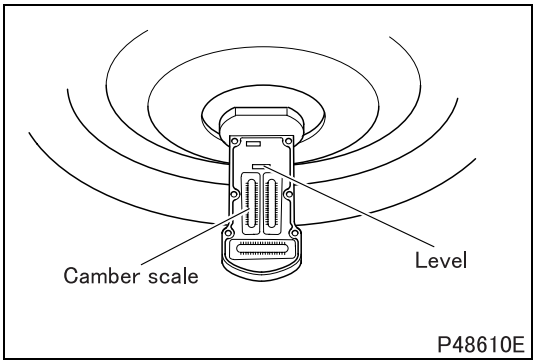
P48609E

- Remove the lock nut.

CAUTION ⚠

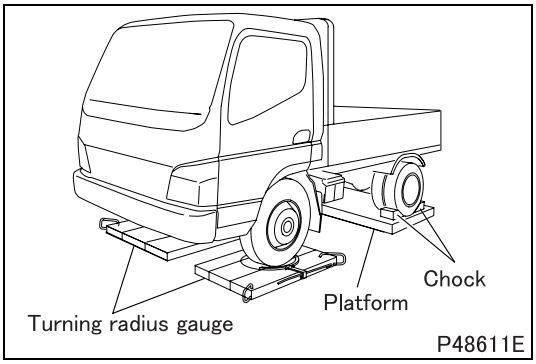
- **Do not apply a vehicle weight to the hub bearing with the lock nut loosened.**

- Wipe off grease from the knuckle end, attach the alignment gauge adapter b and tighten it to the specified torque.
- Attach the camber/caster/king pin gauge.



P48610E

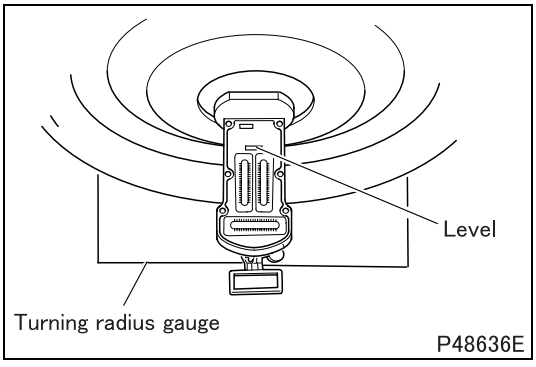
- Adjust the level until the bubble stays in the middle of the scale.
- On the camber scale, read the degree of camber. Do the same procedure for both front tires.
- If the measured value deviates from the standard value, disassemble the front axle for service.



P48611E

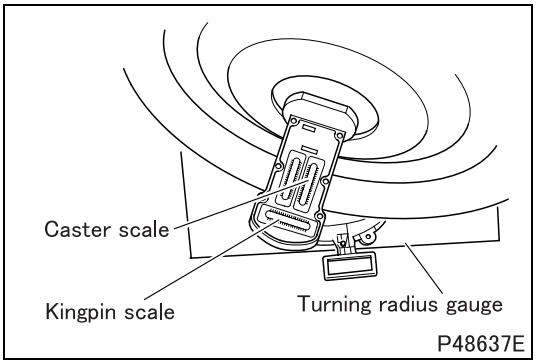
1.3 Inspection of caster and king pin inclination angle

- Prepare a platform with the same height as the turning radius gauge and place it under the rear wheels so that the vehicle will be level.
- Chock the rear tires.
- Keep the turning radius gauge locked.
- Raise the vehicle, and set the right and left front wheels so that the respective ground contact area centers of two wheels and turn table centers may meet.



P48636E

- Unlock the turning radius gauge, and set the scale to 0 degrees.
- In a way similar to the camber measurement in Section **1.2**, attach the camber/caster/king pin gauge, and set the level so that the bubble is centered.



- Apply brake, and with brake applied to the front wheels, turn steering wheel slowly from the point of 0 degrees on the turning radius gauge, until the direction is changed by 20 degrees each to the right side in case of the right front wheel and to the left in case of the left front wheel.

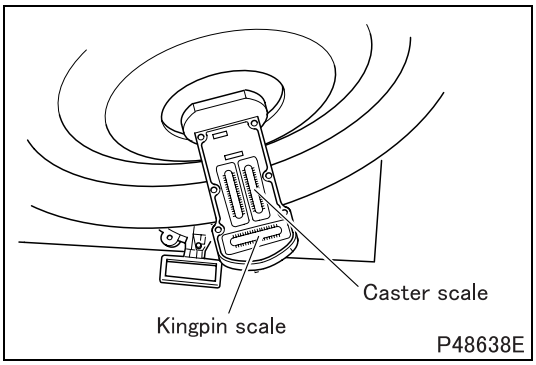
NOTE

- **It is not possible to make exact measurements unless the brake is continuously applied. Otherwise, the wheels will turn slightly.**

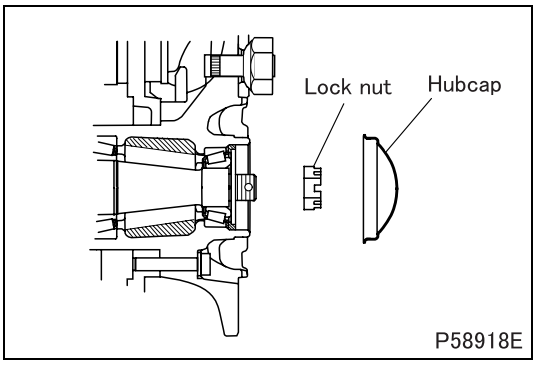
- At the point where the steering wheel has been turned 20 degrees, set the caster scale and the center of the bubble of the king pin scale to 0 degrees by turning the adjuster.

NOTE

- **Pay attention to the king pin scale because it has scales for right and left: align the right king pin scale for the right front wheel, and left king pin scale for the left front wheel.**



- Now reverse this position. Turn the steering wheel slowly until the direction of the front wheels changes by 20 degrees in the opposite direction.
- Read the caster scale and king pin scale to find the caster and king pin inclination angles.
- If the measured value deviates from the standard value, disassemble the front axle for service.



- After inspection, install the lock nut and measure the starting torque of the wheel hub bearing. If the starting torque deviates from the standard value, check the wheel bearings and perform expedient adjustment.
- Fill the specified amount of grease into wheel hub by using nozzle so that the outer bearing is covered with the grease and then install a new hubcap.

2. Inspection and Adjustment of Steering Angle

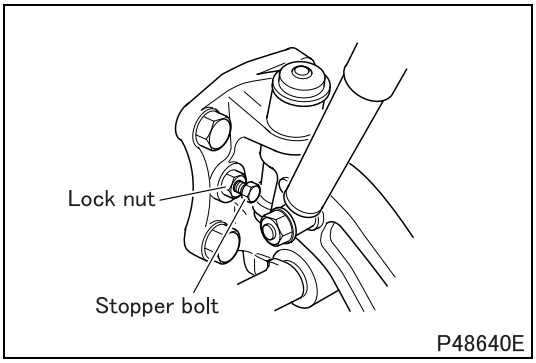
- Perform steering angle inspection and adjustment only after wheel alignment inspection and adjustment has been completed.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Steering angle	Inside (outside steering angle is for reference only)	45° $^{+0°}_{-2°}$ (34°)	–	Adjust

Torque Value: N·m (lbf·ft)

Mark	Fastener	Torque value	Remarks
–	Lock nut (knuckle stopper bolt mounting)	46.5 ± 7 (34 ± 5.4)	–



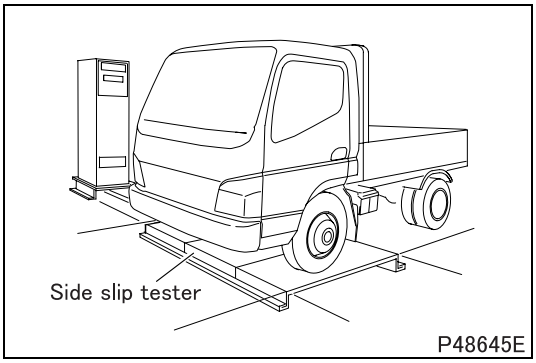
- Set the turning radius gauge and a platform on the vehicle in the same manner as in case of caster and king pin inclination angle measurement performed in Section **1.3**.
- Turn the steering wheel right or left completely from the position where the turning radius gauge is set to 0 degrees, and read the scale of the turning radius gauge to measure the steering angle.
- If the measured value deviates from the standard value, adjust with the knuckle stopper bolt and tighten the lock nut to the specified torque.

3. Inspection of Side Slip

- Perform side slip inspection only after wheel alignment inspection and adjustment has been completed.
- For the side slip amount, which is related to wheel alignment, both the side slip amount and wheel alignment must conform to the standard values.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
–	Side slip amount	0 ± 3 {0 ± 0.12}	–	Adjust



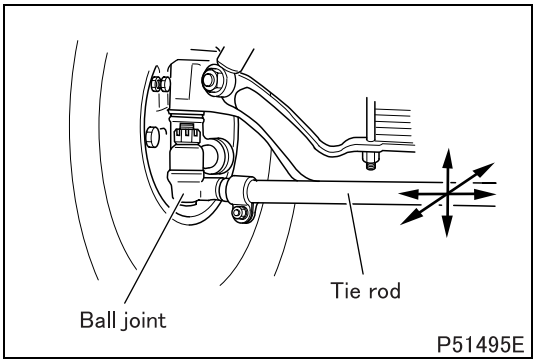
- Set the front wheels exactly to forward running position.
- Move the vehicle forward past the side slip tester as slowly as possible to inspect side slip.

NOTE

- **Pay attention to the following when moving over the side slip tester.**
- **Be sure to hold steering exactly at the forward running position, and make no turn.**
- **Do not apply brake.**
- **Keep the speed constant.**

- If the measured value deviates from the standard value, inspect and adjust wheel alignment.

4. Inspection of Tie Rod End Ball Joint



(1) Play

- Hold the tie rod section of the tie rod with the vehicle kept stationary, and move it in the back-and-forth, up-and-down and right-and-left directions to check for play at ball joints of the tie rod end.

NOTE

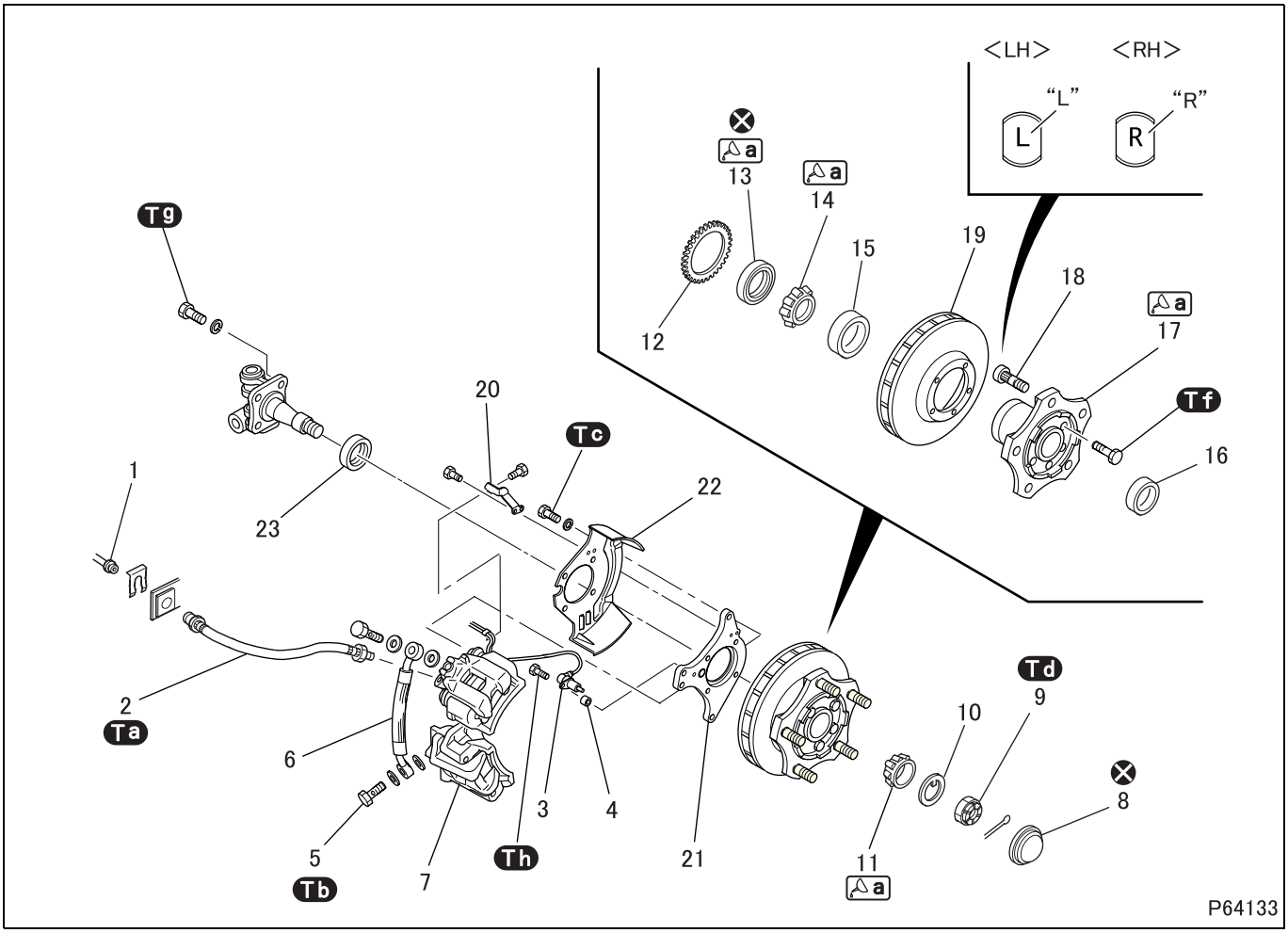
- **Be sure to check for play at ball joints of both right and left sides of the tie rod.**

- If there is play, replace the tie rod end of the tie rod.

(2) Dust cover

- Check the dust cover for wear, cracks and other damage.
- If there is any abnormality, replace the tie rod end.

WHEEL HUB AND ROTOR



● **Disassembly sequence**

1 Brake line
2 Brake hose
3 Wheel speed sensor
4 Spacer
5 Eyebolt
6 Brake hose
7 Front disc brake (see Gr35A)
8 Hubcap
9 Lock nut
10 Lock washer
11 Outer bearing inner race
12 Antilock brake system rotor
13 Oil seal
14 Inner bearing inner race
15 Inner bearing outer race
16 Outer bearing outer race
17 Wheel hub
18 Hub bolt
19 Disc rotor
20 Bracket
21 Adapter
22 Dust shield
23 Spacer

⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose to prevent entry of dust and dirt after it has been removed.**
- **Be careful not to damage the tip of the wheel speed sensor after removing it.**

NOTE

- **Do not remove the antilock brake system rotor unless replacing it.**
- **Do not disassemble the wheel hub and disc rotor unless replacing them.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the disc rotor surface and disc brake pad surface are free from grease to avoid malfunction of brakes.**
- **Make sure that the brake hose is not twisted when installing it.**
- **Inspect the drag torque of disc brakes after assembly. (See Gr35A.)**

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of wheel hub bearing (tangential force at hub bolt position with oil seal assembled)		1 to 3.5 N·m {0.7 to 2.6 lbf·ft} (tangential force: 8.8 to 28.4 N {2.0 to 6.4 lb}	–	Adjust or replace
17	Wear at the outer periphery of wheel hub		–	0.8	Replace
19	Disc rotor	Runout (measure, assembling it into front axle)	0.07 {0.0028} or less	0.10 {0.0039}	Replace
		Thickness	40 {1.57}	38 {1.50}	Replace

Torque Value: N·m (lbf·ft)

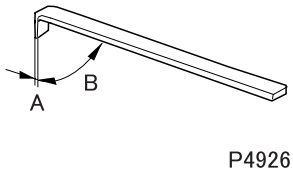
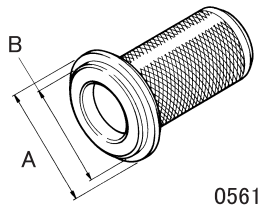
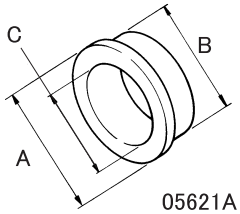
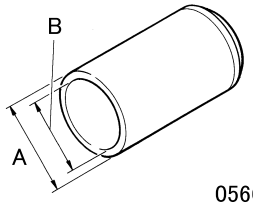
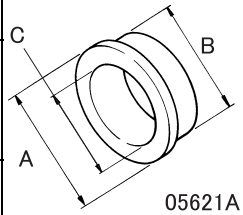
Mark	Component		Torque value	Remarks
Ta	Brake hose		25.5 to 34.3 (18.8 to 25.3)	–
Tb	Eyebolt		22 ± 2 (16 ± 1.5)	–
Tc	Bolt (front disc brake mounting)		152 ± 25 (112 ± 18)	–
Td	Lock nut	Primary tightening	113 ± 15 (83 ± 11)	–
		Secondary tightening after complete tightening	59 (44)	Back-off angle 45° (1/8 of a turn)
Tf	Bolt (wheel hub and disc rotor mounting)		85.8 ± 12 (63 ± 8.9)	–
Tg	Bolt (adapter mounting)		118 ± 20 (87 ± 1.5)	–
Th	Bolt (speed sensor mounting)		12.3 ± 2.5 (9.1 ± 1.8)	–

Lubricant and/or sealant

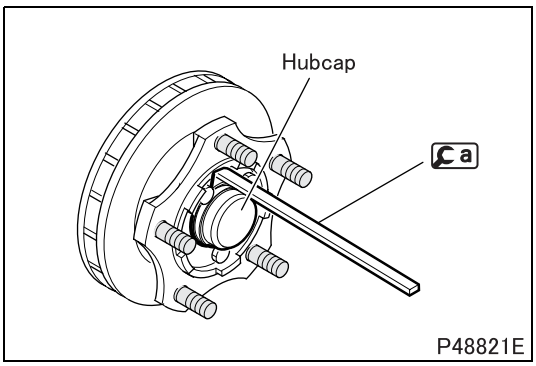
Mark	Points of application			Specified lubricant and/or sealant	Quantity
△a	Pack outside of wheel hub	5 studs		Wheel bearing grease [NLGI No. 2 (Li soap)]	※ 65 ± 10 g {2.29 ± 0.35 oz}
		6 studs			※ 90 ± 10 g {3.17 ± 0.35 oz}
	Pack inside of wheel hub	5 studs			※ 210 ± 20 g {7.41 ± 0.71 oz}
		6 studs	COE 40/45		※ 130 ± 10 g {4.59 ± 0.35 oz}
			COE 50		※ 155 ± 10 g {5.47 ± 0.35 oz}
	Pack space between rollers of outer bearing inner race and inner bearing inner race				As required
	Lip area of oil seal				

※: For a wheel hub

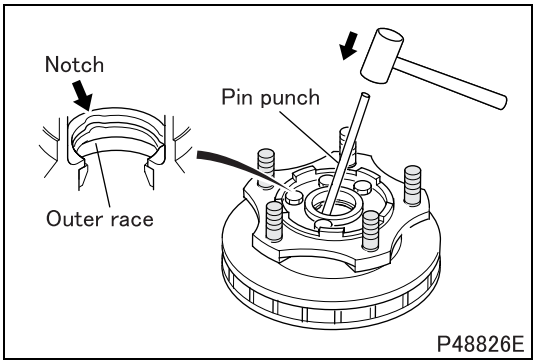
Special tools: mm {in}

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Hubcap wrench
<table><tr><th>A</th><th>B</th></tr><tr><td>0.5
{0.020}</td><td>78°</td></tr></table> 
P49261</td><td>MB999108</td><td>Removal of hubcap</td></tr>
<tr><td>b</td><td>Oil seal installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ84
{3.31}</td><td>ϕ70
{2.76}</td></tr></table> 
05619</td><td>MB999097</td><td rowspan="2">Installation of oil seal (to be used in combination)</td></tr>
<tr><td>c</td><td>Bearing installer
<table><tr><th>Part No.</th><th>A</th><th>B</th><th>C</th><th>Vehicle model</th></tr><tr><td>MB999099</td><td>ϕ88.5
{3.48}</td><td>ϕ71
{2.80}</td><td>ϕ51
{2.01}</td><td>Five studs</td></tr><tr><td>MB999069</td><td>ϕ94.5
{3.72}</td><td>ϕ92.5
{3.64}</td><td>ϕ60
{2.36}</td><td>Six studs</td></tr></table> 
05621A</td><td>MB999099
MB999069</td></tr>
<tr><td>d</td><td>Bearing installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ70
{2.76}</td><td>ϕ57
{2.24}</td></tr></table> 
05668</td><td>MB999100</td><td rowspan="2">Installation of inner bearing outer race and outer bearing outer race (to be used in combination)</td></tr>
<tr><td>e</td><td>Bearing installer
<table><tr><th>Part No.</th><th>A</th><th>B</th><th>C</th><th>Vehicle model</th></tr><tr><td>MB999099</td><td>ϕ88.5
{3.48}</td><td>ϕ71
{2.80}</td><td>ϕ51
{2.01}</td><td>Inner side of five-stud models and outer side of all models</td></tr><tr><td>MB999069</td><td>ϕ94.5
{3.72}</td><td>ϕ92.5
{3.64}</td><td>ϕ60
{2.36}</td><td>Inner side of six-stud models</td></tr></table> 
05621A</td><td>MB999099
MB999069</td></tr>
</table>

◆Removal procedure◆

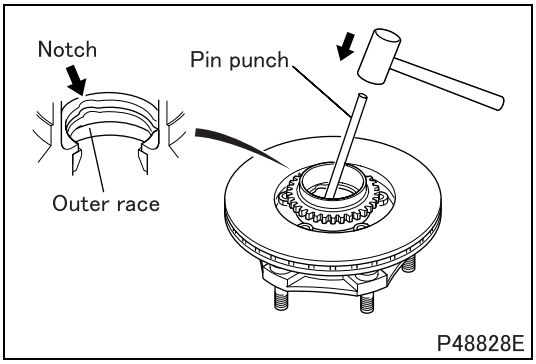


■ **Removal: Hubcap**



■ **Removal: Inner bearing outer race**

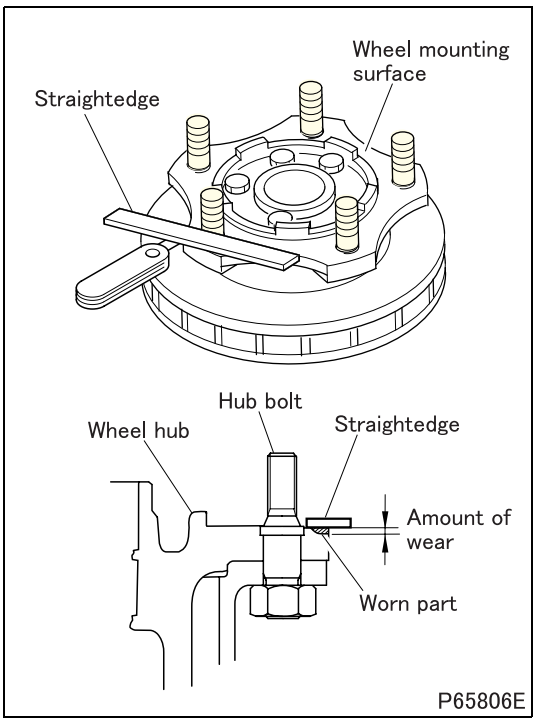
- Drive out the inner bearing outer race by tapping evenly at three indented parts in the wheel hub.



■ **Removal: Outer bearing outer race**

- Drive out the outer bearing outer race by tapping evenly at three indented parts in the wheel hub.

◆Inspection procedure◆



■ Inspection: Wear at the outer periphery of wheel hub

Measurement of the amount of the wear at the outer periphery of wheel hub.

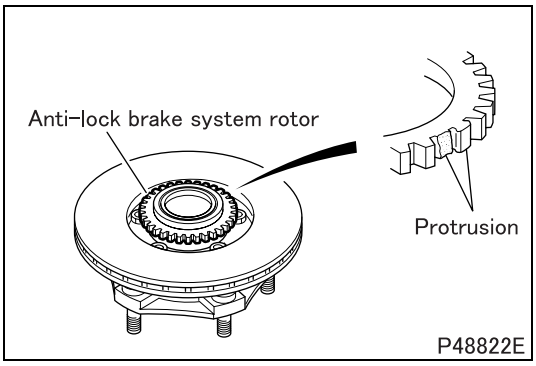
CAUTION ⚠

- **Clean the wheel mounting surface of the wheel hub before inspection.**
- **The straightedge should be placed on the hub so as not to contact to the hub bolt.**

- Place the straightedge on the wheel mounting surface as shown in the drawing.
- Using the straightedge and feeler gauges, measure the amount of wear at the outer periphery of the wheel hub at five positions.
- If the amount of wear at any point exceeds the limit, replace the wheel hub.
- If the wheel has cracks or has a stepped wear at the wheel hub mounting surface, replace the wheel.

CAUTION ⚠

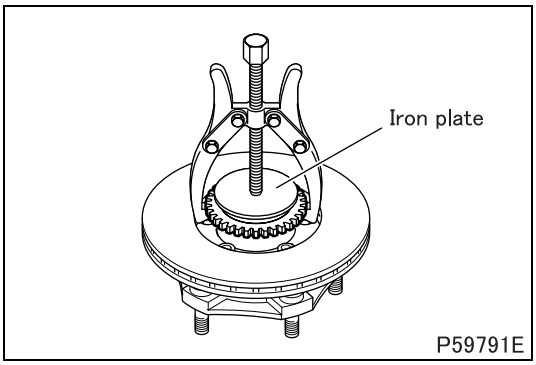
- **Never paint the wheel mounting surface of the wheel hub as it may be a cause of loose bolt.**



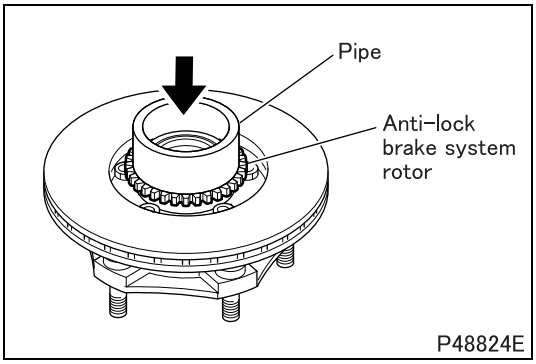
■ Inspection: Antilock brake system rotor

[Inspection]

- Check protrusions of the antilock brake system rotor for chipping and flattening.
- If any abnormality is found, replace the antilock brake system rotor.



[Removal]



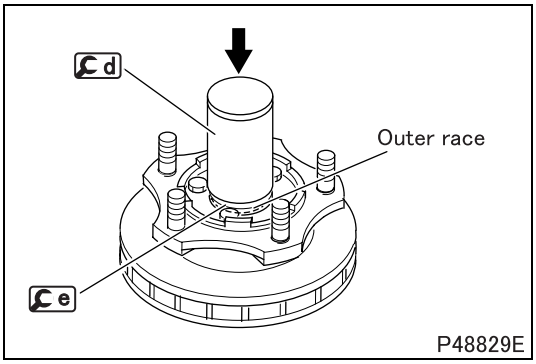
[Installation]

- Warm the antilock brake system rotor to approximately 150°C.
- Install the antilock brake system rotor and wheel hub evenly using a pipe so as not to allow them to tilt.

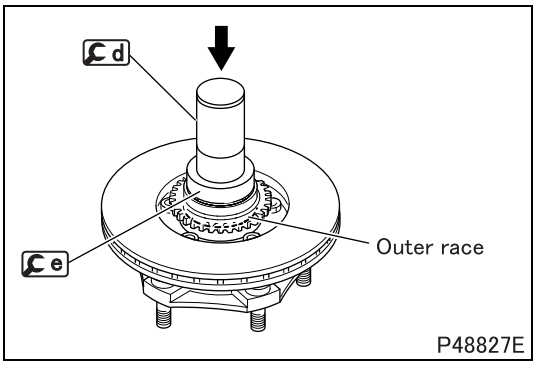
WARNING ⚠

- **Handling the warmed rotor by bare hands may burn.**

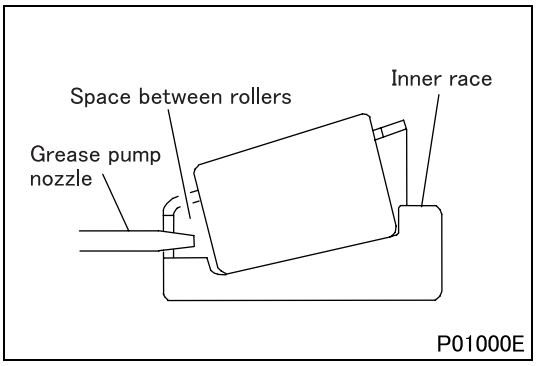
◆Installation procedure◆



■ Installation: Outer bearing outer race

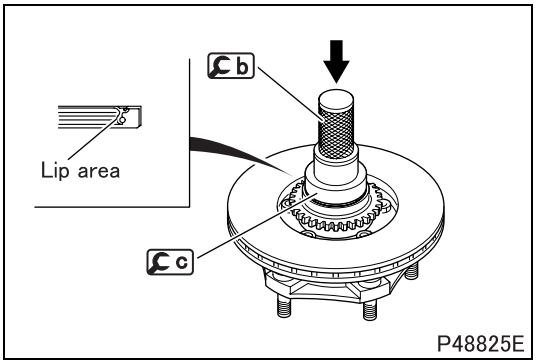


■ Installation: Inner bearing outer race



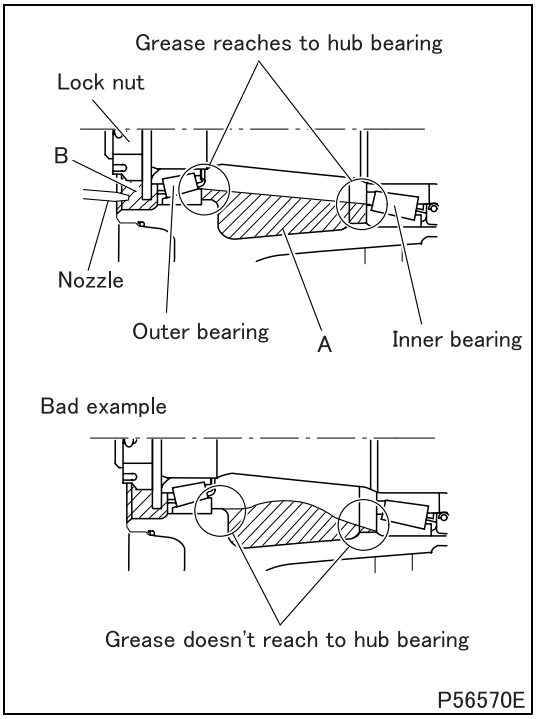
■ Installation: Packing grease in inner bearing inner race

- Insert the grease pump nozzle into the space between rollers of the inner bearing inner race to pack grease sufficiently.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the wheel hub in the illustrated direction.

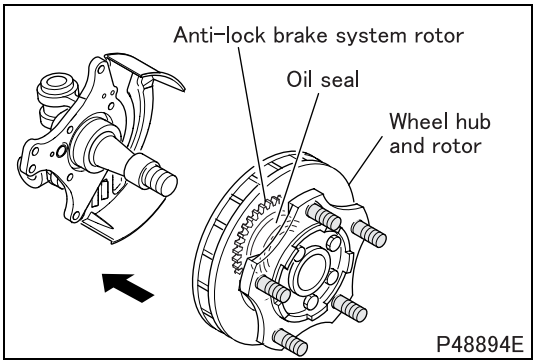


■ **Installation: Wheel hub and rotor**

- Apply specified amount of grease to inside **A** of wheel hub so that the grease reaches inner bearing and outer bearing as illustrated.
- After installing lock nut, insert grease pump nozzle into outside **B** of wheel hub and fill specified amount of grease so as to make a grease wall outside of the outer bearing.

CAUTION ⚠

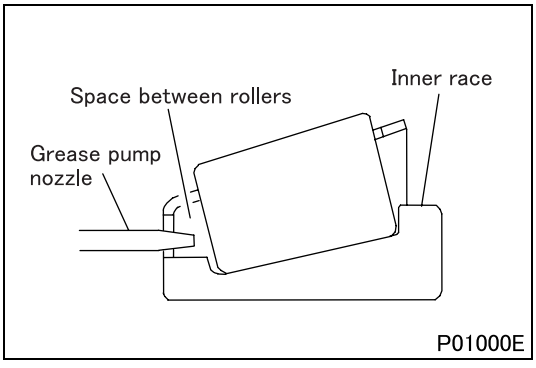
- **Applying grease as illustrated in the "bad example" causes the wheel hub bearing to seize.**



- Slowly install the wheel hub and rotor assembly so as not to cause damage to the oil seal and antilock brake system rotor.

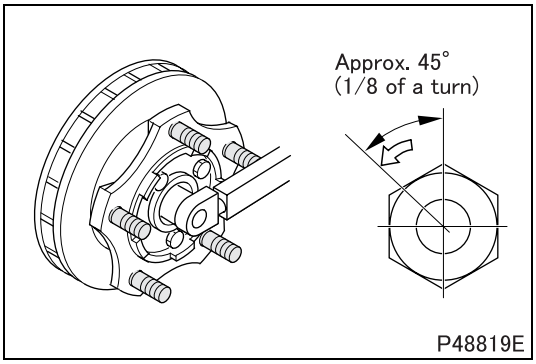
CAUTION ⚠

- **If the antilock brake system rotor is damaged, wheel speed sensor signals become abnormal, causing the antilock brake system to malfunction.**



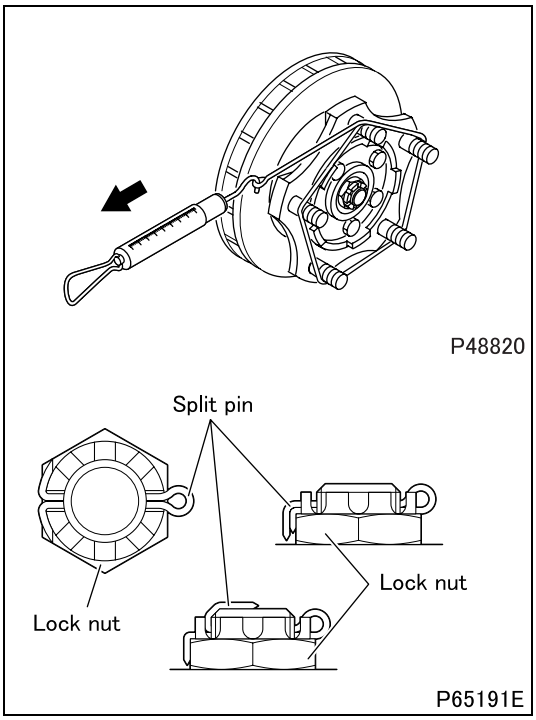
■ **Installation: Packing grease in outer bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the outer bearing inner race to pack grease sufficiently.



[Adjustment]

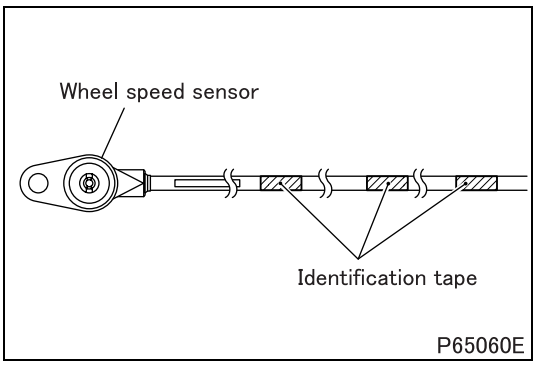
- Tighten the lock nut to the specified torque (primary tightening) while turning the wheel hub and rotor, and then loosen it completely.
- Smooth operation of the outer bearing and inner bearing by turning the wheel hub and rotor several times, and then tighten the lock nut to the specified torque (secondary tightening).
- Return the lock nut by approximately 45 degrees (1/8 of a turn) and secure it with a split pin. If pin holes do not align, align them in the course of loosening. Make sure that there is no play in the axial direction.
- Perform measurement again after adjustment. If any fault is found, replace the outer and inner bearings.



■ Inspection: Starting torque of wheel hub bearing

[Inspection]

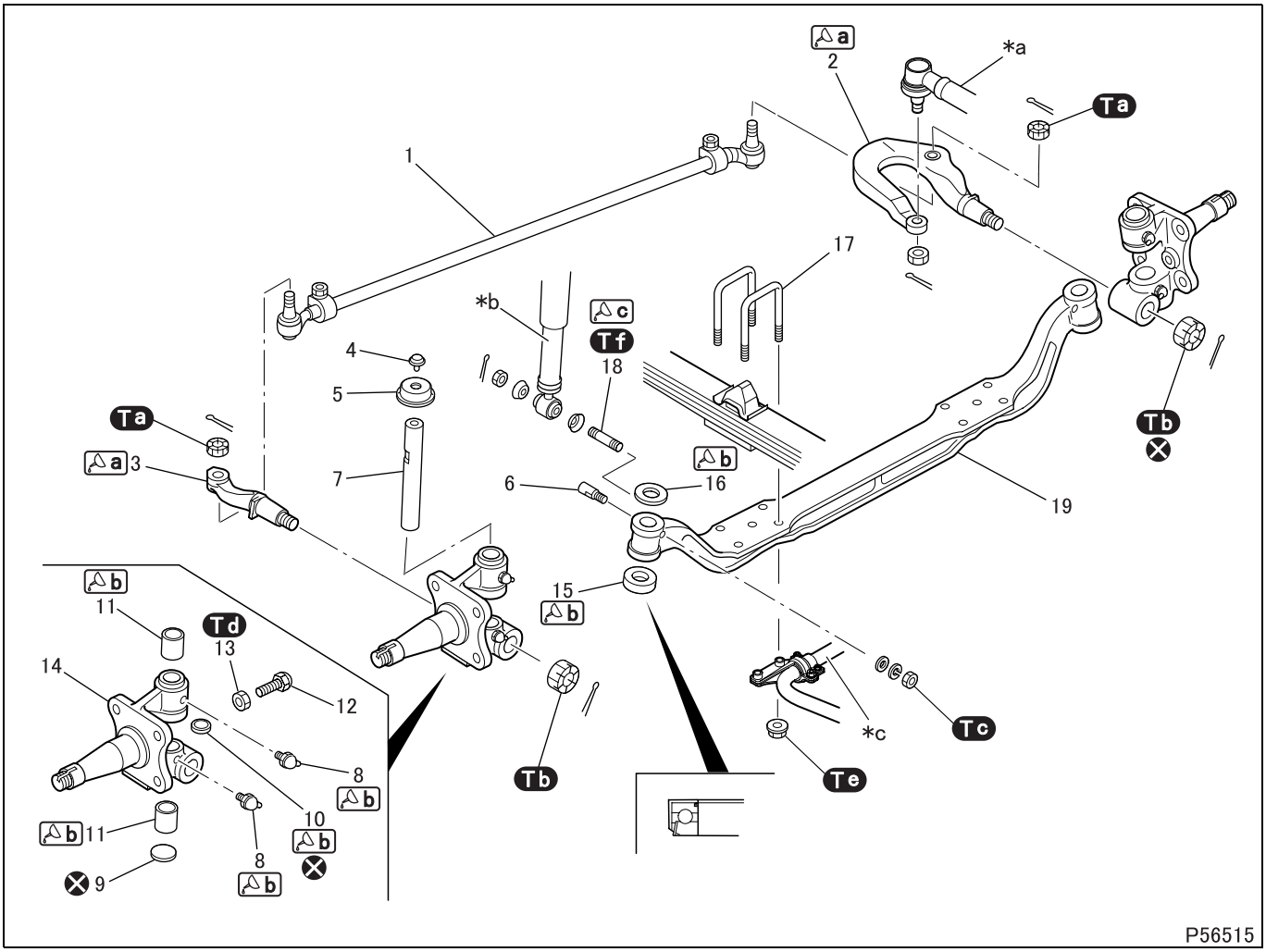
- After installing the lock nut, perform the following inspection.
- Measure the tangential force at the hub bolt position using a spring balance.
- If the tangential force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, adjust the lock nut again.



■ Installation: Wheel speed sensor

- Using clips, secure in place the wheel speed sensor harness at the identification tape portions, ensuring that the harness is free of kinks, slack and/or interference with other parts.

KNUCKLE AND KING PIN, FRONT AXLE



● **Disassembly sequence**

1 Tie rod (See later section.)
2 Knuckle arm
3 Tie rod arm
4 Dust plug
5 Dust cap
6 Lock pin
7 King pin
8 Grease nipple
9 Plug
10 Dust seal
11 Bushing
12 Knuckle stopper bolt
13 Lock nut
14 Knuckle
15 Thrust bearing
16 King pin shim
17 U-bolt
18 Stud bolt
19 Front axle

***a**: Drag link
***b**: Shock absorber
***c**: Stabilizer
⊗: Non-reusable parts

CAUTION ⚠

- **When removing the tie rod, take care not to deform or damage the dust cover.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: king pin kit

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
7	Outer diameter of king pin		27.947 to 27.980 {1.100 to 1.102}	27.9 {1.098}	Replace
7, 11	Clearance between king pin and bushing		0.020 to 0.086 {0.00079 to 0.0034}	0.15 {0.0059}	Replace
7, 19	Clearance between king pin and front axle		0.020 to 0.074 {0.00079 to 0.0029}	0.1 {0.0039}	Replace
11	Inner diameter of bushing (after having been pressed into knuckle)		28.000 to 28.033 {1.102 to 1.103}	–	Replace
14, 19	Vertical clearance between knuckle and front axle		0.02 to 0.10 {0.00079 to 0.0039}	0.20 {0.0079}	Adjust
19	Front axle	Horizontal bend	–	2 {0.079}	Replace
		Vertical bend	–	2 {0.079}	
		king pin inclination angle	8° ± 10’	–	

Torque Value: N·m (lbf·ft)

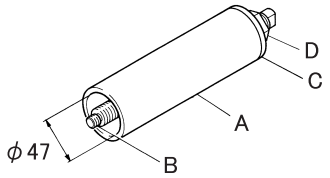
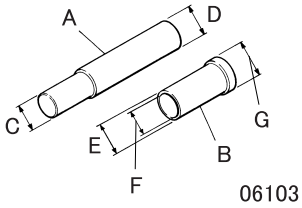
Mark	Fastener		Torque value	Remarks
Ta	Nut (tie rod mounting)		93 ± 25 (69 ± 18)	–
Tb	Nut (knuckle arm mounting)		345 ± 49 (254 ± 36)	–
	Nut (tie rod arm mounting)			
Tc	Nut (lock pin mounting)		33 ± 5 (25 ± 3.6)	–
Td	Lock nut (knuckle stopper bolt tightening)		46.5 ± 7 (34 ± 5.4)	–
Te	Nut (U-bolt mounting)	Except FE85	162 ± 15 (120 ± 11)	–
		FE85	175 ± 5 (129 ± 3.7)	–
Tf	Stud bolt	Stud	88 (65, 9) or more	–
		Nut (return)	137 (101) or more	–

Lubricant and/or sealant

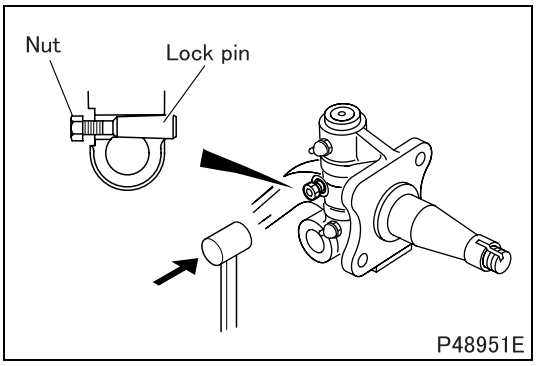
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Knuckle arm and tie rod arm threads	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required when parts are reused
b	Lip area of dust seal		As required
	Inside surface of bushing		
	Top face of thrust bearing		
	Both sides of king pin shim		
	Fill from grease nipple		Until grease starts overflowing from dust plug
c	Stud threads of stud bolt	Loctite 271	As required

KNUCKLE AND KING PIN, FRONT AXLE

Special tools: mm {in}

Mark	Tool name and shape	Part No.	Application
a	King pin puller **A:** Pipe **B:** Bolt **C:** Cap **D:** Nut  06102	MB999013 A: MB999014 B: MB999015 C: MB999016 D: MB999017	Removal of king pin
b	Bushing installer **A:** Bushing installer A **B:** Bushing installer B  06103 **C**: ϕ25 {0.98}; **D**: ϕ30 {1.18}; **E**: ϕ28 {1.10}; **F**: ϕ25 {0.98}; **G**: ϕ32.8 {1.29}	MB999066 A: MB999067 B: MB999068	Removal and installation of king pin bushing

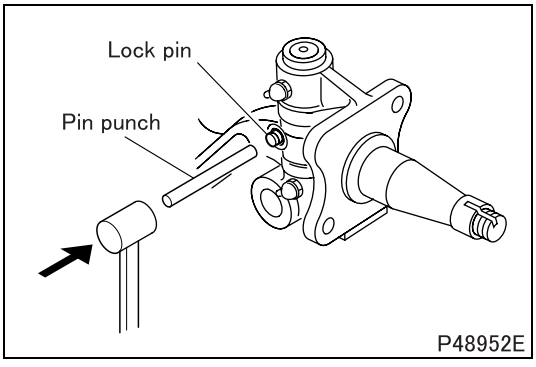
◆Removal procedure◆



P48951E

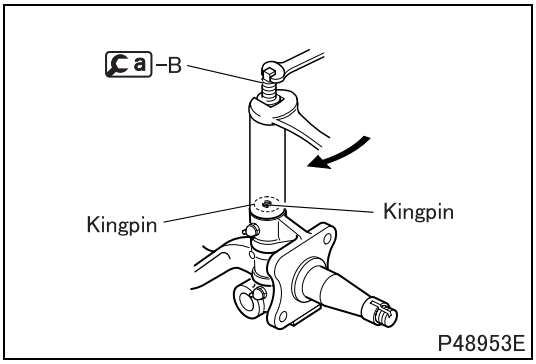
■ **Removal: Lock pin**

- Remove the nut, spring washer and washer.
- Screw in the nut again until just before it is flush with the lock pin, and lightly tap the nut to loosen the lock pin.



P48952E

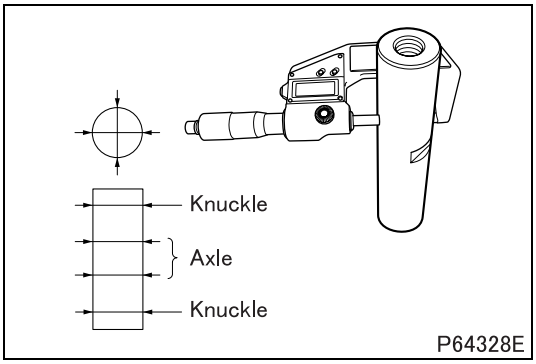
- Remove the nut, apply a pin punch to the lock pin and lightly tap it to remove.



■ **Removal: King pin**

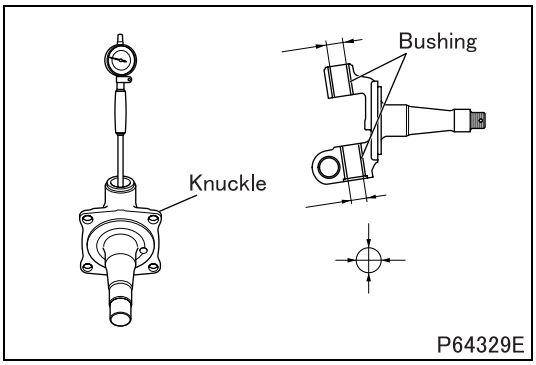
- Screw the bolt of the kin pin puller a-B into the king pin threads to remove the king pin.

◆Inspection procedure◆



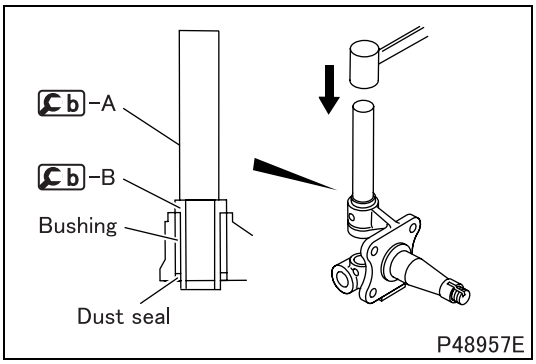
■ **Inspection: Outer diameter of king pin**

- Take measurement at a total of four levels on the king pin: two levels for the axle fitting portion and one level each for the upper and lower knuckle fitting portions.
- If the measured value is under the limit, replace the king pin with a new one.



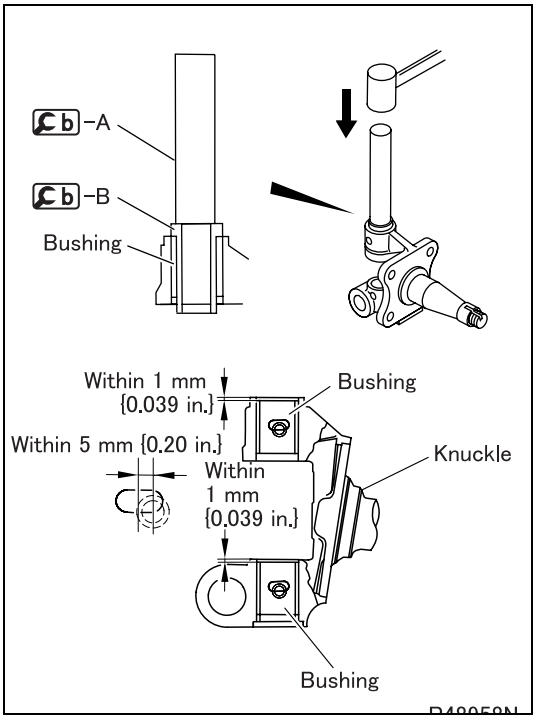
■ **Inspection: Clearance between king pin and bushing**

- Measure the inner diameter of the upper and lower bushings using a cylinder gauge and calculate the clearance deducting the outer diameter of the king pin from the inner diameter of the bushing.
  If the clearance exceeds the limit, replace the bushings with new ones.



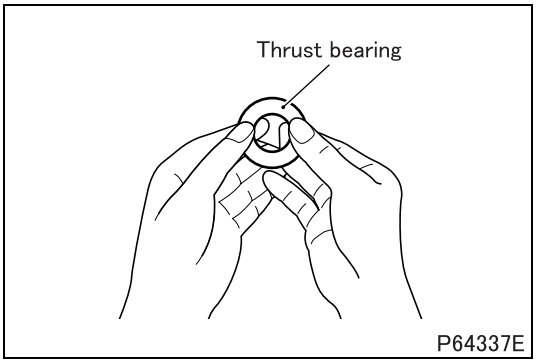
Replacement of bushing
[Removal]

- Remove the bushing and the dust seal at the same time using the bushing installer b.



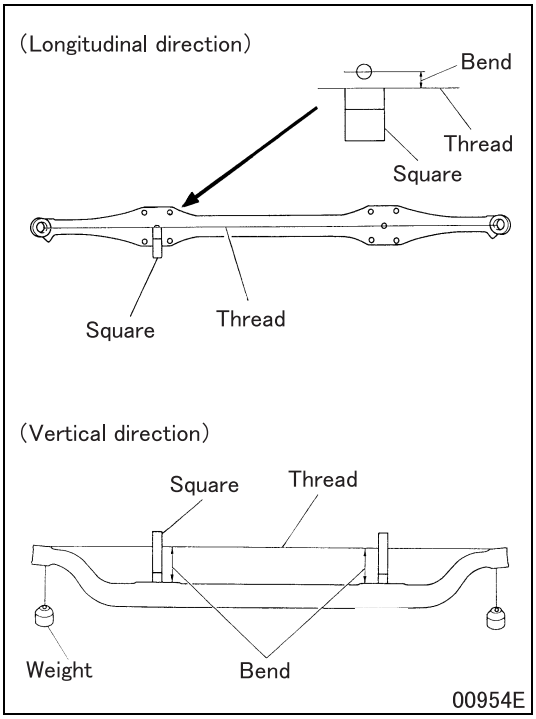
[Installation]

- Install the bushing using the bushing installer Cb so that a step height between the bushing and knuckle is within 1 mm {0.039 in}.
- The oil hole of the bushing must not deviate from the screw hole of the knuckle more than 5 mm {0.20 in}.



■ Inspection: Thrust bearing

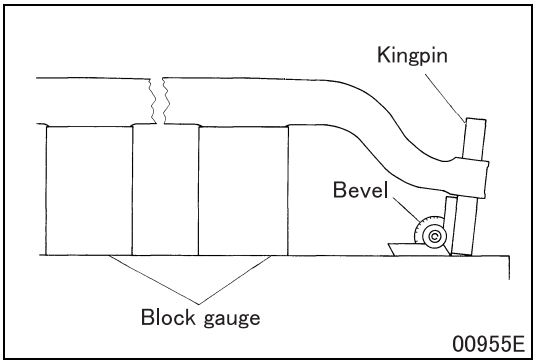
- Inspect the aspect and smooth turning of the thrust bearing. If any crack, damage, or un-smooth turning is found, replace the thrust bearing with a new one.



■ Inspection: Front axle

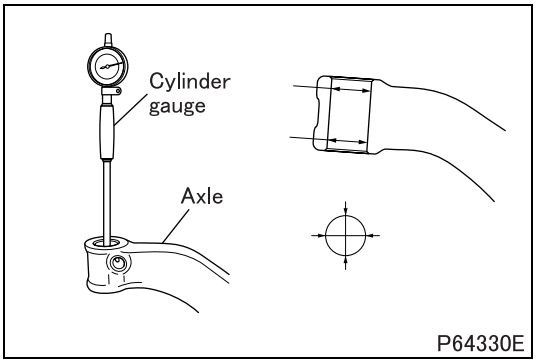
(1) Bend of front axle in the back-and-forth direction and vertical direction

- Put a piece of thread through king pin holes of the front axle and hang weights at both ends.
- Use a square to find bend to each of back-and-forth and vertical directions.
- If the measured value exceeds the limit, replace the front axle.



(2) King pin inclination angle

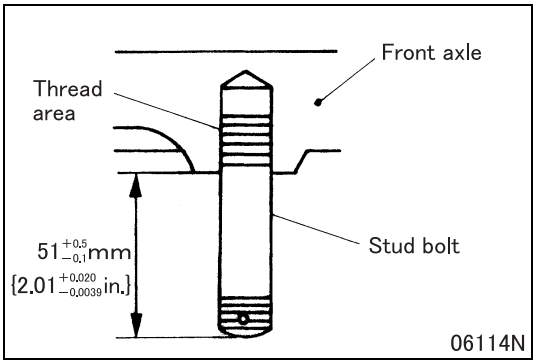
- Set the king pin on the front axle as illustrated to measure the angle.
- If the measured value deviates from the standard value, replace the front axle.



(3) Clearance between king pin and front axle

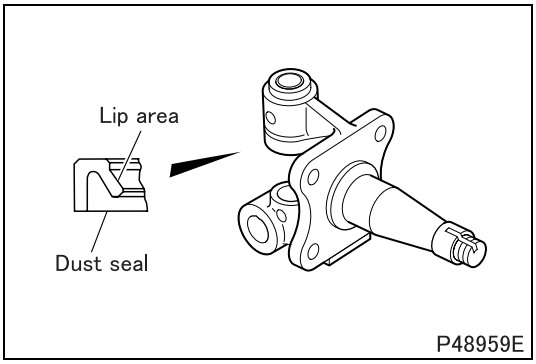
- Measure the inner diameter of the axle's hole where the king pin is inserted using a cylinder gauge and calculate the clearance deducting the outer diameter of the king pin from the inner diameter.
  If the clearance exceeds the limit, replace the axle or the king pin with a new one.

◆Installation procedure◆



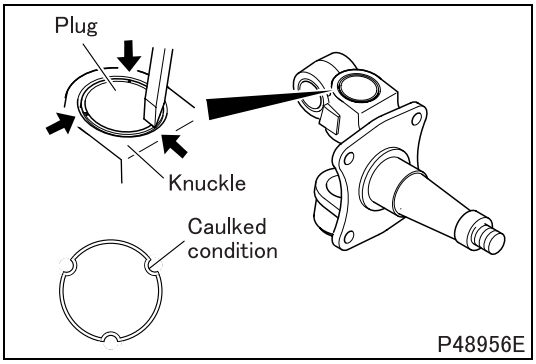
■ Installation: Stud bolt

- Apply Loctite to front axle mounting threads of the stud bolt.
- Install the stud bolt to the dimension as illustrated.



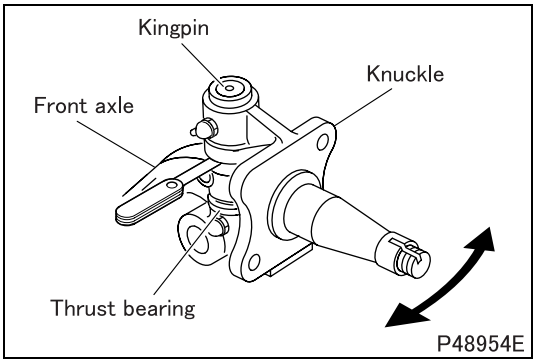
■ Installation: Dust seal

- Apply grease to the lip area of the dust seal and install it on the knuckle in the illustrated direction.



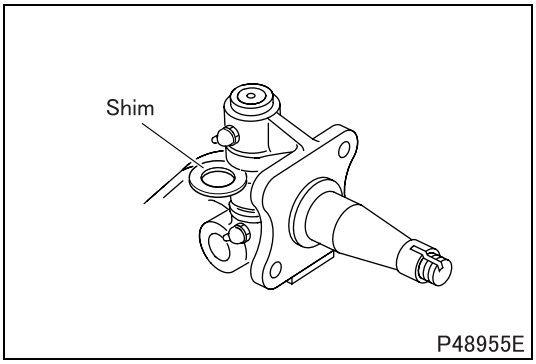
■ **Installation: Plug**

- After installing the plug, caulk the knuckle at three evenly spaced points of the plug circumference avoiding previously caulked points.



■ **Installation: Knuckle**

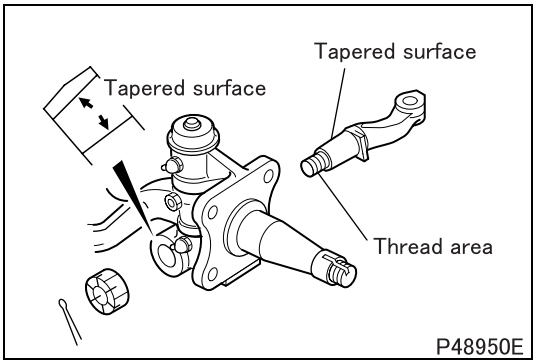
- After temporarily assembling the thrust bearing, knuckle and king pin into the front axle, move the knuckle several times to smooth its operation.
- Measure clearance between the front axle top face and the knuckle bottom.



- If the measured value exceeds the limit, adjust with a king pin shim.
  Thickness of king pin shims available
  0.10, 0.15, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70 mm
  {0.0039, 0.0059, 0.0079, 0.012, 0.016, 0.020, 0.023, 0.028 in}
  (Eight thickness)

CAUTION ⚠

- **Select a king pin shim so that the clearance is as small as possible within the range of the standard value.**
- **After assembly, make sure that the knuckle moves smoothly.**



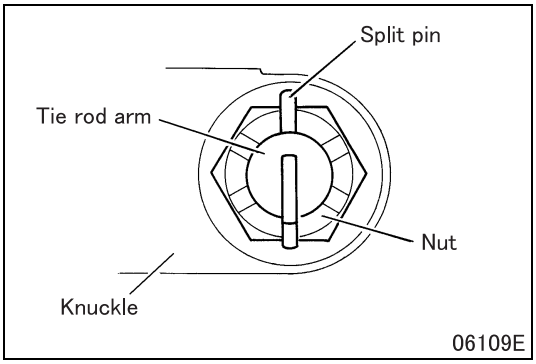
■ **Installation: Tie rod arm and knuckle**

(1) When one or both of the tie rod arm and knuckle need reassembly making use of existing parts

- Polish the entire tapered surfaces of the tie rod arm and knuckle evenly by means of sand paper #120 or above until sand paper score is visible on polished surfaces. (This does not apply to new replacement parts.)
- Clean the tapered surfaces and thread areas of the tie rod arm and knuckle.

NOTE

- **Use acetone, cleaning fluid for color check, or equivalent as solvent.**



- Apply grease to the thread area of the tie rod arm and install it.

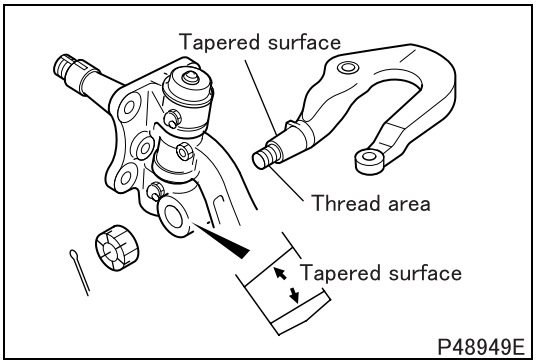
CAUTION ⚠

- **When installing the tie rod arm, make sure that tapered surfaces of the tie rod arm and knuckle are free from grease.**

- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.

(2) When both of the tie rod arm and knuckle for assembling are new parts

- Clean tapered surfaces and thread areas of the tie rod arm and knuckle.
- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.



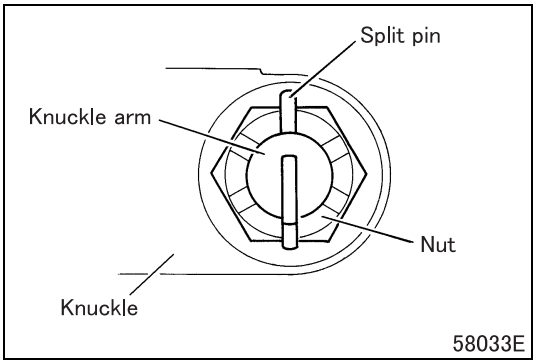
■ Installation: Knuckle arm and knuckle

(1) When one or both of the knuckle arm and knuckle need reassembly making use of existing parts

- Polish the entire tapered surfaces of the knuckle arm and knuckle evenly by means of sand paper #120 or above until sand paper score is visible on polished surfaces. (This does not apply to new replacement parts.)
- Clean the tapered surfaces and thread areas of the knuckle arm and knuckle.

NOTE

- **Use acetone, cleaning fluid for color check, or equivalent as solvent.**



- Apply grease to the thread area of the knuckle arm and install it.

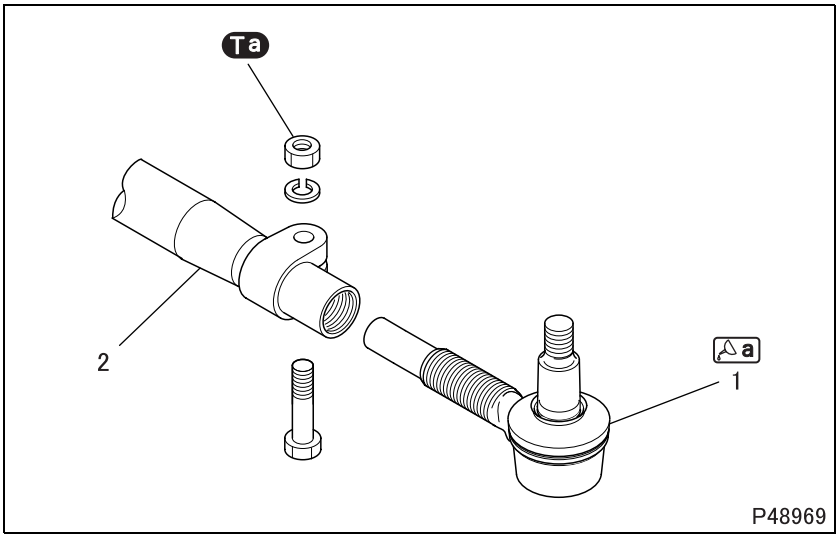
CAUTION ⚠

- **When installing the knuckle arm, make sure that tapered surfaces of the knuckle arm and knuckle are free from grease.**

- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.

(2) When both of the knuckle arm and knuckle for assembling are new parts

- Clean tapered surfaces and thread areas of the knuckle arm and knuckle.
- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.



● **Disassembly sequence**

1 Tie rod end
2 Tie rod

CAUTION ⚠

- **If any abnormality such as tear is found in the dust boot of the tie rod end, replace the tie rod end.**

NOTE

- **Do not disassemble the tie rod end.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
1	Rotation torque of tie rod end	1.0 to 5.9 N·m {0.7 to 4.4 lbf·ft	–	Replace
2	Bend of tie rod	–	1 {0.039} or less	Correct or replace

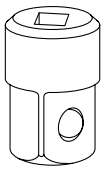
Torque Value: N·m (lbf·ft)

Mark	Fastener	Torque value	Remarks
Ta	Nut (tie rod end tightening)	25 ± 5 (18 ± 3.7)	–

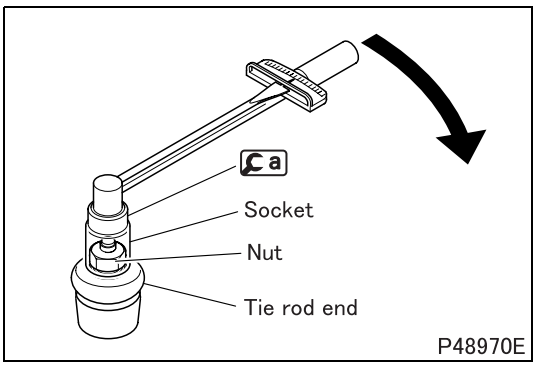
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of dust cover of tie rod end	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

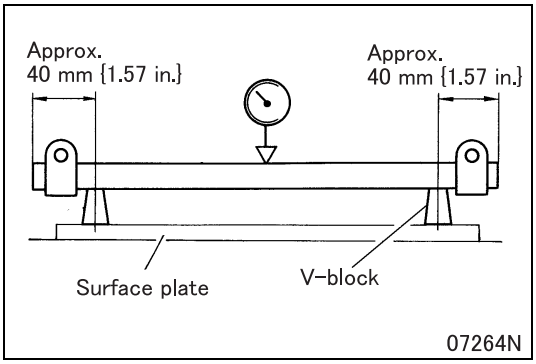
Mark	Tool name and shape	Part No.	Application
a	Preload socket  P48876	MB999326	Measurement of rotation torque of tie rod end

◆Inspection procedure◆



■ **Inspection: Rotation torque of tie rod end**

- Install the tie rod mounting nut on the tie rod end.
- Install the socket, Ca and torque wrench to measure the rotation torque.
- If the measured value deviates from the standard value, replace the tie rod end.



■ **Inspection: Bend of tie rod**

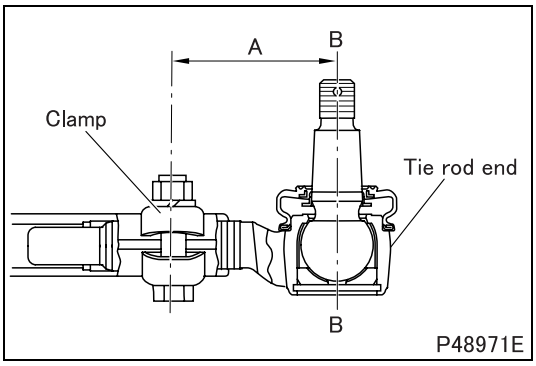
- Measure the bend of the tie rod at its center.

NOTE

- **Give the tie rod one complete turn and read the dial gauge at this time. The bend is one half of the reading.**

- If the measured value exceeds the limit, correct or replace the tie rod.

◆Installation procedure◆



■ **Installation: Tie rod end**

- Screw in the tie rod end so that difference of dimension **A** between the tie rod end and the clamp is within 1.5 mm {0.059 in} between right and left.
  A: Approximately 74 mm {2.91 in}

CAUTION ⚠

- **Ensure that difference of an amount of screwing in the tie rod end between right and left is within one turn.**
- **Secure the tie rod ends so that illustrated axis B-B on the right is parallel to that on the left.**

GROUP 27 INDEX

SPECIFICATIONS **27-2**

STRUCTURE AND OPERATION
1. **Wheel Hub and Rotor** **27-3**
2. **Reduction and Differential** **27-4**
3. **Limited Slip Differential** **24-5**

TROUBLESHOOTING **27-8**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Axle Oil Level Check and Axle Oil Change** **27-10**

WHEEL HUB AND ROTOR **27-12**

AXLE HOUSING **27-22**

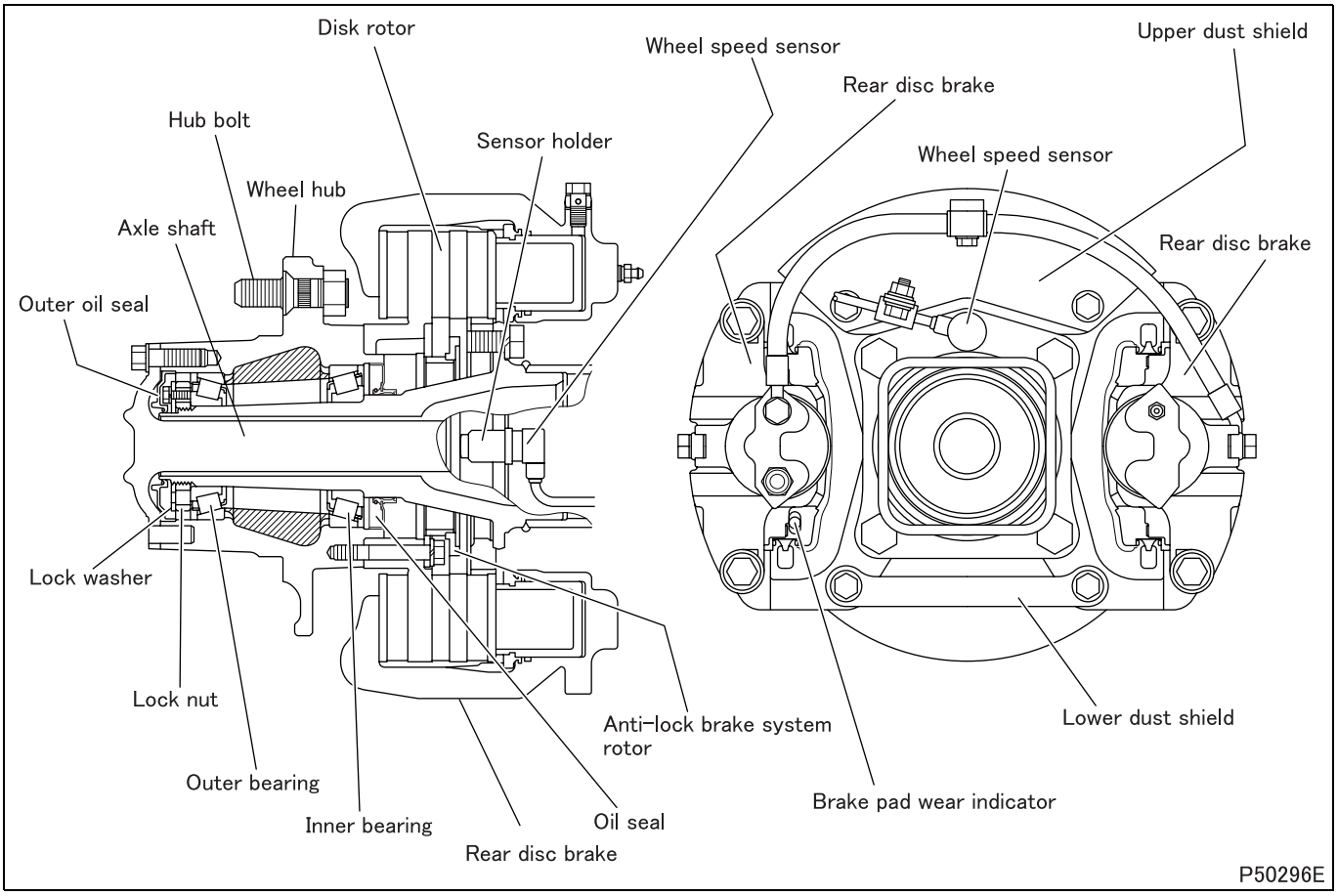
REDUCTION AND DIFFERENTIAL **27-26**

SPECIFICATIONS

Item		Specifications	
		COE 40/45	COE 50
Rear axle	Model	R033T	R035T
	Type	Banjo type, full floating	
Reduction	Model	D033H	D035H
	Type	Single-reduction hypoid gear	
	Gear ratio	4.875 5.285	5.285 5.714
Differential	Tooth shape	Straight bevel gear	
Gear oil	Grade	Normal: Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area: Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140	
	Quantity L {qt}	4.5 {4.8}	
Weight kg {lb}		210 to 230 {460 to 505} (approximately)	250 {550} (approximately)

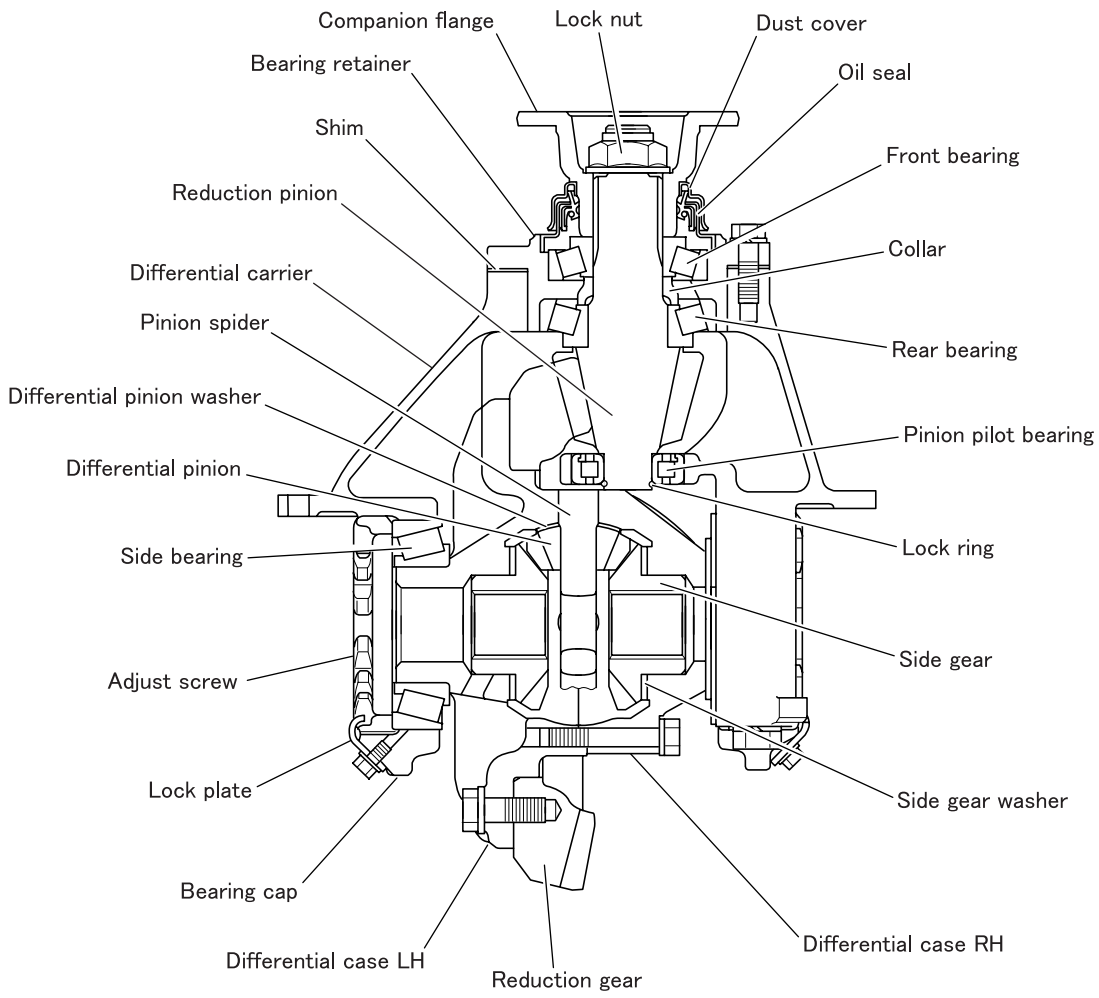
- Use gear oil with a SAE viscosity of 140 when a vehicle is used under heavy load conditions, including frequent driving on prolonged upgrades when the air temperature is above 10°C.
- Limited-slip differential oil API GL-5 SAE 90 is used for models with LSD (limited-slip differential).
- The weight varies according to vehicle model.

1. Wheel Hub and Rotor

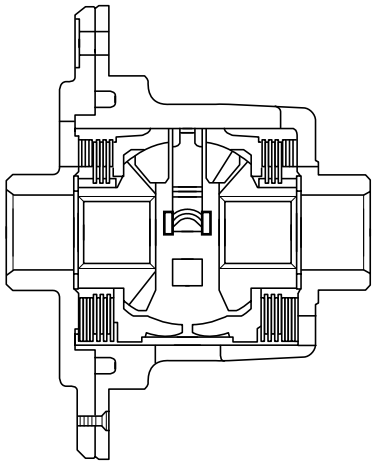


- The brake pad wear indicator is installed only on the right wheels.

2. Reduction and Differential

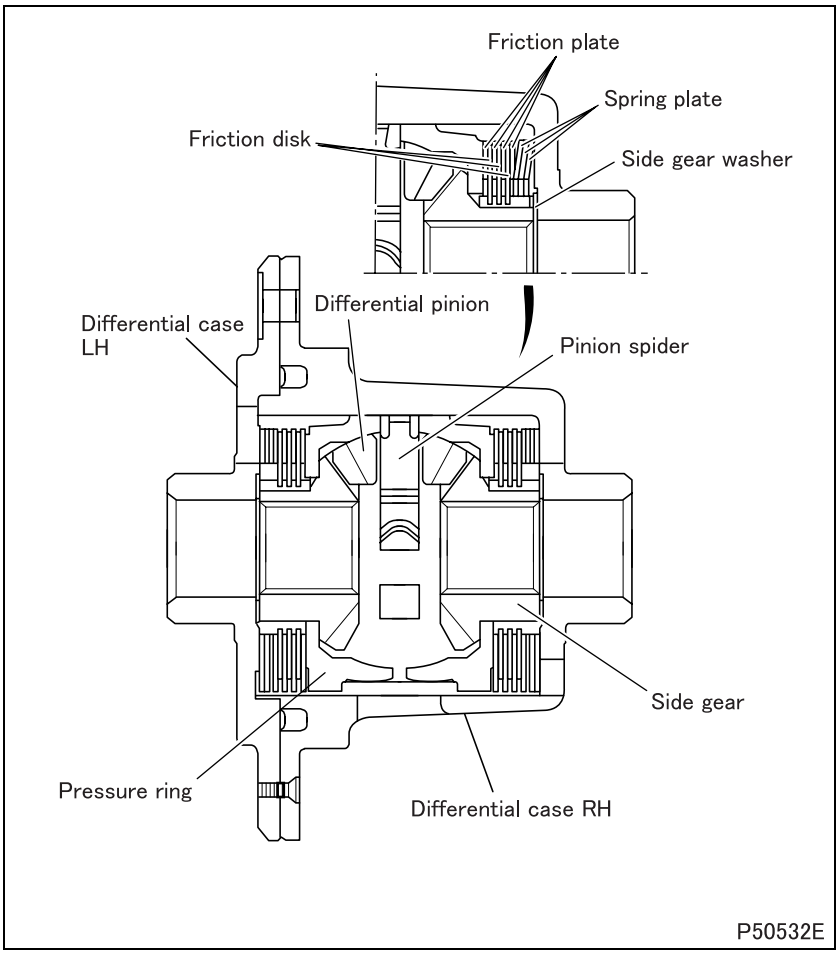


Limited slip differential



P58332E

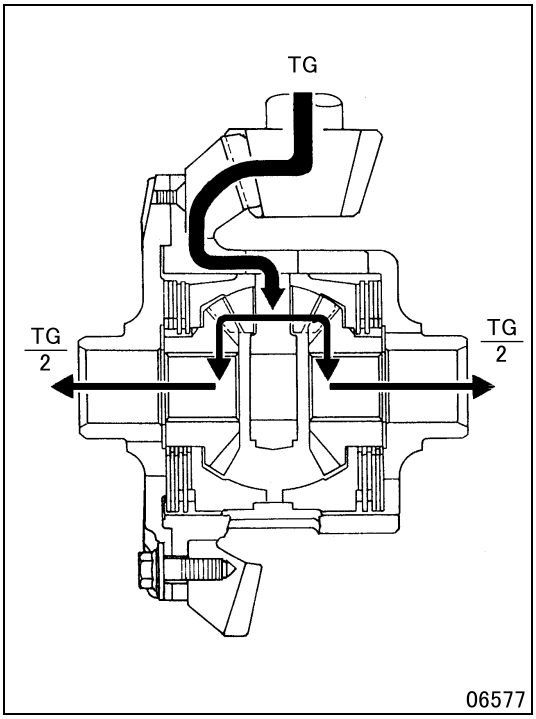
3. Limited Slip Differential



- The friction discs and spring discs, which are fitted in the side gears, and the friction plates, which are fitted in the R/H differential case, are pushed against the pressure rings by the spring plates.
- The pressure rings fit in the groove inside the R/H differential case and always rotate at the same speed.

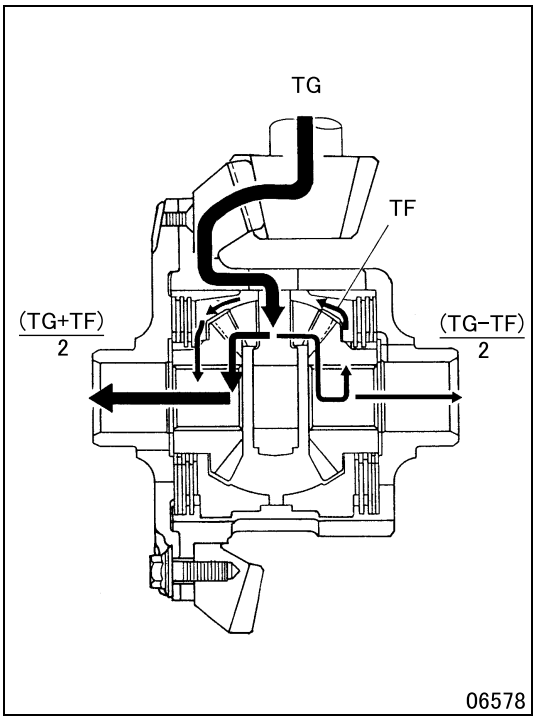
3.1 Operating mechanism

- When one wheel spins, a difference in the revolution speed generates between the side gear and the differential case, L/H and R/H, which causes the friction discs, spring discs and friction plates to revolve with respect to each other. This relative revolution produces a friction torque between the friction discs and friction plates.



3.2 Operation during straight driving

- During straight driving, the right and left axle shafts rotate at the same speed, and no friction torque generates.
  TG: input torque



3.3 Operation when there is a difference in rotation speed between right and left wheels

- If one wheel is on a slippery surface such as mud and the other wheel is not, the differential function becomes effective. Under these conditions, friction torque **TF** is generated, reducing the difference in rotations between right and left wheels. That is, the faster axle shaft is forced to slow down, and the slower axle shaft is forced to turn faster.
  If one wheel spins, a large friction torque is generated, because the spinning creates a large difference in rotational speed. In this way, a small torque is distributed to the spinning wheel at the same time that a large torque is distributed to the non-spinning wheel, which makes it easier for the vehicle to get out of the mud.

$\frac{\mathbf{TG-TF}}{\mathbf{2}}$ High-speed side (spinning side)

$\frac{\mathbf{TG+TF}}{\mathbf{2}}$ Low-speed side

M E M O

Possible causes	Symptoms	Power transmission insufficient						Oil leakage from companion flange assembly	Oil leakage from differential carrier and axle housing	Oil leakage from axle shaft	Reference Gr
		Noise when starting and changing gears	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Propeller shaft turns but vehicle does not move				
Wheel hub, axle shaft, axle housing	Wheel hub bearing seized, worn or rotation faulty		O								
	Wheel hub bearing broken			O							
	Axle shaft mounting bolts loose			O						O	
	Axle shaft broken						O				
	Axle shaft slips out of spline of side gear						O				
	Axle shaft to spline of side gear backlash excessive	O									
	Oil seal faulty									O	
	Axle housing bent		O								
	Inspection plug and drain plug loose								O		
	Air breather and vent plug clogged							O		O	
Reduction and differential	Gear oil excessive							O			
	Gear oil insufficient	O	O								
	Oil seal faulty							O			
	Sealant faulty								O		
	Reduction and differential assembly mounting nuts and bolts loose			O					O		
	Differential carrier cracked or damaged								O		
	Bearing cap mounting bolts loose			O							
	Side bearing seized, worn or rotation faulty		O		O						
	Side bearing broken			O							
	Side bearing preload adjusted incorrectly		O								
	Reduction pinion or reduction gear broken	O		O	O		O				
	Reduction pinion or reduction gear worn		O		O						
	Reduction pinion or reduction gear damaged		O								
	Reduction gear backlash excessive	O									
	Reduction gear backlash or tooth contact adjusted incorrectly		O								

Possible causes	Symptoms	Power transmission insufficient						Oil leakage from companion flange assembly	Oil leakage from differential carrier and axle housing	Oil leakage from axle shaft	Reference Gr
		Noise when starting and changing gears	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Propeller shaft turns but vehicle does not move				
Reduction and differential	Starting torque of pinion bearing faulty	O	O								
	Locknut loose	O	O								
	Front and rear bearings seized		O								
	Front and rear bearings worn		O								
	Front and rear bearings broken			O							
	Pinion pilot bearing worn		O								
	Pinion pilot bearing seized or broken			O							
	Pinion shaft and pinion spider broken						O				
	Reduction gear and differential case mounting bolt and nut loose	O		O							
	Side gear backlash excessive	O									
	Side gear or differential pinion broken			O	O	O	O				
	Side gear or differential pinion seized					O	O				
	Side gear or differential pinion worn				O	O					
	Side gear washer worn or damaged			O	O	O					
	Limited-slip differential (LSD) broken <On vehicles with LSD>	O	O	O	O		O				

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Axle Oil Level Check and Axle Oil Change

Torque value: N·m (lbf·ft)

Mark	Component	Torque value	Remarks
–	Inspection plug	110 ± 10 (81 ± 7.4)	–
	Drain plug		

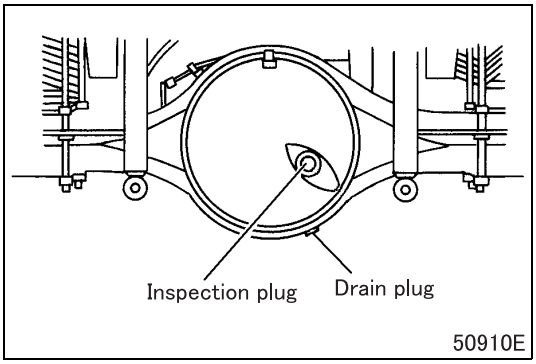
Lubricant and/or sealant

Mark	Points of application		Specified lubricant and/or sealant	Quantity
–	Axle housing	D033H, D035H	Normal: Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area: Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140	4.5 L {4.8 qt}

- Use gear oil with a SAE viscosity of 140 when a vehicle is used under heavy load conditions, including frequent driving on prolonged upgrades when the air temperature is above 10°C.
- Limited-slip differential oil API GL-5 SAE 90 is used for models with LSD (limited-slip differential).

WARNING ⚠

- **Axle oil is extremely hot immediately after vehicle operation. Hot axle oil can cause burns.**



(1) Oil level check

- Remove the fill plug, and check that the axle is filled with oil up to the level of the fill opening.
- If needed, add oil through the fill hole until it is at the level of the fill opening.
- Install the fill plug and tighten it to the specified torque.

(2) Oil change

[Draining and inspection]

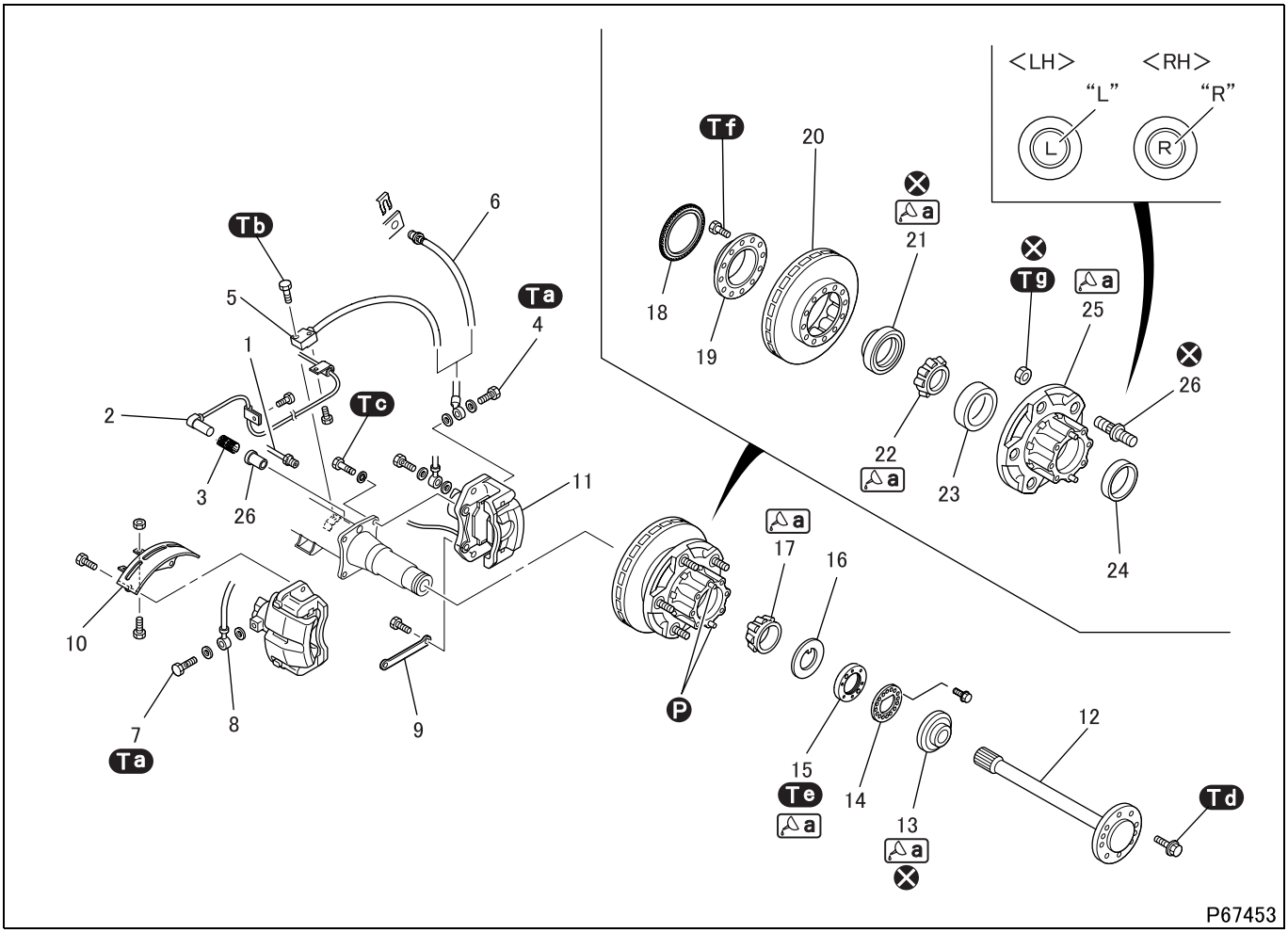
- Remove the fill plug and magnetic drain plug. Drain the oil while the axle is still warm. Catch the unused oil in a suitable container.
- Check the drained oil for presence of metal chips and metal powder. Dispose of the oil properly.
- If an abnormally large amount of metal chips and metal powder is found, remove the axle.

[Filling]

- Clean the magnetic drain plug before installation.
- Add gear oil in the specified quantity through the fill plug opening.
- After filling, check that oil is filled up to the level of the fill opening. If needed, add oil through the fill hole until it is at the level of the fill opening.
- Tighten the fill and drain plugs to the specified torque.

M E M O

WHEEL HUB AND ROTOR



● **Disassembly sequence**

1 Brake line
2 Wheel speed sensor
3 Spring spacer
4 Eye bolt
5 Brake hose (with connector)
6 Brake hose (without connector)
7 Eye bolt
8 Brake hose
9 Lower dust shield
10 Upper dust shield
11 Rear disc brake (see Gr35A)
12 Axle shaft
13 Outer oil seal
14 Lock washer
15 Locknut
16 Lock plate <COE 50>
17 Outer bearing inner race
18 Antilock brake system rotor
19 Antilock brake system rotor flange
20 Disc rotor
21 Oil seal
22 Inner bearing inner race
23 Inner bearing outer race
24 Outer bearing outer race
25 Wheel hub
26 Hub bolt
27 Sensor holder

Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose to prevent entry of dust and dirt after it has been removed.**

NOTE

- **Do not remove the antilock brake system rotor and sensor holder except to replace them.**
- **Do not disassemble the disc rotor and wheel hub except to replace them.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the disc rotor surface and disc brake pad surface are free from grease.**
- **Make sure that the brake hose is not twisted or kinked.**
- **Inspect the drag torque of disc brakes after assembly. (See Gr35A.)**

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of wheel hub bearing (inertial force at hub bolt position with oil seal assembled)		2.0 to 3.9 N·m {1.4 to 2.9 lbf·ft} (inertial force: 18 to 32 N {4.0 to 7.2 lb}	–	Adjust or replace
12	Axle shaft	Bend	1 {0.039} or less	2 {0.079}	Replace
		Bend at flange face	0.03 {0.0012} or less	0.05 {0.0020}	
19	Disc rotor	Runout (measure runout, assembling disc rotor in rear axle)	0.07 {0.0028} or less	0.10 {0.0039}	Replace
		Thickness	40 {1.57}	38 {1.50}	

Torque value: N·m (lbf·ft)

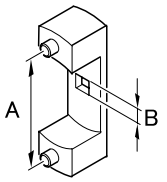
Mark	Fastener			Torque value	Remarks
Ta	Eye bolt			22 ± 2 (16 ± 1.5)	–
Tb	Bolt (brake hose mounting) (with connector)			43.2 ± 10 (32 ± 7.4)	–
Tc	Bolt (rear disc brake mounting)			98 to 140 (72 to 103)	–
Td	Bolt (axle shaft mounting)			98 to 120 (72 to 87)	–
Te	Locknut	Primary tightening	COE 40/45	98 to 130 (72 to 96)	–
			COE 50	150 to 180 (110 to 130)	
		Secondary tightening after complete tightening	COE 40/45	30 to 40 (22 to 29)	–
			COE 50	50 to 60 (37 to 44)	
Tf	Bolt (wheel hub and disc rotor mounting)			45 to 60 (33 to 44)	–
Tg	Nut (hub bolt mounting)			340 ± 40 (251 ± 30)	–

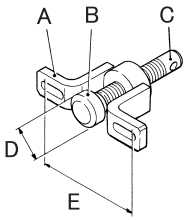
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
△a	Lip area of outer oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Thread area of locknut		
	Pack space between rollers of outer bearing inner race and inner bearing inner race		
	Lip area of oil seal		
	Pack interior of wheel hub		370 ± 37 g ※ {13.1 ± 1.31 oz}

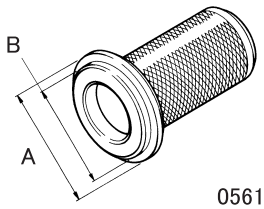
※: For a wheel hub

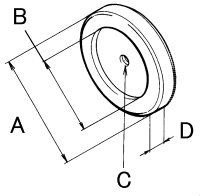
Special tools (Unit: mm {in})

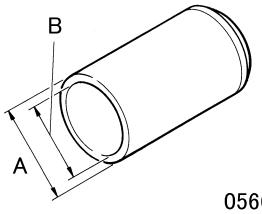
<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Locknut adjuster
 

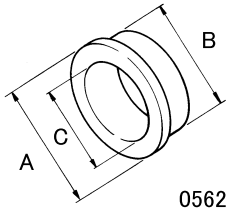
P05617
<table><tr><th>Parts No.</th><th>A</th><th>B</th></tr><tr><td>MB999150</td><td>70
{2.76}</td><td>□12.7
{0.50}</td></tr><tr><td>MC888793</td><td>80
{3.15}</td><td>□12.7
{0.50}</td></tr></table></td><td><FE84>
MB999150
<FE85>
MC888793</td><td>Removal and installation of locknut</td></tr>
<tr><td>b</td><td>Hub puller
A: Hub puller body
B: Attachment
C: Bolt
 

05618
<table><tr><th>D</th><th>E</th></tr><tr><td>ϕ50
{1.97}</td><td>165
{6.50}</td></tr></table></td><td>MB999070

A: MB999071
B: MB999073
C: MB999072</td><td>Removal of wheel hub and rotor</td></tr>
<tr><td>c</td><td>Oil seal installer
 

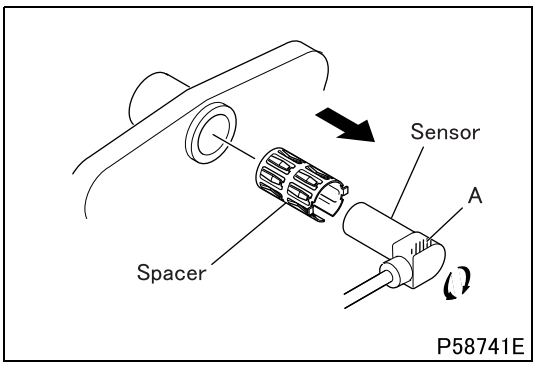
05619
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ84
{3.31}</td><td>ϕ70
{2.76}</td></tr></table></td><td>MB999097</td><td rowspan="3">Installation of oil seal (to be used in combination)</td></tr>
<tr><td>d</td><td>Oil seal installer
 

51705
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><td>ϕ117
{4.61}</td><td>ϕ84
{3.31}</td><td>M10 × 1.25</td><td>20
{0.79}</td></tr></table></td><td>MH062607</td></tr>
<tr><td>e</td><td>Bearing installer
 

05668
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ70
{2.76}</td><td>ϕ57
{2.24}</td></tr></table></td><td>MB999100</td><td rowspan="2">Installation of inner and outer bearing outer races (to be used in combination)</td></tr>
<tr><td>f</td><td>Bearing installer
 

05621
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ109
{4.29}</td><td>ϕ99
{3.90}</td><td>ϕ77
{3.03}</td></tr></table></td><td>MB999098</td></tr>
</table>

◆Removal procedure◆

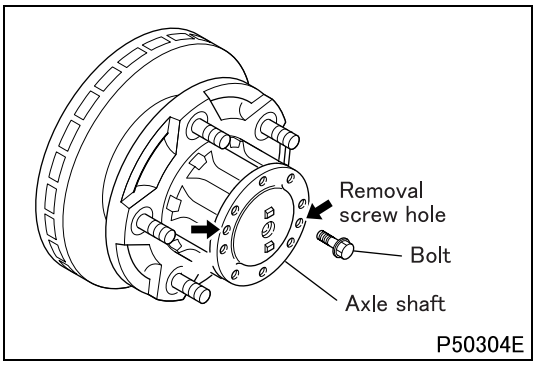


■ Removal: Wheel speed sensor

- Hold the shaded section (section A) of the wheel speed sensor with pliers. Remove the sensor by twisting it slightly to the left and right.
- If the wheel speed sensor pulls out without any resistance, replace the spring spacer.

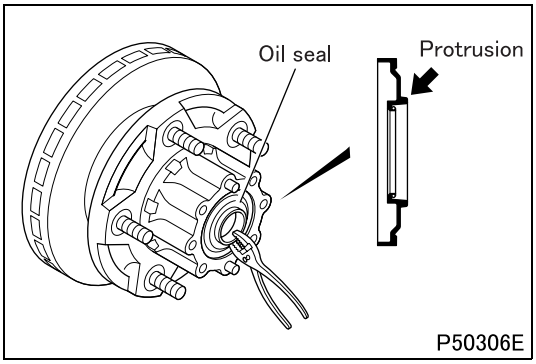
CAUTION ⚠

- **When removing the wheel speed sensor, never apply force to it, such as tapping it with a hammer, prying it with a screwdriver, or yanking on the harness. This could cause the wire to break.**



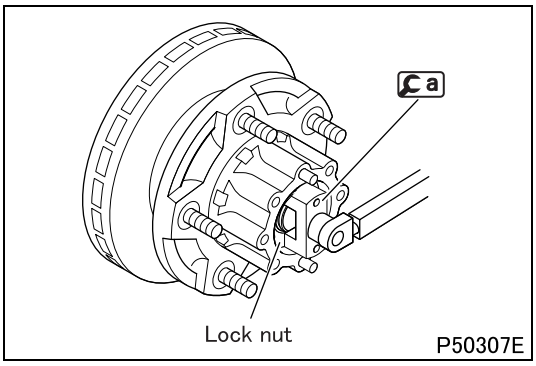
■ Removal: Axle shaft

- Remove the axle shaft mounting bolts that attach the axle shaft to the wheel hub.
- Screw two axle shaft mounting bolts evenly into the axle shaft removal screw holes. Use them as handles to remove the axle shaft.

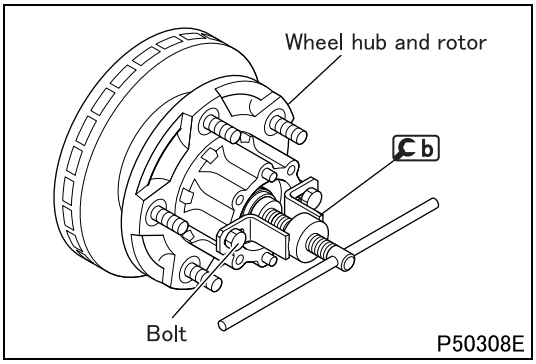


■ Removal: Outer oil seal

- To remove the outer oil seal, use pliers to pull on the protrusions on the outer edge of the outer oil seal. Pull evenly around the whole circumference of the seal.

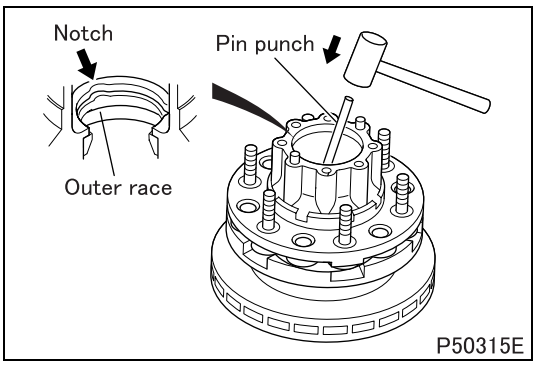


■ Removal: Locknut



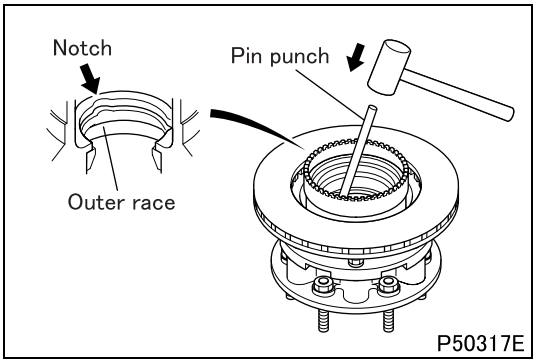
■ **Removal: Wheel hub and rotor**

- Install the hub puller b and fasten it with axle shaft mounting bolts. Remove the wheel hub and rotor assembly.



■ **Removal: Inner bearing outer race**

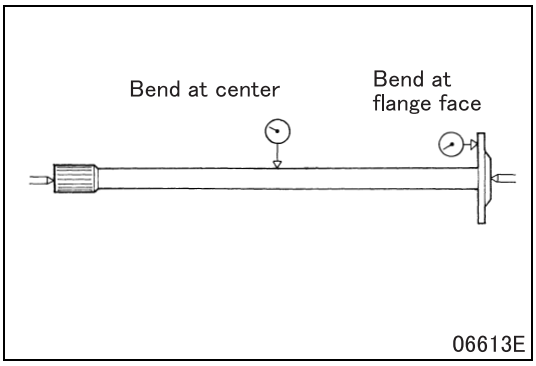
- Drive out the inner bearing outer race by tapping at each of the three indentations in the wheel hub. Keep the race level as it is being removed.



■ **Removal: Outer bearing outer race**

- Drive out the outer bearing outer race by tapping at each of the three indentations in the wheel hub. Keep the race level as it is being removed.

◆Inspection procedure◆



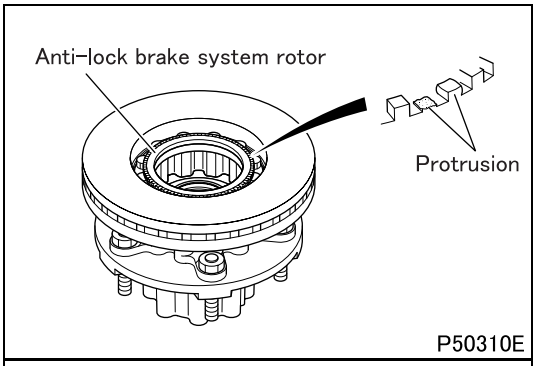
■ **Inspection: Axle shaft**

- Measure the bend of the axle shaft at its center.

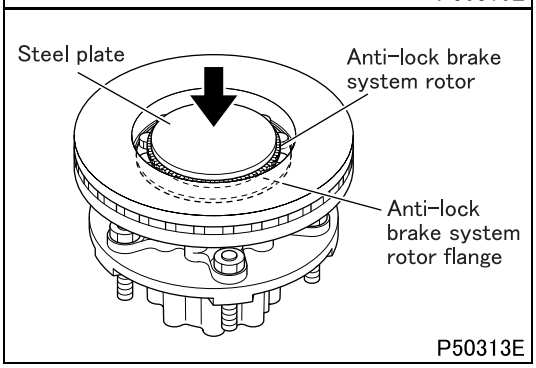
NOTE

- **Give the axle shaft one complete turn and read the dial gauge at this time. The bend is one half of the dial gauge reading.**

- If the measured value exceeds the limit, replace the axle shaft.
- Measure the bend of the flange face of the axle shaft.
- If the measured value exceeds the limit, replace the axle shaft.



P50310E



P50313E

■ Inspection: Antilock brake system rotor

[Inspection]

- Remove any debris on the antilock brake system rotors. Check the protrusions on the antilock brake system rotor for chipping and flattening.
- If any problem is found, replace the antilock brake system rotor.

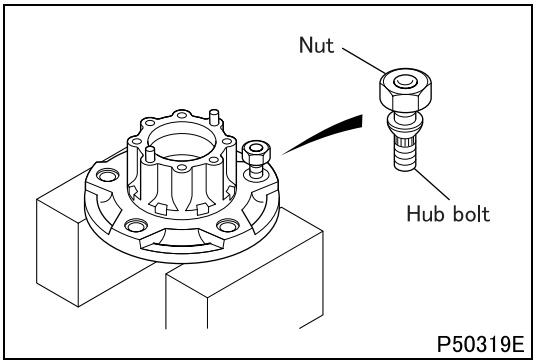
[Installation]

- Heat the antilock brake system rotor to approximately 150°C (302°F).
- Install the antilock brake system rotor and antilock brake system rotor flange evenly using a steel plate so as not to allow them to tilt.

WARNING ⚠

- **Touching the heated rotor will cause burns.**

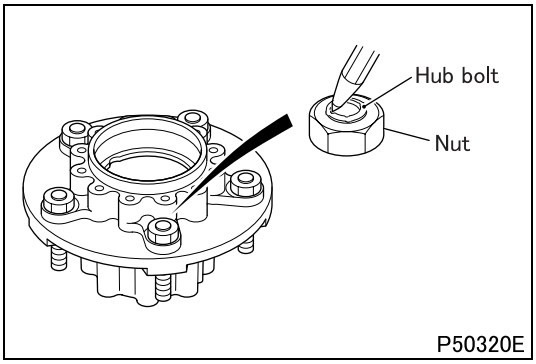
◆Installation procedure◆



P50319E

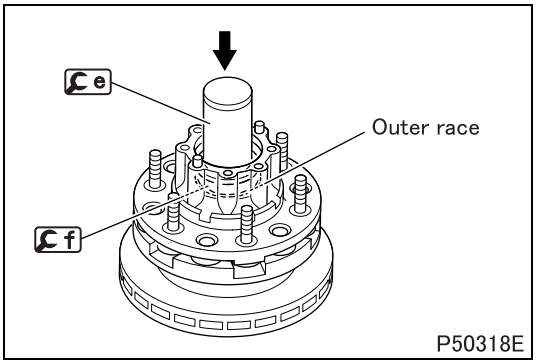
■ Installation: Hub bolt

- Screw the nuts into the hub bolt until they are almost flush with the flange.
- Drive the hub bolt into the wheel hub vertically by hitting the end face of the nut with a brass punch, or similar tool.

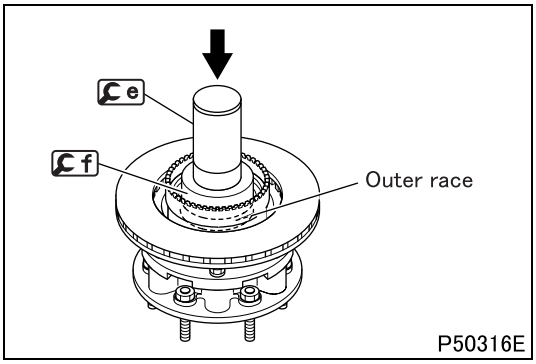


P50320E

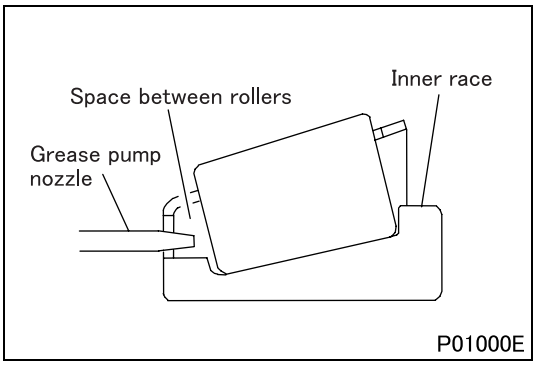
- After tightening the nut to the specified torque, use a punch to lock it in place.



■ **Installation: Outer bearing outer race**

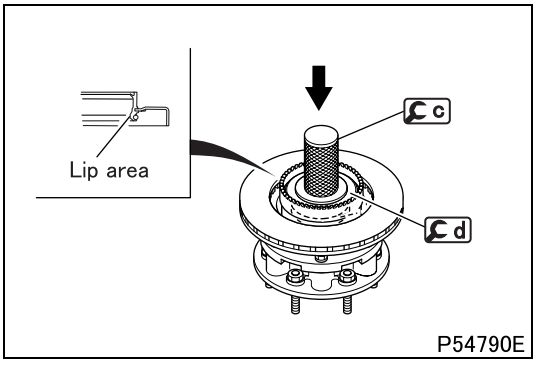


■ **Installation: Inner bearing outer race**



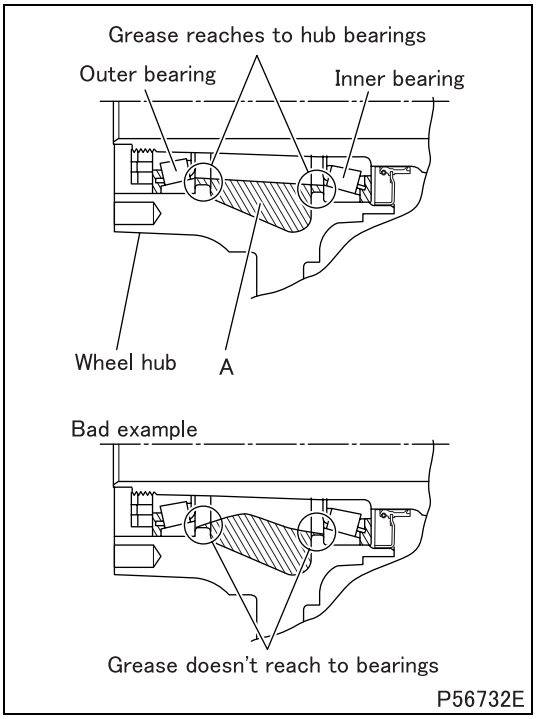
■ **Installation: Packing grease in inner bearing inner race**

- Insert the nozzle of the grease pump into the space between rollers of the inner bearing inner race to pack grease sufficiently.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the wheel hub in the illustrated direction.

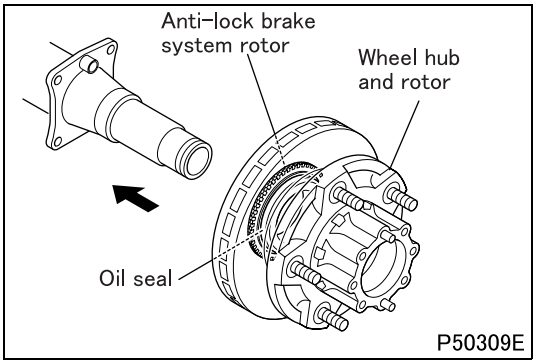


■ **Installation: Wheel hub and rotor**

- Apply the specified amount of grease to area A of wheel hub. The grease must reach to both the inner and outer bearing as shown in the illustration.

CAUTION ⚠

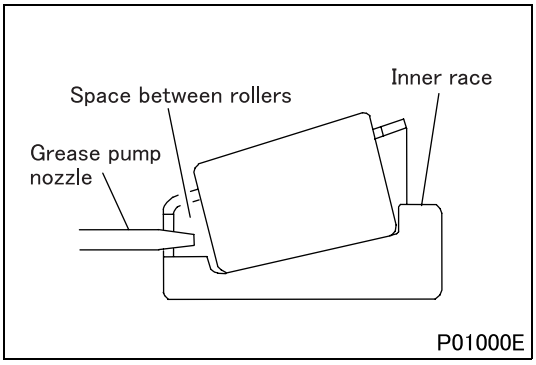
- **Applying grease as shown in the "bad example" causes the wheel hub bearing to seize.**



- Slowly install the wheel hub and rotor assembly so as not to cause damage to the oil seal and antilock brake system rotor.

CAUTION ⚠

- **If the antilock brake system rotor is damaged, wheel speed sensor signals become abnormal, causing the antilock brake system to malfunction.**

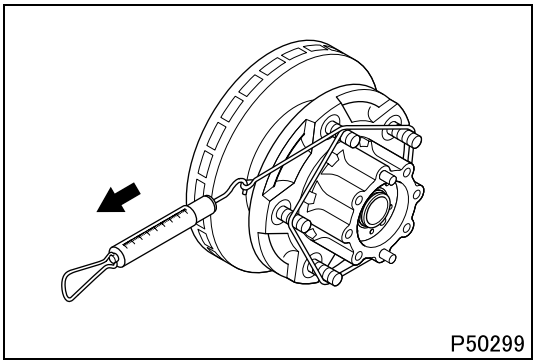


■ **Installation: Packing grease in outer bearing inner race**

- Insert the nozzle of the grease pump into the space between rollers of the inner bearing inner race to pack grease sufficiently.

■ **Installation: Locknut**

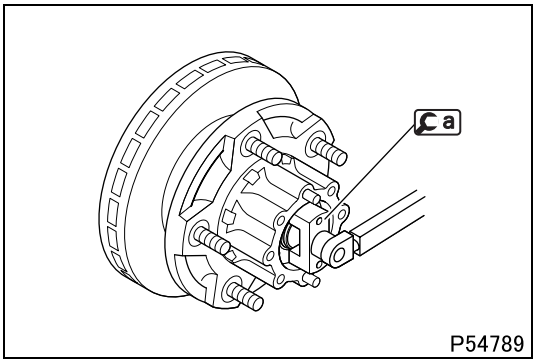
- Install the locknut, as removed. (See ■ **Removal: Locknut**.)


P50299

■ **Inspection: Starting torque of wheel hub bearing**

[Inspection]

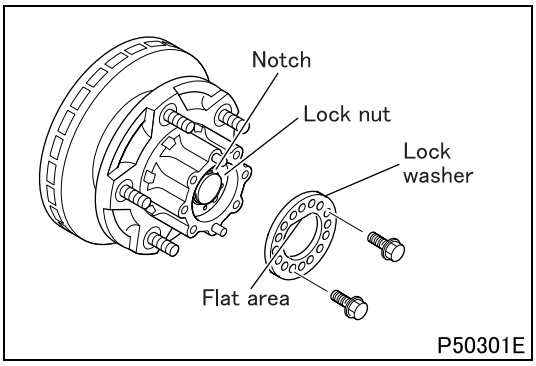
- After installing the lock washer, carry out the following inspections.
- Measure the inertial force at the hub bolt position using a spring balance.
- If the inertial force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, do the adjustment below.



P54789

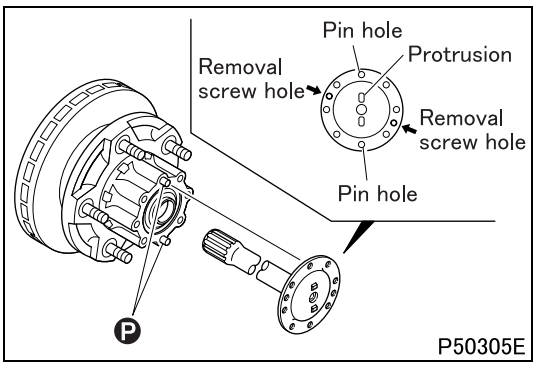
[Adjustment]

- Tighten the locknut to the specified torque (primary tightening) while turning the wheel hub and rotor, and then loosen it completely.
- Turn the wheel hub and rotor back and forth several times until it operates smoothly. Then tighten the locknut to the specified torque (secondary tightening).



P50301E

- Insert the flat area of the lock washer and align it with the notch in the axle housing. Fasten the locknut with two bolts installed across from each other.
- If the locknut does not align with one of the holes in the lock washer, adjust the locknut until it aligns. Make sure that there is no play in the axial direction.
- Do the measurement again after the adjustment. If any problem is found, replace the outer and inner bearings.



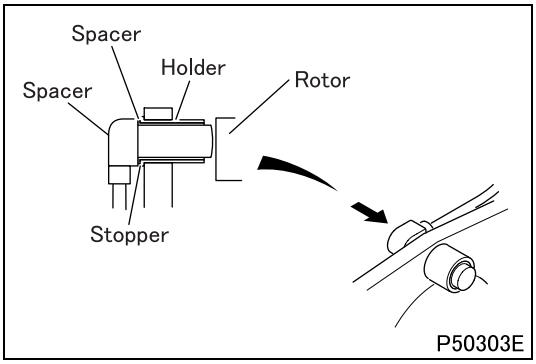
P50305E

■ **Installation: Axle shaft**

- Align the pin hole of the locating pin with that of the axle shaft to install the axle shaft.

NOTE

- **The pin holes do not necessarily line up with the protrusions on the axle shaft flange as shown in the illustration. To locate a pin hole, go clockwise to the second hole from a removal screw hole.**

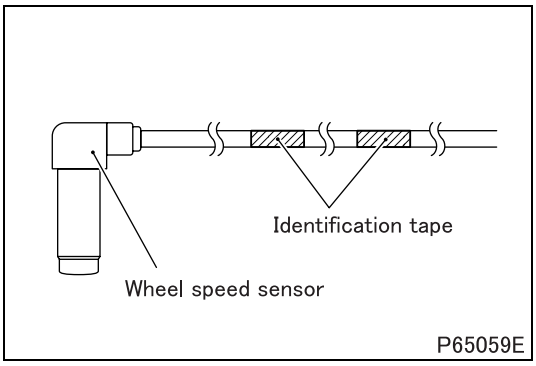


■ **Installation: Wheel speed sensor**

- Install the wheel speed sensor so that it securely contacts the sensor holder together with the spring spacer.

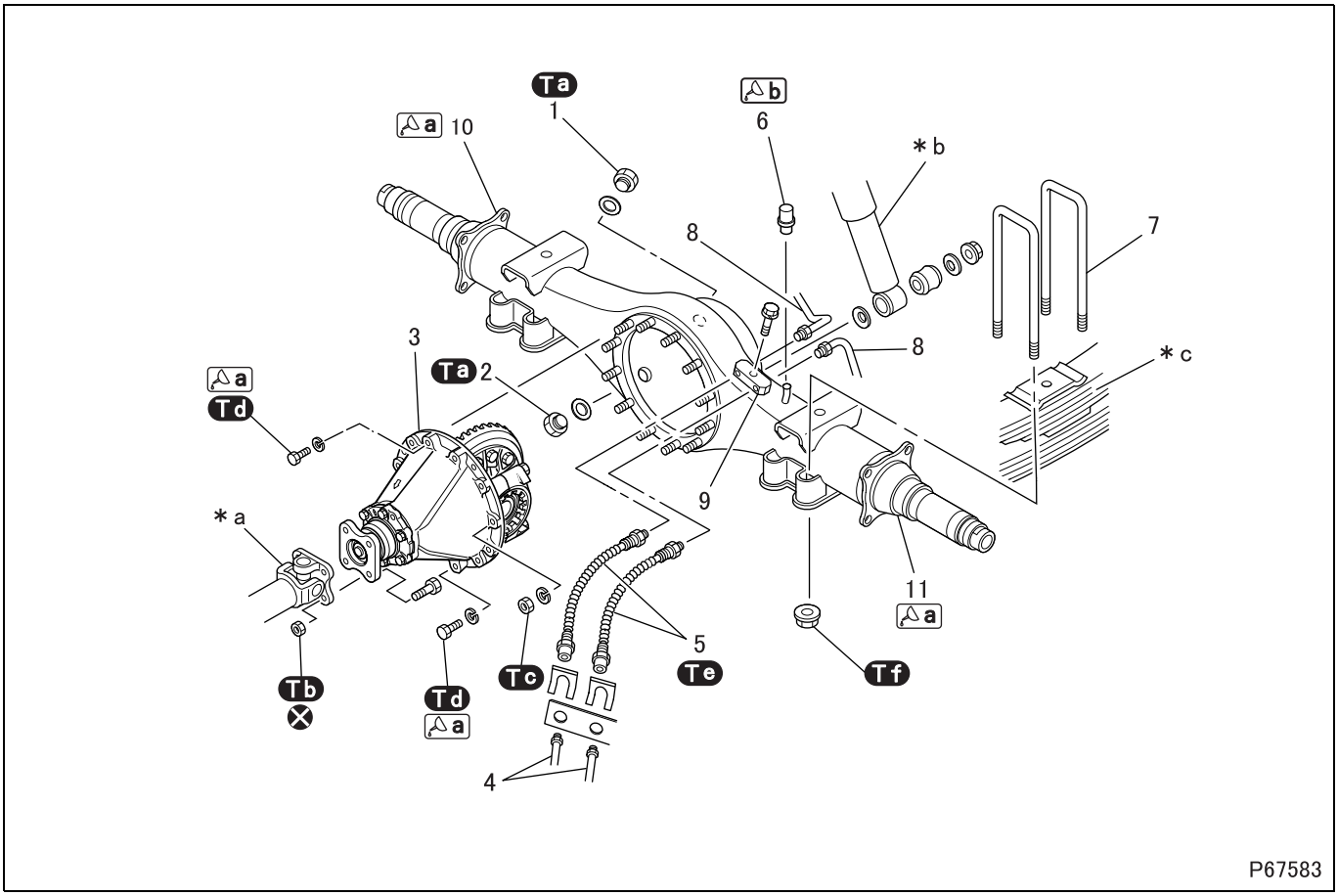
CAUTION ⚠

- **When installing the wheel speed sensor, never apply force to it, such as tapping it with a hammer, prying it with a screwdriver, or yanking on the harness. This could cause the wire to break.**



- Use clips to secure the wheel speed sensor harness at the identification tape portions. Ensure that the harness is free of kinks, slack, and/or interference with other parts.

AXLE HOUSING



● **Removal sequence**

1 Inspection plug
2 Drain plug
3 Reduction and differential (see later sections)
4 Brake pipe
5 Brake hose
6 Packing <COE 45/50>
7 Vent plug
8 U-bolt
9 Brake pipe
10 Connector
11 Axle housing

***a**: Propeller shaft
***b**: Shock absorber
***c**: Leaf spring

⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose and brake line to prevent the entry of dust and dirt into the brake system.**

NOTE

- **Do not remove the axle housing unless a problem is found.**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
7	Injection-valve opening pressure of vent plug		4.9 kPa {0.7 psi} or less	–	Replace
11	Axle housing	Runout at outer bearing portion	0.5 {0.020} or less	1 {0.039}	Replace
		Difference between before and after rotation at center <drive axle>	1 {0.039} or less	5 {0.20}	

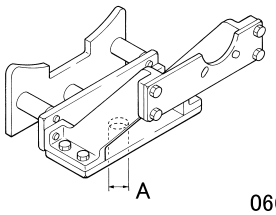
Torque value: N·m (lbf·ft)

Mark	Component		Torque value	Remarks
Ta	Inspection plug		98 ± 120 (72 ± 89)	–
	Drain plug			
Tb	Nut (propeller shaft mounting)		100 to 120 (74 to 89)	M12
Tc	Nut (reduction and differential mounting)		69 to 93 (51 to 69)	–
Td	Bolt (reduction and differential mounting)		83 to 108 (61 to 80)	–
Te	Brake hose	<COE 40>	25.5 to 34.3 (18.8 to 25.3)	–
		<COE 45/50>	20.6 to 31.4 (15.2 to 23.2)	–
Tf	Nut (U-bolt mounting)		292 to 394 (215 to 290)	M18

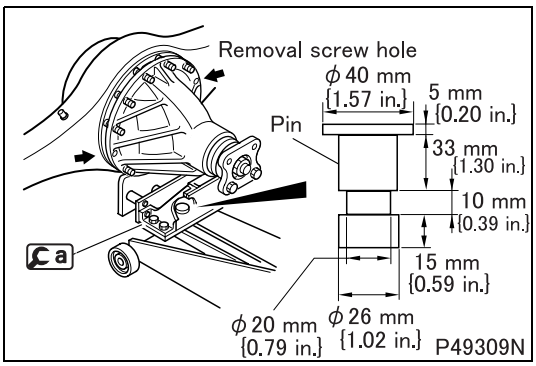
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Thread area of bolt	ThreeBond 1215	As required
	Reduction and differential mounting surface of axle housing		
b	Axle housing mounting surface of vent plug	ThreeBond 1216	As required

Special tools (Unit: mm {in})

Mark	Tool name and shape	Part No.	Application
Ca	Differential carrier base A: ϕ28 {1.10} 	MB999102	Removal and installation of reduction and differential

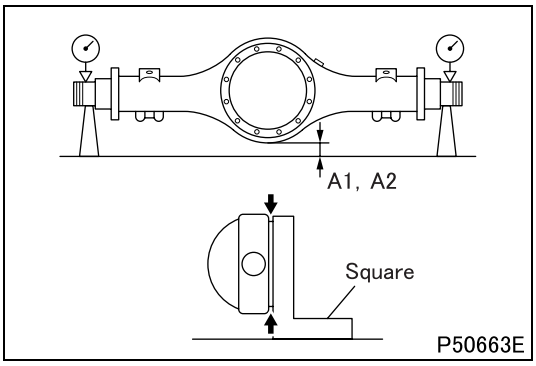
◆Removal procedure◆



■ Removal: Reduction and differential

- Lower the garage jack and place the differential carrier base [a] on it. Use a pin fabricated to the dimensions in the illustration. Insert the pin and fasten it.
- Screw two bolts evenly into the reduction and differential removal screw holes (as shown in illustration), Use them as handles to remove the reduction and differential.
  Bolt size: M12 × 1.25 mm

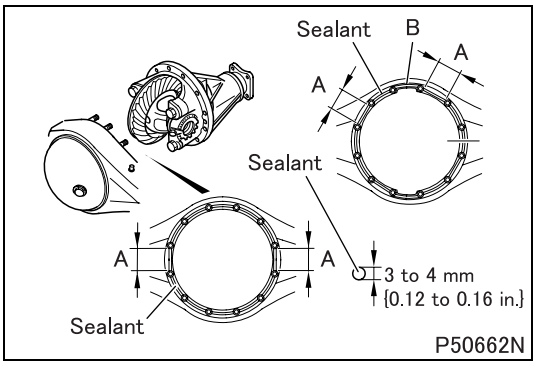
◆Inspection procedure◆



■ Inspection: Axle housing

- Horizontally support the inner bearing fittings at both ends of the housing spindle of the axle housing.
- Apply a dial gauge to the outer bearing fitting and turn it 360 degrees to measure runout.
- For measurement of dimensions **A1** and **A2**, place the axle housing at right angles using a square and measure dimension **A1**. Then, turn it 180 degrees and measure dimension **A2**.
- If the measured value exceeds the limit, replace the axle housing.

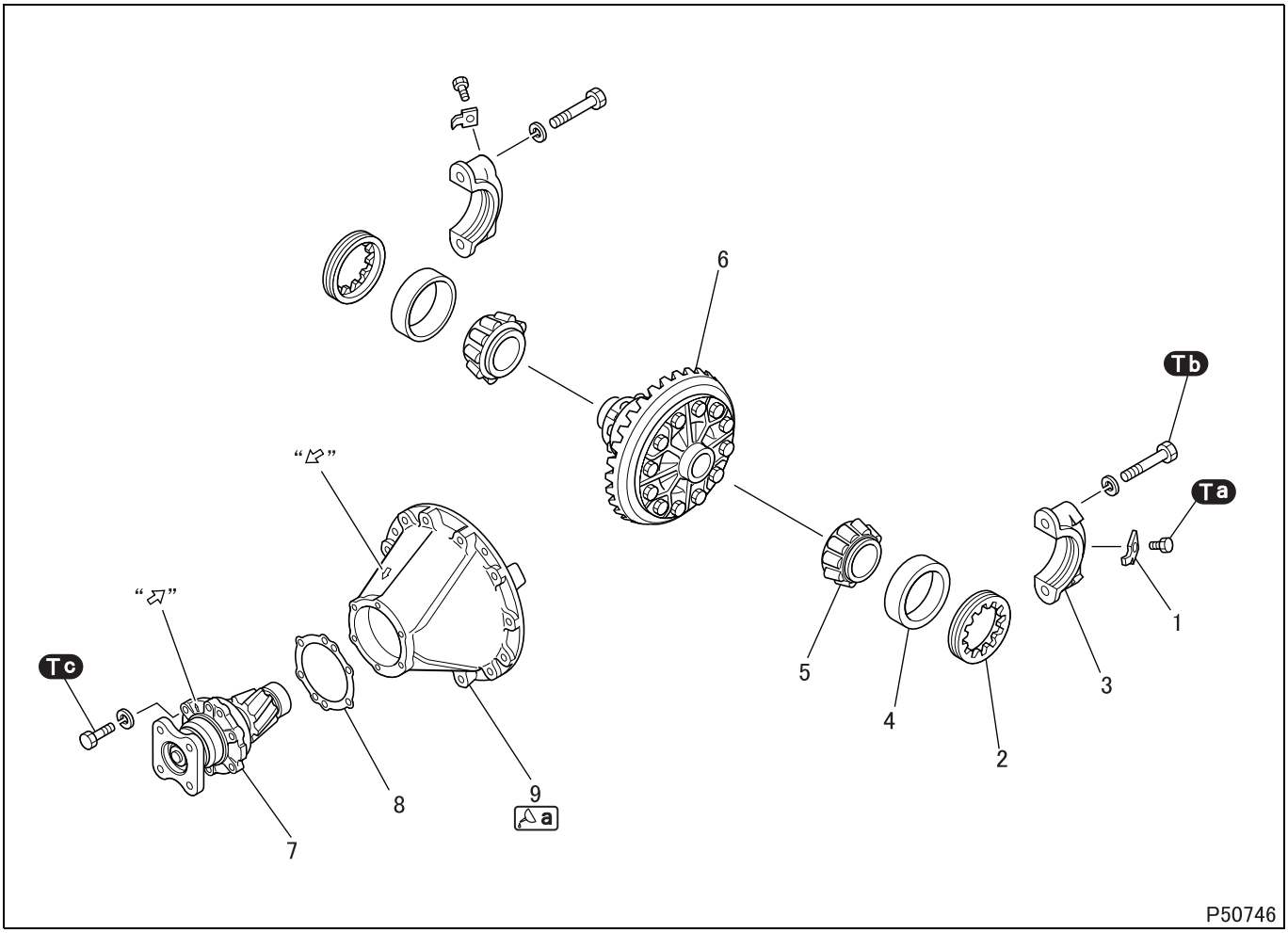
◆Installation procedure◆



■ Installation: Reduction and differential

- Clean a seal surface of each part.
- Apply sealant to the reduction and differential mounting surface of the axle housing evenly and without breaks. Apply sealant in a straight line direction for illustrated position **A** and along the outer periphery for notches of illustrated position **B**.

M E M O



● **Disassembly sequence**

1 Lock plate
2 Side bearing nut
3 Bearing cap
4 Side bearing outer race
5 Side bearing inner race
6 Differential (see later sections)
7 Reduction pinion (see later sections)
8 Shim
9 Differential carrier

CAUTION ⚠

- **Keep side bearings that have been removed separated from each other and ensure that during installation each one is correctly placed.**
- **Be sure to replace the bearing cap, differential carrier and bolts as a differential carrier set.**
- **Be sure to replace the reduction pinion and the reduction gear of the differential as a reduction gear set.**

NOTE

- **Record the number and thickness of shims to use them as reference at assembly.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
7, 8	Starting torque of side bearing	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs}	–	Adjust
9	Wobble at back face of reduction gear	0.1 {0.0039} or less	–	Replace
9, 11	Backlash between reduction gear and reduction pinion	0.20 to 0.28 {0.0079 to 0.011}	0.5 {0.020}	Adjust or replace

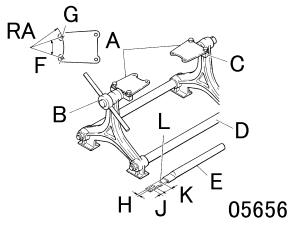
Torque value: N·m (lbf·ft)

Mark	Fastener	Torque value	Remarks
Ta	Bolt (lock plate mounting)	20 to 26 (15 to 19)	–
Tb	Bolt (bearing cap mounting)	200.9 (150)	–
Tc	Bolt (pinion mounting)	67 to 90 (49 to 67)	–

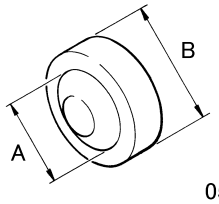
Lubricant and/or sealant

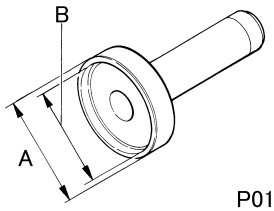
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Pinion pilot bearing mounting surface of differential carrier	Loctite 601	As required

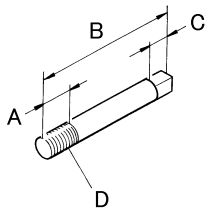
Special tools (Unit: mm {in})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>
Differential working base


05656
<table>
<tr><th colspan="4">Component</th><th>Part No.</th></tr>
<tr><td rowspan="3">A</td><td colspan="3">Attachment</td><td>–</td></tr>
<tr><td>RA</td><td>F</td><td>G</td><td>–</td></tr>
<tr><td>R158
{6.22}</td><td>30°</td><td>ϕ13
{0.51}</td><td>MB999040</td></tr>
<tr><td>B</td><td colspan="3">Holder</td><td>MB999036</td></tr>
<tr><td>C</td><td colspan="3">Holder</td><td>MB999037</td></tr>
<tr><td>D</td><td colspan="3">Working base</td><td>MB999035</td></tr>
<tr><td>E</td><td colspan="3">Flange stopper</td><td>MB999096</td></tr>
</table>
<table>
<tr><th>H</th><th>J</th><th>K</th><th>L</th></tr>
<tr><td>11
{0.43}</td><td>20
{0.79}</td><td>40
{1.57}</td><td>ϕ11
{0.43}</td></tr>
</table>
</td><td>MB999034</td><td>Workbench for reduction and differential

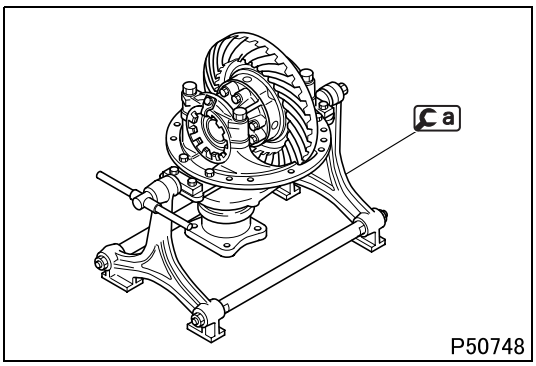
(flange stopper is unused)</td></tr>
<tr><td>b</td><td>
Adapter
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>ϕ45
{1.77}</td><td>ϕ59
{2.32}</td></tr>
</table>


05658
</td><td>MB999076</td><td>Removal of side bearing inner race (to be used in combination with commercial bearing puller)</td></tr>
<tr><td>c</td><td>
Bearing installer
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>ϕ80
{3.15}</td><td>ϕ70
{2.76}</td></tr>
</table>


P01039
</td><td>MH061748</td><td>Installation of side bearing inner race</td></tr>
<tr><td>d</td><td>
Bearing retainer guide pin


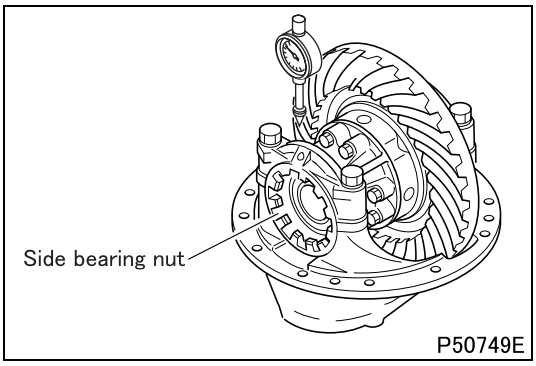
P01041
<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td>18
{0.71}</td><td>85
{3.35}</td><td>12
{0.47}</td><td>M12 × 1.25</td></tr>
</table>
</td><td>MH061745</td><td>Installation of reduction pinion (two pieces are used)</td></tr>
</table>

◆Work before removal◆



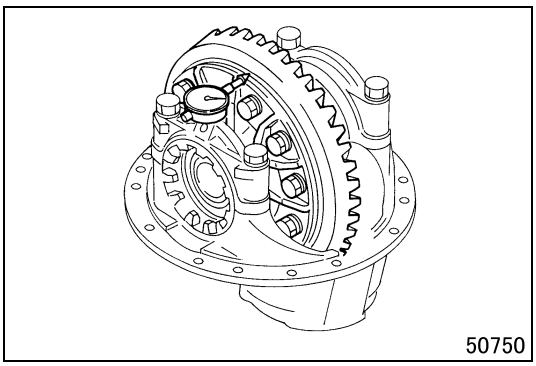
■ **Preparatory work: Installation of differential working base assembly**

- Install the reduction and differential on the differential working base a.



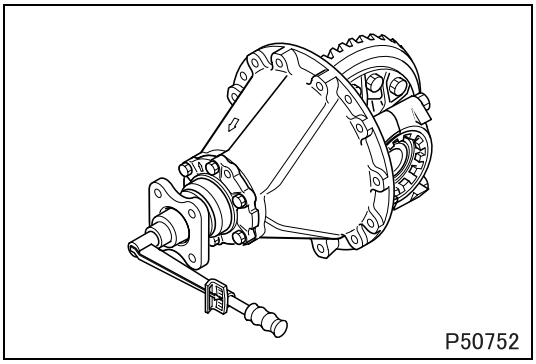
■ **Inspection: Backlash between reduction gear and reduction pinion**

- If backlash is found faulty, the tightening amount of the side bearing nut is probably inappropriate.



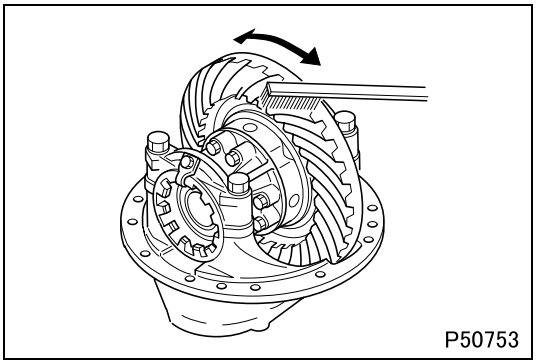
■ **Inspection: Wobble at back face of reduction gear**

- Measure wobble at the illustrated position of the reduction gear.



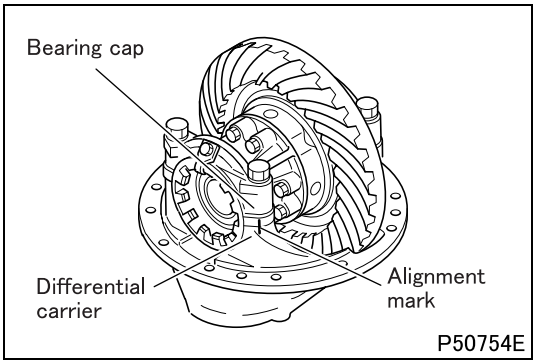
■ **Inspection: Starting torque of side bearing**

- Measure starting torque of the pinion assembly using a torque wrench and calculate the starting torque of the side bearing using the following formula.
  (Total starting torque – Pinion bearing starting torque (See later section.)) × Final ratio = Side bearing starting torque


P50753

■ **Inspection: Tooth contact of reduction gear**

- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several times to check for tooth contact.

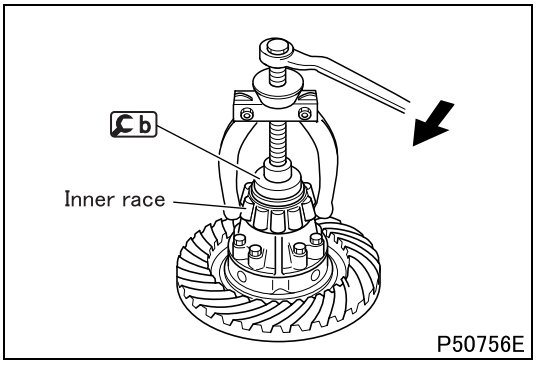


P50754E

■ **Alignment marks: Bearing cap and differential carrier**

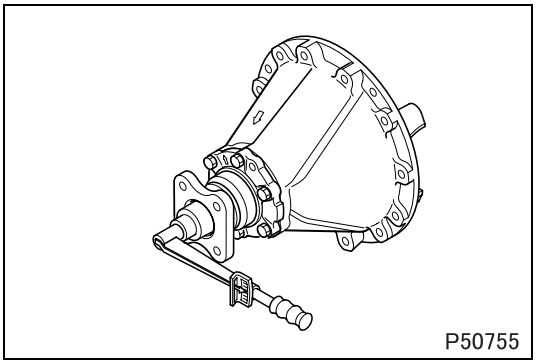
- Put alignment marks on the bearing cap and differential carrier for correct identification of right and left parts.

◆Removal procedure◆



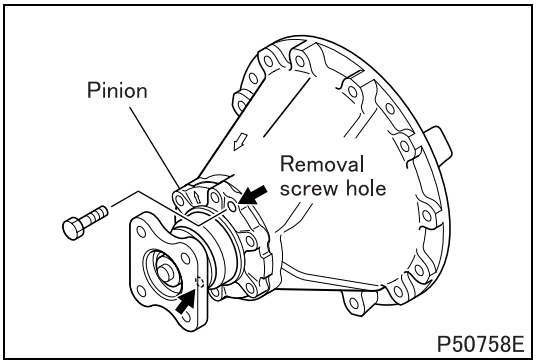
P50756E

■ **Removal: Side bearing inner race**


P50755

■ **Inspection: Starting torque of pinion bearing**

- After removing the differential, measure the starting torque of the pinion bearing.

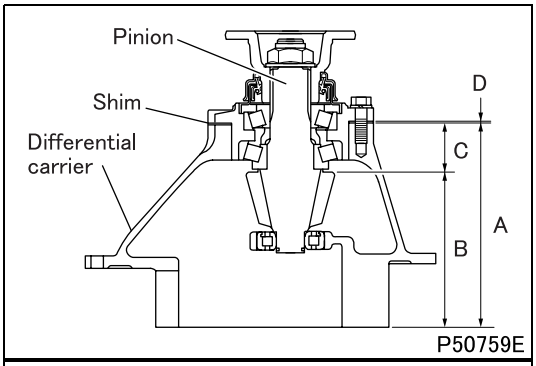


P50758E

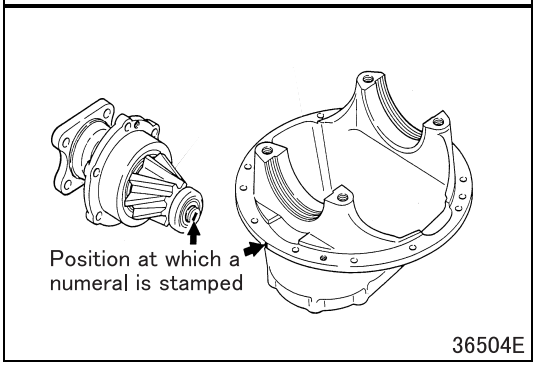
■ **Removal: Pinion**

- Screw two bolts evenly into the pinion removal screw holes to remove the pinion.

◆Adjustment procedure◆



P50759E



36504E

■ Adjustment: Reduction pinion

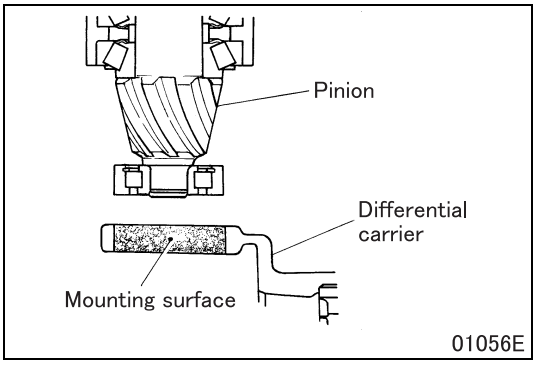
- Perform the following steps to adjust dimensions **A**, **B** and **C**.
- Calculate shim thickness (dimension **D**) by using the following formula based on the machining error data stamped on pinion assembly and differential carrier.
- Formula:
  D = 0.5 mm {0.020 in} – a + b + c
  a = Deviation from standard dimension **A**
  b = Deviation from standard dimension **B**
  c = Deviation from standard dimension **C**

Unit: mm {in}

Location	Standard dimension	How to calculate deviation
Shim thickness	0.5 {0.020}	–
A	203 {7.99}	A numeral, multiplied by 100, is stamped on the outer periphery of the flange of the differential carrier.
B	157 {0.18}	A numeral is stamped on the top of the pinion assembly.
C	46.5 {1.8}	Measure deviation from dimension **C** using a dial gauge. Taking measurement is usually not feasible and assume a value from 0 to 0.2 mm.

- Select a shim based on shim thickness **D**.
  Thickness of shims available
  0.1 mm {0.0039 in}, 0.2 mm {0.0079 in} (two thickness)

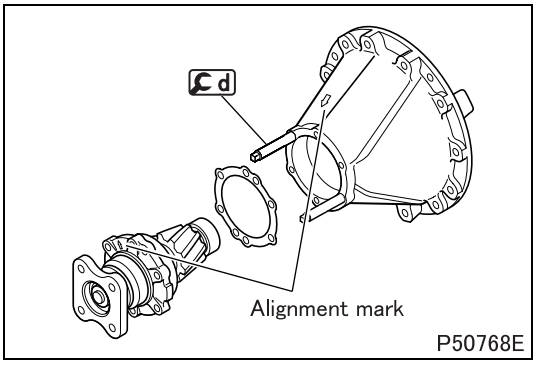
◆Installation procedure◆



01056E

■ Installation: Reduction pinion

- Apply sealant to the pilot bearing mounting surface of the differential carrier.

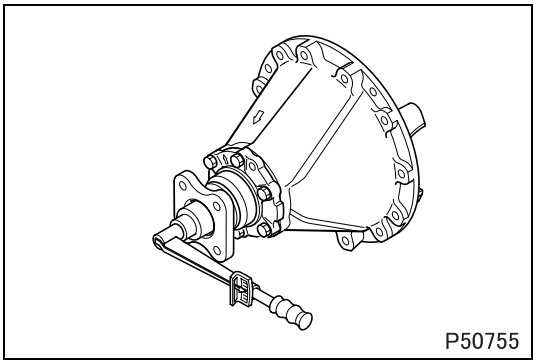


P50768E

- Aligning the embossed alignment mark on the bearing retainer of the pinion assembly with that on the differential carrier, mount the pinion assembly.

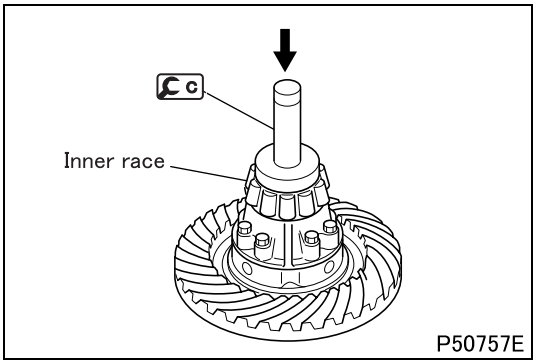
CAUTION ⚠

- **Leave for 30 minutes to 2 hours after installation to let the sealant harden.**
- **Wait at least three hours or, if feasible 24 hours, before running the vehicle to let the sealant harden.**


P50755

■ **Inspection: Starting torque of pinion bearing**

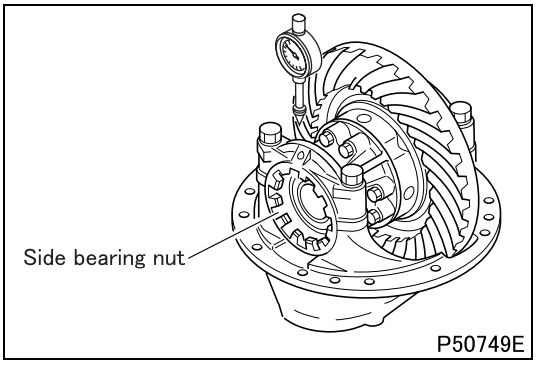
- After installing the pinion, measure the starting torque of the pinion bearing.
- If the measured value deviates from the standard value, adjust.



P50757E

■ **Installation: Side bearing inner race**

◆Work after installation◆



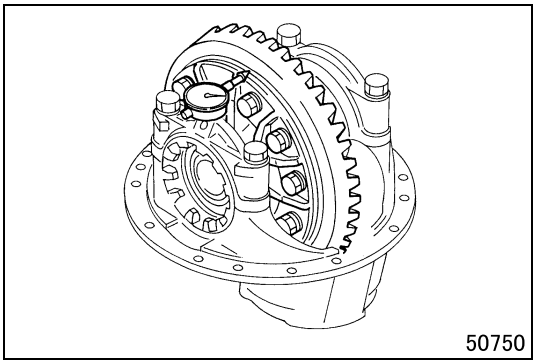
P50749E

■ **Adjustment: Backlash between reduction gear and reduction pinion**

- Adjust backlash with the side bearing nut, using care not to allow the side bearing starting torque to change.

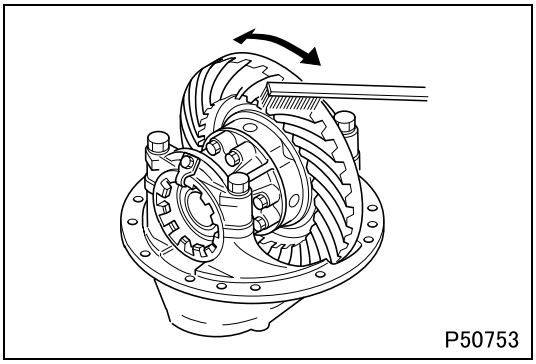
CAUTION ⚠

- **When one side bearing nut is loosened, be sure to tighten the other one the same amount to prevent the side bearing starting torque from changing.**


50750

■ **Inspection: Wobble at back face of reduction gear**

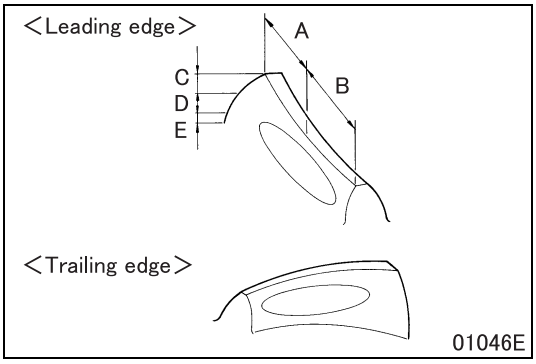
- Measure wobble at the illustrated position of the reduction gear.
- If the measured value deviates from the standard value, replace the reduction gear and reduction pinion of the differential as a set.



■ **Inspection: Tooth contact of reduction gear**

[Inspection]

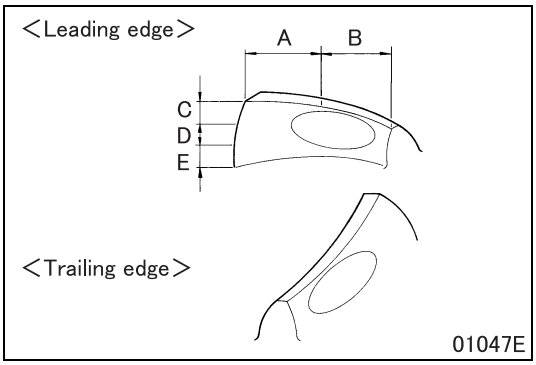
- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several times to check for tooth contact.
- Adjust tooth contact if it is remarkably offset.



● **Correct tooth contact at no load**

<Reduction gear>

A: Heel
B: Toe
C: Face
D: Flank
E: Clearance



<Reduction pinion>

A: Heel
B: Toe
C: Face
D: Flank
E: Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center towards toe
		Vertical direction	From center towards top of tooth for reduction gear and center for reduction pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root and tooth tip

NOTE

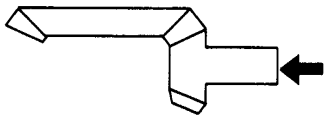
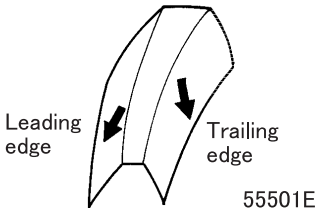
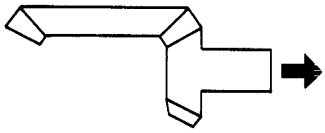
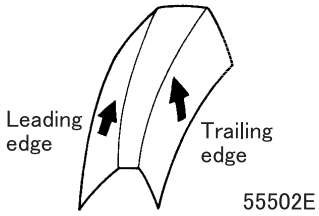
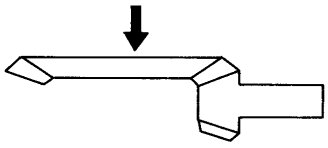
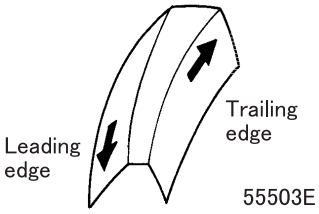
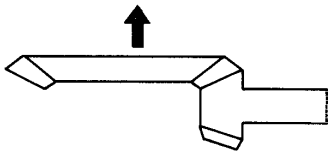
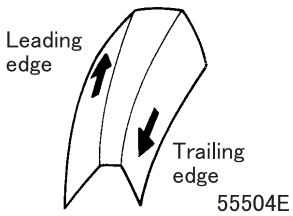
- **When tooth contact is near the toe at no load, it becomes middle area contact at load.**

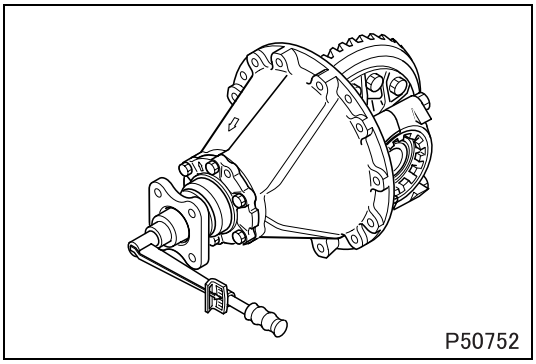
[Adjustment]

- Adjust by backlash between reduction gear and reduction pinion (to be adjusted with the side bearing nut) and addition or reduction of rear bearing shims.

CAUTION ⚠

- **Make sure you replace as a reduction gear set (reduction gear and reduction pinion), when you replace the gear because of excessive teeth wear.**

	Method of adjustment	Moving direction	
Tooth contact by addition or reduction of shims	Advance reduction pinion to reduction gear (shims are reduced)  55497	 55501E	Tooth contact moves towards tooth root
	Retard reduction pinion from reduction gear (shims are added)  55498	 55502E	Tooth contact moves towards tooth tip
Tooth contact by adjustment with side bearing nut	Advance reduction gear to reduction pinion center (less backlash)  55499	 55503E	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard reduction gear from reduction pinion center (more backlash)  55500	 55504E	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth


P50752

■ **Inspection: Starting torque of side bearing**

[Inspection]

- Measure starting torque of the pinion assembly using a torque wrench and calculate the starting torque of the side bearing using the following formula.
  (Total starting torque – Pinion bearing starting torque (See later section.)) × Final ratio = Side bearing starting torque

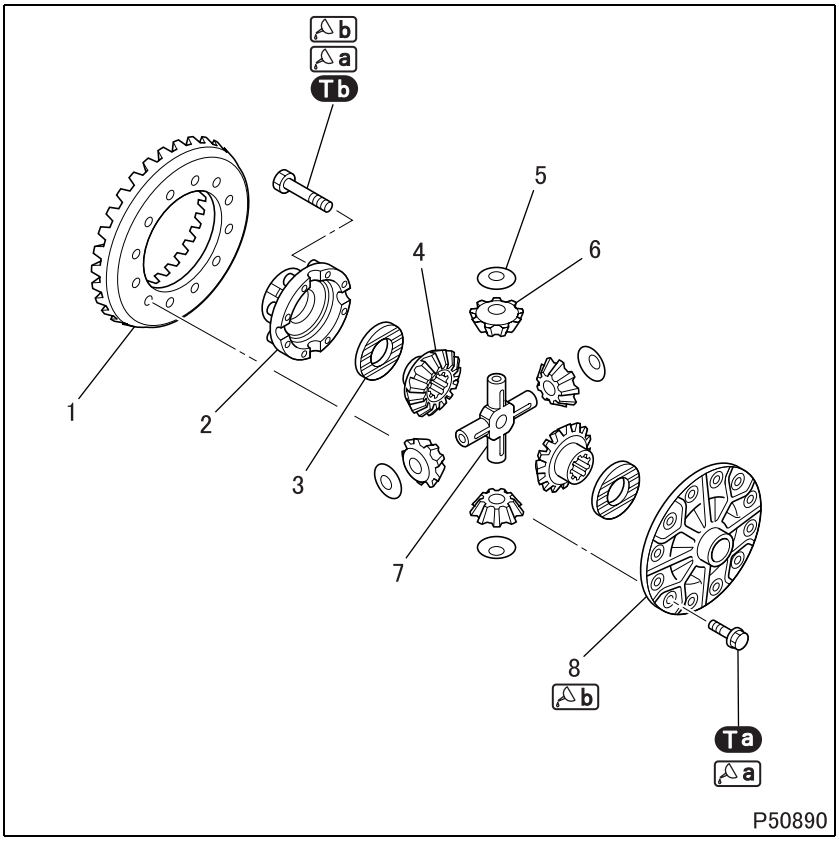
[Adjustment]

- Adjust by means of the right- and left-hand adjusting screws.

CAUTION ⚠

- **Always adjust both adjusting screws by the same amount.**
- **The starting torque must be adjusted without causing the backlash between the reduction gear and reduction pinion out of the standard value.**

Differential



● Disassembly sequence

1 Reduction gear
2 Differential case, R/H
3 Side gear washer
4 Side gear
5 Pinion washer
6 Differential pinion
7 Pinion spider
8 Differential case, L/H

CAUTION ⚠

- **Be sure to replace the R/H differential case and the L/H differential case as a differential case set.**
- **Be sure to replace the side gear and the differential pinion as a side gear set.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
4	Backlash between side gear and spline of axle shaft	0.05 to 0.15 {0.0020 to 0.0059}	0.5 {0.020}	Replace
4, 6	Backlash between side gear and differential pinion	0.15 to 0.20 {0.0059 to 0.0079}	0.5 {0.020}	Replace
6, 7	Clearance between differential pinion and pinion spider	0.17 to 0.27 {0.0067 to 0.011}	0.5 {0.020}	Replace

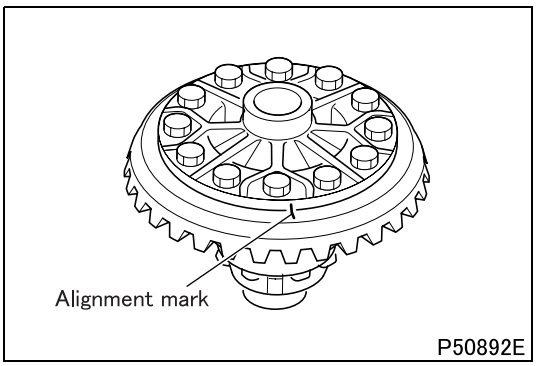
Torque value: N·m (lbf·ft)

Mark	Fastener	Torque value	Remarks
Ta	Bolt (reduction gear mounting)	166.6 to 225.4 (120 to 165)	–
Tb	Bolt (R/H and L/H differential case mounting)	83.3 to 112.7 (61 to 83)	–

Lubricant and/or sealant

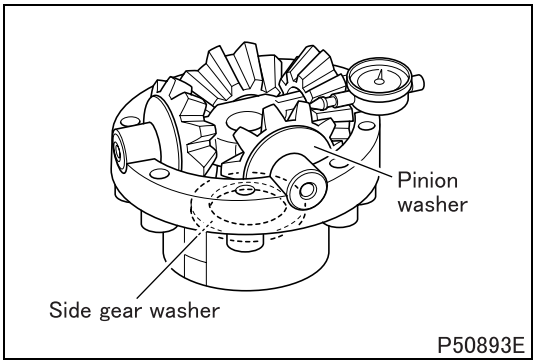
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Entire bolt	Rust preventive	As required
b	Thread area of bolt	Loctite 271	As required
	Bolt tip of L/H differential case		

◆Work before removal◆



■ **Alignment marks: Reduction gear and L/H differential case**

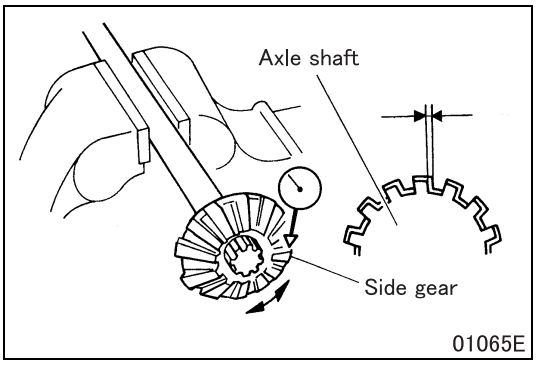
- Put alignment marks on the reduction gear and L/H differential case.



■ **Inspection: Backlash between side gear and differential pinion**

- If backlash is found faulty, thickness of the side gear washer and pinion washer is probably inappropriate.

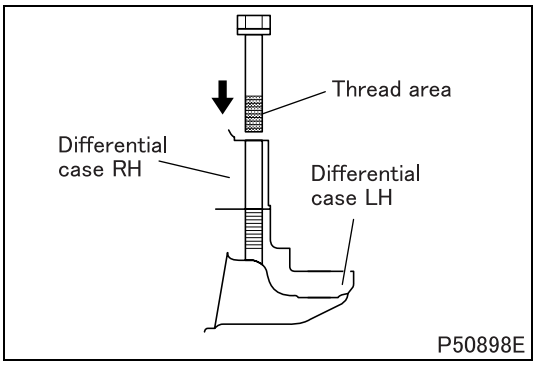
◆Inspection procedure◆



■ **Inspection: Backlash between side gear and axle shaft**

- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆

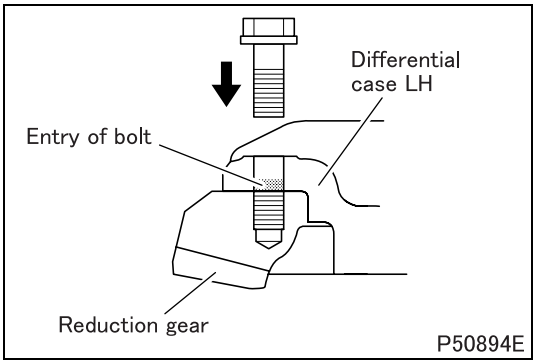


■ **Installation: Differential case, R/H and L/H**

- Apply rust preventive to the entire surface of the bolt. After applying it, blow off the excess rust preventive on the bolt by compressed air.
- Apply thread lock cement to the bolt threads.
- Tighten the bolt to the specified torque.

CAUTION ⚠

- **Make sure to apply rust preventive when tightening the bolt to the specified torque.**
- **Wait at least one hour after installation before actually running the vehicle to let the thread lock cement harden.**
- **Wait at least four hours after installation before operating the vehicle at full torque to let the thread lock cement harden.**



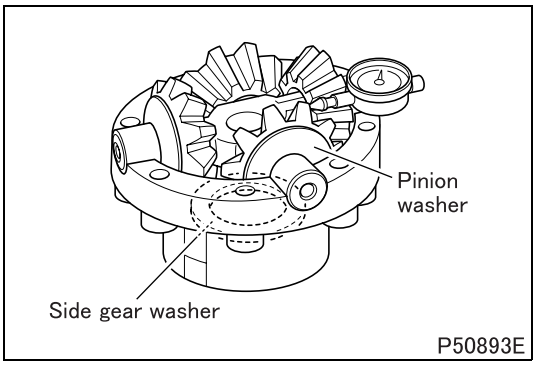
■ **Installation: Reduction gear and L/H differential case**

- Apply rust preventive to the entire surface of the bolt. After applying it, blow off the excess rust preventive on the bolt by compressed air.
- Apply thread lock cement at the entry of bolt holes on the L/H differential case.
- Tighten the bolt to the specified torque.

CAUTION ⚠

- **Make sure to apply rust preventive when tightening the bolt to the specified torque.**
- **Wait at least one hour after installation before actually running the vehicle to let the thread lock cement harden.**
- **Wait at least four hours after installation before operating the vehicle at full torque to let the thread lock cement harden.**

◆Work after installation◆



■ **Inspection: Backlash between side gear and differential pinion**

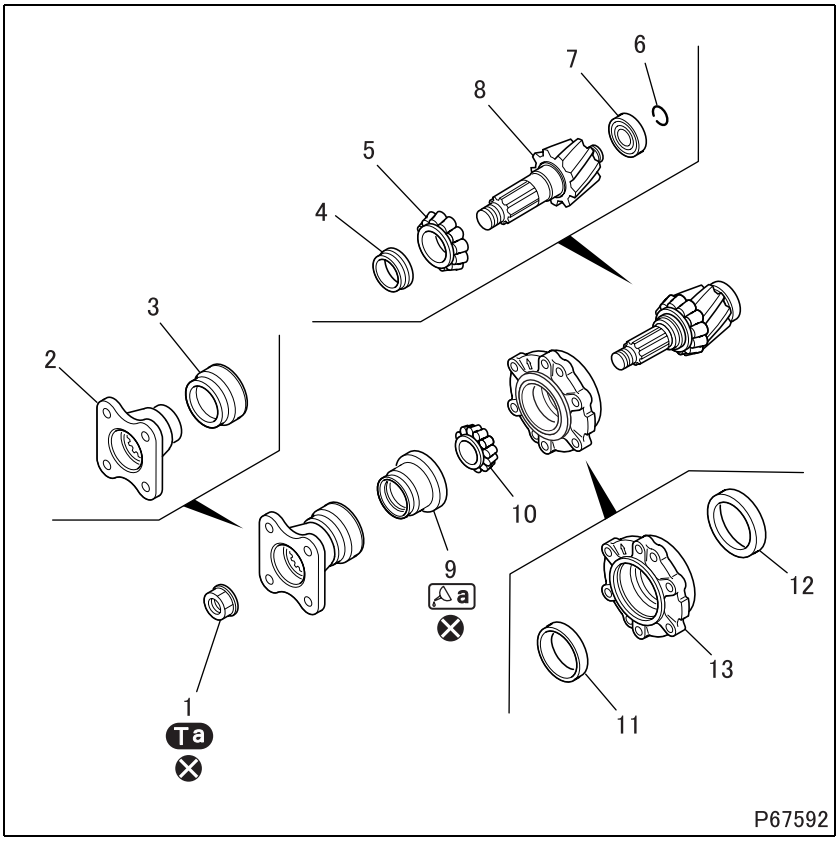
- If the measured value deviates from the standard value, replace the side gear washer and pinion washer.
  Thickness of side gear washers available
  3.0 mm {0.11 in} (one thickness)
  Thickness of pinion washers available
  1.6 mm {0.063 in} (one thickness)

CAUTION ⚠

- **Use side gear washers of the same thickness for the right and left sides.**
- **Use pinion washers of the same thickness at four locations.**

M E M O

Pinion



● Disassembly sequence

1 Locknut
2 Companion flange
3 Dust cover
4 Collar
5 Rear bearing inner race
6 Lock ring
7 Pinion pilot bearing
8 Reduction pinion
9 Oil seal
10 Front bearing inner race
11 Front bearing outer race
12 Rear bearing outer race
13 Bearing retainer

⊗: Non-reusable parts

NOTE

- **Record the height of the collar to use it as reference at assembly.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of pinion bearing (inertial force at outer periphery point of bearing retainer)	When new bearing is used	2.0 to 2.9 N·m {1.4 to 2.2 lbf·ft} (inertial force: 34 to 52 N {7.6 to 11 lb})	–	Adjust or replace
		When old bearing is reused	1.6 to 2.4 N·m {1.2 to 1.7 lbf·ft} (inertial force: 27 to 41 N {6.1 to 9.2 lb})	–	Adjust or replace

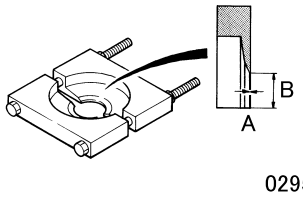
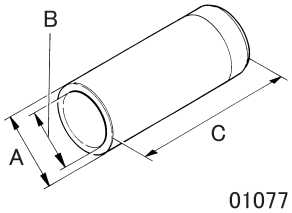
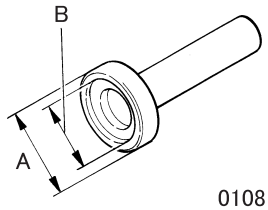
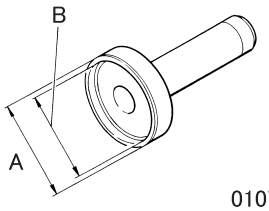
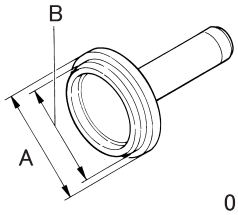
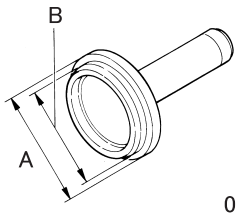
Torque value: N·m (lbf·ft)

Mark	Fastener	Torque value	Remarks
Ta	Locknut (companion flange mounting)	372.4 to 470.4 (275 to 345)	–

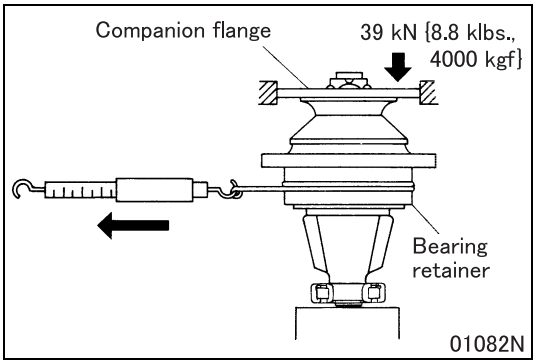
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

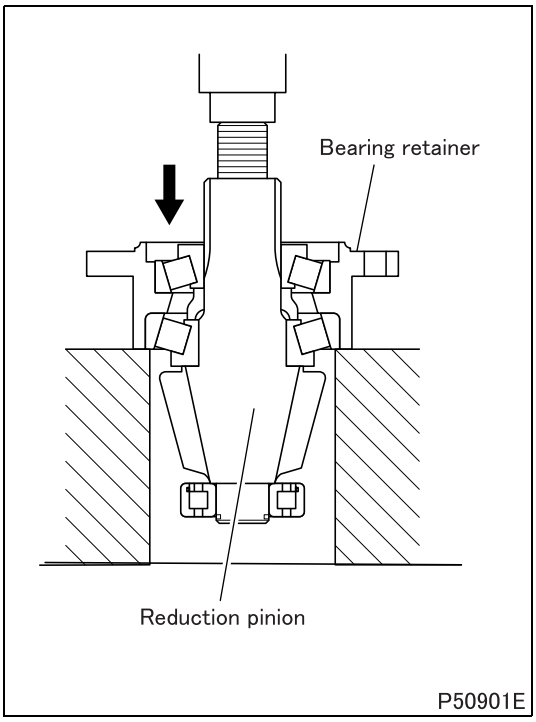
Special tools (Unit: mm {in})

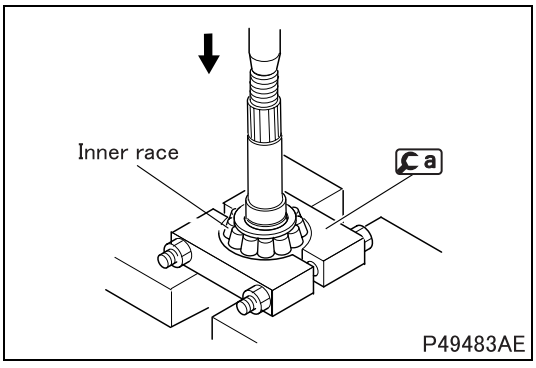
Mark	Tool name and shape	Part No.	Application
a	Pinion bearing remover A: 0.5 {0.020}, B: 25.6 {1.00}  02956	MB999045	Removal of rear bearing inner race
b	Pinion bearing installer A: ϕ62 {2.44}, B: ϕ52 {2.05}, C: 125 {4.92}  01077	MH061005	Installation of rear bearing inner race and front bearing inner race
c	Pinion pilot bearing installer A: ϕ45.2 {1.78}, B: ϕ39.2 {1.54}  01081	MH061976	Installation of pinion pilot bearing
d	Oil seal installer A: ϕ112 {4.41}, B: ϕ88 {3.46}  01076	MH061750	Installation of oil seal
e	Pinion bearing installer A: ϕ89 {3.50}, B: ϕ78 {3.07}  01078	MH061977	Installation of front bearing outer race
f	Pinion bearing installer A: ϕ99 {3.90}, B: ϕ88 {3.46}  01078	MH061264	Installation of rear bearing outer race

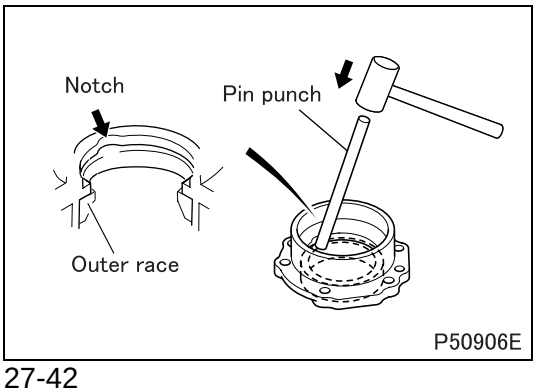
◆Work before removal◆



◆Removal procedure◆







■ **Inspection: Starting torque of pinion bearing**

- Apply the specified load to the companion flange or tighten the locknut to the specified torque.
- Measure the inertial force at outer periphery point of the bearing retainer using a spring balancer.

CAUTION ⚠

- **Securely fix the companion flange to measure.**

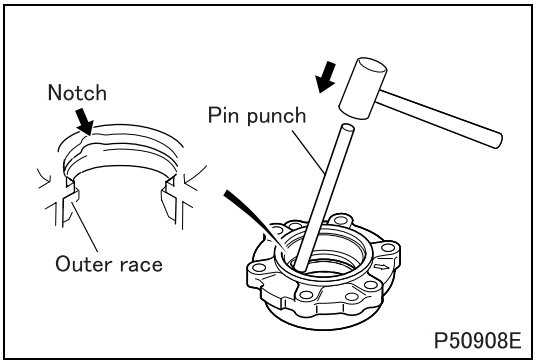
- If the measured inertial force is within the specified value, the starting torque conforms to the standard value.

■ **Removal: Reduction pinion**

■ **Removal: Rear bearing inner race**

■ **Removal: Front bearing outer race**

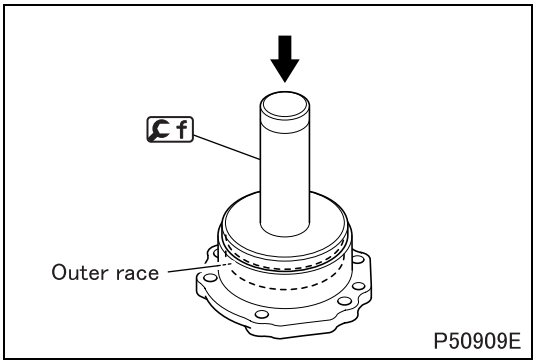
- Drive out the front bearing outer race by tapping at each of the three indentations in the bearing retainer. Keep the race level as it is being removed.



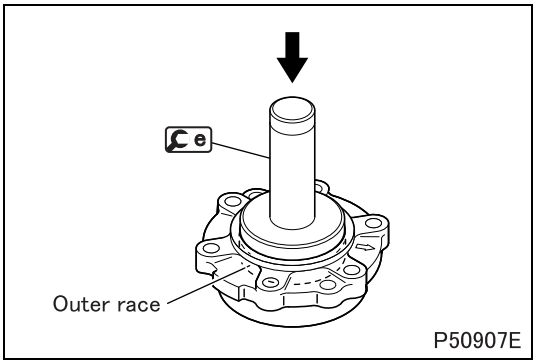
■ **Removal: Rear bearing outer race**

- Drive out the rear bearing outer race by tapping at each of the three indentations in the bearing retainer. Keep the race level as it is being removed.

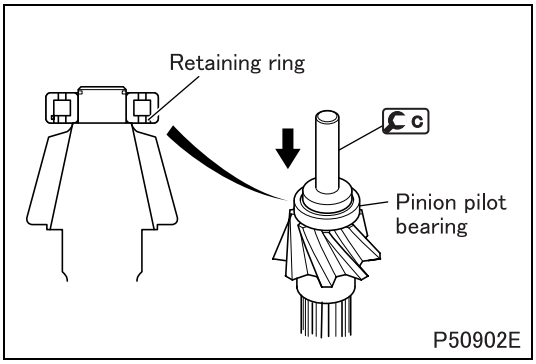
◆Installation procedure◆



■ **Installation: Rear bearing outer race**

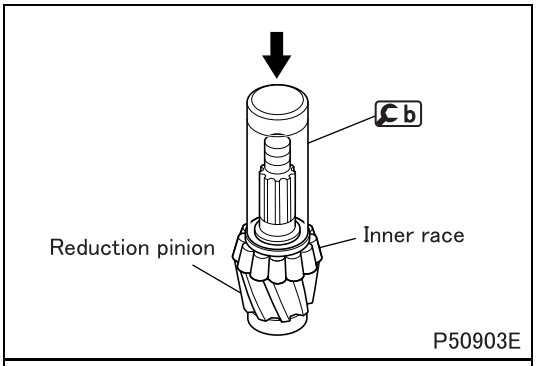


■ **Installation: Front bearing outer race**

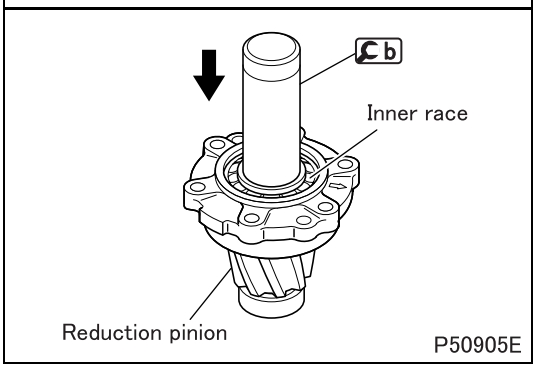


■ **Installation: Pinion pilot bearing**

- Install the pinion pilot bearing with its retaining ring placed on the gear.

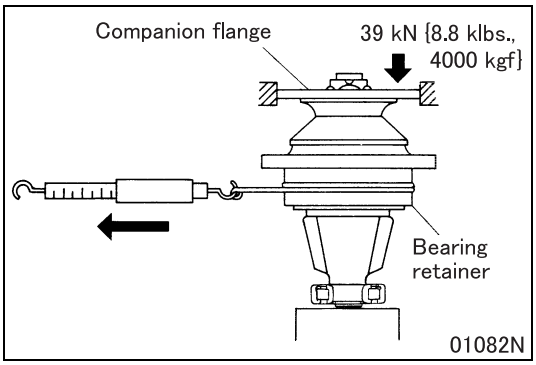


■ **Installation: Rear bearing inner race**



■ **Installation: Front bearing inner race**

- Install the front bearing inner race with the pinion assembled into the bearing retainer.



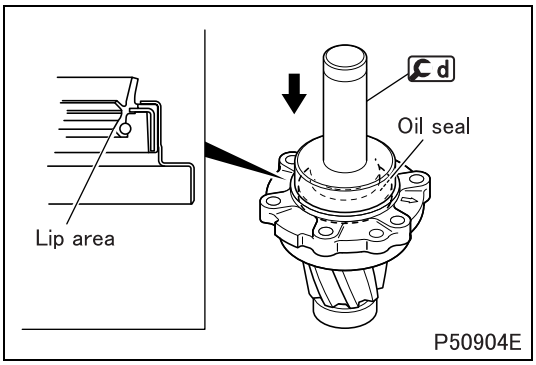
■ **Inspection: Starting torque of pinion bearing**

- Apply the specified load to the companion flange or tighten the locknut to the specified torque.
- Measure the inertial force at outer periphery point of the bearing retainer using a spring balance.

CAUTION ⚠

- **Securely fix the companion flange to measure.**
- **Do not assemble the oil seal when measuring the inertial force.**

- If the measured inertial force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the standard value, adjust by changing a collar.
  Thickness of collars available
  15.600 to 16.200 mm {0.61 to 0.64 in} (25 thickness in 0.025 mm {0.00098 in} increments)

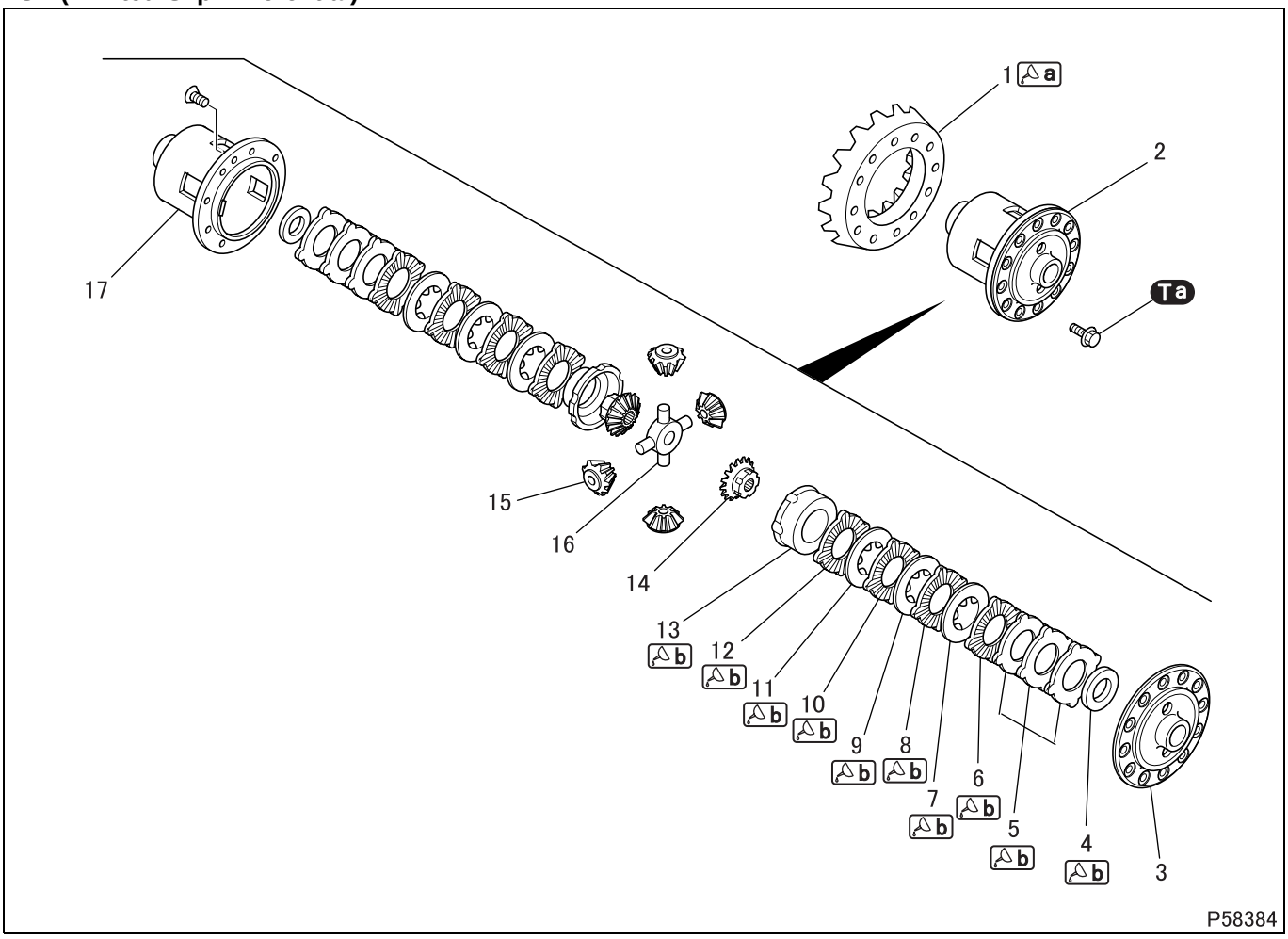


■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the bearing retainer in the illustrated direction.

M E M O

LSD (Limited-Slip Differential)



● **Disassembly sequence**

1 Reduction gear
2 LSD (limited-slip differential)
3 Differential case, L/H
4 Side gear washer
5 Spring plate
6 Friction plate
7 Friction disc
8 Friction plate
9 Friction disc
10 Friction plate
11 Friction disc
12 Friction plate
13 Pressure ring
14 Side gear
15 Differential pinion
16 Pinion spider
17 Differential case, R/H

CAUTION ⚠

- **Make sure to replace the side gear and the differential pinion as a side gear set.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item			Standard value	Limit	Remedy
2	LSD	Rotation torque of clutch plate	When new clutch plate is assembled	201 to 298 N·m {150 to 220 ft.lbs}	–	Replace
			When old clutch plate is reassembled	117 to 298 N·m {86 to 220 ft.lbs}	–	
		Clearance in side gear axial direction		0.05 to 0.20 {0.0020 to 0.0079}	–	
		Clearance in differential case axial direction		0.05 to 0.20 {0.0020 to 0.0079}	–	
4, 11 to 14	Difference in dimensions from side gear washer end face to pressure ring back face between right and left			0 to 0.05 {0 to 0.0020}	–	Replace
7 to 10	Friction disc and friction plate		Distortion	–	0.08 {0.0031}	Replace
			Wear	–	0.1 {0.0039}	
			Difference in thickness of right and left combination	0 to 0.05 {0 to 0.0020}	–	Adjust

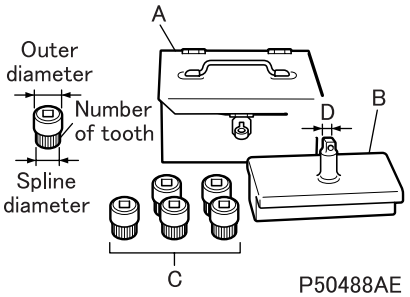
Torque value: N·m (lbf·ft)

Mark	Fastener	Torque value	Remarks
Ta	Bolt (reduction gear mounting)	167 to 225 (120 to 165)	–

Lubricant and/or sealant

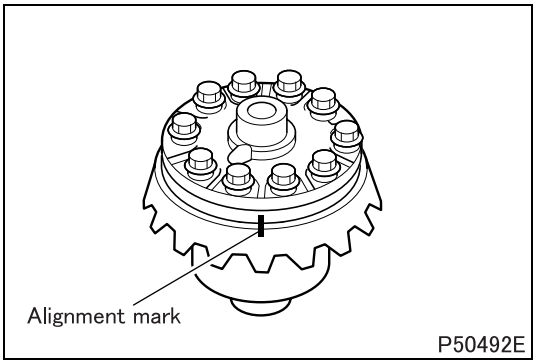
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads of reduction gear	Loctite 271	As required
b	Each part	Limited slip differential oil API GL-5 SAE 90	As required

Special tools (Unit: mm {in})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>
Side gear holding tool se
<table>
<tr><th>D</th></tr>
<tr><td>20
{0.79}</td></tr>
</table>


P50488AE
<table>
<tr><th colspan="2">Component</th><th>Part No.</th><th>Applied type</th></tr>
<tr><td>A</td><td>Gauge case</td><td>MB990551</td><td>–</td></tr>
<tr><td>B</td><td>Side gear holding base</td><td>MB999141</td><td>–</td></tr>
<tr><td rowspan="5">C</td><td>Side gear holding tool</td><td>–</td><td>–</td></tr>
<tr><td>Outer diameter / Number of teeth / Spline diameter</td><td>–</td><td>–</td></tr>
<tr><td>ϕ39 {1.54} / 16 {0.63} / ϕ35.6 {1.40}</td><td>MH063422</td><td>–</td></tr>
<tr><td>ϕ42 {1.65} / 18 {0.71} / ϕ39.6 {1.56}</td><td>MB999142</td><td>D033H</td></tr>
<tr><td>ϕ42 {1.65} / 20 {0.79} / ϕ42 {1.65}</td><td>MH063423</td><td>D035H</td></tr>
</table>
</td><td>MB999140</td><td>Measure rotation torque of LSD clutch plate</td></tr>
</table>

◆Work before removal◆

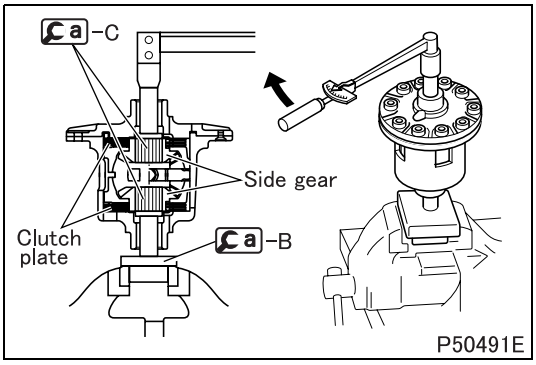


P50492E

■ Alignment marks: Reduction gear and limited slip differential

- Put alignment marks on the reduction gear and limited slip differential.

◆Inspection procedure◆



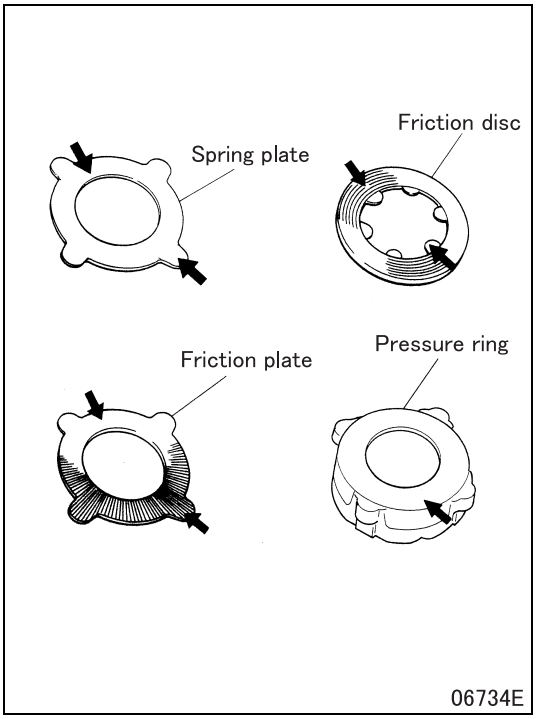
P50491E

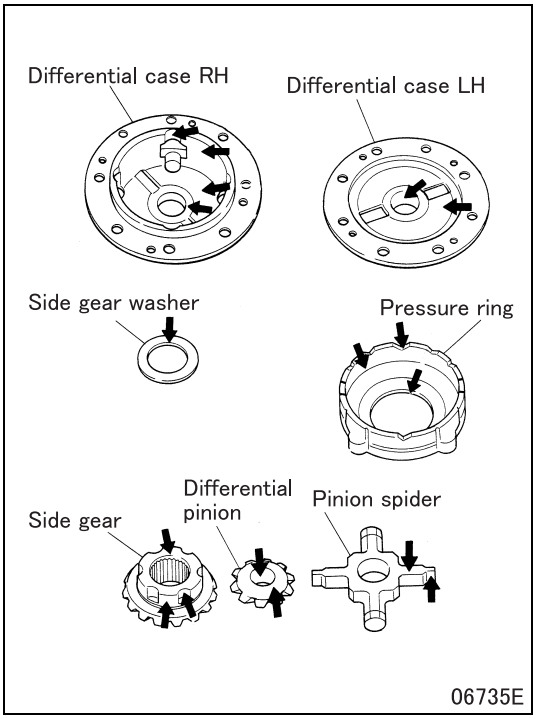
■ Inspection: Rotation torque of LSD clutch plate

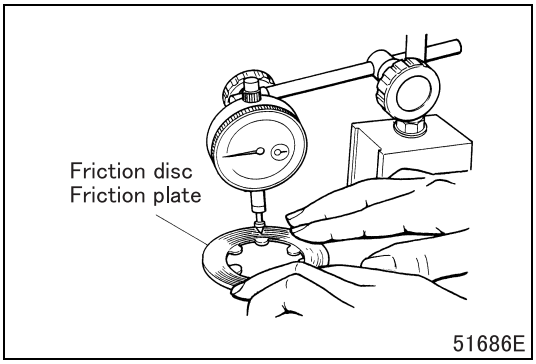
- After removing the reduction gear, carry out the following inspection.
- Measure the rotation torque to check for the friction force of the clutch plate.

NOTE

- **For measurement of rotation torque, rotate the side gears to sufficiently smooth their operation and measure the value during their rotation.**







■ **Inspection: Limited slip differential**

(1) Inspection of contacting and sliding surfaces

- If heat discoloration and remarkable wear are found on friction surfaces and sliding surfaces of the spring plates, spring discs, friction discs and friction plates, replace defective parts.

NOTE

- **Strong contact on the inner periphery of friction surfaces is caused by the spring force of each plate and disc. Do not mistake that it is caused by abnormal wear.**

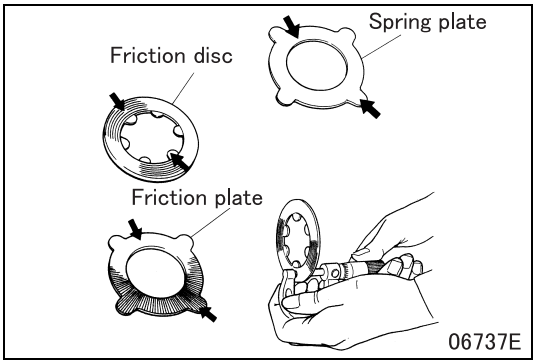
- If cracks and damage are found on protrusions on the inside and outside periphery of the spring plates, friction discs and friction plates, replace defective parts.
- If dents and damage are found on the friction surfaces and sliding surfaces of the pressure rings to friction discs, polish them with an oilstone, and lap and correct them with a compound on a surface plate.

NOTE

- **Strong contact on the inner periphery of friction surfaces is caused by the spring force of each plate and disc. Do not mistake that it is caused by abnormal wear.**
- Inspect contacting and sliding areas ⬅ of the L/H differential case, side gear washers, pressure rings, side gears, differential pinion, pinion spider and R/H differential case, and correct burrs and dents with an oilstone.

(2) Inspection of distortion

- Apply a dial gauge to the friction disc and friction plate on a surface plate and measure their distortion (flatness) while turning them. If the measured value exceeds the limit, replace.



(3) Inspection of thickness

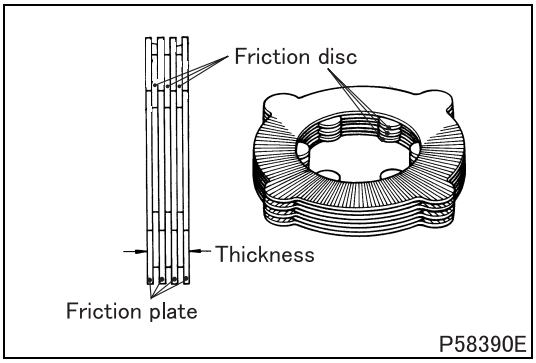
- Measure thickness of the friction surfaces and protrusions ⬅ of the spring plate, friction disc and friction plate, and find the difference. If it exceeds the limit, replace defective parts.

NOTE

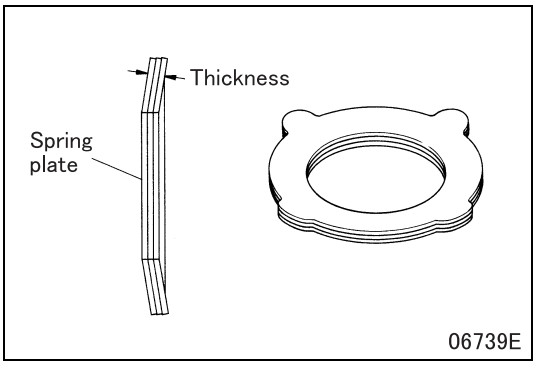
- **Take measurement at several points for each part.**

◆Work before assembly◆

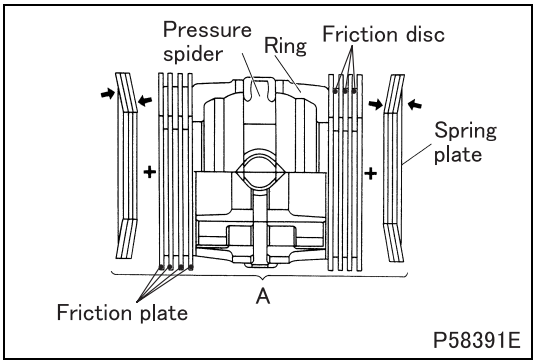
- Before assembling the limited slip differential, adjust the dimensional difference (friction force of clutch plate) in the axial direction and the clearance in the side gear axial direction.



- Pile friction discs and friction plates as illustrated and measure thickness with a micrometer. Select the combination so that the difference in thickness between the right and left combination falls within the range of the standard value.
  Thickness of friction discs available
  1.9, 2.0, 2.1 mm {0.075, 0.079, 0.083 in} (three sizes)
  Thickness of friction plates available
  2.0 mm {0.079 in} (one size)



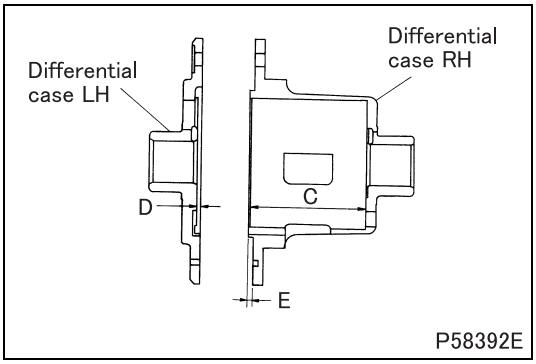
- Pile a spring plate and a spring disc as illustrated and measure thickness with a micrometer. Select the combination so that the difference in thickness between the right and left combination is as small as possible.
  Thickness of spring plates available
  2.0 mm {0.079 in} (one size)



- Assemble the pressure rings, pinion spiders, friction discs, friction plates, spring plates and spring discs and measure overall width **A** with a micrometer.

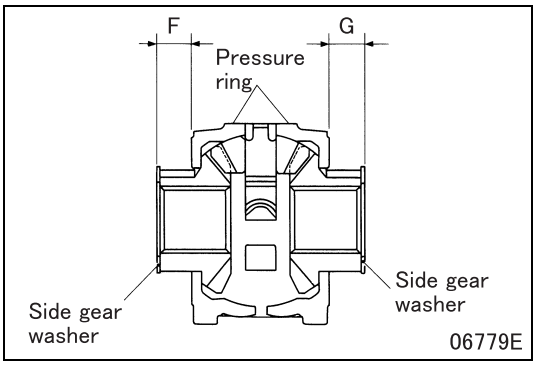
NOTE

- **Measure the overall width with the V-shaped groove of the pressure ring pressed against the pinion spider from both sides to obtain secure contact.**



- Find dimension **B** between spring plate contact faces when the L/H and R/H differential cases are combined.
  B=C+D–E

- If overall width **A** measured in the previous item and the clearance (**B**-**A**) between the L/H and R/H differential cases deviate from the standard value, adjust by changing a friction plate.
  Thickness of friction plates available
  1.9, 2.0, 2.1 mm {0.075, 0.079, 0.083 in} (three sizes)

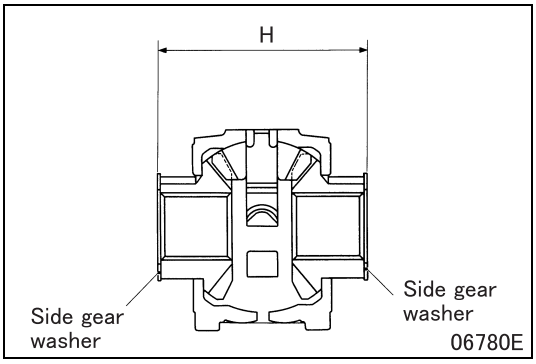


- After installing the side gear washers as illustrated, make sure that the difference between dimensions **F** and **G** from the back face of the pressure rings to the end face of the side gear washers falls within the range of the standard value.

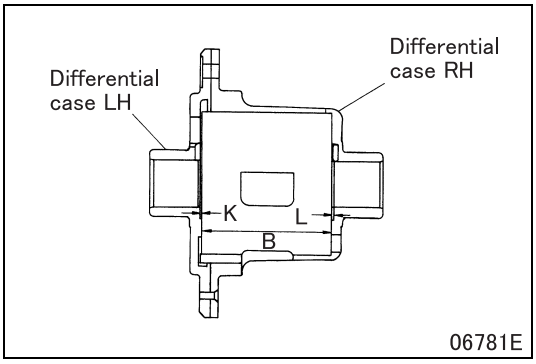
NOTE

- **Measure the dimensions with the V-shaped groove of the pressure ring pressed against the pinion spider from both sides to obtain secure contact.**

- If the difference in dimension deviates from the standard value, adjust by changing the side gear washer.
  Thickness of side gear washers available
  1.5, 1.6, 1.7 mm {0.059, 0.063, 0.067 in} (three sizes)



- Measure overall width **H**.



- Find dimension **J** between side gear washer contact faces when the L/H and R/H differential cases are combined.
  J=B+K+L

NOTE

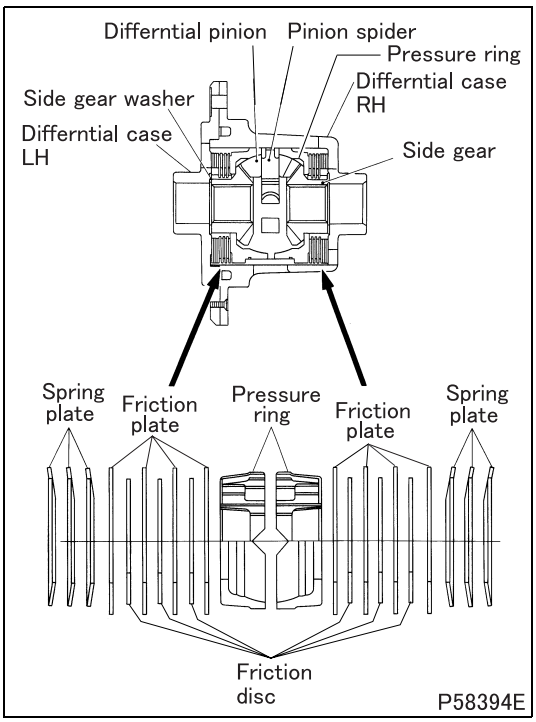
- **For dimension B, refer to the difference between spring plate contact surfaces found in the previous item when the L/H and R/H differential cases are combined.**

- Check that clearance in the side gear axial direction is within the range of the standard value.
- If the clearance deviates from the standard value, adjust by changing the side gear washer.
  Thickness of side gear washer available
  1.5, 1.6, 1.7 mm {0.059, 0.063, 0.067 in} (three sizes)

NOTE

- **Select side gear washers so that the right and left dimensional difference from the back face of the pressure rings to the end face of the side gear washers conforms to the standard value.**

◆Assembly procedure◆

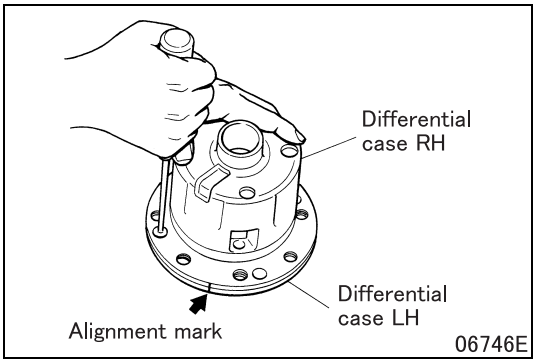


■ **Assembly: LSD (Limited Slip Differential)**

- Assemble each part into the R/H differential case in the illustrated direction.

NOTE

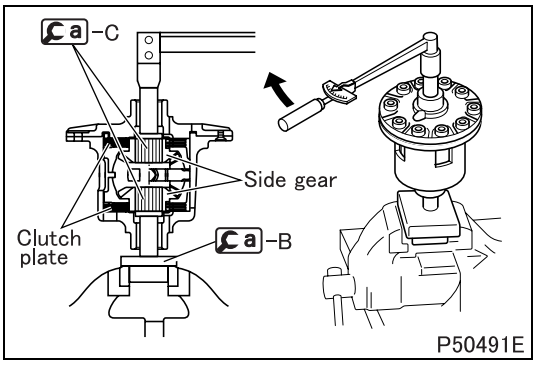
- **Take care not to install the friction discs and friction plates in a wrong sequence and the spring plates in a wrong direction.**
- **When assembling, apply gear oil to each part. Especially, apply gear oil carefully to contact surfaces and sliding surfaces.**



- Aligning the alignment mark (the same Arabic numeral) of the L/h differential case with that of the R/H differential case, tighten screws in the diagonal sequence gradually and evenly.

NOTE

- **If the L/H and R/H differential cases do not contact positively each other even after screws have been tightened fully, improperly assembled side gear washers and spring plates are suspected. In that case, reassemble these parts.**



■ **Inspection: Rotation torque of limited slip differential clutch plate**

- After assembling LSD, carry out the following inspection.
- Measure the rotation torque to check for the friction force of the clutch plate.

NOTE

- **For measurement of rotation torque, rotate the side gears to sufficiently smooth their operation and measure the value during their rotation.**

- If the measured value deviates from the standard value, replace defective parts of the internal components.

GROUP 31 INDEX

SPECIFICATIONS 31-2

TROUBLESHOOTING 31-3

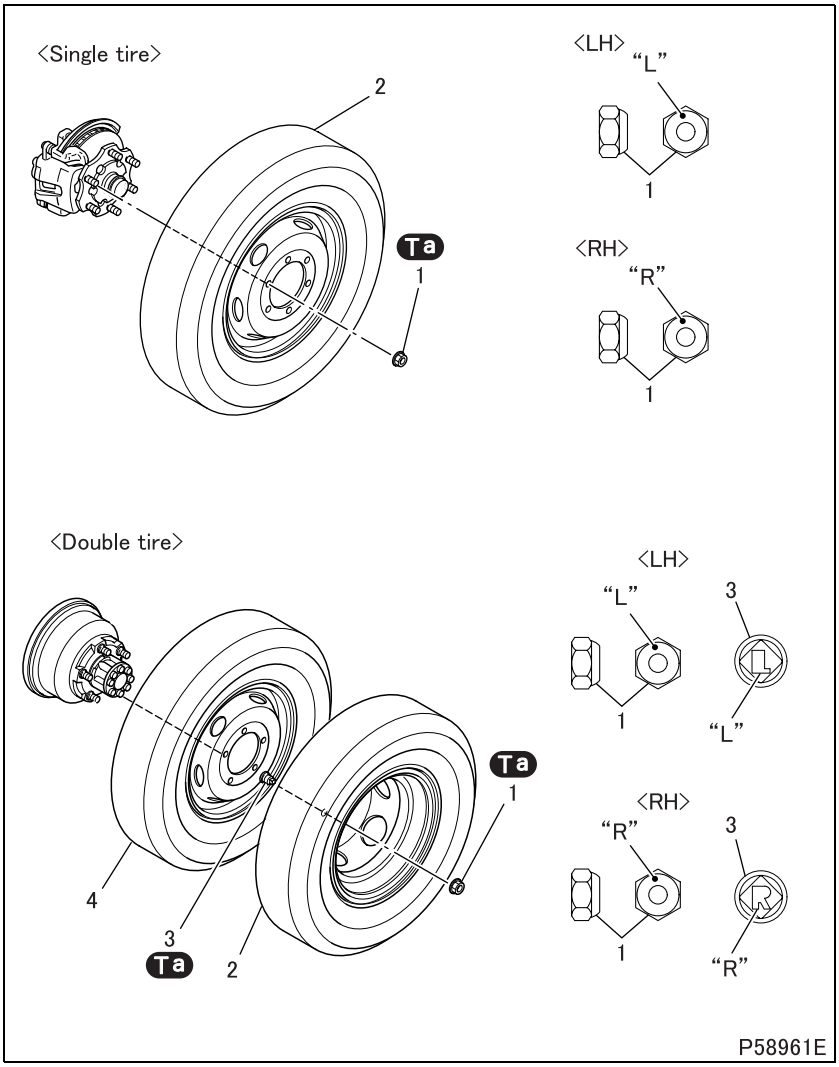
WHEEL AND TIRE 31-4

SPECIFICATIONS

Tire size	Wheel type
215/85R16	16 × 6K-127
215/75R17.5	17.5 × 6.00-127

- Tire pressures for each tire size are shown on the tire pressure label.

Probable causes \ Symptoms			Tire tread wear										Reference Gr
			Both shoulders worn	Center worn	Outside worn	Inside worn	Worn in feather pattern from outside in	Worn in feather pattern from inside out	Worn in wave pattern	Worn in concave (one spot or more)	Worn in pit over the entire periphery	Worn in serration	
Overload			O										
Tire pressure		Too low	O						O	O	O	O	
		Too high		O									
Wheel alignment	Toe-in	Excessive			O		O						Gr26
		Insufficient				O							
	Camber	Excessive			O								
		Insufficient				O							
	Excessive toe-out					O		O					
	Multiple misalignment		O		O	O	O	O	O	O	O		
Knuckle arm bent					O	O	O	O					
Left and right tie-rods different in length							O						
Wheels out of balance									O	O	O	O	
Wheel bearing loose									O	O	O	O	Gr26, 27
Ball joint loose										O			Gr26
Tie-rod end loose										O			Gr37
Brake drum eccentrically mounted <Drum brake>										O	O		Gr35
Axle bent <Rigid axle suspension>									O	O			Gr26, 27
Left and right wheels steered at improper angles												O	Gr26
Hard acceleration, braking, or steering												O	
Specific road surface conditions					O	O							



NOTE

The studs and nuts have stamped marks for easy identification; an "R" mark for right-hand threads and an "L" mark for left-hand threads.

●Removal sequence

1 Wheel nut <Single-wheel>
Wheel nut (outer) <Dual-wheel>
2 Tire (See later section.)
3 Wheel nut (inner) <Dual-wheel>
4 Tire <Dual-wheel>
(see later section)

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **The wheel nuts are designed to be tightened without any coating of grease. Never grease the wheel nuts. Even if tightened to the specified torques, greased wheel nuts can become loose.**

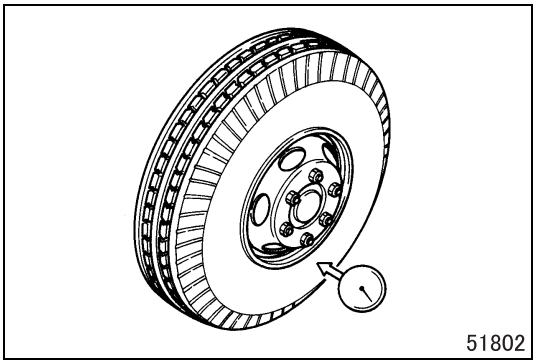
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
2, 4	Tire lateral runout (sideway deflection)	3.5 {0.14} or less	–	Correct or replace

Torque: N·m {lbf·ft}

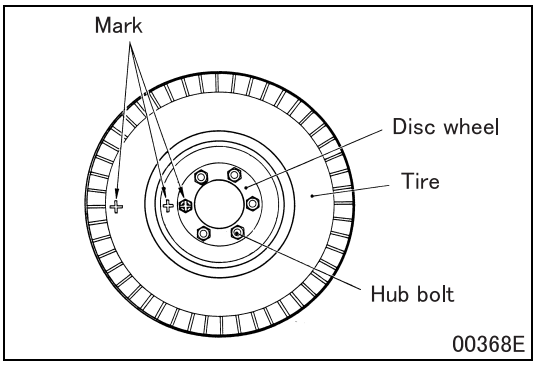
Mark	Fastener		Torque value	Remarks
Ta	Wheel nut	16 × 6K-127 16 × 6K-135 17.5 × 6.00-127	490 ± 49 {360 ± 36}	–

◆Inspection procedure◆



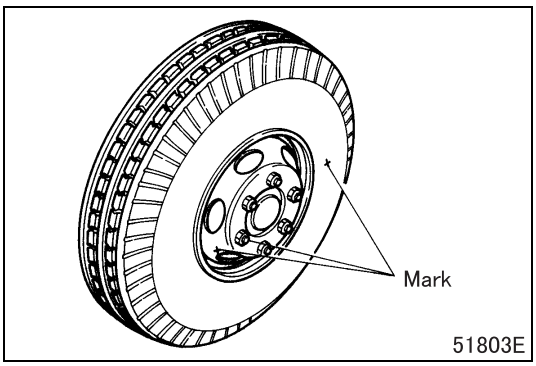
■ **Inspection: Tire**

- Measure the tire for lateral runout (sideway deflection).
- If the measured value is equal to or exceeds the standard value, correct as follows.



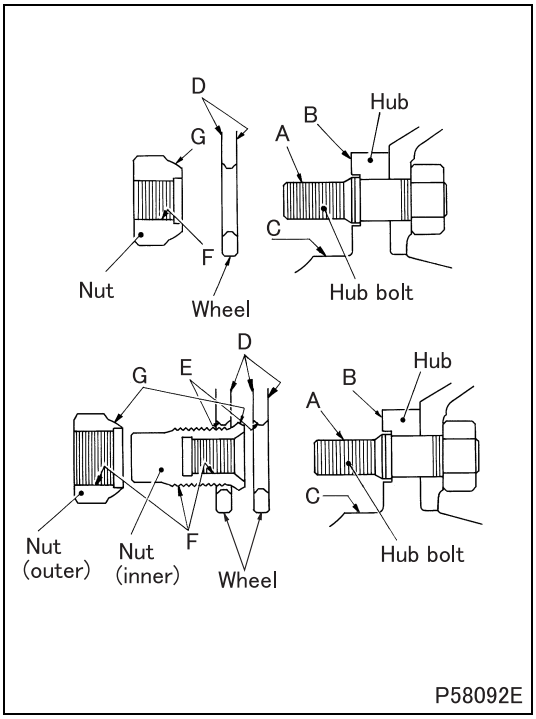
■ **Correction: Tire**

- Mark the tire, disc wheel, and one of the hub bolts in the illustrated locations.
- Remove the tire from the disc wheel.



- Measure the disc wheel for lateral runout.
- If the disc wheel's maximum runout is located near the mark on the wheel, install the tire such that the mark on the tire is 180° away from the mark on the disc wheel.
- Measure the tire again for lateral runout.
- If the measured value still does not conform to the standard value, replace the tire.

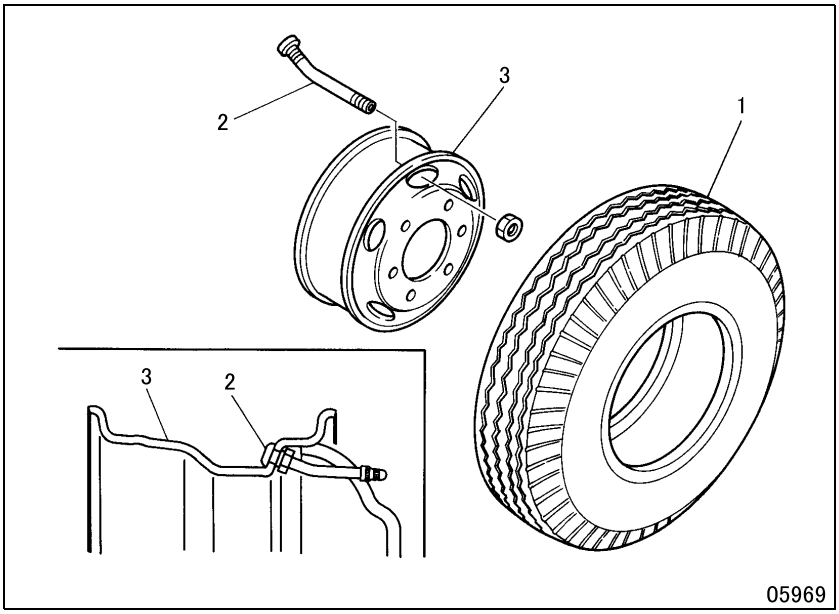
◆Installation procedure◆



■ Installation: Tire

- To prevent hardware and parts from becoming loose and/or damaged, thoroughly clean the following areas, removing rust, dirt, paint and foreign matter, before installing the tire.
  - **A:** Threaded portion of hub bolt
  - **B:** Wheel mounting surface of hub
  - **C:** Wheel alignment area of hub
  - **D:** Mating surfaces of disc wheel
  - **E:** Wheel nut mounting surface of disc wheel
  - **F:** Threaded portion of wheel nut
  - **G:** Spherical portion of wheel nut

Tire



●Disassembly sequence

1 Tire
2 Air valve
3 Disc wheel

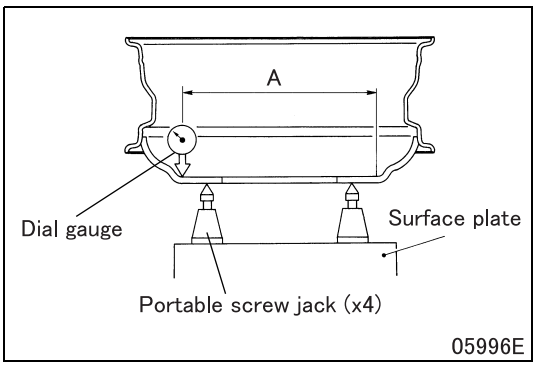
●Assembly sequence

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item			Standard value	Limit	Remedy
–	Tire assembly static unbalance tolerance			70 g {2.47 oz} or less	–	Correct
3	Disc wheel	16 × 6K-127 16 × 6K-135 17.5 × 6.00-127	Flatness (at hub surface)	0.3 {0.012} or less	–	Replace
			Lateral runout (sideway deflection)	1.5 {0.059} or less	–	
			Radial runout (vertical deflection)	1.5 {0.059} or less	–	

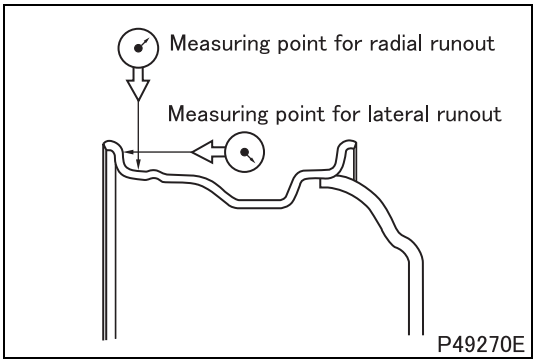
◆Inspection procedure◆



■ **Inspection: Disc wheel**

(1) Flatness

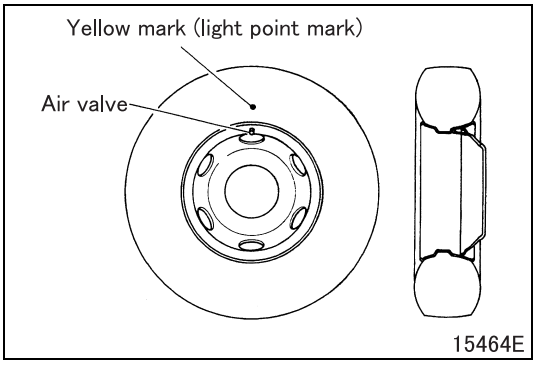
- Using a dial gauge, measure the disc wheel for flatness (difference between the maximum and minimum values measured) at specified distance **A** from the center of the wheel, at 5 locations for 5-stud units and 6 locations for 6-stud units that are equally divided around the specified circumference on the wheel.
  A: ϕ170 mm, 270 mm {6.69, 10.6 in} 16 × 6K-127
  16 × 6K-135
  ϕ175 mm, 275 mm {6.89, 10.8 in} 17.5 × 6.00-127
- If the measured flatness is equal to or exceeds the specified value, replace the disc wheel.



(2) Runout

- If the measured value is equal to or exceeds the standard value, replace the disc wheel.

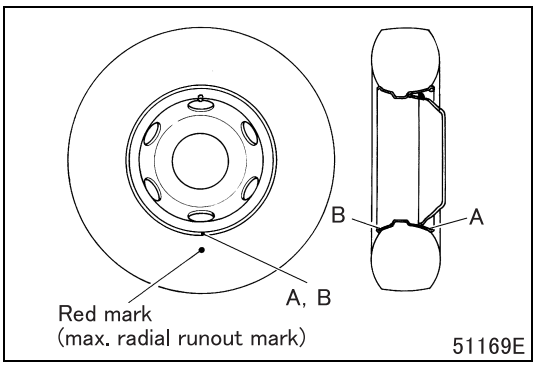
◆Installation procedure◆



■ **Installation: Tire**

<Tire with no red mark>

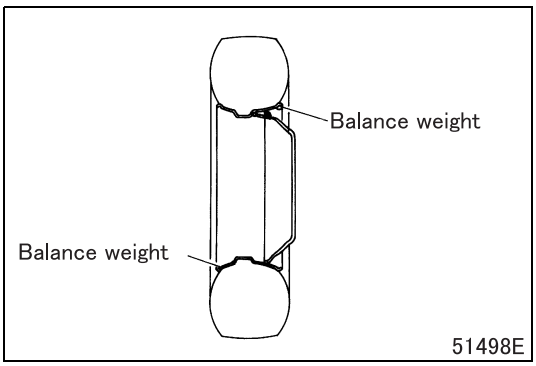
- Install the tire such that the yellow mark (light point mark) on the tire is aligned with the air valve on the disc wheel.



<Tire with red mark>

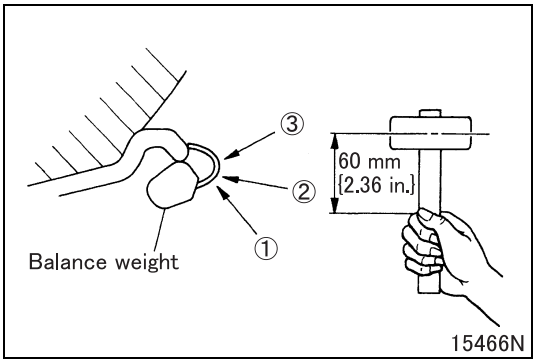
- Install the tire such that the red mark (max. radial runout mark) on the tire is aligned with mark **A** or **B** on the disc wheel.
  A: Front face of disc wheel <All wheels except 17.5-inch wheel>
  B: Back face of disc wheel <17.5-inch wheel>

◆Installation procedure◆

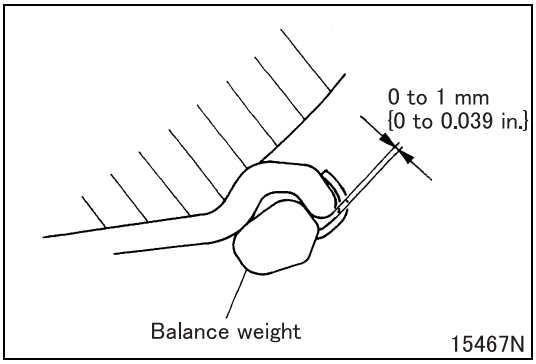


■ **Installation: Balance weight**

- Install balance weights onto the front and back sides of the disc of the tires on front axle. Ensure that the static imbalance of the tire being balanced remains within the standard value.



- Use a 1-pound resin hammer to drive balance weights into position.
- To install a balance weight, tap the clip of the weight in the center at 1, 2 and 3 in that order.



- Leave a clearance of approx. 0 to 1 mm {0 to 0.039 in} between the clip and the disc wheel. Ensure that the balance weight is not loose after installation.
- Do not use a balance weight that has been improperly tapped or dropped to the floor during installation attempt.
- When 2 weights are being installed, these weights should be as much equal to each other as possible in weight. Also remember that the center point between the weights will become the support point for a balancer.

GROUP 33 INDEX

STRUCTURE AND OPERATION
1. Front Suspension Elements 33-2

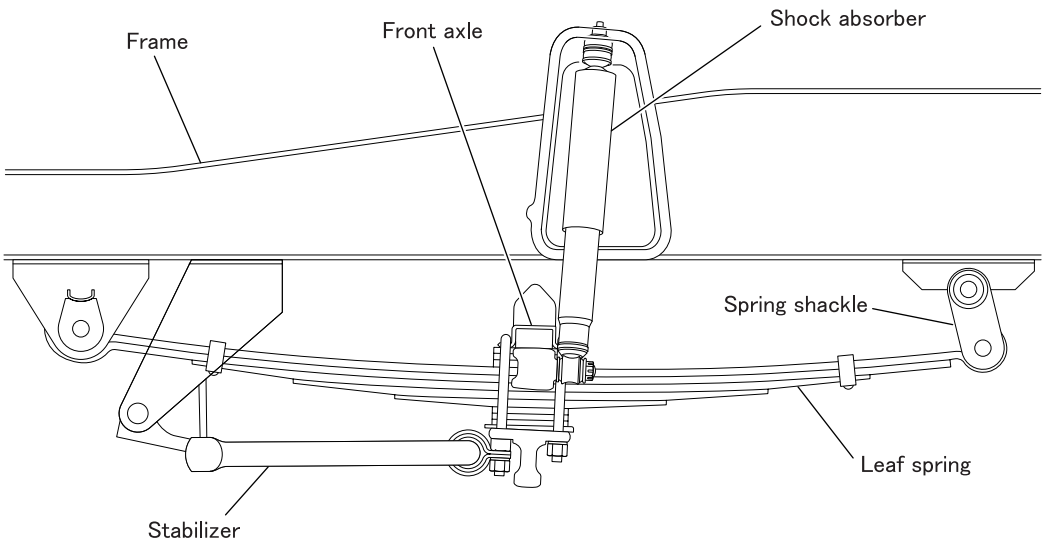
TROUBLESHOOTING 33-3

STABILIZER 33-4

SHOCK ABSORBER 33-6

LEAF SPRING 33-8

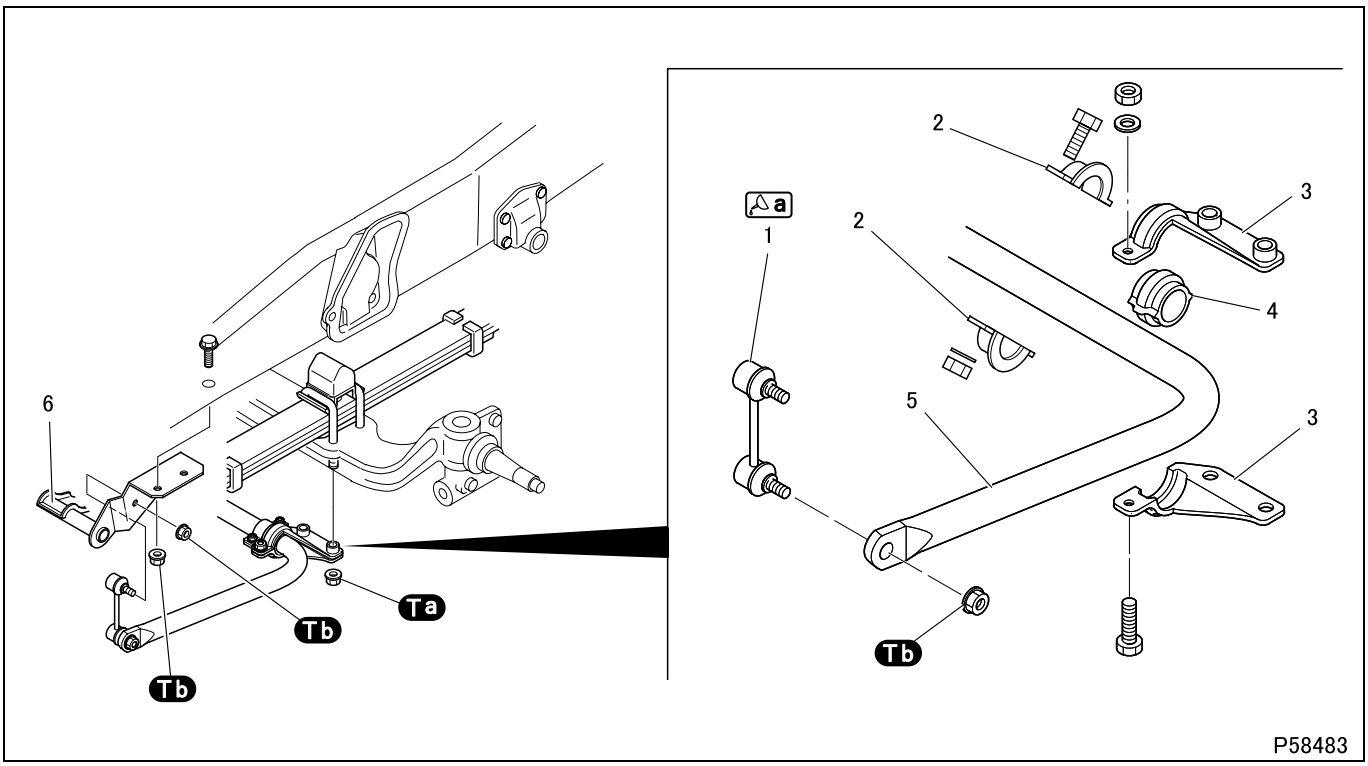
1. Front Suspension Elements



- The front suspensions shown above both use a spring shackle connected to the rear end of the leaf spring (shackle-link type suspension).
- The stabilizer prevents the vehicle from pitching, keeping it parallel with the ground.

Symptoms / Probable causes		Feels as if floating	Tends to be noisy	Road bumps/pits received as shocks	Heavy rolling	Cyclical shocks from underneath	Vehicle tilted	Poor linearity	Reference Gr
Deformed stabilizer bar or link					O				
Shock absorber	Substantial loss of oil and damping capacity	O							
	Rubber bushing worn		O						
	Loose fitting		O						
Leaf spring	Cracks or other damage			O			O		
	Broken		O				O		
	Loose U-bolt		O				O		
	Spring bushing worn		O				O		
Tire	Uneven wear				O			O	
	Tire and wheel needs balancing					O		O	Gr31
	Excessive tire pressure			O					
Wheels out of alignment								O	Gr26

STABILIZER



● **Removal sequence**

1 Stabilizer link
2 Stabilizer retainer
3 Stabilizer clamp
4 Stabilizer bushing
5 Stabilizer bar
6 Stabilizer bar bracket

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
1	Stabilizer link	Starting torque	0.68 to 1.96 N·m {0.5 to 1.4 lbf·ft}	–	Replace
		Play	0.2 {0.0079} or less	–	

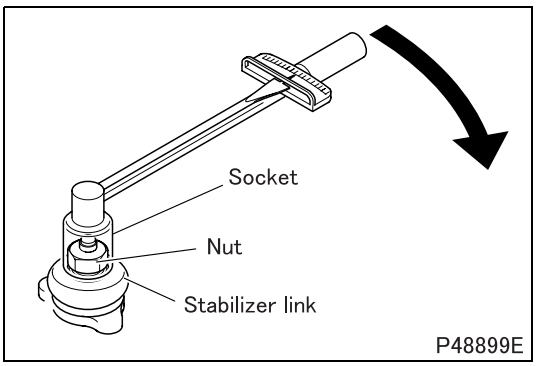
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (U-bolt mounting)	162 ± 15 {120 ± 11}	–
Tb	Nut (stabilizer mounting)	90 to 120 {66 to 89}	–
	Nut (stabilizer link mounting)		
	Nut (stabilizer bar bracket mounting)		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Dust cover lips on stabilizer link	Mitsubishi wheel bearing grease [NLGI No. 2 (Li soap)]	As required

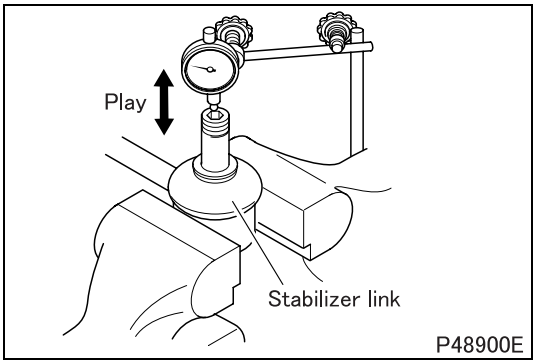
◆Inspection procedure◆



■ **Inspection: Stabilizer link**

(1) Starting torque

- Install a nut onto the stabilizer link.
- Install a socket and a torque wrench onto the nut. Measure the starting torque of the stabilizer link.
- If the measured value does not conform to the standard value, replace the stabilizer link.



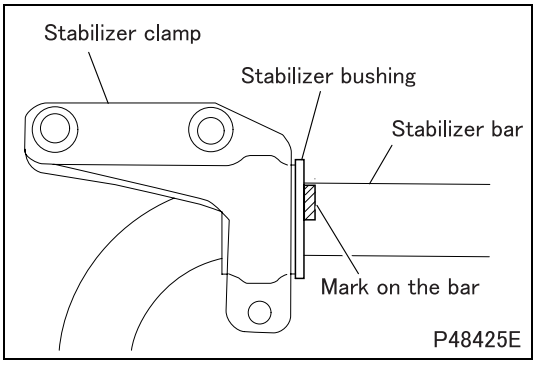
(2) Play

- If the measured value does not conform to the standard value, replace the stabilizer link.

(3) Dust cover

- Check the dust cover for wear, crack, and damage.

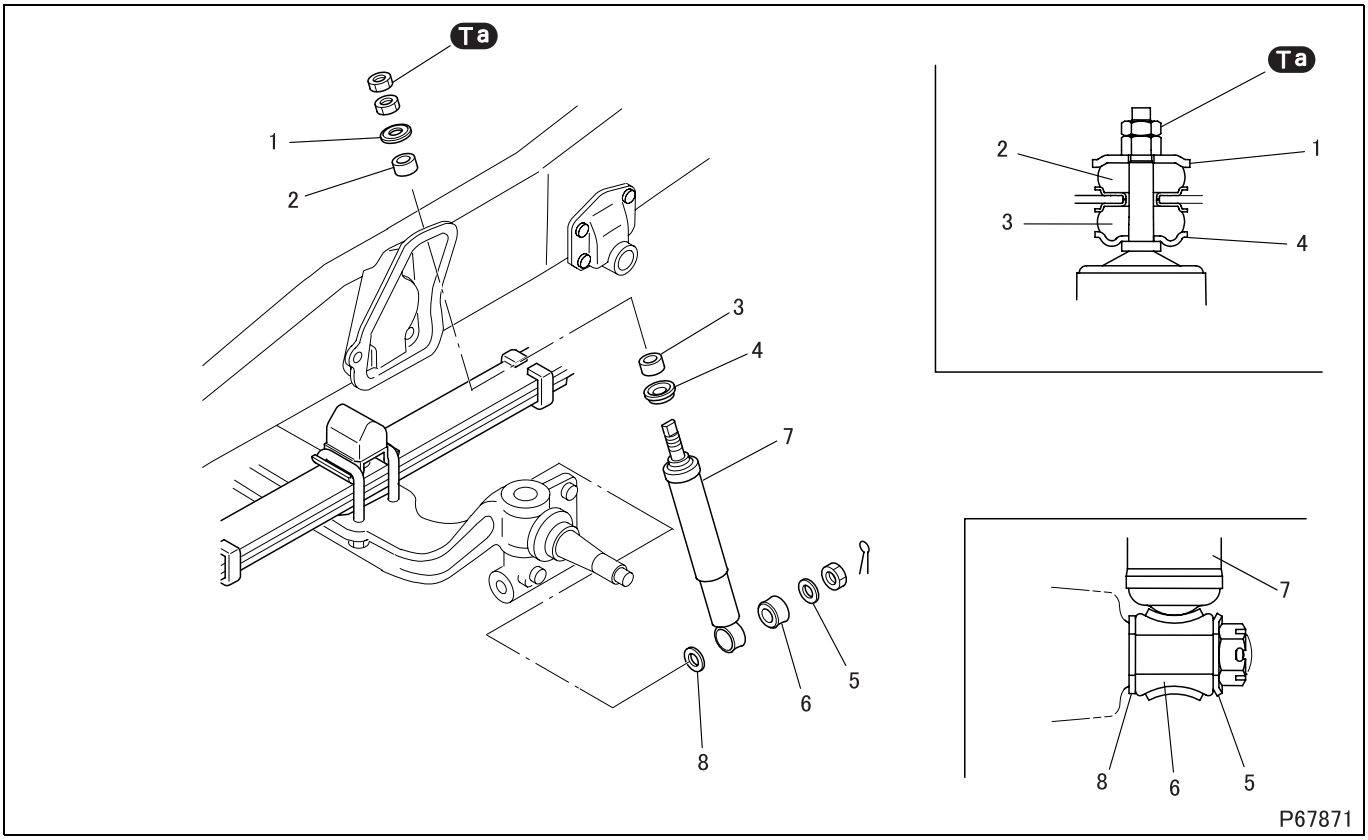
◆Installation procedure◆



■ **Installation: Stabilizer clamp and bushing**

- Position the stabilizer bushing onto the stabilizer bar such that the end of the bushing aligns with the mark on the bar. Clamp them in place with the stabilizer clamp.

SHOCK ABSORBER



●Removal sequence

1 Washer
2 Rubber bushing
3 Rubber bushing
4 Washer
5 Washer
6 Rubber bushing
7 Shock absorber
8 Washer

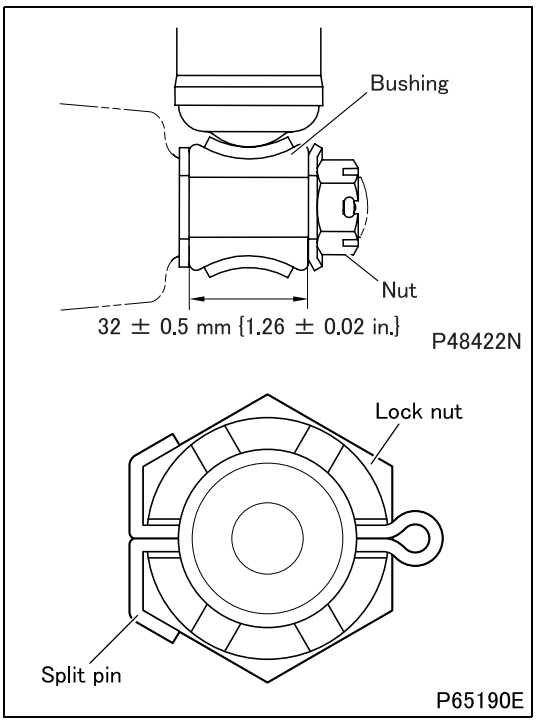
●Installation sequence

Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

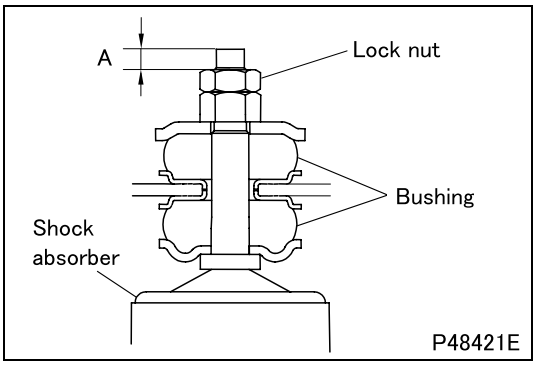
Mark	Fastener	Torque value	Remarks
Ta	Lock nut (rubber bushing mounting)	13 to 17 {9.6 to 13}	–

◆Installation procedure◆



■ **Installation: Rubber bushing**

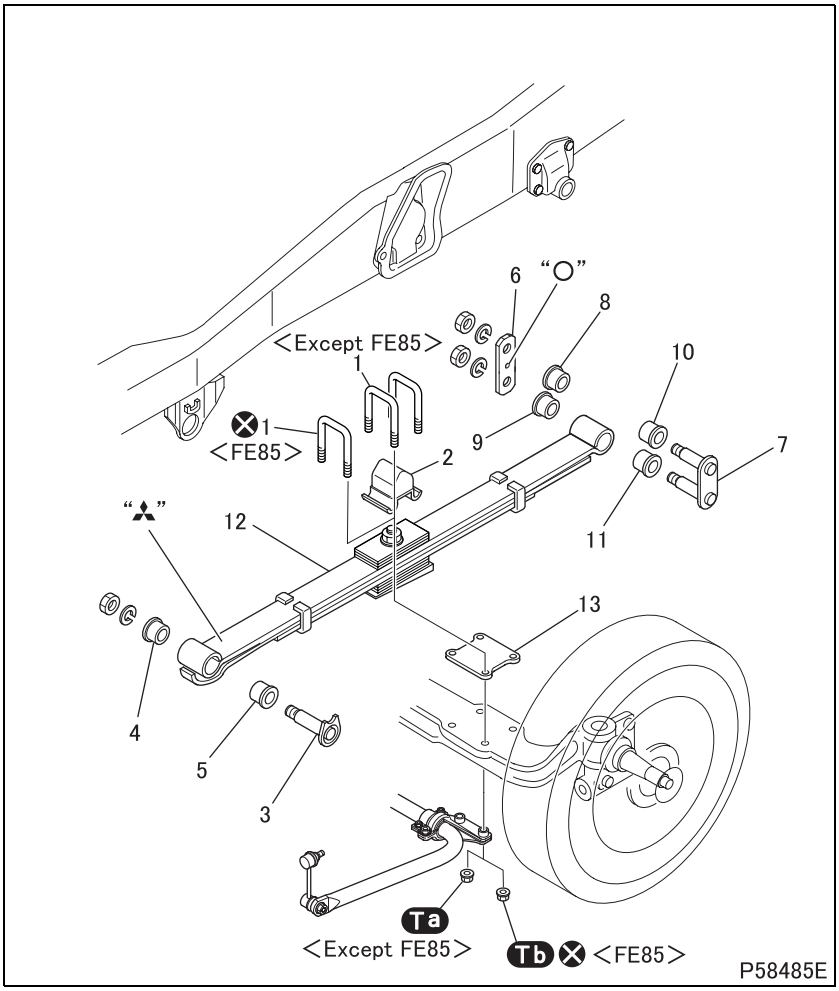
- Tighten the nut until the rubber bushing is squeezed to the illustrated dimension.
- Install the split pin as shown in the illustration.



■ **Installation: Rubber bushing**

- Tighten the nuts until dimension A in the illustration becomes equal to the following value.
  A: 4.7 mm {0.19 in}

LEAF SPRING



●Removal sequence

1 U-bolt
2 Front axle bumper
3 Spring pin
4 Rubber bushing
5 Rubber bushing
6 Shackle plate
7 Spring shackle
8 Rubber bushing
9 Rubber bushing
10 Rubber bushing
11 Rubber bushing
12 Leaf spring (See later section.)
13 Spacer

⊗: Non-reusable parts

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **U-bolt and mounting nut are non-reusable. <COE 50>**
- **Make sure to jack the vehicle up when tightening the U-bolt mounting nut to specified torque.**
- **Make sure to tighten the U-bolt mounting nut in dry tightening. If putting any oil or solvent on the nut, never use it.**

NOTE

- **The right-hand and left-hand leaf spring assemblies have different cambers from each other. Ensure that both assemblies are installed correctly. Reversed installation results in a slanted vehicle.**

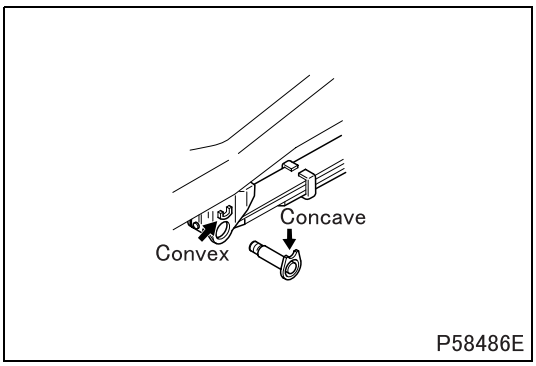
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
3 to 5	Clearance between spring pin and rubber bushings	0 to 0.03 {0.0012}	–	Replace
7 to 11	Clearance between spring shackle and rubber bushings	0 to 0.03 {0.0012}	–	Replace

Torque: N·m {lbf·ft}

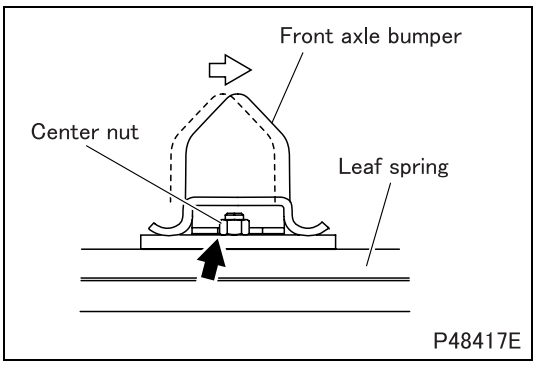
Mark	Fastener	Torque value	Remarks
Ta	Nut (U-bolt mounting)	162 ± 15 {119 ± 11}	Nut color: Yellow
Tb	Nut (U-bolt mounting)	175 ± 5 {129 ± 3.7}	Nut color: Green

◆Installation procedure◆



■ **Installation: Spring pin**

- Install the spring pin such that the concave on the pin engages with the convex on the frame.

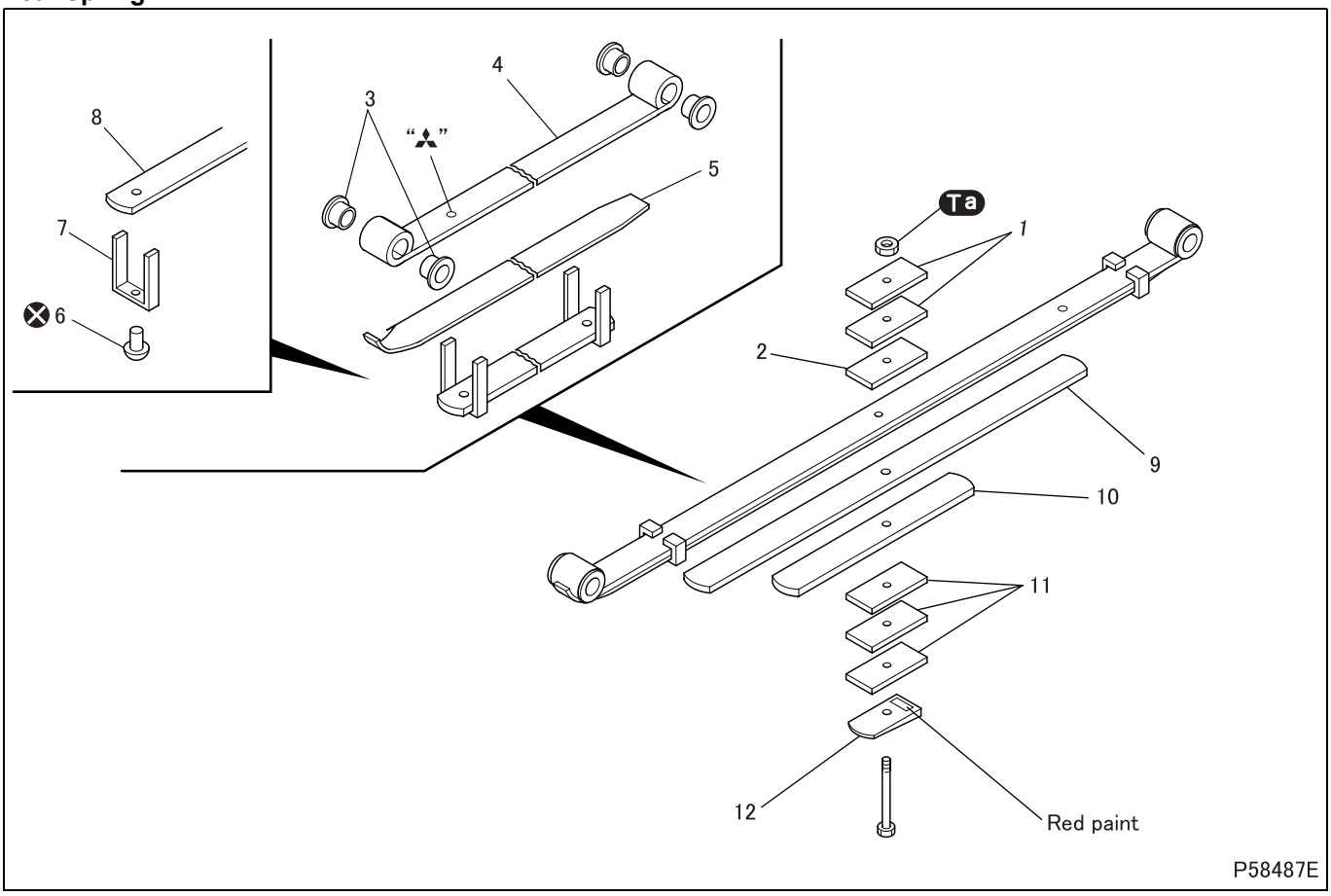


■ **Installation: Front axle bumper**

- With the unloaded vehicle, slide the front axle bumper on the leaf spring to the rear of the vehicle until it is against the center nut of the leaf spring. Then, install the bumper using U-bolts.

LEAF SPRING

Leaf Spring



●Disassembly sequence

1 Sheet (8 mm {0.31 in} thick)
2 Sheet (10 mm {0.39 in} thick)
3 Collar
4 Leaf spring (No. 1)
5 Leaf spring (No. 2)
6 Rivet
7 Clip
8 Leaf spring (No. 3)
9 Leaf spring (No. 4)
10 Leaf spring (No. 5)
11 Sheet (8 mm {0.31 in} thick)
12 Caster shim

⊗: Non-reusable parts

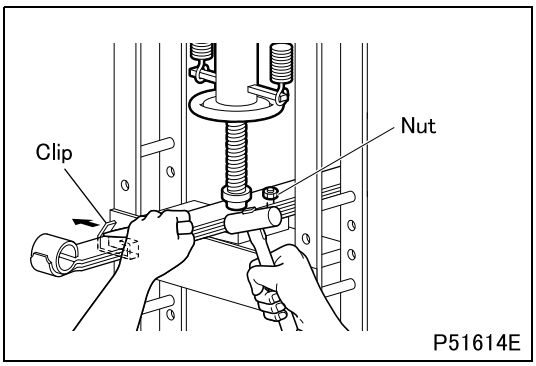
●Assembly sequence

Follow the disassembly sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (assembly of leaf spring)	34 to 54 {25 to 40}	–

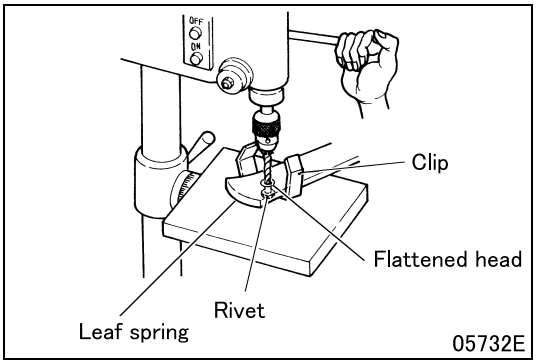
◆Work before removal◆



■ **Compression: Leaf spring**

- Using a press, compress the leaf spring as illustrated for subsequent operations.
- Using a chisel or the like, open the bent ends of the clip.

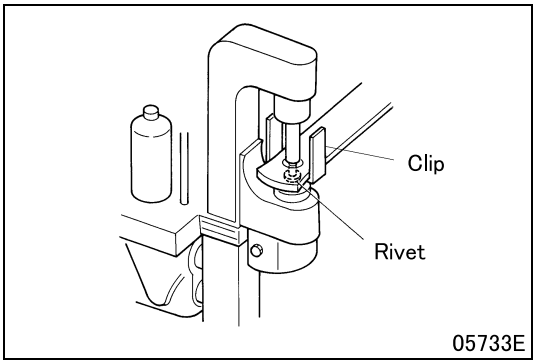
◆Removal procedure◆



■ **Removal: Clip**

- Using a drill press, break the flattened head of the rivet and remove the clip from the leaf spring (No. 3).

◆Installation procedure◆



■ **Installation: Clip**

- Using a riveting machine, rivet a clip onto the leaf spring.

INDEX

STRUCTURE AND OPERATION
1. Rear Suspension Elements 34-2

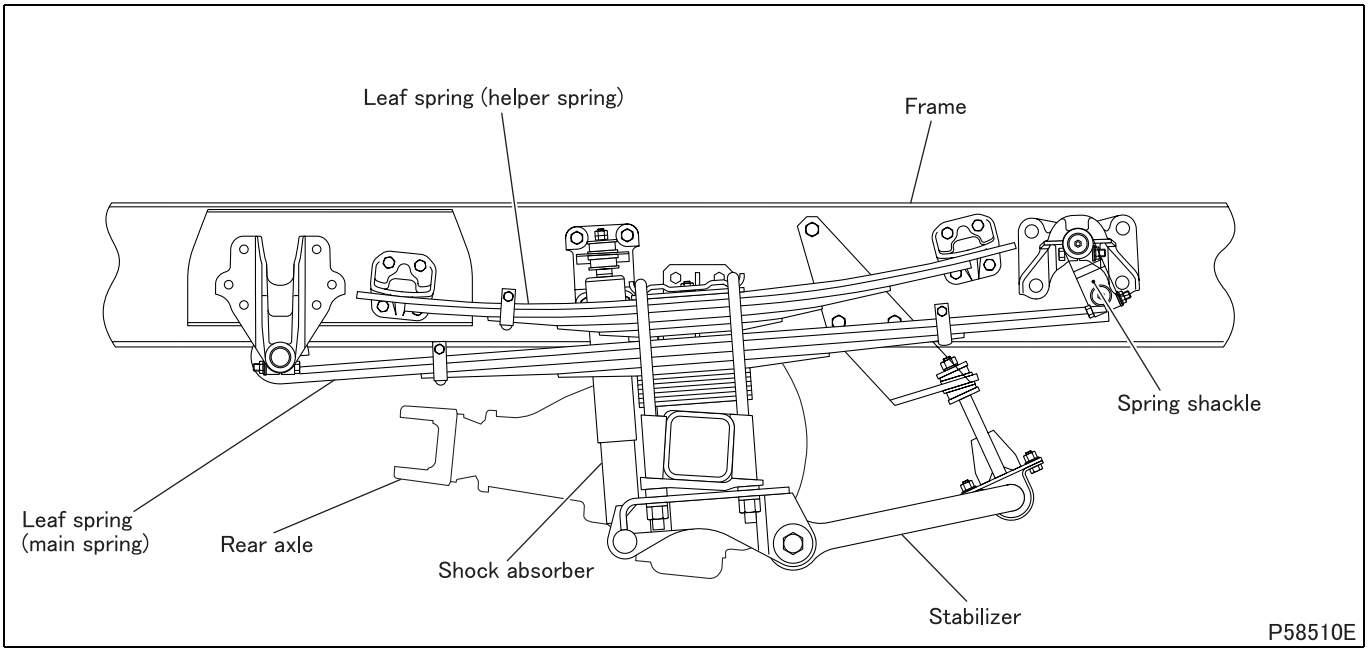
TROUBLESHOOTING 34-3

SHOCK ABSORBER 34-4

LEAF SPRING 34-6

STABILIZER 34-22

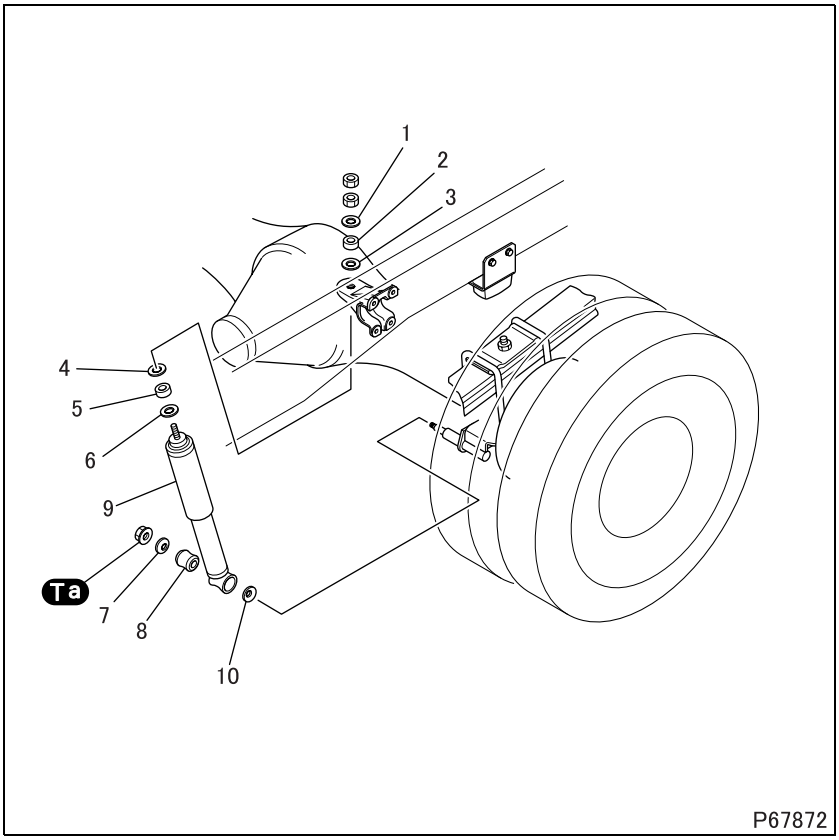
1. Rear Suspension Elements



- The rear suspensions shown above both use a spring shackle connected to the rear end of the leaf spring (shackle-link type suspension).
- The above schematics are only examples. Details may differ depending on vehicle models, including the number of spring leaves, the shape of spring shackle, and the location of the shock absorbers.

Symptoms / Probable causes		Feels as if floating	Tends to be noisy	Road bumps/pits received as shocks	Heavy rolling	Cyclical shocks from underneath	Excessive rolling while cruising	Reference Gr
Shock absorber	Substantial loss of oil and damping capacity	O						
	Rubber bushing worn		O					
	Loose fitting		O					
Tire	Tire and wheel needs balancing					O		Gr31
	Excessive tire pressure			O				
Leaf spring	Cracks or other damage			O				
	Broken		O					
	Loose U-bolt		O					
	Spring bushing worn		O					
Thrust clearance of metal bushing-type spring pin or shackle pin			O					
Helper rubber or helper spring stopper damaged or broken			O					
Spring pin over-tightened			O					
Stabilizer deformed, bushing worn							O	

SHOCK ABSORBER



●Removal sequence

1 Washer
2 Rubber bushing
3 Washer
4 Washer
5 Rubber bushing
6 Washer
7 Washer
8 Rubber bushing
9 Shock absorber
10 Washer

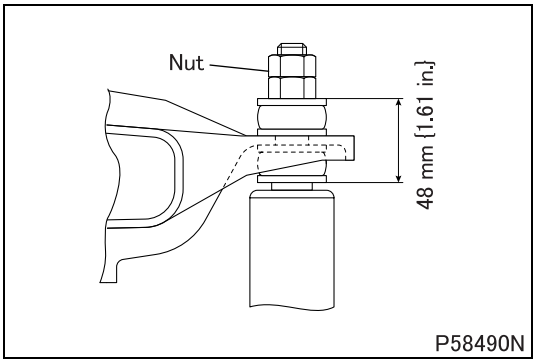
●Installation sequence

Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (shock absorber mounting)	90 to 130 {66 to 96}	–

◆Installation procedure◆



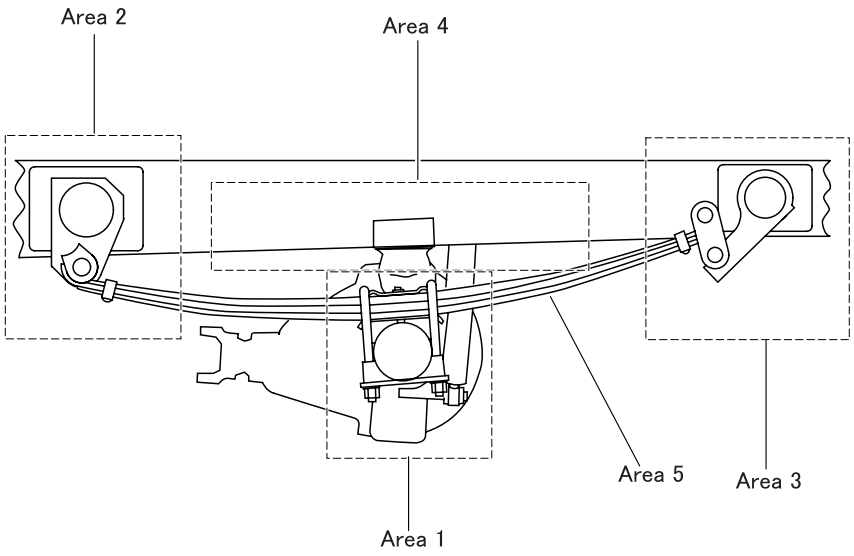
■ Installation: Shock absorber

- Tighten the nut until the distance between top washer and low washer becomes the amount as illustrated.

M E M O

LEAF SPRING

Leaf Spring Assembly Layout

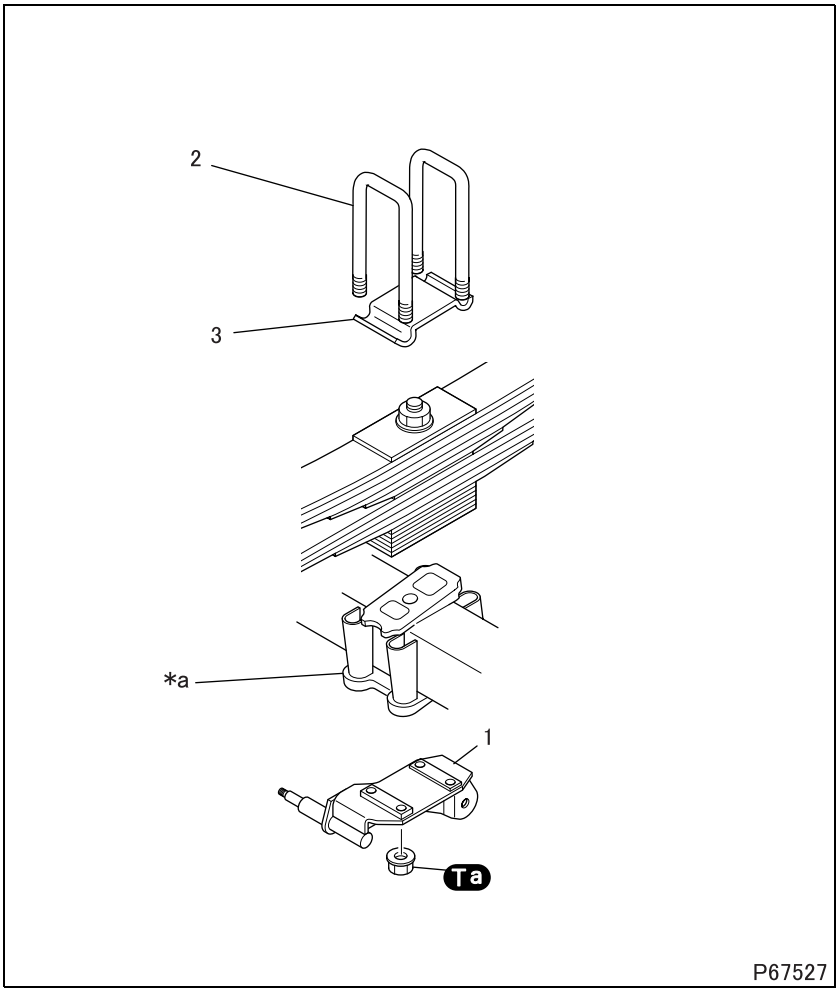


P49758E

- This section divides the leaf spring in 5 areas and describes removal and installation procedures for each area. For information on specific components, see the descriptions for the applicable area.

U-bolt U-bolt nut	Area 1 (center section of leaf spring)
Spring pin Bushing	Area 2 (front section of leaf spring)
Spring shackle Bushing	Area 3 (rear section of leaf spring)
Helper rubber Helper spring stopper	Area 4 (stoppers)
Leaf spring	Area 5 (leaf springs)

Area 1 (center section of leaf spring)



●Removal sequence

1 Stabilizer bracket lower
2 U-bolt
3 Spring pad

***a**: Rear axle

●Installation sequence

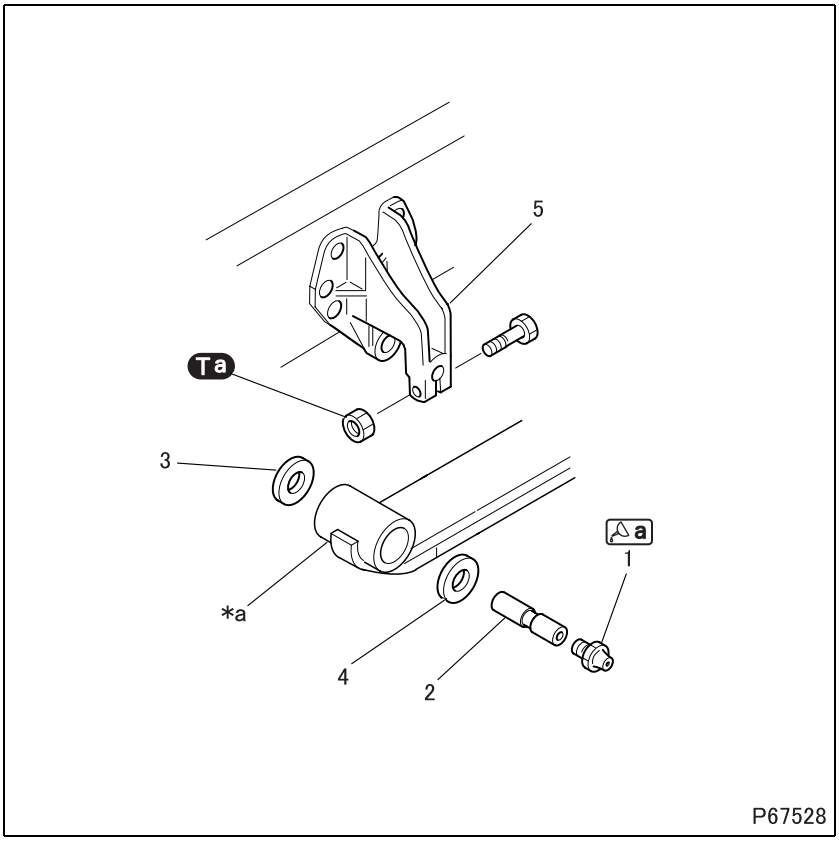
Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (U-bolt mounting)	292 to 394 {215 to 290}	–

LEAF SPRING

Area 2 (front section of leaf spring)



●Removal sequence

1 Grease fitting
2 Spring pin
3 Inboard adjustment washer
4 Outboard adjustment washer
5 Rear spring hanger

***a**: Leaf spring

●Installation sequence

Follow the removal sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
2, 5	Clearance between spring pin and rear spring hanger	0 to 0.04 {0.0016}	0.3 {0.012}	Replace
2, *a	Clearance between spring pin and leaf spring bushing	0 to 0.12 {0.0047}	0.3 {0.012}	Replace
5, *a	Clearance between rear spring hanger and leaf spring	0.07 to 1.03 {0.0028 to 0.041}	1.3 {0.051}	Adjust or replace

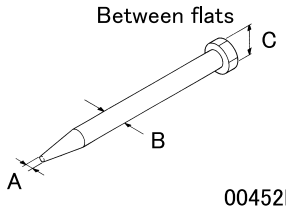
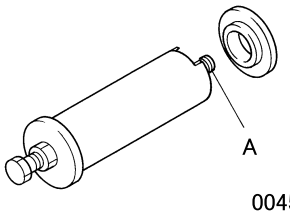
Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (spring pin mounting)	80 to 110 {59 to 81}	–

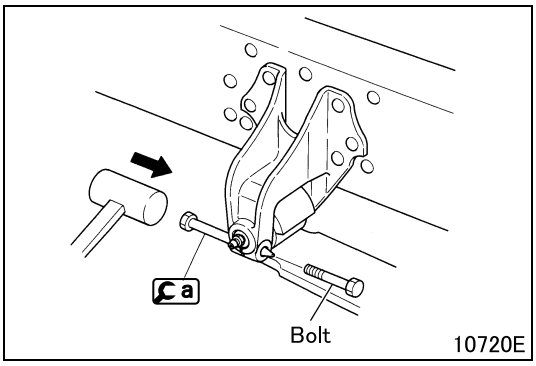
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply from grease nipple	Chassis grease [NLGI No. 1 (Li soap)]	As required

Special tools (Unit: mm {in})

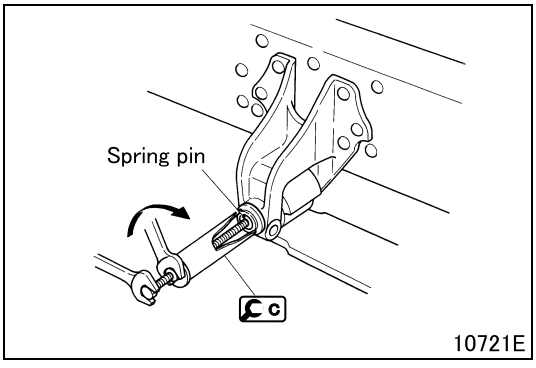
Mark	Tool name and shape	Part No.	Application
a	Shackle pin setting bar A: φ4 {0.16}, B: φ12 {0.47}, C: 17 {0.67}  00452E	MC023419	Removal and installation of spring pin mounting bolt
c	Spring pin remover A: PT 1/8  00453	MH061452	Removal of spring pin

◆Removal procedure◆



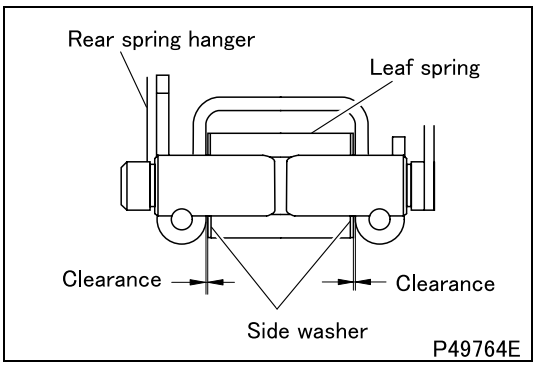
10720E

■ **Removal: Spring pin**



10721E

◆Inspection procedure◆



P49764E

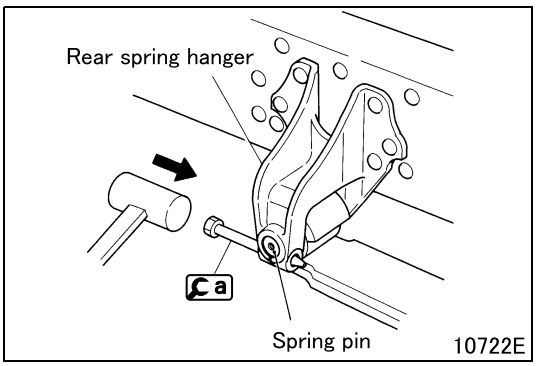
■ **Inspection: Clearance between rear spring hanger and leaf spring**

- Measure the spring-to-hanger clearance on both sides of the leaf spring. If the measured value is equal to or exceeds the limit, adjust by means of side washers.

Side washer sizes available (mm {in})

2.8, 3.2, 3.5, 3.8, 4.0 {0.11, 0.13, 0.14, 0.15, 0.16}

◆Installation procedure◆



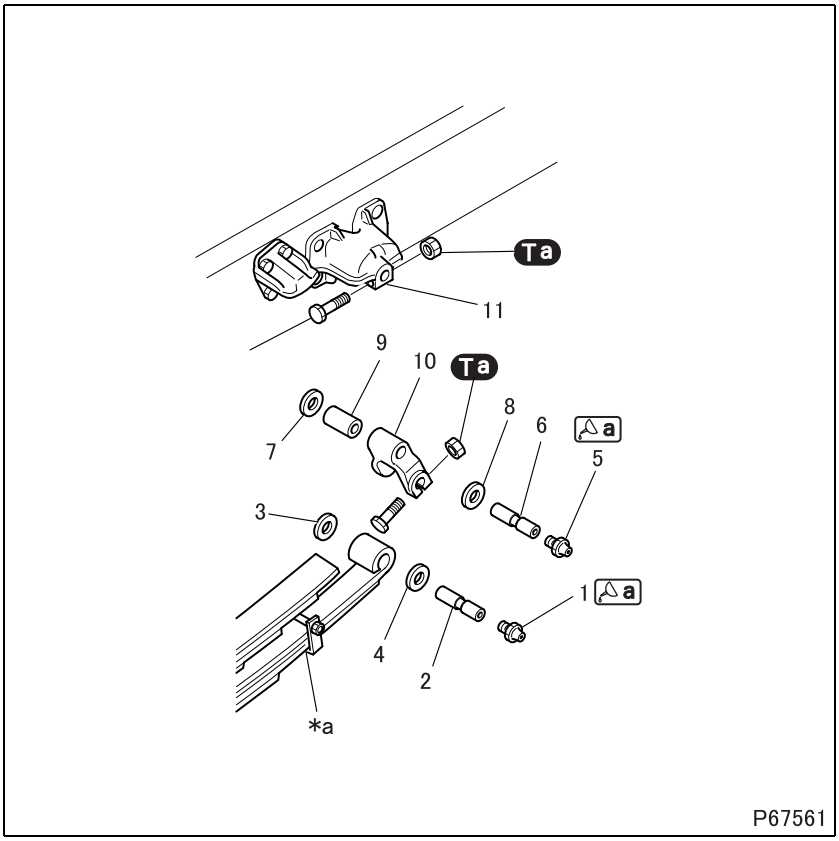
■ **Installation: Spring pin**

- Using a, align the bolt hole in the rear spring hanger with the bolt groove in the spring pin.

M E M O

LEAF SPRING

Area 3 (rear section of leaf spring)



●Removal sequence

1 Grease fitting
2 Spring pin
3 Side washer (for adjustment)
4 Side washer (for adjustment)
5 Grease nipple
6 Spring pin
7 Side washer (for adjustment)
8 Side washer (for adjustment)
9 Bushing
10 Spring shackle
11 Rear shackle hanger

***a**: Leaf spring

●Installation sequence

Follow the disassembly sequence in reverse.

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
2, 10	Clearance between spring pin and spring shackle	0 to 0.04 {0.0016}	0.3 {0.012}	Replace
2, *a	Clearance between spring pin and leaf spring	0 to 0.12 {0.0047}	0.3 {0.012}	Replace
6, 9	Clearance between spring pin and bushing	0.02 to 0.14 {0.00079 to 0.0055}	0.3 {0.012}	Replace
6, 11	Clearance between spring pin and rear shackle hanger	0 to 0.04 {0.0016}	0.3 {0.012}	Replace
10, 11	Clearance between spring shackle and rear shackle hanger	0.07 to 0.73 {0.0028 to 0.029}	1.0 {0.039}	Adjust or replace
10, *a	Clearance between spring shackle and leaf spring	0.07 to 1.03 {0.0028 to 0.041}	1.3 {0.051}	Adjust or replace

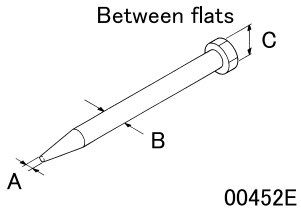
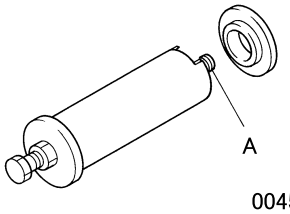
Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (spring pin mounting)	80 to 112 {59 to 83}	–

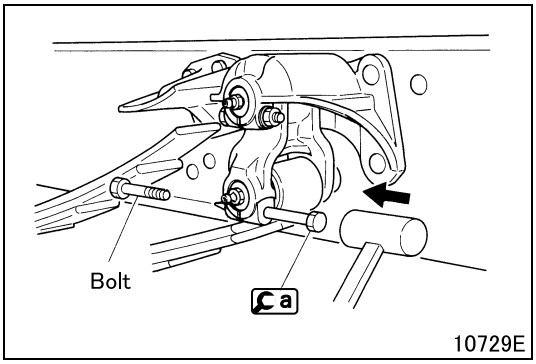
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply from grease nipple	Chassis grease [NLGI No. 1 (Li soap)]	As required

Special tools (Unit: mm {in})

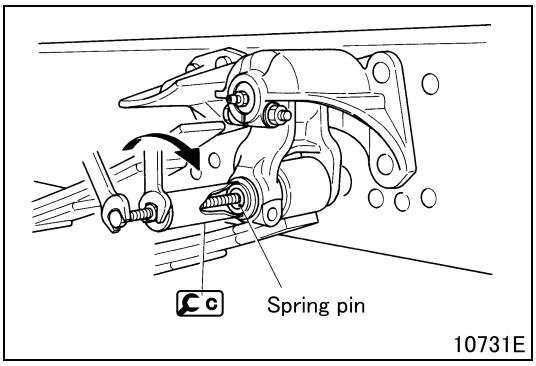
Mark	Tool name and shape	Part No.	Application
a	Shackle pin setting bar A: φ4 {0.16}, B: φ12 {0.47}, C: 17 {0.67}  00452E	MC023419	Removal and installation of spring pin mounting bolt
c	Spring pin remover A: PT 1/8  00453	MH061452	Removal of spring pin

◆Removal procedure◆

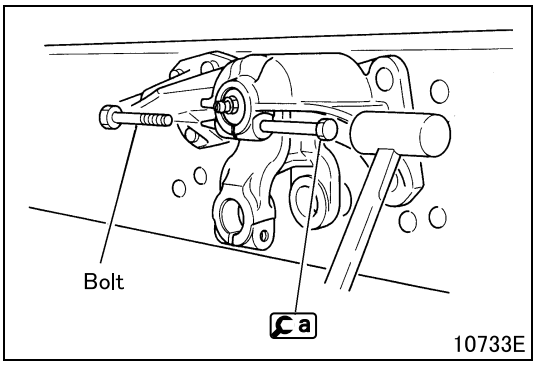


10729E

■ **Removal: Spring pin**

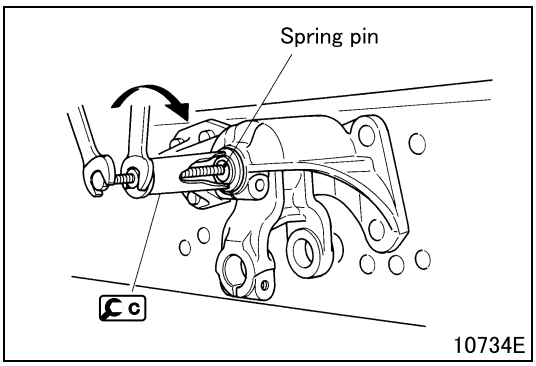


10731E

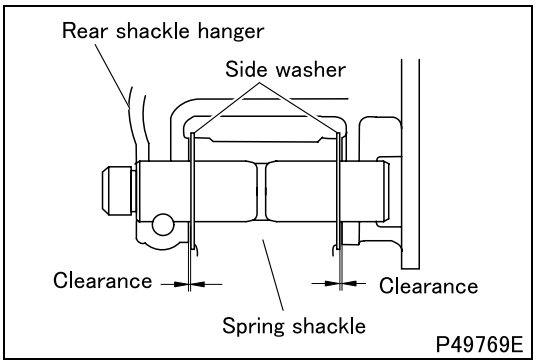


10733E

■ **Removal: Spring pin**



◆Inspection procedure◆

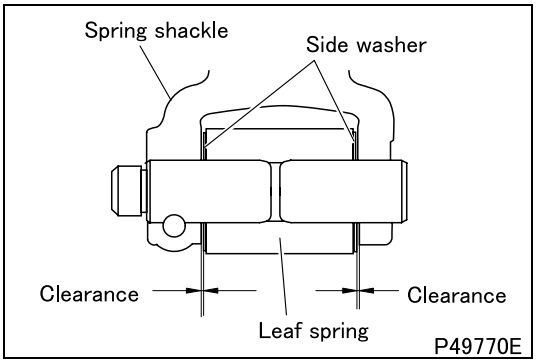


■ **Inspection: Clearance between spring shackle and rear shackle hanger**

- Measure the spring-to-hanger clearance on both sides of the leaf spring. If the measured value is equal to or exceeds the limit, adjust by means of side washers.

Side washer sizes available (mm {in})

2.8, 3.2, 3.5, 3.8, 4.0 {0.11, 0.13, 0.14, 0.15, 0.16}



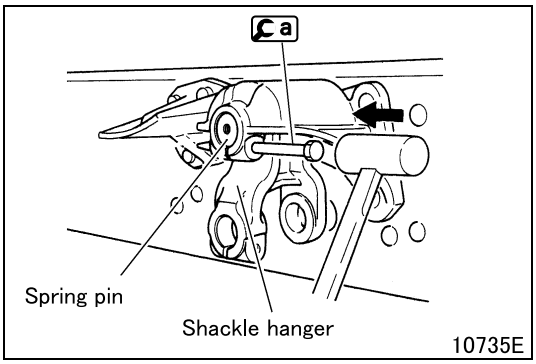
■ **Inspection: Clearance between spring shackle and leaf spring**

- Measure the spring-to-hanger clearance on both sides of the leaf spring. If the measured value is equal to or exceeds the limit, adjust by means of side washers.

Side washer sizes available (mm {in})

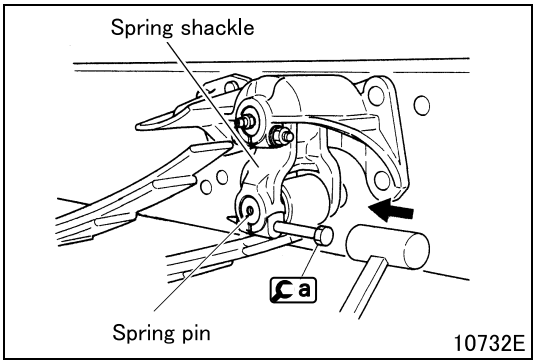
2.8, 3.2, 3.5, 3.8, 4.0 {0.11, 0.13, 0.14, 0.15, 0.16}

◆Installation procedure◆



■ **Installation: Spring pin**

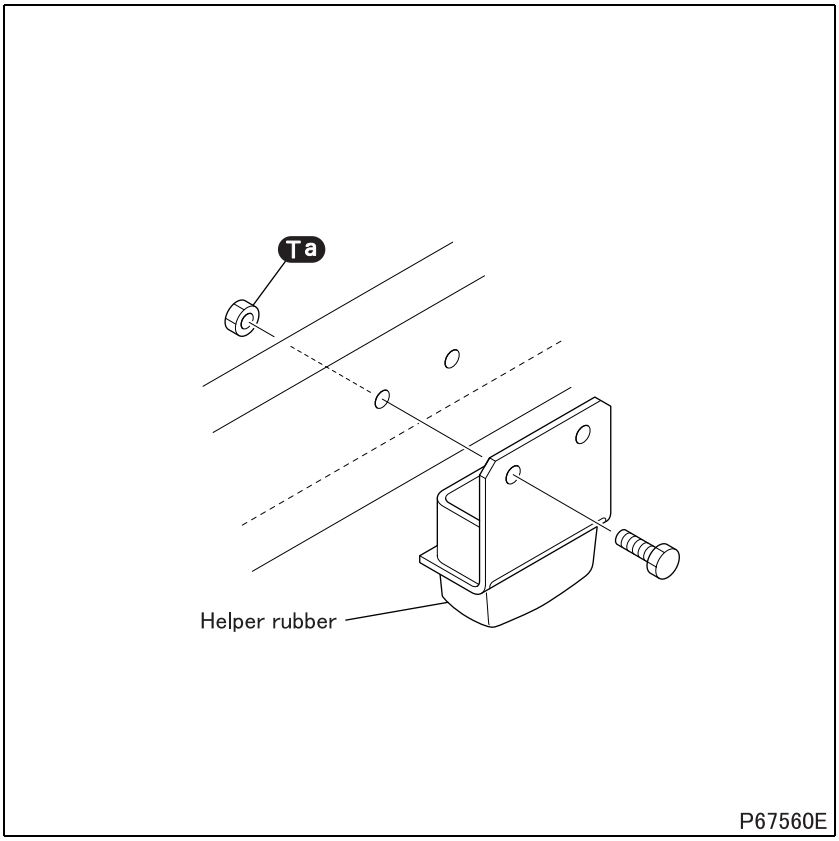
- Using the shackle pin setting bar a, align the bolt hole in the shackle hanger with the bolt groove in the spring pin.



■ **Installation: Spring pin**

- Using the shackle pin setting bar [a], align the bolt hole in the spring shackle with the bolt groove in the spring pin.

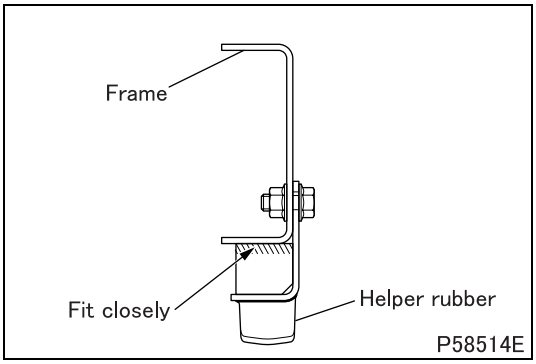
Area 4 (stoppers)



Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (helper rubber mounting)	12 to 15 {8.9 to 11}	–

◆Installation procedure◆



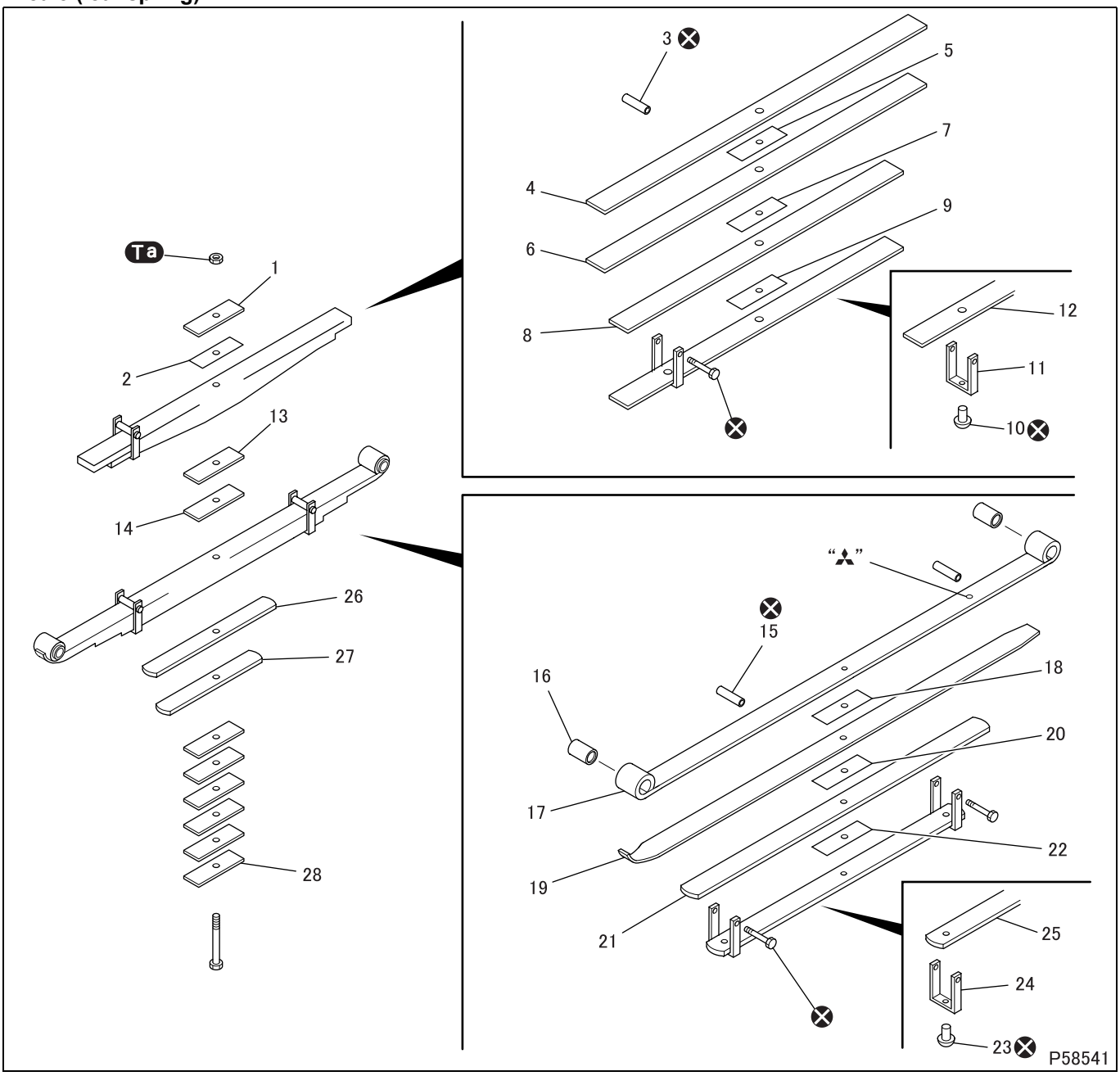
■ Installation: Helper rubber

- Fit helper rubber to the lower face of frame closely as illustrated, then tighten installation bolt and nut.

M E M O

LEAF SPRING

Area 5 (leaf spring)



● Disassembly sequence

1 Spacer
2 Center spacer
3 Pipe
4 Leaf spring (helper)
5 Center spacer
6 Leaf spring (helper)
7 Center spacer
8 Leaf spring (helper)
9 Center spacer
10 Rivet
11 Clip
12 Leaf spring (helper)
13 Spacer
14 Spacer
15 Pipe
16 Metal bushing or collar
17 Leaf spring (main)
18 Center spacer
19 Leaf spring (main)
20 Center spacer
21 Leaf spring (main)
22 Center spacer
23 Rivet
24 Clip
25 Leaf spring (main)
26 Leaf spring (main)
27 Leaf spring (main)
28 Spacer

⊗: Non-reusable parts

NOTE

- **The above schematic is only an example. Details may differ depending on vehicle models, such as the number of spring leaves, spacers, and the parts used.**

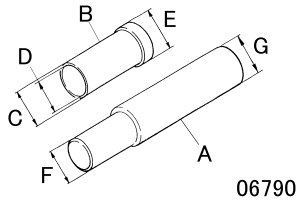
●Assembly sequence

Follow the disassembly sequence in reverse.

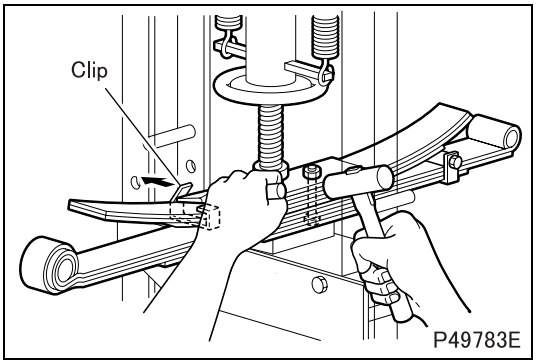
Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (assembly of leaf spring)	69 to 93 {51 to 69}	–

Special tools (Unit: mm {in})

Mark	Tool name and shape	Part No.	Application
Ca	Bushing installer **A:** Bushing installer A **B:** Bushing installer B  06790 C: φ28 {1.10}; D: φ25 {0.98}; E: φ32.8 {1.29}; F: φ25 {0.98}; G: φ30 {1.18}	MB999066 A: MB999067 B: MB999068	Removal and installation of metal bushing

◆Work before removal◆

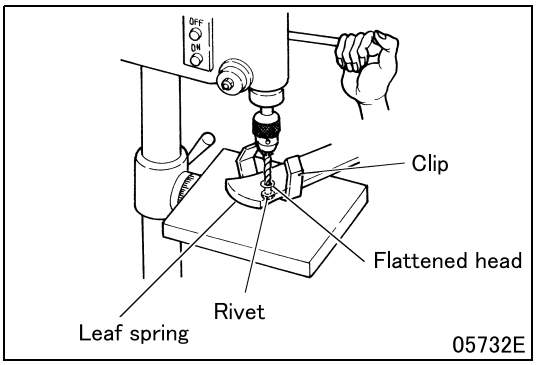


P49783E

■ **Compression: Leaf spring**

- Using a press, compress the leaf spring as illustrated for subsequent operations.
- Using a chisel or the like, open the bent ends of the clip.

◆Removal procedure◆

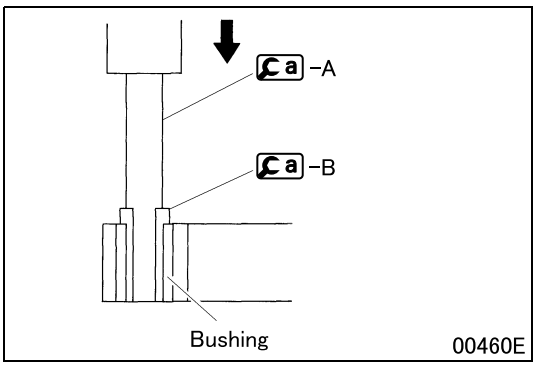


05732E

■ **Removal: Clip**

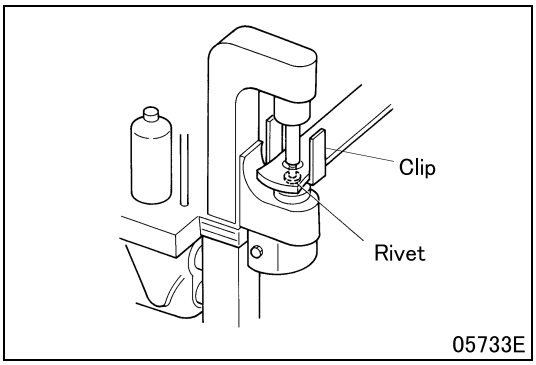
- Using a drill press, break the flattened head of the rivet and remove the clip from the leaf spring.

◆Installation procedure◆



■ **Removal: Metal bushing**

◆Installation procedure◆



■ **Installation: Clip**

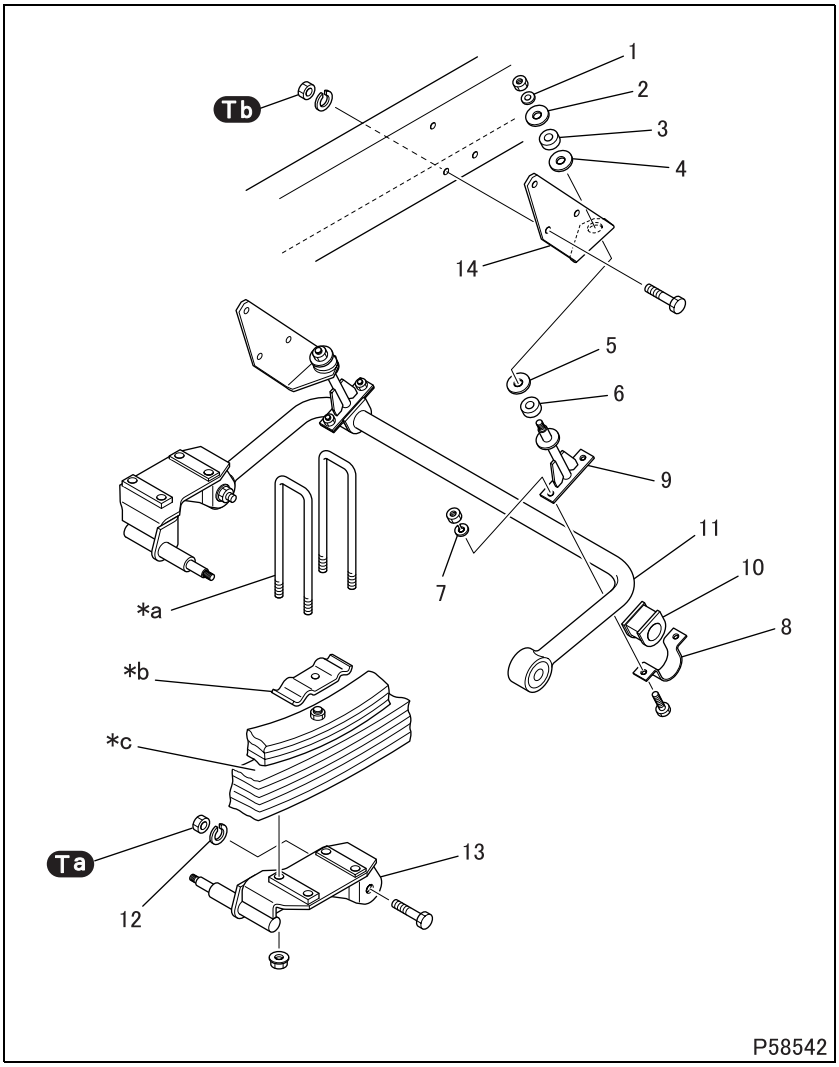
- Using a riveting machine, rivet a clip onto the leaf spring.

■ **Installation: Metal bushing**

- Install the metal bushing in a manner similar to that for removal. (See **"■Removal: Metal bushing"**.)

M E M O

STABILIZER



●Removal sequence

1 Washer
2 Seat
3 Bushing
4 Seat
5 Seat
6 Bushing
7 Washer
8 Clamp
9 Stabilizer hanger
10 Stabilizer bushing
11 Stabilizer bar
12 Washer
13 Stabilizer bracket lower
14 Stabilizer bracket upper

***a**: U-bolt
***b**: Spring pad
***c**: Leaf spring

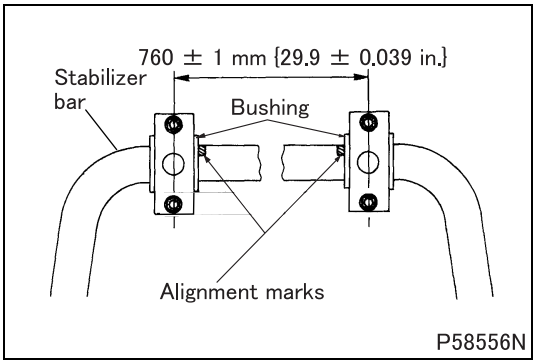
●Installation sequence

Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

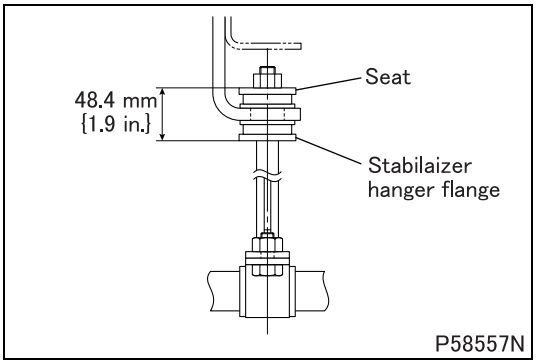
Mark	Parts to be tightened	Torque value	Remarks
Ta	Nut (stabilizer bracket mounting)	410 to 550 {300 to 405}	–
Tb	Nut (stabilizer bracket mounting)	130 to 180 {96 to 130}	–

◆Installation procedure◆



■ Installation: Stabilizer bushing

- Mount stabilizer bushings with their end surfaces aligned with marks on stabilizer bar.



■ **Installation: Stabilizer hanger**

- Tighten the mounting nut until the dimension between the seat and stabilizer hanger flange becomes the amount as illustrated.

GROUP 35A INDEX

SPECIFICATIONS 35A-2

STRUCTURE AND OPERATION
1. Brake System 35A-4
2. Vacuum Pump 35A-7
3. Vacuum Booster and Brake Master Cylinder 35A-8
4. Hydraulic Booster and Brake Master Cylinder 35A-14
5. Flow Priority Valve 35A-20
6. Front Disc Brake 35A-21
7. Rear Disc Brake 35A-22
8. Exhaust Brake System 35A-23

TROUBLESHOOTING 35A-24

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Replacement of Brake Fluid 35A-28
2. Air Bleeding of Brake System 35A-30
3. Inspection and Adjustment of Brake Pedal Free Play 35A-34
4. Inspection and Adjustment of Brake Pedal Pressed Height from Floor 35A-34
5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal 35A-35
6. Inspection and Replacement of Disc Brake Pad 35A-36
7. Measurement of Disc Brake Drag Torque 35A-39
8. Inspection of Check Valve in Vacuum Line Hose 35A-40
9. Inspection of Vacuum Pump 35A-40
10. Inspection of Vacuum Booster .. 35A-42
11. Inspection of Hydraulic Booster 35A-46

VACUUM PUMP..... 35A-48

BRAKE MASTER CYLINDER
<WITH VACUUM BOOSTER> 35A-50
<WITH HYDRAULIC BOOSTER>..... 35A-54

BRAKE PEDAL & VACUUM BOOSTER, HYDRAULIC BOOSTER..... 35A-56

FRONT DISC BRAKE
<ϕ235 mm {9.25 in} DISC>..... 35A-58
<ϕ252 mm {9.92 in} DISC>..... 35A-62

REAR DISC BRAKE
<ϕ235 mm {9.25 in} DISC>..... 35A-66
<ϕ252 mm {9.92 in} DISC>..... 35A-68

EXHAUST BRAKE SYSTEM 35A-70

SPECIFICATIONS

Vacuum Booster and Brake Master Cylinder

Item				Specifications
Vacuum booster	Boosting type			Vacuum tandem type
	Diaphragm diameter		inch	ϕ9 + ϕ10
	Manufacturer			BOSCH CORPORATION
Brake master cylinder	Inner diameter		mm {in}	ϕ31.75 {1.25}
	Stroke	Front	mm {in}	16.0 {0.63}
		Rear	mm {in}	16.0 {0.63}
	Manufacturer			NISSIN KOGYO

Hydraulic Booster and Brake Master Cylinder

Item				Specifications
Hydraulic booster	Boosting type			Hydraulic type
	Manufacturer			BOSCH CORPORATION
Brake master cylinder	Inner diameter		mm {in}	ϕ33.34 {1.31}
	Stroke	Front	mm {in}	17.5 {0.69}
		Rear	mm {in}	16.0 {0.63}
	Manufacturer			BOSCH CORPORATION

Front Disc Brake

Item		Specifications	
		COE 40/45	COE 50
Brake type		Twin caliper type	
Effective diameter for braking	mm {in}	ϕ235 {9.25}	ϕ252 {9.92}
Disc rotor outer diameter × thickness	mm {in}	ϕ293 × 40 {11.5 × 1.57}	ϕ310 × 40 {12.2 × 1.57}
Caliper piston inner diameter	mm {in}	ϕ51.1 {2.01}	ϕ54 {2.13}
Thickness of pad	mm {in}	14 {0.55}	14 {0.55}

Rear Disc Brake

Item		Specifications	
		COE 40/45	COE 50
Brake type		Twin caliper type	
Effective diameter for braking	mm {in}	ϕ235 {9.25}	ϕ252 {9.92}
Disc rotor outer diameter × thickness	mm {in}	ϕ293 × 40 {11.5 × 1.57}	ϕ310 × 40 {12.2 × 1.57}
Caliper piston inner diameter	mm {in}	ϕ51.1 {2.01}	ϕ54 {2.13}
Thickness of pad	mm {in}	14 {0.55}	14 {0.55}

Vacuum Pump

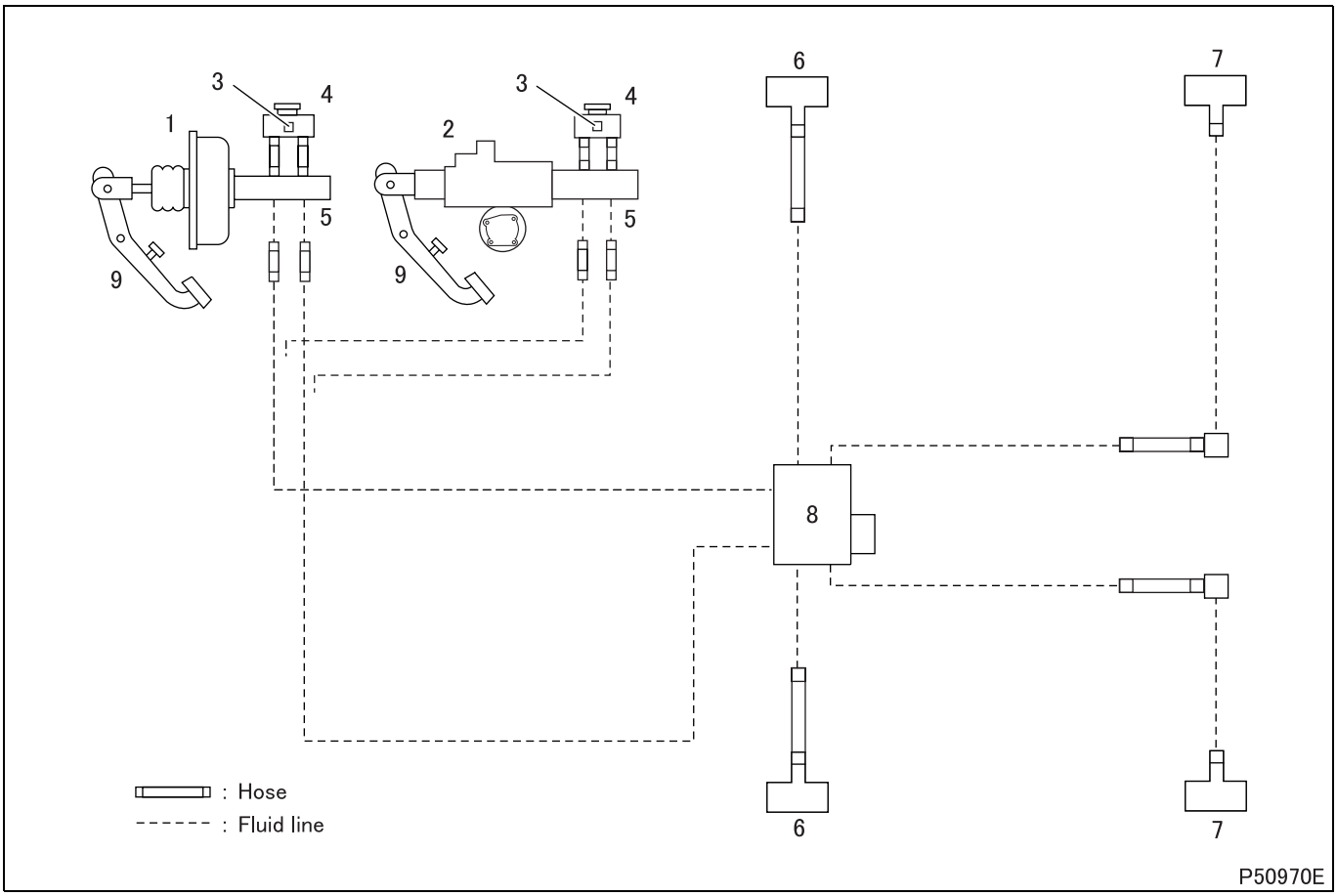
Item		Specifications
Type		Vane type
Output	cm^3 {cu.in}	60 {3.66}
Manufacturer		Mitsubishi Electric Corporation

Exhaust Brake

Item	Specifications
Control type	Combined electric and vacuum control
Valve type	Butterfly valve type

1. Brake System

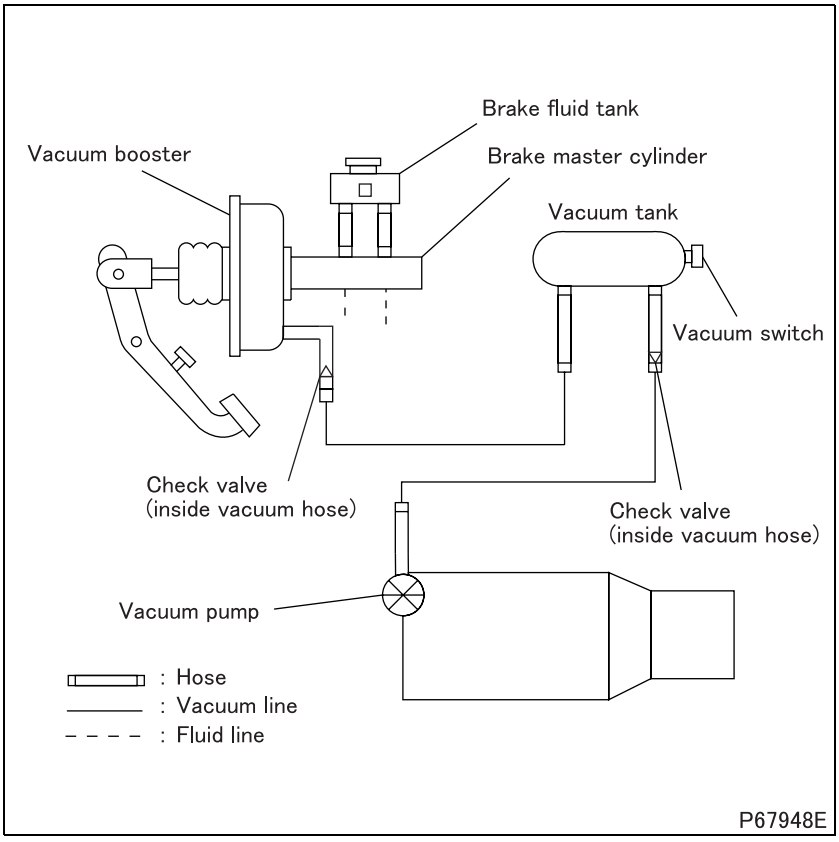
1.1 Brake fluid line



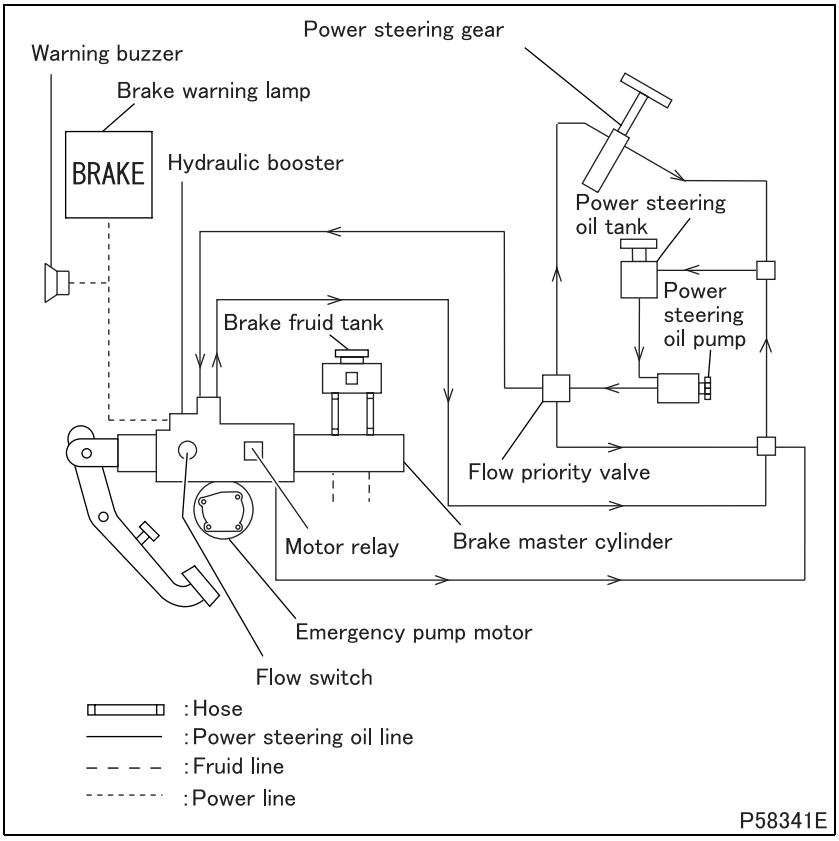
1 Vacuum booster
2 Hydraulic booster
3 Brake fluid level switch
4 Brake fluid tank
5 Brake master cylinder
6 Front wheel brake
7 Rear wheel brake
8 Hydraulic unit (antilock brake system)
9 Stop lamp switch

- The brake system incorporating the vacuum booster uses vacuum to provide servo-assisted braking to all wheels of the vehicle onto which it is mounted.
- The brake system incorporating the hydraulic booster uses the power steering oil pump pressure to provide servo-assisted braking to all wheels of the vehicle onto which it is mounted.

1.2 Vacuum booster line



1.3 Hydraulic booster line



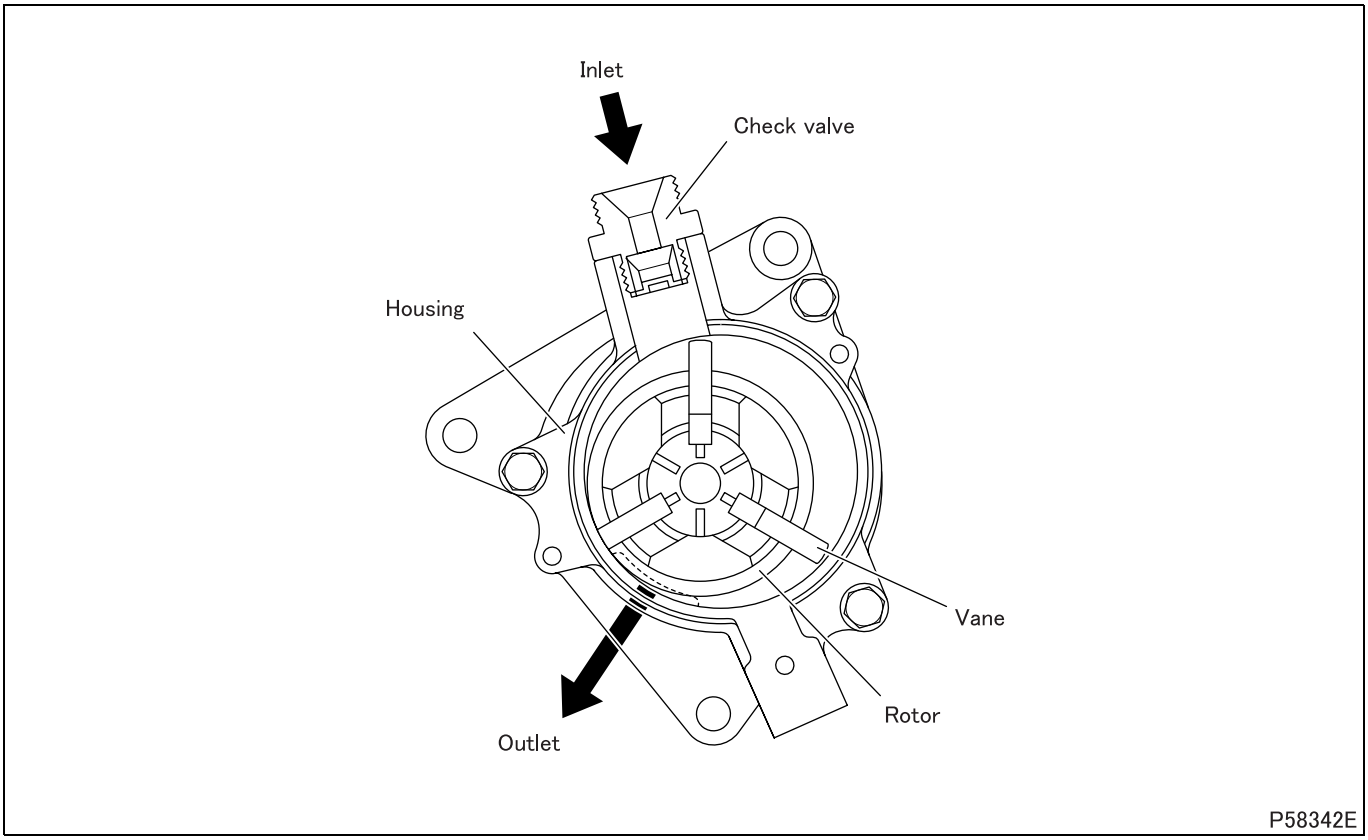
- The stepping force applied on the brake pedal is boosted by the hydraulic booster which operates on the pressure provided by the power steering oil pump.
- When brakes are applied hard while the steering wheel is turned, the associated steering shock is dampened by the flow priority valve in the system.
- When engine stall, power steering oil pump failure, or oil leakage from the power steering line causes oil pressure to drop, the flow switch detects this. This causes the motor relay to switch over, providing power to the emergency pump motor which then turns to generate emergency oil pressure.

- The emergency pump motor operates only when the brake pedal is depressed. The motor has various operating modes, as summarized below.

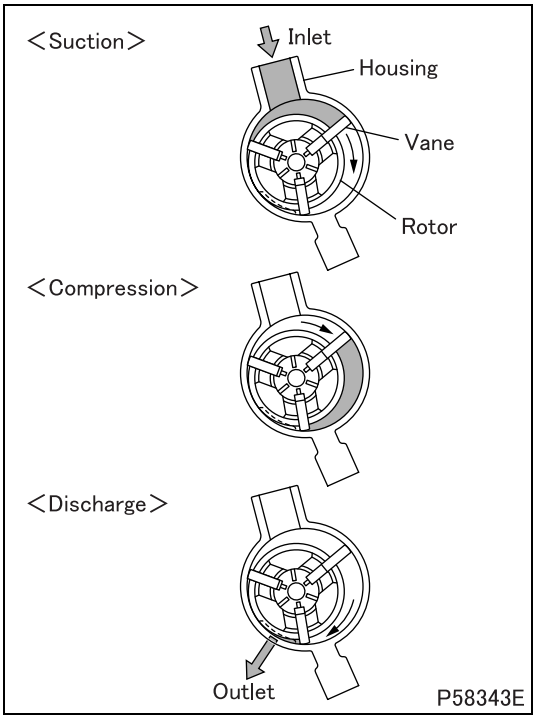
Starter switch	Engine	Parking switch	Warning		Power steering oil pressure	Emergency pump motor O: ON ×: OFF	Vehicle state
			Brake warning lamp O: ON ×: OFF	Warning buzzer O: ON ×: OFF			
ON	Run	ON (pulled)	O	×	Available	×	Normal
			O	×	Not available	O	* Oil leakage from power steering line
		OFF (released)	×	×	Available	×	Normal
			O	O	Not available	O	* Oil leakage from power steering line
	Stop	ON (pulled)	O	×		O	At engine start
						O	Engine stalled at uphill start
		OFF (released)	O	O		O	Engine stall
OFF		ON (pulled)	×	×		O	Vehicle moved after parked (parking brake lever pulled insufficiently)
		OFF (released)	×	×		O	Engine stopped before vehicle came to complete halt

*: The failsafe feature of the hydraulic booster cuts off oil supply to the power steering line to maintain oil pressure.

2. Vacuum Pump



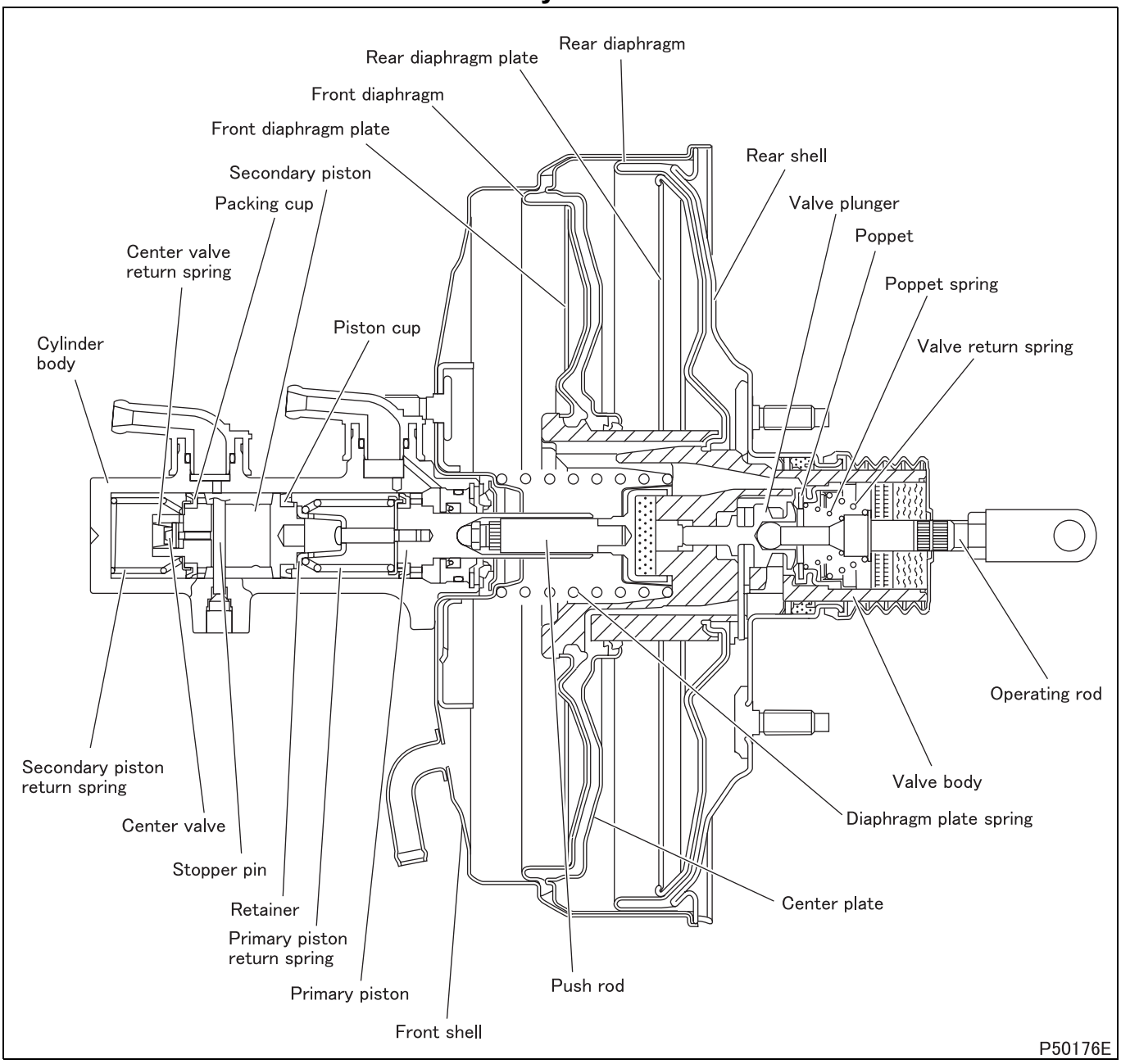
- The vacuum pump is mounted onto the timing gear case, and is driven by the idler gear.
- The check valve is provided to ensure that no air or engine oil flow from the vacuum pump back to the vacuum tank when the engine is stationary.



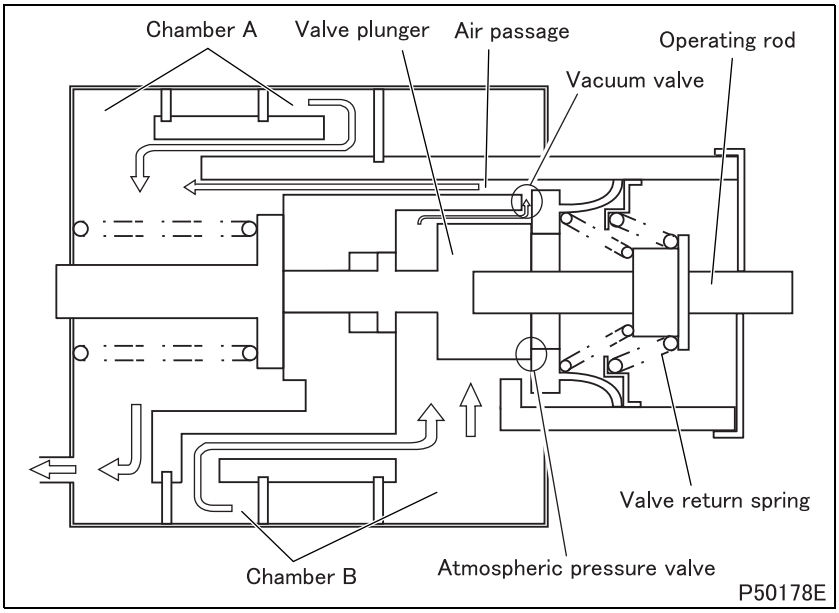
2.1 Operation

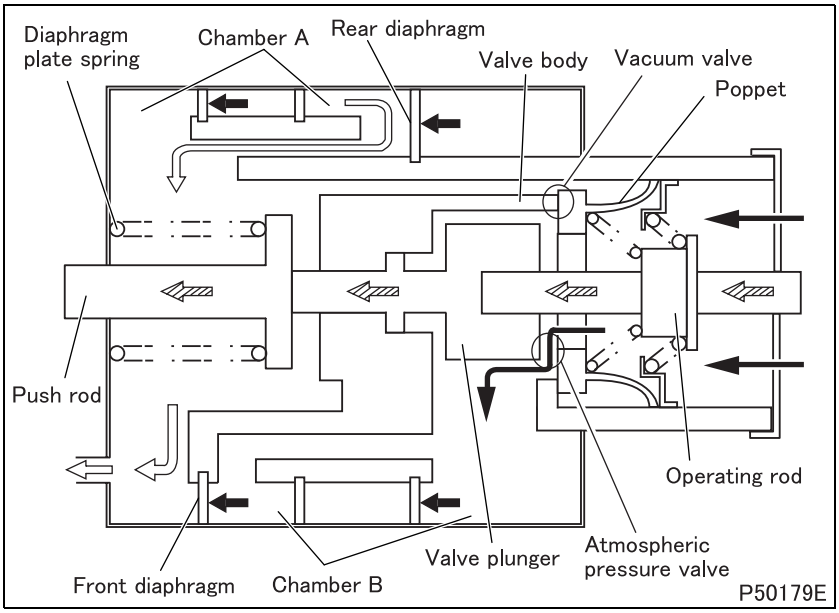
- A rotor with 3 movable vanes is housed in a cylindrical housing. As the rotor rotates, the vanes are pressed against the inner face of the housing by centrifugal force.
- The rotor is eccentrically mounted relative to the housing. As the rotor rotates, air in the vacuum tank is sucked through the pump inlet and then compressed before being discharged through the outlet. The suction-compression-discharge cycle is repeated to generate vacuum in the vacuum tank.
- The inside of the housing is lubricated and cooled by engine oil. After lubrication/cooling, the engine oil together with the compressed air is returned through the pump outlet and into the oil pan.

3. Vacuum Booster and Brake Master Cylinder



- The vacuum booster magnifies the stepping force applied onto the brake pedal (therefore reduces the operator's pedal effort) through the utilization of pressure difference between the vacuum it generates and the atmospheric pressure. The system is of a tandem type and has 2 vacuum chambers, achieving size reduction while offering a great capacity for highly efficient boosting performance.
- The brake master cylinder serves both the front and rear brake systems that are independent of each other. Should fluid leakage occur in either the front or rear brake system, stopping power can still be provided by whichever system is intact.

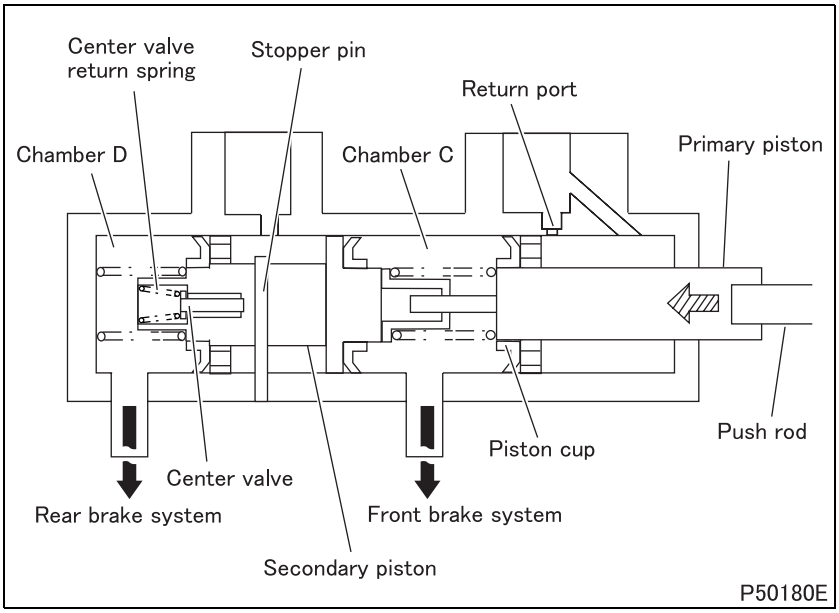




3.1 When brake pedal is depressed

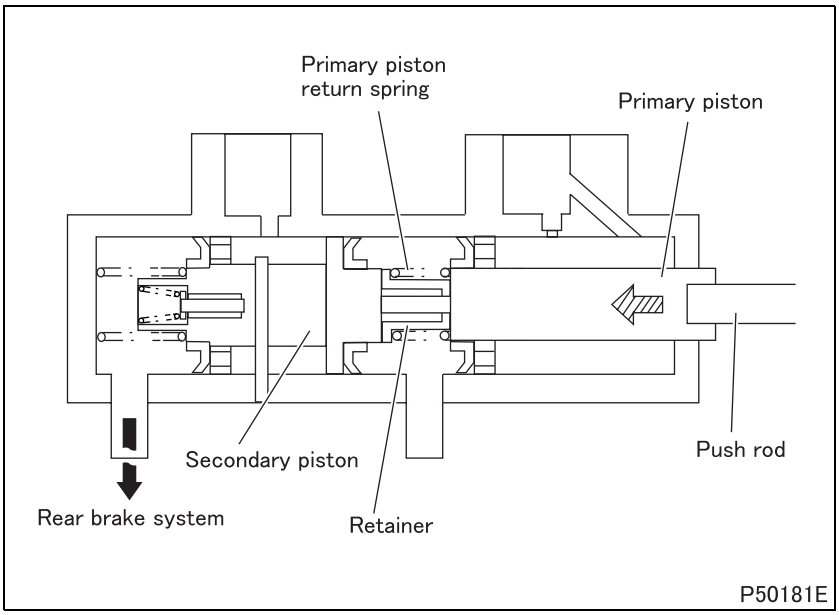
(1) Vacuum booster operation

- With the brake pedal released and no stepping force applied to the brake pedal, the operating rod and the valve plunger are held to the right by the force of the valve return spring. The atmospheric pressure valve remains closed while the vacuum valve remains open.
- The vacuum pump creates vacuum in chamber **A**. As the atmospheric pressure valve is closed, no outside air flows into chamber **B**. Instead, vacuum in chamber **A** flows through the air passage and into chamber **B**. Chambers **A** and **B** are both filled with vacuum, and there is no pressure difference between the chambers. No boosting occurs.
- As the brake pedal is depressed, the stepping force acts on the operating rod. This seats the poppet onto the valve body, closing the vacuum valve and cutting off vacuum supply into chamber **B**. As the brake pedal is depressed further, the valve plunger separates from the poppet. This opens the atmospheric pressure valve, allowing outside air into chamber **B**. There is now a pressure difference between chambers **A** and **B**.
- The stepping force, boosted as a result of the pressure difference between chambers **A** and **B**, overcomes the force of the diaphragm plate spring, pushing the front and rear diaphragms and the push rod to operate the brake master cylinder.



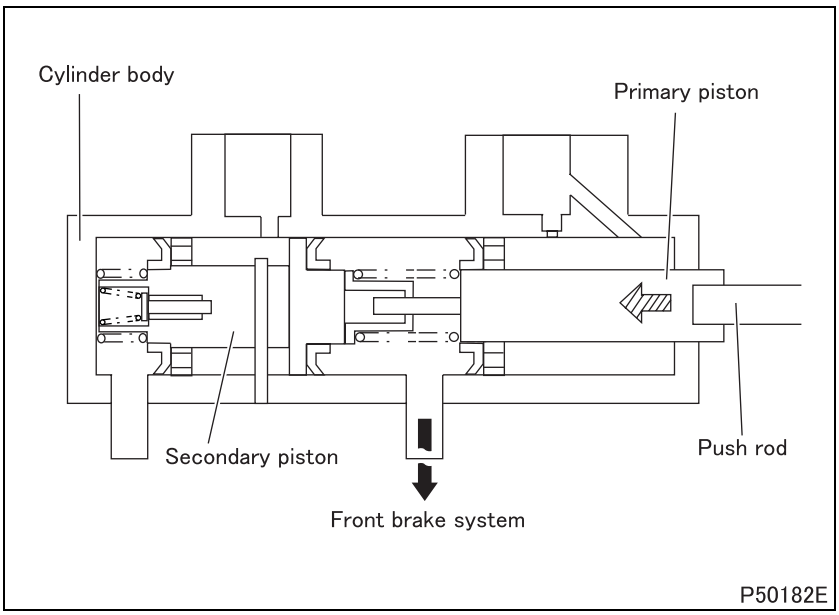
(2) Brake master cylinder operation

- As the push rod pushes the primary piston, the return port is closed by the piston cup. Fluid pressure now builds up in chamber **C**.
- The pressure buildup is sent to the front brake system and at the same time pushes the secondary piston.
- The center valve in front of the secondary piston separates from the stopper pin. The center valve return spring now closes the center valve, seating it onto the secondary piston.
- Fluid pressure now builds up in chamber **D** in front of the secondary piston, and the pressure is sent to the rear brake system.



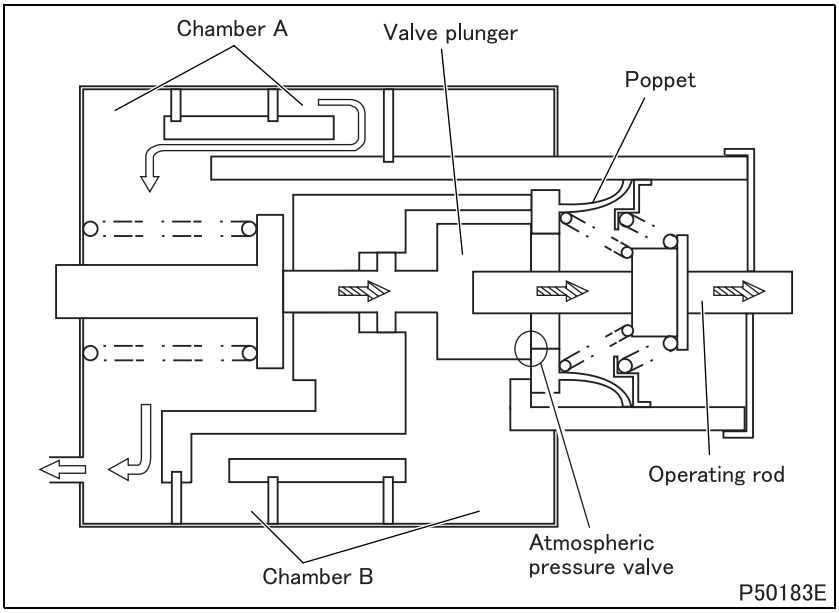
3.2 Fluid leakage in front brake system

- As the brake pedal is depressed, the push rod moves to push the primary piston. As there is fluid leakage in the front brake system, no fluid pressure builds up in that system.
- As the brake pedal is depressed further, the primary piston overcomes the force of the primary piston return spring and, via the retainer, pushes the secondary piston. Fluid pressure is now sent to the rear brake system.



3.3 Fluid leakage in rear brake system

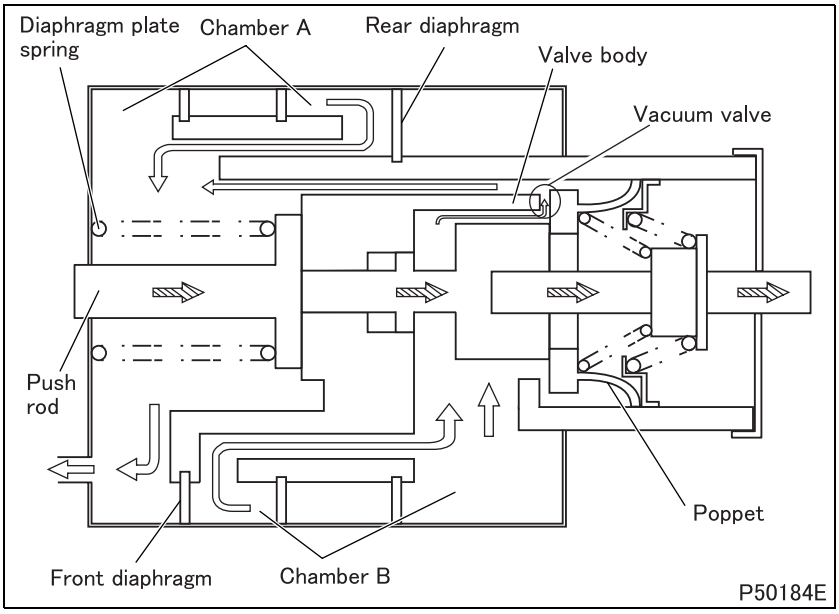
- As the brake pedal is depressed, the push rod moves to push the primary and secondary pistons. As there is fluid leakage in the rear brake system, no pressure builds up in that system.
- As the brake pedal is depressed further, the tip of the secondary piston contacts the cylinder body while the primary piston continues to be pushed. Fluid pressure builds up further in the front brake system.



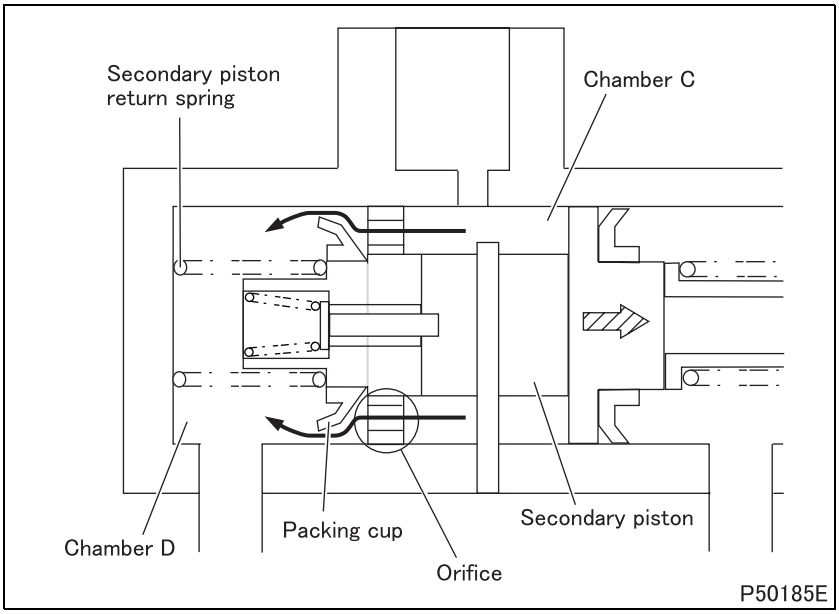
3.4 When brake pedal is released

(1) Vacuum booster operation

- With the brake pedal depressed, chamber **A** is filled with vacuum generated by the vacuum pump while chamber **B** is open to the atmosphere. When the brake pedal is released, the stepping force no longer acts on the operating rod. This causes the valve plunger to seat on the poppet, closing the atmospheric pressure valve and cutting off air flow into chamber **B**.

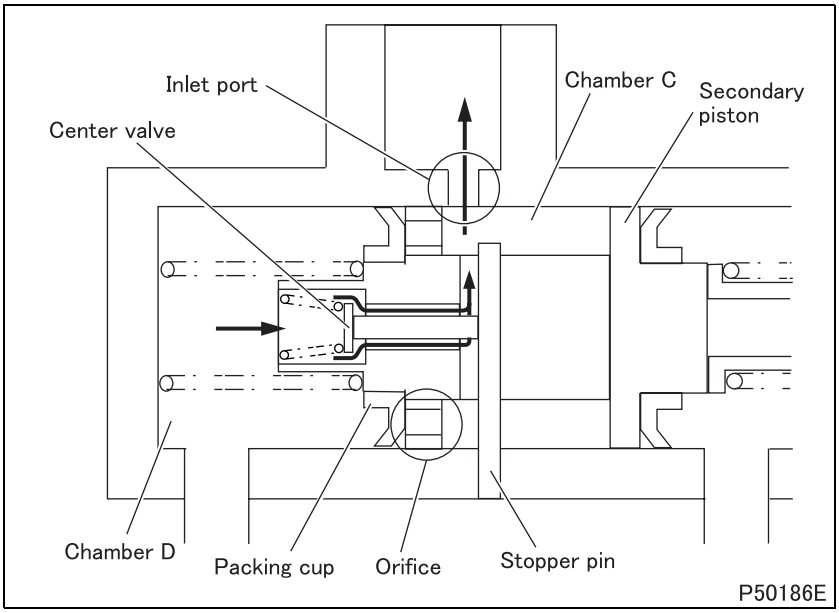


- In further progression, the poppet separates from the valve body. This opens the vacuum valve, allowing vacuum from the vacuum pump to flow into chamber **B**. As there is now no pressure difference between chambers **A** and **B**, the diaphragm plate spring pushes back the front and rear diaphragms and also the push rod to their original positions.

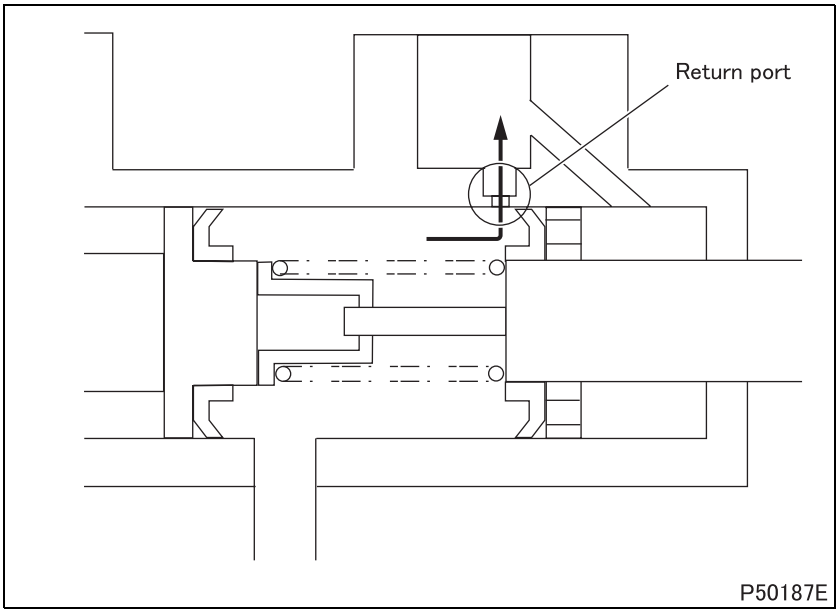


(2) Brake master cylinder operation

- As the push rod returns to its original position, the secondary piston immediately starts to be pushed back by the force of the secondary piston return spring. The speed of return is gradual as there is no difference between chambers **C** and **D** in fluid pressure supplied by the brake master cylinder.
- As the secondary piston starts to return to its original position, the pressure in chamber **D** becomes lower than the pressure in chamber **C**. The pressure difference causes the packing cup to buckle, allowing the fluid pressure in chamber **C** to flow through the orifices and into chamber **D**.



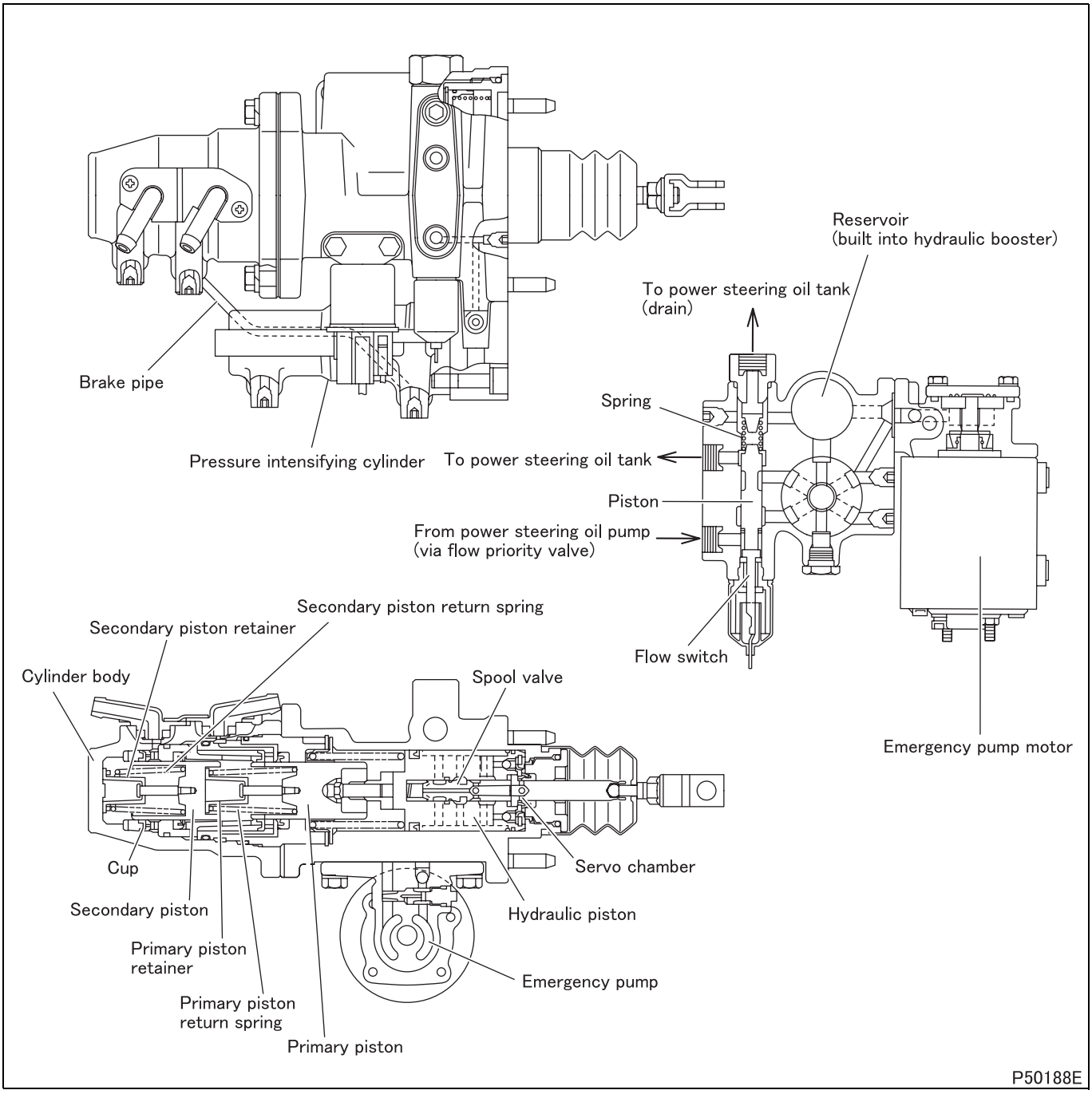
- With the secondary piston back in its original position, there is no difference in fluid pressure between chambers **C** and **D**. The packing cup restores its original shape, blocking the orifices. The liquid pressure in the brake line now flows through the center valve, which has been open since hitting the stopper pin. The liquid pressure then returns through the inlet port to the brake fluid tank.



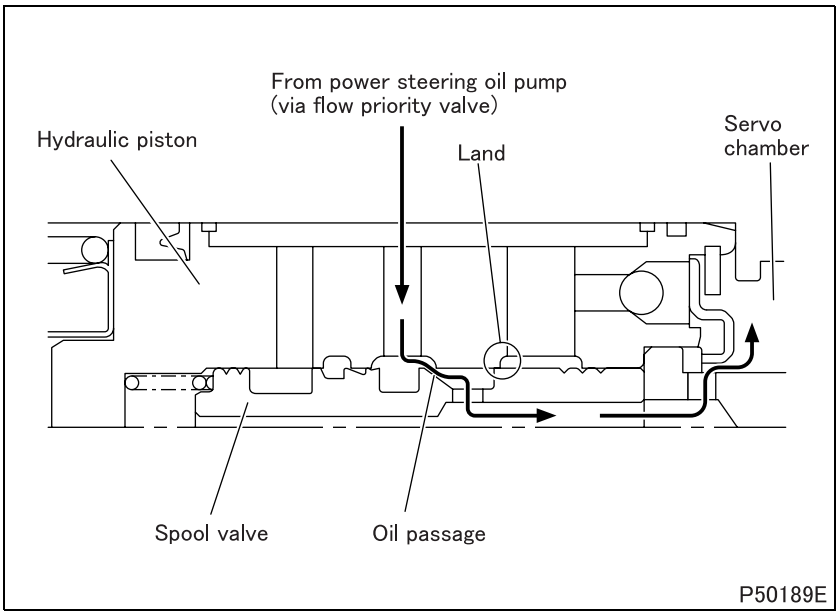
- The fluid pressure in the primary (front) brake line returns through the return port to the brake fluid tank.

M E M O

4. Hydraulic Booster and Brake Master Cylinder



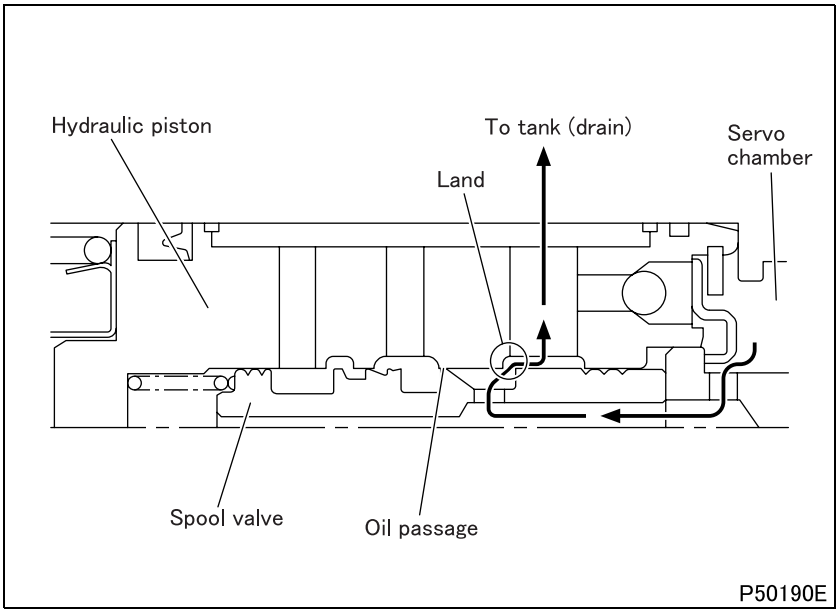
- The hydraulic booster magnifies the stepping force applied onto the brake pedal (therefore reduces the operator's pedal effort) through the utilization (via the flow priority valve) of the steering pump pressure.
- The brake master cylinder serves both the front and rear brake systems that are independent of each other. Should fluid leakage occur in either the front or rear brake system, stopping power can still be provided by whichever system is intact.
- The spool valve is connected to the brake pedal, and generates oil pressure proportional to the pedal stepping force.
- The hydraulic piston, which is connected to the brake master cylinder, operates to store oil supplied via the spool valve into the servo chamber for pressure boost.
- Should oil pressure is lost, the piston is pushed to the left by the force of the spring, blocking oil flow from the power steering oil pump and to the power steering oil tank. At the same time, the flow switch is turned ON, providing power to the emergency pump motor. The emergency pump generates oil pressure for the hydraulic booster to continue to operate.



4.1 Spool valve

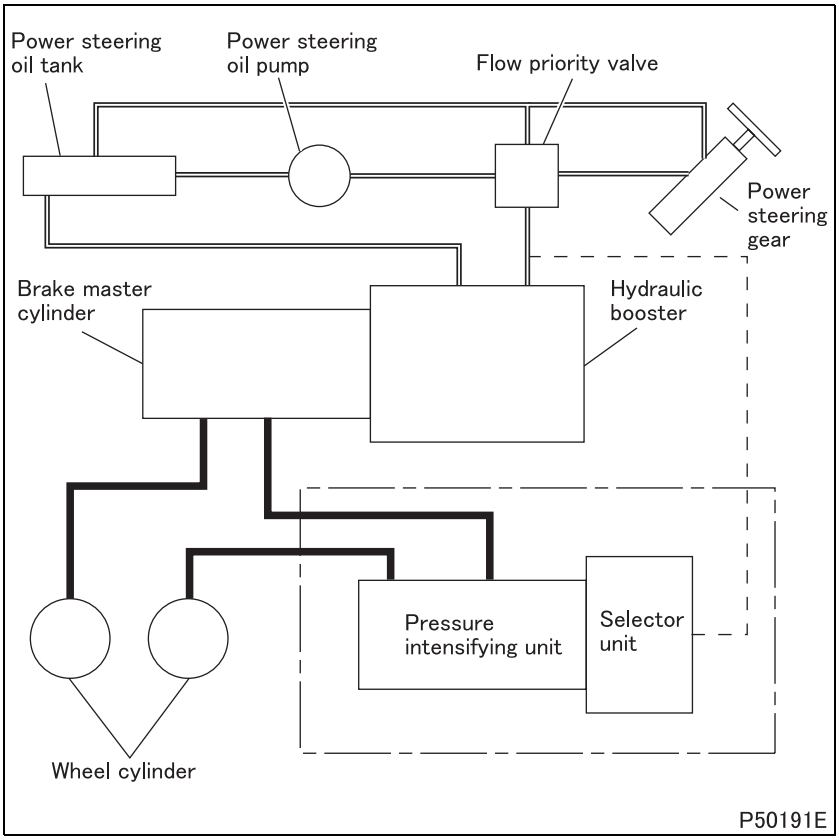
(1) When brake pedal is depressed

- As the brake pedal is depressed, the spool valve moves to the left, closing the land.
- Oil pressure from the flow priority valve builds up.
- The high pressure oil flows through the oil passage and into the servo chamber.
- The hydraulic piston is pushed to the left.
- The pistons in the brake master cylinder are moved, supplying pressure for brake application.



(2) When brake pedal is released

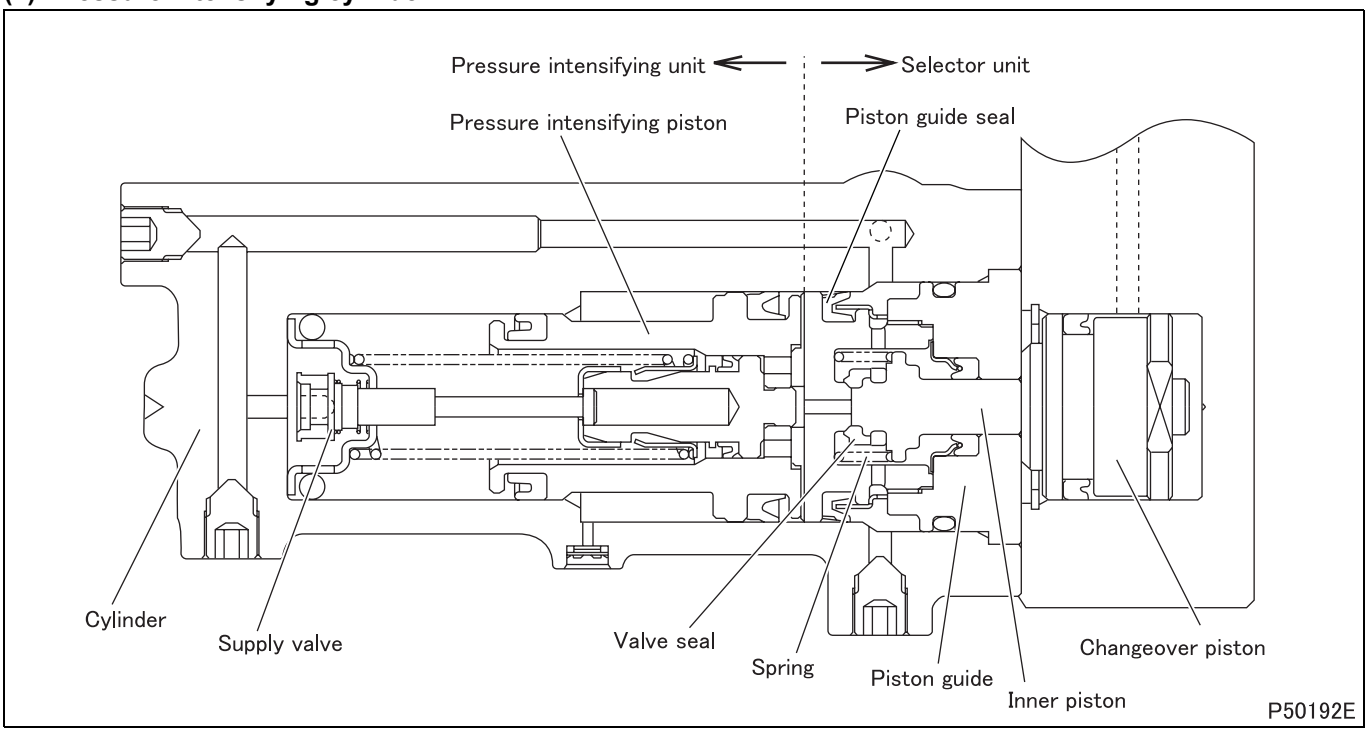
- As the brake pedal is released, the spool valve moves to the right. This opens the land while the oil passage is closed.
- Oil pressure from the flow priority valve drops.
- The oil in the servo chamber drains to the tank as well as to the reservoir.
- The hydraulic piston returns to its original position.
- Pressure acting on the pistons in the brake master cylinder is released.



4.2 Pressure intensifying cylinder system

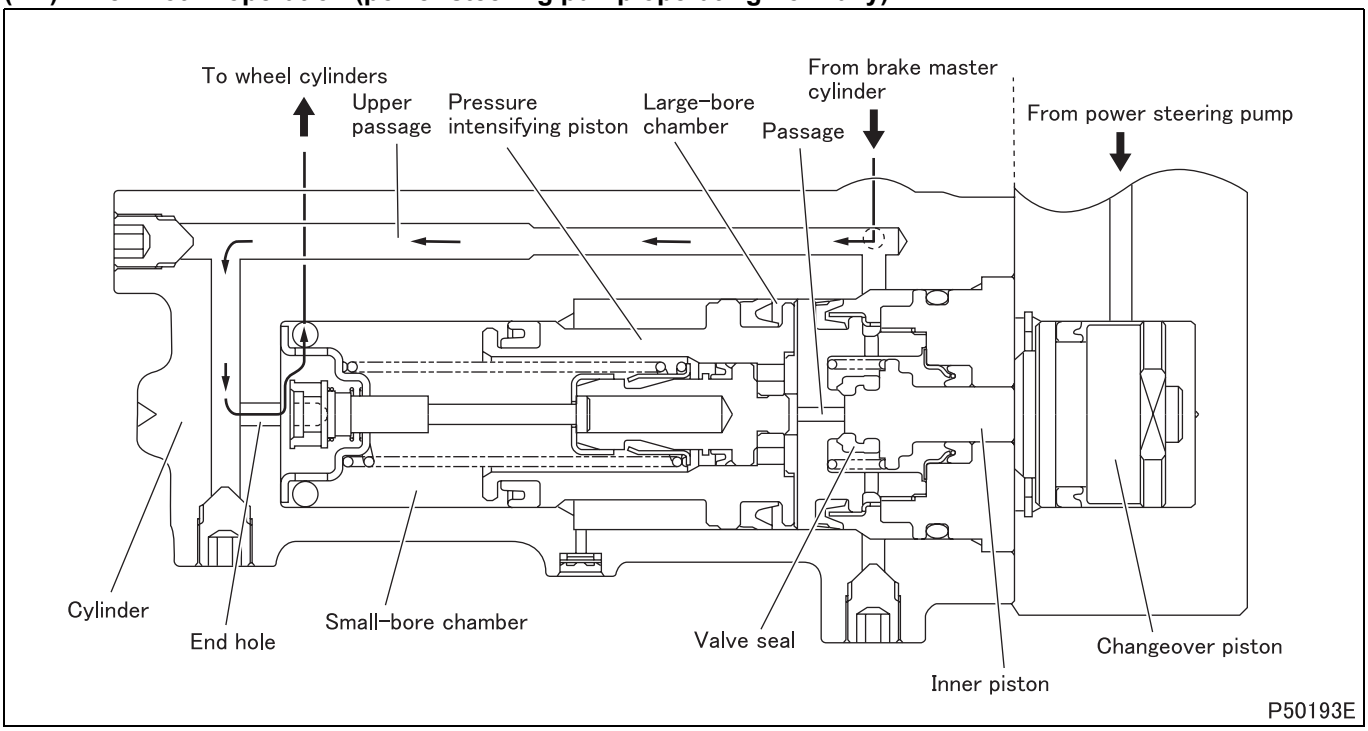
- The pressure intensifying cylinder system is attached onto the hydraulic booster which operates on the power steering oil pump pressure.
- Should the pump fail, depressing the brake pedal causes the system to boost the fluid pressure from the brake master cylinder and send it to the wheel cylinders.

(1) Pressure intensifying cylinder



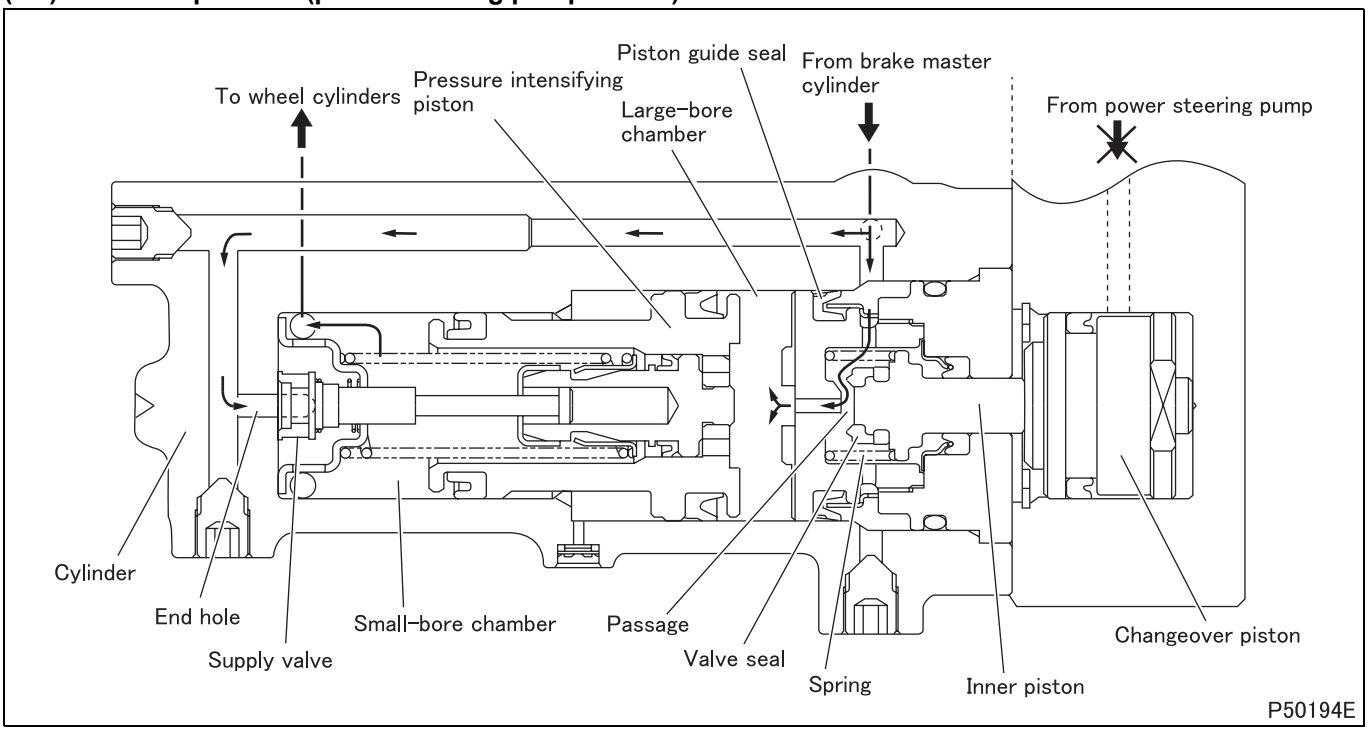
- Should the power steering pump fail to discharge oil, the selector unit detects this. The unit also ensures that pressure not be intensified when the power steering pump is functioning normally.
- Should the power steering pump fail, the pressure intensifying unit comes into action, boosting the fluid pressure from the brake master cylinder before sending it to the wheel cylinders.

(1.1) When not in operation (power steering pump operating normally)



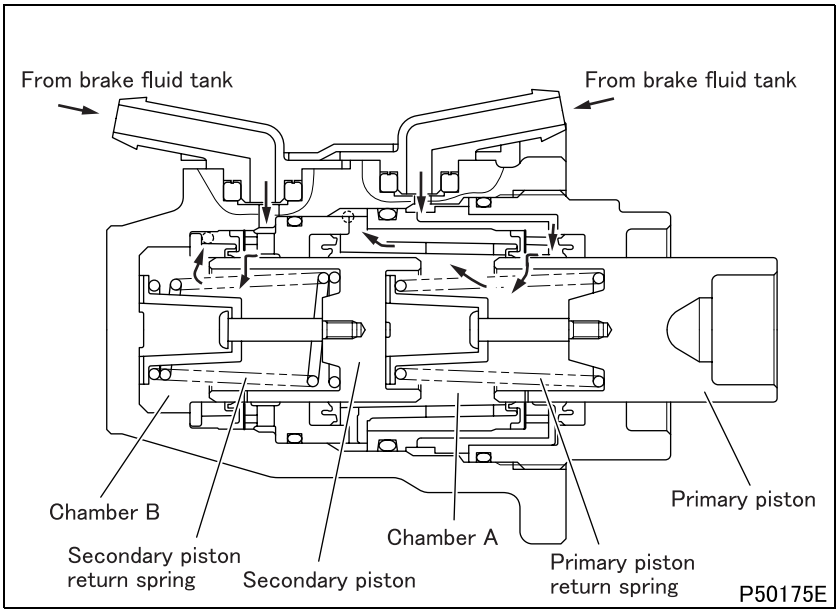
- Power steering oil pump pressure pushes the changeover piston, which then moves the inner piston. As a result, the passage to the large-bore chamber is blocked by the valve seal. Fluid pressure from the brake master cylinder flows through the upper passage, the end hole, the small-bore chamber, and into the wheel cylinders. As fluid pressure acts only on the small-bore end of the pressure intensifying piston, the piston remains in the same position.

(1.2) When in operation (power steering pump failure)



- When the power steering oil pump fails to discharge oil, the spring at the end of the inner piston pushes back the inner and changeover pistons. This opens up the passage through the valve seal into the large-bore chamber.
- Fluid pressure from the brake master cylinder flows into both the large- and small-bore chambers. As the large-bore end of the pressure intensifying piston has a larger area than the small-bore end, the piston moves to the left. As a result, the end hole is blocked by the supply valve.

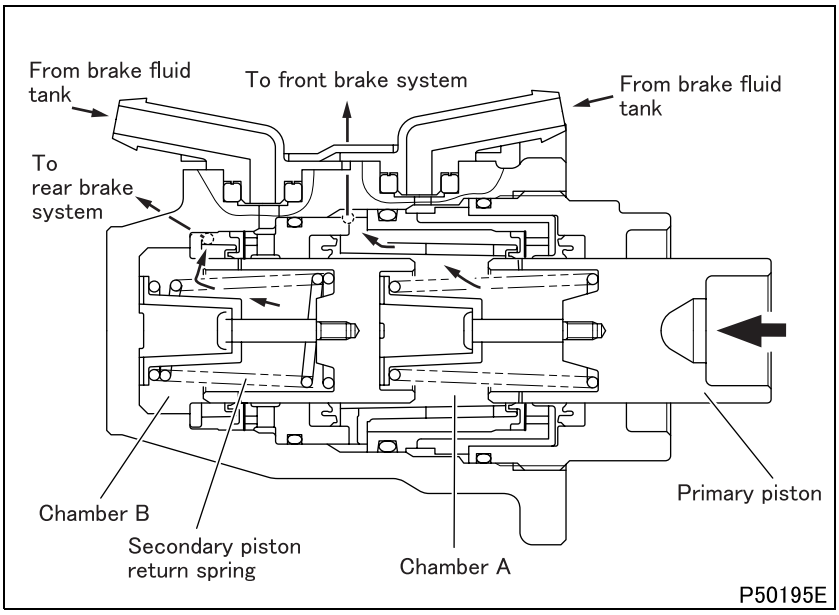
- The brake master cylinder continues to supply fluid into the pressure intensifying cylinder, which in turn sends the increasing pressure to the wheel cylinders.
- When the brake pedal is released, pressure fluid in the large-bore chamber flows through the valve seal, the back of the piston guide seal, and to the brake master cylinder.



4.3 Brake master cylinder

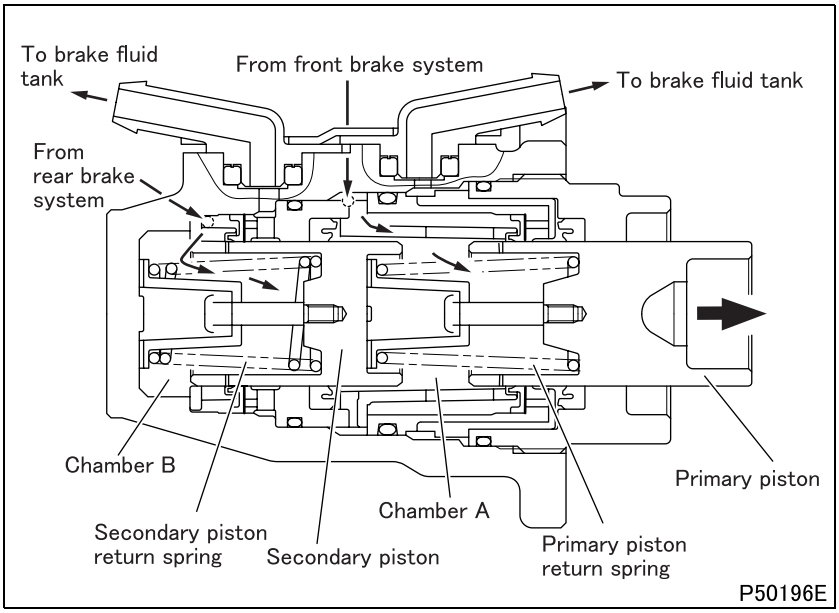
(1) When not in operation

- With the brake pedal released, the primary and secondary pistons are held to the right by the forces of the primary and secondary piston return springs respectively.
- Chambers **A** and **B** are open to the brake fluid tank.



(2) When brake pedal is depressed

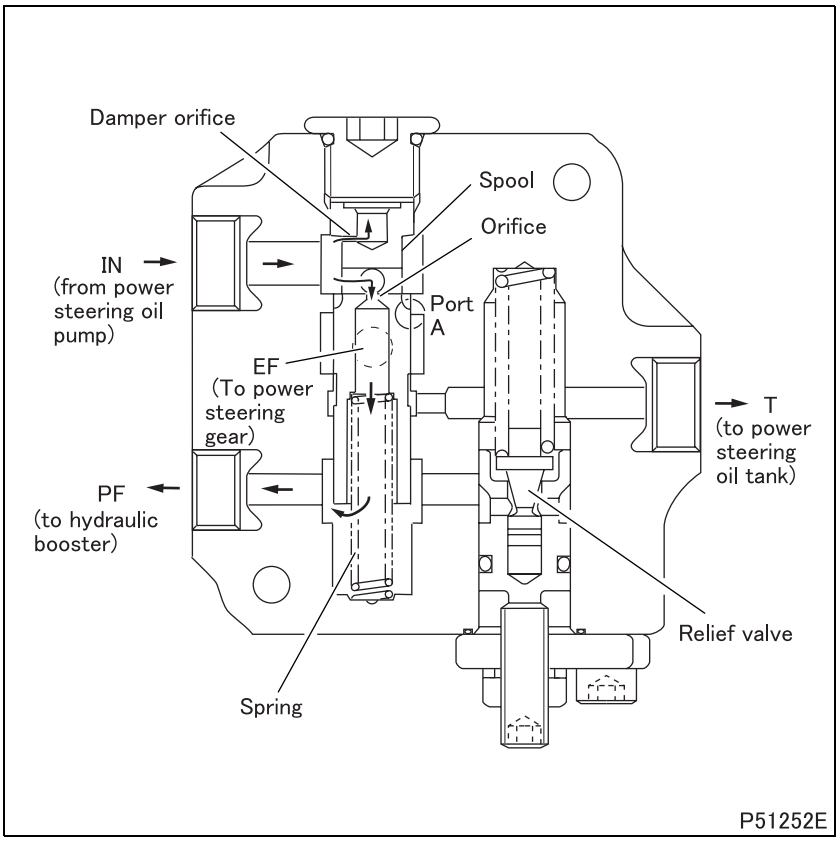
- As the brake pedal is depressed, the primary piston is pushed via the push rod.
- The secondary piston return spring is compressed, and the passages from chambers **A** and **B** to the brake fluid tank are blocked.
- As the brake pedal is depressed further, the primary piston is pushed. Fluid pressure builds up in chambers **A** and **B**, and is sent to the front and rear brake systems respectively.
- When fluid leakage occurs in either the front or rear brake system, the master cylinder operates basically in the same manner as the master cylinder with the vacuum booster.



(3) When brake pedal is released

- As the brake pedal is released and the push rod returns to the original position, the primary piston return spring pushes back the primary piston. Chamber **A** restores the original volume and the pressure in the chamber drops accordingly.
- The secondary piston return spring pushes back the secondary piston. Chamber **B** restores the original volume and pressure.
- Chambers **A** and **B** open up to the brake fluid tank.
- Pressure fluid in the front and rear brake lines flows back into chambers **A** and **B**.

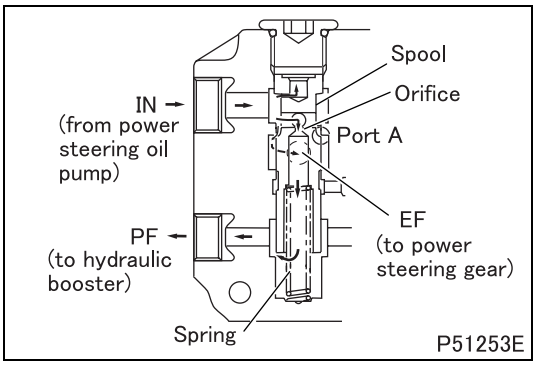
5. Flow Priority Valve



- When brakes are applied hard while the steering wheel is turned, the flow priority valve dampens the associated steering shock by appropriately distributing the flow from the power steering oil pump between the hydraulic booster and the power steering gear.

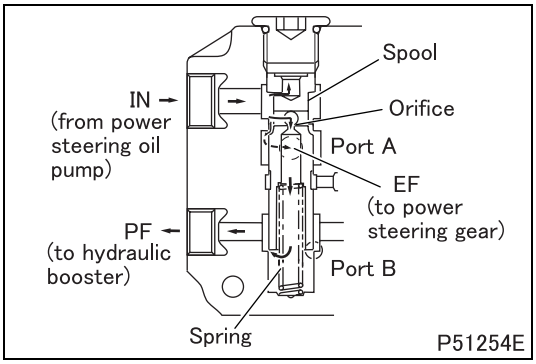
5.1 When pump output is at or below regulated flow rate

- The power steering oil pump output flows through the orifice and to the hydraulic booster.
- The pressure difference across the orifice acts on the spool which is then pushed down against the spring. However, port **A** remains blocked by the spool. As a result, the full flow from the pump is directed to PF.



5.2 When pump output exceeds regulated flow rate

- When the pump output exceeds the regulated flow rate, the pressure difference across the orifice becomes greater and acts on the spool such that the spool is pushed down against the spring until port **A** opens. Excess flow is directed through port **A** and into EF.
- In this state, if the hydraulic booster is operated and a greater flow is demanded by PF line (PF pressure > EF pressure), the spool moves to reduce the opening of port **A** so that the required pressure and the regulated flow rate are both achieved.



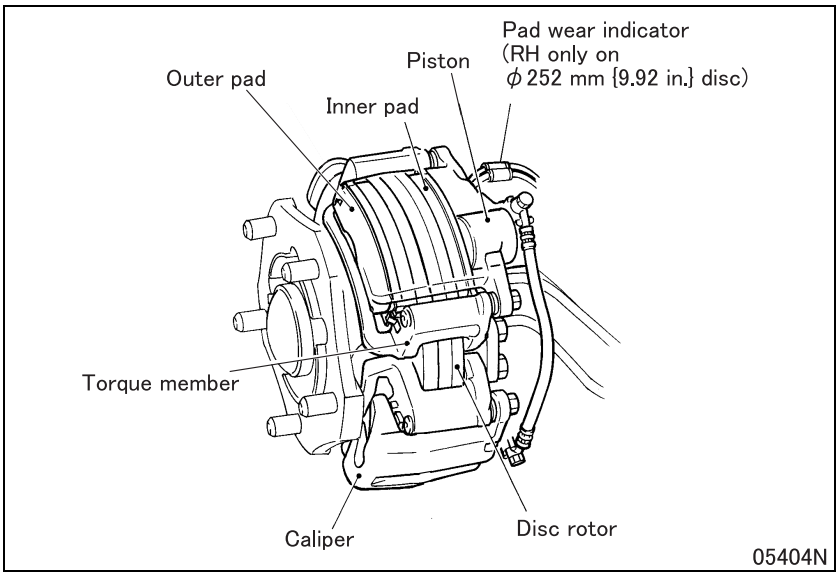
5.3 When power steering gear (EF line) is operated

- When power steering gear (EF line) is operated and a greater flow is demanded by EF line (PF pressure < EF pressure), the pressure difference across the orifice acts on the spool such that the spool is pushed down against the spring until the opening of port **B** is reduced. As a result, the required pressure and the regulated flow rate are both achieved.

5.4 When hydraulic booster (PF line) and power steering gear (EF line) are both operated

- When the hydraulic booster (PF line) and the power steering gear (EF line) are both operated and greater flows are demanded by these lines, the spool is moved against the spring such that the openings of ports **A** and **B** are appropriately balanced to achieve the regulated flow rate.

6. Front Disc Brake

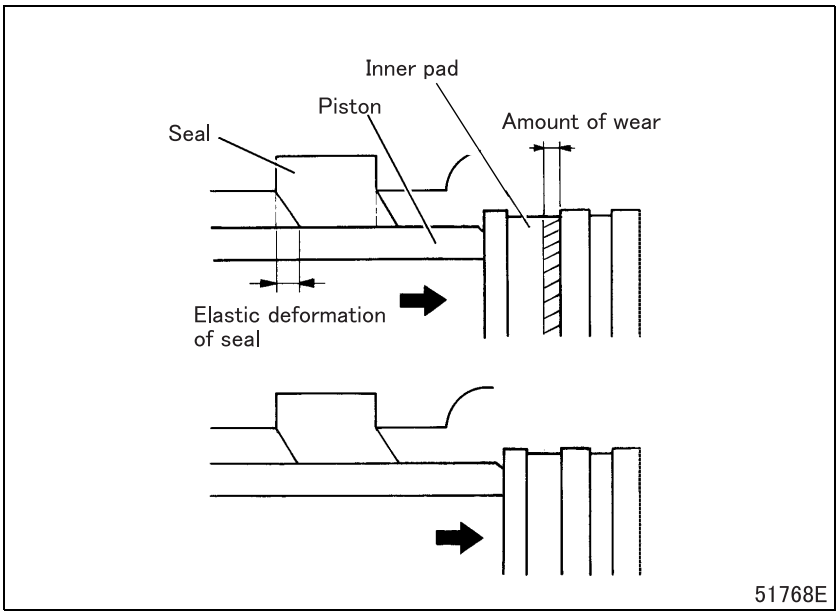


- The front disc brake uses a twin floating-type calipers.
- The caliper houses one each of cylinder and piston. Stopping power is generated by squeezing the disc rotor between the pads, with the outer pad pressed against the disc rotor by reaction.
- The inner pad is equipped with wear indicator which serves to indicate replacement timing for both the inner and outer pads.
- The front disc brake is equipped with a self-adjusting mechanism to compensate for pad wear and maintain the correct clearances between the disc rotor and the inner and outer pads. The adjustment is made each time braking is performed.

6.1 Self-adjusting mechanism

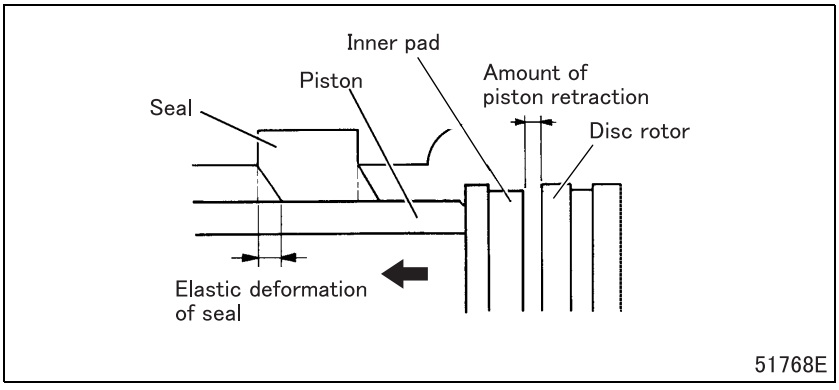
(1) Operation

(1.1) When brake pedal is depressed



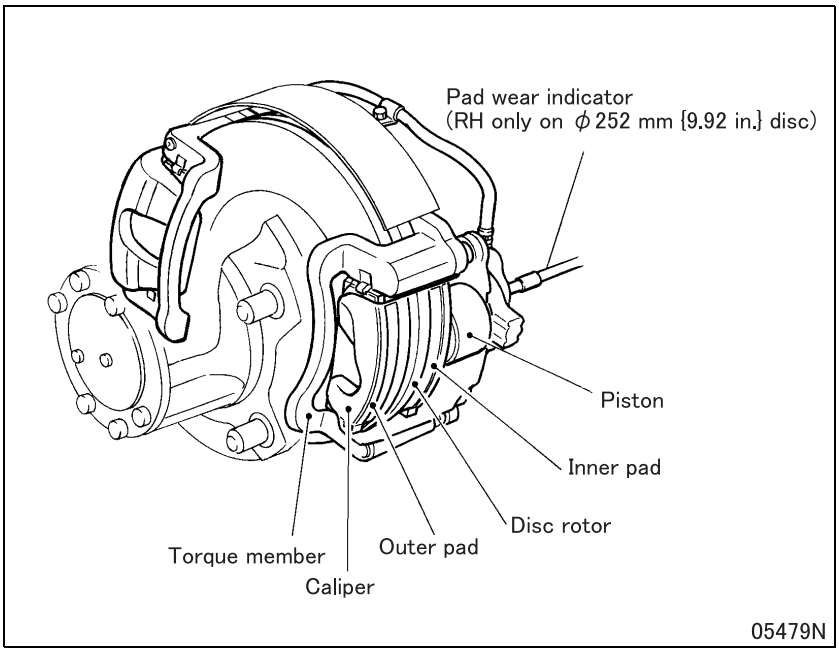
- The piston extends in excess of the seal's elastic deformation by the amount of inner pad wear (shown hatched).

(1.2) When brake pedal is released



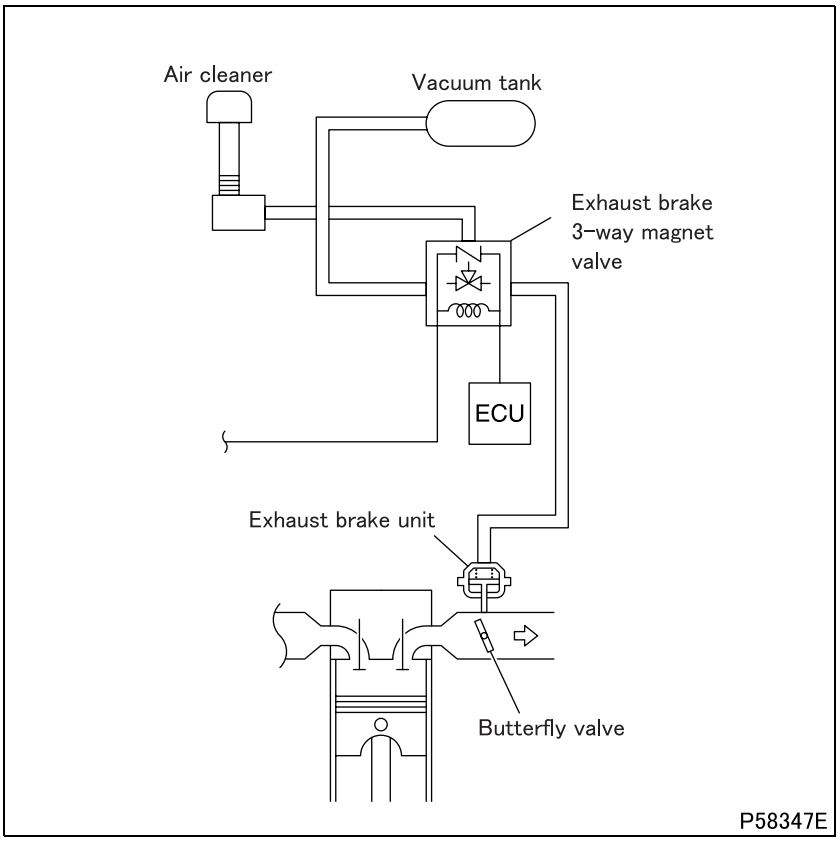
- The piston retracts as much as the amount of the seal's elastic deformation, thus maintaining the correct clearance between the disc rotor and the inner pad.

7. Rear Disc Brake



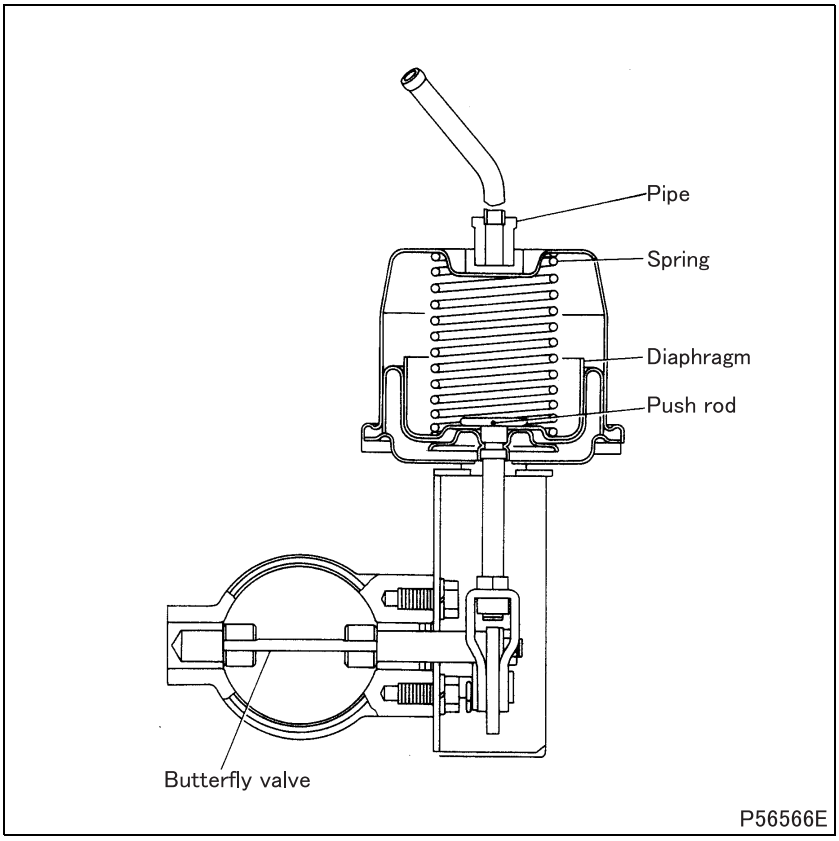
- The rear disc brake uses a twin floating-type calipers.
- The caliper houses one each of cylinder and piston. Stopping power is generated by squeezing the disc rotor between the pads, with the outer pad pressed against the disc rotor by reaction.
- The inner pad is equipped with wear indicator which serves to indicate replacement timing for both the inner and outer pads.
- The rear disc brake is equipped with a self-adjusting mechanism to compensate for pad wear and maintain the correct clearances between the disc rotor and the inner and outer pads. The adjustment is made each time braking is performed.
- The self-adjusting mechanism operates in the same manner as that of the front disc brake.

8. Exhaust Brake System



- The exhaust brake system provides stopping power by closing the exhaust piping. Specifically, pressure builds up in the blocked exhaust piping, which then is used to resist the pistons as they move to discharge exhaust in the exhaust stroke.
- The exhaust brake system supplements the foot brake. It is equipped with the exhaust brake unit incorporating a butterfly valve.
- When the exhaust brake switch is turned ON, the excitation winding within the exhaust brake 3-way magnet valve is magnetized. This closes the atmospheric pressure valve while opening the vacuum valve. Vacuum in the vacuum tank acts on the exhaust brake unit, closing the butterfly valve and bringing the exhaust braking in operation.

8.1 Exhaust brake unit (power chamber)



Wheel Brake

Possible causes	Symptoms	Brake application one sided					Insufficient stopping power	Reduced pedal travel	Noise and shock when brake pedal de-pressed		Reference Gr
		Brake drag (slow disengagement after pedal release)	Stopping power different from right to left	Unstable stopping power	Locking point varies	Other			Continuous noise during brake application (at low vehicle speed)	Other	
Wheel brake	Backing plate surface rough	O		O							
	Backing plate deformed or incorrectly installed			O							
	Lubricant or moisture on brake pad surface		O		O						
	Deterioration or incorrect material used for brake pad		O								
	Brake pad unevenly worn or with rough surface		O								
	Fade (pad surface deterioration)				O						
	Brake pad worn to limit								O		
	Incorrect contact of brake pad		O		O		O				
	Disc rotor worn unevenly		O								
	Disc rotor deformed			O							
	Disc rotor worn				O						
	Disc rotor surface rough						O				
	Disc rotor inaccurately machined									O	
	Movable parts insufficiently lubricated									O	

Possible causes \ Symptoms		Brake application one sided							Noise and shock when brake pedal de-pressed		Reference Gr
		Brake drag (slow disengagement after pedal release)	Stopping power different from right to left	Unstable stopping power	Locking point varies	Other	Insufficient stopping power	Reduced pedal travel	Continuous noise during brake application (at low vehicle speed)	Other	
Brake pedal	Incorrect pedal travel						O				
	Incorrectly adjusted, too much play							O			
Brake fluid	Fluid level low							O			
	Fluid leakage							O			
	Air ingress							O			
	Vapor lock							O			
Vacuum system	Vacuum drop						O				
Vacuum booster	Faulty						O	O			
Hydraulic booster	Faulty hydraulic booster						O	O			
	Faulty piston cup							O			
Tire	Tire pressure uneven between wheels					O					Gr31
	Different tire sizes from left to right					O					
Axle	Wheel hub bearing incorrectly adjusted					O			O		Gr26, 27
	Wheelbase different from left to right					O					
	Incorrect wheel alignment					O					Gr26

Possible causes \ Symptoms		Brake noise			Judder	Abnormal brake pedal return	Brake drag	Reference Gr
		Noisy when vehicle is new, or after brake lining/pad replacement	Brakes used under severe conditions	Other				
Wheel brake	Lubricant or moisture on brake pad surface		O					
	Wear powder attached on brake pad			O				
	Brake pad worn			O				
	Incorrect contact of brake pad	O						
	Disc rotor glazed		O					
	Disc rotor thickness uneven				O			
Brake pedal	Pedal play insufficient						O	
	Linkage rusted or deformed					O		
	Return spring fatigued or broken					O		
	Vacuum/hydraulic booster operating rod thrust					O		
Brake master cylinder	Faulty piston cup						O	
Axle	Wheel hub bearing incorrectly adjusted			O	O			Gr26, 27
	King pin bushing worn				O			Gr26

Exhaust Brake

Symptoms / Possible causes		Exhaust brake not effective	Exhaust brake does not disengage	Reference Gr
Vacuum system	Insufficient vacuum	O		
	Collapsed piping	O		
Faulty 3-way magnet valve		O	O	Gr54
Exhaust brake unit	Faulty valve	O	O	
	Stuck valve shaft	O	O	
	Faulty valve chamber	O		
Faulty electric system		O	O	Gr54

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Replacement of Brake Fluid

- Brake fluid is shared by the brake and clutch systems, and is divided in the brake fluid tank into the two systems. This section describes the replacement of the brake fluid for the brake system. In order to completely replace the brake fluid, the brake fluid in the clutch system should also be replaced.

Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
–	Air bleeder	5.8 to 8.8 {4.3 to 6.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required

WARNING ⚠

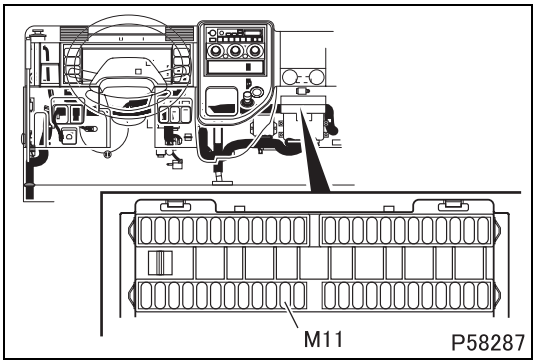
- **Be sure to use new brake fluid. Do not mix it with brake fluid of different properties or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of FUSO Brake Fluid, causing the boiling point to drop as well as the brake rubber parts to swell. Faulty operation of the brake will result.**
- **Ensure that no foreign matter or water enter into the brake fluid when refilling it, as they will cause faulty brake operation.**
- **Use a mug exclusively kept for the specified brake fluid. This ensures that no brake fluid of different properties or mineral oil enter into the system.**

CAUTION ⚠

- **Brake fluid is corrosive on paint work. Be careful not to spill it onto the paint work. If brake fluid is spilled onto the paint work, immediately wipe it off.**

NOTE

- **During brake fluid replacement operation, a change in color of the brake fluid being discharged indicates that the old brake fluid in the system has been replaced with new brake fluid.**
- **During the replacement, be sure to keep the brake fluid level at the “MAX” mark on the tank.**



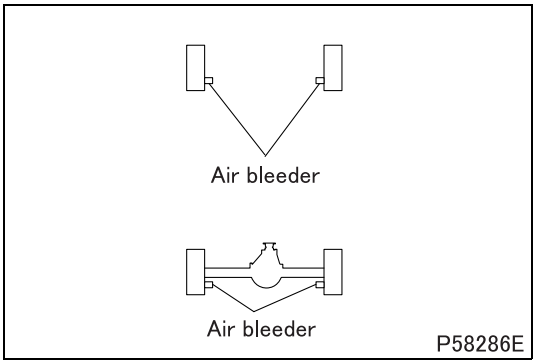
1.1 Work before replacement

- Remove the power fuse (M11) for the electronic control unit of antilock brake system.

WARNING ⚠

- **Do not install the power fuse until after the brake fluid replacement is completed. Otherwise, the initial system check starts, possibly causing air to enter into the secondary system (antilock brake system operating circuit).**

- On vehicles equipped with a vacuum booster, in order to ensure that the vacuum booster function properly, start the engine and keep it running at idle until the replacement is completed.
- On vehicles equipped with a hydraulic booster, the emergency pump is used for the replacement operation. Therefore, shut down the engine and turn the ignition switch ON.
- Install one end of a vinyl pipe onto each air bleeder. Place the loose end into a container.



1.2 Replacement of brake fluid

- Loosen each bleeder screw, and depress and release the brake pedal repetitively until brake fluid is no longer discharged from the pipes.
- While filling the brake fluid tank with new brake fluid up to the “MAX” mark, cycle the brake pedal repetitively until the old brake fluid being discharged is replaced with new brake fluid. Tighten each air bleeder to the specified torque.
- Proceed to Air Bleeding of Brake System.

2. Air Bleeding of Brake System

- Brake fluid is shared by the brake and clutch systems, and is divided in the brake fluid tank into the two systems. This section describes the air bleeding of the brake system.

Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
–	Air bleeder	5.8 to 8.8 {4.3 to 6.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required

WARNING ⚠

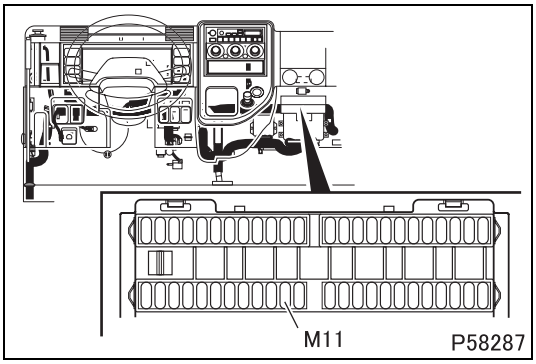
- **Be sure to use new brake fluid. Do not mix it with brake fluid of different properties or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of FUSO Brake Fluid, causing the boiling point to drop as well as the brake rubber parts to swell. Faulty operation of the brake will result.**
- **Ensure that no foreign matter or water enter into the brake fluid when refilling it, as they will cause faulty brake operation.**
- **Use a mug exclusively kept for the specified brake fluid. This ensures that no brake fluid of different properties or mineral oil enter into the system.**

CAUTION ⚠

- **Brake fluid is corrosive on paint work. Be careful not to spill it onto the paint work. If brake fluid is spilled onto the paint work, immediately wipe it off.**

NOTE

- **Brake fluid level drops during the air bleeding operation. Be sure to keep the brake fluid level at the "MAX" mark on the tank.**



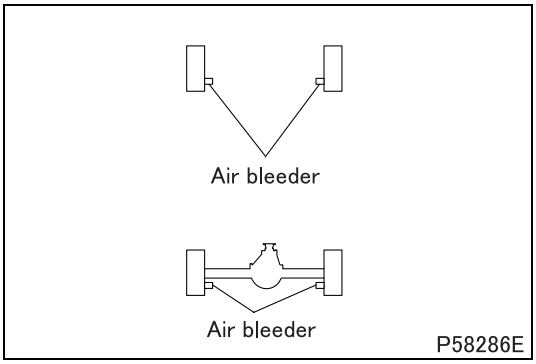
2.1 Work before replacement

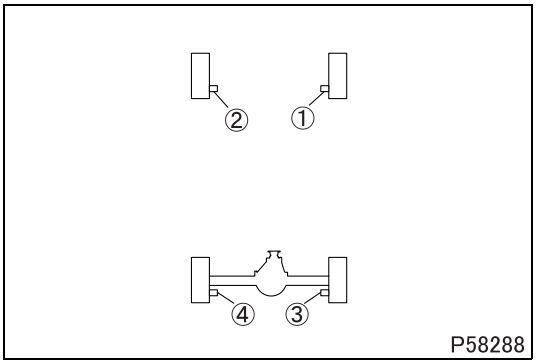
- Remove the power fuse (M11) for the electronic control unit of antilock brake system.

WARNING ⚠

- **Do not install the power fuse until after the air bleeding of the primary brake system (normal circuit) is completed. Otherwise, the initial system check starts, possibly causing air to enter into the secondary system (antilock brake system operating circuit).**

- On vehicles equipped with a vacuum booster, in order to ensure that the vacuum booster function properly, start the engine and keep it running at idle until the replacement is completed.
- On vehicles equipped with a hydraulic booster, the emergency pump is used for the replacement operation. Therefore, shut down the engine and turn the ignition switch ON.
- Install one end of a vinyl pipe onto each air bleeder. Place the loose end into a container.





2.2 Air bleeding of brake system

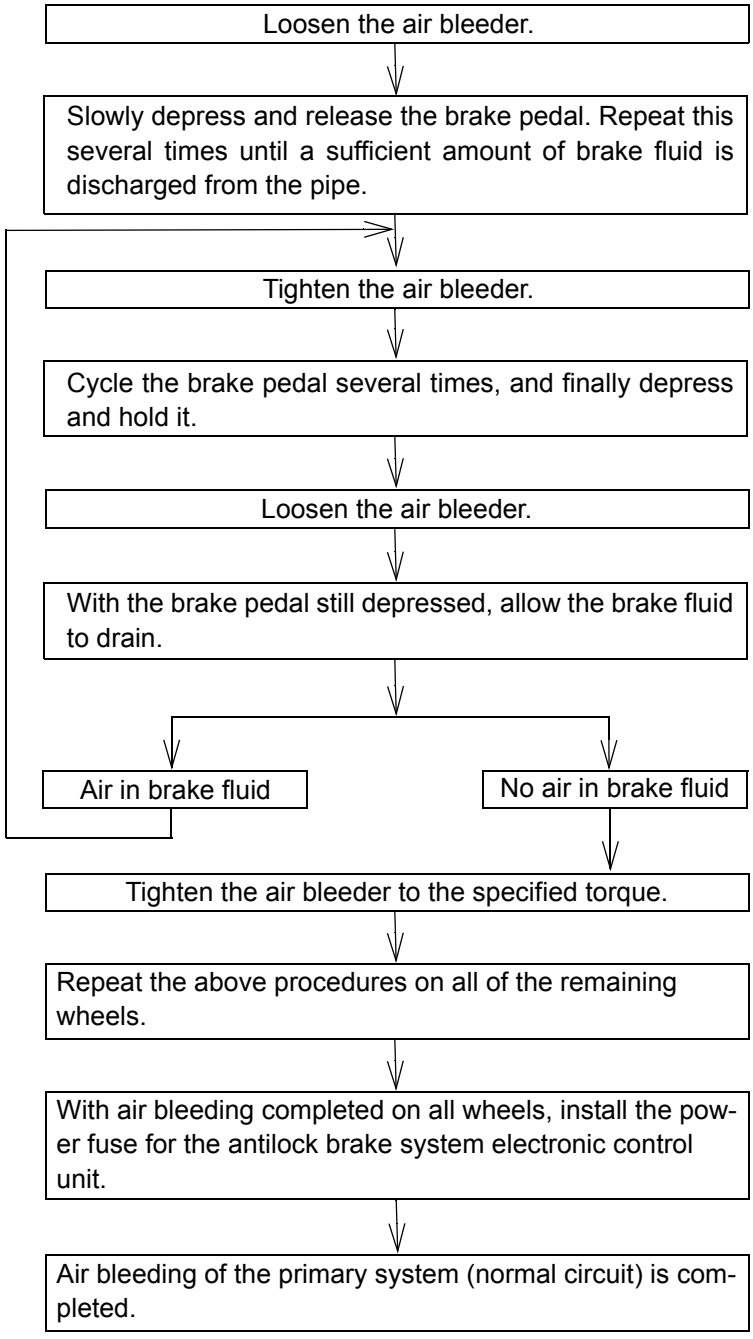
(1) Air bleeding of primary brake system (normal circuit)

- Perform the air bleeding sequence described below on each of the 4 wheels in the order of the following table.

Order of air bleeding	Brake system	Wheel
(1)	Front	Front right
(2)		Front left
(3)	Rear	Rear right
(4)		Rear left

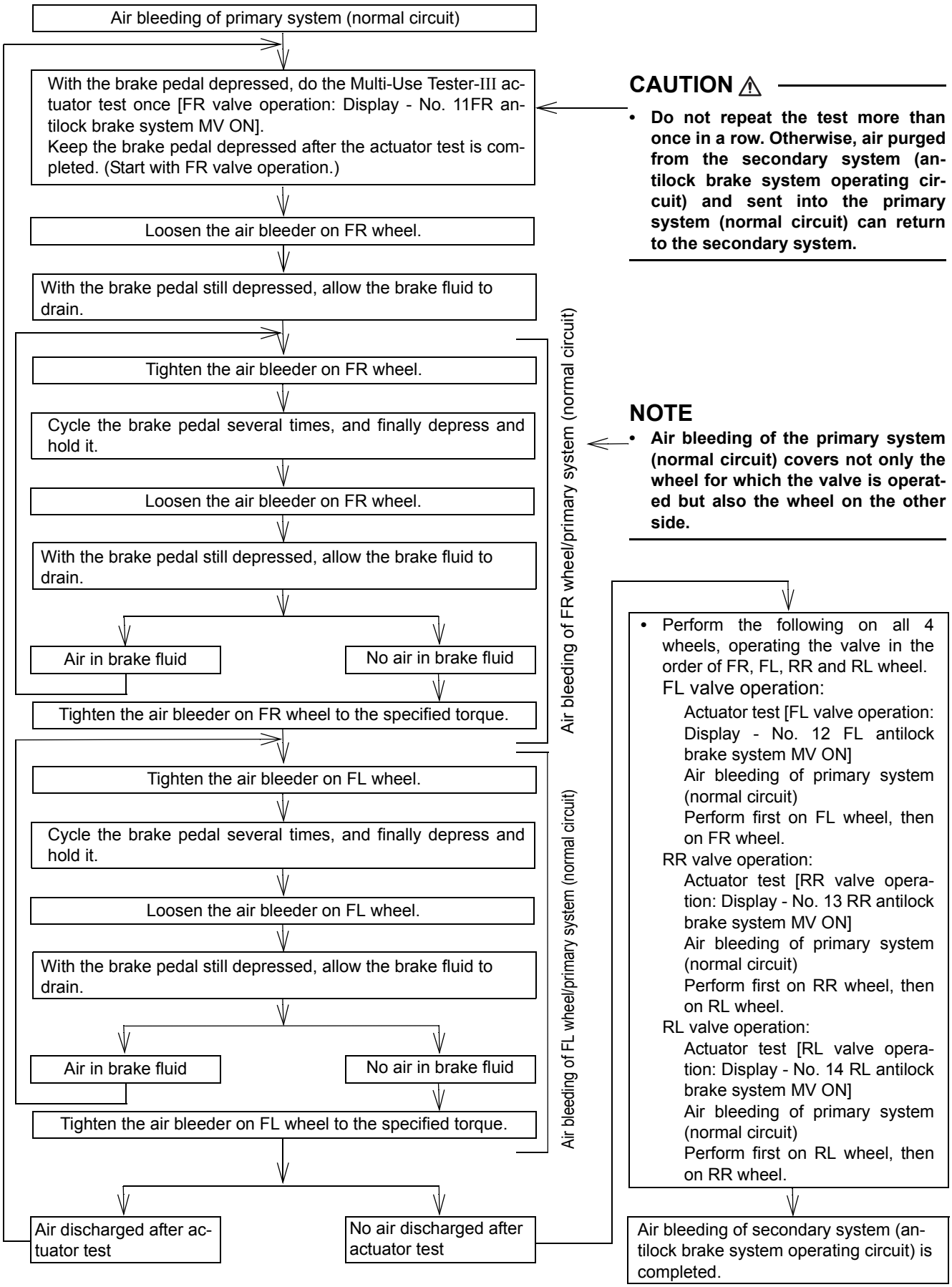
NOTE

- **If air has entered into the secondary brake system (antilock brake system operating circuit), bleed air from the secondary system after completing the air bleeding of the primary system (normal circuit).**
- **Normally, during air bleeding or hydraulic unit replacement operation, air cannot enter into the secondary system (antilock brake system operating circuit) which is filled with brake fluid and is closed off. Therefore, only the primary system (antilock brake system operating circuit) needs to be bled of air.**



(2) Air bleeding of secondary brake system (antilock brake system operating circuit)

- If the antilock brake system is operated with air still remaining in the primary brake system (normal circuit), air can enter into the secondary brake system (antilock brake system operating circuit).
- If air has entered into the secondary system (antilock brake system operating circuit), that air can also flow into the primary system (normal circuit) when the antilock brake system is operated, possibly causing the brake pedal stroke to extend.
- Multi-Use Tester-II or Multi-Use Tester-III actuator test (antilock brake system operating mode) is performed as part of the air bleeding procedures.



CAUTION ⚠

- **Do not repeat the test more than once in a row. Otherwise, air purged from the secondary system (antilock brake system operating circuit) and sent into the primary system (normal circuit) can return to the secondary system.**

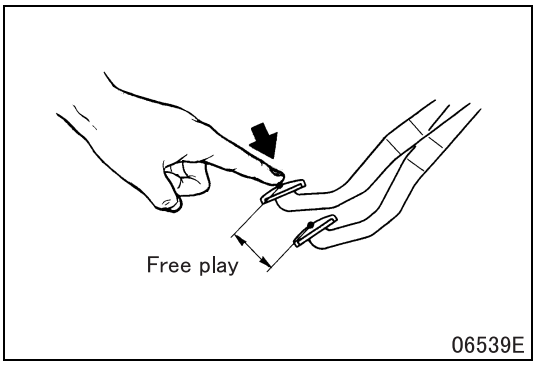
NOTE

- **Air bleeding of the primary system (normal circuit) covers not only the wheel for which the valve is operated but also the wheel on the other side.**

3. Inspection and Adjustment of Brake Pedal Free Play

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
–	Pedal free play	0.1 to 3 {0.0034 to 0.12}	–	Adjust



[Inspection]

- With the engine stationary, ensure that the pedal play conforms to the standard value.
- If the measured value does not conform to the standard value, adjust the installed height of the brake pedal.

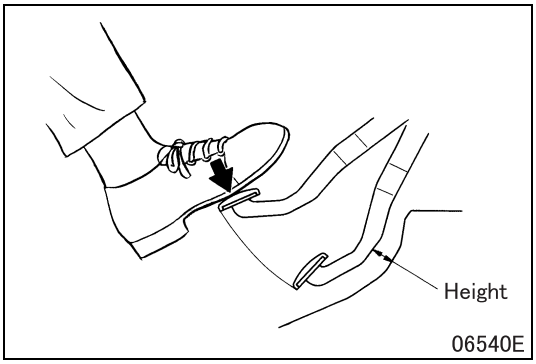
[Adjustment]

- For adjustment procedures, see “5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal.”

4. Inspection and Adjustment of Brake Pedal Pressed Height from Floor

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
–	Brake pedal height from floor (when depressed with a force of 490 N {110 lbf}	20 {0.79} or above	–	Adjust



[Inspection]

- With the engine running at idle, press the brake pedal with a force of 490 N {110 lbf} and measure the brake pedal height from the floor.
- If the measured value does not conform to the standard value, adjust the installed height of the brake pedal.

[Adjustment]

- For adjustment procedures, see “5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal.”

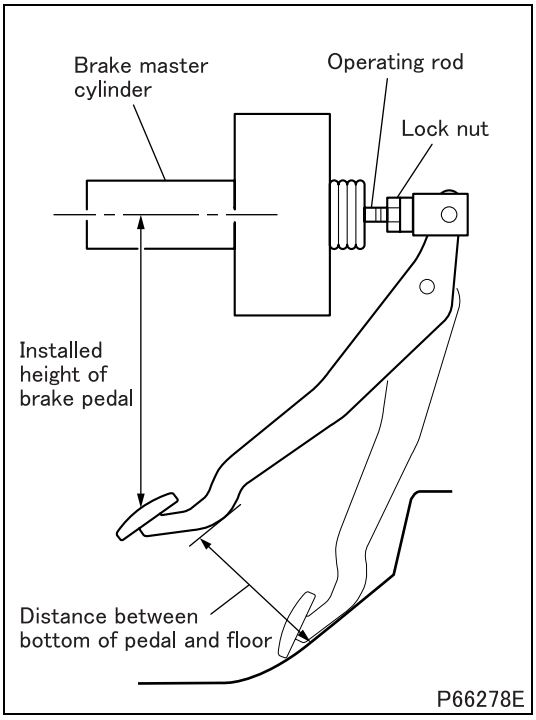
5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	Pedal full stroke (distance between bottom of pedal and floor with brake pedal released)	With vacuum booster	170 to 177 {6.68 to 6.97}	–	Adjust
		With hydraulic booster	173 to 181 {6.82 to 7.11}	–	
	Installed height of brake pedal (pedal pad center to brake master cylinder center)	With vacuum booster	233 ± 3 {9.17 ± 0.12}	–	Adjust
		With hydraulic booster	230.2 ± 3 {9.06 ± 0.12}	–	

Torque: N·m {lbf·ft}

Mark	Fastener		Torque value	Remarks
–	Lock nut	With vacuum booster	21.6 ± 2.94 {16 ± 2.2}	–
		With hydraulic booster	9.8 to 15.7 {7.2 to 12}	–



5.1 Inspection of pedal stroke

- With the brake pedal released, measure the distance between the bottom of pedal and the floor. If the measurement conforms to the standard value, the pedal full stroke is correctly adjusted.
- If the above measurement does not conform to the standard value, adjust the installed height of the brake pedal.

5.2 Adjustment of installed height of brake pedal

- After loosening the lock nut, turn the operating rod of the vacuum booster/hydraulic booster until the distance from the pedal pad center to the axis of brake master cylinder conforms to the standard value.
- Tighten the lock nut to the specified torque.
- With the lock nut correctly tightened, adjust the stop lamp switch and inspect the brake pedal play.

CAUTION ⚠

- **When the pedal is fully depressed, the vacuum booster/hydraulic booster operating rod functions as a stopper for the brake pedal.**
- **To prevent brakes from dragging, ensure that the threaded end of the stop lamp switch does not touch the brake pedal stopper.**

6. Inspection and Replacement of Disc Brake Pad

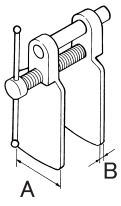
Service standards: mm {in}

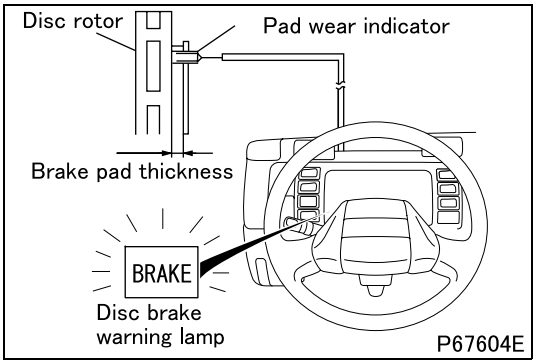
Location	Maintenance item	Standard value	Limit	Remedy
–	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
–	Pin bolt	40 to 50 {30 to 37}	–

Special tools: mm {in}

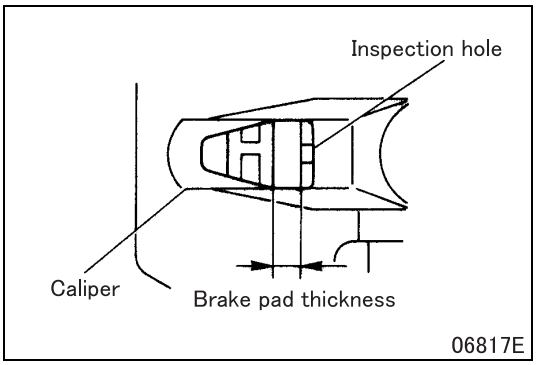
Mark	Tool name and shape	Part No.	Application
a	Piston expander A: 50 {1.97}, B: 5 {0.20}  06815	MB990520	Pressing piston during brake pad replacement



P67604E

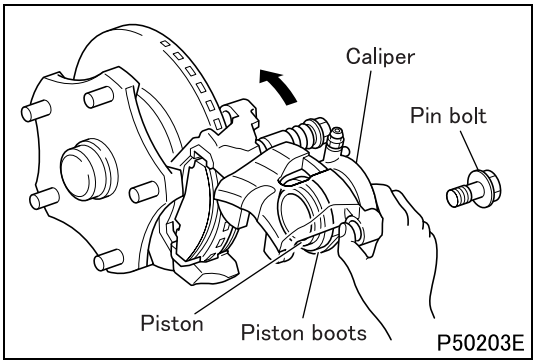
[Inspection]

- When a brake pad has worn down to a thickness of approximately 4 mm {0.16 in}, the pad wear indicator contacts the disc rotor. This breaks the circuit, illuminating the disc brake warning lamp on the meter cluster to tell the operator that the brake pads need replacement.



06817E

- Through the inspection hole in the caliper, measure the brake pad thickness. If the measured value is less than the limit, replace all of the brake pads on that axle with a new kit.



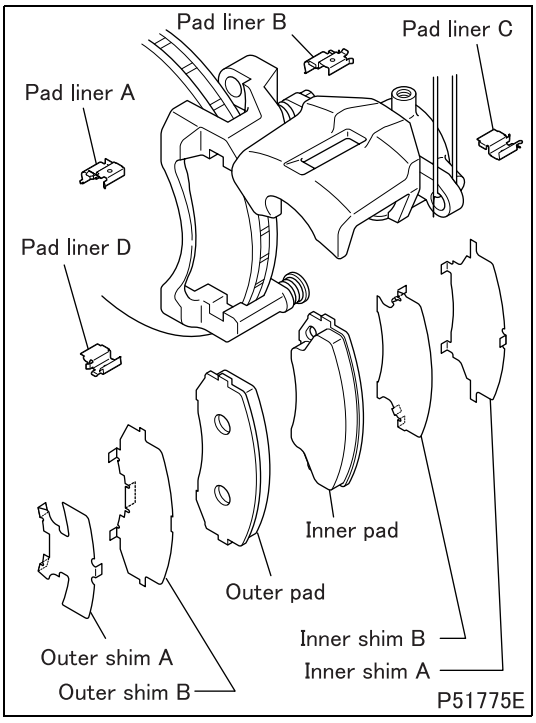
[Replacement]

- Remove the lower pin bolt. Flip the caliper upwards and suspend it in place using a wire or the like.

CAUTION ⚠

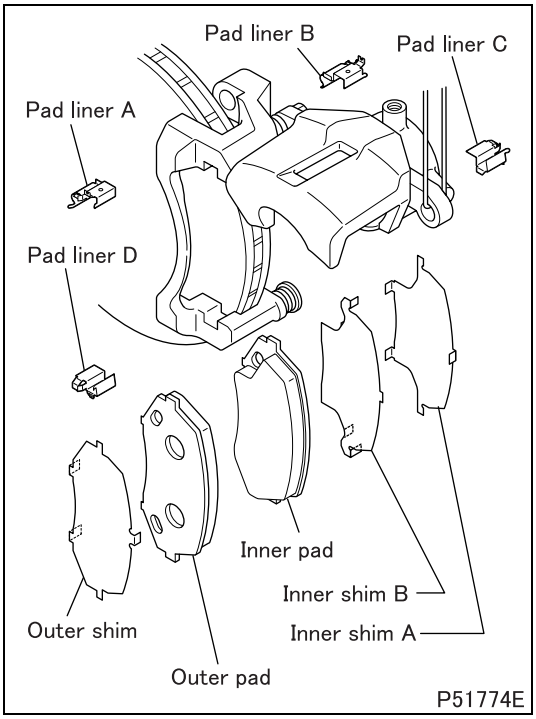
- **Suspend the caliper firmly in place so that it does not drop, which could result in stretching, squeezing or otherwise damaging the brake plumbing or harness.**

- Inspect the piston for fluid leakage. Inspect the piston boots for damage. Faulty parts must be replaced.
- Remove the following parts. Installation follows the removal procedure in reverse. When installing shims onto the pads, be sure to face them in the illustrated directions.



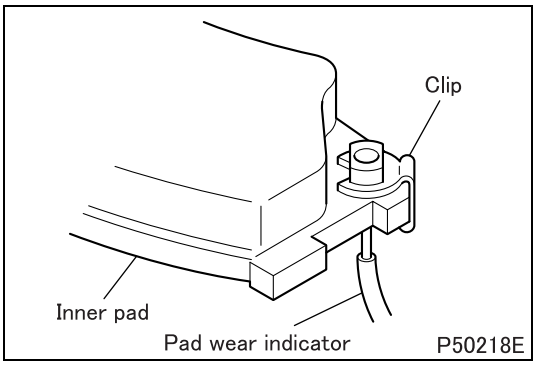
<ϕ235 mm {9.25 in} disc>

- The inner pad on the R/H wheel and the inner pad on the L/H wheel are both equipped with a pad wear indicator.



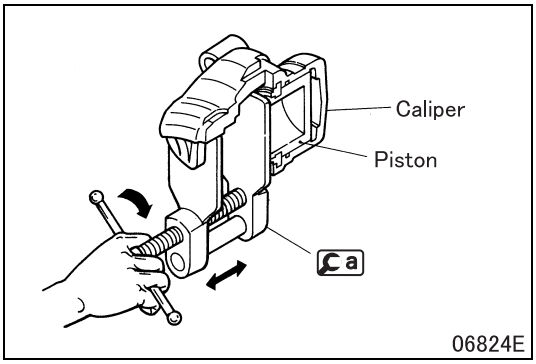
<ϕ252 mm {9.92 in} disc>

- The inner pad on the R/H wheel and the inner pad on the L/H wheel are both equipped with a pad wear indicator.

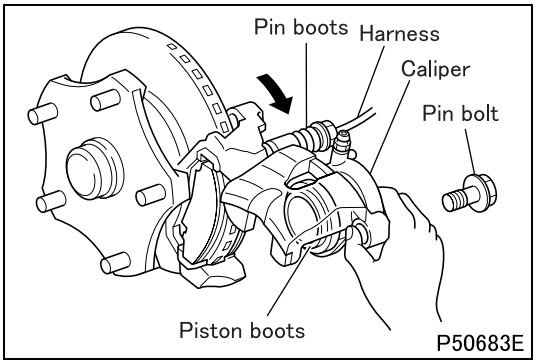


- Install a pad wear indicator onto the inner pad (included in the pad kit) using a clip (included in the pad wear indicator kit).

Pad wear indicator to be installed on	Inner pads on R/H and L/H wheels



- Using the piston expander [a], screw in the piston of the caliper until it bottoms on the back of the caliper.



- Move the caliper back to the original place while taking care not to damage the piston boots.
- Bleed the pin boots of air.
- Ensure that the pin boots are firmly attached into the groove on the slide pin.
- Tighten the pin bolt to the specified torque.
- Correctly route the harness(es) for the pad wear indicator(s).
- Measure the drag torque of the disc brake.
- Cycle the brake pedal several times, and check the brake fluid level in the tank. The fluid level should be at the “MAX” mark on the tank. Add brake fluid as required.

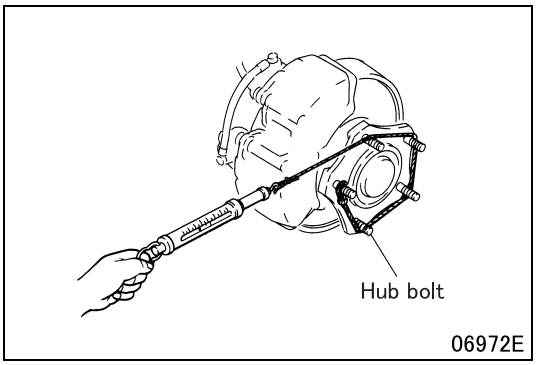
7. Measurement of Disc Brake Drag Torque

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Drag torque of disc brake (inertial force at hub bolts)	Approx. 5 sec. after releasing brake pedal	9.8 N·m {7.2 lbf·ft} or less	–	Inspect
		After turning disc rotor 10 revolutions	6.9 N·m {5.1 lbf·ft} or less	–	

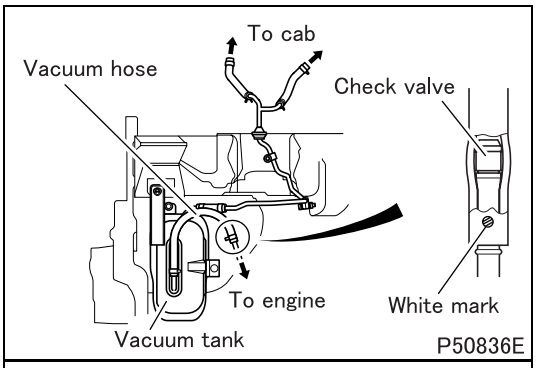
Table of inertial forces

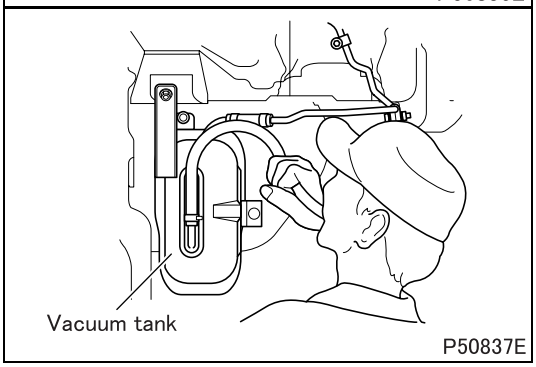
	Approx. 5 sec. after releasing brake pedal	After turning disc rotor 10 revolutions
Front	81 N {18.2 lbf}	57 N {12.8 lbf}
Rear	83 N {18.7 lbf}	59 N {13.3 lbf}



- Ensure that the starting torque of the wheel hub bearings conforms to the standard value.
- Using a spring balance, measure the inertial force at the hub bolts.
- The inertial force is calculated by the following formula.
  Inertial force = Dragging torque / (hub bolt P.C.D. / 2)
- If the measured inertial force conforms to the specified value, this means that the drag torque of the disc brake conforms to the standard value.
- If the measured value does not conform to the specified torque, check the sliding portions of the piston and piston seal.

8. Inspection of Check Valve in Vacuum Line Hose





NOTE

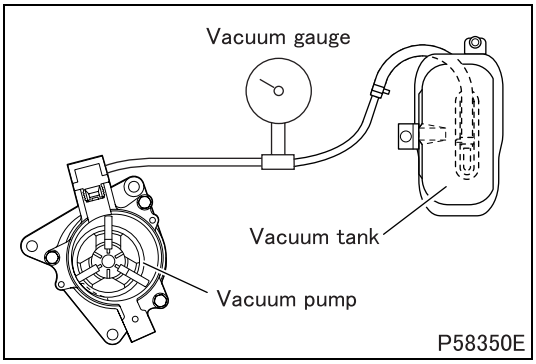
- **Be careful not to allow moisture into the check valve.**
- **During the inspection, ensure that the check valve opens as well as closes correctly.**
- **Do not attempt to remove the check valve from the vacuum hose.**

- Perform the following inspections. If the check valve does not pass both inspections, replace the check valve complete with the vacuum hose.
  - Blow into the hose. The check valve should close, preventing the breath from passing it.
  - Suck on the hose. The check valve should open, allowing air to pass.

9. Inspection of Vacuum Pump

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Time to reach vacuum of 80 kPa {23.6 inHg}	At 1500 rpm	Within 20 sec.	–	Replace
		At 3000 rpm	Within 12 sec.	–	



- Install a vacuum gauge between the vacuum tank and the vacuum pump.
- Start the engine and measure the time taken to reach the specified degree of vacuum.
- If the measured time does not conform to the standard value, disassemble and service the vacuum pump.

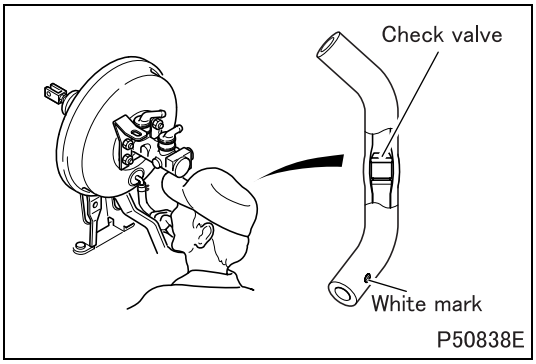
M E M O

10. Inspection of Vacuum Booster

- The vacuum booster can be inspected in 2 ways: one without using any tester and the other using a simplified tester. In either way, ensure that the brake piping and hosing and their connections are free of leakage, damage, or other faults.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Precision inspection (vacuum loss) (vacuum of 67 kPa {19.8 inHg}, 15 sec. after engine shutdown)	3.3 kPa {0.97 inHg} or less	–	Replace
–	Fluid pressure at vacuum of 67 kPa {19.8 inHg}	4360 kPa {630 psi} (pedal depressed with a force of 98 N {22.0 lbf})	–	Replace
		8800 kPa {1280 psi} (pedal depressed with a force of 295 N {66.3 lbf})	–	
–	Fluid pressure at vacuum of 0 kPa {0 inHg}	315 kPa {46 psi} (pedal depressed with a force of 98 N {22.0 lbf})	–	Replace
		1550 kPa {225 psi} (pedal depressed with a force of 295 N {66.3 lbf})	–	



10.1 Inspection of check valve in vacuum hose

CAUTION ⚠

- **Be careful not to allow moisture into the check valve.**
- **During the inspection, ensure that the check valve opens as well as closes correctly.**
- **Do not attempt to remove the check valve from the vacuum hose.**

- Start the engine and charge the vacuum tank with vacuum.
- Shut down the engine, and immediately remove the clamp that attaches the vacuum hose to the vacuum line.
- Blow into the hose. The check valve should close, preventing any air from passing through it.
- Apply suction to the hose while depressing the brake pedal. The check valve should immediately open, allowing air to pass.
- If any problem is discovered during these inspections, replace the check valve and vacuum hose.

10.2 Operational check of vacuum booster

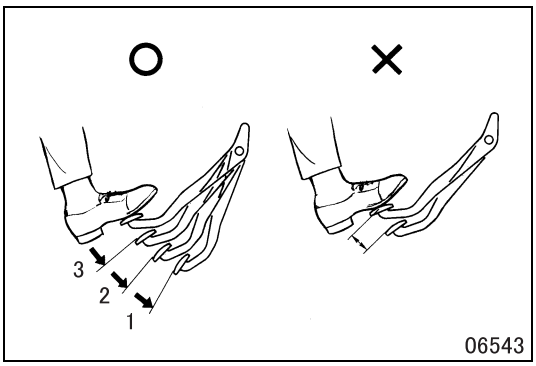
CAUTION ⚠

- **The vacuum booster operational checks described below are preliminary. If the vacuum booster continues to malfunction, remove the vacuum booster from the vehicle.**
- **If the vacuum booster is found to be faulty during the more detailed testing, return it to the manufacturer for repairs.**

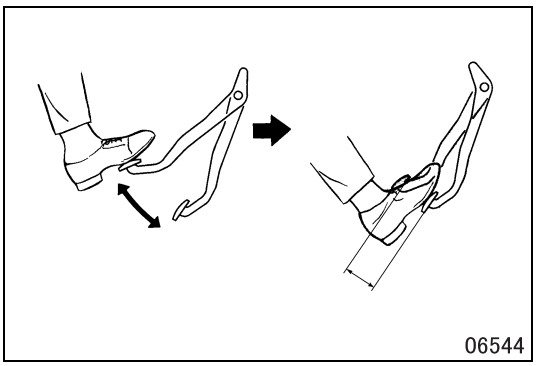
(1) Operational check without any tester

- Inspect the check valve in the vacuum hose for normal operation.

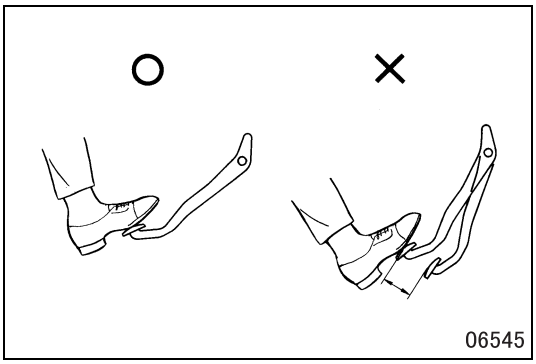
- Perform the checks described below. If any fault is found during these checks, inspect the following parts.
  - Vacuum booster
  - Vacuum pump



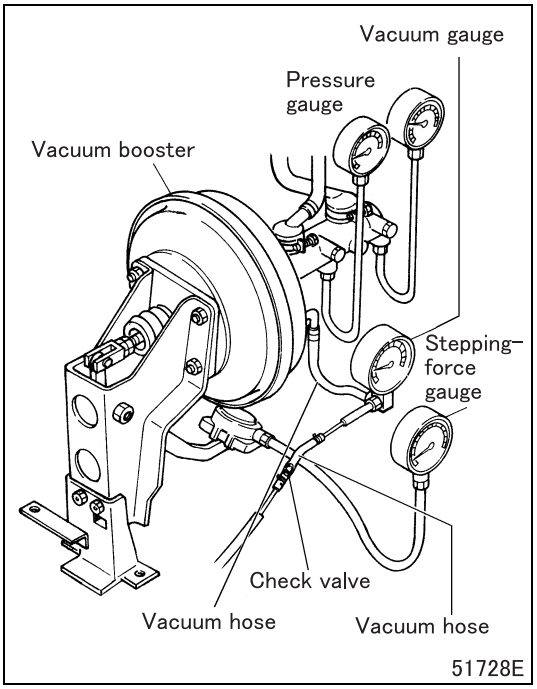
[Check 1]
- Start the engine and run it for 1 to 2 minutes. Shut down the engine.
- Depress the brake pedal repetitively with the normal stepping force.
- The pedal stroke should become smaller each time the pedal is depressed.



[Check 2]
- With the engine stationary, depress the brake pedal several times.
- With the brake pedal depressed, start the engine. The pedal should sink slightly.



[Check 3]
- With the engine running and the brake pedal depressed, shut down the engine.
- The brake pedal should maintain the same height for approximately 30 seconds.



(2) Operational check with a simplified tester

(2.1) Airtightness check

- Inspect the check valve in the vacuum hose for normal operation.
- Remove the vacuum hose from the vacuum booster and connect it to the vacuum gauge.
- Connect another hose (not equipped with a check valve) onto the vacuum booster and the vacuum gauge.
- Install 2 pressure gauges and 1 stepping-force gauge as illustrated. Bleed the pressure gauges of air.
- Perform the following checks. If any fault is encountered during these checks, inspect the vacuum booster.

[Check 1]

- Start the engine. When the reading on the vacuum gauge has reached 67 kPa {19.8 inHg}, shut down the engine.
- The vacuum lost in approximately 15 seconds of the engine stop should conform to the standard value.

[Check 2]

- Start the engine, and depress the brake pedal. When the reading on the vacuum gauge has reached 67 kPa {19.8 inHg}, shut down the engine.
- The vacuum lost in approximately 15 seconds of the engine stop should conform to the standard value.

(2.2) System characteristics check

- Perform the following system characteristics checks after the airtightness check described above is completed.
- Perform the following checks. If any fault is encountered during these checks, inspect the vacuum booster.

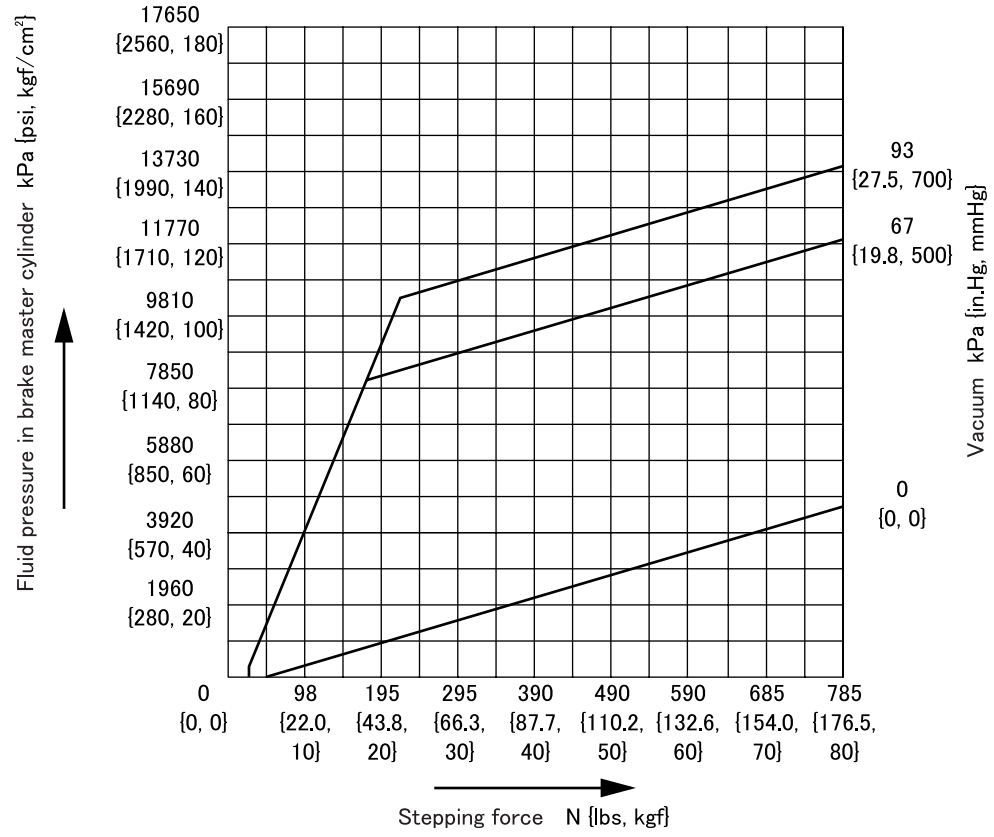
[Check 1]

- Start the engine. When the reading on the vacuum gauge has reached 67 kPa {19.8 inHg}, depress the brake pedal with the specified stepping forces.
- The fluid pressures indicated on the pressure gauges should conform to the specified values.

[Check 2]

- Start the engine. When the reading on the vacuum gauge shows zero pressure, depress the brake pedal with the specified stepping forces.
- The fluid pressures indicated on the pressure gauges should conform to the specified values.

(2.3) Vacuum booster performance graph



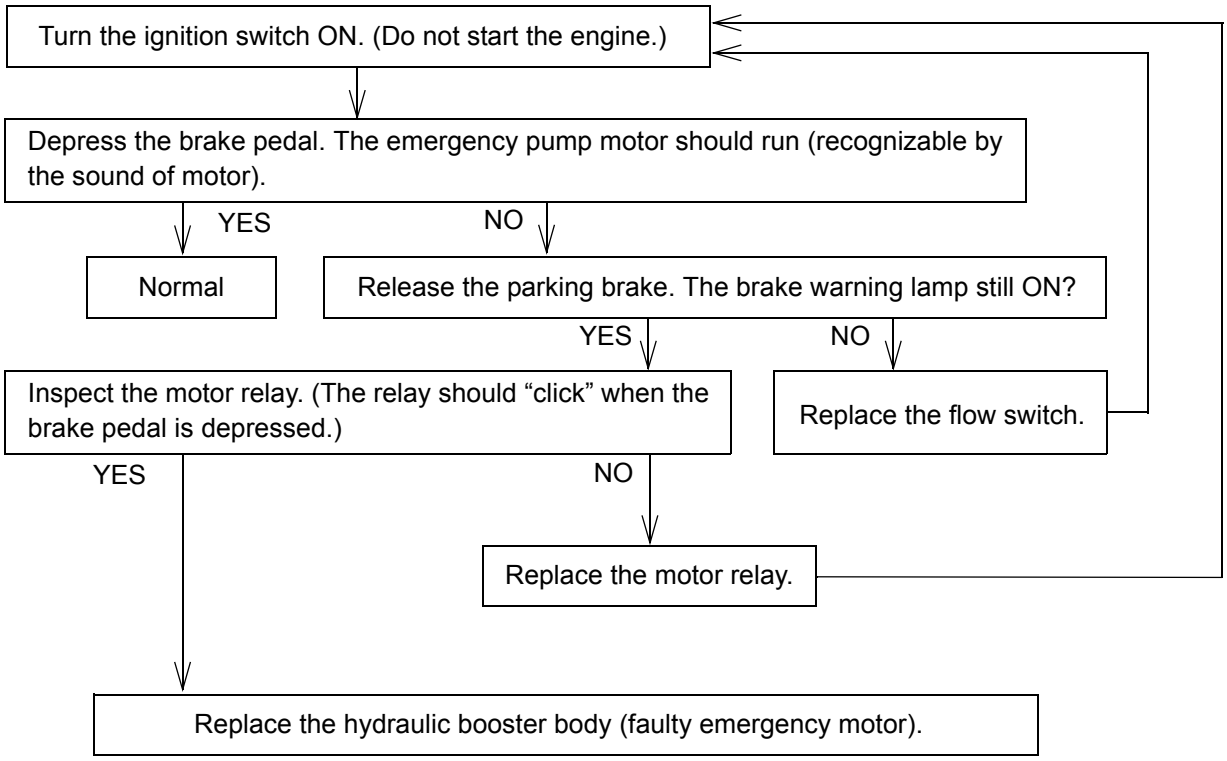
11. Inspection of Hydraulic Booster

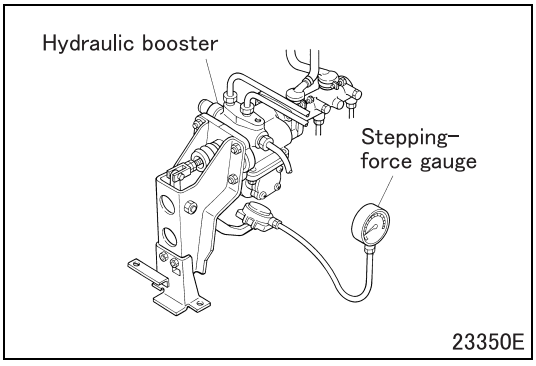
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Fluid pressure at power steering oil temperature of 60°C {140°F} or below	Pedal depressed with a force of 98 N {22.0 lbf)	4620 kPa {670 psi)	–	Replace
		Pedal depressed with a force of 295 N {66.3 lbf}	13600 kPa {1970 psi}	–	

11.1 Inspection of electric equipment

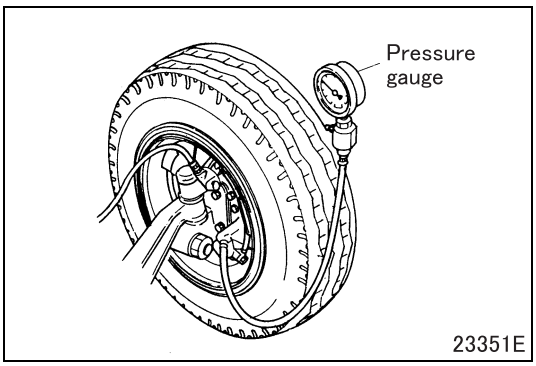
- Inspect in accordance with the following flow chart.
- Before inspection, park the vehicle on a flat surface, apply the parking brake firmly, and chock the wheels.





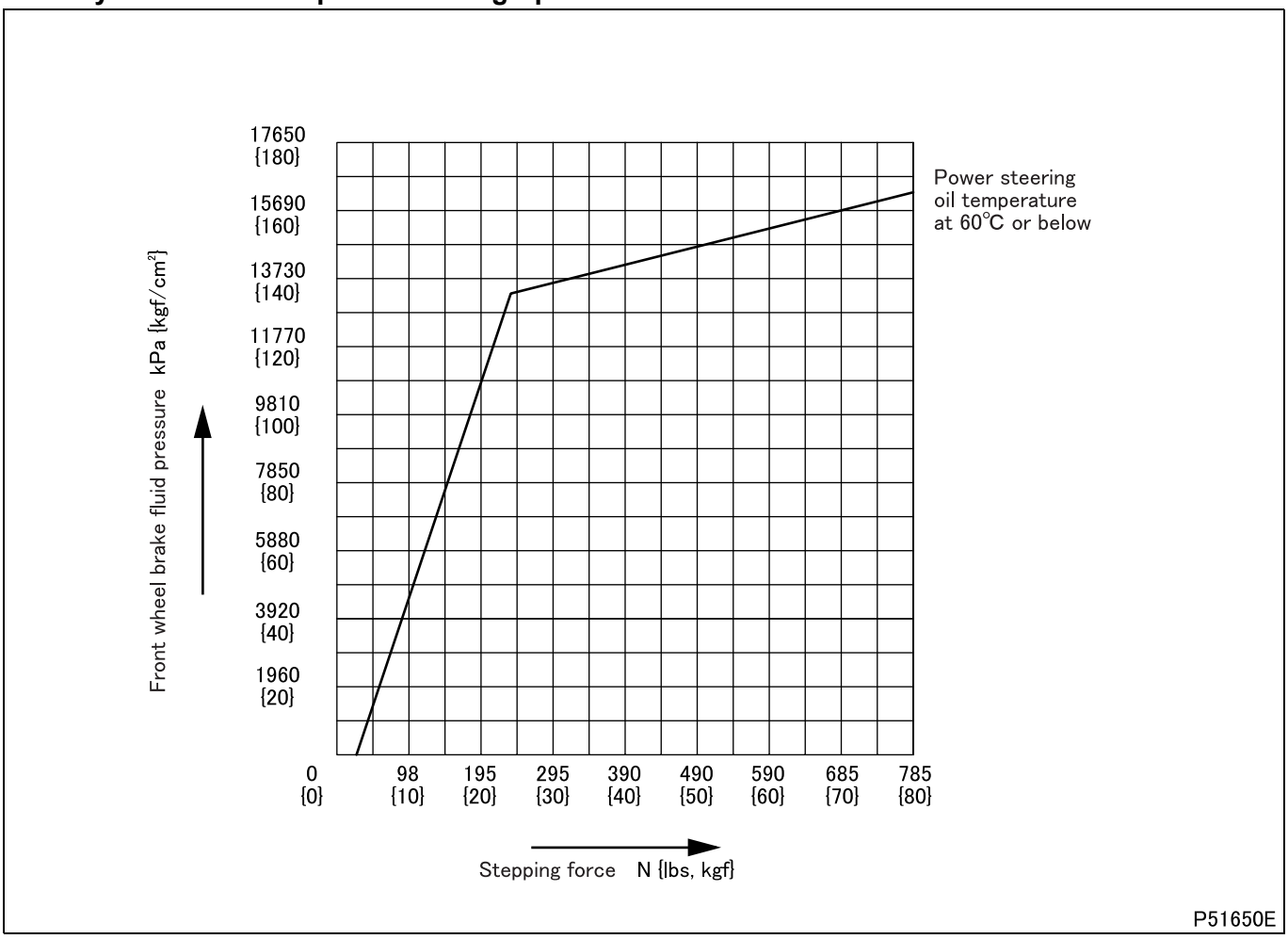
11.2 Functional check

- Install a stepping-force gauge onto the brake pedal. Remove an air bleeder from the front wheel brake, and install a pressure gauge. Bleed the gauge of air.
- Carry out performance test on the power steering system. Ensure that the system pressure is to specification.
- After confirming that the electric equipment has passed the inspection described above, depress the brake pedal with varying forces. The reading of the front wheel brake fluid pressure should follow the pressure line of the graph.

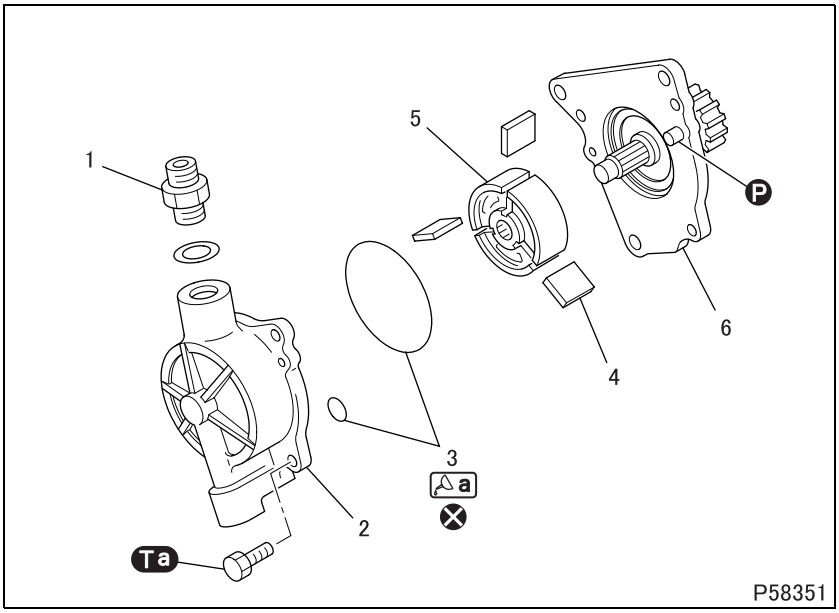


- If any fault is observed during these checks, replace the hydraulic booster.

11.3 Hydraulic booster performance graph



VACUUM PUMP



● **Disassembly sequence**

1 Check valve
2 Housing
3 O-ring
4 Vane
5 Rotor
6 Bracket

Ⓟ: Locating pin
⊗: Non-reusable parts

NOTE

- **For removal and installation procedures, see Gr11.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Time to reach vacuum of 80 kPa {23.6 inHg} (vacuum tank capacity: 10 L {11 qt})	At 1500 rpm	Within 20 sec.	–	Replace
		At 3000 rpm	Within 12 sec.	–	

Torque: N·m {lbf·ft}

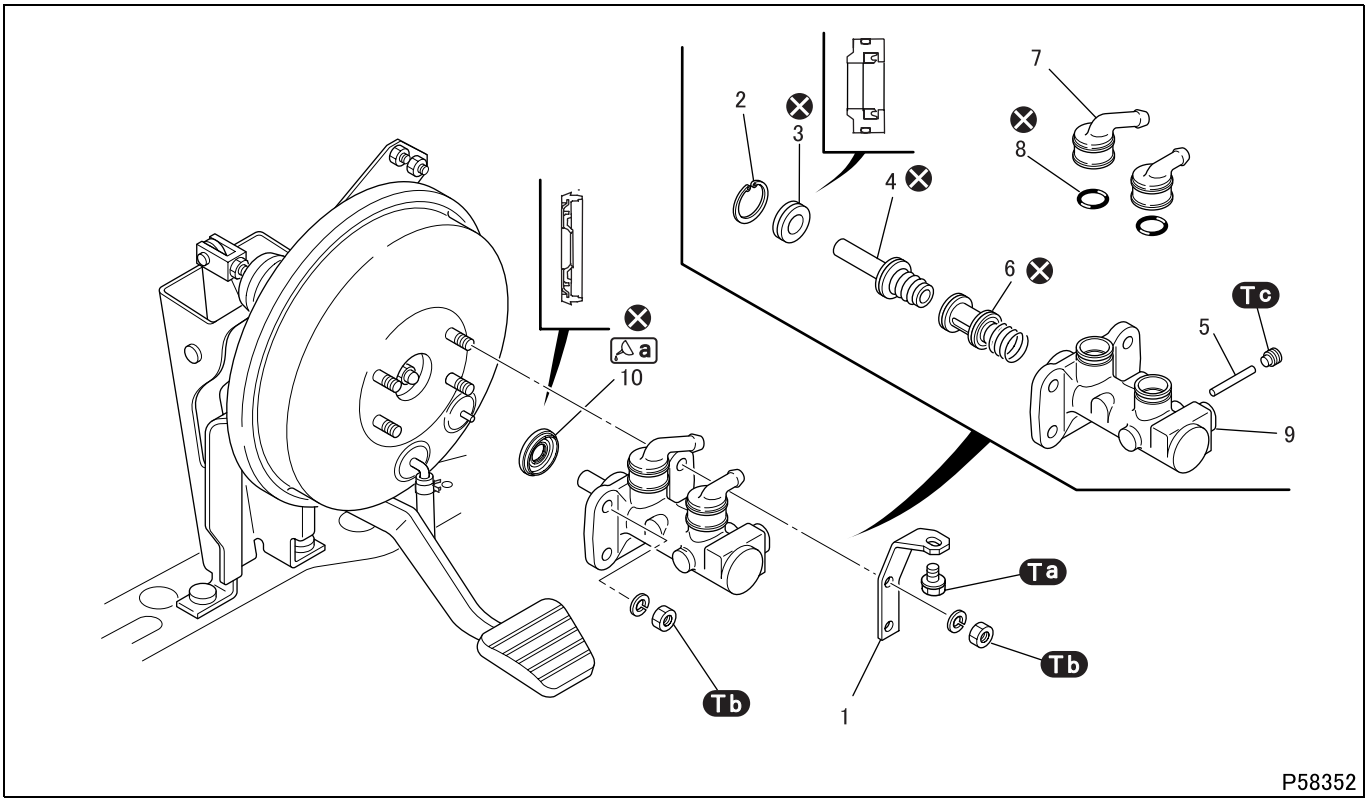
Mark	Fastener	Torque value	Remarks
Ta	Bolt (housing and bracket assembling)	8.8 ± 2 {6.5 ± 1.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

M E M O

BRAKE MASTER CYLINDER <WITH VACUUM BOOSTER>



● **Disassembly sequence**

1 Bracket
2 Retaining ring
3 Piston guide
4 Primary piston
5 Set pin
6 Secondary piston
7 Connector
8 O-ring
9 Cylinder body
10 Seal

⊗: Non-reusable parts

CAUTION ⚠

- **For cleaning, use brake fluid.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Master cylinder repair kit

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
4	Primary piston spring load	113.7 to 125.4 N {26 to 28 lbf}	110.7 N {25 lbf}	Replace
4, 6, 9	Clearance between primary and secondary pistons and cylinder body	0.02 to 0.10 {0.00079 to 0.0039}	0.2 {0.0079}	Replace
6	Secondary piston spring load	81.3 to 91.1 N {18 to 20 lbf}	79.4 N {18 lbf}	Replace

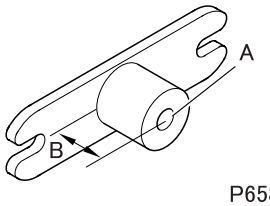
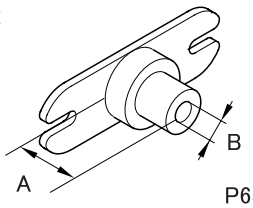
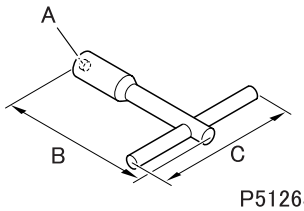
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Bolt (bracket mounting)	9 to 14 {6.6 to 10}	–
Tb	Nut (brake master cylinder mounting)	9.8 to 15.7 {7.2 to 12}	–
Tc	Screw (set pin mounting)	8.8 to 11.8 {6.5 to 8.7}	–

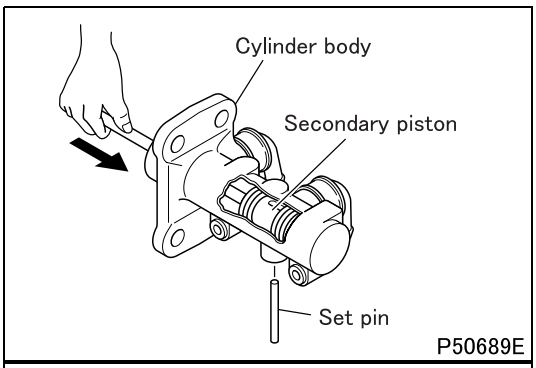
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Seal lips and outer periphery	Rubber grease	As required
	Seal ring groove		

Special tools: mm {in}

Mark	Tool name and shape	Part No.	Application
a	Support tool A: No. of splines: 23 B: 30 {1.18}  P65860	MK528895	Adjustment of vacuum booster push rod
b	Support tool for measurement A: 36 {1.42} B: ϕ11.5 {0.45}  P65861	MK528896	
c	Box spanner A: Width across flats: 8 B: 120 {4.72} C: 120 {4.72}  P51263	MB999062	

◆Removal procedure◆

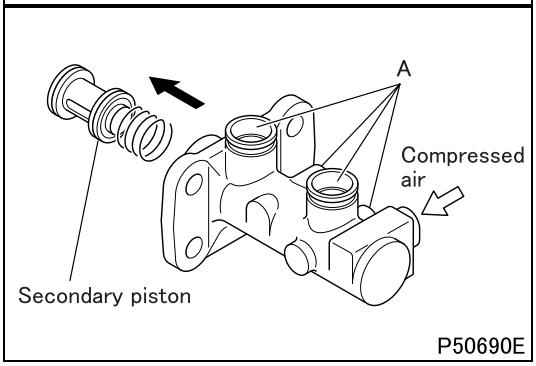


■ **Removal: Secondary piston**

- Position the cylinder body such that the set pin faces down. Using a rod or the like, compress the secondary piston to ease out the set pin. Be ready to catch the set pin when it falls out. Do not allow it to drop.

CAUTION ⚠

- **Do not allow the set pin to drop on the floor. This may damage the set pin.**

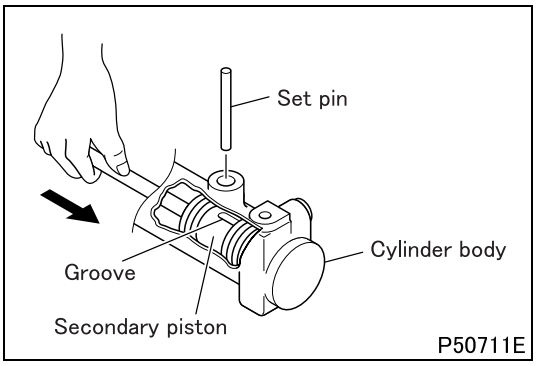


- With the ports marked **A** blocked, feed compressed air in the direction of the arrow, gradually increasing the pressure from zero until the secondary piston is ejected.

WARNING ⚠

- **Do not apply compressed air suddenly and at high pressure. The secondary piston may fly out with great force and cause a personal injury.**

◆Installation procedure◆

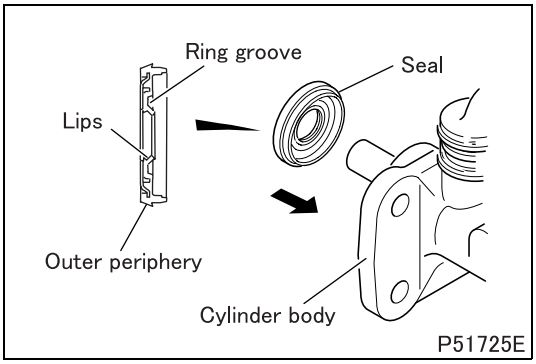


■ **Installation: Secondary piston**

- Position the cylinder body with the set pin hole facing up. Using a thin rod or similar tool, insert the secondary piston into the cylinder body. At the same time, try to insert the set pin.

NOTE

- **If necessary, rotate the secondary piston to align the groove on the piston with the set pin hole.**



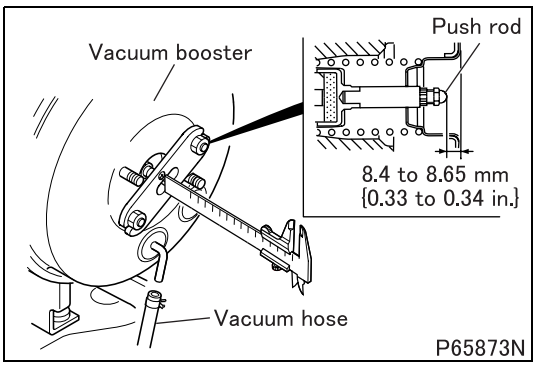
■ **Installation: Seal**

- Apply grease on the lips and outer periphery of the seal. Also, pack grease into the seal's ring groove. Then, face the seal in the illustrated direction before installing it onto the cylinder body.

CAUTION ⚠

- **Ensure that the seal is facing as shown in the illustration and is installed correctly, without roll-up or damage. An improperly installed seal will not hold vacuum.**

◆Work after installation◆



NOTE

- **If the brake master cylinder or the primary piston is replaced, be sure to inspect and, if required, adjust the illustrated distance between the push rod and the end of the brake pedal & vacuum booster.**

■ **Inspection: Brake pedal & vacuum booster**

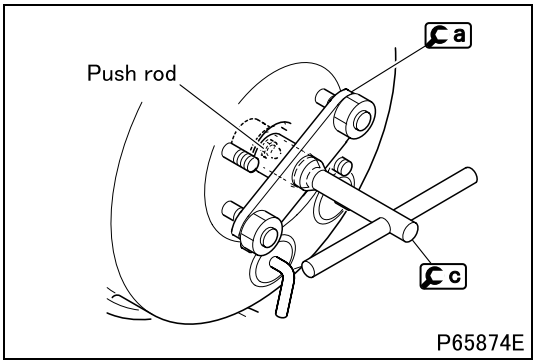
[Inspection]

- Remove the vacuum hose from the brake pedal & vacuum booster to fill the vacuum booster with the atmospheric pressure.

NOTE

- **The vacuum booster must be filled to atmospheric pressure to obtain accurate results from this inspection.**

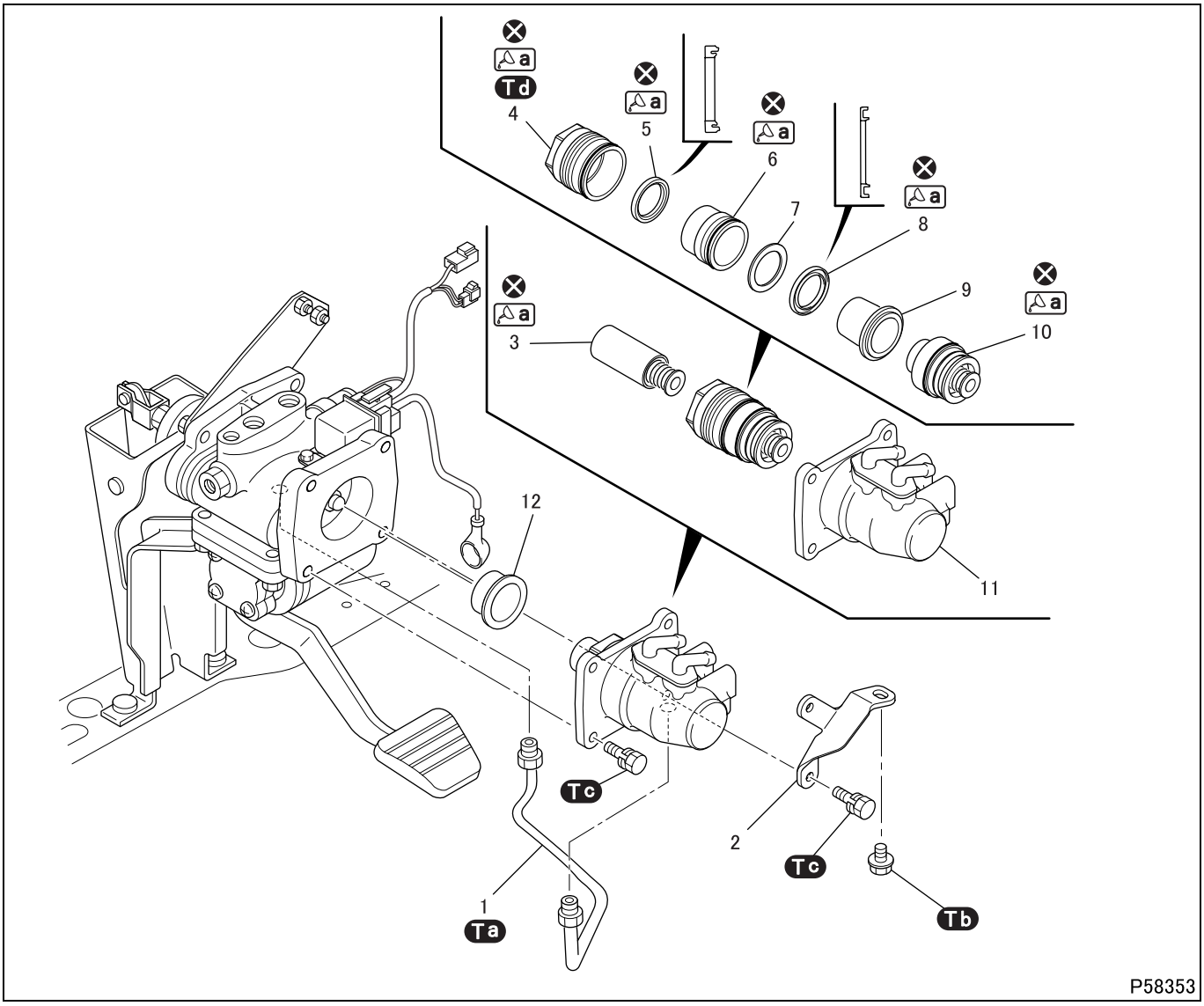
- Measure the distance (as shown in the illustration) between the push rod and the end of the brake pedal & vacuum booster.
- If the measured value does not conform to the specified value, adjust the distance as follows.



[Adjustment]

- Set the distance to the specified value by turning the push rod in or out.

BRAKE MASTER CYLINDER <WITH HYDRAULIC BOOSTER>



● **Disassembly sequence**

1 Brake line
2 Bracket
3 Primary piston
4 Cap
5 Secondary cup
6 Bushing
7 Cup spacer
8 Primary cup
9 Cup retainer
10 Secondary piston
11 Cylinder
12 Piston protector

⊗: Non-reusable parts

CAUTION ⚠

- **For cleaning, use brake fluid.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Master cylinder repair kit, Cap kit

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
3	Primary piston spring load (installed length: 49.7 {1.96})	130 to 140 N {29 to 31 lbf}	125 N {28 lbf}	Replace
3, 10, 11	Clearance between primary and secondary pistons and cylinder	0.065 to 0.125 {0.0026 to 0.0049}	0.13 {0.0051}	Replace
10	Secondary piston spring load (installed length: 44.5 {1.75})	102 to 118 N {23 to 27 lbf}	96 N {22 lbf}	Replace

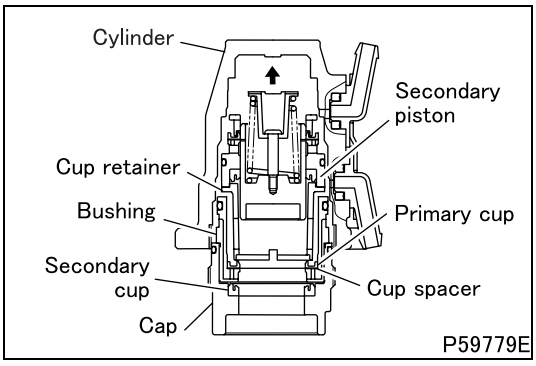
Torque: N·m {lbf·ft}

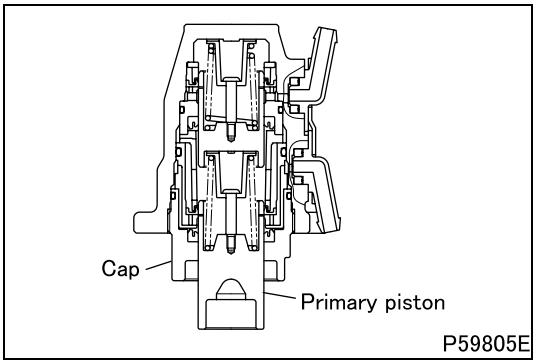
Mark	Component	Torque value	Remarks
Ta	Brake line	17.2 ± 2.5 {13 ± 1.8}	–
Tb	Bolt (bracket mounting)	9 to 14 {6.6 to 10}	–
Tc	Bolt (brake master cylinder mounting)	17.6 to 27.4 {13 to 20}	–
Td	Cap	68.6 to 78.4 {51 to 58}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding face of primary piston	Rubber grease	As required
	O-ring on cap		
	Secondary cup		
	O-ring on bushing		
	Primary cup		
	Sliding face of secondary piston		

◆Installation procedure◆





■ **Installation: Cap, secondary cup, cup spacer, primary cup, bushing, cup retainer, secondary cup and primary piston**

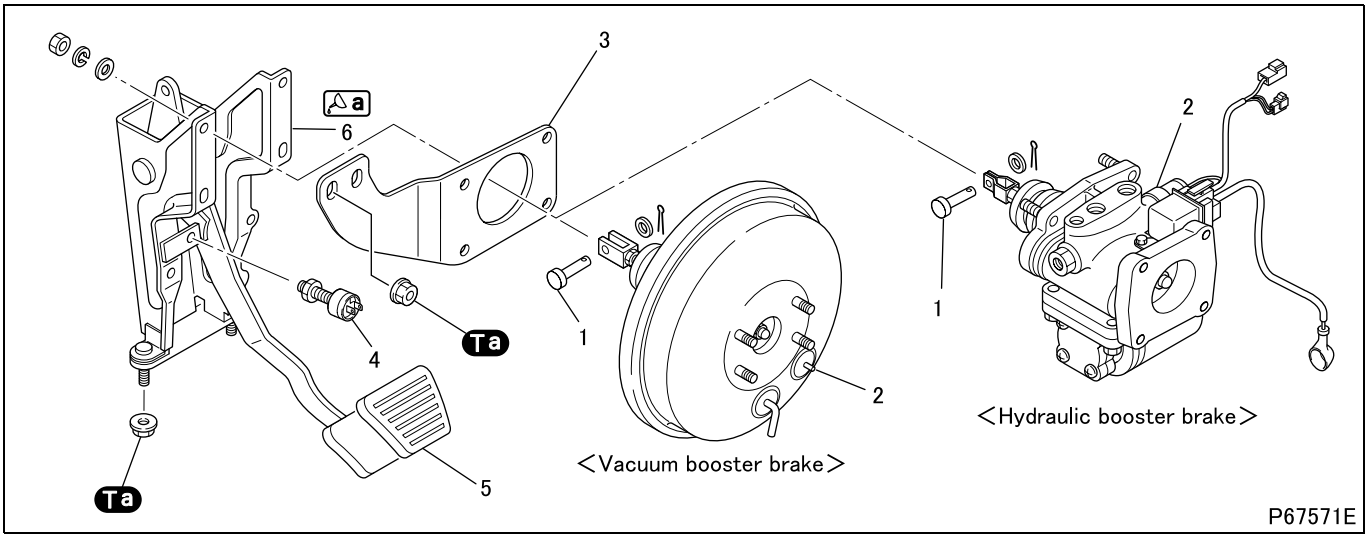
- With the end of the cylinder facing upward, insert each assembled part slowly.

CAUTION ⚠

- **To prevent the cup retainer from falling off, hold the cylinder with its end upward until the cap is screwed into the cylinder.**

- After screwing the cap into the cylinder, tighten it to the specified torque.
- Slowly insert the primary piston through the cap.

BRAKE PEDAL & VACUUM BOOSTER, HYDRAULIC BOOSTER



● **Disassembly sequence**

1 Clevis pin
2 Vacuum booster
<Vacuum booster brake>
Hydraulic booster (See later section.)
<Hydraulic booster brake>
3 Bracket <Vacuum booster brake>
4 Stop lamp switch
5 Pedal pad
6 Brake pedal & pedal support

CAUTION ⚠

- **Do not attempt to disassemble the vacuum booster.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

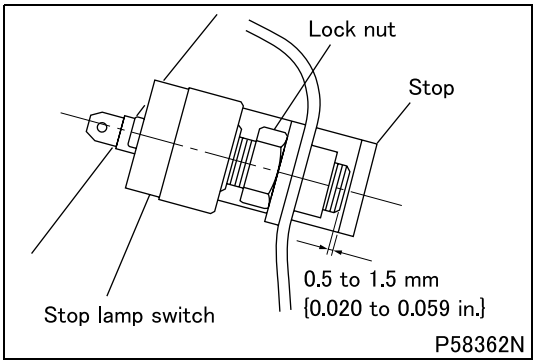
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (bracket mounting)	9 to 14 {6.6 to 10}	–
	Nut (brake pedal & pedal support mounting)		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Return spring of brake pedal & pedal support; Inner periphery of clevis pin hole	Chassis grease [NLGI No. 1 (Li soap)]	As required

◆**Installation procedure**◆



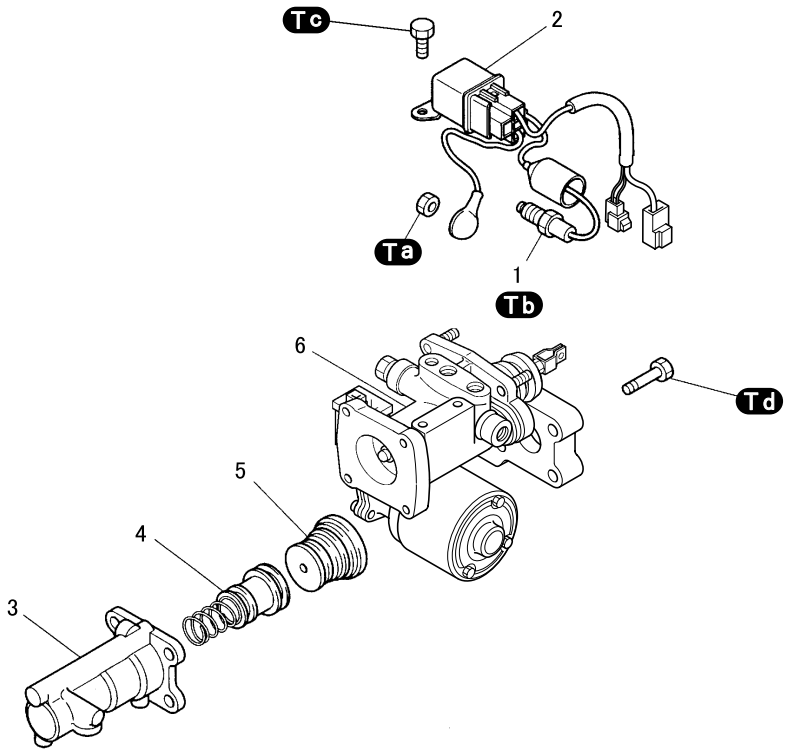
■ **Installation: Stop lamp switch**

- Set the distance between the threaded end of the stop lamp switch and the stop for the brake pedal & pedal support to the illustrated value. Then, fix the assembly with the lock nut.

CAUTION ⚠

- **To prevent brake drag, ensure that the threaded end of the stop lamp switch does not interfere with the stop for the brake pedal.**

Hydraulic Booster



P58355

● Disassembly sequence

1 Flow switch
2 Motor relay
3 Pressure intensifying cylinder
4 Valve piston guide
5 Pressure intensifying piston
6 Hydraulic booster body

● Assembly sequence

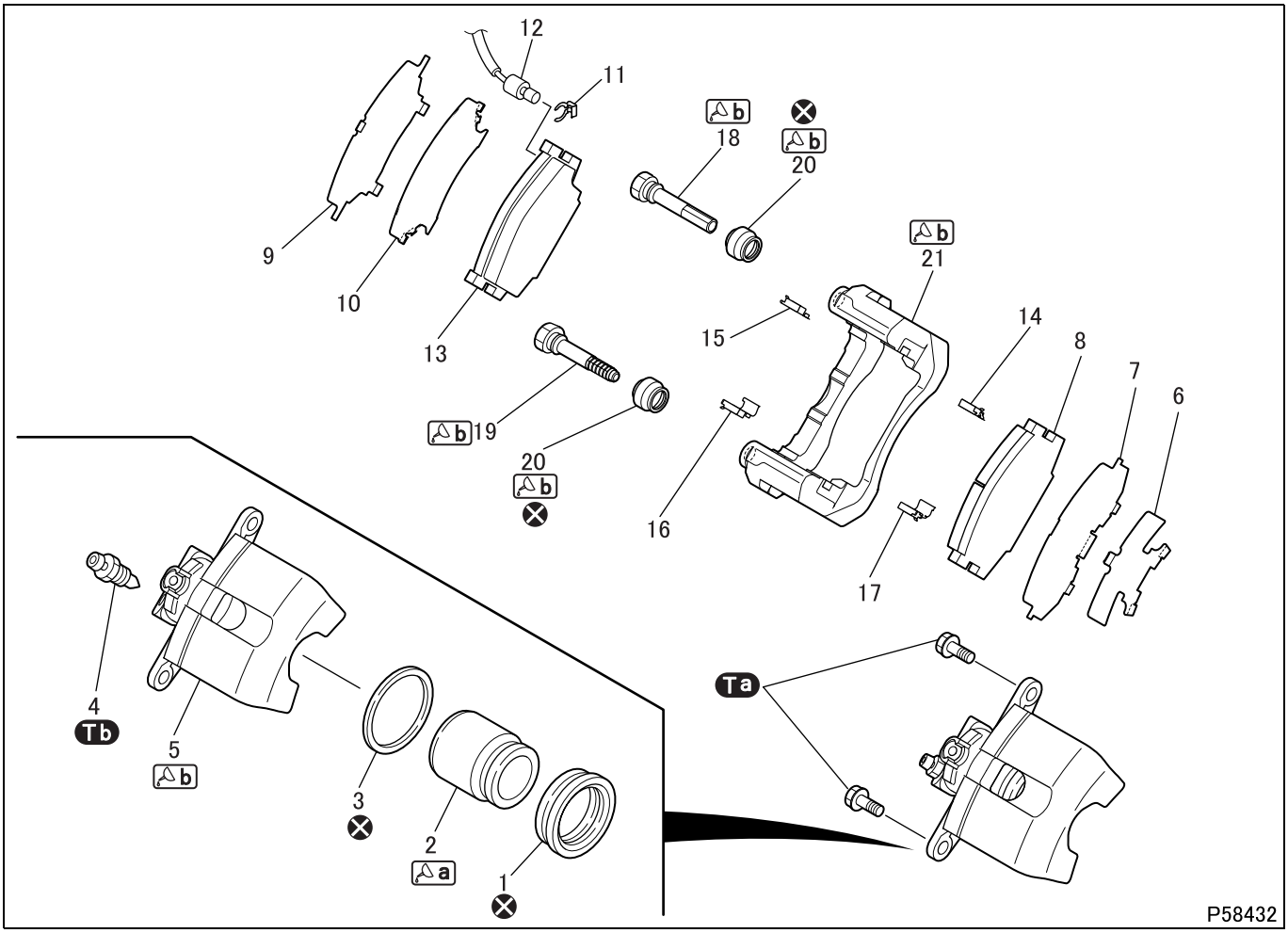
Follow the disassembly sequence in reverse.

Repair kit: Valve piston guide, Pressure intensifying piston

Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
Ta	Nut (motor relay earth mounting)	2.45 to 4.41 {1.8 to 3.3}	–
Tb	Flow switch	24.5 to 34.3 {18 to 25}	–
Tc	Bolt (motor relay mounting)	4.41 to 7.35 {3.3 to 5.4}	–
Td	Bolt (pressure intensifying cylinder mounting)	17.6 to 27.4 {13 to 20}	–

FRONT DISC BRAKE <ϕ235 mm {9.25 in} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (lower)
5 Caliper
6 Outer shim A
7 Outer shim B
8 Outer pad
9 Inner shim A
10 Inner shim B
11 Clip
12 Pad wear indicator
13 Inner pad
14 Pad liner A
15 Pad liner B
16 Pad liner C
17 Pad liner D
18 Main slide pin
19 Sub slide pin
20 Pin boots
21 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the front disc brake, see Gr26.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
8, 13	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

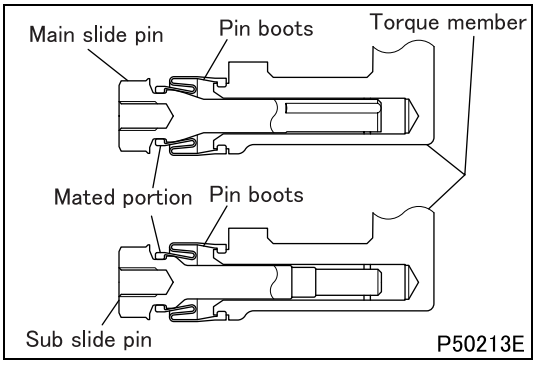
Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
Ta	Pin bolt	40 to 50 {30 to 37}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5}	–

Lubricant and/or sealant

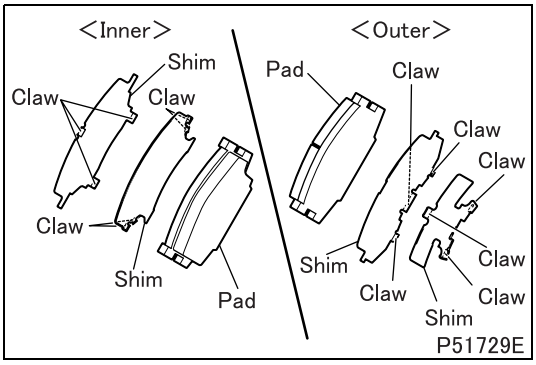
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆



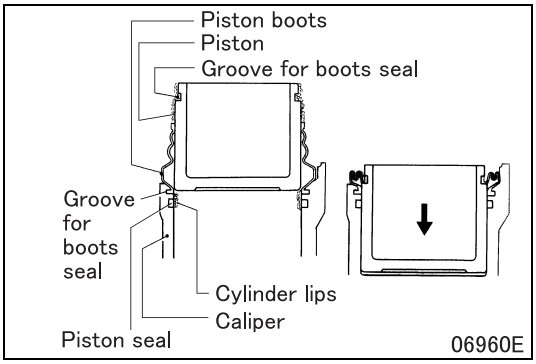
■ **Installation: Main slide pin, sub slide pin, pin boots, and torque member**

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.



■ **Installation: Shims**

- Position shims such that they face the illustrated directions before installing them onto the pads.

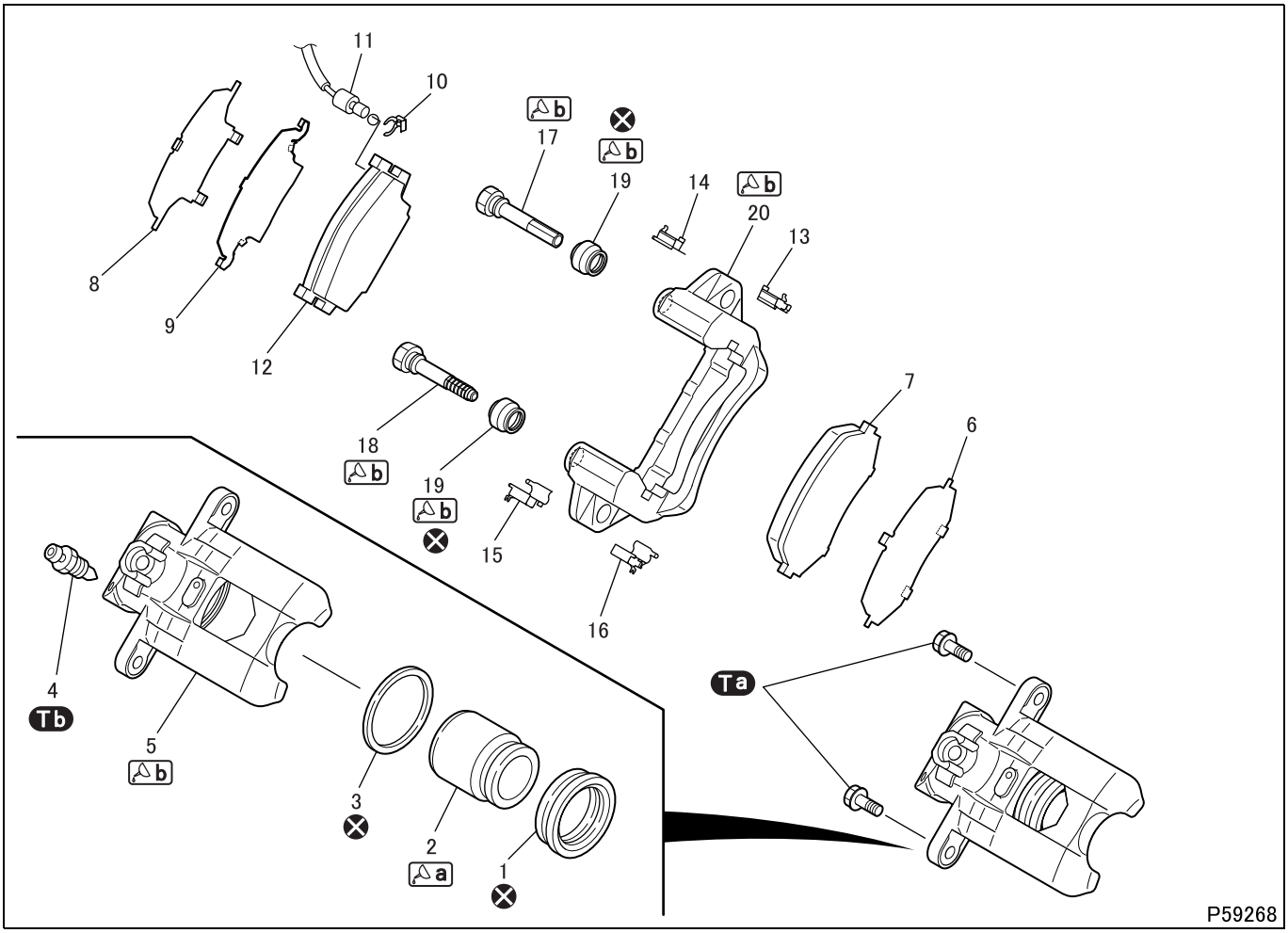


■ **Installation: Piston boots, piston, and piston seal**

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

M E M O

FRONT DISC BRAKE <ϕ252 mm {9.92 in} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (lower)
5 Caliper
6 Outer shim
7 Outer pad
8 Inner shim A
9 Inner shim B
10 Clip (upper R/H only)
11 Pad wear indicator (upper R/H only)
12 Inner pad
13 Pad liner A
14 Pad liner B
15 Pad liner C
16 Pad liner D
17 Main slide pin
18 Sub slide pin
19 Pin boots
20 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the front disc brake, see Gr26.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
7, 10	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

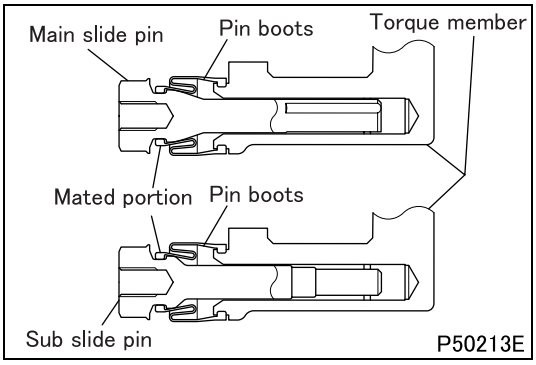
Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
Ta	Pin bolt	40 to 50 {30 to 37}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5}	–

Lubricant and/or sealant

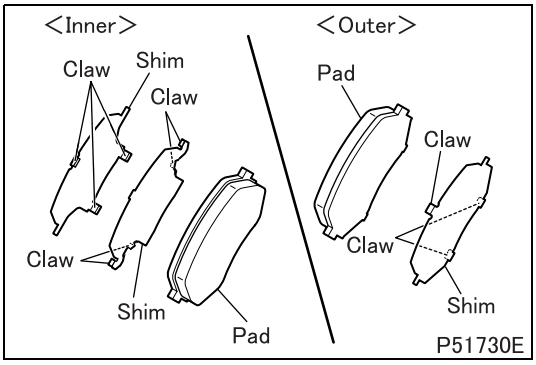
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆



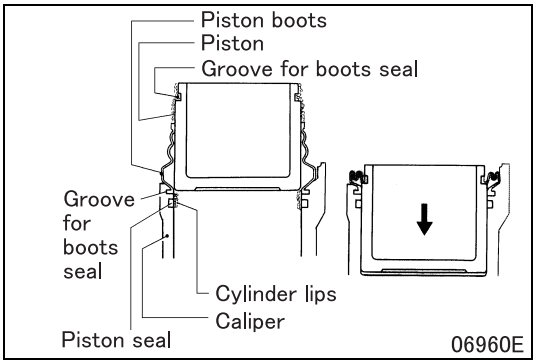
■ Installation: Main slide pin, sub slide pin, pin boots, and torque member

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.



■ Installation: Shims

- Position shims such that they face the illustrated directions before installing them onto the pads.

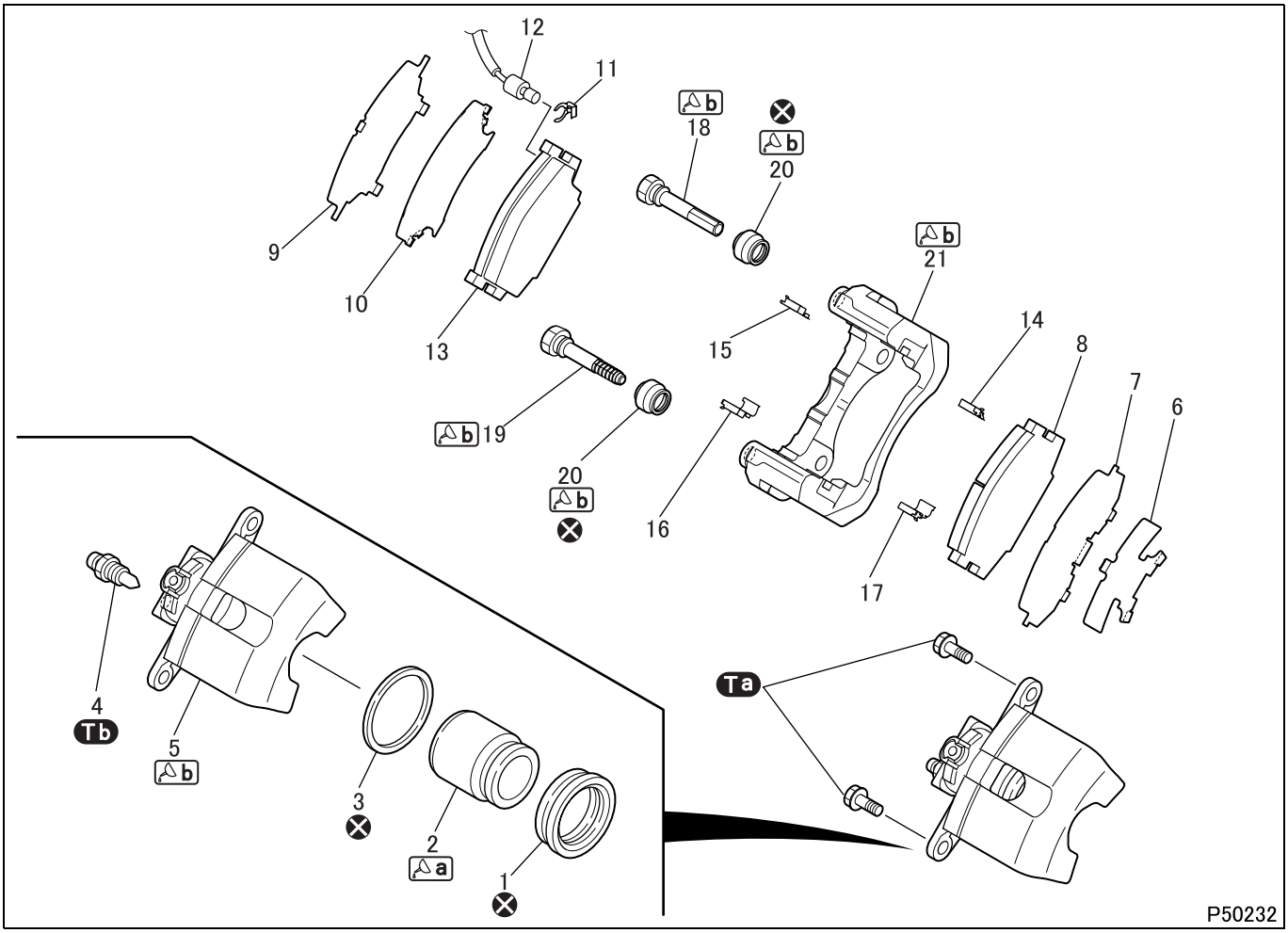


■ **Installation: Piston boots, piston, and piston seal**

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

M E M O

REAR DISC BRAKE <ϕ235 mm {9.25 in} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (front)
5 Caliper
6 Outer shim A
7 Outer shim B
8 Outer pad
9 Inner shim A
10 Inner shim B
11 Clip (rear)
12 Pad wear indicator (rear)
13 Inner pad
14 Pad liner A
15 Pad liner B
16 Pad liner C
17 Pad liner D
18 Main slide pin
19 Sub slide pin
20 Pin boots
21 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the rear disc brake, see Gr27.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
8, 13	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

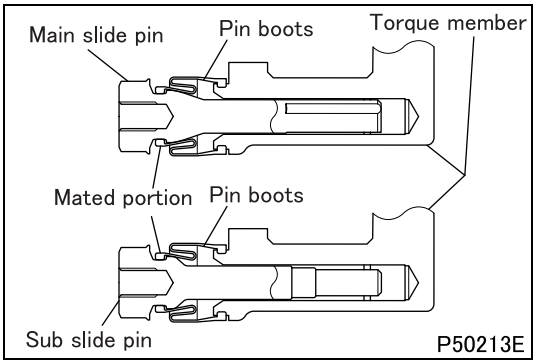
Torque: N·m {lbf·ft}

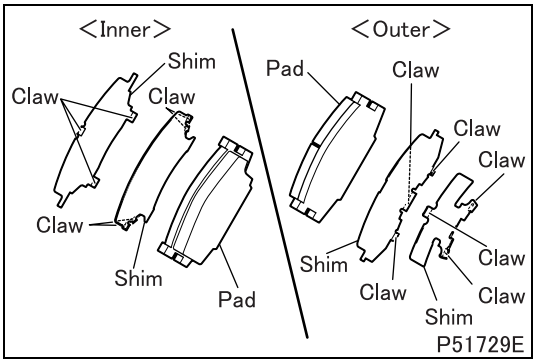
Mark	Component	Torque value	Remarks
Ta	Pin bolt	40 to 50 {30 to 37}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5}	–

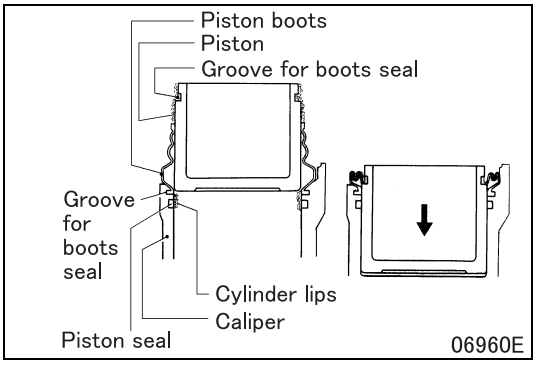
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆







■ Installation: Main slide pin, sub slide pin, pin boots, and torque member

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.

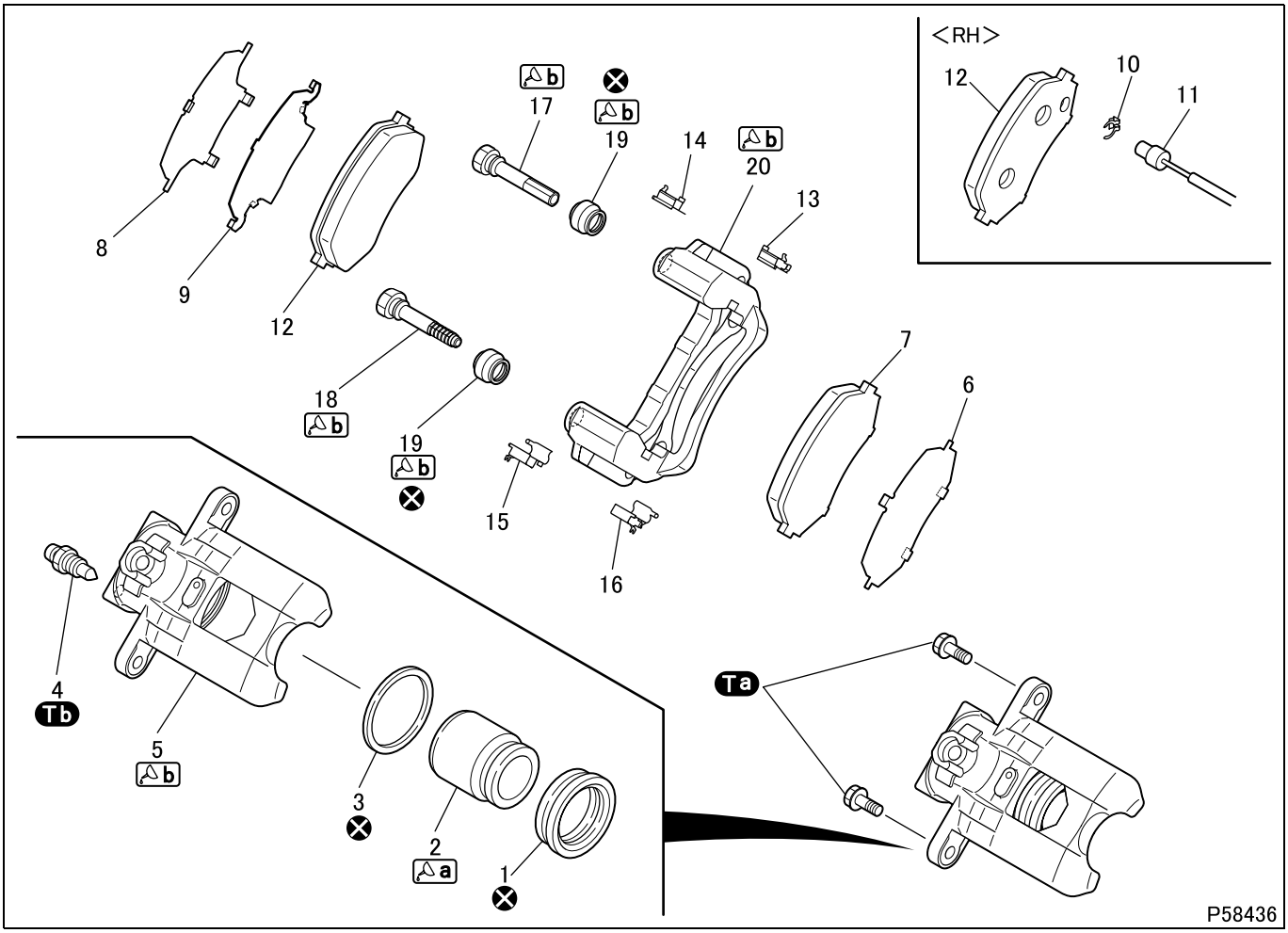
■ Installation: Shims

- Position shims such that they face the illustrated directions before installing them onto the pads.

■ Installation: Piston boots, piston, and piston seal

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

REAR DISC BRAKE <ϕ252 mm {9.92 in} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (front)
5 Caliper
6 Outer shim
7 Outer pad
8 Inner shim A
9 Inner shim B
10 Clip (rear R/H only)
11 Pad wear indicator (rear R/H only)
12 Inner pad
13 Pad liner A
14 Pad liner B
15 Pad liner C
16 Pad liner D
17 Main slide pin
18 Sub slide pin
19 Pin boots
20 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the rear disc brake, see Gr27.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
7, 12	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

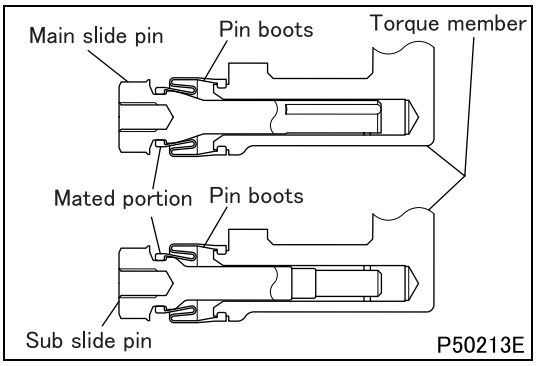
Torque: N·m {lbf·ft}

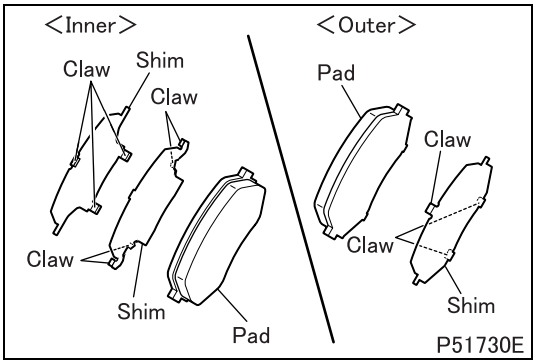
Mark	Component	Torque value	Remarks
Ta	Pin bolt	40 to 50 {30 to 37}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5}	–

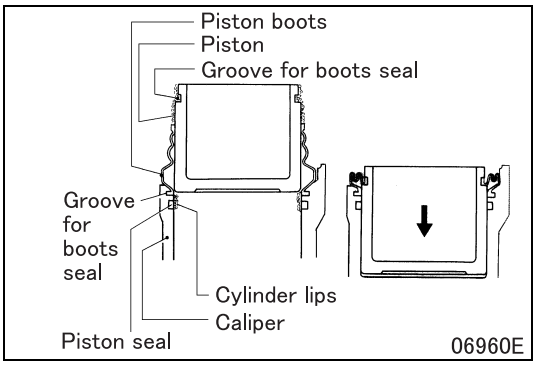
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆







■ Installation: Main slide pin, sub slide pin, pin boots, and torque member

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.

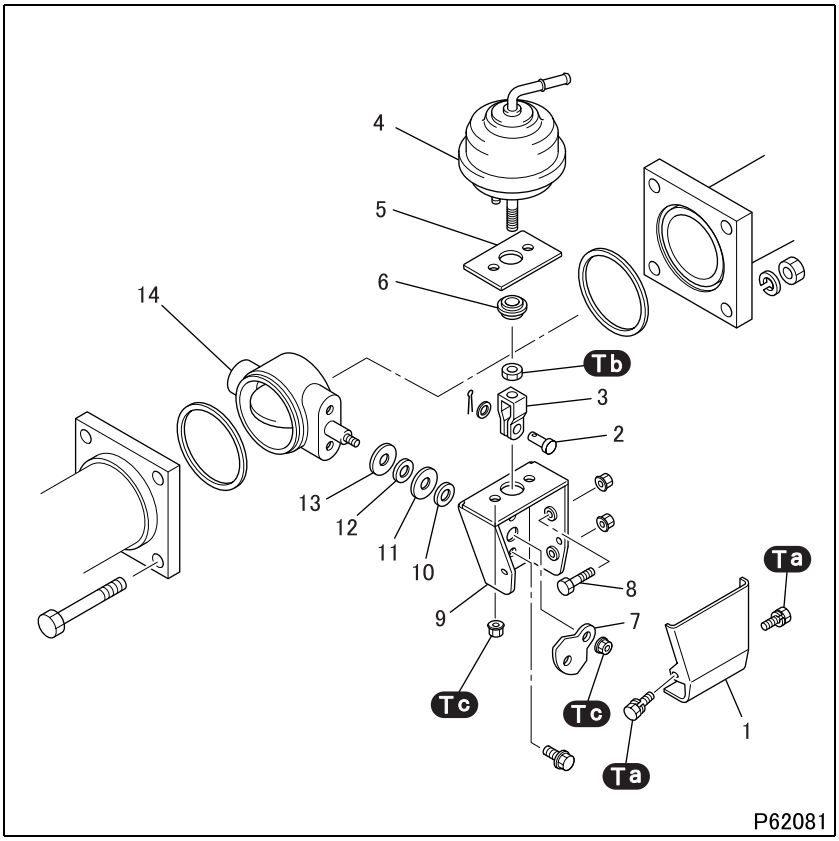
■ Installation: Shims

- Position shims such that they face the illustrated directions before installing them onto the pads.

■ Installation: Piston boots, piston, and piston seal

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

Exhaust Brake Unit



● Disassembly sequence

1 Cover
2 Clevis pin
3 Clevis
4 Power chamber
5 Gasket
6 Bearing
7 Lever
8 Adjust bolt
9 Bracket
10 Seal ring A
11 Seal ring B
12 Seal ring A
13 Seal ring B
14 Valve

CAUTION ⚠

- **Do not attempt to disassemble the power chamber.**

NOTE

- **For removal and installation procedures of the exhaust brake unit, see Gr15.**

● Assembly sequence

Follow the disassembly sequence in reverse.

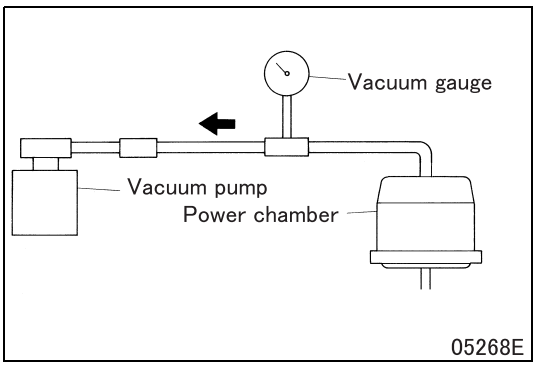
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
–	Average of top and bottom clearances between butterfly valve and body with valve fully closed (with power chamber vacuum of 87 to 93 kPa {25.7 to 27.5 inHg} or above)	0.10 to 0.25 {0.0039 to 0.0098}	–	Adjust
4	Air-tightness of power chamber (at 15 sec. after vacuum of 67 kPa {19.8 inHg} is achieved in chamber)	63 kPa {18.6 inHg} or above	–	Replace

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Bolt (cover mounting)	4.9 to 6.9 {3.6 to 5.1}	–
Tb	Lock nut (clevis retention)	9.8 to 16 {7.2 to 12}	–
Tc	Nut (power chamber mounting)	11 to 17 {8.0 to 12}	–
	Nut (lever mounting)		

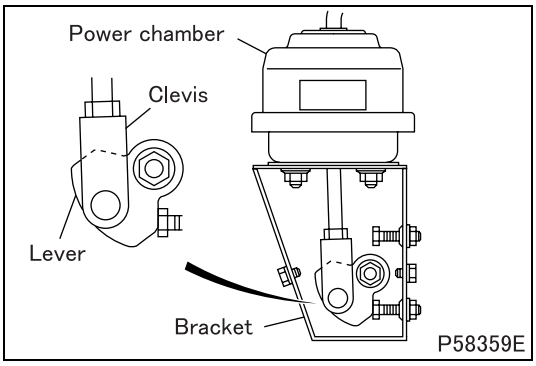
◆Inspection procedure◆



■ **Inspection: Power chamber air-tightness**

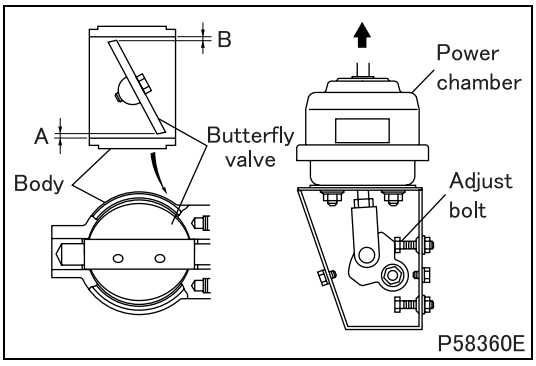
- Connect the components with piping as illustrated. When a vacuum of 67 kPa {19.8 inHg} or above is applied to the power chamber, stop the vacuum pump.
- Fifteen seconds later, the reading on the vacuum gauge should conform to the standard value.
- If not, replace the power chamber.

◆Adjustment after installation◆



■ **Adjustment: Clevis**

- Assemble the power chamber onto the bracket. Then, adjust the location of the clevis such that the hole in the clevis is aligned by half with the hole in the lever.

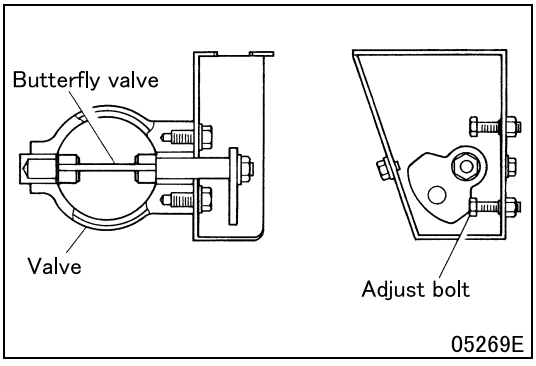


■ **Adjustment: Butterfly valve**

(1) Butterfly valve fully-closed position

- Apply a vacuum of 87 to 93 kPa {25.7 to 27.5 inHg} to the power chamber to fully close the butterfly valve. With the valve fully closed, measure the top and bottom clearances **B** and **A** between the valve and the body, and obtain the average of the two. The average value should conform to the standard value. Adjust with the adjust bolt as required.

$$\text{Average clearance} = \frac{(\mathbf{A} + \mathbf{B})}{2}$$



(2) Valve fully-open position

- Adjust the butterfly valve to the full open position using the adjust bolt.

GROUP 35E INDEX

SPECIFICATIONS 35E-2

STRUCTURE AND OPERATION
1. **Overview 35E-4**
2. **Electronic Control System 35E-14**
3. **Electronic Control Unit Schematic Diagram 35E-17**

TROUBLESHOOTING
1. **Diagnosis Procedure 35E-18**
2. **Diagnostic Precautions 35E-19**
3. **Diagnosis Based on Diagnosis Codes 35E-20**
4. **Multi-Use Tester Service Data 35E-26**
5. **Actuator Test Using Multi-Use Tester 35E-28**
6. **Inspection at Hydraulic Unit (Electronic Control Unit) Connector 35E-29**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Functional Check 35E-32**
2. **Oscilloscopic Inspection through Wheel Speed Sensor Signal Waveform 35E-33**
3. **Inspection of Hydraulic Unit (Electronic Control Unit) Operation 35E-34**
4. **Inspection after Replacing or Removing/Installing Hydraulic Unit (Electronic Control Unit) 35E-35**

HYDRAULIC UNIT CONNECTOR COUPLING AND UNCOUPLING 35E-36

INSPECTION OF ELECTRICAL COMPONENTS 35E-38

COMPONENT LOCATIONS 35E-40

ELECTRICAL WIRING DIAGRAM 35E-42

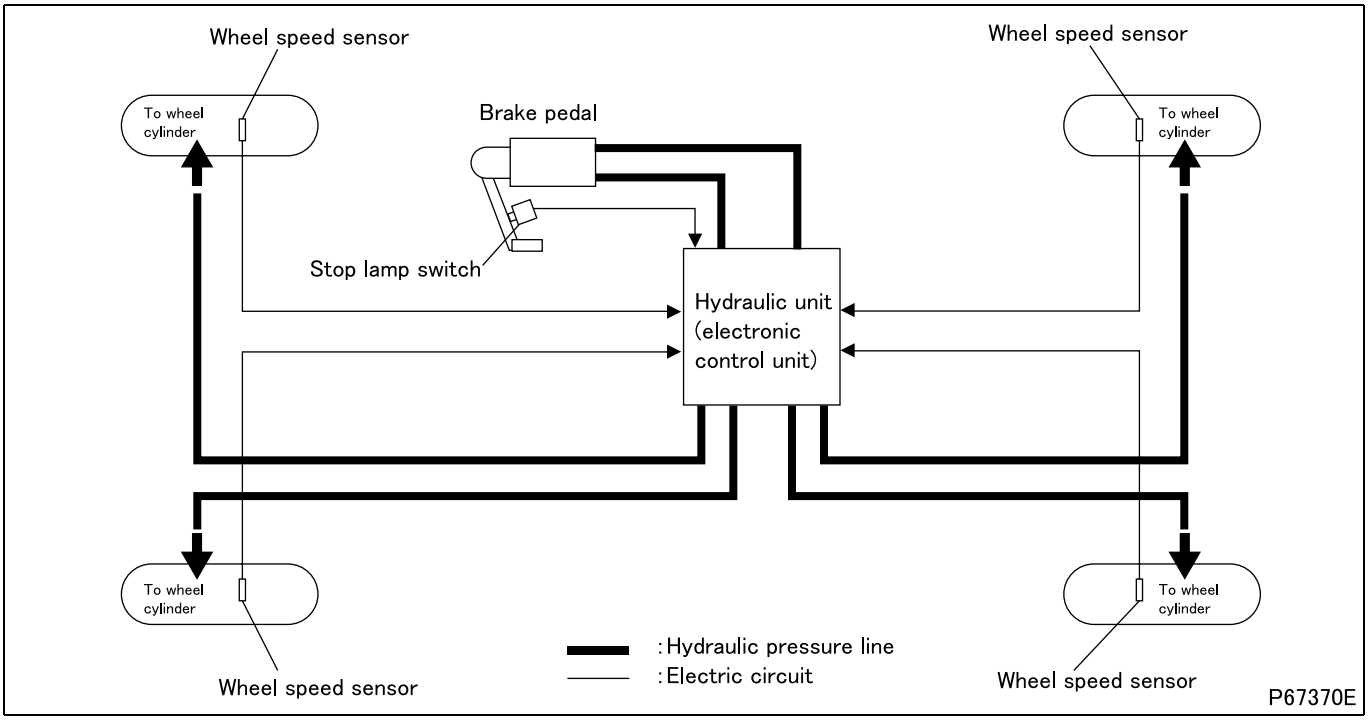
SPECIFICATIONS

Item		Specifications
Hydraulic unit (electronic control unit)	Manufacturer	ADVICS
	Rated voltage V	DC12
	Working voltage range V	DC10 to 18
*Wheel speed sensor	Manufacturer	SUMITOMO ELECTRIC Bosch

*Manufacturers of wheel speed sensor differ depending on the model of the brakes.

M E M O

1. Overview

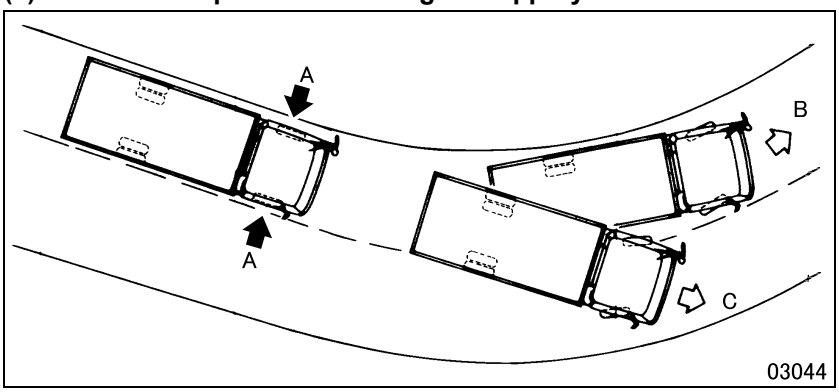


- The antilock brake system (ABS) prevents wheel lock-up and resultant skid when braking hard or on slippery roads, thus maintain vehicle stability and steerability.

1.1 Outline of antilock brake system

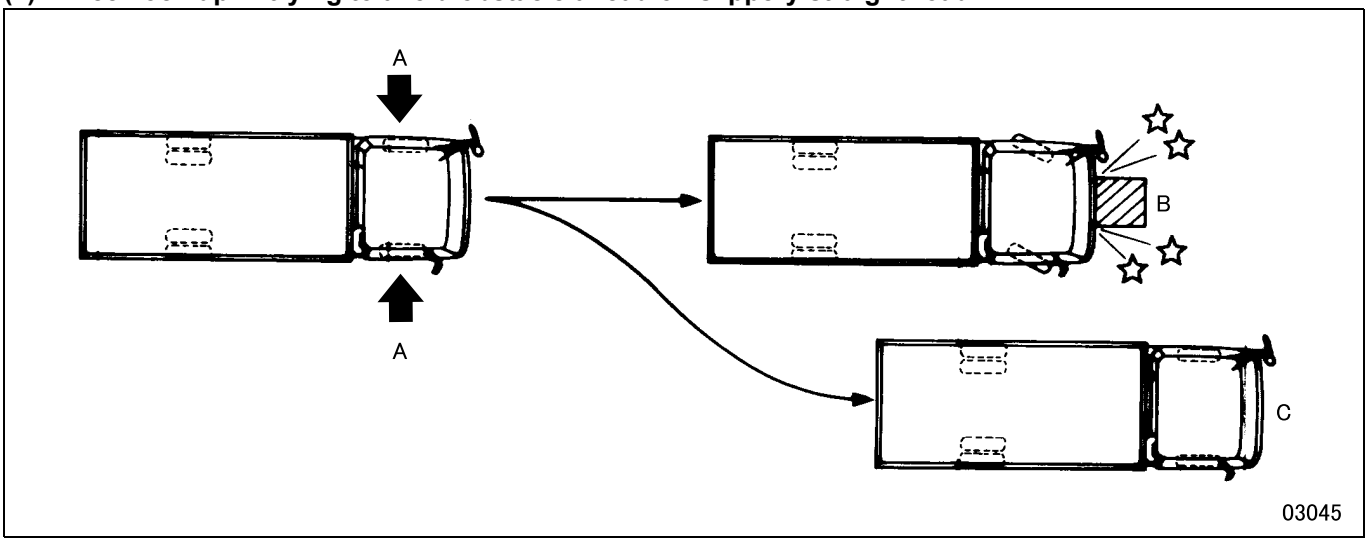
- Wheels will roll along on the road in the direction of their rotation. Therefore, the driver can steer the vehicle as he/she wishes by maneuvering the steering wheel.
  However, on vehicles not equipped with ABS, applying the brakes hard can cause wheel lock-up. Once tires are locked up, they are simply a piece of rubber in contact with the road surface and steering control will be lost. The vehicle will skid in the direction of inertia irrespective of the steering angle.
  In other words, vehicle stability and steerability are lost and the vehicle is beyond the driver's control.
- On vehicles equipped with antilock brake system, the system prevents wheel lock-up by reducing the braking power to the wheel that is about to lock up and, thereby, maintain vehicle stability and steerability.

(1) Wheel lock-up when cornering on slippery road



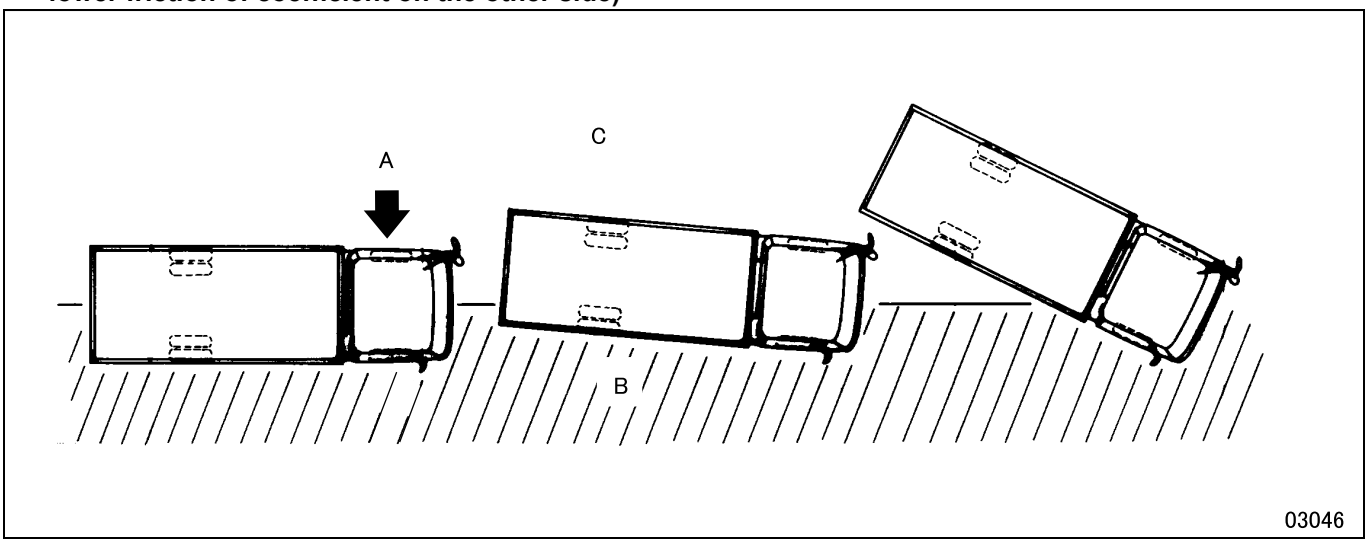
- If wheel lock-up occurs during braking on a slippery curve, steering control will be lost. If this happens, the vehicle may deviate, while skidding, from the intended course no matter how the driver maneuvers the steering wheel.
  - **A:** Application of brakes (wheel lock-up)
  - **B:** Intended course
  - **C:** Go out of course

(2) Wheel lock-up in trying to avoid obstacle ahead on slippery straight road



- If wheel lock-up occurs during hard braking on a slippery straight road in trying to avoid an obstacle ahead, steering control will be lost. If this happens, the vehicle will not be able to avoid the obstacle no matter how the driver maneuvers the steering wheel.
  A: Application of brakes (wheel lock-up)
  B: Obstacle
  C: Intended course

(3) Split μ (Wheel lock-up on asymmetrical road surface, with higher friction of coefficient on one side and lower friction of coefficient on the other side)



- If the front and rear wheels on one side of the vehicle are on the side of the road that has a lower friction of coefficient and therefore is more slippery than the other side of the road, these wheels are more likely to lock up and slip than the wheels on the other side of the vehicle. When the brakes are applied under such conditions, the braking efficiency will be different between the right and left sides of the vehicle and the vehicle will lose stability. Braking hard under such conditions can even cause the vehicle to spin.
  A: Application of brakes (wheel lock-up)
  B: Less slippery road surface
  C: More slippery road surface

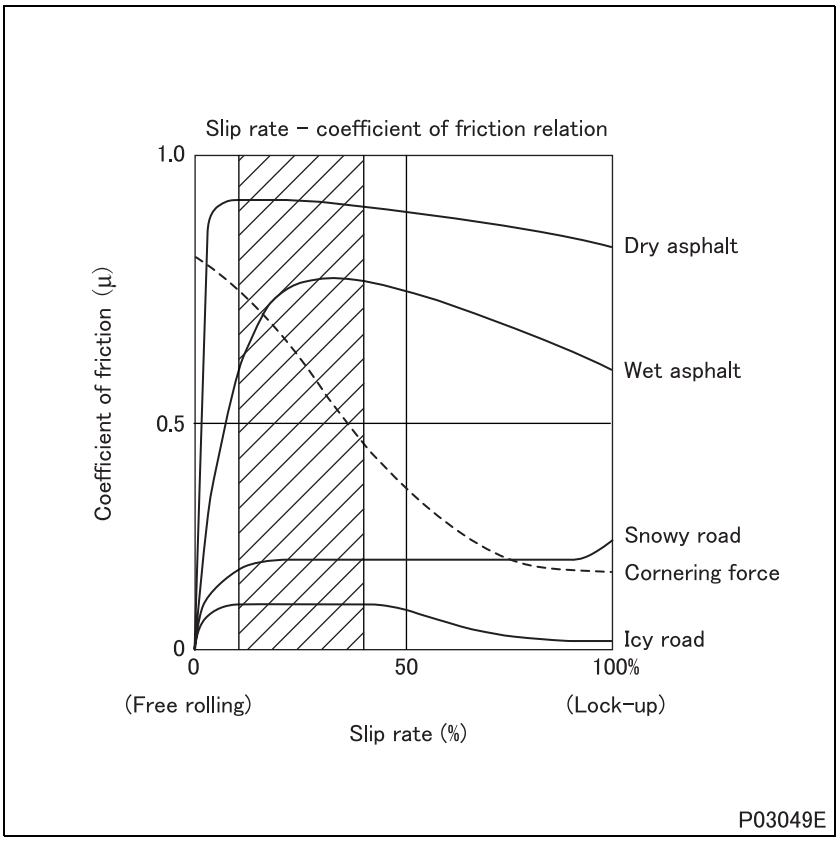
- As mentioned above, the system prevents wheel lock-up by providing controlled braking force to each wheel. This prevents wheel slip and skid and ensures steering control and vehicle stability even during hard braking.

1.2 Antilock brake system control process

- Antilock brake system ensures controlled yet optimum braking in a given road surface condition by placing the braking force within a certain range of slip rate determined by the wheel speed - vehicle speed relation.
- Stepping on the brake pedal causes the wheel speed to slow down and, as a result, the vehicle also slows down. However, the vehicle will still try to move on due to the inertia that has built up. This causes a difference between the wheel speed and the vehicle speed, or, in other words, slip. The amount of slip can be expressed as slip rate, as follows.

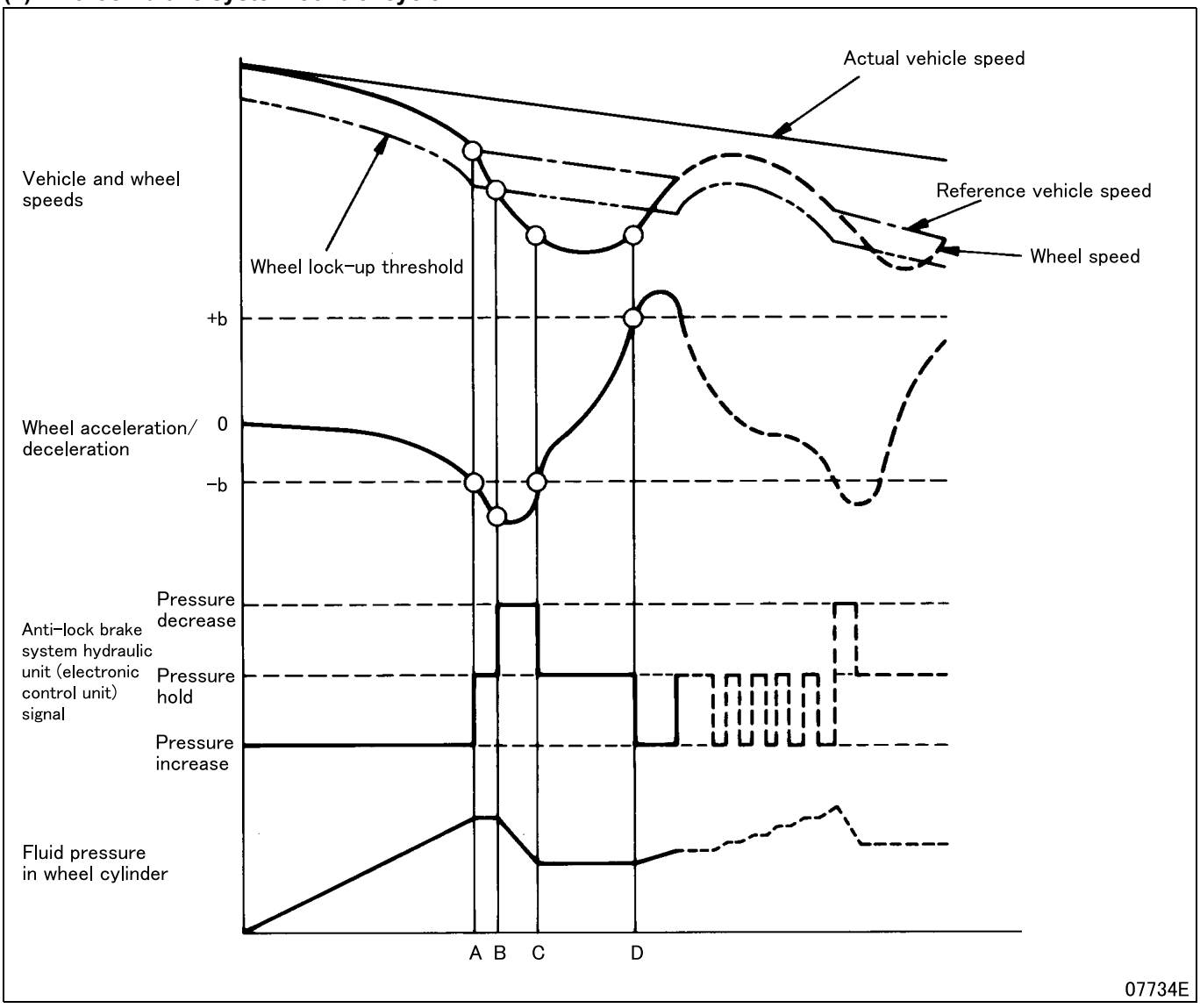
$$\text{Slip rate (\%)} = \frac{\text{Vehicle speed} - \text{Wheel speed}}{\text{Vehicle speed}} \times 100$$

- A slip ratio of 0% means that there is no slip between the wheel and the road surface. A slip rate of 100% means that the wheel is locked up.



- The graph shows the variation in the tire's coefficient of friction from free rolling to lock-up. As the brake pedal is slowly depressed, the tires continue to rotate but start slipping.
- As the stepping force on the brake pedal increases, the tires will stop rotating and the vehicle will just skid. This is wheel lock-up.
- As the graph shows, the coefficient of friction peaks within the hatched area.
- In other words, the maximum coefficient of friction can be achieved, not by stepping on the brake pedal with full force, but by doing so moderately to try to place the slip rate within the hatched area.
- On vehicles equipped with antilock brake system, the hydraulic control unit (electronic control unit) controls the braking force so that it falls within the hatched area. This will ensure that the tires do not lock up but have the maximum coefficient of friction, thus achieving efficient braking performance.

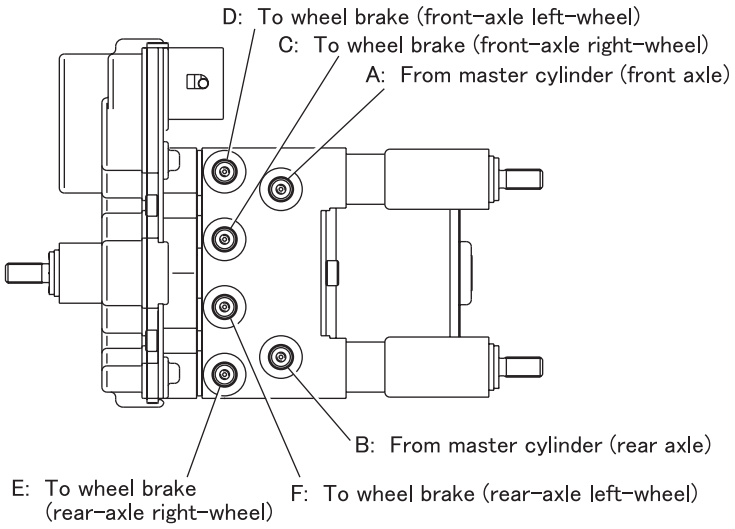
(1) Antilock brake system control cycle

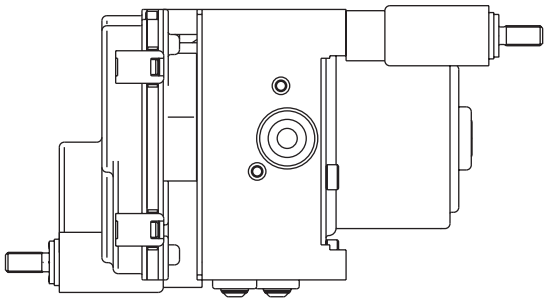


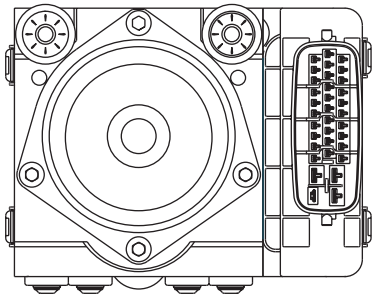
- The above chart shows the typical control cycle of antilock brake system following the application of brakes, detailing in time series the variation in wheel speed, wheel speed acceleration/deceleration and fluid pressure in the wheel cylinder.
- When the wheel speed acceleration/deceleration drops to the “–b” threshold at A, the hydraulic unit (electronic control unit) sends “pressure hold” signal to maintain the fluid pressure in the wheel cylinder.
  At the same time, the hydraulic unit (electronic control unit) calculates the reference vehicle speed.
- When the vehicle decelerates to the wheel lock-up threshold at B, the hydraulic unit (electronic control unit) interprets this as imminent wheel lock-up and sends “pressure decrease” signal to reduce the fluid pressure in the wheel cylinder.
- When the wheel speed picks up and exceeds the “–b” threshold at C, the hydraulic unit (electronic control unit) sends “pressure hold” signal to maintain the fluid pressure in the wheel cylinder at the current level.
- When the wheel speed exceeds the “+b” threshold at D, the hydraulic unit (electronic control unit) determines that the imminent wheel lock-up has gone and sends “pressure increase” signal to increase the fluid pressure in the wheel cylinder.
- The pressure hold-decrease-increase cycle is repeated to keep the slip rate at optimum levels to prevent wheel lock-up.

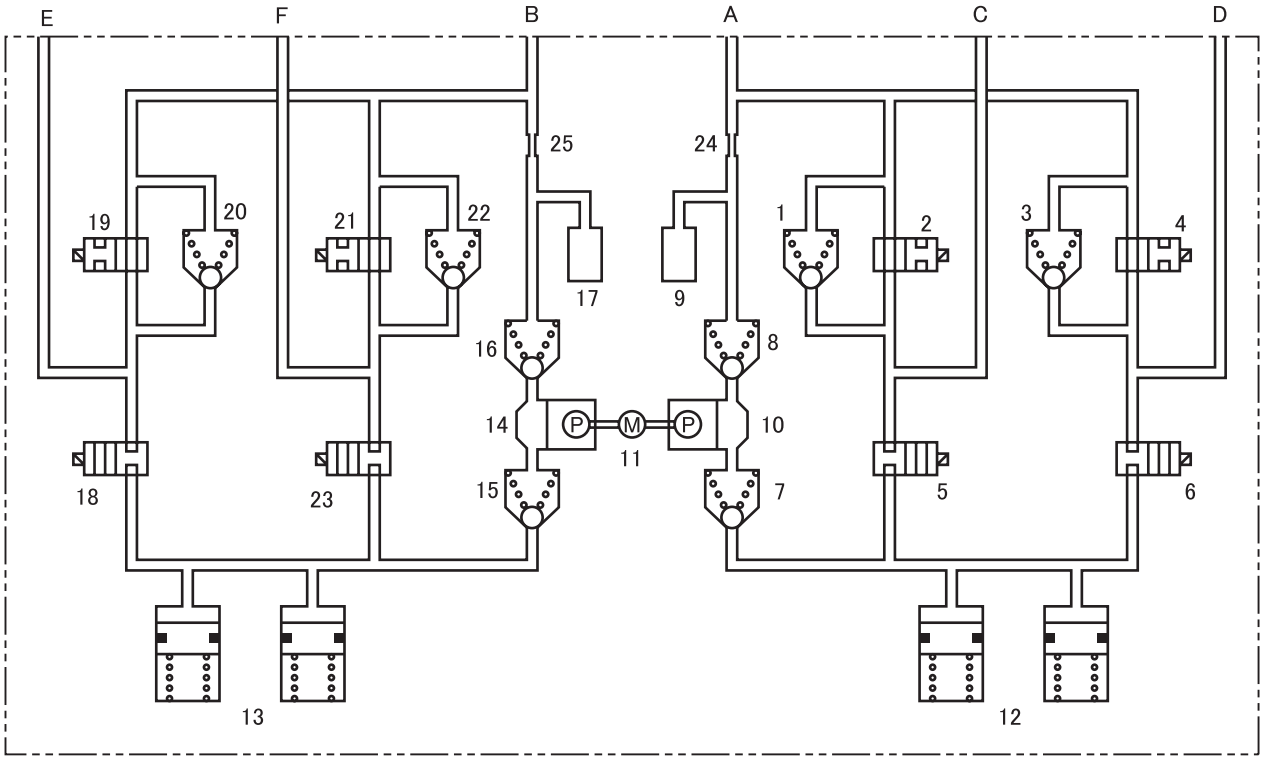
1.3 Hydraulic unit (electronic control unit)

(1) Schematic circuit diagram









P78478E

1 Check valve (front-axle right-wheel)
2 Solenoid valve (front-axle right-wheel HOLD)
3 Check valve (front-axle left-wheel)
4 Solenoid valve (front-axle left-wheel HOLD)
5 Solenoid valve (front-axle right-wheel DECREASE)
6 Solenoid valve (front-axle left-wheel DECREASE)
7 Inlet valve (front axle)
8 Outlet valve (front axle)
9 Damper (front axle)
10 Plunger pump (front axle)
11 Motor
12 Reservoir (front axle)
13 Reservoir (rear axle)
14 Plunger pump (rear axle)
15 Inlet valve (rear axle)
16 Outlet valve (rear axle)
17 Damper (rear axle)
18 Solenoid valve (rear-axle right-wheel DECREASE)
19 Solenoid valve (rear-axle left-wheel HOLD)
20 Check valve (rear-axle right-wheel)
21 Solenoid valve (rear-axle left-wheel HOLD)
22 Check valve (rear-axle left-wheel)
23 Solenoid valve (rear-axle left-wheel DECREASE)
24 Orifice (front axle)
25 Orifice (rear axle)

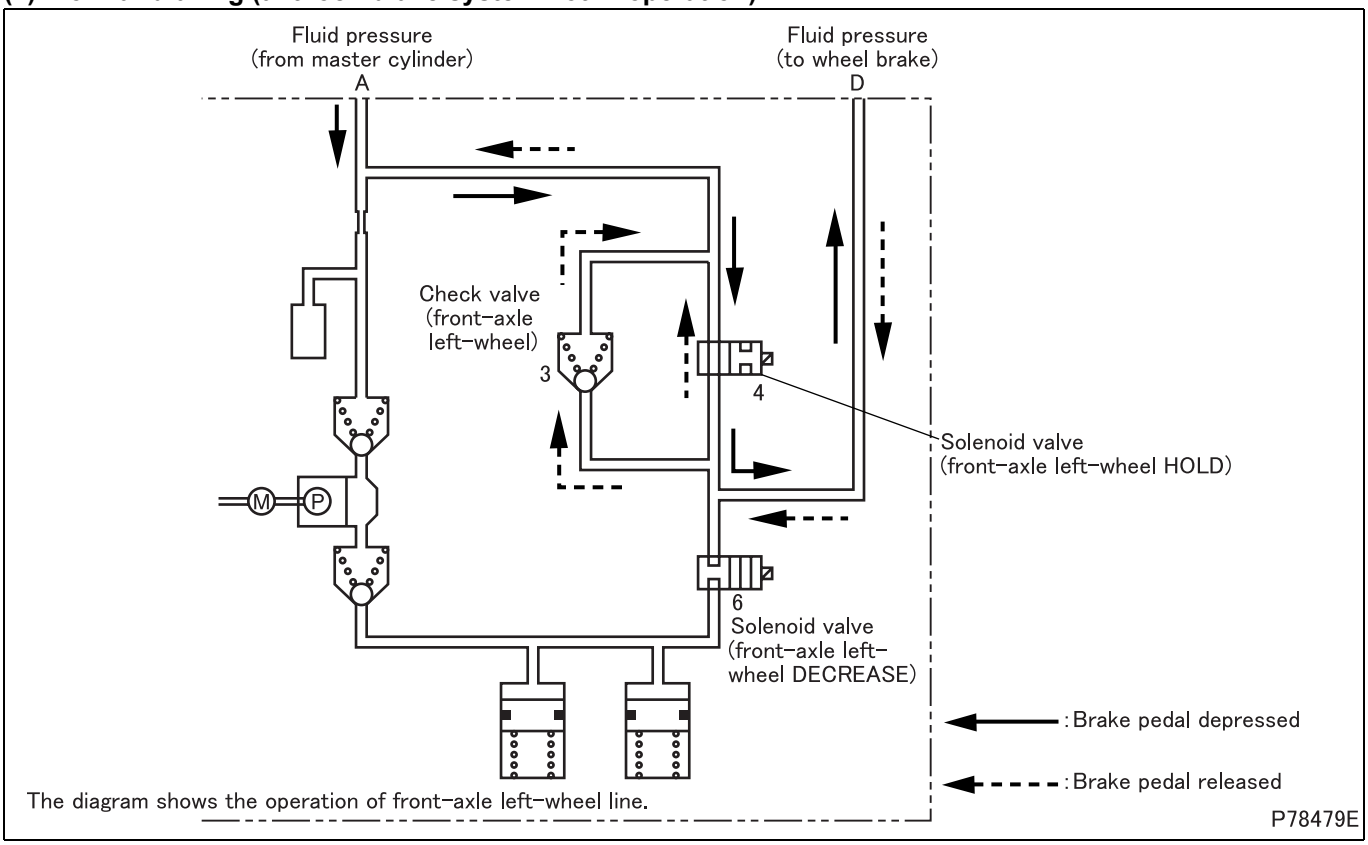
A: From master cylinder (front axle)
B: From master cylinder (rear axle)
C: To wheel brake (front-axle right-wheel)
D: To wheel brake (front-axle left-wheel)
E: To wheel brake (rear-axle right-wheel)
F: To wheel brake (rear-axle left-wheel)

- The hydraulic unit (electronic control unit) is the heart of antilock brake system control, energizing/de-energizing the solenoid valves and turning ON/OFF the motor. The table below shows how each solenoid valve and the motor are controlled in each phase.

		Antilock brake system control											
		Front-axle right-wheel			Front-axle left-wheel			Rear-axle right-wheel			Rear-axle left-wheel		
		DECREASE	HOLD	INCREASE	DECREASE	HOLD	INCREASE	DECREASE	HOLD	INCREASE	DECREASE	HOLD	INCREASE
Solenoid valve	Front-axle right-wheel DECREASE	O	×	×	–	–	–	–	–	–	–	–	–
	Front-axle right-wheel HOLD	O	O	×	–	–	–	–	–	–	–	–	–
	Front-axle left-wheel DECREASE	–	–	–	O	×	×	–	–	–	–	–	–
	Front-axle left-wheel HOLD	–	–	–	O	O	×	–	–	–	–	–	–
	Rear-axle right-wheel DECREASE	–	–	–	–	–	–	O	×	×	–	–	–
	Rear-axle right-wheel HOLD	–	–	–	–	–	–	O	O	×	–	–	–
	Rear-axle left-wheel DECREASE	–	–	–	–	–	–	–	–	–	O	×	×
	Rear-axle left-wheel HOLD	–	–	–	–	–	–	–	–	–	O	O	×
Motor		O											

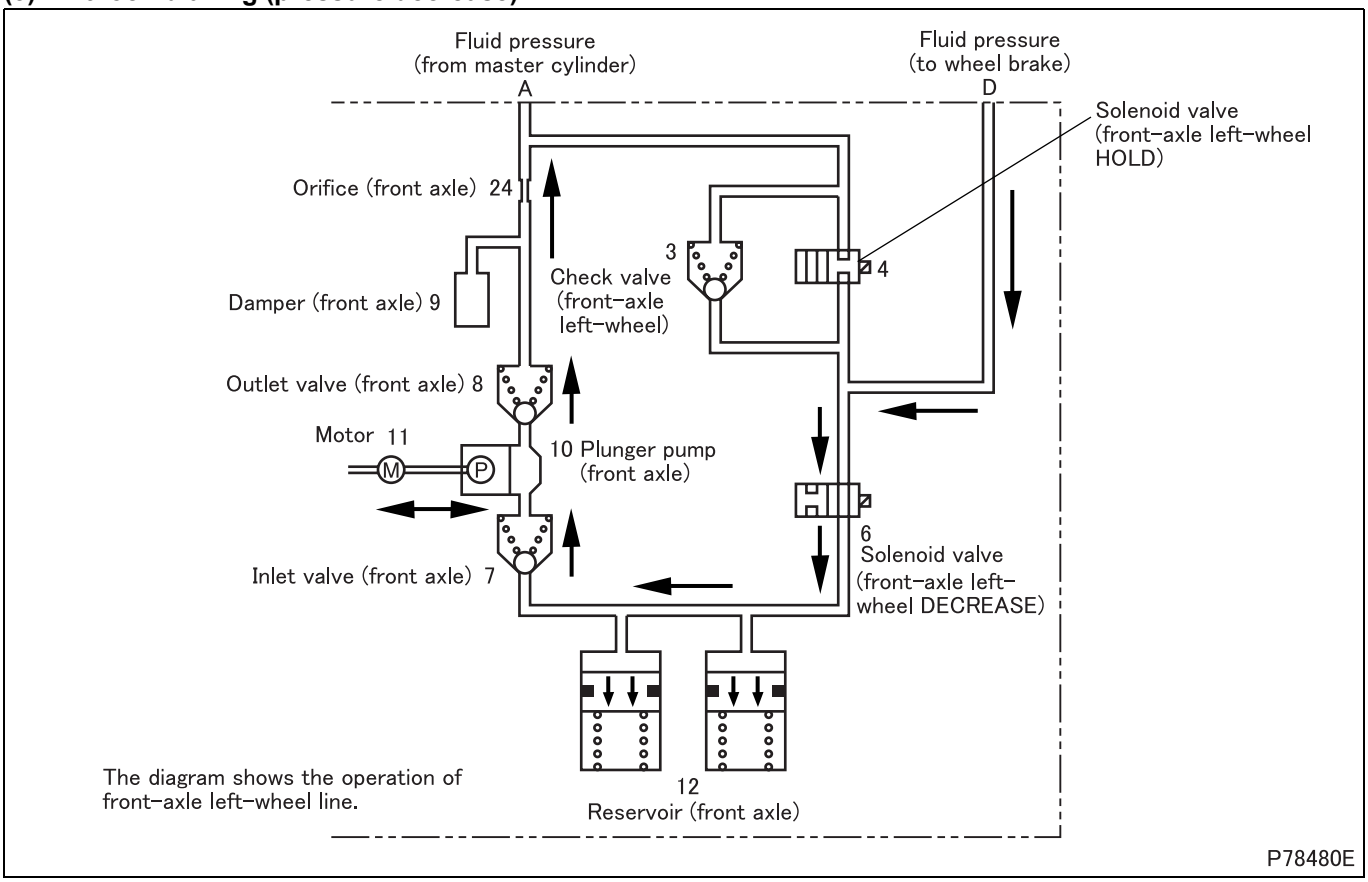
O: On
×: OFF

(2) Normal braking (antilock brake system not in operation)



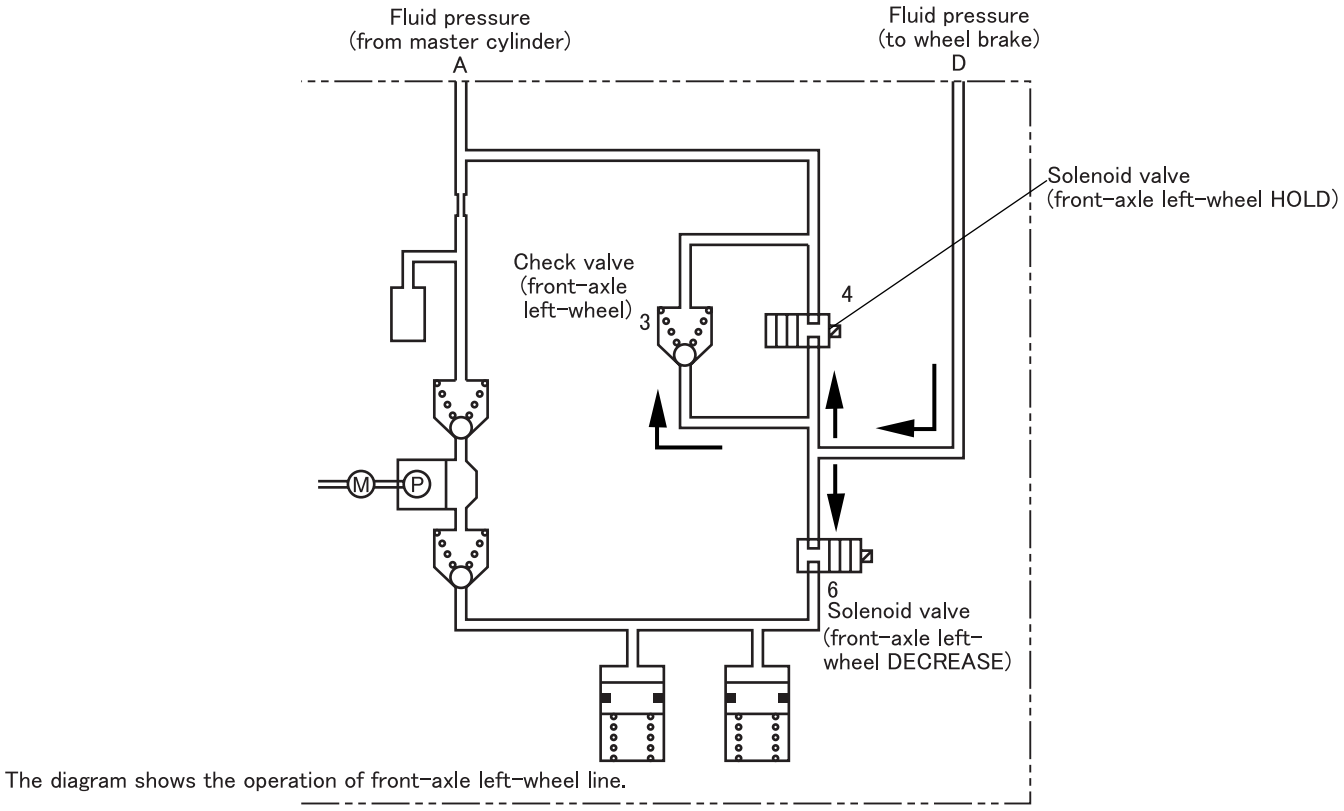
- When the brake pedal is depressed and there is no imminent wheel lock-up, the hydraulic unit (electronic control unit) will not send any control signal to the solenoid valve (front-axle left-wheel DECREASE) or to the solenoid valve (front-axle left-wheel HOLD). The former valve remains closed while the latter valve stays open.
- Pressure fluid **A** from the brake master cylinder flows past the solenoid valve (front-axle left-wheel HOLD) and to the wheel brake **D**.
- When the brake pedal is released, pressure fluid **A** from the brake master cylinder drops. Pressure fluid from the wheel brake **D** now flows past the solenoid valve (front-axle left-wheel HOLD) and the check valve (front-axle left-wheel) and returns to the brake master cylinder.

(3) Antilock braking (pressure decrease)



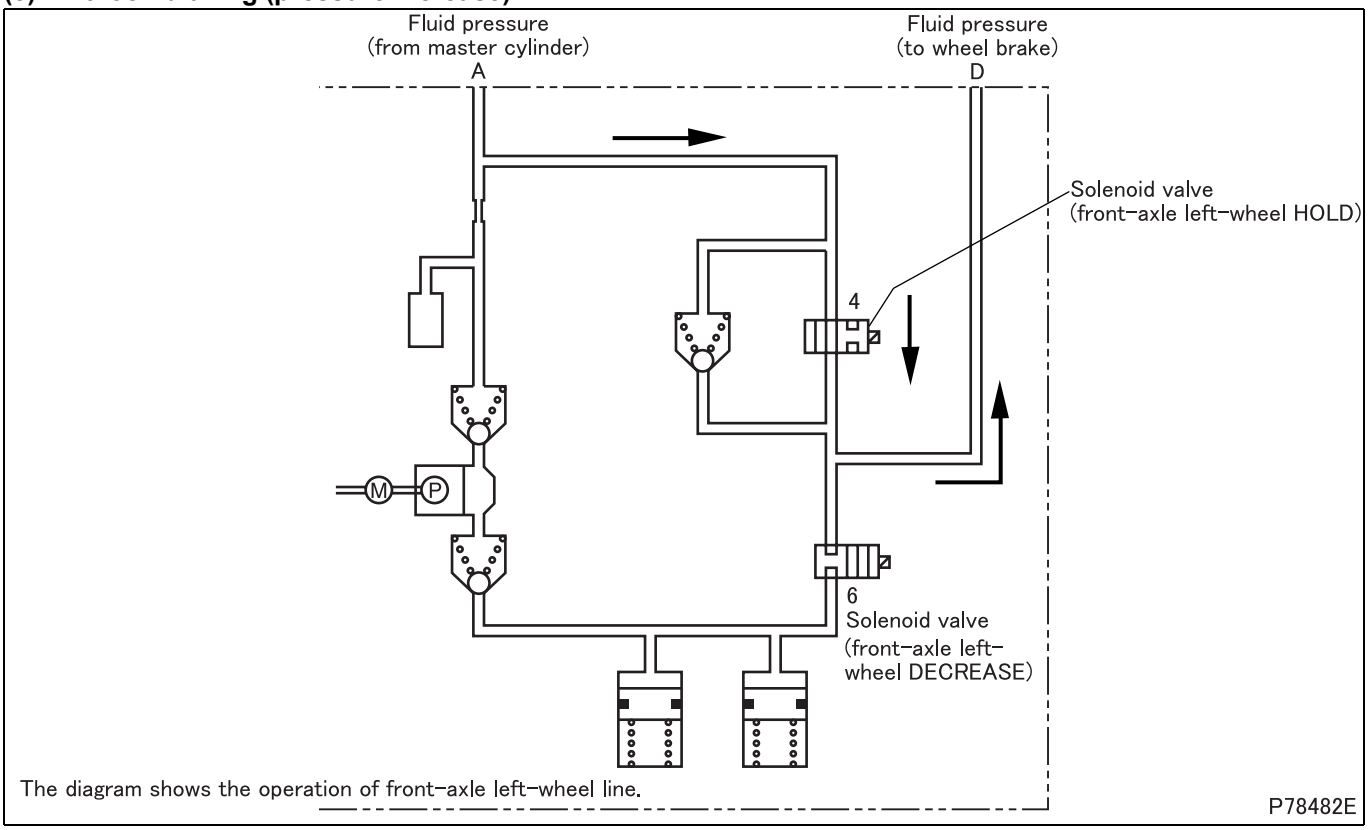
- When the brake pedal is depressed and there is imminent wheel lock-up, the hydraulic unit (electronic control unit) sends control signal to the solenoid valve (front-axle left-wheel DECREASE) and the solenoid valve (front-axle left-wheel HOLD). The former valve will open while the latter valve will close.
- Pressure fluid form the wheel brake **D** now flows past the solenoid valve (front-axle left-wheel DECREASE) and to the reservoirs. The line pressure will drop.
- When the hydraulic unit (electronic control unit) sends control signal to the solenoid valve (front-axle left-wheel DECREASE) and the solenoid valve (front-axle left-wheel HOLD), it also sends control signal to the motor at the same time, causing the plunger pump (front axle) to start pumping. Pressure fluid in the reservoirs now flows past the inlet valve (front axle), the outlet valve (front axle), the damper (front axle) and the orifice (front axle) and returns to the master cylinder.
- During this process, the check valve (front-axle left-wheel) remains closed by the fluid pressure **A** from the brake master cylinder. As a result, no pressure fluid from the master cylinder flows to the wheel brake.

(4) Antilock braking (pressure hold)



- When it becomes necessary to hold the fluid pressure **D** in the wheel brake at the same level as part of antilock brake system control, the hydraulic unit (electronic control unit) sends “HOLD” signal to the solenoid valve (front-axle left-wheel HOLD). As a result, both of the solenoid valve (front-axle left-wheel HOLD) and the solenoid valve (front-axle left-wheel DECREASE) will be closed, which holds the fluid pressure in the wheel brake at the current level.
- The check valve (front-axle left-wheel) remains closed by the fluid pressure **A** from the brake master cylinder.

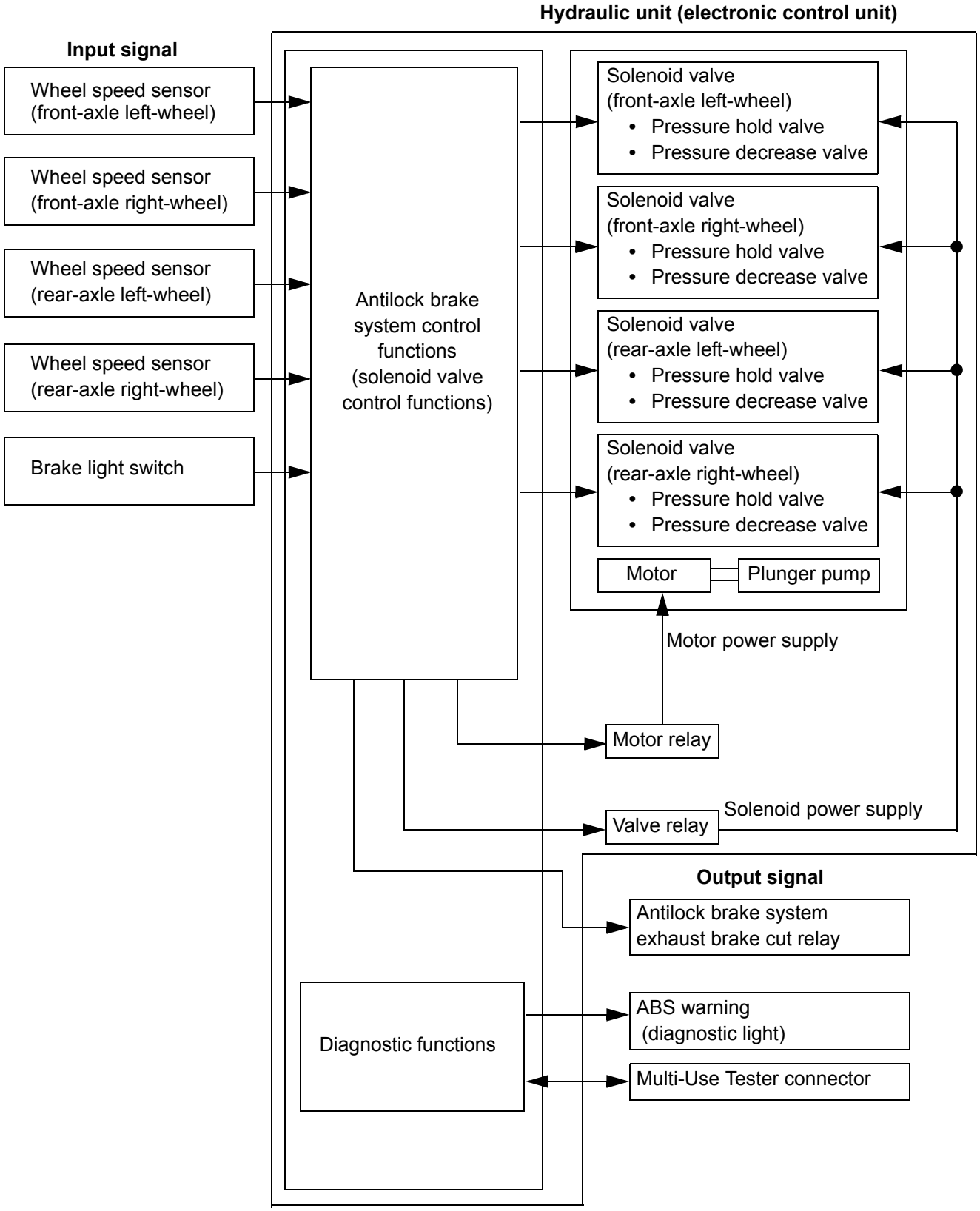
(5) Antilock braking (pressure increase)



- When it becomes necessary to increase the fluid pressure **D** in the wheel brake, control signal from the hydraulic unit (electronic control unit) to the solenoid valve (front-axle left-wheel HOLD) and to the solenoid valve (front-axle left-wheel DECREASE) will be cut off.
- As a result, the solenoid valve (front-axle left-wheel HOLD) will open while the solenoid valve (front-axle left-wheel DECREASE) will close. Both valves are now in their normal-braking positions. Fluid pressure **A** being generated by the depression of the brake pedal is now applied to the wheel brake to increase the braking force.

2. Electronic Control System

2.1 Block diagram



Part	Primary function or operation
Wheel speed sensor	Senses wheel speed
Brake light switch	Senses the depression of brake pedal
Antilock brake system exhaust brake cut relay	Cuts off exhaust brake in antilock braking mode
ABS warning (diagnostic light)	Displays antilock brake system faults; Performs system check
Multi-Use Tester connector	Communicates with Multi-Use Tester; Displays/Clears diagnosis codes

2.2 Antilock brake system control functions

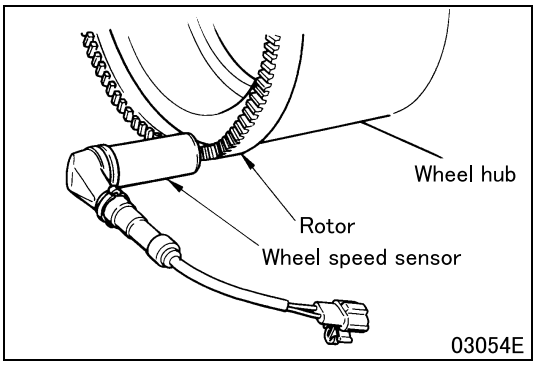
- The hydraulic unit (electronic control unit) continuously monitors signals from the wheel speed sensors. The unit sends signal to solenoid valves.

(1) Antilock brake system fail-safe

- If any fault occurs in the antilock brake system, the warning light comes on to warn the driver of the fault and the normal braking will resume in place of the antilock braking which will be disabled.

(2) Antilock brake system and exhaust brake

- On slippery roads, wheel lock-up can result even from application of the exhaust brake. In the antilock braking mode, activation of the exhaust brake makes it difficult for antilock brake system to perform controlled braking.
  To avoid this, the exhaust brake will be disabled upon activation of antilock brake system even when the exhaust brake switch is in the “ON” position.
  The exhaust brake will automatically be enabled upon deactivation of antilock brake system.



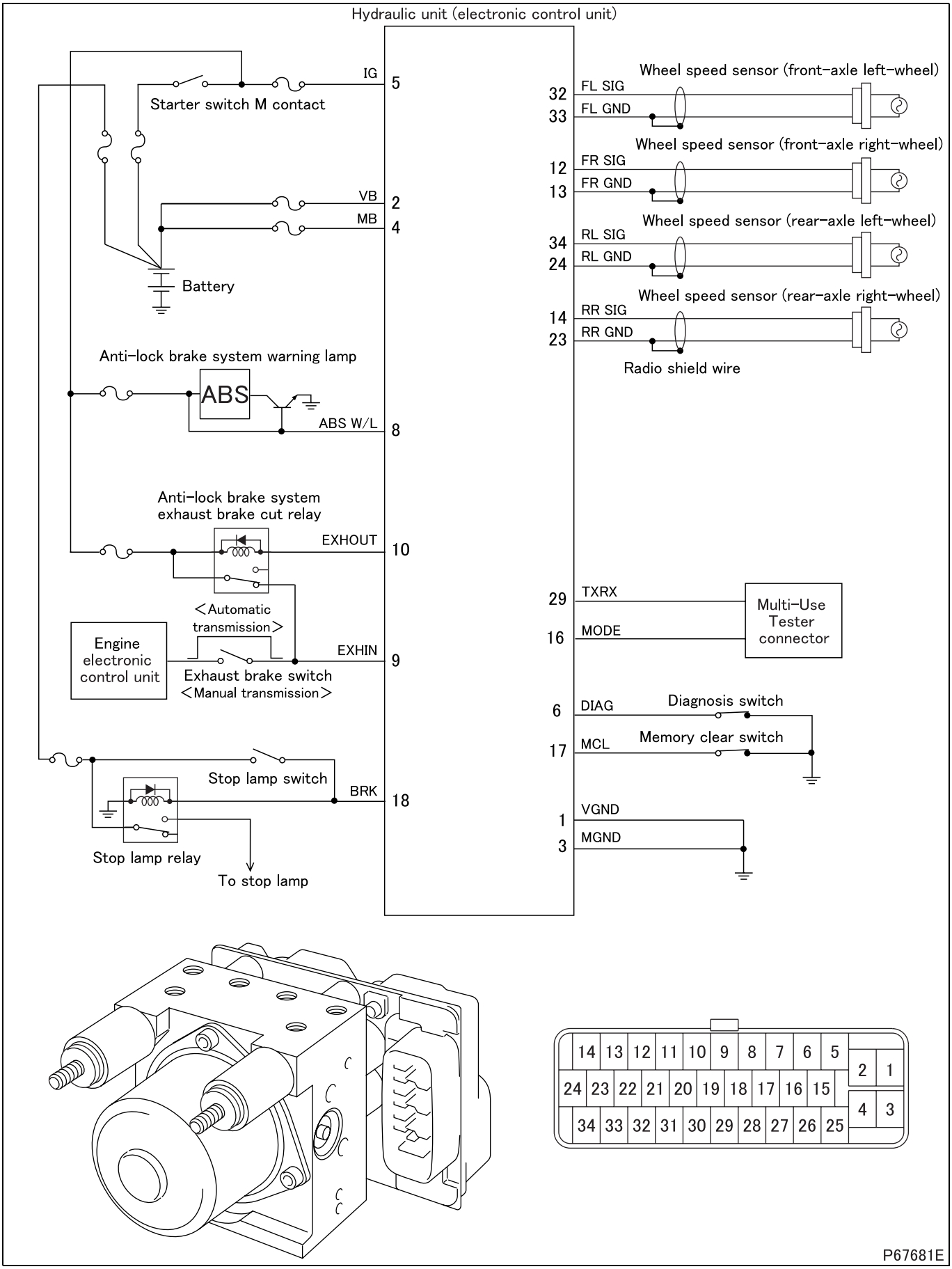
(3) Wheel speed sensor

- Each wheel speed sensor detects wheel speed and sends this as a signal to the hydraulic unit (electronic control unit). The sensor is essentially a magnetic pickup unit, consisting of a permanent magnet core and a coil of wire wound around the core.
- A rotor is fitted onto the wheel hub. This rotor, like a ring gear, has a set of evenly-spaced teeth directly facing the sensor. As the wheel rotates, these teeth pass through the magnetic flux of the sensor, inducing potential difference in the coil which is then sent as a signal (alternating voltage proportional to the wheel speed) to the hydraulic unit (electronic control unit).

2.3 Diagnostic functions

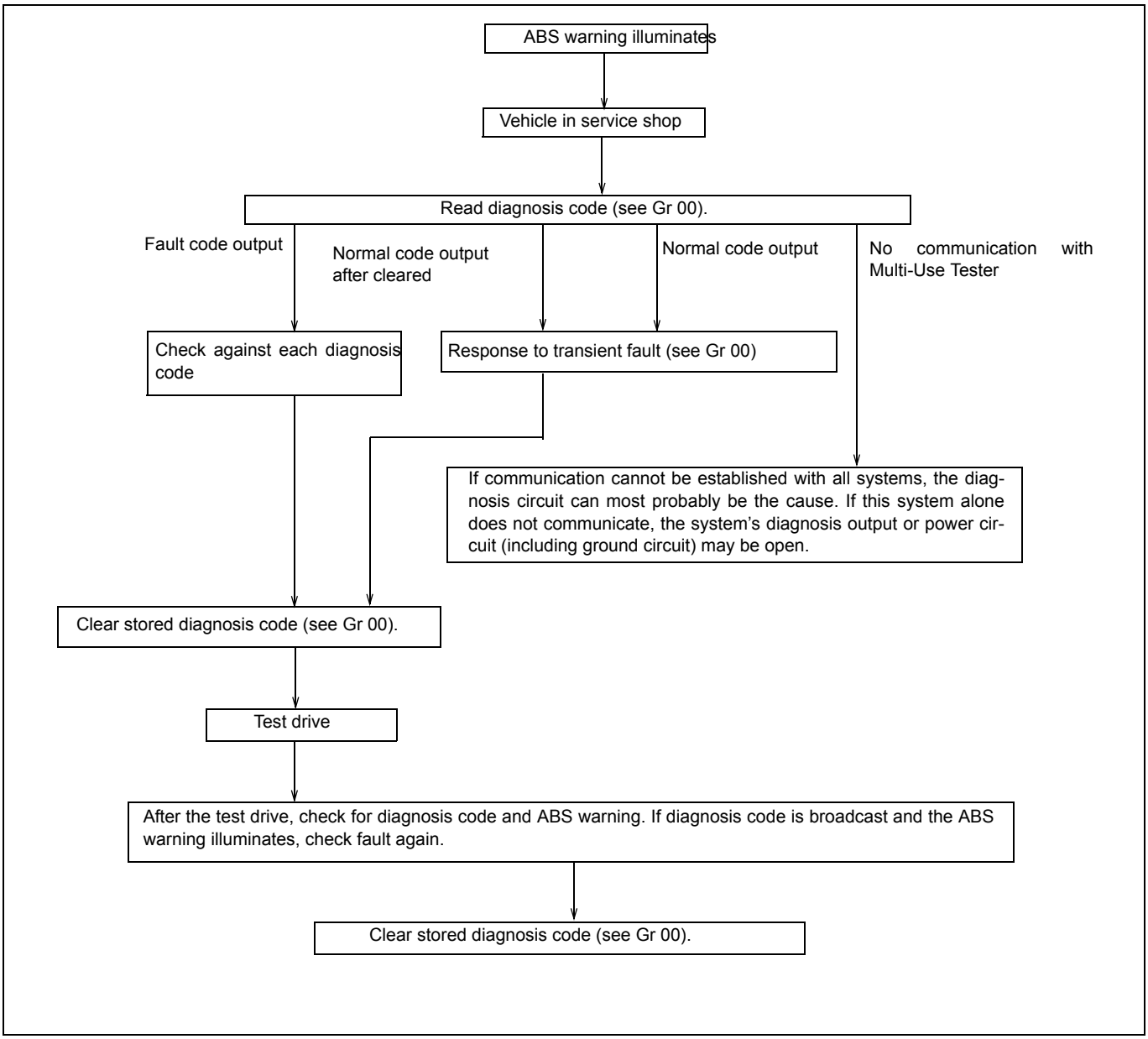
- When the ignition switch is in the ON position, the system continuously monitors the sensors and other system components. If any fault is detected, the system warns the driver of this by displaying the relevant fault information on the meter cluster. At the same time, the system also stores a relevant diagnosis code in the memory and starts operation in the fault mode.
- In the fault-mode operation, the system functions are limited to ensure safety for the driver and the vehicle. Stored diagnosis codes can be accessed using Multi-Use Tester or can be read by observing the flashing of the diagnostic light.

3. Electronic Control Unit Schematic Diagram



1. Diagnosis Procedure

- The system can be efficiently inspected for faults using a Multi-Use Tester.
  System inspection can be accomplished basically in two ways according to trouble symptom and diagnosis code as shown below.
  - Check against each diagnosis code stored in memory by the electronic control unit
  - Response to transient fault



2. Diagnostic Precautions

- Before measuring voltage, check the battery for charged condition and specific gravity. If system inspection is performed with the battery uncharged or reduced in specific gravity, accurate measurements cannot be achieved.
- To avoid having electrical parts damaged, set the ignition switch and headlight switch to LOCK or OFF before disconnecting and reconnecting battery cables.
- Before disconnecting connectors, set the ignition switch to LOCK or OFF, then allow at least 20 seconds. Voltage may remain in electric parts or connected circuit.
- When performing measurement with the tester, handle the test bar carefully so that it does not damage internal circuit and other electrical parts of the electronic control unit to result in a short-circuit failure between terminals in connector or between connector and car body.
- Resistance is affected by temperature. Determine the necessity of resistance measurement following given temperature specification as a guide. Otherwise, use normal temperature (10 to 35°C {50 to 95°F}) as the measuring condition.

3. Diagnosis Based on Diagnosis Codes

3.1 List of diagnosis codes

Code	Message
11	FR SENSOR
12	FL SENSOR
13	RR SENSOR
14	RL SENSOR
21	FR SENSOR SIG
22	FL SENSOR SIG
23	RR SENSOR SIG
24	RL SENSOR SIG
31	BATT VOLT ERR
35	EXB CUT RLY
41	FR VALVE
42	FL VALVE
43	RR VALVE
44	RL VALVE
51	VALVE RLY
52	MOTOR RLY
53	MOTOR ERR
61	ECU ID ERR
63	ECU ERR
64	ILLEGAL WHEEL
65	LONG ABS

3.2 Code generation criteria and inspection items

11: FR SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after ignition switch OFF → ON.
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	11: FR SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

12: FL SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after ignition switch OFF → ON.
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	12: FL SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

13: RR SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after ignition switch OFF → ON.
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	13: RR SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

14: RL SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after ignition switch OFF → ON.
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	14: RL SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

21: FR SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after ignition switch OFF → ON
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	11: FR SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (See Gr26.) • Incorrectly installed wheel speed sensor

22: FL SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after ignition switch OFF → ON
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	12: FL SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (See Gr26.) • Incorrectly installed wheel speed sensor

23: RR SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after ignition switch OFF → ON
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	13: RR SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (See Gr27.) • Incorrectly installed wheel speed sensor

24: RL SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after ignition switch OFF → ON
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	14: RL SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (See Gr27.) • Incorrectly installed wheel speed sensor

31: BATT VOLT ERR

Code generation criteria		Electronic control unit power-supply terminal voltage out of range
Resettability		Normal signal with ignition switch in the ON position
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power supply circuit

35: EXB CUT RLY

Code generation criteria		Antilock brake system exhaust brake cut relay monitor terminal voltage out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Exhaust brake control disabled (no exhaust brake cut while antilock brake system is operating)
Inspection item	Service data	22: EXB CUT RLY, 23: EXB MONITOR
	Actuator test	22: EXB RLY ON
	Electronic control unit connector	03: Antilock brake system exhaust brake cut relay
	Electrical part	#201: Antilock brake system exhaust brake cut relay
	Wiring diagram	Antilock brake system exhaust brake cut relay circuit

41: FR VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

42: FL VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

43: RR VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

44: RL VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

51: VALVE RLY

Code generation criteria		Terminal voltage of valve relay in electronic control unit out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

52: MOTOR RLY

Code generation criteria		Terminal voltage of motor relay in electronic control unit out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Service data	32: MOTOR RLY
	Actuator test	21: ABS MOTOR ON
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit

53: MOTOR ERR

Code generation criteria		Motor terminal voltage out of range
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

61: ECU ID ERR

Code generation criteria		Wiring incorrect for vehicle system
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system enabled
Inspection item	Electronic control unit connector	04: Configuration check
	Wiring diagram	Antilock brake system EXB cut relay circuit

63: ECU ERR

Code generation criteria	Electronic control unit internal fault
Resettability	Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control	Antilock brake system enabled
Other	Clear memory and re-energize. If system still does not reset, replace hydraulic unit (electronic control unit).

64: ILLEGAL WHEEL

Code generation criteria		At 30 km/h {18.6 mph} or above, difference in output signal between wheel speed sensors exceeds the limit. (The difference should be less than 20% between front and rear wheel speed sensors and less than 10% between left and right wheel speed sensors.)
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	11: FR SPEED, 12: FL SPEED, 13: RR SPEED, 14: RL SPEED * Min. speed displayed = 2 km/h {1.2 mph}
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

65: LONG ABS

Code generation criteria		Antilock brake system operates longer than the specified time duration.
Resettability		Normal signal after ignition switch OFF → ON (re-energize electronic control unit)
Electronic control unit control		Antilock brake system disabled
Inspection item	Service data	11: FR SPEED, 12: FL SPEED, 13: RR SPEED, 14: RL SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (See Gr26, Gr27.) • Incorrectly installed wheel speed sensor

4. Multi-Use Tester Service Data

NOTE

- **Service data can be accessed while actuator test is being performed, and vice versa.**

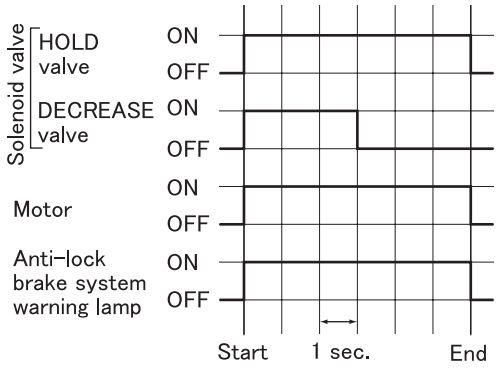
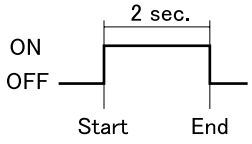
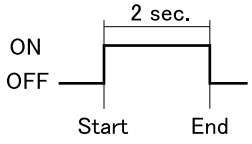
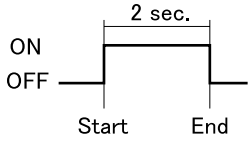
No.	Item	Data	Diagnosis condition	Pass criteria
11	FR SPEED	■■■. ■km/h	Drive at a constant speed	Synchronized with speedometer
12	FL SPEED	■■■. ■km/h		
13	RR SPEED	■■■. ■km/h		
14	RL SPEED	■■■. ■km/h		
15	BATT VOLTAGE	■■. ■■V	Ignition switch ON	Correspond with battery voltage
21	BRAKE SW	ON/OFF	Brake pedal depressed	ON
			Brake pedal released	OFF
22	EXB CUT RLY	ON/OFF	When antilock brake system exhaust brake cut relay activated	ON
			When antilock brake system exhaust brake cut relay not activated	OFF
			[Actuator test] 22: EXB RLY ON	
23	EXB MONITOR	ON/OFF	When antilock brake system exhaust brake cut relay activated	ON
			When antilock brake system exhaust brake cut relay not activated	OFF
			[Actuator test] 22: EXB RLY ON	
24	ABS LAMP	ON/OFF	ABS warning ON	ON
			ABS warning OFF	OFF
			[Actuator test] 23: ABS LAMP ON	
25	DIAGNOSIS SW	OPEN/CLOSE	Diagnosis switch fuse removed	OPEN
			Diagnosis switch fuse plugged in	CLOSE
26	DIAG.RESET SW	OPEN/CLOSE	Memory clear switch fuse removed	OPEN
			Memory clear switch fuse plugged in	CLOSE
27	4WD SW	4WD/2WD	All times	2WD
31	VALVE RLY	ON/OFF	When valve relay activated	ON
			When valve relay not activated	OFF
32	MOTOR RLY	ON/OFF	Motor in operation	ON
			Motor stationary	OFF
			[Actuator test] 11: FR ABS MV ON 12: FL ABS MV ON 13: RR ABS MV ON 14: RL ABS MV ON 21: ABS MOTOR ON	
41	FR-DV	ON/OFF	Solenoid valve energized (front-axle right-wheel DECREASE)	ON
			Solenoid valve de-energized (front-axle right-wheel DECREASE)	OFF
			[Actuator test] 11: FR ABS MV ON	

No.	Item	Data	Diagnosis condition	Pass criteria
42	FR-HV	ON/OFF	Solenoid valve energized (front-axle right-wheel HOLD)	ON
			Solenoid valve de-energized (front-axle right-wheel HOLD)	OFF
			[Actuator test] 11: FR ABS MV ON	
43	FL-DV	ON/OFF	Solenoid valve energized (front-axle left-wheel DECREASE)	ON
			Solenoid valve de-energized (front-axle left-wheel DECREASE)	OFF
			[Actuator test] 12: FL ABS MV ON	
44	FL-HV	ON/OFF	Solenoid valve energized (front-axle left-wheel HOLD)	ON
			Solenoid valve de-energized (front-axle left-wheel HOLD)	OFF
			[Actuator test] 12: FL ABS MV ON	
45	RR-DV	ON/OFF	Solenoid valve energized (rear-axle right-wheel DECREASE)	ON
			Solenoid valve de-energized (rear-axle right-wheel DE-CREASE)	OFF
			[Actuator test] 13: RR ABS MV ON	
46	RR-HV	ON/OFF	Solenoid valve energized (rear-axle right-wheel HOLD)	ON
			Solenoid valve de-energized (rear-axle right-wheel HOLD)	OFF
			[Actuator test] 13: RR ABS MV ON	
47	RL-DV	ON/OFF	Solenoid valve energized (rear-axle left-wheel DECREASE)	ON
			Solenoid valve de-energized (rear-axle left-wheel DECREASE)	OFF
			[Actuator test] 14: RL ABS MV ON	
48	RL-HV	ON/OFF	Solenoid valve energized (rear-axle left-wheel HOLD)	ON
			Solenoid valve de-energized (rear-axle left-wheel HOLD)	OFF
			[Actuator test] 14: RL ABS MV ON	

5. Actuator Test Using Multi-Use Tester

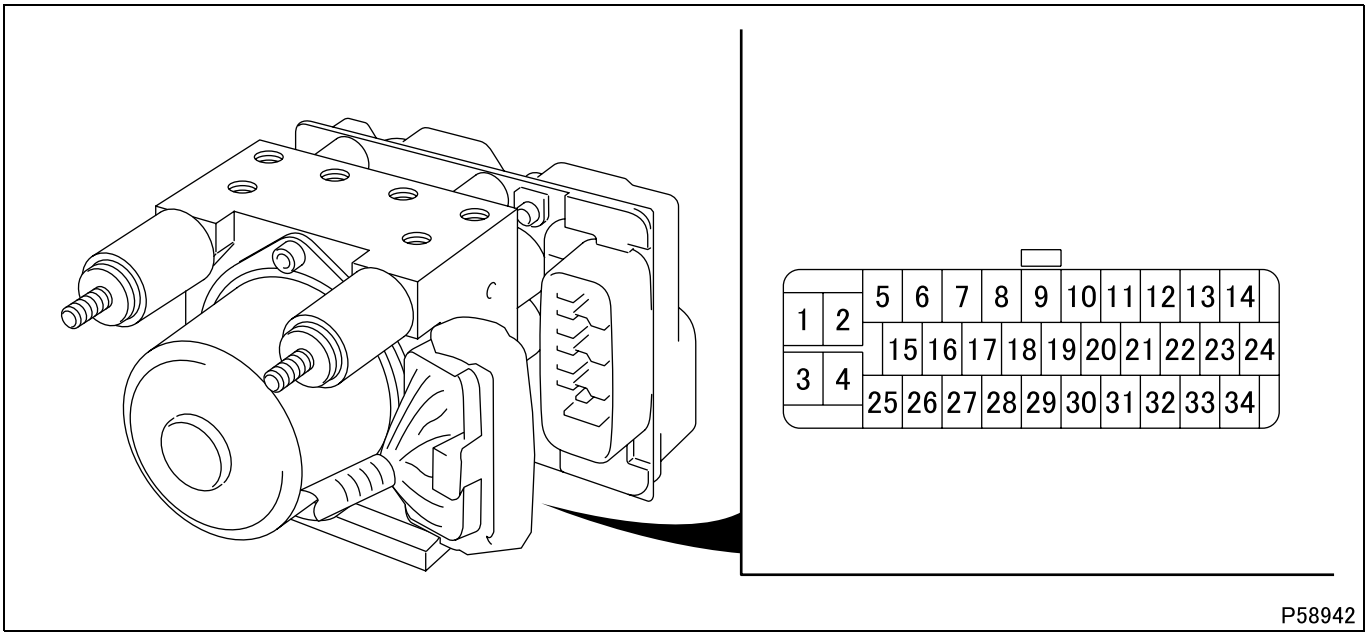
NOTE

- **Service data can be accessed while actuator test is being performed, and vice versa.**

No.	Item	Description	Verification method
11	FR ABS MV ON	 P49621E	Hydraulic unit (electronic control unit) functional check [Service data] 32: MOTOR RLY 41: FR-DV 42: FR-HV 43: FL-DV 44: FL-HV 45: RR-DV 46: RR-HV 47: RL-DV 48: RL-HV Use the data when bleeding the system (See Gr 35A.)
12	FL ABS MV ON		
13	RR ABS MV ON		
14	RL ABS MV ON		
21	ABS MOTOR ON	Motor  P49620E	Motor noise [Service data] 32: MOTOR RLY
22	EXB RLY ON	Exhaust brake cut relay  P49620E	Relay noise [Service data] 22: EXB CUT RLY 23: EXB MONITOR
23	ABS LAMP ON	ABS warning  P49620E	ABS warning ON [Service data] 24: ABS LAMP

6. Inspection at Hydraulic Unit (Electronic Control Unit) Connector

- This inspection is intended to aid troubleshooting by verifying whether or not hydraulic unit (electronic control unit) signals are correctly transmitted via the vehicle harness and connector.
  The ⓫ ⓬ ··· in the table below is a cross reference to the electronic control unit connector inspection items listed in the table in "**3. Diagnosis Based on Diagnosis Codes**" of this manual.



- The inspection requires the connector with a locking feature to be uncoupled. Before carrying out the inspection, read the "Hydraulic Unit Connector Uncoupling and Coupling" in this manual.

CAUTION ⚠

- **Do not touch terminals that are not part of the inspection being performed. When using a tester, be careful not to cause a short circuit across the terminals being measured.**

Check item	Measurement
⓫ Wheel speed sensor resistance	[Condition] • Ignition switch OFF • With the connector uncoupled, inspect at vehicle harness connector half [Pass criteria] Between terminals: 12 and 13 (FR) Between terminals: 32 and 33 (FL) Between terminals: 14 and 23 (RR) Between terminals: 34 and 24 (RL) • The resistance measured should be 1 to 2 kΩ
⓬ Electronic control unit power-supply voltage	[Condition] • Ignition switch ON • With the connector uncoupled, inspect at vehicle harness connector half [Pass criteria] Between terminals (+) - (–): 2 - 1 (VB) 4 - 3 (MB) 5 - 1 (IG) • 10 to 18 V

Check item	Measurement
03 Antilock brake system exhaust brake cut relay voltage	[Condition] • Ignition switch ON • With the connector uncoupled, inspect at vehicle harness connector half [Pass criteria] Between terminals (+) - (–): 10 - 1 (EXHOUT) 9 - 1 (EXHIN) • 10 to 18 V
04 Configuration check	[Pass criteria] Terminals 11, 22 and 30 should be free (no wiring connected). **NOTE** • **If wires are connected to these terminals, disconnect the wires and insulate the exposed portions.**

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Functional Check

1.1 Inspection with vehicle stationary

- While depressing the brake pedal, check the hydraulic unit (electronic control unit) and the brake lines and connections for fluid leakage.
- If fluid is leaking from the hydraulic unit (electronic control unit), replace the unit. If fluid is leaking from the brake lines or connections, retighten the hardware.

1.2 Inspection using brake tester

- Using the brake tester, check each wheel for braking force following the normal procedures.
- If faulty, check the wheel brake in question, the service brake system and the hydraulic unit (electronic control unit).

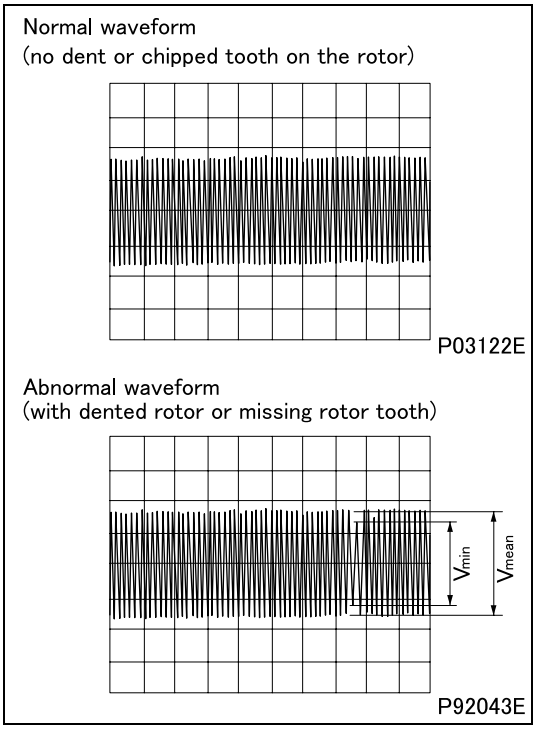
1.3 Inspection of antilock brake system operation while driving the vehicle

WARNING ⚠

- **To prevent personal injury, do not allow any other vehicle or any persons onto the test course during this inspection.**

- The vehicle being tested should be unloaded.
- Apply white tape to the sidewalls of both front and rear tires to aid observation of wheel rotation.
- Turn the ignition switch from LOCK to ON. The ABS warning should illuminate and, in several seconds, go out.
- Drive the vehicle at 20 to 30 km/h {12 to 19 mph} and apply the brakes hard. The wheels should not lock up.

2. Oscilloscope Inspection of Wheel Speed Sensor Signal Waveform



- If the rotor is dented or rotor teeth are missing, do not use the brake tester. Instead, use an oscilloscope capable of recording waveforms.
- Raise the wheel under inspection. Disconnect the wheel speed sensor connector.
- Connect the oscilloscope terminals to the open terminals. Rotate the wheel at a definite speed and check the oscilloscope waveform for a dented rotor or missing rotor teeth.
- In many cases, a dented rotor or missing rotor teeth can be caused by contact of the rotor with the axle. This can occur as the rotor is being press-fitted in the hub tip as part of the process of assembling the hub and brake drum onto the axle. Therefore, take care that the rotor does not touch other parts when the hub and brake drum are assembled to the axle.
- If any wave is evidently smaller in width than others, there should be a dented rotor or missing rotor tooth. The standard wave width is as calculated below.

$$\frac{\text{Vmean} - \text{Vmin}}{\text{Vmean}} \times 100\ \% \ 20\%$$

where
Vmin: Minimum wave width
Vmean: Average of maximum wave widths

- If there is a wave more than 20% smaller in width than others, visually examine the rotor for defects and replace it if any are found (see Gr26, 27).

3. Inspection of Hydraulic Unit (Electronic Control Unit) Operation

3.1 Inspection using Multi-Use Tester

- Raise the vehicle with a jack and support it on safety stands, or place the vehicle on the rollers of a brake tester.

WARNING ⚠

- **Apply the parking brake when testing the front brakes. Chock the front wheels when testing the rear brakes.**

NOTE

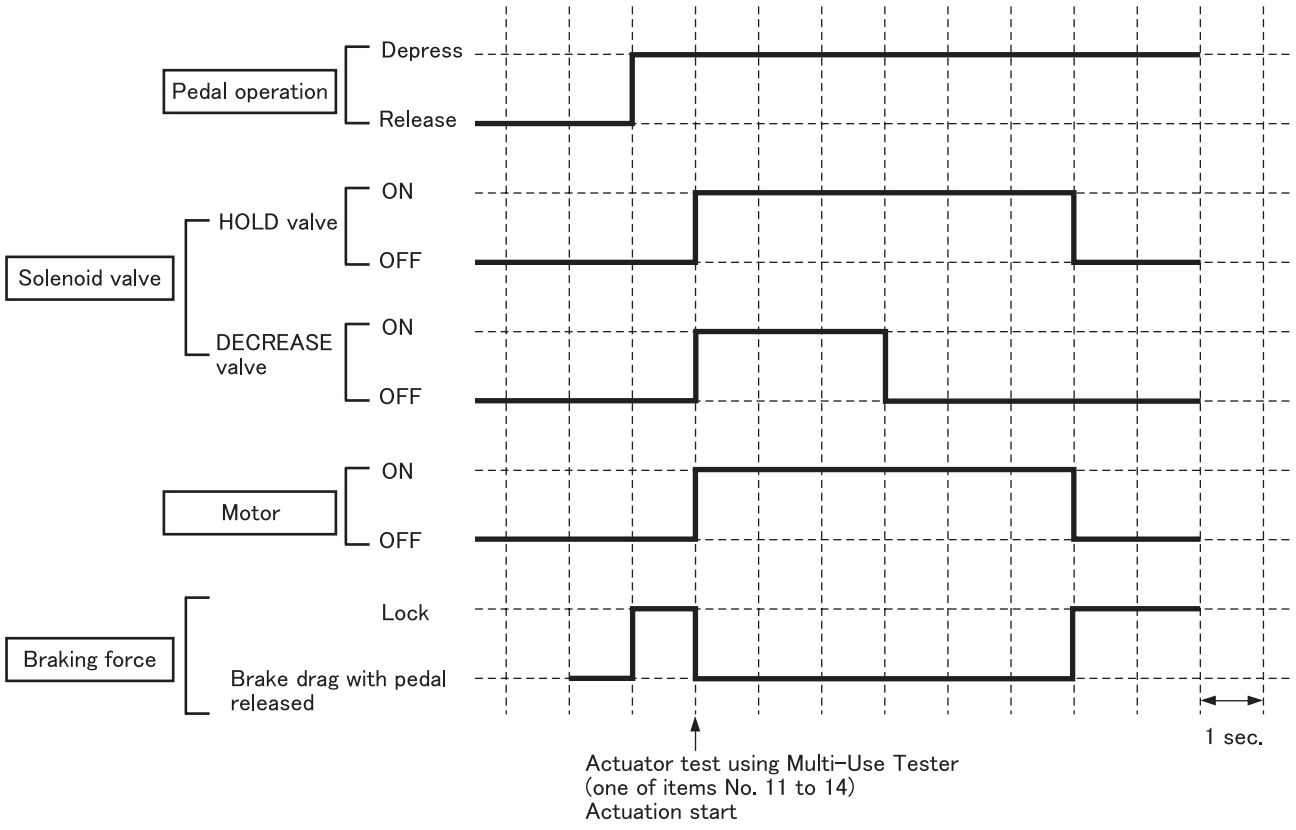
- **During the inspection, keep the brake tester rollers and the tires dry.**

- With the parking brake released, feel the brake drag of each wheel. When using a brake tester, note the brake drag reading.
- Connect the Multi-Use Tester (see Gr00).
- With the transmission in neutral, start the engine.
- Using the Multi-Use Tester, move the actuator.

NOTE

- **It is not possible to test the actuator using the Multi-Use Tester when the hydraulic unit (electronic control unit) is inoperative in fail-safe mode.**

- While rotating the wheel by hand, feel the variation in brake drag/force as the brake pedal is depressed and released. This can be expressed as follows.



- Determine whether the system is faulty or not by referring to the diagnosis table on the next page. If faulty, take the actions indicated.

Diagnosis table (actuator test using Multi-Use Tester)

No.	Multi-Use Tester display	Operation	Diagnosis		Cause	Remedial action
			Normal	Faulty		
11	FR ABS MV ON	(1) Depress the brake pedal to lock up the wheel. (2) Using Multi-Use Tester, select the wheel being tested and move the corresponding actuator. (3) Rotate the wheel being tested using the brake tester or by hand, and check the variation in braking force.	Braking force drops for 6 seconds following wheel lock-up.	Wheel will not lock up when brake pedal is depressed.	Clogged brake line outside hydraulic unit (electronic control unit)	Inspect and clean brake line
12	FL ABS MV ON				Clogged line inside hydraulic unit (electronic control unit)	Replace hydraulic unit (electronic control unit)
13	FR ABS MV ON			Braking force will not drop.	Incorrectly connected hydraulic unit (electronic control unit) brake piping	Connect piping correctly
14	RL ABS MV ON				Faulty hydraulic unit (electronic control unit) magnetic valve	Replace hydraulic unit (electronic control unit)

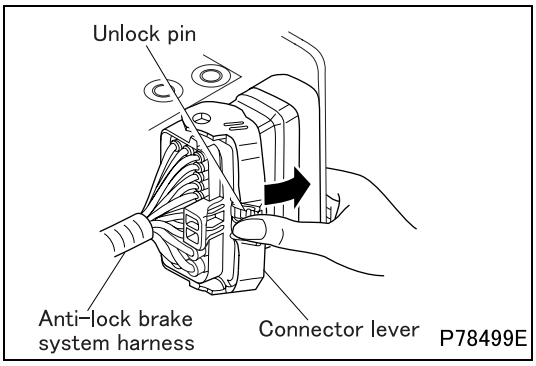
- With the inspection completed, turn the ignition switch to LOCK before removing the Multi-Use Tester.

4. Inspection after Replacing or Removing/Installing Hydraulic Unit (Electronic Control Unit)

- Check the hydraulic unit (electronic control unit) for normal operation.
- After replacing or removing/installing the hydraulic unit (electronic control unit), always check the system for normal operation. Controlled braking will not be available if the piping is incorrect.
- After replacement or reinstallation of the hydraulic unit (electronic control unit), be sure to bleed the brake system. (See Gr35A.)
- The vehicle harness connector is equipped with a locking device. For correct use of the device, refer to "**HYDRAULIC UNIT CONNECTOR COUPLING AND UNCOUPLING**" in this manual.

HYDRAULIC UNIT CONNECTOR COUPLING AND UNCOUPLING

1. Uncoupling the Connector



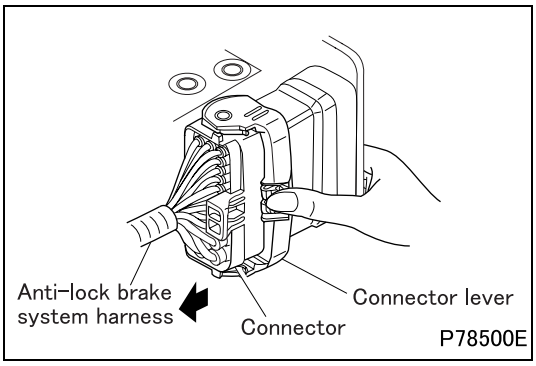
- While holding the connector, push the unlock pin on the connector lever.
- With the connector unlocked, push the connector lever in the direction of the arrow.

CAUTION ⚠

- **Do not force the connector lever. It may break.**

NOTE

- **If the connector lever will not move, return the connector lever to the locked position and try again.**

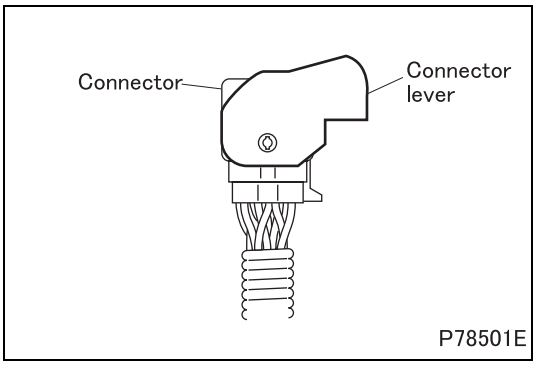


- With the connector lever fully pushed back, remove it, together with the antilock brake system harness, while continuing to hold the connector.

CAUTION ⚠

- **If the locking device is not completely unlocked, do not attempt to remove the connector by force. This may damage the connector. Push the connector lever all the way back and try again.**

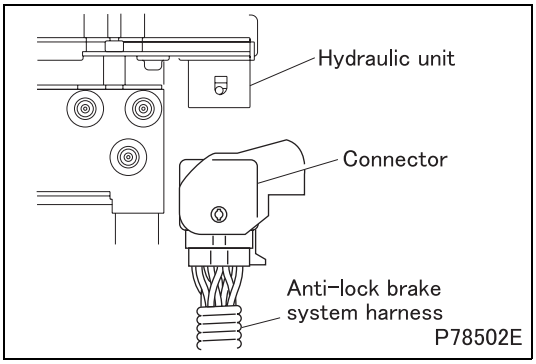
2. Coupling the Connector



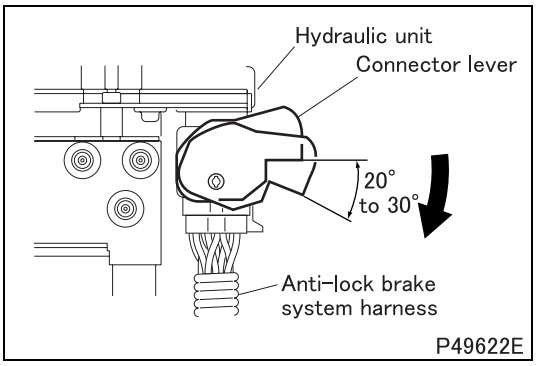
- Ensure that the connector terminals are clean and free from dirt or debris.
- Set the connector lever to the position shown in the illustration.

CAUTION ⚠

- **If the connector lever is not properly positioned, trying to plug in the connector may damage the connector lever.**



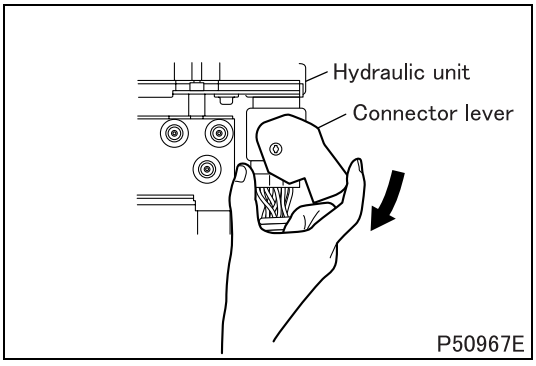
- Insert the antilock brake system harness connector straight into the other connector half on the hydraulic unit.



- Gently turn the connector lever to the specified angle in the direction of the arrow.

CAUTION ⚠

- **If the connector lever fails to turn to the specified angle, start the connector installation procedure again from the beginning. If this is not done, the connector lever could be broken when it is turned in the next step.**

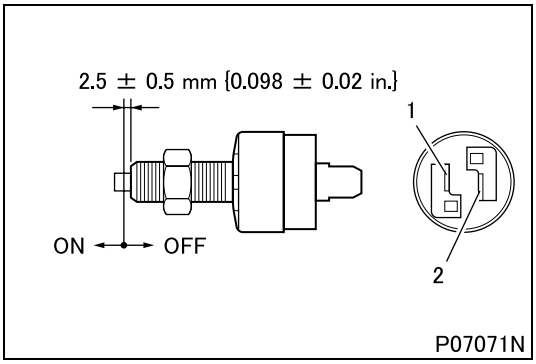


- In order to lock the connector lever, turn the lever in the direction of the arrow until it clicks. Apply force to the central part of the lever while holding the connector body.

NOTE

- **If the connector is not completely connected, the antilock brake system (ABS) warning may be illuminated. If the light is illuminated, start the connector installation procedure again.**

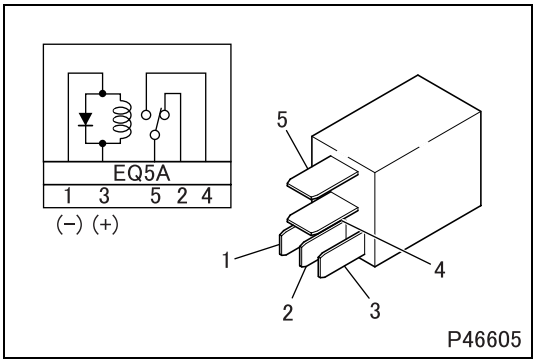
INSPECTION OF ELECTRICAL COMPONENTS



#042 Inspection of brake light switch

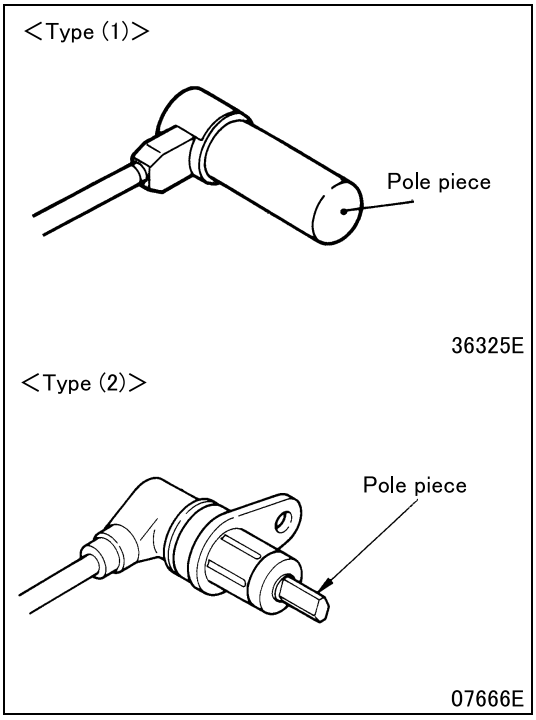
Switch position	Continuity between the terminals
OFF	–
ON	1 – 2

- If faulty, replace the brake light switch.



#201 Inspection of relay (normally open 5-pin relay)

- Check the relay for continuity and normal operation. If faulty, replace the relay.



#329 Inspection of wheel speed sensor

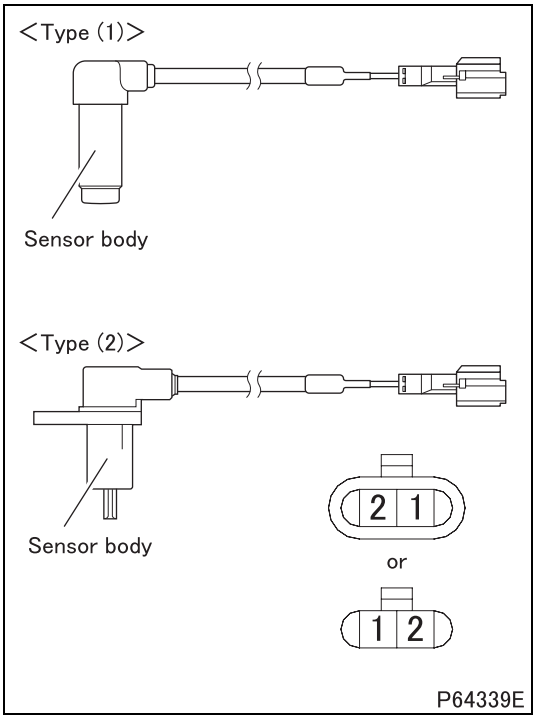
- Manufacturer of wheel speed sensor.

Type	Manufacturer
(1)	Sumitomo Electric
(2)	Bosch

- Carry out the following checks. If faulty, replace the wheel speed sensor.

CAUTION ⚠

- **The pole piece is magnetized by the magnet housed in the wheel speed sensor. Be careful not to allow metal parts to stick onto the pole piece.**



(1) Resistance between terminals

Standard value	Type (1)	1.4 ± 0.2 kΩ
	Type (2)	1.6 ± 0.16 kΩ

(2) Insulation resistance (between the sensor body and each terminal)

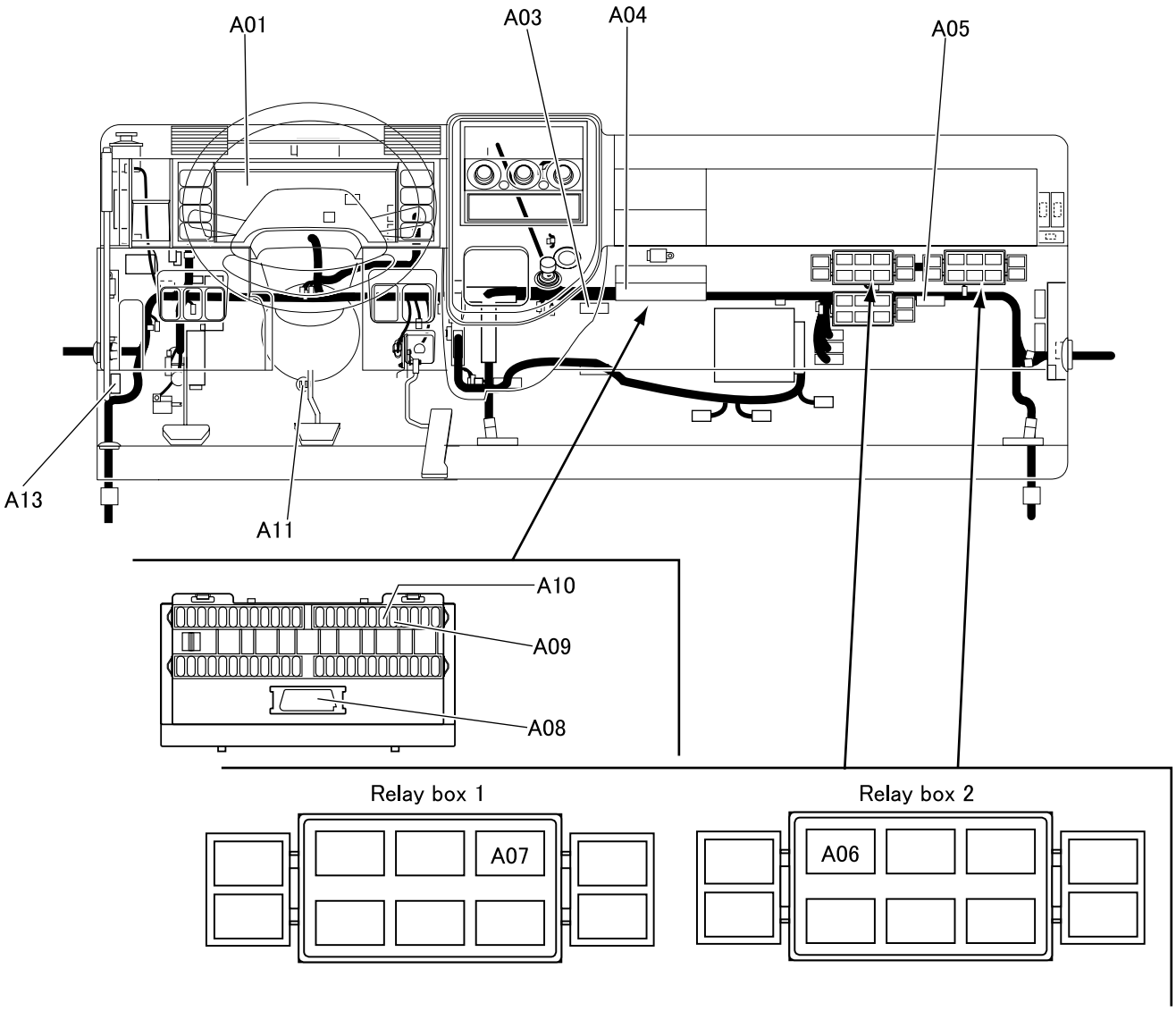
Standard value	Type (1)	1000 kΩ or above
	Type (2)	100 kΩ or above

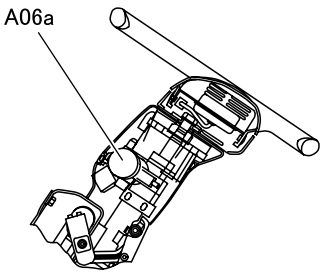
(3) Open circuit

- If open circuit is suspected, remove the harness clamps and wiggle the harness to determine whether it is an intermittent fault or not. Check also the connector terminals for proper connection.

COMPONENT LOCATIONS

A01 to 13





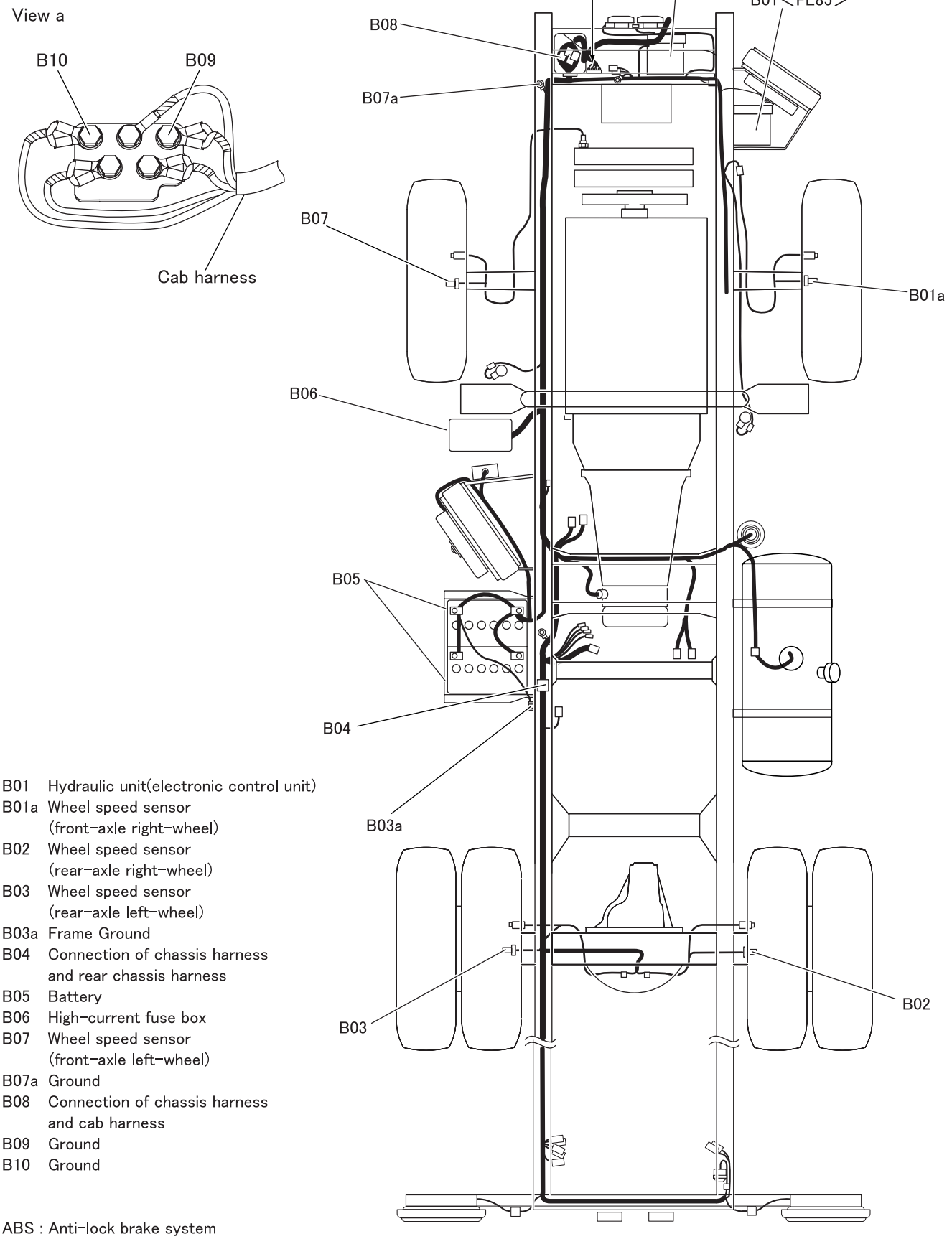
No relevant parts in a missing number

A01 Meter cluster
A03 Joint connector (J/C-1)
A04 Fuse box
A05 Joint connector (J/C-2,3)
A06 ABS exhaust brake cut relay
A06a Starter switch
A07 Stop lamp relay
A08 Multi-Use Tester connector (for recorder)
A09 Memory clear switch
A10 Diagnosis switch
A11 Stop lamp switch
A13 Multi-Use Tester connector (for inspection)

ABS:Anti-lock brake system

L01276

B01 to 10

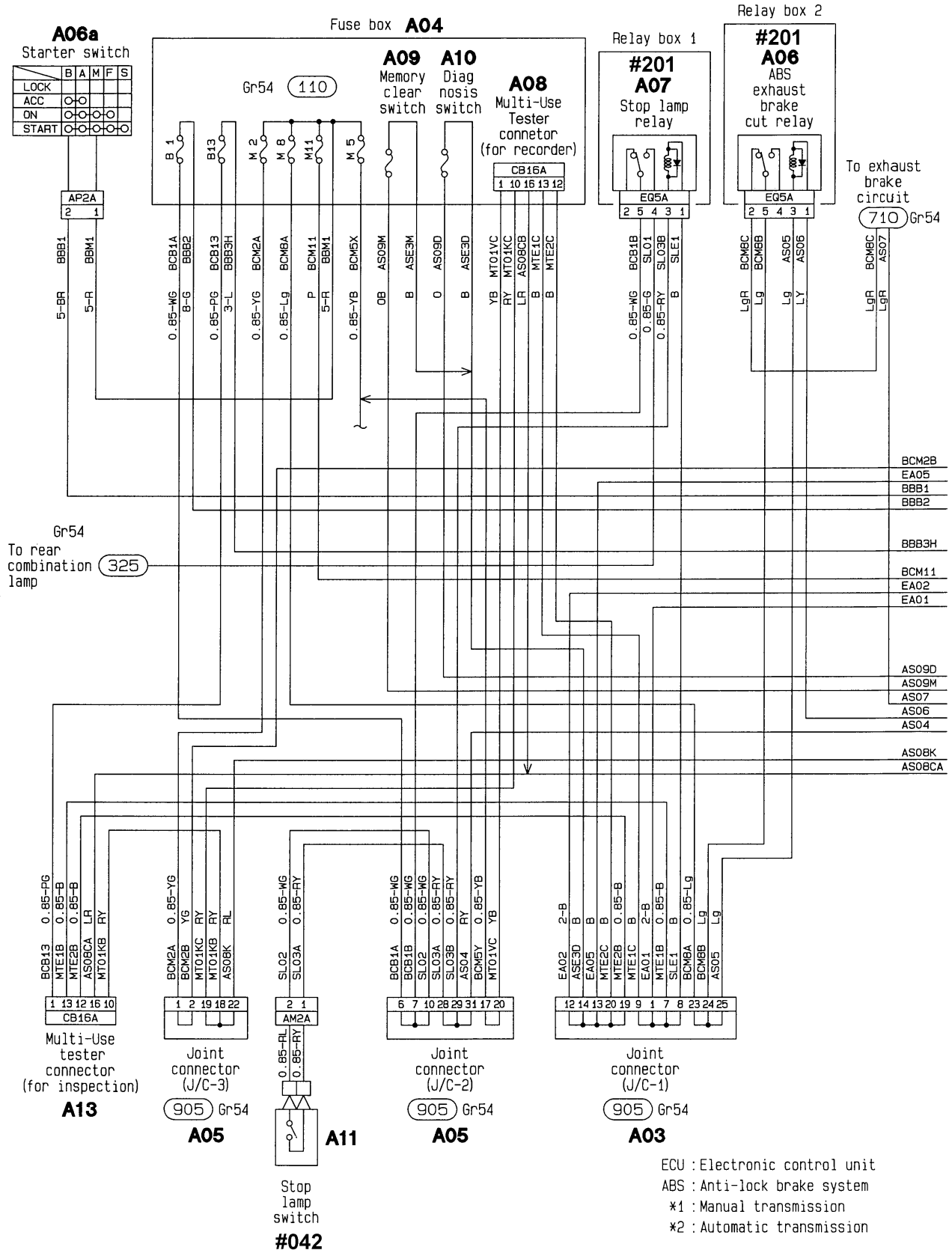


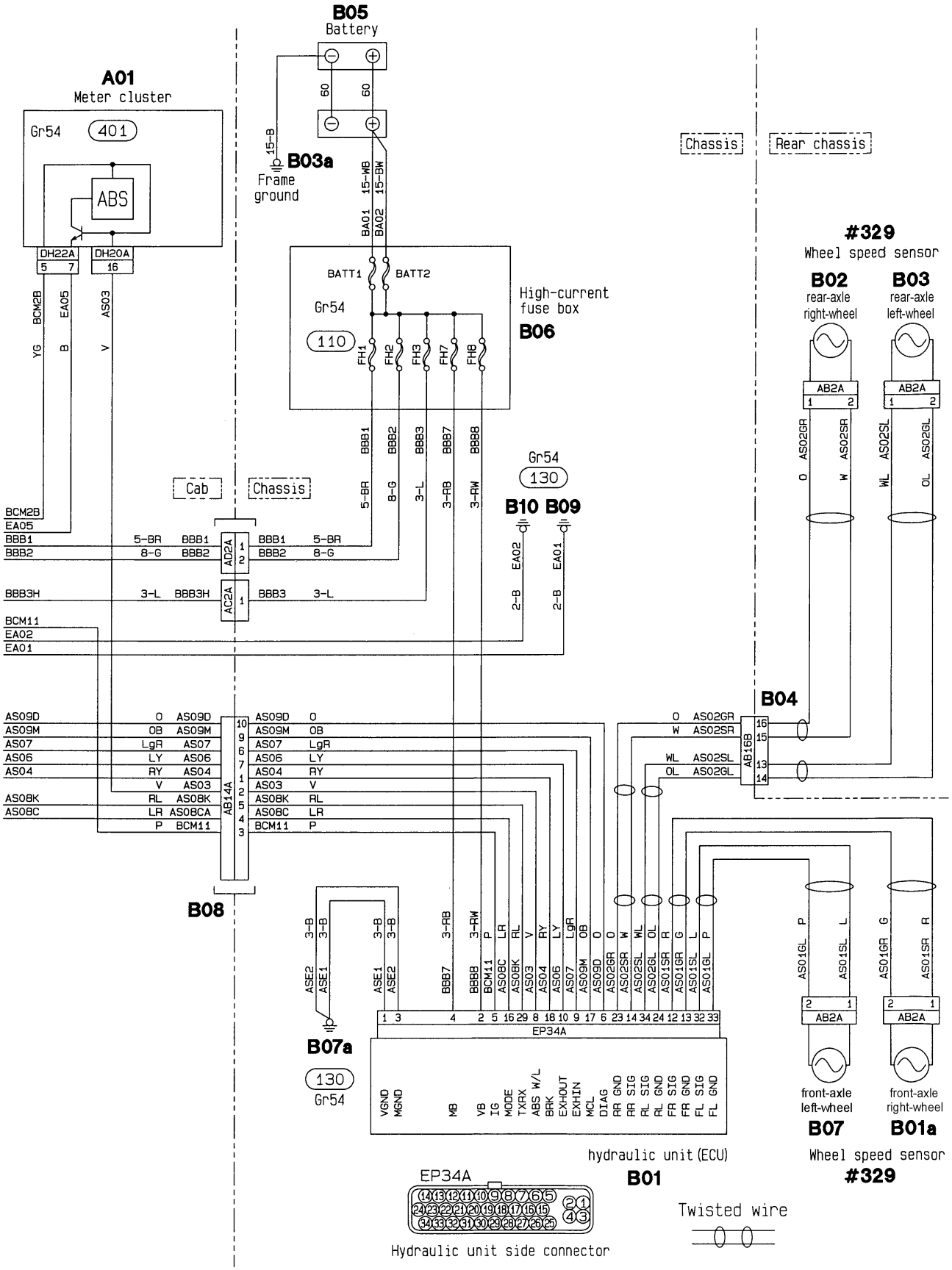
B01 Hydraulic unit(electronic control unit)
B01a Wheel speed sensor (front-axle right-wheel)
B02 Wheel speed sensor (rear-axle right-wheel)
B03 Wheel speed sensor (rear-axle left-wheel)
B03a Frame Ground
B04 Connection of chassis harness and rear chassis harness
B05 Battery
B06 High-current fuse box
B07 Wheel speed sensor (front-axle left-wheel)
B07a Ground
B08 Connection of chassis harness and cab harness
B09 Ground
B10 Ground

ABS : Anti-lock brake system

L01274

ELECTRICAL WIRING DIAGRAM




B05
Battery
A01
Meter cluster
Gr54
401
ABS
DH22A
DH20A
B03a
Frame ground
BA01
BA02
15-WB
15-BW
BATT1
BATT2
Gr54
110
FH1
FH2
FH3
FH7
FH8
High-current fuse box
B06
Chassis
Rear chassis
#329
Wheel speed sensor
B02
rear-axle right-wheel
B03
rear-axle left-wheel
AB2A
Cab
Chassis
AD2A
AC2A
BCM2B
EA05
BBB1
BBB2
BBB3H
BCM11
EA02
EA01
B10 B09
Gr54
130
B04
AB16B
AS09D
AS09M
AS07
AS06
AS04
AS03
AS08K
AS08C
AB14A
B08
ASE2
ASE1
B07a
130
Gr54
EP34A
VGND
MGND
MB
VB
IG
MODE
TXRX
ABS W/L
BRK
EXHOUT
EXHIN
MCL
DIAG
RR GND
RR SIG
RL SIG
RL GND
FR SIG
FR GND
FL SIG
FL GND
hydraulic unit (ECU)
B01
front-axle left-wheel
front-axle right-wheel
B07
B01a
Wheel speed sensor
#329
EP34A
Hydraulic unit side connector
Twisted wire

C02282-2

GROUP 36 INDEX

SPECIFICATIONS 36-2

STRUCTURE AND OPERATION
1. Components and Parts 36-3
2. Parking Brake Lever 36-3
3. Parking Brake 36-4

TROUBLESHOOTING 36-5

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Adjustment of Parking Brake Shoe Clearance 36-6
2. Inspection and Adjustment of Parking Brake Lever 36-7

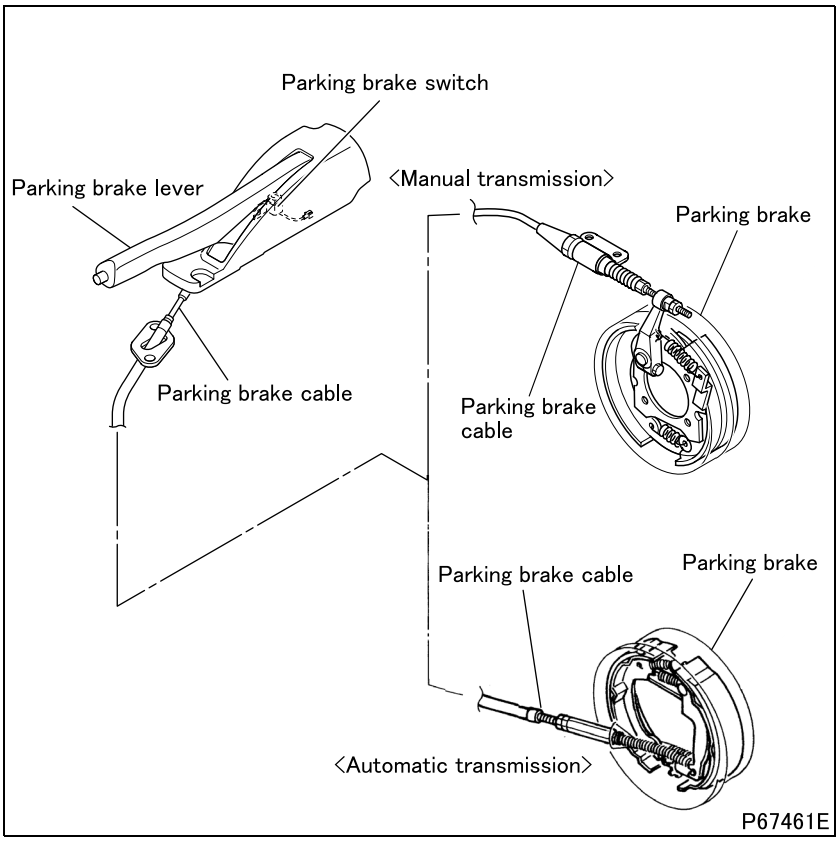
PARKING BRAKE CONTROL 36-10

PARKING BRAKE
<MANUAL TRANSMISSION> 36-14
<AUTOMATIC TRANSMISSION> 36-16

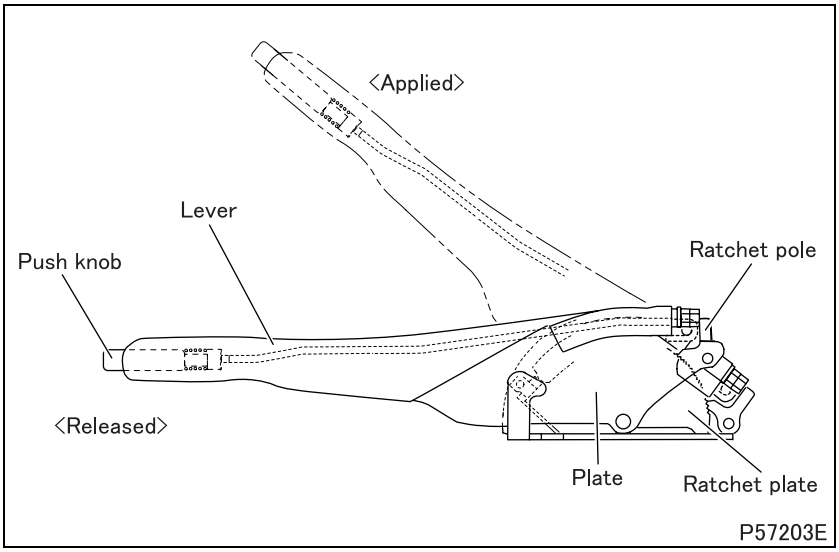
SPECIFICATIONS

Item			Specifications	
Brake	Type		Internal expanding type acting on propeller shaft (driveline)	
	Operation type		Mechanical cable	
Parking brake	Type		Duo servo type	
	Brake drum I.D.	mm {in}	ϕ190 {7.48}	ϕ203.2 {8.00}
	Lining width × thickness	mm {in}	45 × 4.0 {1.77 × 0.16}	50 × 4.0 {1.97 × 0.16}

1. Components and Parts



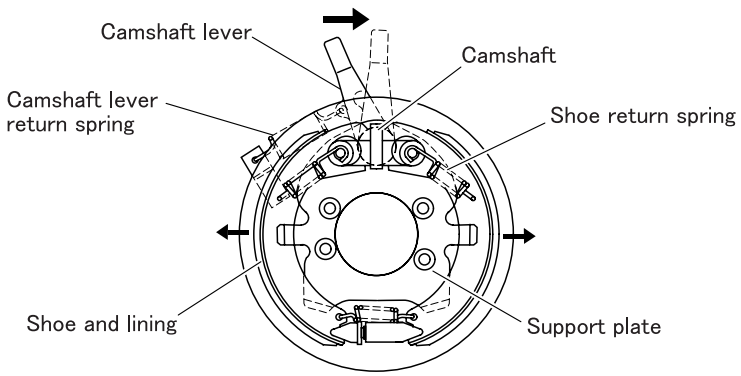
2. Parking Brake Lever



- Pulling the parking brake lever makes the parking brake work, at which point the ratchet pole engages with the ratchet plate and the lever is locked.
- To release the parking brake lever, slightly pull it up while pushing the release knob. This disengages the ratchet pole from the ratchet plate, allowing the parking brake lever to return to the released position.

3. Parking Brake

3.1 Duo servo type <Manual transmission>

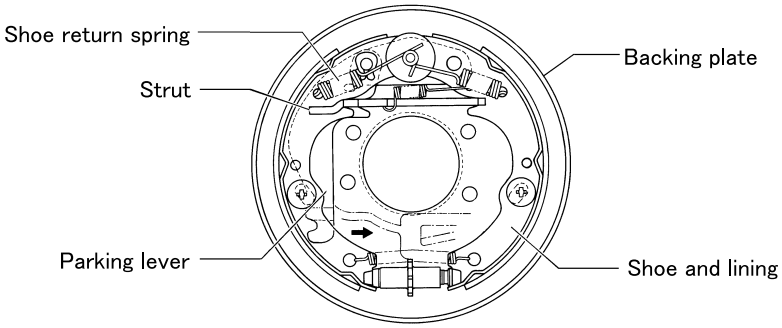


P56131E

- The camshaft lever, which is used to actuate the shoes/linings, is built into the parking brake unit. Pulling the parking brake lever actuates the camshaft lever via the parking brake cable.
- Actuation of the camshaft lever causes the camshaft to rotate, which expands both shoes/linings onto the brake drum. In this case, both shoes/drums function as a leading shoe.
- As the parking brake lever (camshaft lever) is released, the forces of shoe and camshaft lever return springs restore the components to their home positions. This releases the parking brake.

3.2 Duo servo type

<Automatic transmission>



67462E

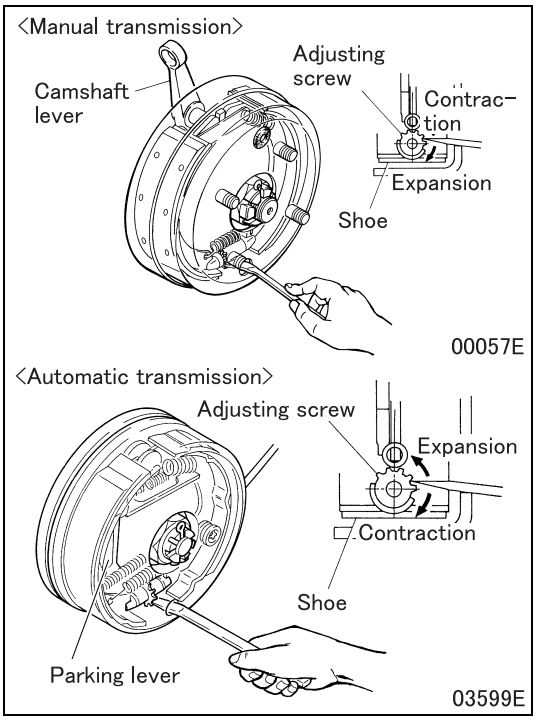
- The parking lever that actuates the shoe and lining is a built-in component of the parking brake body. Pulling the parking brake lever pulls the parking brake cable, which in turn pulls the parking lever.
- When the parking lever is pulled, one shoe and lining is forced to expand with the medium of strut. At the same time, the parking lever directly expands the other shoe and lining. Thus, each shoe and lining assembly works as a leading shoe.
- When the parking brake lever (parking lever) is returned to the released position, the repercussive force of the shoe return spring releases the brake.

Possible causes / Symptoms		Parking brake does not work	Parking brake release not smooth (dragging)	Parking brake lever operating physical force insufficient	Parking brake lever operating physical force excessive	Reference Gr
Parking brake cable	Inner cable stretched or damaged	O	O	O	O	
	Inner cable improperly adjusted	O	O	O	O	
	Front parking cable and rear parking cable improperly connected	O	O	O	O	
	Front parking cable and rear parking cable joints in poor contact	O	O	O	O	
Parking brake lever	Ratchet pole and ratchet plate pawl engaged improperly	O				
	Pulling stroke insufficient		O		O	
	Pulling stroke excessive	O		O		
Parking brake	Shoe clearance insufficient		O		O	
	Shoe clearance excessive	O		O		
	Parking brake drum inner surface deformed or warped	O		O		
	Lining worn unevenly	O		O		
	Brake drum inner surface greasy or oily	O				
	Lining surface greasy or oily	O				
	Camshaft lever return spring fatigued or fractured <Manual transmission>		O			
	Shoe return spring fatigued or fractured		O			

1. Adjustment of Parking Brake Shoe Clearance

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	Brake shoe clearance	Manual transmission	0.1 to 0.25 {0.0039 to 0.0098}	–	Adjust
		Automatic transmission	0.2 to 0.25 {0.0079 to 0.0098}	–	



- Chock the front wheels and raise the rear wheels with a jack before adjusting the shoe clearance.
- Operate the parking brake lever to release the parking brake. (The parking lever or camshaft lever is released from locking.)
- Using a standard screwdriver inserted through the shoe adjusting hole in the parking brake drum, turn the adjusting screw in the C direction (expansion) shown to bring the shoe into close contact with the brake drum.
- Turn the adjusting screw 8 notches in the B direction (contraction) shown from the position where the shoe is in close contact with the drum. The shoe clearance should be adjusted to the standard value.

2. Inspection and Adjustment of Parking Brake Lever

Service standards

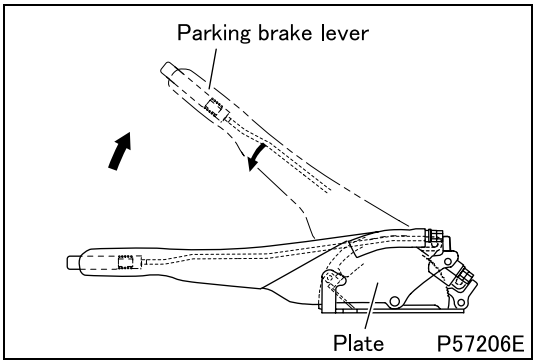
Location	Maintenance item	Standard value	Limit	Remedy
–	Parking brake lever pulling stroke (with operating physical operating of 300N {67 lbf})	7 to 9 notches	–	Adjust or inspect

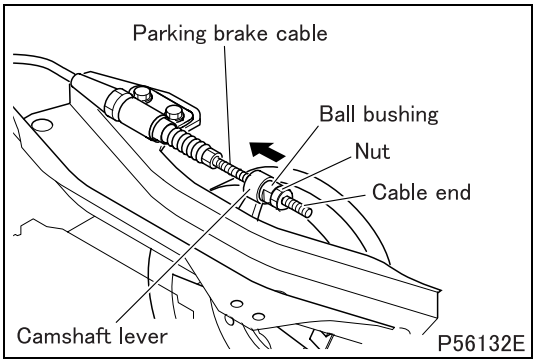
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
–	Lock nut <Automatic transmission>	18.7 to 27.5 {14 to 20}	–

Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
–	Camshaft lever (on sliding face with parking brake cable and on contact face with ball bushing) <Manual transmission>	Chassis grease [NLGI No. 1 (Li soap)]	As required





[Inspection]

- Pull the parking brake lever from the released position with an operating physical force of 300N {67 lbf} and count the number of cleared notches.
- If the count of notches deviates from the specified range of standard values, adjust the length of the parking brake cable.
- If the count of notches (pulling stroke) is still out of the specified range after cable length adjustment, check the parking brake shoe clearance.

[Adjustment]

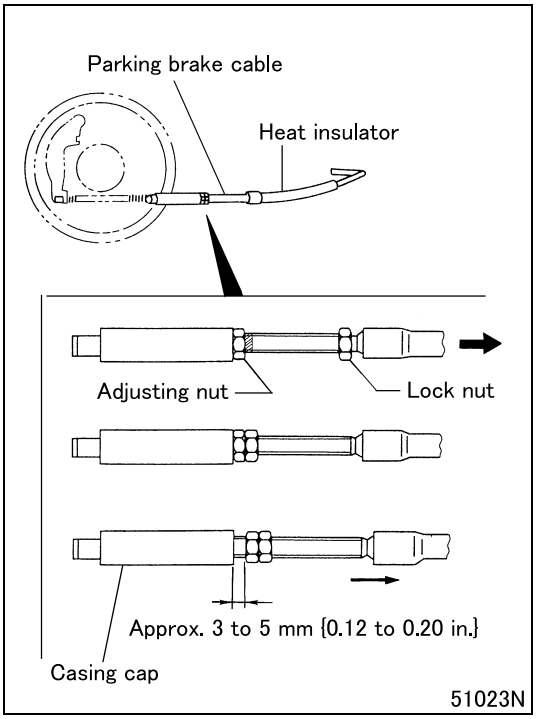
<Manual transmission>

- Pull on the parking brake cable end with a force of 100 N {22 lbf} to remove any slack from the cable.
- Apply grease onto the camshaft lever, on the sliding face with the parking brake cable and on the contact face with the ball bushing.
- While pulling the cable end of the camshaft lever in the direction of the arrow with a force of 45 to 50 N {10 to 11 lbf}, rotate the ball bushing until it contacts the cable end of the camshaft lever.

CAUTION ⚠

- **Do not rotate the ball bushing so much as to cause the camshaft lever to move.**

- Pull the parking brake lever 3 times with a force of 500 N {110 lbf}.
- This operation causes the cable to extend. Rotate the ball bushing again until it contacts the camshaft lever. Then, pull the parking brake lever with a force of 45 to 50 N {10 to 11 lbf}. The camshaft lever should not move more than 1mm {0.039 in}.
- Pull the parking brake lever from the released position with a force of 300 N {67 lbf}. The lever should travel past the specified number of notches. Tighten the nut.



<Automatic transmission>

- Pull the outer cable of the parking brake cable with a force of 60 to 100 N {13 to 22 lbf} to zero the parking brake shoe clearance.

CAUTION ⚠

- **When pulling the outer cable, take care not to move heat insulator on the parking brake cable out of place.**

- While pulling the parking brake cable, tighten the adjusting nut until it seats the cable support end.
- Lock the adjusting nut with the lock nut.
- Operate the parking brake lever several times with the force of 500 N {110 lbf}.
- Pull the outer cable of the rear parking brake cable again with the force of 60 to 100 N {13 to 22 lbf}.

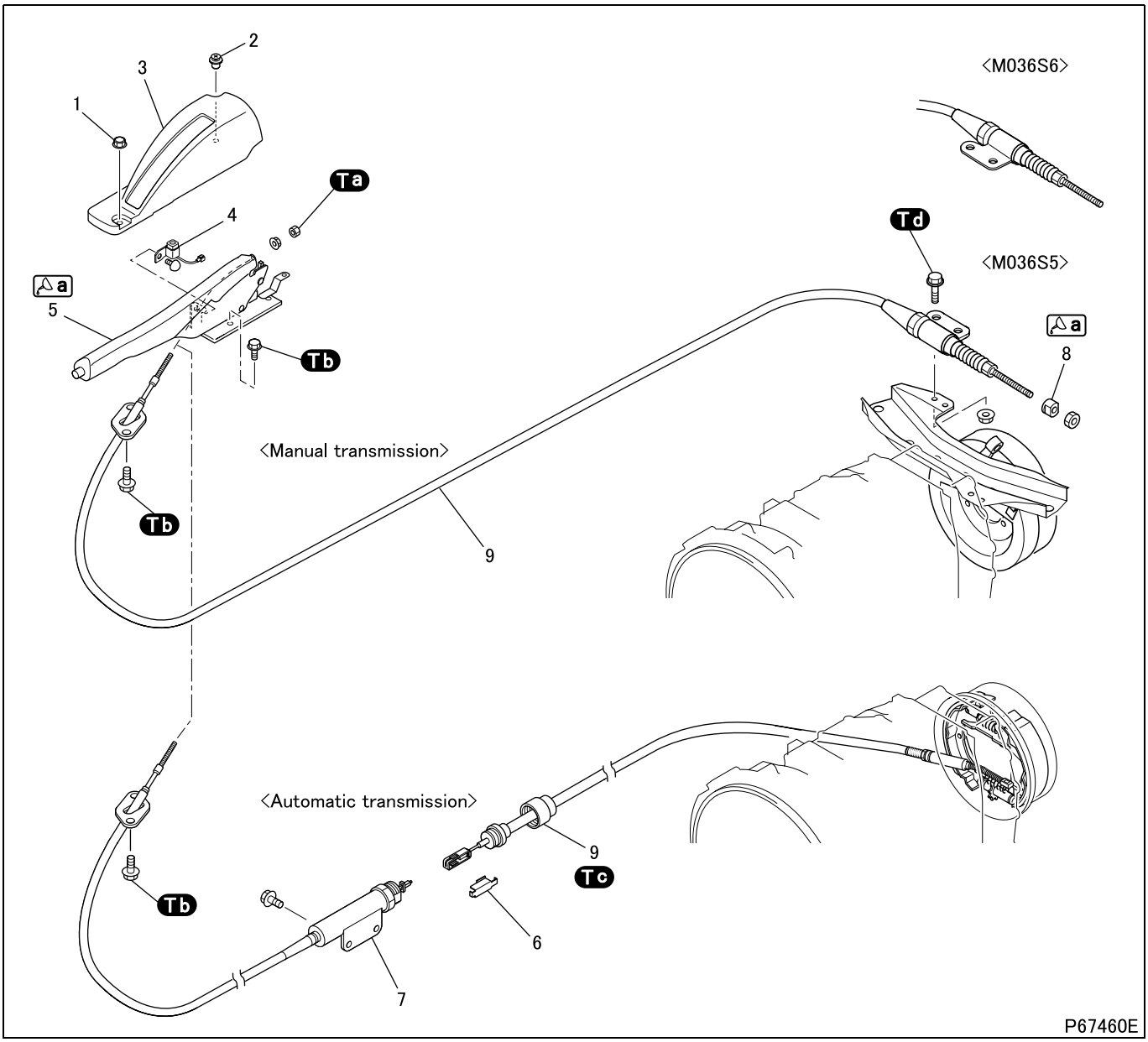
CAUTION ⚠

- **When pulling the outer cable, take care not to move heat insulator on the parking brake cable out of place.**

- Holding the parking brake cable in the pulled state, turn the adjusting nut until its distance from the casing cap becomes 3 to 5 mm {0.12 to 0.20 in} as shown in the illustration.
- Return the parking brake cable to the original position.
- Tighten the lock nut to the specified torque.

M E M O

PARKING BRAKE CONTROL



●Removal sequence

1 Push nut
2 Push turn rivet
3 Cover
4 Parking brake switch
5 Parking brake lever
6 Cap <Automatic transmission>
7 Front parking brake cable <Automatic transmission>
8 Ball bushing <Manual transmission>
9 Parking brake cable <Manual transmission>
Rear parking brake cable <Automatic transmission>

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **Perform the adjustment of the parking brake lever after installation (see ON-VEHICLE INSPECTION and ADJUSTMENT).**

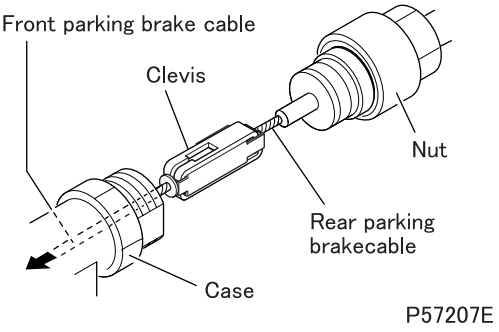
Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
Ta	Nut (parking brake cable attaching)	4 to 6 {3.0 to 4.4}	–
Tb	Bolt (parking brake lever mounting)	12 to 15 {8.9 to 11}	–
	Bolt (parking brake cable attaching)		
Tc	Rear parking brake cable to front parking brake cable connection <Automatic transmission>	62.5 ± 7.5 {46 ± 5.5}	–
Td	Bolt (parking brake cable attaching) <Manual transmission>	19 to 28 {14 to 21}	–

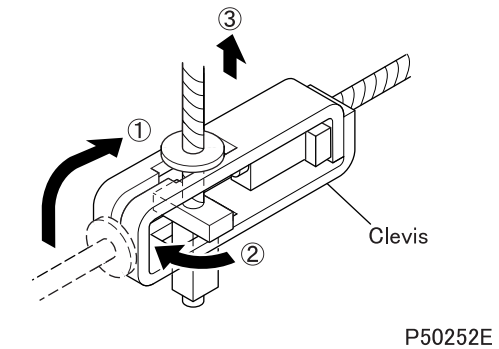
Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
a	Contact surfaces of parking brake lever	Chassis grease [NLGI No. 1 (Li soap)]	As required
	Spherical face of ball bushing <Manual transmission>		

◆Removal procedure◆



P57207E

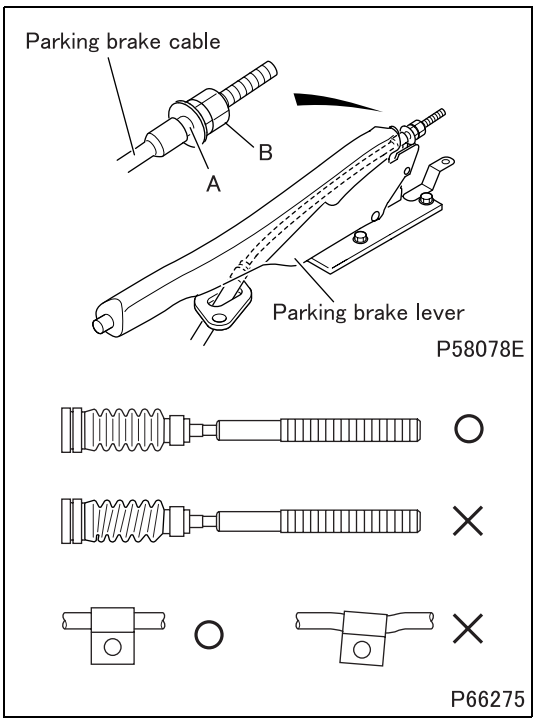


P50252E

■ **Removal: Front parking brake cable <Automatic transmission>**

- Loosen the nut connecting the front and rear parking brake cables, then separate the front parking brake cable case from the rear parking brake cable.
- Remove the cap and pull out the clevis from the front parking brake cable case and remove it at the steps of 1, 2 and 3 in that order as shown.

◆Installation procedure◆

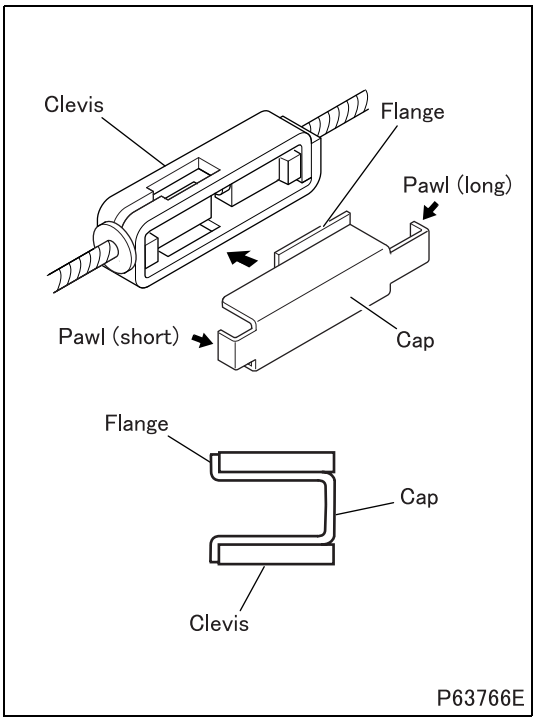


■ **Installation: Front parking brake cable or parking brake cable**

- Connect the front parking brake cable to the rear parking brake cable by following the removal procedure in reverse. <Automatic transmission>
- Attach the parking brake cable to the parking brake lever by fully tightening nut **A**, then tightening nut **B** to the specified torque.

CAUTION ⚠

- **Cable bending radius must be at least 100 mm.**
- **The cable must not be bent at clamped portions.**
- **There must not be torsion in the boot.**
- **Avoid any interference with other components when routing the cable.**

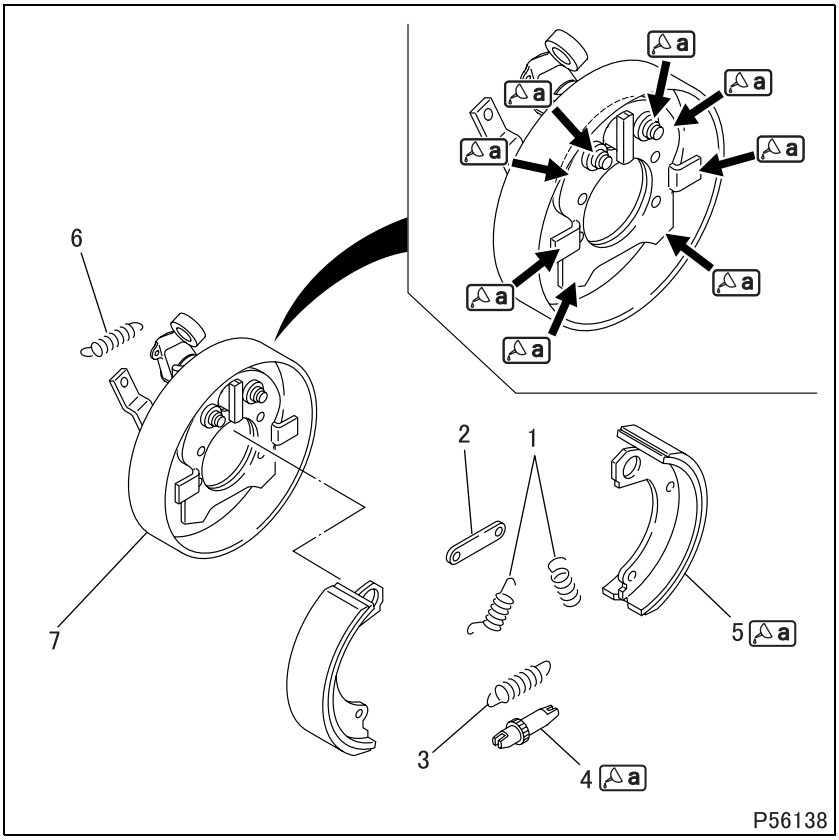


■ **Installation: Cap <Automatic transmission>**

- Attach the cap to the clevis of the rear parking brake cable from the direction shown in the illustration.
- Fit the cap into the clevis all the way so that the flange of the cap comes out at the other side of the clevis.

M E M O

PARKING BRAKE <MANUAL TRANSMISSION>



● **Disassembly sequence**

1 Shoe return spring
2 Anchor pin brace
3 Adjust wheel return spring
4 Adjust screw
5 Shoe & lining
6 Camshaft lever return spring
7 Support plate & dust cover

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **To prevent poor working of the brake, do not smear the surface of shoe and lining with grease or oil.**
- **When the shoe and lining has been replaced with a new one, always check it for contact with the parking brake drum.**

NOTE

- **See Gr22 for parking brake removal and installation procedures.**

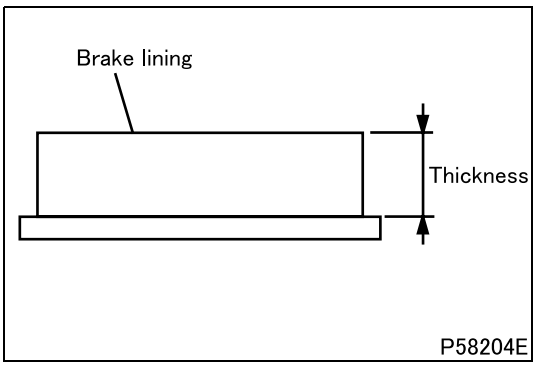
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
1	Shoe return spring installed load (installed length: 57.5 {2.26})	145 ± 15 N {33 ± 3.3 lbf}	115 N {26 lbf}	Replace
3	Adjust wheel return spring installed load (installed length: 59 {2.32})	78 ± 7.8 N {18 ± 1.8 lbf}	63 N {14 lbf}	Replace
5	Brake lining thickness	4.0 {0.16}	1.4 {0.055}	Replace
6	Cam shaft lever return spring installed load (installed length: 85 {3.35})	62 ± 5.9 N {14 ± 1.3 lbf}	49 N {11 lbf}	Replace

Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
a	Adjust screw ends' contact faces with shoe & lining	Brake grease (AKB100)	As required
	Contact faces between support plate, camshaft and shoe & lining		
	Contact faces between support plate, anchor pin and shoe & lining		

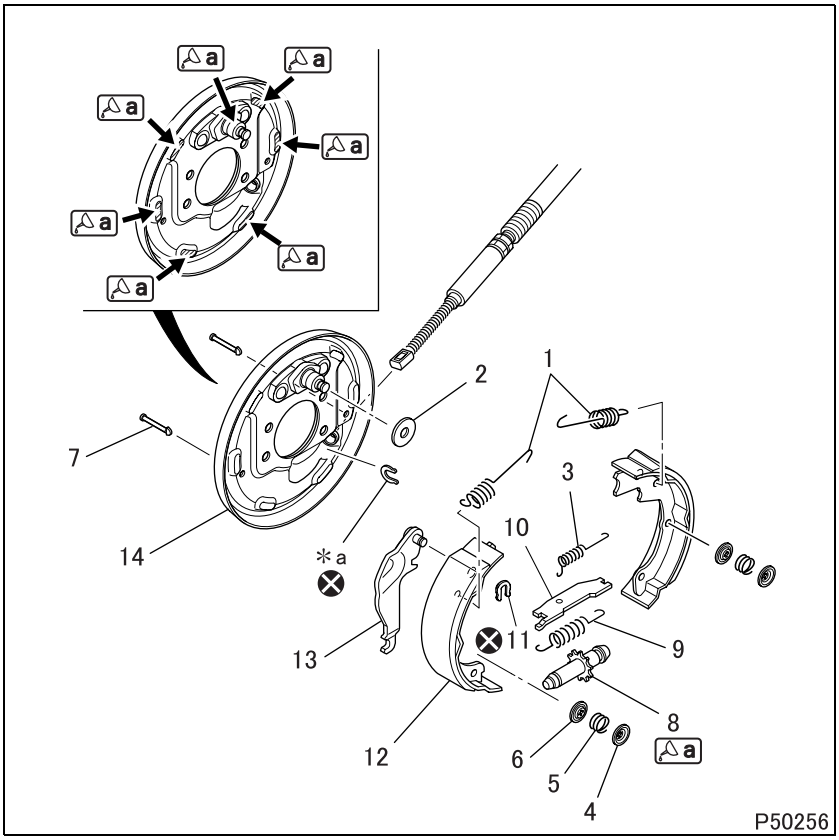
◆Inspection procedure◆



■ **Inspection: Brake lining thickness of shoe and lining**

- If the measured value is lower than the limit, replace the shoe and lining.

PARKING BRAKE <AUTOMATIC TRANSMISSION>



● **Disassembly sequence**

1 Shoe return spring
2 Washer
3 Strut spring
4 Shoe holddown cup
5 Shoe holddown spring
6 Shoe holddown cup
7 Shoe holddown pin
8 Adjuster
9 Adjuster spring
10 Strut
11 Retainer
12 Shoe and lining
13 Parking lever
14 Backing plate

***a**: Retainer
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **To prevent poor working of the brake, do not smear the surface of shoe and lining with grease or oil.**
- **When the shoe and lining has been replaced with a new one, always check it for contact with the parking brake drum.**

NOTE

- **Refer to Gr23 for parking brake removal and installation procedures.**

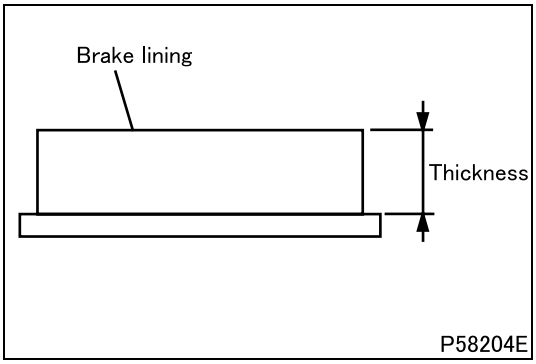
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (installed length: 67.1 {2.64})	58.8 ± 5.9 N {13 ± 1.3 lbf}	49 N {11 lbf}	Replace
3	Installed load of strut spring (installed length: 49 {1.93})	29.4 ± 2.9 N {6.6 ± 0.7 lbf}	26 N {5.8 lbf}	Replace
5	Installed load of shoe holddown spring (installed length: 15.5 {0.61})	78.5 ± 7.9 N {18 ± 1.8 lbf}	71 N {16 lbf}	Replace
9	Installed load of adjuster spring (installed length: 78.2 {3.08})	58.8 ± 5.9 N {13 ± 1.3 lbf}	49 N {11 lbf}	Replace
12	Brake lining thickness of shoe and lining	4.0 {0.16}	1.4 {0.053}	Replace

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Adjuster ends in contact with shoe and lining	Brake grease (AKB100)	As required
	Backing plate anchor pin and surface in contact with shoe and lining		

◆Inspection procedure◆



■ **Inspection: Brake lining thickness of shoe and lining**

- If the measured value is lower than the limit, replace the shoe and lining.

GROUP 37 INDEX

SPECIFICATIONS 37-2

STRUCTURE AND OPERATION
1. Steering System 37-4
2. Oil Flow 37-4
3. Power Steering Gear (Backlash Compensation Mechanism) 37-5
4. Power Steering Oil Pump <Kayaba Industry Product> 37-6
5. Power Steering Oil Pump <Unisia JKC Product> 37-8

TROUBLESHOOTING 37-10

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Change of Power Steering Fluid 37-12
2. Bleeding of Power Steering System 37-13
3. Performance Verification Test of Power Steering System 37-14
4. Steering Wheel Play 37-15
5. Steering Column Looseness 37-15
6. Inspection of Drag Link Ball Joint 37-15

STEERING COLUMN 37-16

POWER STEERING GEAR AND DRAG LINK 37-26

POWER STEERING OIL PUMP
<KAYABA INDUSTRY Product> 37-44
<UNISIA JKC Product> 37-48

POWER STEERING OIL TANK 37-52

SPECIFICATIONS

Steering wheel, steering shaft and power steering gear

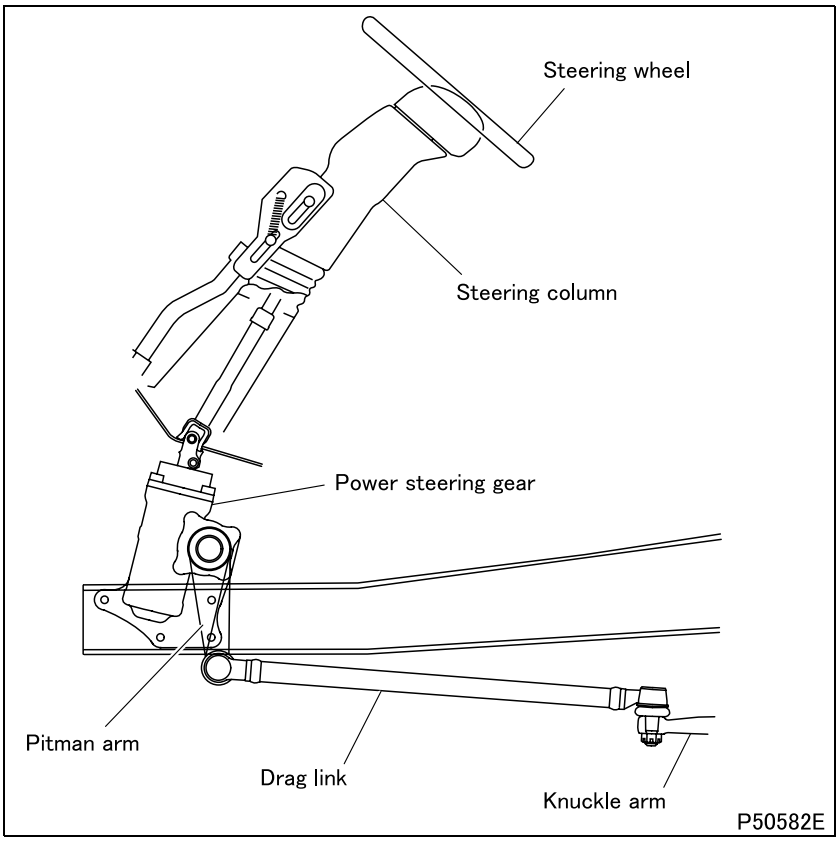
Item		Specifications
Steering wheel	Type	2-spoke type
	Outer diameter mm {in}	400 {15.7}
Steering shaft	Type	Universal joint (tilt and telescopic type)
Power steering gear assembly	Manufacturer	Unisia JKC Steering Systems
	Type	Ball nut
	Form	Integral form
	Item number	448-00203
	Gear ratio	22.7
	Cylinder diameter mm {in}	85 {3.35}

Power steering oil pump

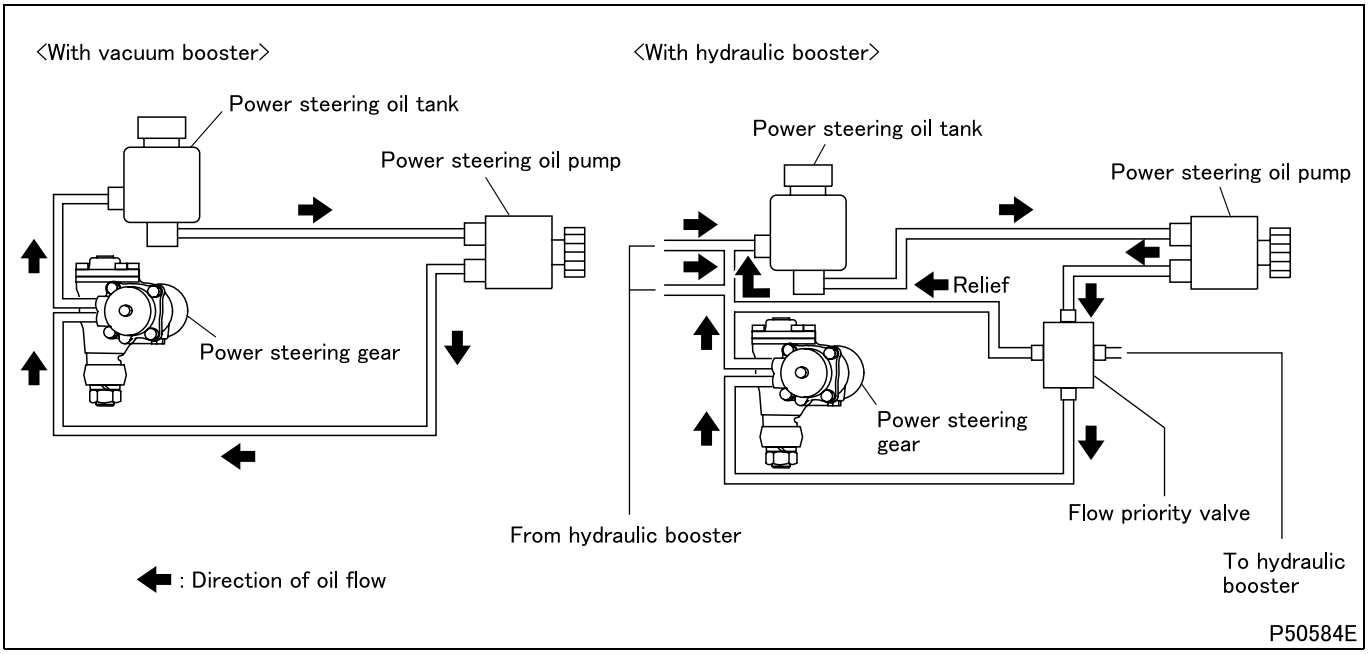
Item	Specifications	
	COE 40/45	COE 50
Manufacturer	Unisia JKC steering systems	Kayaba industry
Type	Vane type	
Manufacturer's item number	478-04302	B4220-13002
Delivery rate cm^3 {in^3}/rev.	9.6 {0.59}	12.6 {0.77}
Adjusted flow volume L {qt}/min	6 to 8 {6.3 to 8.5}	11 to 13 {12 to 14}
Adjusted pressure (relief valve) MPa {psi}	$10.8\,^{+0.20}_{-0.49}$ {$1560\,^{+29}_{-71}$,	$12.3\,^{0}_{-0.49}$ {$1780\,^{0}_{-71}$}
Permissible revolutions rpm	600 to 6500	

M E M O

1. Steering System

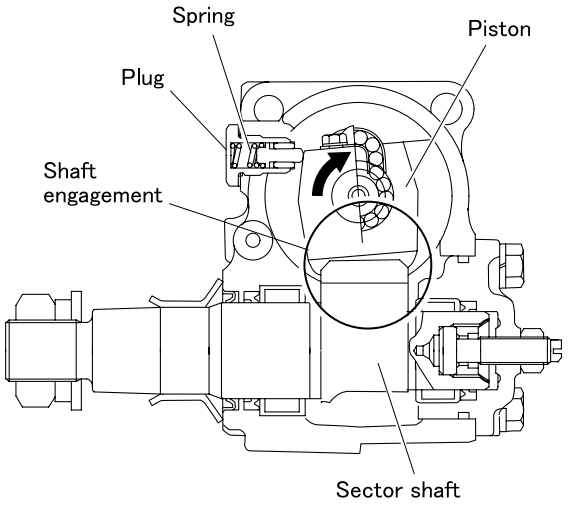


2. Oil Flow



- The power steering system with hydraulic booster is provided with a flow priority valve to reduce the steering shock that occurs when the brakes are suddenly applied during steering wheel use.

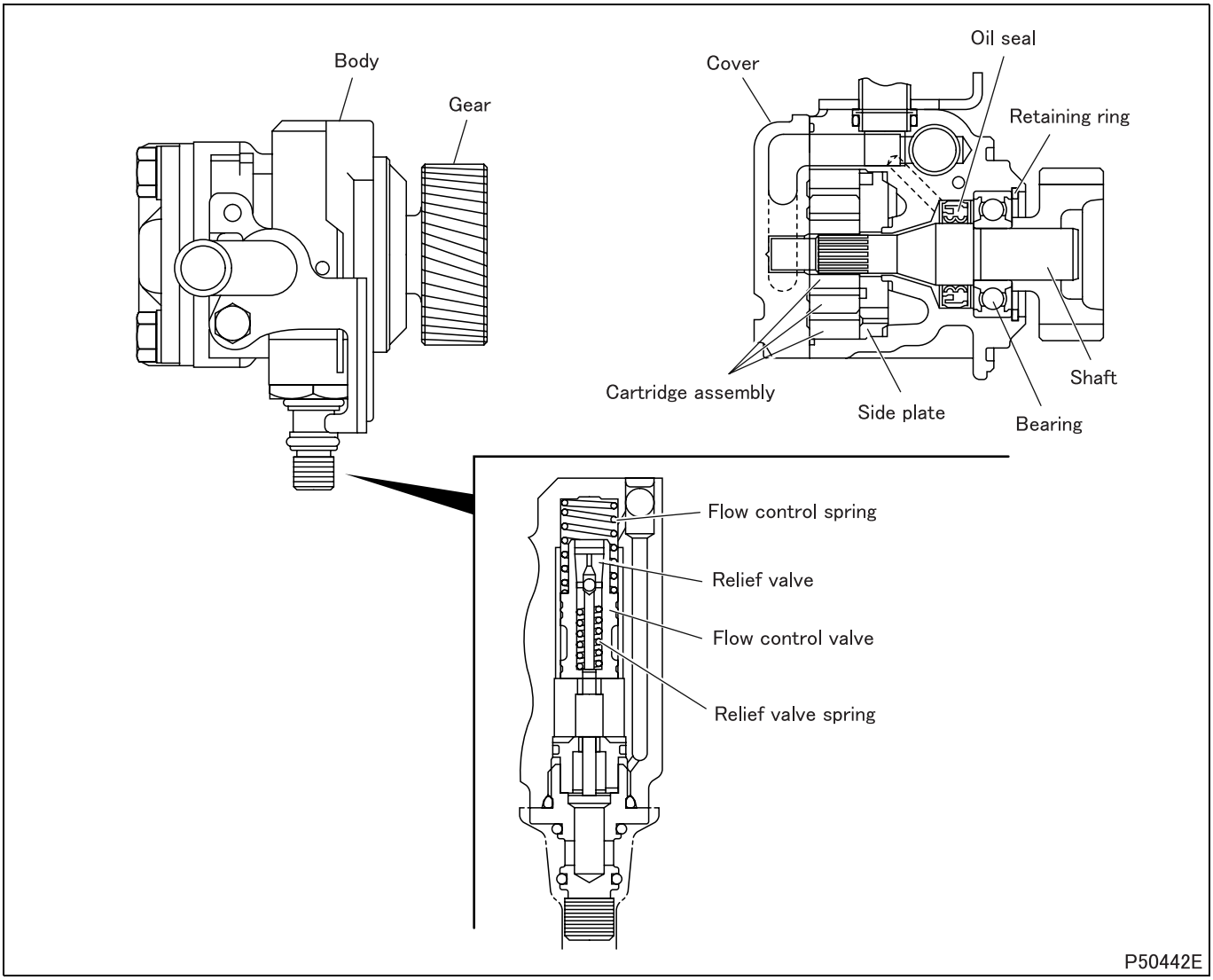
3. Power Steering Gear (Backlash Compensation Mechanism)



P67496E

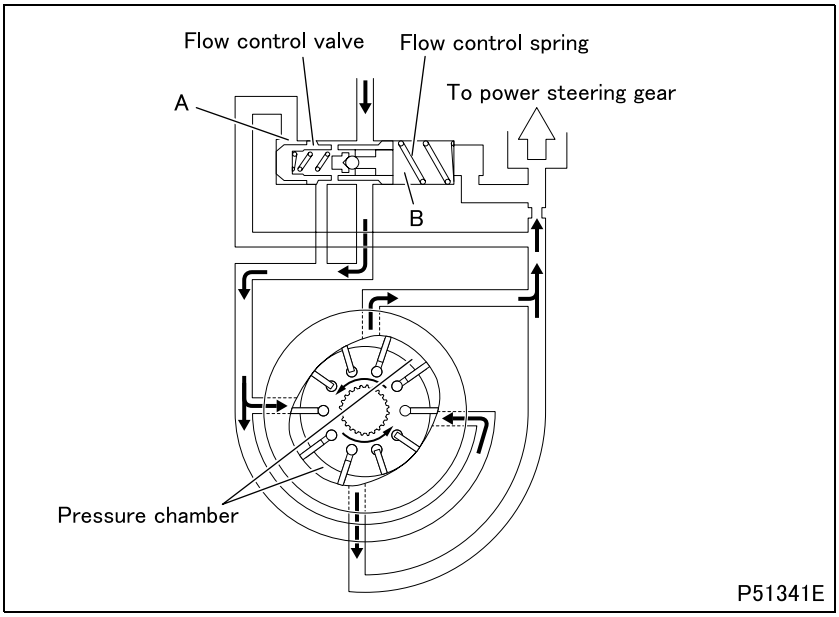
- The plug constantly presses the ball screw set shaft (piston in the case of Unisia JKC) in the illustrated turning direction with the force of internal spring.
- This eliminates play between the ball screw set shaft and sector shaft where they are engaged to suppress backlash during straight travel, thus improving steerability.

4. Power Steering Oil Pump <Kayaba Industry Product>



- The power steering oil pump is a hydraulic source pump with the vane in the rotor groove and is geared to the engine.
- The power steering oil pump consists of a cartridge assembly that discharges oil, a flow control valve that controls the oil flow rate and a relief valve that prevents free oil pressure rise.
- The flow control valve maintains a constant quantity of oil to the power steering gear during steering wheel use. The relief valve is provided in the flow control valve to prevent oil pump pressure from rising beyond necessary level during stationary swing operation.

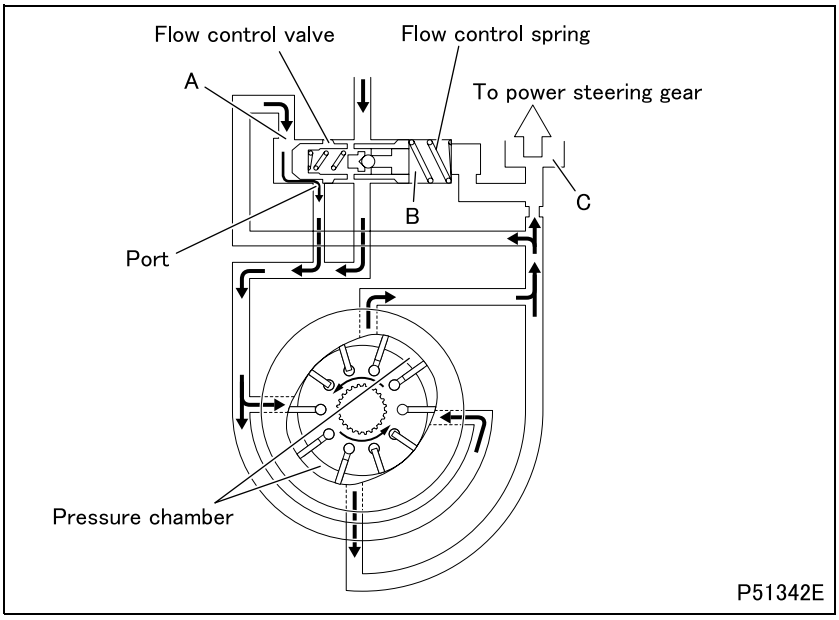
4.1 Flow control valve



(1) Operation of flow control valve

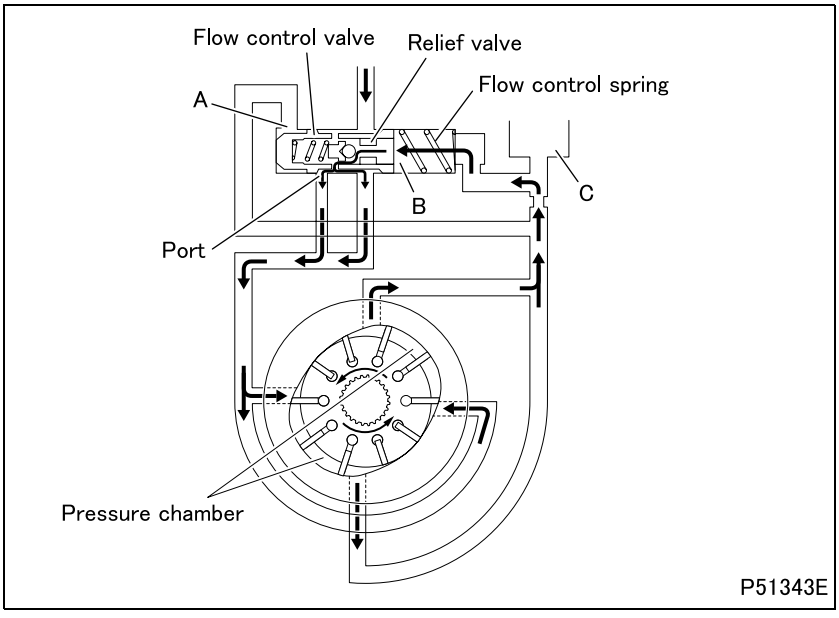
(1.1) When not functioning (oil pump in operation at low speed)

- Oil pressure in chamber **A** is weaker than the combined force of oil pressure in chamber **B** and the tension on the flow control spring. The flow control valve remains stationary.



(1.2) When functioning (oil pump in operation at middle to high speeds)

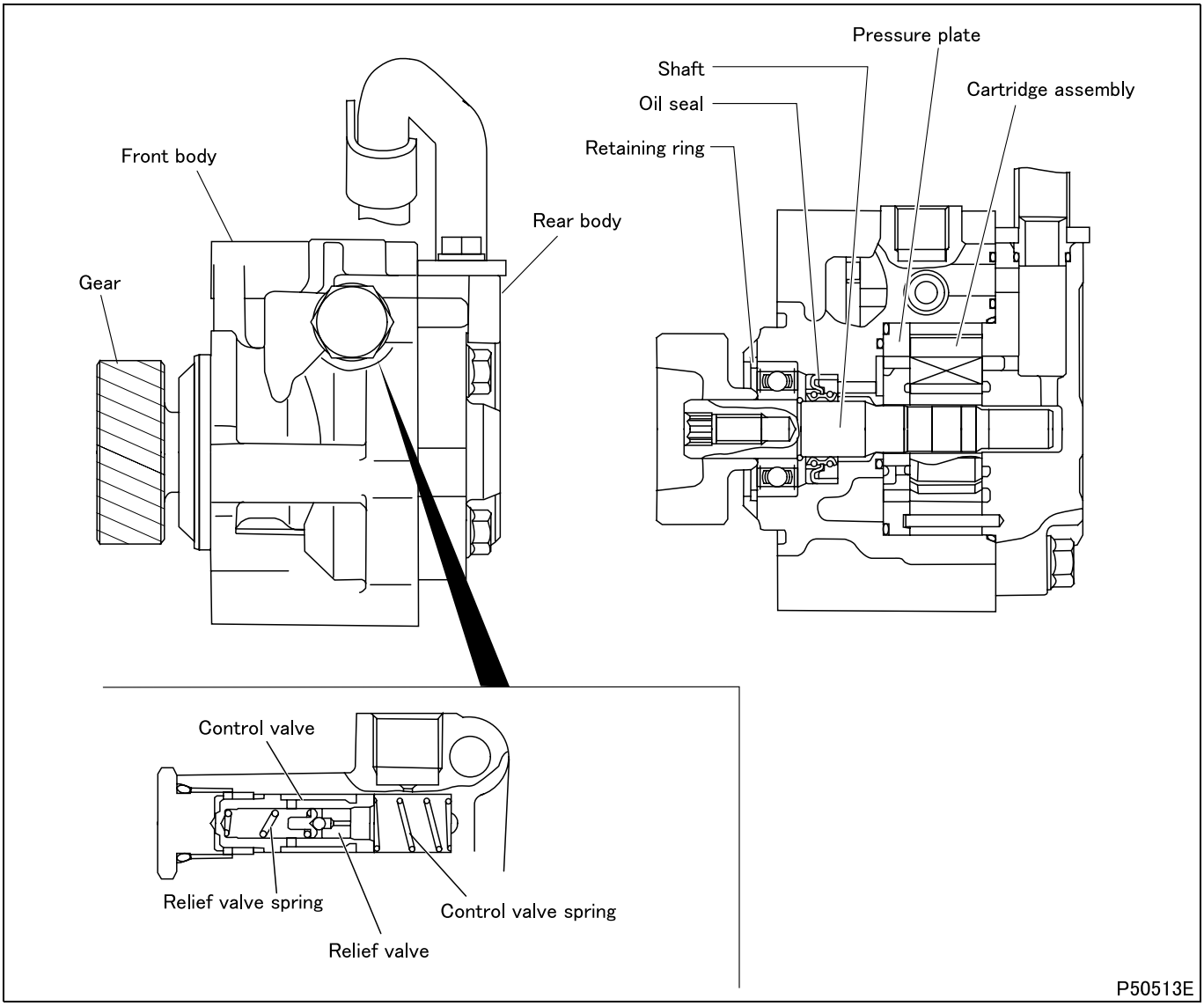
- Oil pressure in chamber **A** overcomes the combined force of oil pressure in chamber **B** and the tension on the flow control spring. The flow control valve opens.
- The port opens to release the oil pressure, and the flow rate from chamber **C** remains constant.



(2) Operation of relief valve

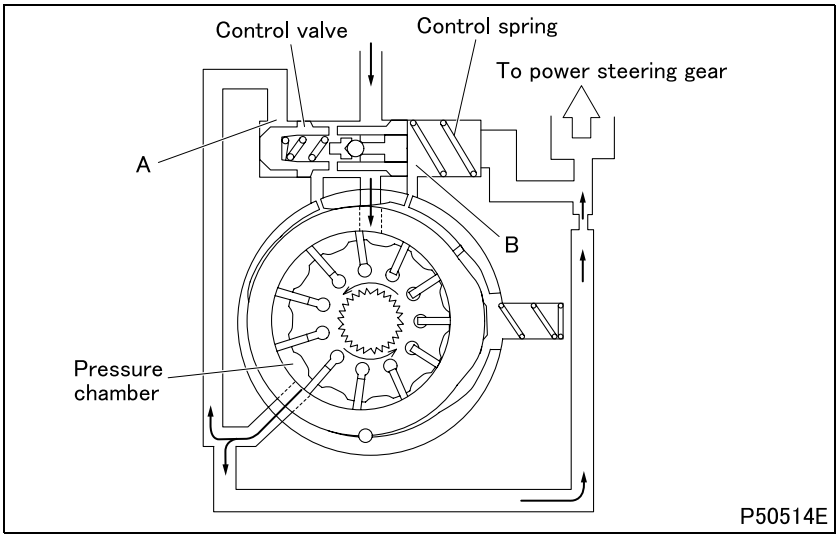
- When the combined force of oil pressure in chamber **B** and the tension on the flow control spring overcomes oil pressure in chamber **A**, the flow control valve closes. Further increased oil pressure in chamber **B** pushes the relief valve to open the port, which prevents excessive oil pressure in chamber **C**.

5. Power Steering Oil Pump <Unisia JKC Product>



- The power steering oil pump is a hydraulic source pump with a vane in the rotor groove and is geared to the engine.
- The power steering oil pump consists of a cartridge assembly that discharges oil, a control valve that controls the oil flow rate and a relief valve that prevents free oil pressure rise.
- The control valve maintains a constant quantity of oil to the power steering gear during steering wheel use. The relief valve is provided in the control valve to prevent oil pump pressure from rising beyond the necessary level during stationary swing operation.

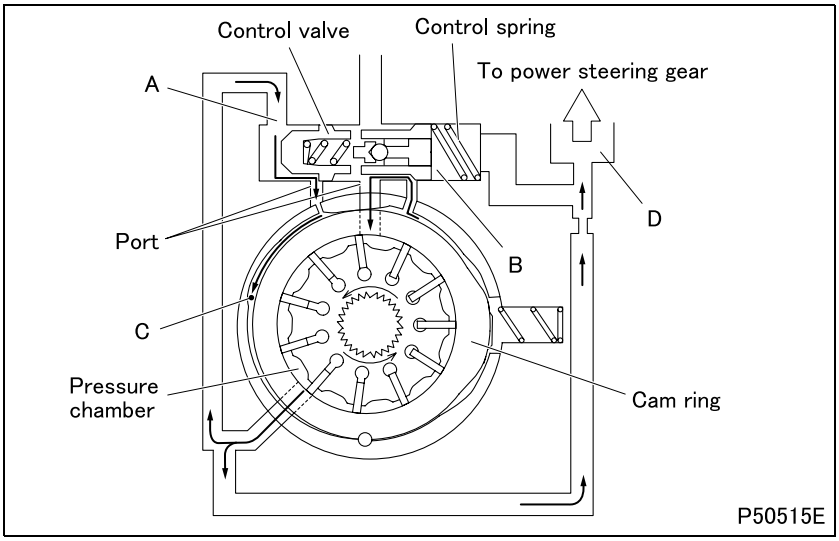
5.1 Control valve



(1) Operation of control valve

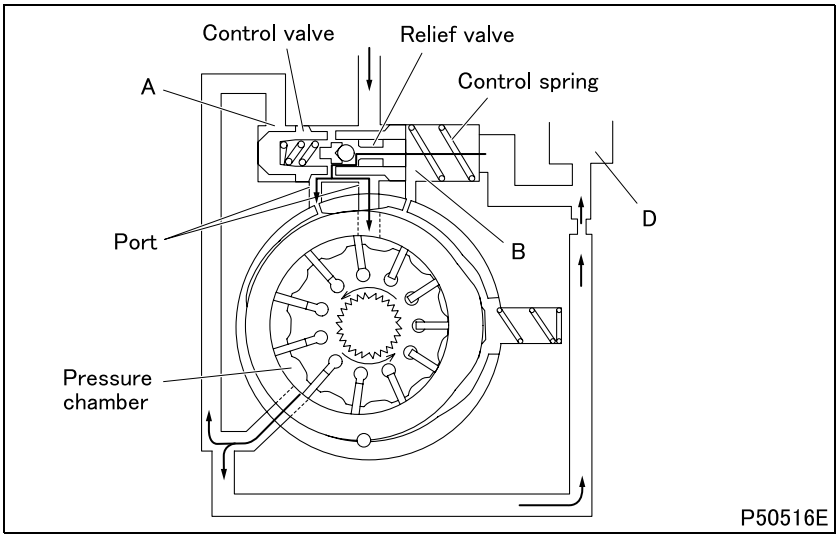
(1.1) When not functioning (oil pump in operation at low speed)

- Oil pressure in chamber **A** is weaker than the combined force of oil pressure in the chamber **B** and the tension on the control spring. The control valve remains stationary.



(1.2) When functioning (oil pump in operation at medium to high speeds)

- Oil pressure in chamber **A** overcomes the combined force of oil pressure in chamber **B** and the tension on the control spring. The control valve opens.
- The port opens to release oil pressure from chamber **A** into chamber **C**, and the cam ring is shifted to the right.
- This reduces the capacity of the pressure chamber capacity and decreases oil pump output per revolution. This maintains a constant flow rate from chamber **D**.



(2) Operation of relief valve

- The combined force of oil pressure in chamber **B** and the tension on the control spring overcomes oil pressure in chamber **A**, and the control valve closes.
  Increased oil pressure in chamber **B** pushes the relief valve to open the port, which prevents excessive oil pressure in chamber **D**.

Possible causes	Symptoms	Steering wheel heavy to operate	Steering wheel play excessive and unstable	Steering wheel pulled to one side	Steering wheel vibration	Steering wheel return not smooth	Steering wheel does not turn	Steering angle insufficient or different between right and left	Oil leakage	Oil pump oil pressure abnormal	Noise from oil pump (grinding)	Noise from oil pump (squeaking)	Noise from oil pump (low whirring)	Reference Gr
Faulty power steering mechanism	Oil quantity insufficient	O	O											
	Air bleeding insufficient	O	O											
	Oil viscosity unsuitable	O												
	Hydraulic circuit clogged	O												
	Power steering gear assembly faulty	O	O	O	O	O	O							
	Power steering gear assembly improperly installed	O	O			O								
	Gear engagement rotating torque incorrectly adjusted	O				O								
	Pitman mounting position incorrect							O						
Faulty steering column and link mechanism	Steering shaft universal joint abnormally worn, or damaged	O	O											
	Link deformed	O						O						
	Drag link ball joint abnormally worn or damaged	O	O											
	Tie rod ball joint abnormally worn or damaged	O	O											
	Steering angle off center between left and right			O										
	Tie rod bent						O							
Faulty front axle, etc.	King pin poorly greased	O				O								Gr26
	Front wheel alignment (toe-in, camber and caster) incorrect	O		O	O	O								
	Thrust bearing damaged	O												
	Wheel hub bearing worn out or damaged		O	O	O									
	King pin or bushing worn out or damaged		O	O	O									
	Front axle deformed			O										
	Knuckle arm, tie rod arm, knuckle, etc. improperly tightened				O									
	Front spring U bolt, nut, etc. loose				O									Gr33A
	Front tire radial and lateral runout; static and dynamic balance incorrect				O									Gr31
	Front axle parts overtightened					O								Gr26
	Steering angle incorrectly adjusted						O	O						
	Mounted parts, connections loose		O											
	Knuckle stopper bolt improperly adjusted							O						

Possible causes \ Symptoms		Steering wheel heavy to operate	Steering wheel play excessive and unstable	Steering wheel pulled to one side	Steering wheel vibration	Steering wheel return not smooth	Steering wheel does not turn	Steering angle insufficient or different between right and left	Oil leakage	Oil pump oil pressure abnormal	Noise from oil pump (grinding)	Noise from oil pump (squeaking)	Noise from oil pump (low whirring)	Reference Gr
Faulty oil pump	Oil pump housing faulty								O					
	O-ring, oil seal faulty								O					
	Bolt improperly tightened								O					
	Maximum generated oil pressure insufficient									O				
	Oil line crushed or clogged									O				
	Air caught in oil pump										O			
	Oil pump interior seized									O	O	O		
	Mounting bolt and nut loose												O	
	Pump body faulty												O	
	Valve malfunctioning									O				
Faulty oil tank	Oil leakage from oil tank due to filling beyond capacity								O					
	Oil leakage from oil tank due to air caught inside								O					
Other problems	Load excessive forward of load-carrying platform	O												
	Load excessive aft of load-carrying platform		O											
	Load excessive on one side of loading bed			O										
	Difference excessive in wheelbase between left and right			O										
	Propeller shaft runout excessive				O									Gr25
	Rear axle housing bent			O										Gr27
	Final drive gear and final drive pinion damaged or improperly engaged				O									Gr27
	Tire pressure insufficient	O												Gr31
	Tire pressure excessive		O											
	Difference excessive in degree of wear between left and right tires			O										
	Left and right tires different in outer diameter			O										
	Front tire radial and lateral runout, static and dynamic balance incorrect				O									
	Braking force unbalanced			O										Gr35A, E

ON-VEHICLE INSPECTION AND ADJUSTMENT

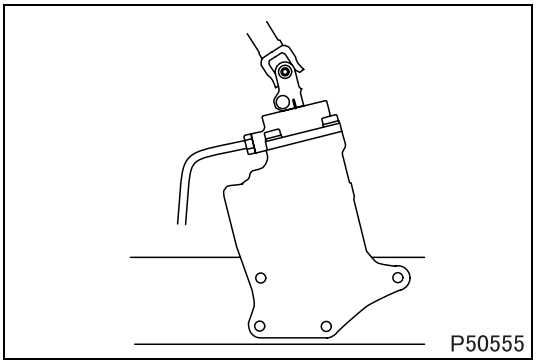
1. Change of Power Steering Fluid

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
–	Feed pipe and return pipe	11.8 to 17.6 {8.7 to 13}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Power steering oil tank	Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III)	Between MIN and MAX of power steering oil tank



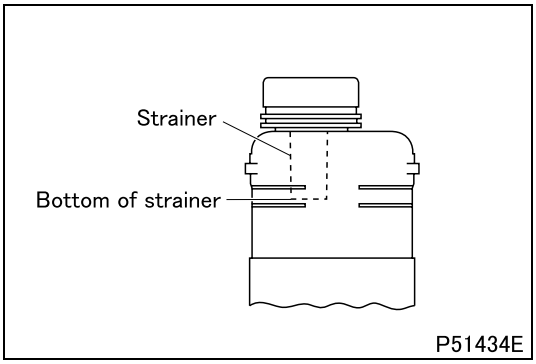
(1) Draining

- Jack up the front wheels.
- Loosen feed and return pipes connected to the power steering gear.

CAUTION ⚠

- **Clean the port area to prevent ingress of dirt, dust, and other foreign matters inside the power steering gear.**

- Repeatedly turn the steering wheel fully left and right to drain the fluid from the power steering gear.
- After draining the fluid, tighten the feed and return pipes to specified torque.



(2) Filling

- Pour fluid into the power steering oil tank up to the bottom of the strainer.

CAUTION ⚠

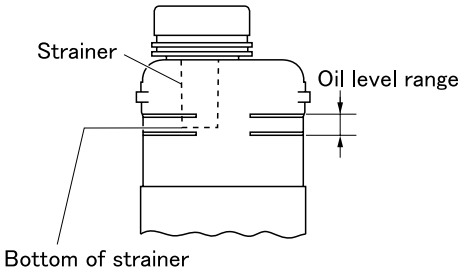
- **Power steering fluid is used for brake booster (hydraulic booster). Therefore, do not supply any other oil than power steering fluid such as brake fluid to the oil tank. <Hydraulic booster>**

- Bleed the power steering system of air.

2. Bleeding of Power Steering System

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Power steering oil tank	Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III type)	Between MIN and MAX of power steering oil tank



P50444E

- Pour fluid to the power steering oil tank up to the bottom of the strainer.

CAUTION ⚠

- **Power steering fluid is used for brake booster (hydraulic booster). Therefore, do not supply any other oil than power steering fluid such as brake fluid to the oil tank. <Hydraulic booster>**

- With the engine stopped, jack up the front wheels.
- Repeatedly turn the steering wheel fully left and right. When the fluid level has dropped, add fluid enough to maintain the fluid level within the specified range.
- Start the engine to idle.
- When the fluid level has dropped, stop the engine and add fluid enough to maintain the fluid level within the specified range.
- Restart the engine. While checking for a drop in fluid level, turn the steering wheel fully left and right and add fluid as much as necessary. Repeat this practice until the fluid level is stabilized within the specified range.
- Fully press the brake pedal (with a foot force of approximately 250 N {55 lbf) a few times. Repeat this until the fluid level is stabilized within the specified range. (In this case, there is no need to operate the steering wheel.) <Hydraulic booster>
- Turn the steering wheel fully left and right repeatedly.

CAUTION ⚠

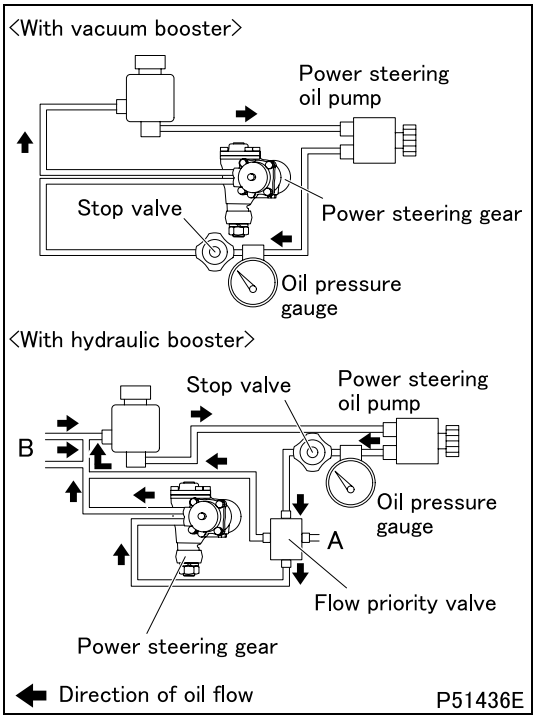
- **To avoid seizure of the power steering oil pump, do not keep the steering wheel turned fully to left or right for more than 10 seconds when the engine is running.**

- If there is any abnormal noise or a fluid level fluctuation, air should be still trapped in the power steering system. Turn the steering wheel several times to raise the fluid temperature to approximately 60 to 80°C {140 to 175°F}.
- Stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise or fluid level fluctuation, the bleeding of the power steering system is completed.
- With the engine stopped, press the brake pedal several times and bleed the brake booster (hydraulic booster) by means of emergency pump. <Hydraulic booster)
- Repeat starting and stopping the engine several times to remove small air bubbles left in the power steering oil tank.
- If air bubbles are not removed completely, drive the vehicle for a while, then check for abnormal noise and oil level fluctuation.
- When bleeding is finished, check that fluid in the power steering oil tank is within the specified level range. Also check pipe and hose connections for fluid leaks.
- After bleeding is finished, check the brake booster (hydraulic booster) for performance (input and output characteristics). <Hydraulic booster>

3. Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Power steering system fluid pressure (with hands off steering wheel)	With vacuum booster	490 kPa {71 psi}	–	Repair
		With hydraulic booster	980 kPa {140 psi}	–	
–	Relief set pressure	With vacuum booster	$10.8\ ^{+0.20}_{-0.49}$ MPa {$1560\ ^{+29}_{-71}$ psi}	–	Replace
		With hydraulic booster	$12.3\ ^{0}_{-0.49}$ MPa {$1780\ ^{0.0}_{-71}$ psi	–	



- Perform the following tests to verify normal operation of the power steering gear assembly and power steering oil pump.
  A: To hydraulic booster
  B: From hydraulic booster

NOTE

- **If fluid pressure in the power steering system is higher than the standard value with the engine idling, check the power steering gear and hydraulic circuit for clogging.**

CAUTION ⚠

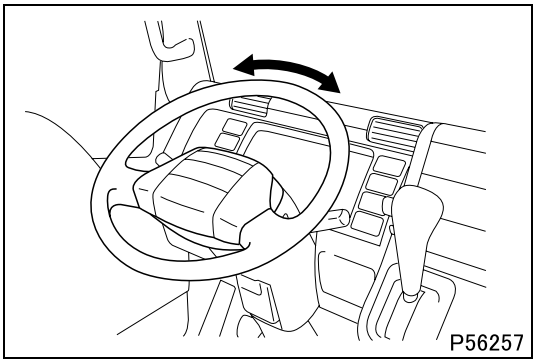
- **To avoid seizure of the power steering oil pump, never close the stop valve for more than 10 seconds.**

Test item	Test procedure	Assembly standard
Verification of smooth operation	• Jack up front wheels and turn steering wheel fully left and right.	Smooth operation throughout test
Measuring conditions	• Install oil pressure gauge capable of measuring upward of 13.2 MPa {1910 psi} and stop valve between power steering oil pump and power steering gear <with vacuum booster> or flow priority valve <with hydraulic booster>, then bleed air. • Start engine to idle. • Turn steering wheel left and right several times to raise fluid temperature up to 50 to 60°C {122 to 140°F}. • With the engine idling, fully open stop valve.	–
Measurement of fluid pressure in power steering system	• Measure fluid pressure with hands off steering wheel.	Specified standard value
Measurement of relief set pressure	• Gradually increase engine speed to 1000 to 1500 rpm, then close stop valve and measure maximum fluid pressure. • Do not close stop valve for longer than 10 seconds.	Specified standard value

4. Steering Wheel Play

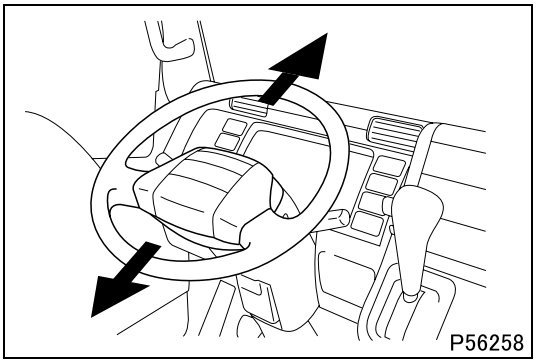
Service standards: mm {in}

Location	Maintenance item	Standard value	Limit	Remedy
–	Steering wheel play (measure at the outer edge of the steering wheel)	5 to 50 {0.2 to 2.0}	–	Adjust



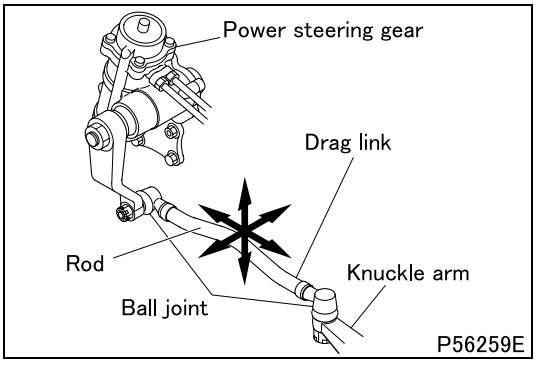
- With the front wheels in the straight-ahead position, start the engine and gently turn the steering wheel left and right to measure its free play.
- If the play deviates from the standard value, check tightening points and the power steering gear.

5. Steering Column Looseness



- Push and pull the steering wheel by hand to check the steering column for looseness.
- With the steering column tilted all the way forward, pull the steering wheel backward and check the steering column for looseness.
- If the steering column is loose, adjust the tilting and telescoping lever.

6. Inspection of Drag Link Ball Joint

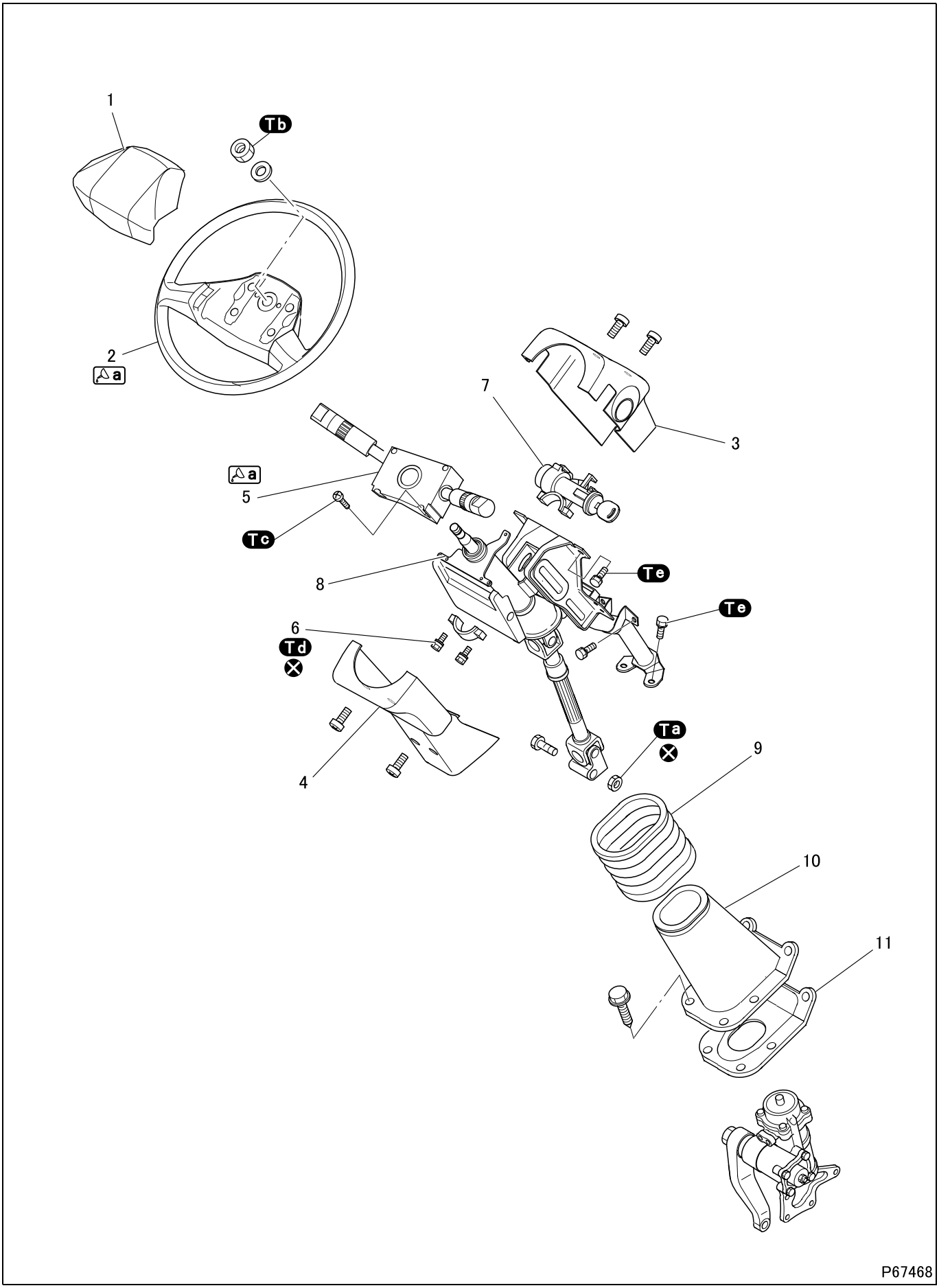


(1) Backlash

- With the vehicle stopped, move the drag link forward and aft, up and down, and side to side. Check for play at the ball joints that connect to the power steering gear and the knuckle arm.
- If play is excessive, replace the drag link.

(2) Dust cover

- Check the dust cover for wear, cracks and other damage.
- If there is any problem, replace the dust cover.


1
Tb
2
a
7
3
a
5
Tc
8
Te
Te
6
Td
4
Ta
9
10
11
P67468

● **Removal sequence**

1 Horn pad
2 Steering wheel
3 Front column cover
4 Rear column cover
5 Combination switch
6 Twist-off bolt
7 Ignition switch
8 Steering column
(For details, see STEERING COLUMN)
9 Dust cover
10 Dust cover
11 Dust cover

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After installation, check the steering column for looseness (see ON-VEHICLE INSPECTION AND ADJUSTMENT).**

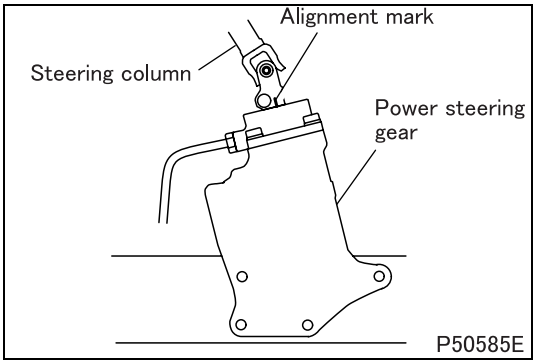
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (steering column and power steering gear mounting)	22 to 31 {16 to 23}	–
Tb	Nut (steering wheel mounting)	39 to 49 {29 to 36}	–
Tc	Screw (combination switch mounting)	2.5 ± 0.5 {1.8 ± 0.4}	–
Td	Twist-off bolt (ignition switch mounting)	14.2 ± 1.5 {10 ± 1.1}	–
Te	Bolt (steering column assembly mounting)	17 to 25 {12 to 19}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
⚠a	Contact ring under steering wheel	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Horn contact piece on combination switch side		

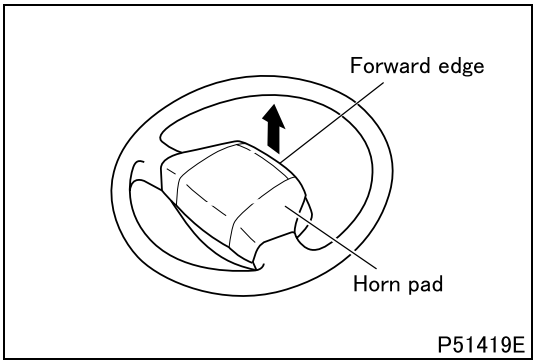
◆Work before removal◆



■ **Alignment mark: Steering column and power steering gear**

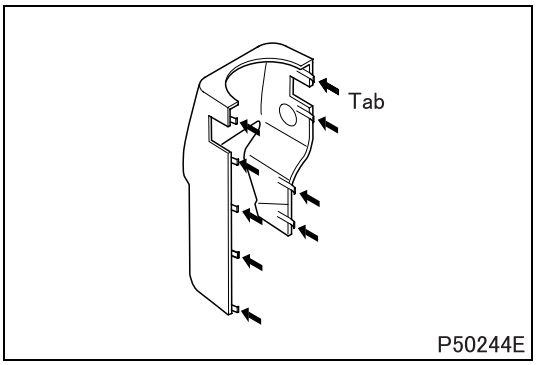
- Provide alignment marks on the steering column and power steering gear.

◆Removal procedure◆

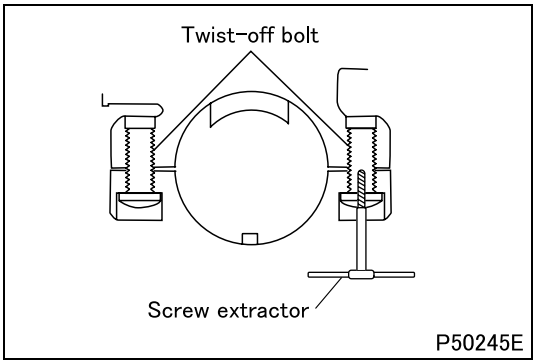


■ **Removal: Horn pad**

- Lift up the horn pad by the forward edge to remove from the steering wheel.

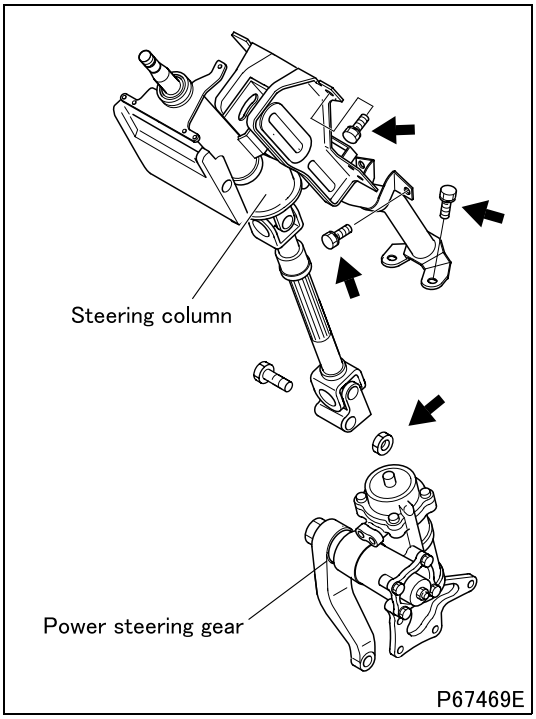


■ **Removal: Front column cover**



■ **Removal: Ignition switch**

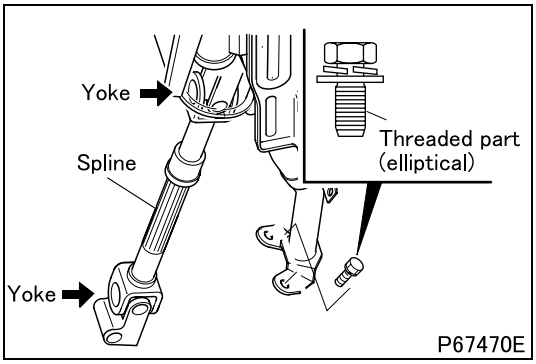
- Drill a hole of 5.5 to 6 mm {0.22 to 0.24 in} in diameter to a depth of 10 to 15 mm {0.39 to 0.59 in} in the twist-off bolt.
- Using the drilled hole, screw the screw extractor counterclockwise into the twist-off bolt and remove it.



■ **Removal: Steering column**

- To remove the steering column, remove the nut connecting it to the power steering gear, in addition to mounting bolts in the cab.

◆Installation procedure◆



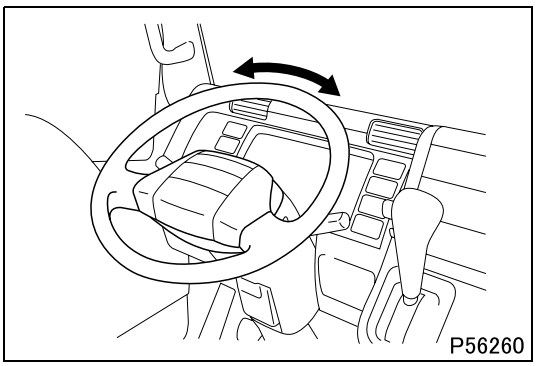
■ **Installation: Steering column**

- If the spline is off the steering column, assemble them with the yokes facing in the same direction.
- Install the steering column using the illustrated bolts. The threaded portion of these bolts is elliptical for grounding the horn circuit properly.

■ **Installation: Ignition switch**

- Install the ignition switch using new twist-off bolts. Tighten the bolts to the specified torque to snap off their heads.

◆Inspection after installation◆

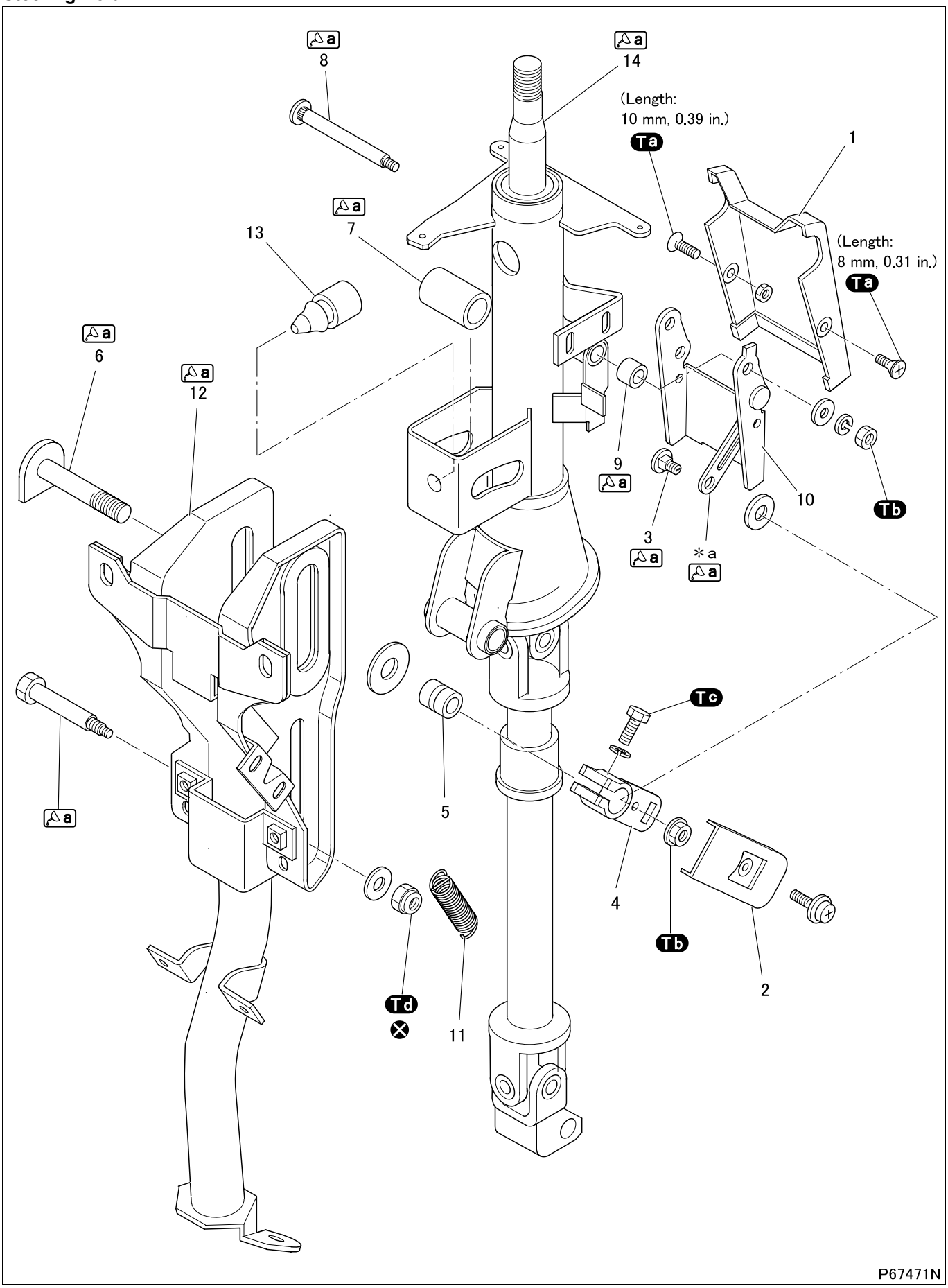


■ **Inspection: Noise from steering wheel**

- Lightly turn the steering wheel left and right and check for noise and other problems.
- If any problem is found, disassemble the steering wheel, remove the cause and reinstall.

M E M O

Steering Column



● **Disassembly sequence**

1 Lever cover
2 Lever protector
3 Pin
4 Lock lever
5 Nut
6 Bolt
7 Spacer
8 Pin
9 Collar
10 Tilting and telescoping lever
11 Spring
12 Steering column support
13 Shock absorbing rubber
14 Steering column

★a: Link plate
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

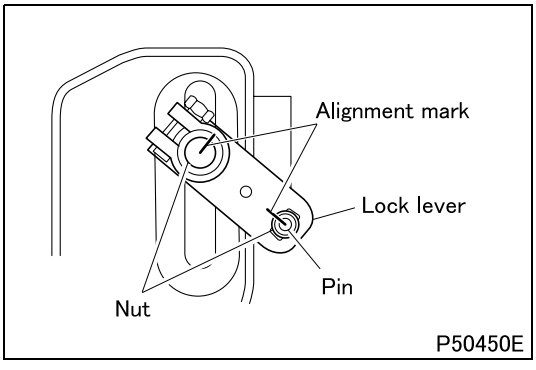
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Screw (lever cover mounting)	1.0 to 1.5 {0.7 to 1.1}	–
Tb	Nut (lock lever mounting)	3.9 to 5.9 {2.9 to 4.4}	–
	Nut (tilting and telescoping lever mounting)		–
Tc	Bolt (lock lever mounting)	16 to 20 {12 to 15}	–
Td	Nut (steering column support mounting)	9 to 14 {6.6 to 10}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Friction surface of pin	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Friction surface of collar		
	Staked area of link plate		
	Friction surface and thread of bolt		
	Friction surface of spacer		
	Friction surfaces of steering column support and steering column		
	Friction surface of bolt		

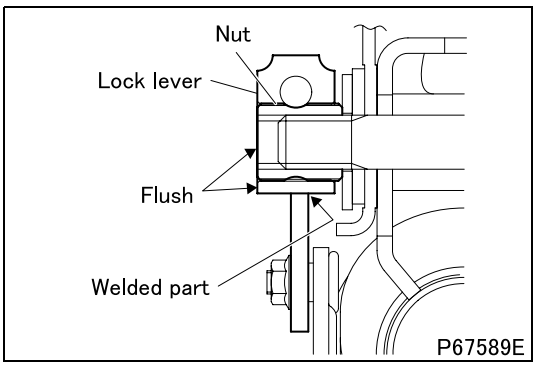
◆**Work before removal**◆



■ **Alignment mark: Nut and lock lever**

- Be sure to provide alignment marks on the lock lever and nuts before removal.

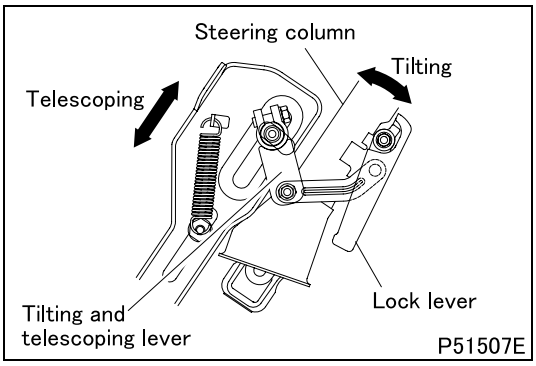
◆Installation procedure◆



■ **Installation: Lock lever**

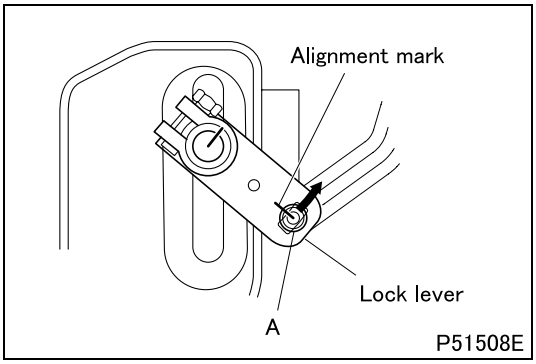
- Install the lock lever flush with the nut, with the welded part facing in the illustrated direction.

◆Inspection after installation◆



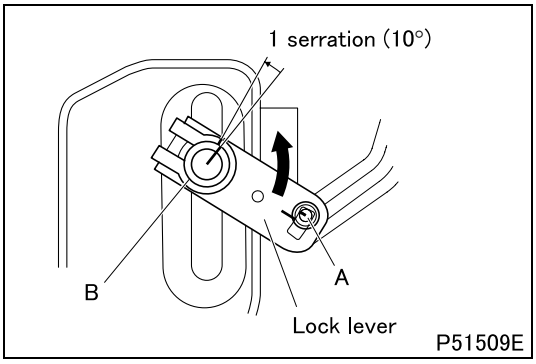
■ **Inspection: Tilting and telescoping lever operating force**

- Tilt the steering column all the way forward and telescope it to the mid-point of the movable range.
- Push the tilting and telescoping lever in and lock the steering column. In this state, check that the force required to operate the tilting and telescoping lever is 140 N {31 lbf} or more.
- Push the steering column forward by hand to check that it is securely held.
- Adjust the installed position of the lock lever if necessary.



■ **Adjustment: Lock lever**

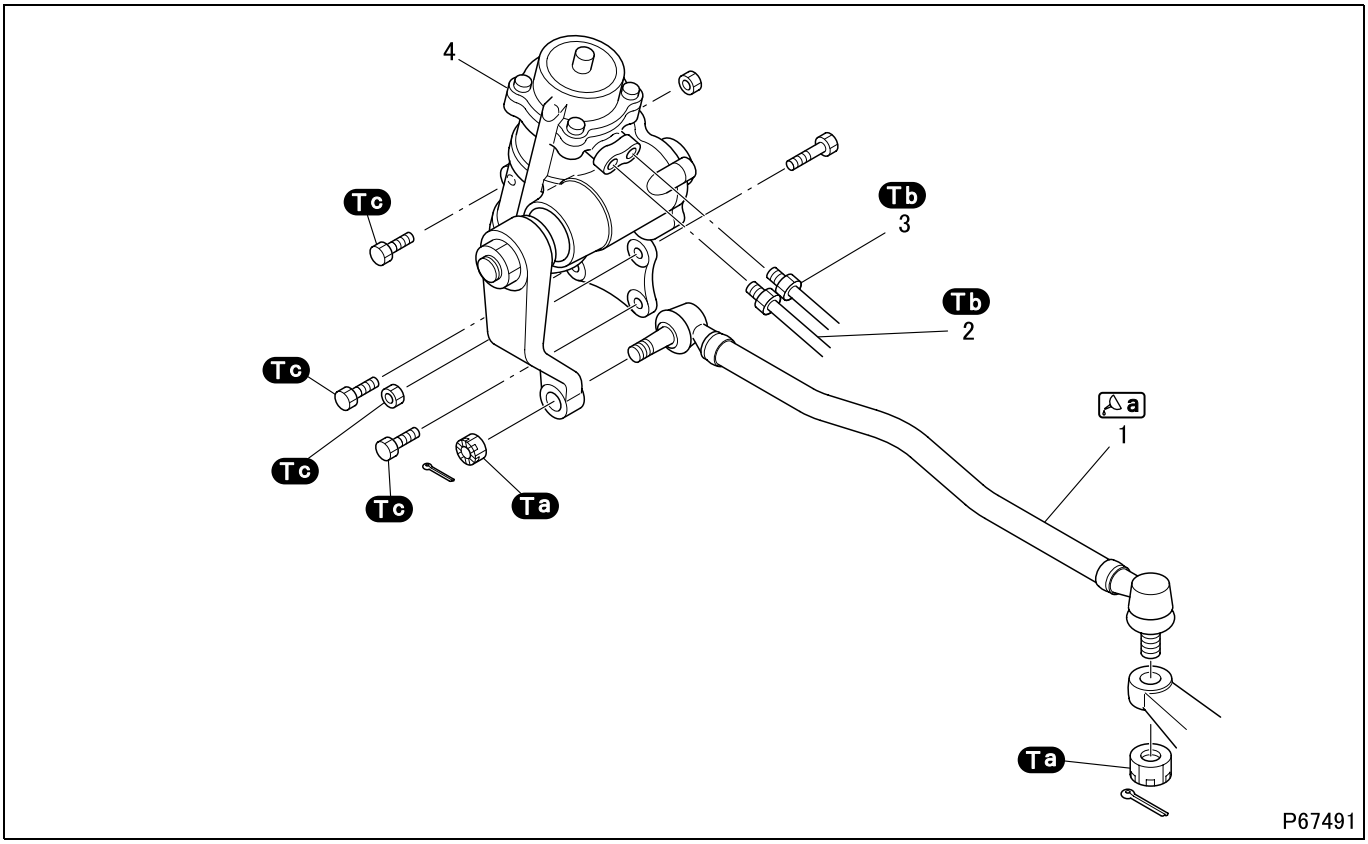
- Loosen nut **A**.
- Move the lock lever to relocate the nut **A** in the slot from the alignment mark in the arrow direction, then tighten the nut **A** in that position.



- If the nut **A** is already at the end of the slot in the lock lever and cannot be relocated, remove the lock lever and turn the nut **B** one serration (10°) from the alignment mark in the arrow direction, then reinstall the lock lever.
- Adjust the tightening position of the nut **A** so that the tilting and telescoping lever operating force becomes 140 N {31 lbf} or more.

M E M O

POWER STEERING GEAR AND DRAG LINK



● **Removal sequence**

1 Drag link
2 Feed pipe
3 Return pipe
4 Power steering gear

CAUTION ⚠

- **When removing the drag link, take care not to deform or damage the dust cover.**
- **Do not attempt to disassemble the drag link because it is of a unit construction.**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Turning torque of drag link ball joint	0.1 to 5.9 N·m {0.1 to 4.4 lbf·ft}	–	Replace

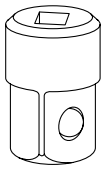
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (drag link mounting)	137 to 196 {100 to 145}	–
Tb	Feed pipe and return pipe	11.8 to 17.6 {8.7 to 13}	–
Tc	Bolt or nut (power steering gear mounting)	83.5 to 108 {61 to 80}	–

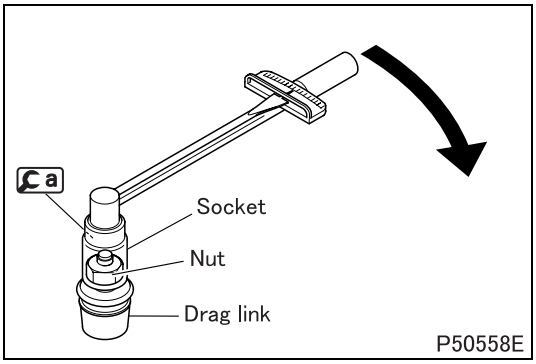
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of drag link ball joint dust cover	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

Mark	Tool name and shape	Part No.	Application
a	Preload socket  P48876	MB990326	Measurement of drag link ball joint turning torque

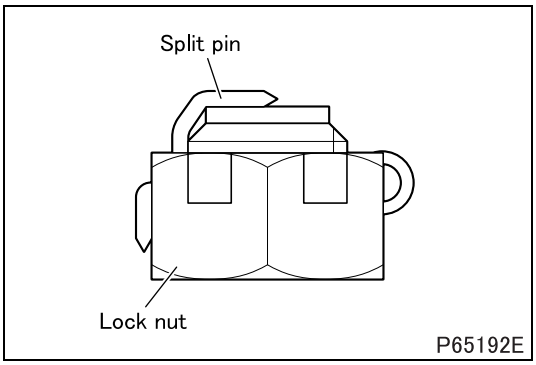
◆Inspection procedure◆



■ Inspection: Drag link

- Install nut onto the drag link ball joint.
- Using the preload socket a and a torque wrench set on the nut, measure the turning torque of the nut.
- If the measurement deviates from the standard value, replace the drag link.

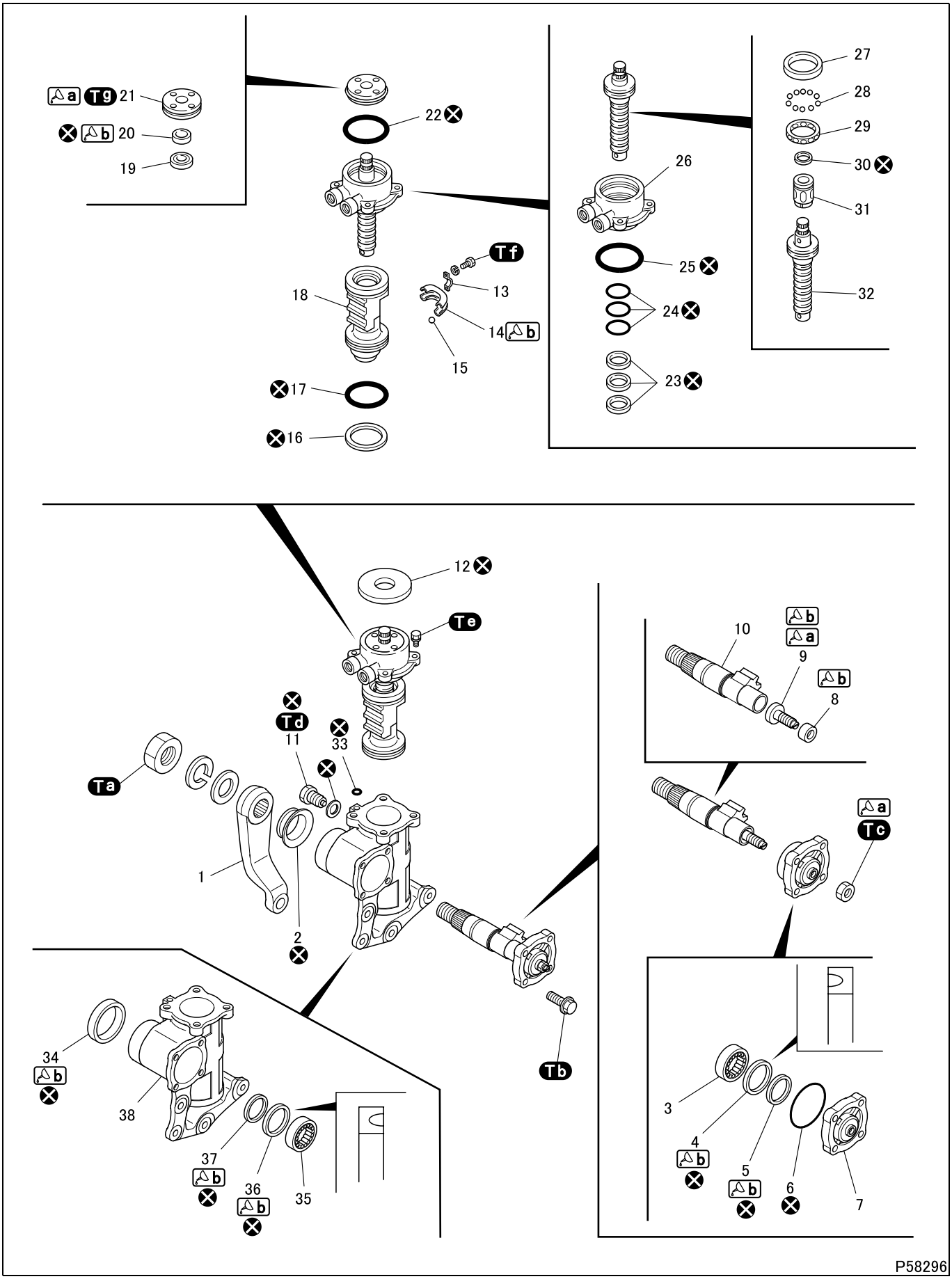
◆Installation procedure◆



■ Installation: Drag link

- Align a slot in the lock nut with the split pin hole in the ball joint by turning the lock nut in the tightening direction while checking the torque is within the specified range, then install the split pin as shown in the illustration.

Power Steering Gear



● **Disassembly sequence**

1 Pitman arm
2 Dust cover
★**3** Needle bearing
4 Y-packing
5 Backup ring
6 O-ring
7 Side cover
★**8** Retainer
★**9** Adjusting screw
10 Sector shaft
11 Plug
12 Dust cover
13 Ball tube clip
14 Ball tube
15 Steel ball
16 Seal ring
17 O-ring
18 Piston
19 Ball bearing
20 Oil seal
21 Adjusting plug
22 O-ring
23 Seal ring
24 O-ring
25 O-ring
26 Valve housing
27 Side race
28 Steel ball
29 Bearing cage
30 Seal ring
31 Rotor
32 Worm and stub shaft
33 O-ring
34 Oil seal
★**35** Needle bearing
36 Y-packing
37 Backup ring
38 Body

⊗: Non-reusable parts

NOTE

- **Do not remove parts marked ★ unless absolutely necessary.**

CAUTION ⚠

- **When holding the body with a vise, take care not to scratch the gasket seated surface of plug.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Repair kit

Service standards: mm {in}

Location	Maintenance item		Standard value	Limit	Remedy
–	Power steering gear	Starting torque	0.88 N·m {0.6 lbf·ft} or less	–	Adjust
		Engaging torque	0 to 0.25 N·m {0 to 0.2 lbf·ft}	–	
		Normal turning torque	0.15 to 0.78 N·m {0.1 to 0.6 lbf·ft}	–	
9, 10	Play between adjusting screw and sector shaft		0.1 {0.0039} or less	–	Replace
10	Sector shaft outer diameter	Adjusting screw side	ϕ34.975 {1.38}	ϕ34.875 {1.37}	Replace
		Pitman side	ϕ44.975 {1.77}	ϕ44.875 {1.77}	
18, 32	Play in diametric direction between piston and worm and stub shaft		–	0.5 {0.020} or less	Replace
18, 38	Clearance between piston and body		0.11 {0.0043}	0.16 {0.0063}	Replace
31, 32	Clearance between rotor and worm and stub shaft		0.02 {0.00079}	0.03 {0.0012}	Replace

Torque: N·m {lbf·ft}

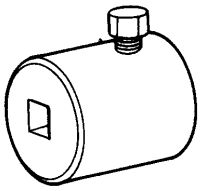
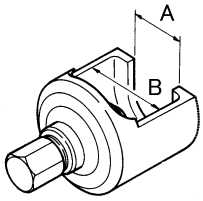
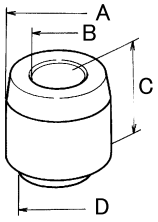
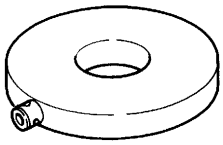
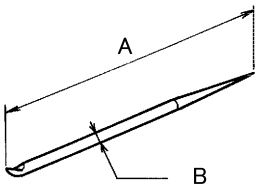
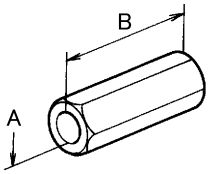
Mark	Fastener	Torque value	Remarks
Ta	Lock nut (pitman arm fastening)	294 to 343 {215 to 255}	–
Tb	Bolt (sector shaft mounting)	53.9 to 63.7 {40 to 47}	–

Mark	Fastener	Torque value	Remarks
Tc	Nut (adjusting screw tightening)	63.7 to 73.5 {47 to 54}	–
Td	Plug	73.6 to 83.4 {54 to 62}	–
Te	Bolt (valve housing attaching)	98.1 to 107.9 {72 to 80}	–
Tf	Screw (ball tube clip fitting)	4.41 to 5.39 {3.3 to 4.0}	–
Tg	Adjusting plug	147 to 166 {110 to 120}	–

Lubricant and/or sealant

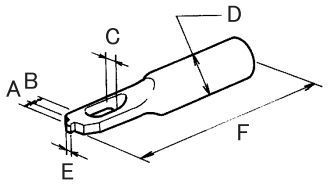
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Nut threads and contact surface of side cover	Hermetic seal 101Y or ThreeBond 1102	As required
	Adjusting screw threads		
	Periphery of adjusting plug		
b	Inner periphery of backup ring	Multi-purpose type grease [NLGI No. 2 (Li soap)]	As required
	Inner periphery of Y-packing		
	Inner periphery of retainer		
	Adjusting screw threads and contact surface of sector shaft		
	Inner surface of ball tube		
	Inner periphery of oil seal		

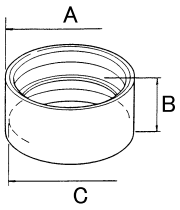
Special tools: mm {in}

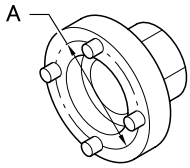
Mark	Tool name and shape	Part No.	Application
ⓐ	Preload socket  10028	MB991006	Measurement of power steering gear starting torque
ⓑ	Pitman arm puller A: 49 {1.93}, B: 76 {2.99}  01355	MH062472	Removal of pitman arm
ⓒ	Insert tool assembly  01358 A: ϕ35 {1.38}, B: ϕ25 {0.98}, C: 53.5 {2.11}, D: ϕ33 {1.30}	MH062881 *910-21719	Forming of backup ring
ⓓ	Insert tool assembly  01356	MC811971 *910-11001	Forming of backup ring and installation of oil seal
ⓔ	Needle A: 120 {4.72}, B: ϕ3 {0.12}  02288	MC811948 *910-21200	Removal of O-ring and seal ring
ⓕ	Bar A: ϕ16.5 {0.65}, B: 57 {2.24}  01360	MC811955 *910-22811	Turning of retainer

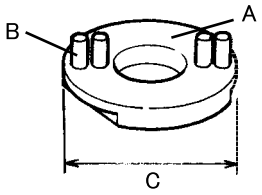
*: Unisia JKC part numbers

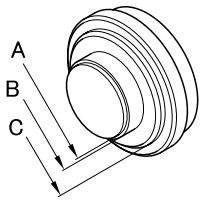
Special tools: mm {in}

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>g</td><td>Squeeze tool
 

67927
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr><tr><td>5
{0.20}</td><td>8
{0.31}</td><td>18
{0.71}</td><td>ϕ30
{1.18}</td><td>6
{0.24}</td><td>160
{6.30}</td></tr></table></td><td>MC811950
*910-21801</td><td>Crimping of retainer</td></tr>
<tr><td>h</td><td>Piston seal insert tool
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ98
{3.86}</td><td>50
{1.97}</td><td>ϕ85.05
{3.35}</td></tr></table> 

02289</td><td>MC8131516
*910-21718</td><td>Forming of piston seal ring</td></tr>
<tr><td>i</td><td>Wrench assembly
<table><tr><th>A</th></tr><tr><td>ϕ52
{2.05}</td></tr></table> 

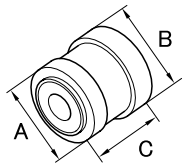
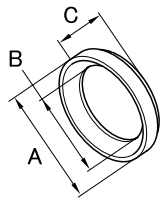
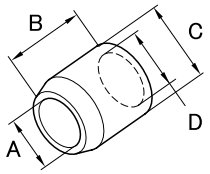
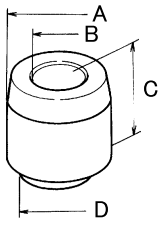
P51270</td><td>MH062883
*910-10745</td><td>Removal and installation of adjusting plug</td></tr>
<tr><td>j</td><td>Attachment assembly
(A: Adapter)
(B: Bolt (pin))
<table><tr><th>C</th></tr><tr><td>ϕ147
{5.79}</td></tr></table> 

02290</td><td>MC811969
*910-10671
(A:
*910-23581)
(B:
*910-23194)</td><td>Fixing of valve housing</td></tr>
<tr><td>k</td><td>Press-fit tool
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ29.7
{1.17}</td><td>ϕ31.8
{1.25}</td><td>ϕ45
{1.77}</td></tr></table> 

P51271</td><td>MH062884
*910-20405</td><td>Installation of oil seal</td></tr>
</table>

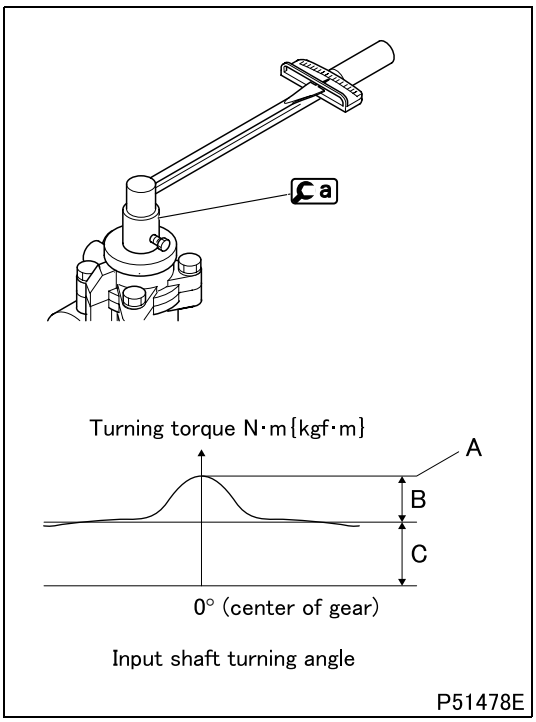
*: Unisia JKC part numbers

Special tools: mm {in}

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>Cl</td><td>Adjusting tool
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ59.5
{2.34}</td><td>ϕ65.5
{2.58}</td><td>65
{2.56}</td></tr></table> 
P51272</td><td>MH062885
*910-22997</td><td rowspan="2">Assembly of thrust bearing</td></tr>
<tr><td>Cm</td><td>Guide assembly
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ76
{2.99}</td><td>ϕ56
{2.20}</td><td>13
{0.51}</td></tr></table> 
P51273</td><td>MH062886
*910-23051</td></tr>
<tr><td>Cn</td><td>Seal ring insert tool
 
P51274
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><td>ϕ28.1
{1.11}</td><td>45
{1.77}</td><td>ϕ40
{1.57}</td><td>ϕ30.3
{1.19}</td></tr></table></td><td>MH062882
*910-22776</td><td>Forming of rotor seal ring and valve housing seal ring</td></tr>
<tr><td>Co</td><td>Backup ring insert tool
 
55473
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><td>ϕ45
{1.77}</td><td>ϕ20
{0.79}</td><td>45
{1.77}</td><td>ϕ33
{1.30}</td></tr></table></td><td>MH062880
*910-21716</td><td>Forming of backup ring</td></tr>
</table>

*: Unisia JKC part numbers

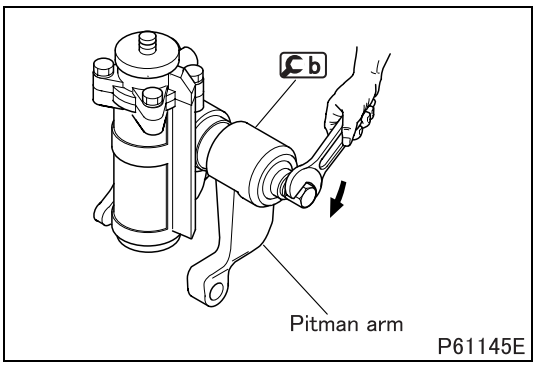
◆Inspection before removal◆



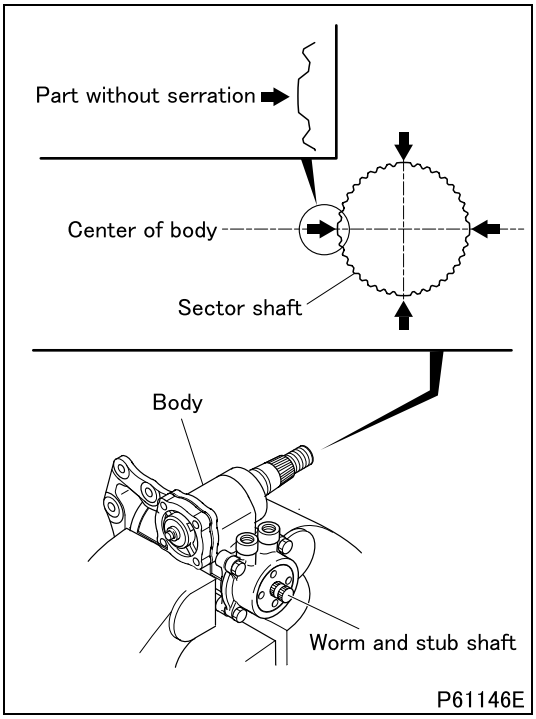
■ **Inspection: Starting torque**

- Using a, measure the starting torque of the power steering gear for reference at the time of reassembly before removal.
  - **A:** Starting torque (= engaging torque + normal turning torque)
  - **B:** Engaging torque
  - **C:** Normal turning torque

◆Removal procedure◆

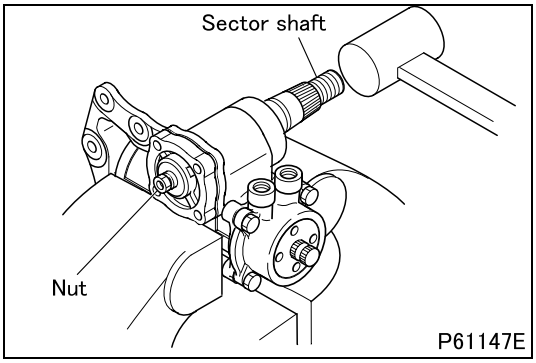


■ **Removal: Pitman arm**



■ **Removal: Sector shaft**

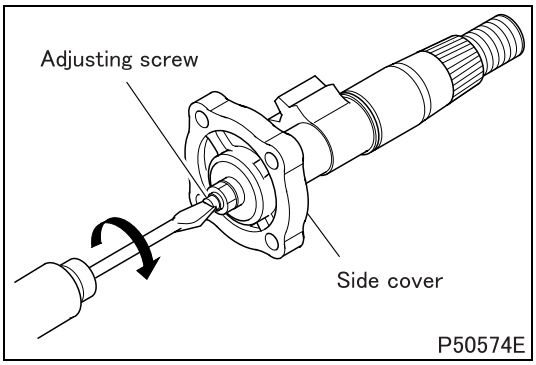
- Before removing, set the sector shaft in neutral position as follows.
- Turn the worm and stub shaft counterclockwise into the lock position, then back it up roughly 2.6 turns to bring the serration missing part of the serrated portion of the sector shaft into parallelism with the center of the body as shown.



- Loosen nut, and remove the sector shaft by tapping the shaft end with a plastic hammer.

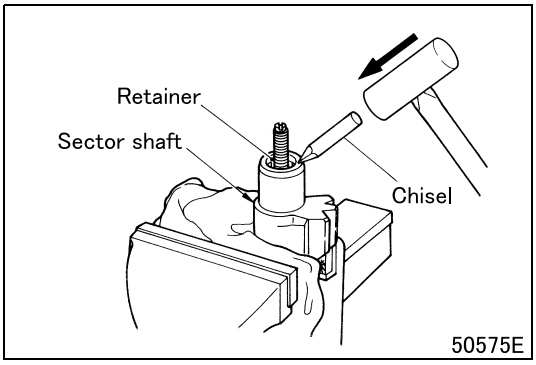
CAUTION ⚠

- **If the sector shaft is stuck, it should be out of neutral position. In such a case, do not attempt to force it out by hammering but redo the neutral positioning procedure.**



■ **Removal: Side cover**

- Remove the side cover by screwing in the adjusting screw.

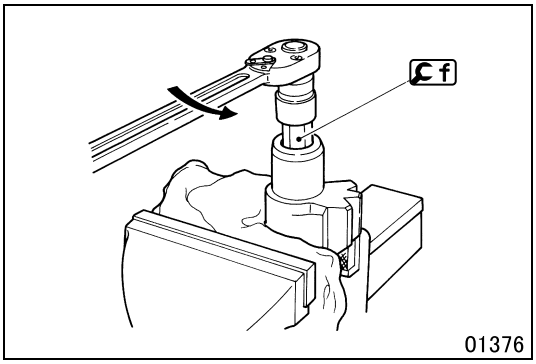


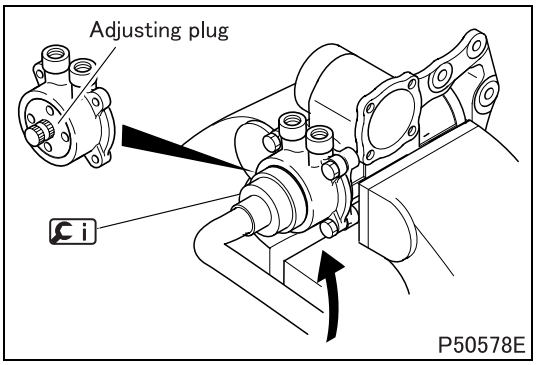
■ **Removal: Retainer**

- Undo the crimp of the retainer (at 2 points) using a chisel.

CAUTION ⚠

- **When holding the sector shaft with a vise, be sure to cover it with a cloth or the like for protection.**



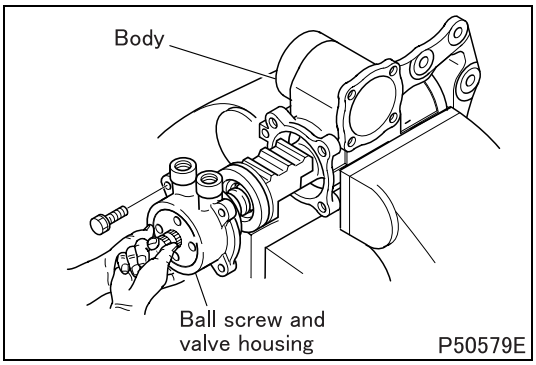


■ **Removal: Ball screw and valve housing**

- Before removing the ball screw and valve housing, back up the adjusting plug by roughly 180° with i.

CAUTION ⚠

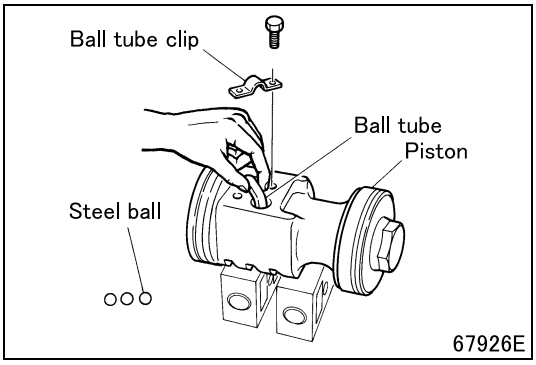
- **Do not remove the adjusting plug. If it is removed, bearing in the valve housing may pop out.**



- Remove the ball screw and valve housing from the body.

CAUTION ⚠

- **Take care so that balls in the ball screw and valve housing do not pop out.**
- **Take care not to scratch or otherwise damage the inner surface of the body and piston.**

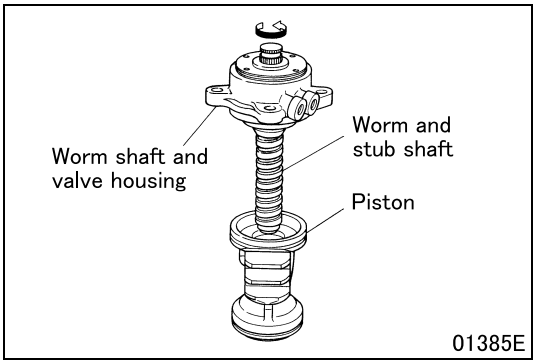


■ **Removal: Ball tube and steel ball**

- First remove steel balls from the piston, then remove ball tube clip. Hold the ball tube between fingers and remove it from the piston moving it lightly.

CAUTION ⚠

- **Be careful not to lose the steel balls (28 pieces in all).**

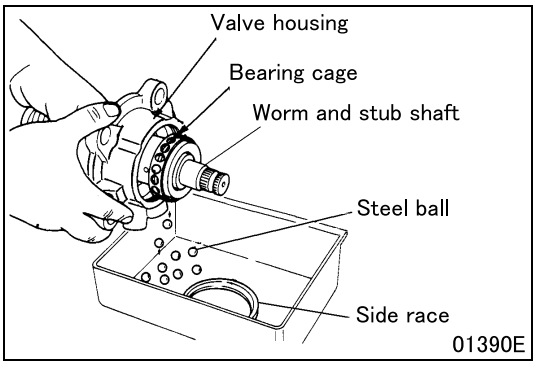


■ **Removal: Piston**

- Holding the worm shaft and valve housing with the piston downward, turn the worm and stub shaft and remove the piston.

CAUTION ⚠

- **Be careful not to tilt the piston during removal. If it is tilted, steel balls will fall off the race of the piston and worm and stub shaft into the piston.**



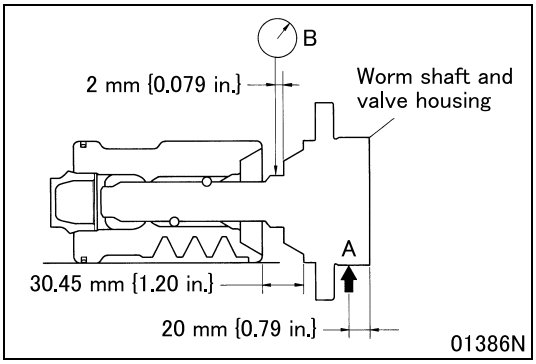
■ **Removal: Worm and stub shaft**

- Remove the worm and stub shaft by pushing its piston-side end out.

CAUTION ⚠

- **Use a suitable receptacle not to lose the side race, steel balls and bearing cage that fall off in separated pieces.**

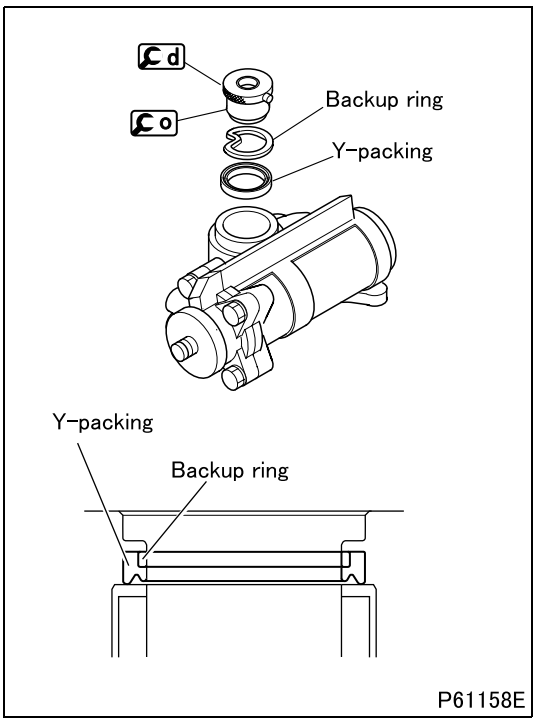
◆Inspection procedure◆



■ **Inspection: Side play of piston and worm and stub shaft**

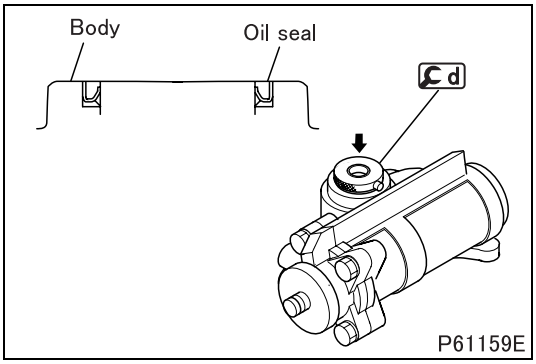
- Apply a force of 49 N {11 lbf} to the illustrated point **A** and measure play **B** (play in the diametric direction) of the worm shaft and valve housing.
- If the measurement exceeds the limit, replace the faulty parts.

◆Installation procedure◆



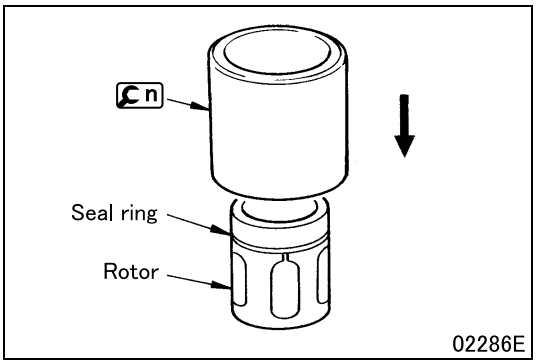
■ **Installation: Backup ring and Y-packing**

- Fill grease in the groove of Y-packing and install Y-packing in the illustrated direction.
- Install backup ring, formed as shown, using d and o.



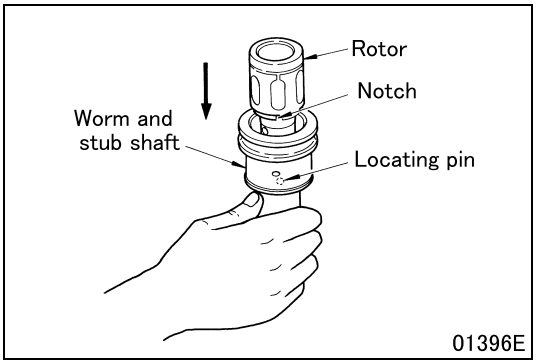
■ **Installation: Oil seal**

- Install the oil seal to the body in the illustrated direction.



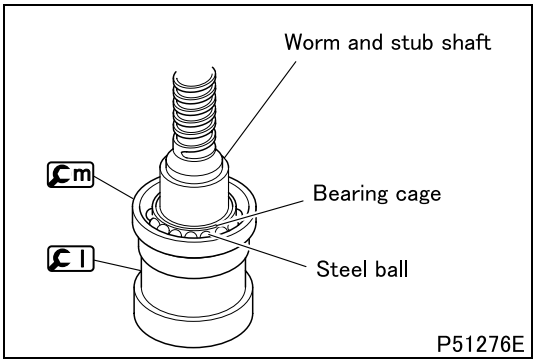
■ **Installation: Seal ring**

- Install the seal ring onto the rotor.
- Form the seal ring to fit the rotor using n.



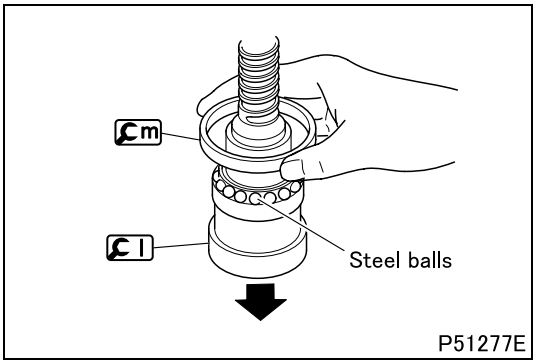
■ **Installation: Rotor**

- Install the rotor aligning its notch with the locating pin of the worm and stub shaft.

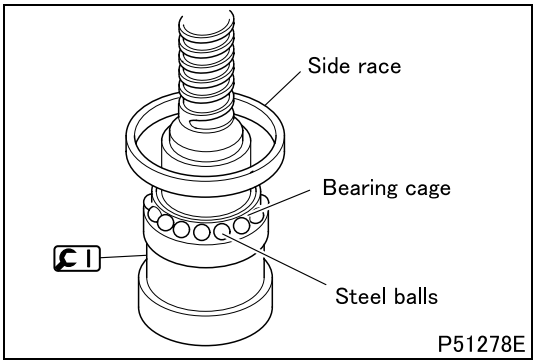


■ **Installation: Side race, steel balls and bearing cage**

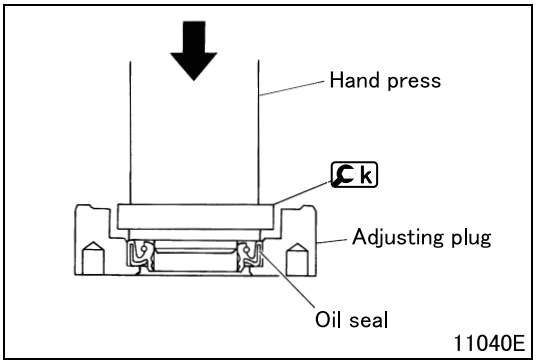
- Using [l] and [m] assembled, install the worm and stub shaft in the illustrated direction.
- Install the bearing cage and steel balls onto the worm and stub shaft.



- Holding [m] with hand, slide [l] downward to have steel balls set in place.

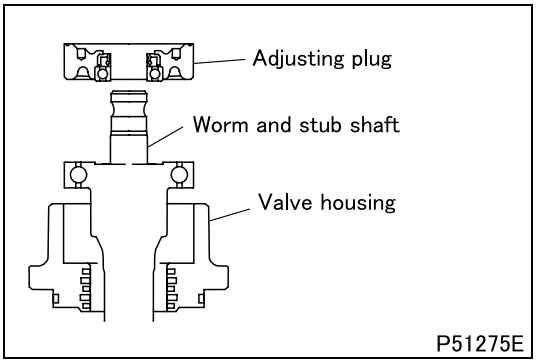


- Install the side race onto the steel balls and bearing cage.



■ **Installation: Oil seal**

- Using k, press oil seal in the illustrated direction into the adjusting plug.

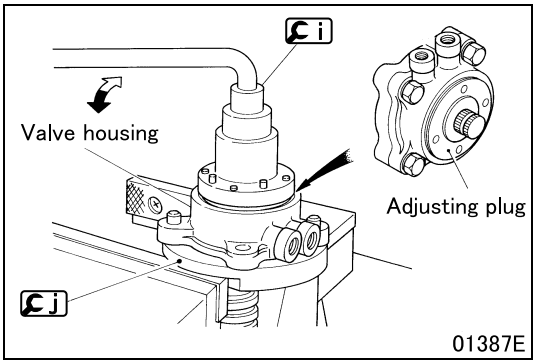


■ **Installation: Worm and stub shaft**

- Install the valve housing onto the worm and stub shaft and secure it in place with adjusting plug.

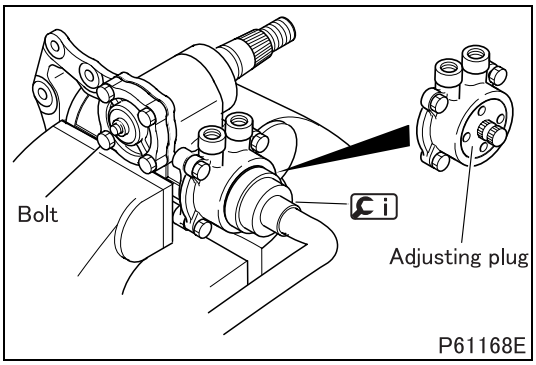
CAUTION ⚠

- **Take care not to damage the seal rings with the ball race of the worm and stub shaft.**

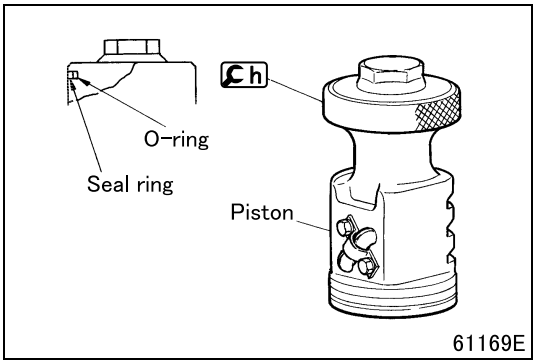


■ **Installation: Adjusting plug**

- Hold j with a vise and secure the valve housing to it.
- Tighten the adjusting plug to the specified torque using i, then back it up by approximately 180°.

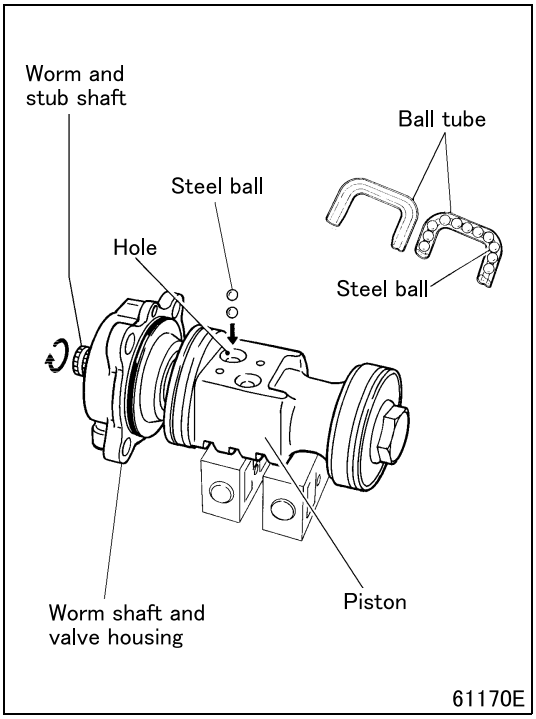


- Tighten bolt to the specified torque, then retighten the adjusting plug using i.



■ **Installation: Seal ring and O-ring**

- Install seal ring and O-ring in the outer surface grooves of the piston, and form the seal ring to fit in place using Ch.

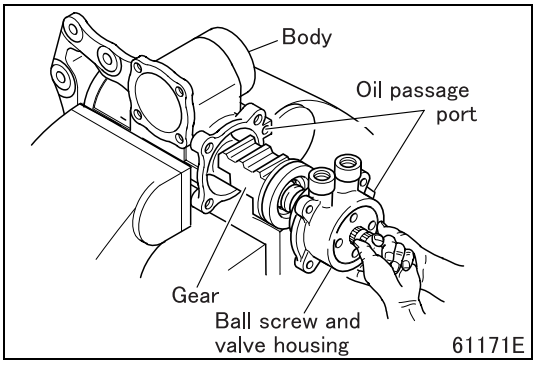


■ **Installation: Ball tube**

- Pack grease in one half of the ball tube, place 10 to 11 steel balls in it and put the other half upon it.
- Place the piston on a flat workbench, align the positions of the worm shaft and valve housing and piston ball race, then while turning the worn and stub shaft, let steel balls fall from the ball tube hole.

CAUTION ⚠

- **Do not draw out the warm shaft and valve housing until its end passes over the ball tube hole during installation. Otherwise the steel balls will come out of the ball race.**

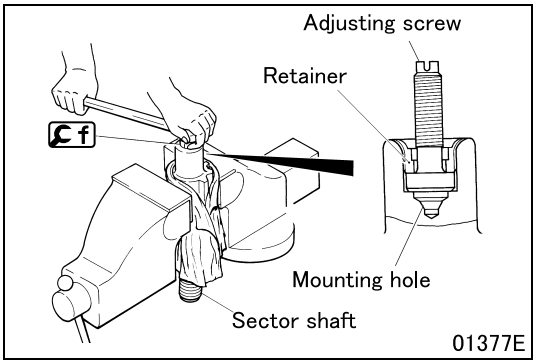


■ **Installation: Ball screw and valve housing**

- Position the gear toothed portion of the ball screw and valve housing in the illustrated direction so that it engages with the sector shaft.
- Install the ball screw and valve housing to the body, lightly holding it with hand so that its gear portion does not turn out of position. When installing, align the oil passage ports of the ball screw and valve housing and body.

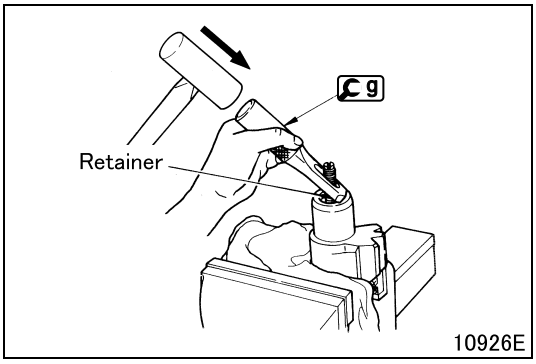
CAUTION ⚠

- **Be careful not to damage the seal ring on the piston and the inner surface of the body.**

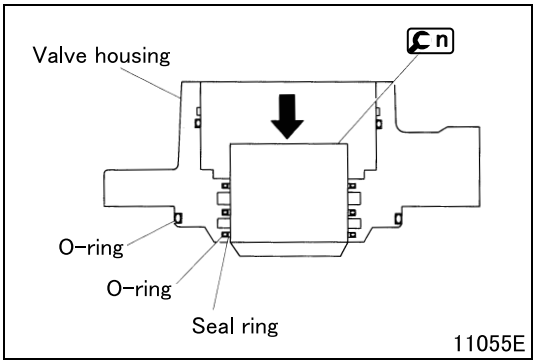


■ **Installation: Retainer**

- Pack grease in the adjusting screw mounting hole on the sector shaft.
- Install the adjusting screw into the sector shaft.
- Using Cf, tighten the retainer into place in the sector shaft.
- Back up the retainer by 180°, retighten it to a torque of 39 N·m {29 lbf·ft}, then back it up again by 20°.
- Check that the adjusting screw turns smoothly.

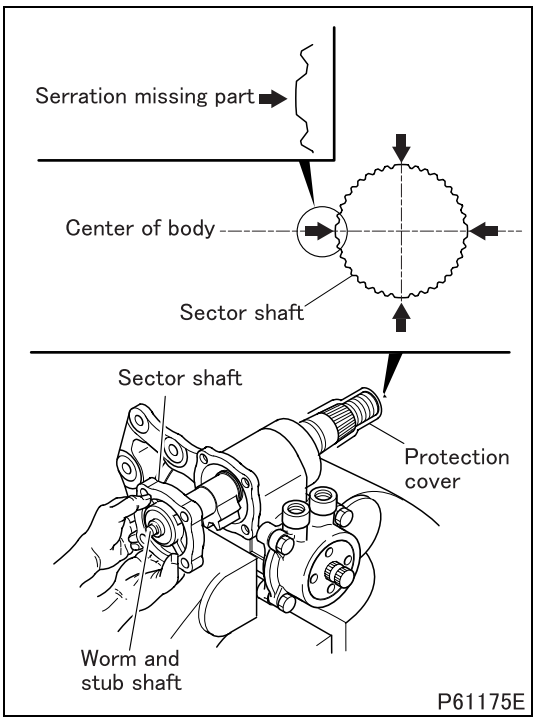


- Using Cg, crimp the retainer at two places.



■ **Installation: Seal ring and O-rings**

- Install seal ring and O-rings to the valve housing.
- Form seal ring to fit the valve housing using Cn.



■ **Installation of sensor shaft**

- Set the sector shaft in the neutral position and install it into the body.

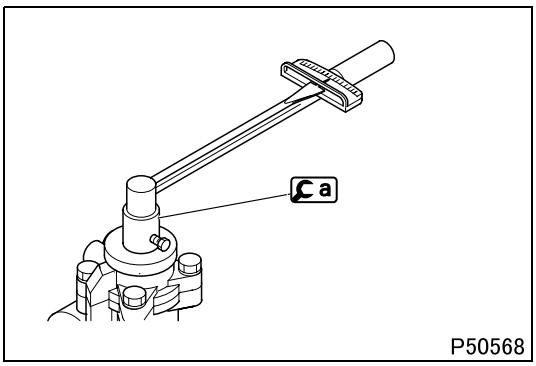
CAUTION ⚠

- **When installing the sector shaft, cover up its threaded end and serration portions for protection.**

NOTE

- **Turn the worm and stub shaft to check that it makes roughly five turns lock to lock.**
- **If the number of turns is less, check engagement of the worm and stub shaft with the sector shaft, and correct if necessary.**

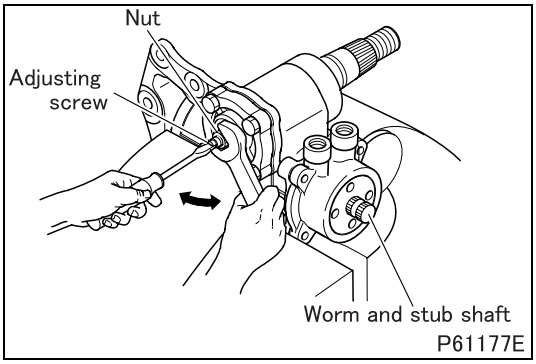
◆Adjustment after installation◆



■ **Inspection: Starting torque**

[Inspection]

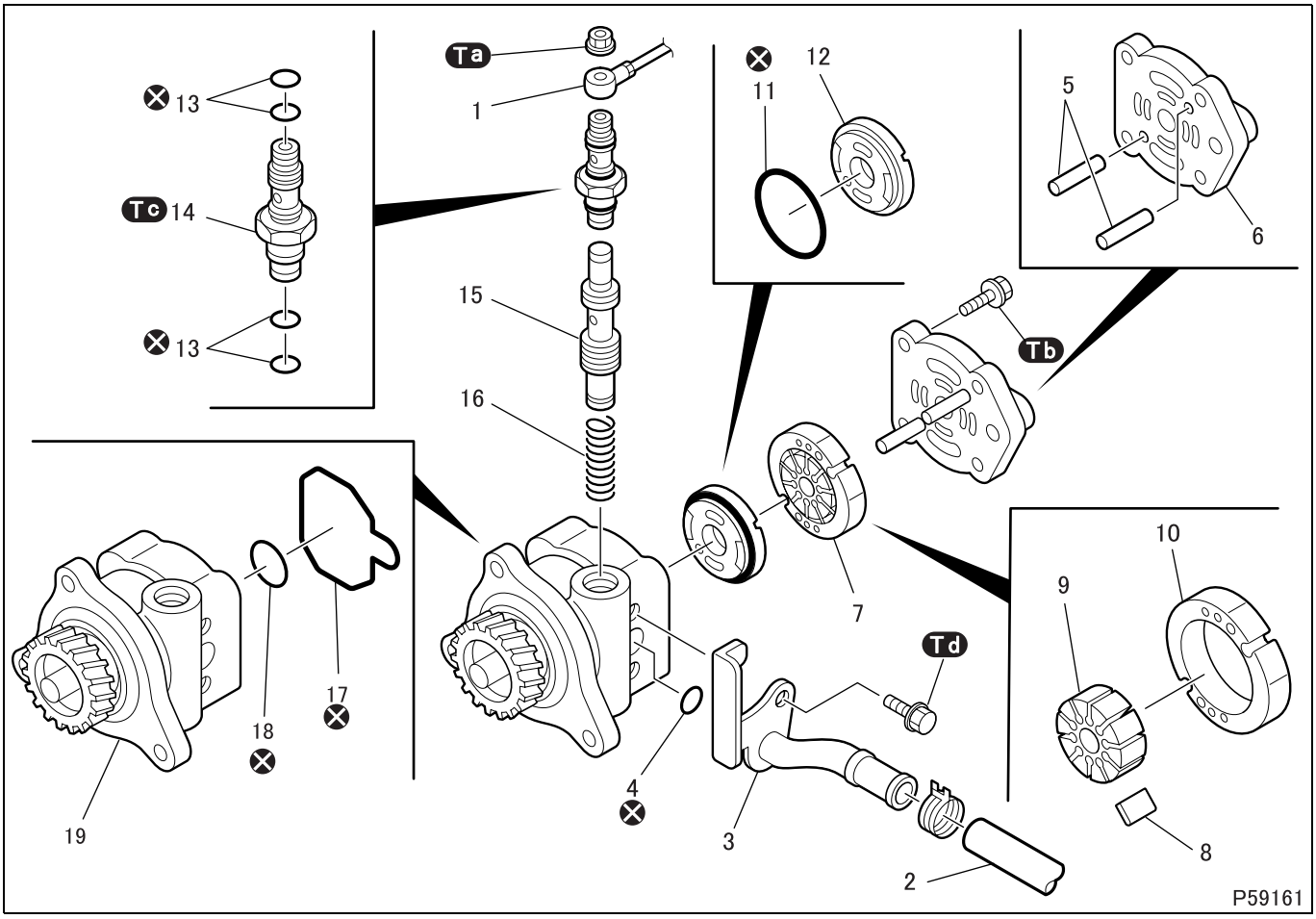
- Using a, measure the starting torque of the power steering gear in the same manner as the measurement before removal. If the measurement deviates from the standard value, adjust the power steering gear for proper starting torque or replace.



[Adjustment]

- Loosen nut.
- Rotating the worm and stub shaft approximately 1/4 turns left and right, make adjustment for proper starting torque with the adjusting screw.

POWER STEERING OIL PUMP <KAYABA INDUSTRY Product>



● **Disassembly sequence**

1 Pipe
2 Hose
3 Suction connector
4 O-ring
5 Pin
6 Cover
7 Cartridge assembly
8 Vane
9 Rotor
10 Cam ring
11 O-ring
12 Side plate
13 O-ring
14 Connector
15 Flow control valve
16 Flow control spring
17 O-ring
18 O-ring
19 Body

⊗: Non-reusable parts

NOTE

- **See Gr11 for removal and installation of the power steering oil pump.**

CAUTION ⚠

- **Do not disassemble the flow control valve and body.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Seal repair kit

Service standards: mm {in}

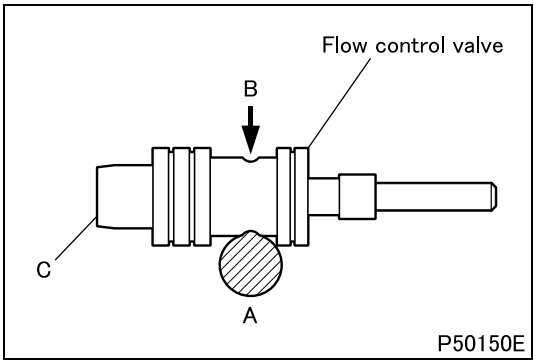
Location	Maintenance item	Standard value	Limit	Remedy
6	Stepped wear on rotor and vane contact surfaces of cover	–	0.05 {0.0020}	Replace*
8, 9	Clearance between vane and rotor	0.01 {0.00039}	0.06 {0.0024}	Replace
12	Stepped wear on rotor and vane contact surfaces of side plate	–	0.05 {0.0020}	Replace*
15, 19	Clearance between flow control valve and body	0.01 to 0.02 {0.00039 to 0.00079}	0.03 {0.0012}	Replace*
16	Free length of flow control spring	36.5 {1.44}	33.5 {1.32}	Replace

*: Replace the power steering oil pump.

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (pipe mounting)	29.4 to 39.2 {22 to 29}	–
Tb	Bolt (cover mounting)	18 to 22 {13 to 16}	–
Tc	Connector	49 to 69 {36 to 51}	–
Td	Bolt (suction connector mounting)	7.8 to 11.8 {5.8 to 8.7}	–

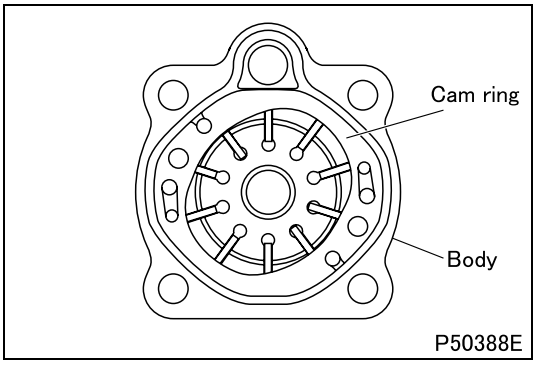
◆Inspection procedure◆



■ Inspection: Flow control valve

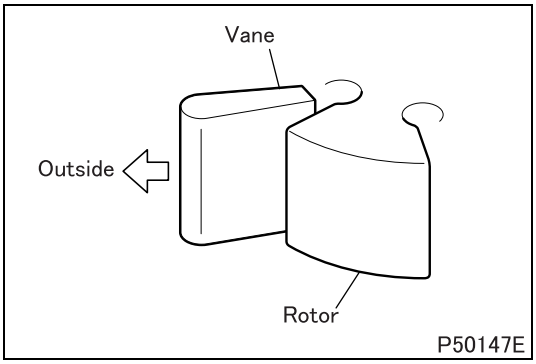
- Cover port **A** of the flow control valve with a finger.
- Apply air pressure (390 to 490 kPa {57 to 71 psi}) to port **B**.
- Check for a leak of air from port **C**.
- If there is an air leakage, replace the power steering oil pump.

◆Installation procedure◆



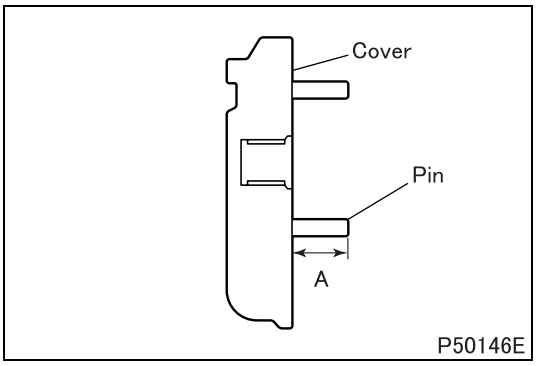
■ Installation: Cam ring

- Install the cam ring in the illustrated direction to the body.



■ **Installation: Vane**

- Fit the vane into the rotor, with its round edge facing toward outside.

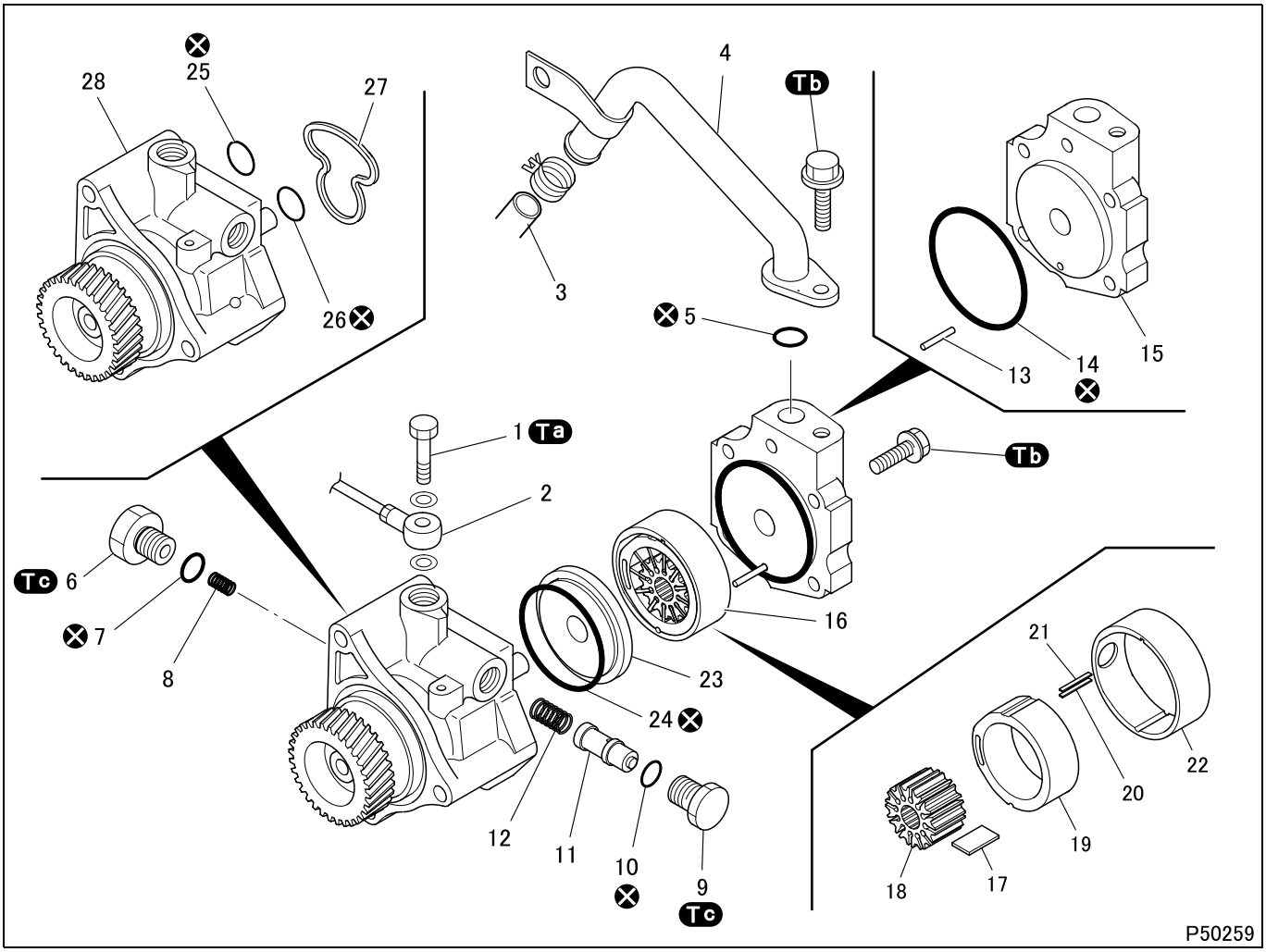


■ **Installation: Pin**

- Fit the pins into the cover so that they protrude to the illustrated length **A** from the cover.
  A: 14.5 mm {0.57 in}

M E M O

POWER STEERING OIL TANK <UNISIA JKC Product>



● **Disassembly sequence**

1 Eyebolt
2 Pipe
3 Hose
4 Suction connector
5 O-ring
6 Plug
7 O-ring
8 Spring
9 Plug
10 O-ring
11 Control valve
12 Control valve spring
13 Straight pin
14 O-ring
15 Rear body
16 Cartridge assembly
17 Vane
18 Rotor
19 Cam ring
20 Seal
21 Rubber spring
22 Adapter
23 Pressure plate
24 O-ring
25 O-ring
26 O-ring
27 Seal ring
28 Front body

⊗: Non-reusable parts

NOTE

- **See Gr11 for removal and installation of the power steering oil pump.**

CAUTION ⚠

- **Do not disassemble the control valve and front body.**
- **If the cartridge assembly is difficult to disassemble, not attempt to pry it out but heat the side surface of the front body with a dryer.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Repair kit

Service standards: mm {in})

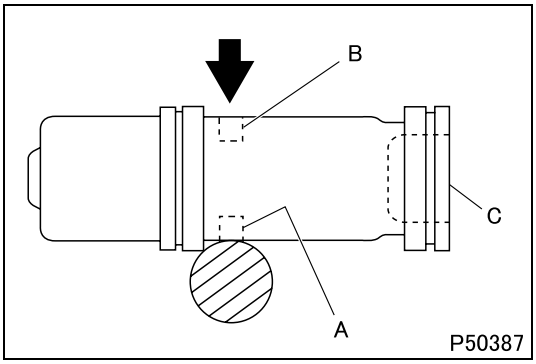
Location	Maintenance item	Standard value	Limit	Remedy
8	Free length of spring	24 {0.94}	23 {0.91}	Replace
11, 28	Clearance between control valve and front body	0.02 {0.00079}	0.03 {0.0012}	Replace*
12	Free length of control valve spring	26.2 {1.03}	23.6 {0.93}	Replace
15	Stepped wear on rotor and vane contact surfaces of rear body	–	0.01 {0.00039}	Replace*
17, 18	Clearance between vane and rotor	0.02 {0.00079}	0.03 {0.0012}	Replace
23	Stepped wear on rotor and vane contact surfaces of pressure plate	–	0.01 {0.00039}	Replace*

*: Replace the power steering oil pump.

Torque: N·m {lbf·ft}

Mark	Component	Torque value	Remarks
Ta	Eyebolt (pipe mounting)	49.0 to 63.7 {36 to 47}	–
Tb	Bolt (suction connector mounting)	17.7 to 24.5 {13 to 18}	–
	Bolt (rear body mounting)		
Tc	Plug	29.4 to 39.2 {22 to 29}	–

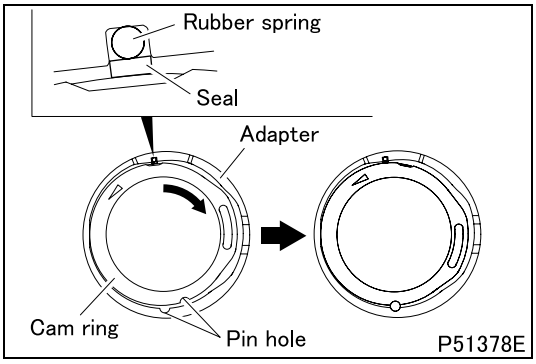
◆Inspection procedure◆



■ **Inspection: Control valve**

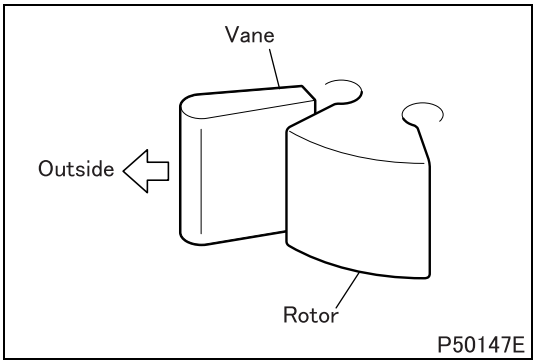
- Cover port **A** of the control valve with a finger.
- Apply air pressure (390 to 490 kPa {57 to 71 psi}) to port **B**.
- Check for a leak of air from port **C**.
- If there is an air leakage, replace the control valve.

◆Installation procedure◆



■ **Installation: Seal and rubber spring**

- Align the peripheral groove of the cam ring to the inner groove of the adapter, then fit the rubber spring (black) into the adapter and the seal (white) into the cam ring.
- Turn the cam ring clockwise to align pin holes.

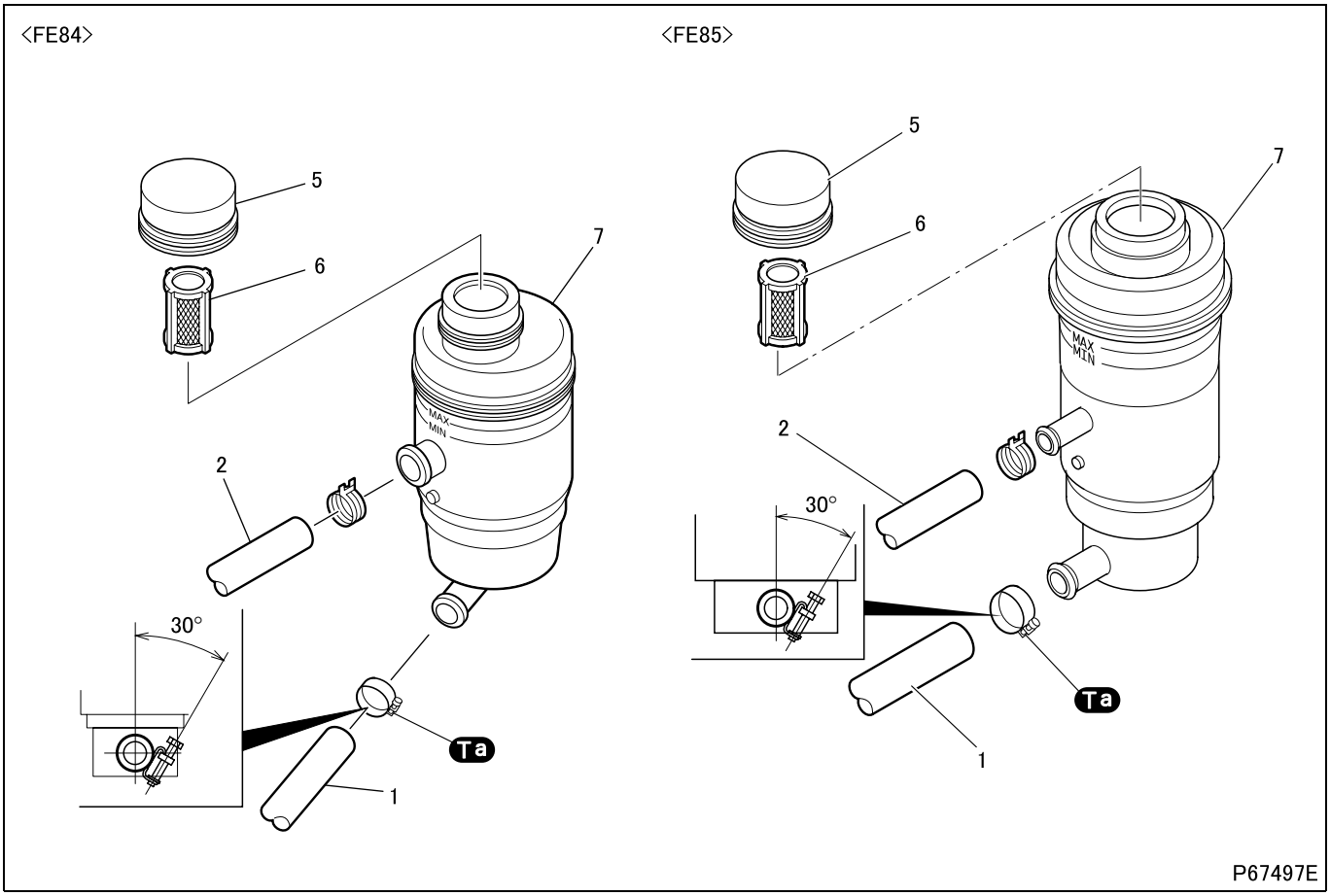


■ **Installation: Vane**

- Fit the vane into the rotor, with its round edge facing toward outside.

M E M O

POWER STEERING OIL TANK



● **Disassembly sequence**

1 Hose
2 Hose
3 Cap
4 Strainer
5 Body

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Clamp	2.0 to 2.5 {1.5 to 1.8}	–

GROUP 41 INDEX

SPECIFICATIONS **41-2**

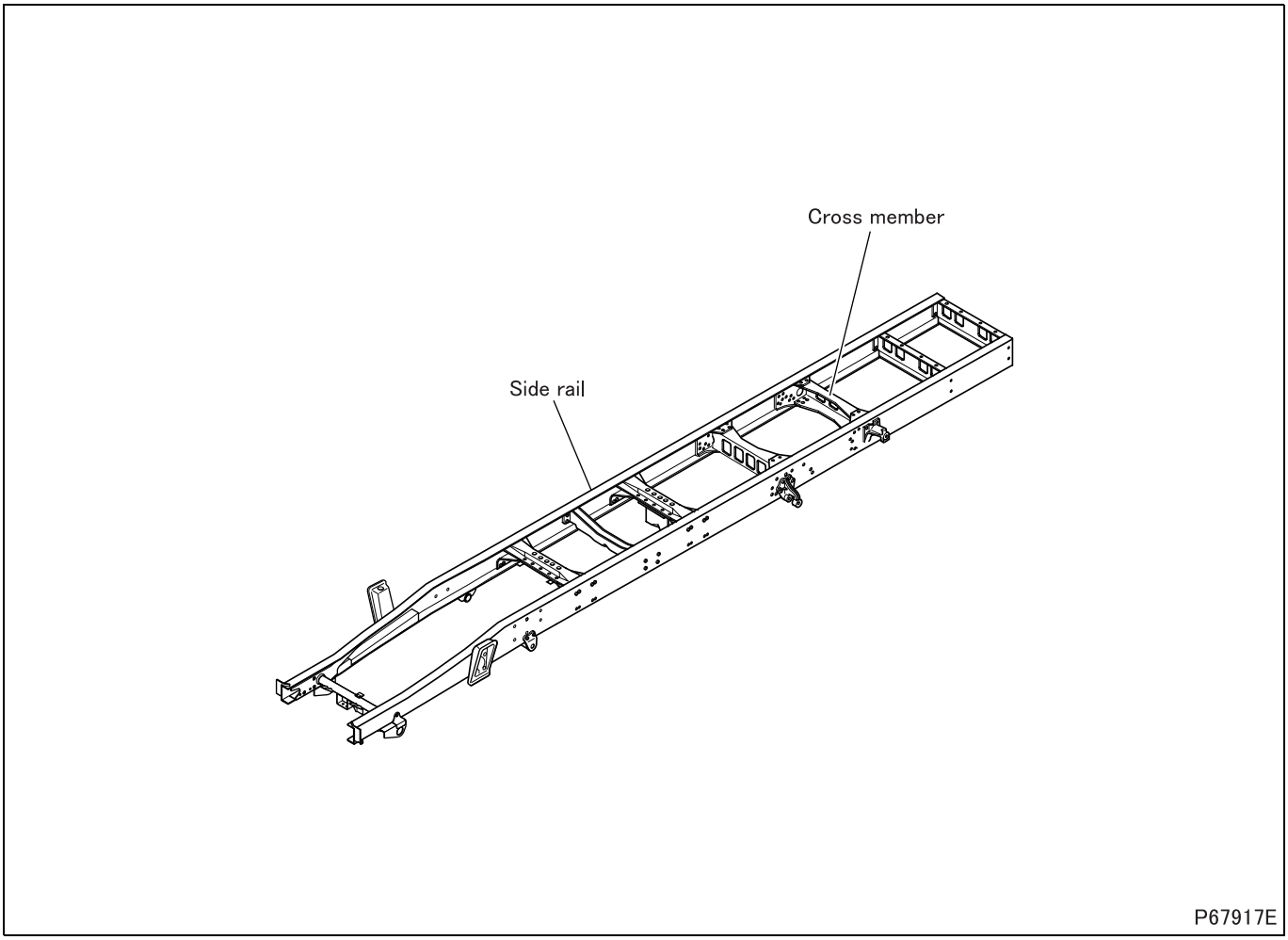
STRUCTURE AND OPERATION **41-3**

FRONT BUMPER **41-4**

FRAME **41-6**

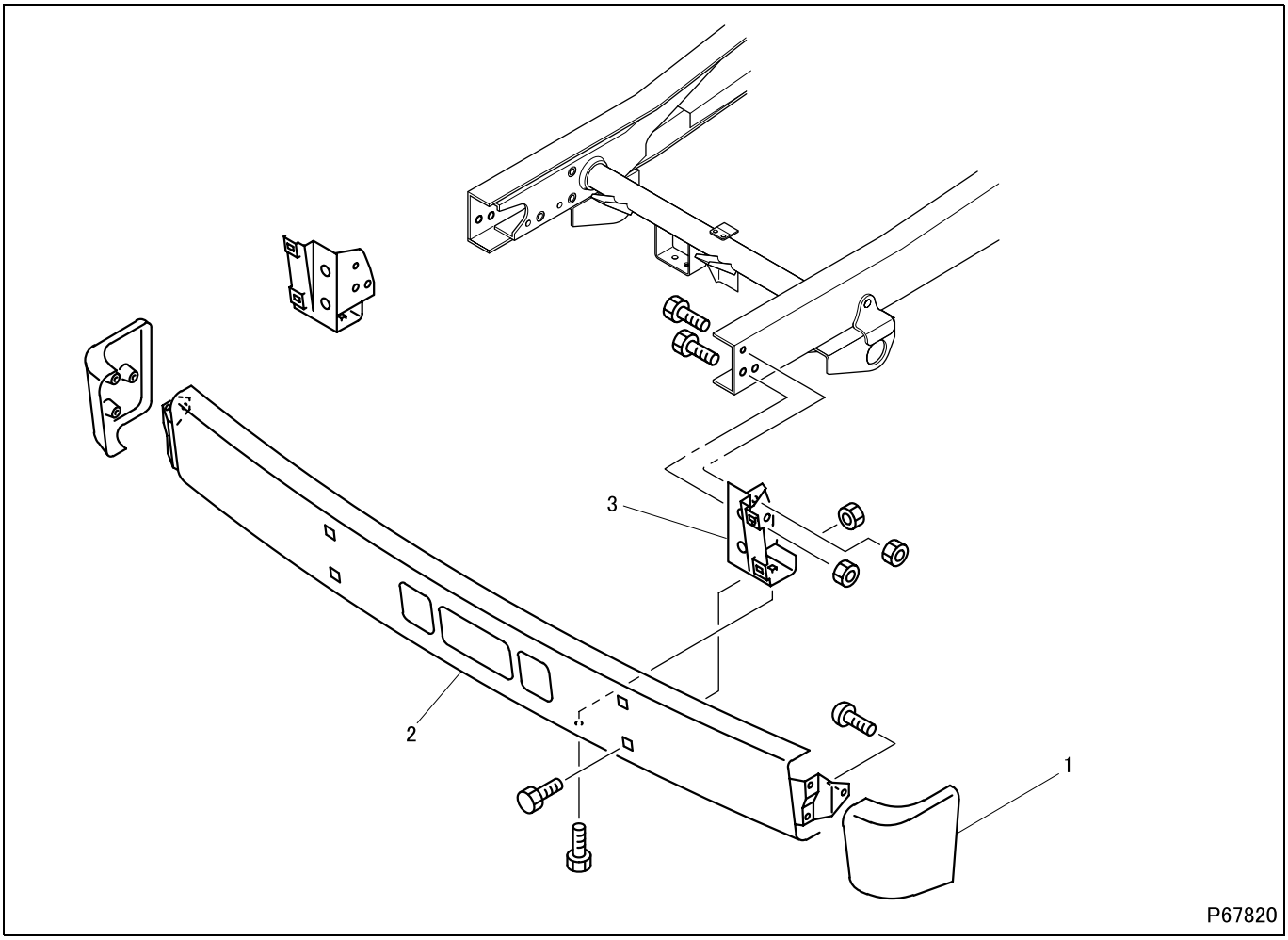
SPECIFICATIONS

Item	Specifications
Frame type	Ladder type
Cross section configuration of side rail	⊐ shaped (open) channel section



- The frame has cross members fastened to the web of the side rail (lateral linkage), which reduces stress on the joints. This allows the rivets to remain tight and ensures long-lasting high torsional stiffness.
- Unlike vertical linkage where cross members are fastened to the flange of the side rail, no rivets appear on top of the frame, making body mounting much easier.

FRONT BUMPER



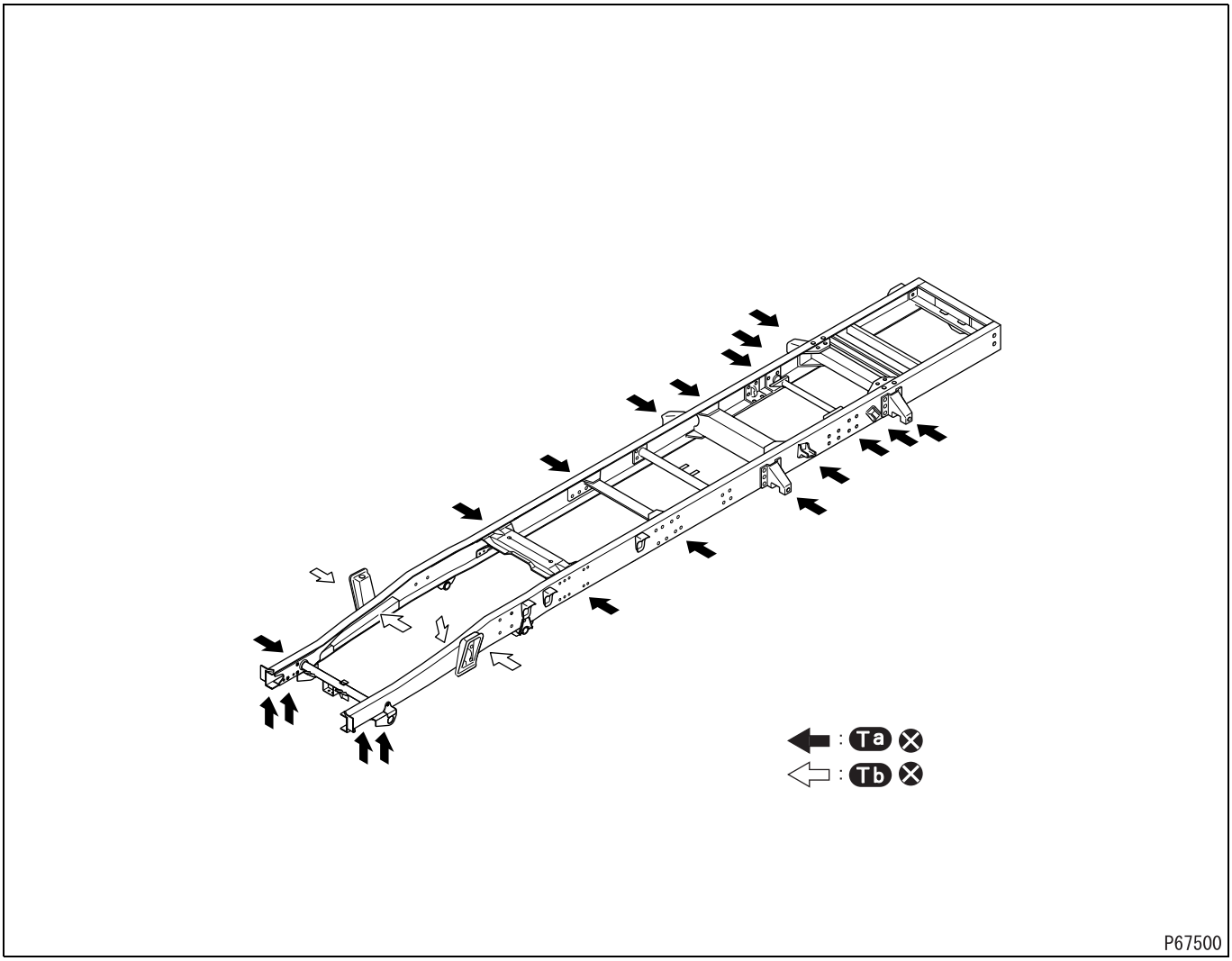
● **Removal sequence**

1 Corner bumper
2 Front bumper
3 Bumper stay

● **Installation sequence**

Follow the removal sequence in reverse.

M E M O



⊗: Non-reusable parts

CAUTION ⚠

- **Since the mounting bolts and nuts are tightened by a torque-to-yield method, they must not be reused.**

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	M10 bolt or nut	60 to 80 {43 to 58}	–
Tb	M12 bolt or nut	98 to 120 {72 to 87}	–

◆Cleaning procedure◆

■ Cleaning: Frame

- Remove all mud, grease, rust etc. from the outer and inner surfaces of the frame.

◆Inspection procedure◆

■ Inspection: Frame

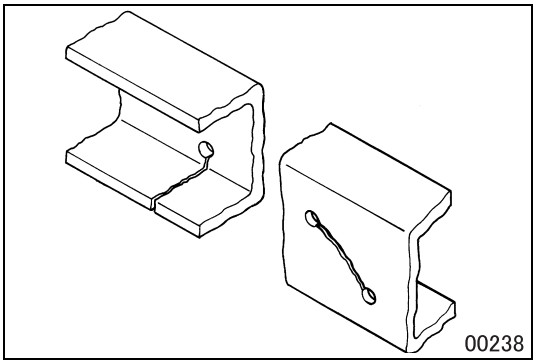
(1) Inspection for deformation

- If deformation or any other defect is found, repair the frame.

(2) Inspection for cracks

- Remove paint from suspected areas and carefully inspect exposed surfaces for cracks.
- If visual inspection is difficult, perform dye check or any other suitable examination.

  If a crack is found, repair as follows.

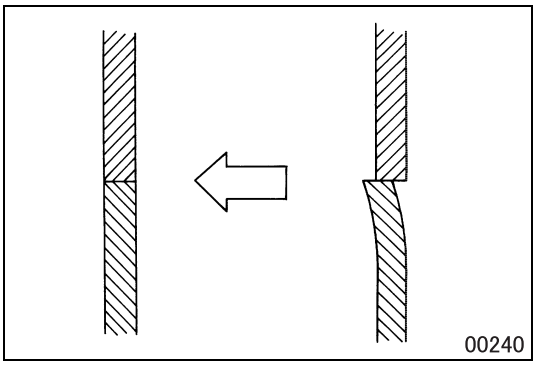


(3) Repairing crack in frame

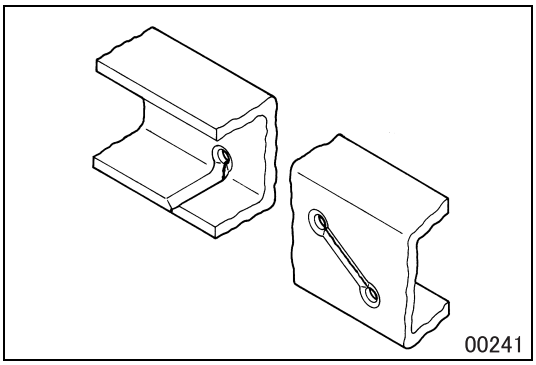
- With the vehicle unloaded, level the frame.
- Drill a hole, roughly twice the thickness of frame plate in diameter, 10 mm {0.4 in} from the inside end of crack.

NOTE

- **If the crack is within the frame plate, drill holes at both ends of the crack.**



- The edges of the crack should be even. If the edges of the crack are not even, repair them.



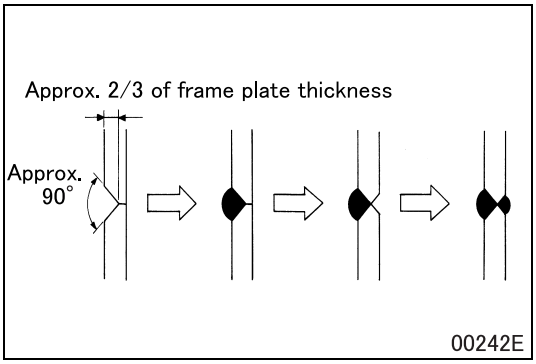
- Using a grinder, cut a 90° V-channel at the crack to a depth of approximately 2/3 of the frame plate thickness, then fill the channel with filler metal by welding.

WARNING ⚠

- **Before performing any electric welding on a vehicle, disconnect the battery power and ground cable, and any electronic control units or similar devices installed on the vehicle. Electric currents produced during electric welding can damage various electrical components on the vehicle, which could result in malfunction of the components.**

CAUTION ⚠

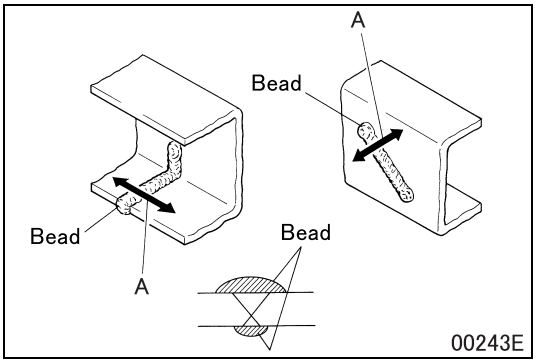
- **Avoid gas welding because heat embrittles the material of welded area. Be sure to use electric welding.**



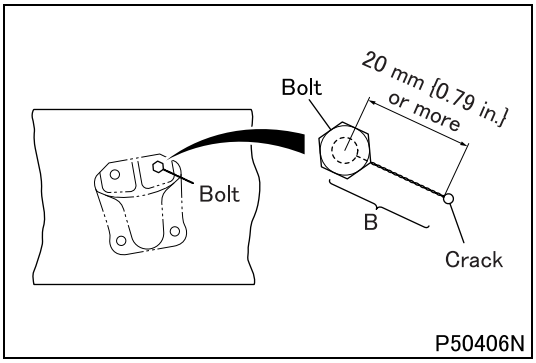
- Then, make a similar V-channel on the opposite side of the weld and fill it with filler metal by electric welding as well. At the same time, deposit metal to cover up the hole or holes at both ends of the crack by welding.

NOTE

- **In cold weather, heat the weld zone to approximately 200°C {390°F} after welding.**

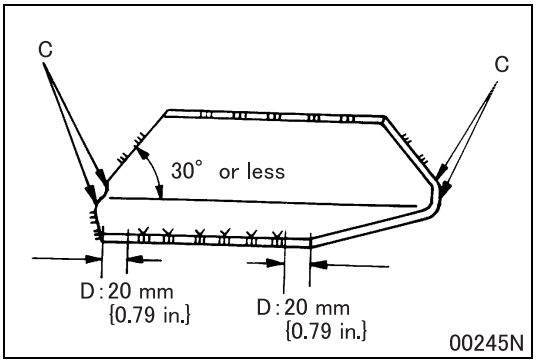


- After welding, run a grinder over the bead at right angles (see **A**) to remove the hatched portion from the weld on each side of the plate.
- Finish the ground surfaces flat to a thickness equal to the original plate thickness.



[Repairing crack from rivet or bolt hole]

- To make the edges of cracked hole even, temporarily tighten bolt in the hole.
- First weld to close the crack at a point at least 20 mm {0.79 in} apart from the center of the bolt.
  Use the procedures for "**Repairing crack in frame"** in this manual.
- Remove the temporary bolt. After making hole edges even, weld to close the rest (see **B**) of the crack. Fill the hole with weld metal at the same time.
- Drill a hole at the location of original hole, and install a rivet or bolt in it.



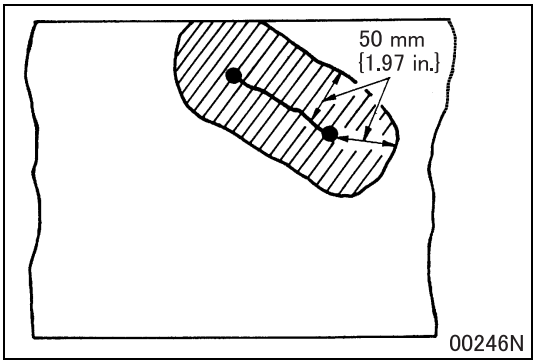
[Repairing using reinforcement plate]

- To prevent the concentration of welding stress at both ends (marked **C**) of the reinforcement plate, cut the ends at a bevel of 30° or less for welding. Do not weld at points marked **D**.
- The reinforcement plate must have enough to cover the cracked area.

NOTE

- **Reinforcement plate thickness must be equal to frame plate thickness.**
- **For reinforcement plate materials, use the specifications below, or equivalent.**

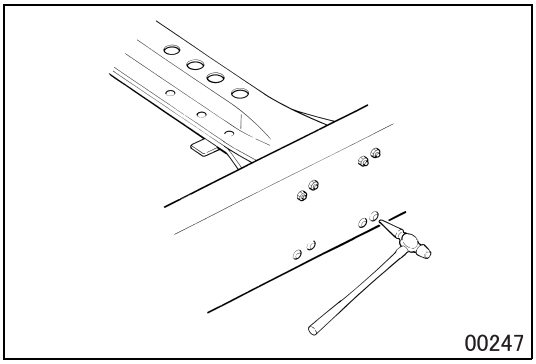
SAPH440 (Hot rolled steel for automobiles), or SS400 (Rolled steel for general structures)



- After welding, heat the cross-hatched area to 600 to 700°C {1110 to 1292°F}.

CAUTION ⚠

- **Be sure to protect mounting areas that may be damaged by heat, using heat insulators or similar protection.**

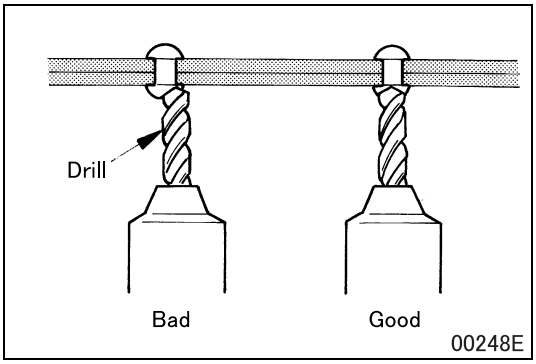


(4) Inspection of rivets for looseness

- Lightly tap the head of each rivet using an inspection hammer. Feel or listen for the echo to determine if the rivet is loose.
- Rusting between rivet and frame plate is an indication of a loose rivet.

CAUTION ⚠

- **Be sure to replace loose rivets. They could break off or allow cracks to develop from the rivet holes, leading to frame rail damage.**

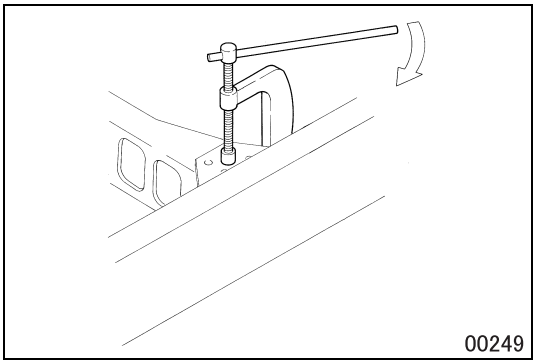


(5) Replacement of rivets

- To remove a loosened rivet, eliminate its head using a drill or grinder. When a drill is used, make a dent in the middle of the rivet's head and align the drill bit to the dent as shown.

NOTE

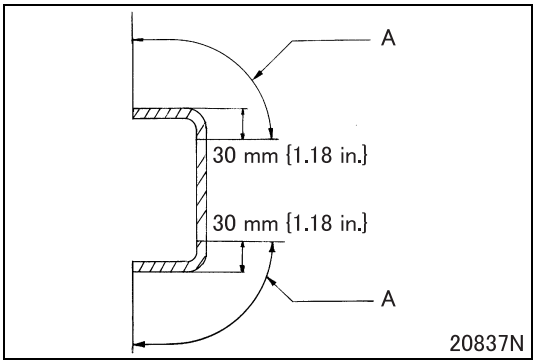
- **The rivet hole must be intact.**



- Before riveting, clamp the two plates closely together near the rivet hole using a C-clamp.
- Using a riveting machine, drive the rivet (cold rivet) into the rivet hole.
- If riveting is impracticable, ream the rivet hole, drive a reamer bolt in the hole, fully tighten the nut, then weld it in place.
  As the reamer bolt and nut, use a flange bolt and a flange nut.

(6) Inspection of bolts and nuts for looseness

- Inspect the bolts attaching cross members to the side rails for looseness. If any loose bolt is found, retighten it to specified torque.



(7) Drilling hole in frame

- When drilling holes in the frame becomes necessary, perform it using care in the following respects.

CAUTION ⚠

- **When drilling holes in the side rail, avoid the illustrated ranges A to prevent cracking.**
- **Grind the edge of drilled hole smooth.**
- **Avoid drilling a hole in the vicinity of a point where the rigidity of the side rail change sharply, such as an area near the joint to the cross member or an end of the stiffener.**
- **The diameter of drilled holes must be 11 mm {0.43 in} or smaller and the hole-to-hole distance must be 20 mm {0.79 in} or larger.**

GROUP 42 INDEX

SPECIFICATIONS 42-2

STRUCTURE AND OPERATION
- **1. Front Cab Mounting 42-3**
- **2. Rear Cab Mounting 42-3**
- **3. Cab Tilt Link 42-4**

TROUBLESHOOTING 42-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
- **1. Adjustment of Cab Tilt System 42-8**

REMOVAL AND INSTALLATION OF CAB 42-10

FRONT CAB MOUNTING 42-14

REAR CAB MOUNTING 42-16

CAB TILT LINK 42-18

CAB STAY 42-20

SPECIFICATIONS

Cab

Item	Specifications
Type	Cab-over type (forward control type)
Mass kg {lb}	410 {905}

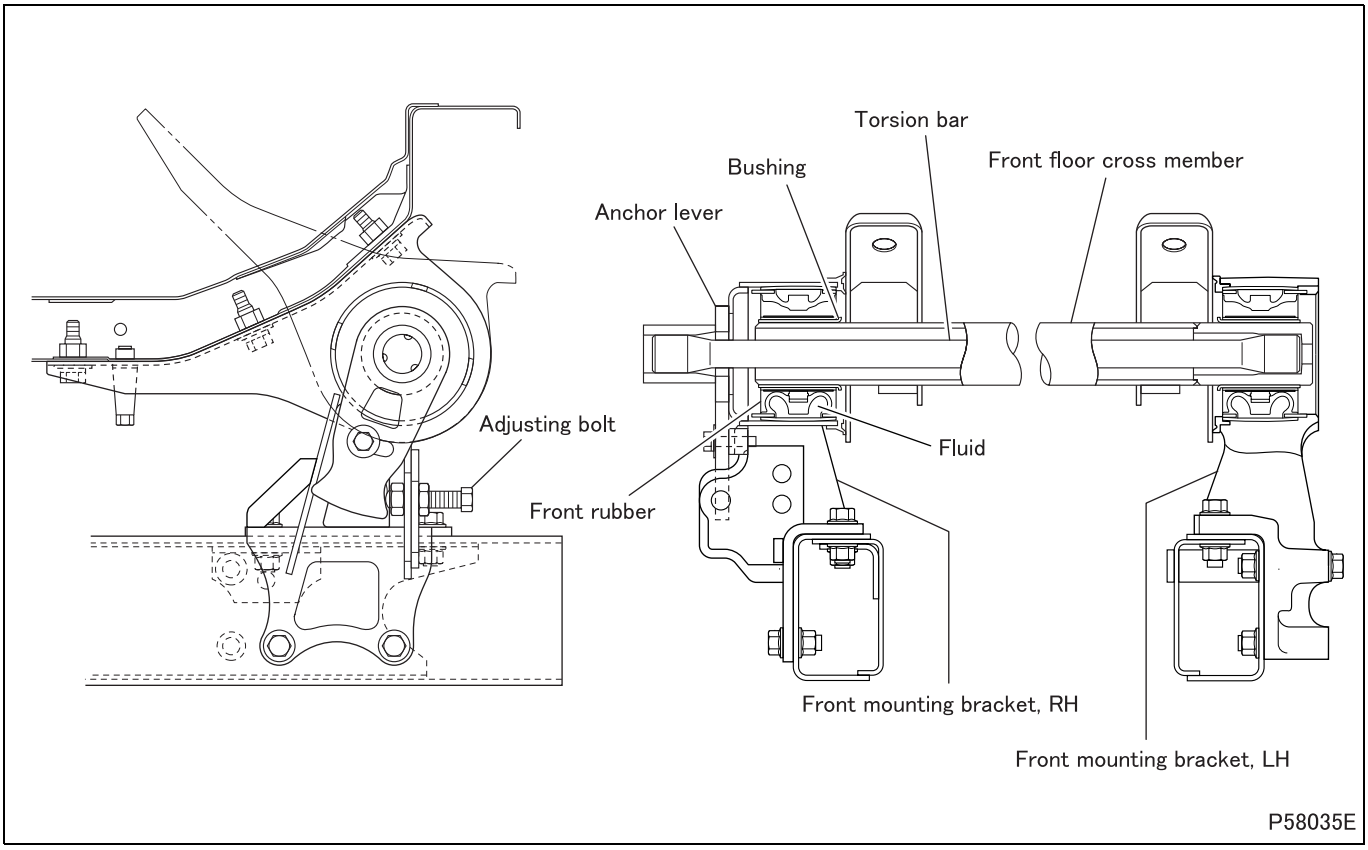
Cab Mounting

Item	Specifications
Type	Semi-floating type
Kind	Liquid-filled rubber cushioned mounting

Cab Tilt System

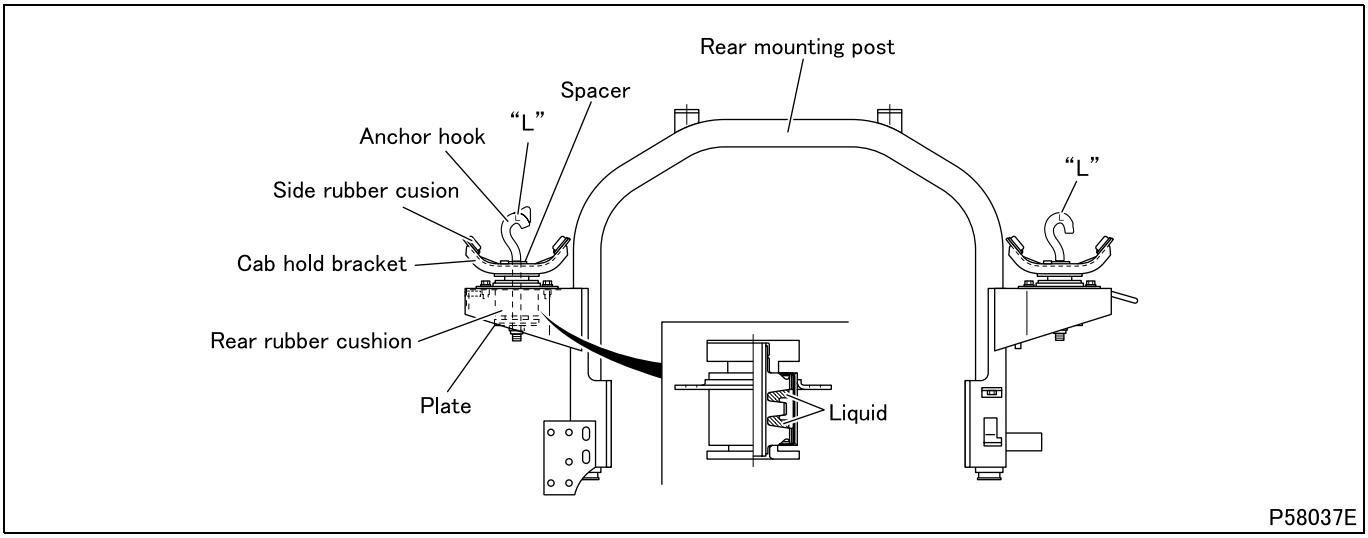
Item	Specifications
Type	Torsion bar type
Tilt angle	45°
Cab tilt lock	Manually operated hook type

1. Front Cab Mounting



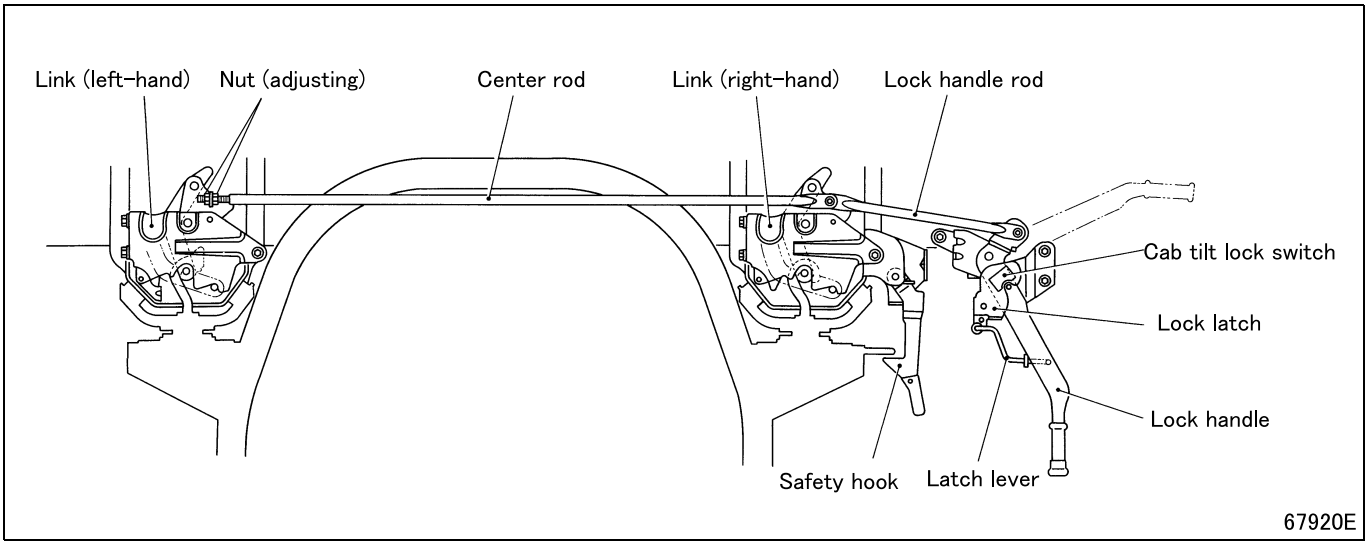
- The cab tilt system can be adjusted using the adjusting bolt on the front mounting bracket.
- The front rubber cushion reduces vibration and noise in the cab.

2. Rear Cab Mounting



- The the lock handle can be adjusted by increasing and decreasing the number of spacers provided between the anchor hook and the cab hold bracket.
- Rear mounting upper and lower rubber cushions reduce vibration and noise in the cab.

3. Cab Tilt Link



- The length of the center rod can be changed using the adjusting nut.
- The cab tilt lock switch monitors the locking status of the lock handle.

M E M O

Cabs in general

Probable causes \ Symptoms			Cab shimmy (vibration with pitching and rolling)	High-frequency vibration (above 20Hz) and noise in cab and steering wheel	Reference Gr
Cab-related problems	Front cab mounting	Front mounting bracket loose, play	O		
		Sagging of front rubber cushion		O	
	Center or rear cab mounting	Sagging of mounting rubber cushion		O	
	Cab improperly mounted			O	
Engine-related problems		Propeller shaft inclination angle excessive due to increased tilt angle caused by deteriorated engine mounting		O	Gr11
		Engine improperly mounted		O	
		Intake and exhaust system components improperly installed		O	Gr15
Transmission-related problem		Transmission improperly mounted		O	Gr22
Propeller shaft-related problems		Propeller shaft runout excessive		O	Gr25
		Universal joint excessively worn		O	
		Backlash excessive at slip yoke joint		O	
		Center bearing play excessive		O	
		Angle at propeller shaft joint excessive due to deteriorated center bearing rubber cushions or other causes		O	
		Angle at propeller shaft joint excessive due to increased tilt of drive axle caused by overloading		O	
Front axle-related problem		Sympathetic vibrations from axle seat	O		Gr26
Rear axle-related problems		Reduction gears in poor mesh		O	Gr27
		Differential gears in poor mesh		O	
Wheel and tire-related problems		Wheel and tire runout excessive	O		Gr31
		Wheels and tires out of balance	O		
		Use of tires different in size or type	O		
		Wheel mounting surface deformed	O		
Front suspension-related problem		Friction excessive between spring leaves	O		Gr33
Brake-related problems		Brake drum out of balance <Drum brake>	O		Gr35A
		Brake drum eccentric <Drum brake>	O		
		Disc brake rotor runout <Disc brake>	O		

Manual cab tilt system

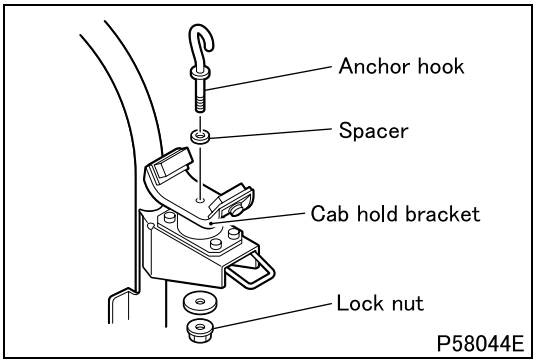
Symptoms / Probable causes	Cab fails to tilt up.	Cab cannot lock on rear mounting post.	Cab tilt warning lamp fails to come on.	Cab tilt warning lamp fails to go out.	Reference Gr
Main hook not released	O				
Safety hook not released	O				
Torsion bar damaged or fatigued	O				
Main hook does not engage with hook pin bracket		O			
Cab tilt lock switch poorly adjusted			O	O	
Cab tilt lock switch faulty			O	O	
Cab tilt warning lamp faulty			O		
Fuse or high current fuse blown			O		
Wiring open or improperly connected			O		

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Adjustment of Cab Tilt System

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
–	Lock nut (anchor hook fitting)	83 to 98 {61 to 72}	–



(1) Adjustment of lock handle

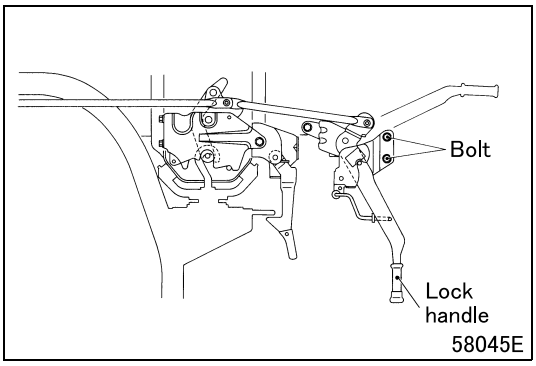
- Remove the lock nut, then remove the anchor hook.
- To adjust the lock handle, increase or decrease the number of spacers between the anchor hook and the cab hold bracket as follows.

	Number of spacers
If lock handle feels too heavy	Increase
If lock handle feels too light	Decrease

- After adjustment, tighten the lock nut to the specified torque.
- Turn ON the ignition switch and make sure the cab tilt warning does not illuminate. If the cab tilt warning illuminates, the cab is not properly locked down.

WARNING ⚠

- **If the lock handle feels too light, it could easily be unlocked by the vibration of the running vehicle, possibly causing an injury accident.**

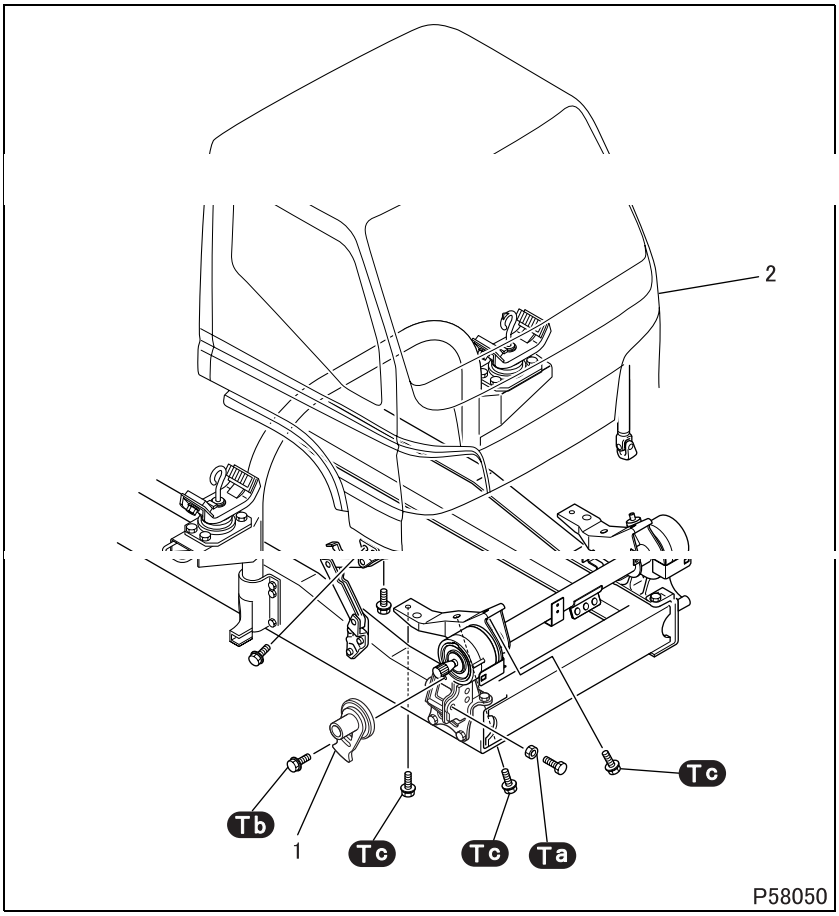


(2) Adjustment of latch

- If the latch sticks, loosen the bolts and use the bolt slot to adjust the lock handle.
- After adjustment, retighten the bolts.

M E M O

REMOVAL AND INSTALLATION OF CAB



● **Removal sequence**

1 Anchor lever
2 Cab

CAUTION ⚠

- **To prevent possible personal injury, chock all the tires, fore and aft, to ensure that the vehicle does not move. Leave the chocks in place until the cab installation is completed and the parking brake is set.**
- **To prevent damage, ensure that all cables, hoses, wires, etc. have been all disconnected before lifting the cab.**

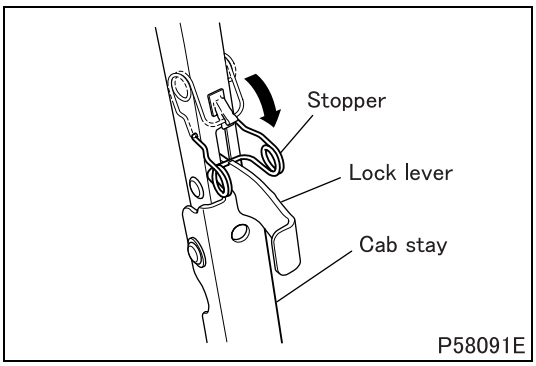
● **Installation sequence**

Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Lock nut (anchor lever adjusting bolt locking)	59 to 83 {43 to 61}	–
Tb	Bolt (anchor lever attaching)	34 to 54 {25 to 40}	–
Tc	Bolt (cab mounting)	70 to 95 {51 to 70}	–

◆Removal procedure◆

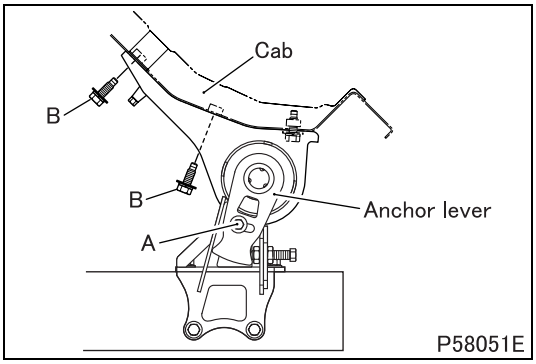


■ **Removal: Cab**

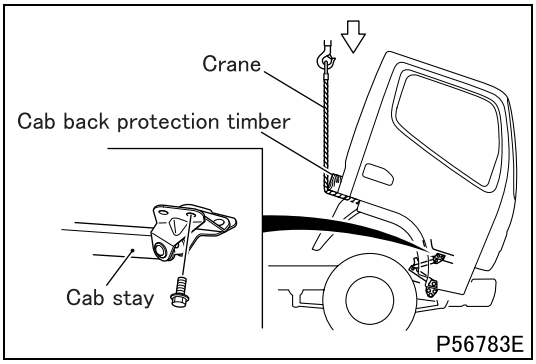
- Tilt the cab and securely lock the cab stay.

WARNING ⚠

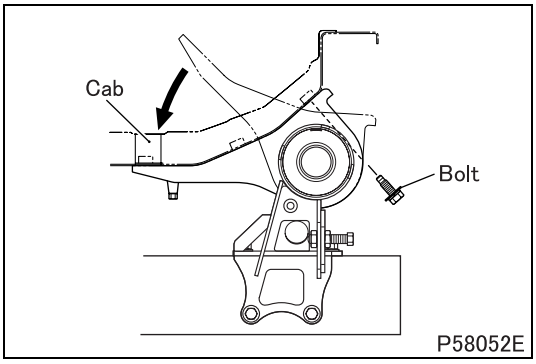
- **Be sure to fit the stopper (hold-down) into the notch in the lock lever to prevent the cab from dropping, which could cause a personal injury.**



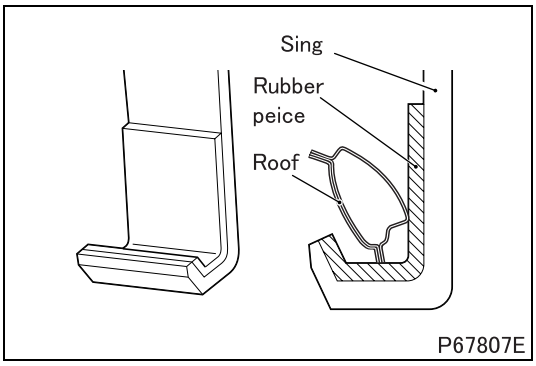
- Remove bolt **A**, then detach the anchor lever.
- Remove bolts **B** that hold the cab in place.



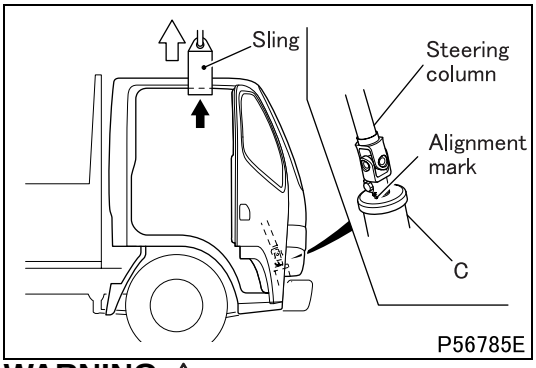
- Supporting the tilted cab with the crane, remove the cab stay.



- Lower the cab all the way, then remove the bolt.



- Make available a sling rigid enough to carry the weight of the cab.
- The hook portion of the sling must be lined with a rubber piece as shown to prevent deformation of the roof of the cab.



- Hook the sling onto the cab roof as shown. Hoist the cab a little to see if it remains level (balanced on its center of gravity).
- Provide alignment marks on the power steering gear at location **C** and on the steering column.
- Disconnect the steering column and tie it securely to the cab using a rigid cord.
- Lift off the cab straight.

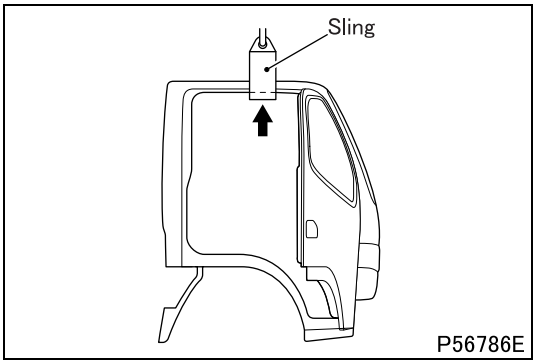
WARNING ⚠

- **Do not allow anyone to walk or stand underneath a cab suspended on a lifting device. If the cab were to drop, it could cause a severe personal injury.**

CAUTION ⚠

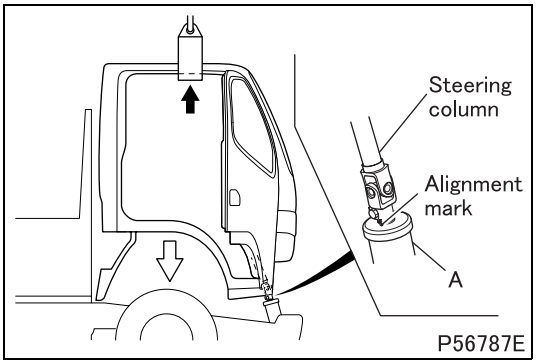
- **To prevent damage, ensure that all cables, hoses, wires, etc. have been all disconnected before lifting the cab.**

◆Installation procedure◆

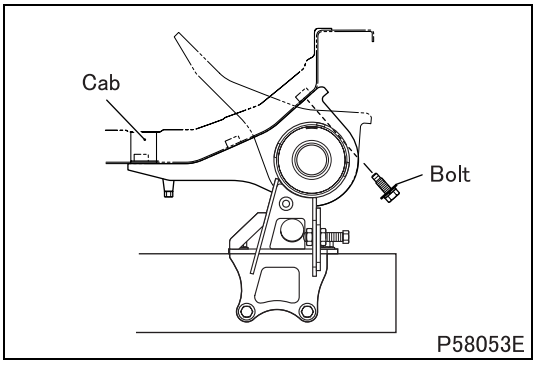


■ Installation: Cab

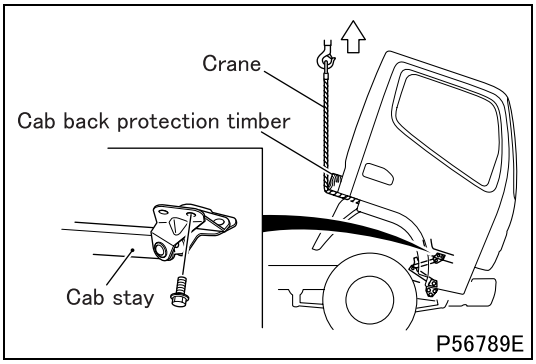
- Hook the sling at center-of-gravity points on both sides of the cab roof, and lift the cab.



- Slowly lower the cab halfway.
- Join the power steering gear **A** and steering column together in accordance with the alignment marks.



- Further lower the cab slowly to mount in position, then unhook the sling.
- Tighten the mounting bolts to specified torque.

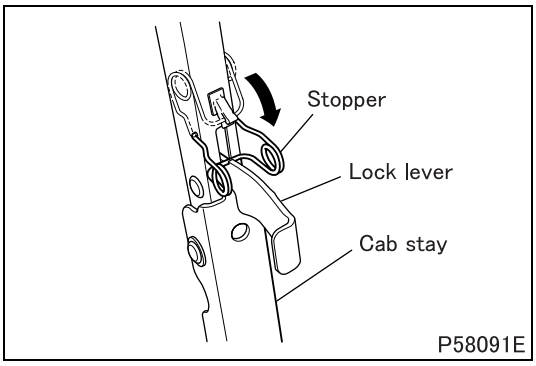


- Before tilting, support the cab using the crane.

Tilt the cab with the crane, and install the cab stay.

WARNING ⚠

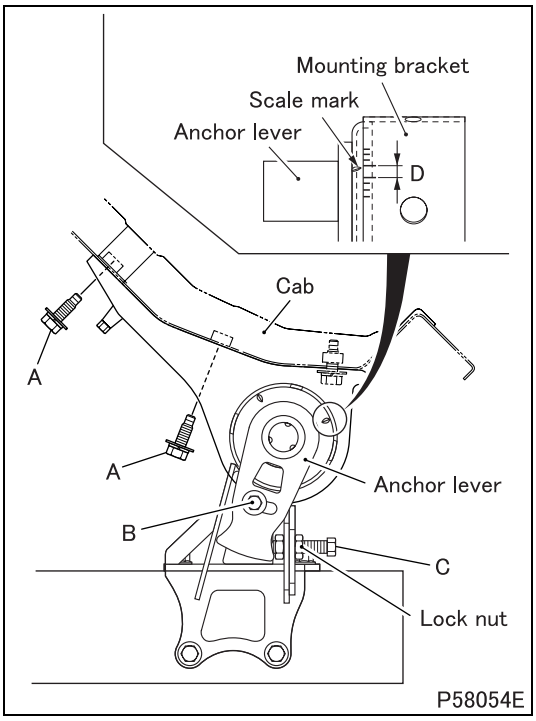
- **Be careful not to tilt the cab more than necessary. The cab can drop suddenly, causing a personal injury.**



After the cab stay is installed, tilt the cab to securely lock the cab stay. Then, remove the crane from the cab.

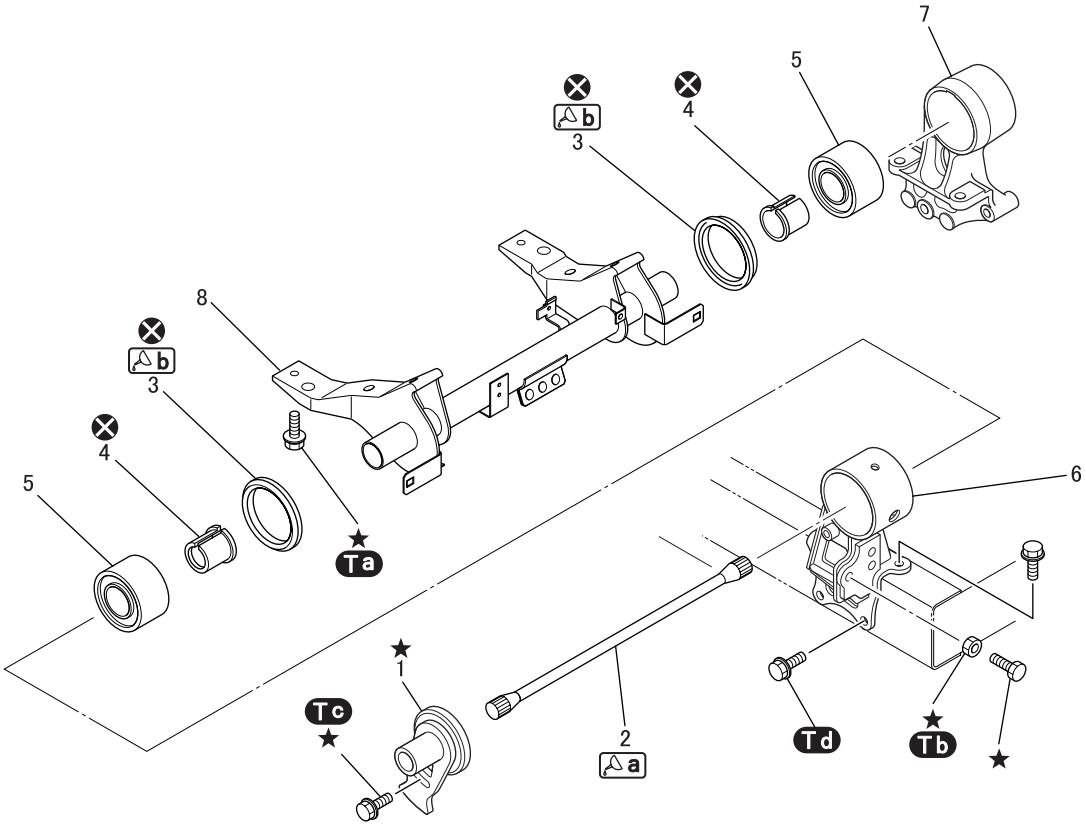
WARNING ⚠

- **Be sure to fit the stopper (hold-down) into the notch in the lock lever to prevent the cab from dropping, which could cause a personal injury.**



- Tighten bolt **A** to the specified torque.
- Align the mark on the anchor lever to the illustrated range of **D** (large division) of the scale graduated on the mounting bracket, then install bolt **B** finger-tight.
- Tighten bolt **C** to turn the anchor lever 5 degrees (one short division on the scale on the mounting bracket), then tighten the lock nut to specified torque.
- Tighten bolt **B** to the specified torque.

FRONT CAB MOUNTING



Parts marked with ★ are to be installed while the cab assembly is mounted.
Assemble them by reference to the removal and installation procedures of cab.

P58055E

● Disassembly sequence

1 Anchor lever
2 Torsion bar
3 Side cushion
4 Bushing
5 Front rubber cushion
6 Front mounting bracket, right-hand
7 Front mounting bracket, left-hand
8 Front floor cross member

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

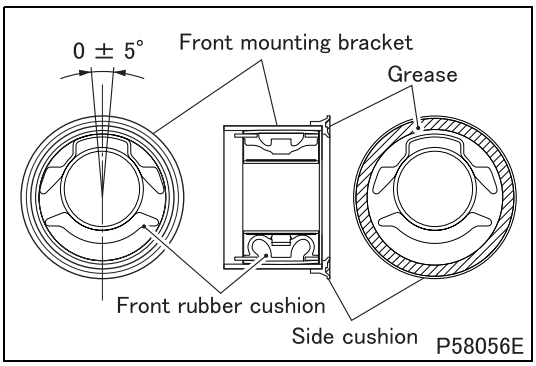
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Bolt (cab mounting)	70 to 95 {51 to 70}	–
Tb	Nut (anchor lever adjusting bolt tightening)	59 to 83 {43 to 61}	–
Tc	Bolt (anchor lever attaching)	34 to 54 {25 to 40}	–
Td	Bolt (front mounting bracket attaching)	200 to 270 {145 to 200}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Both serrated end portions of torsion bar	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
b	Front floor cross member contact surface of side cushion	Rubber Grease	As required

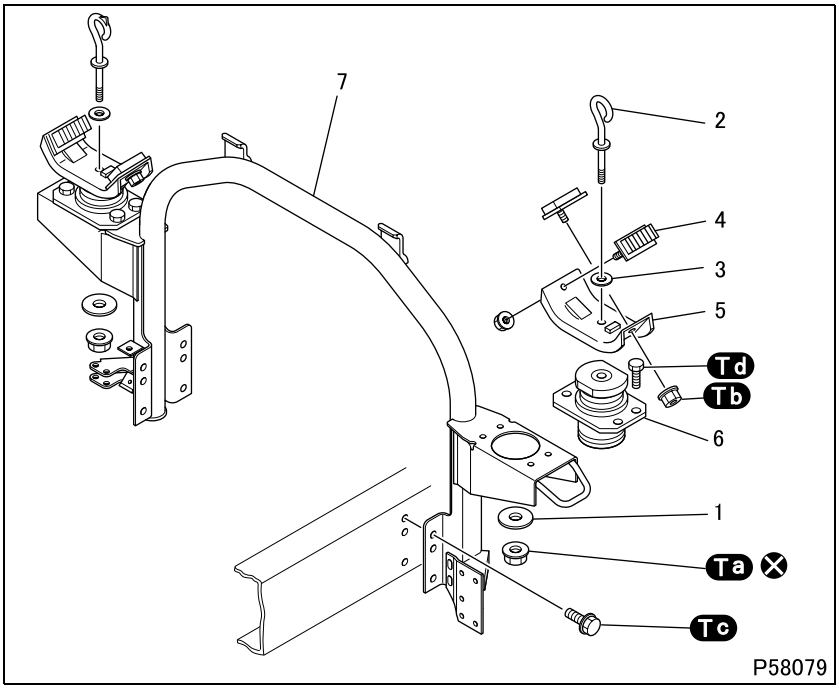
◆Installation procedure◆



■ Installation: Side rubber cushion and front rubber cushion

- Fit the front rubber cushion to the front mounting bracket at an angle within the illustrated range.
- After installing the front rubber cushion, fit the side rubber cushion to it and fill the side rubber cushion with grease as shown.

REAR CAB MOUNTING



● Disassembly sequence

1 Plate
2 Anchor hook
3 Spacer
4 Side rubber cushion
5 Cab hold bracket
6 Rear lower rubber cushion
7 Rear mounting post

⊗: Non-reusable parts

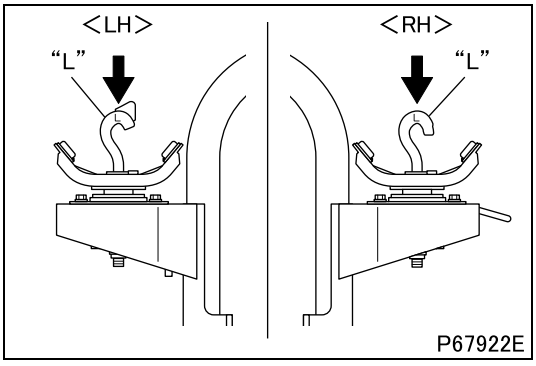
● Assembly sequence

Follow the disassembly sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Lock nut (anchor hook attaching)	83 to 98 {61 to 72}	–
Tb	Nut (side rubber cushion attaching)	10 to 15 {7.4 to 11}	–
Tc	Bolt (rear mounting post attaching)	78 to 108 {5.8 to 80}	–
Td	Bolt (rear rubber cushion attaching)	16 to 20 {12 to 14}	–

◆Installation procedure◆

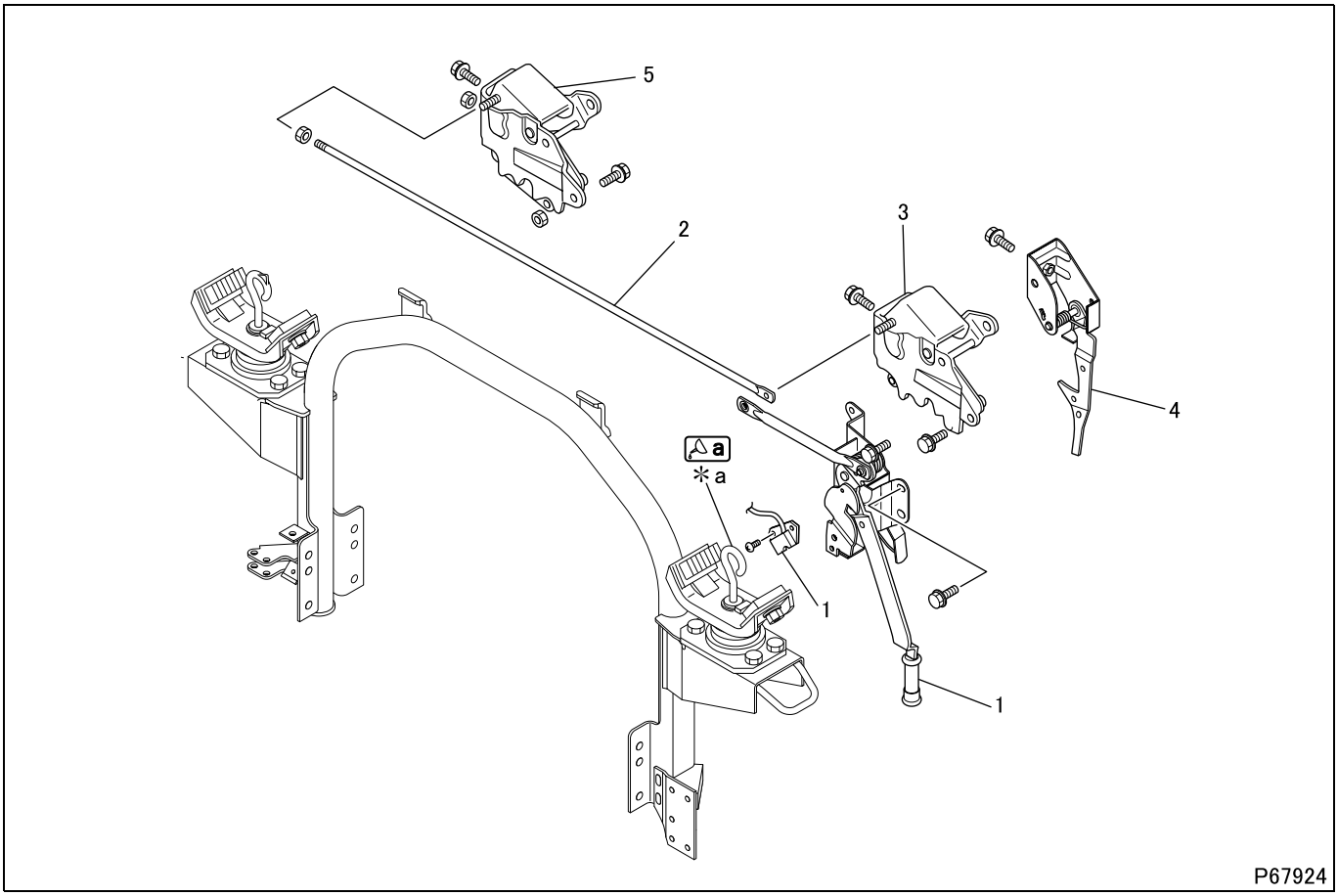


■ Installation: Anchor hook

- Fit the anchor hooks to the rear mounting post as shown in the illustration.

M E M O

CAB TILT LINK



● **Disassembly sequence**

1 Lock handle
2 Center rod
3 Link (right-hand)
4 Safety hook
5 Link (left-hand)

***a**: Anchor hook

● **Assembly sequence**

Follow the disassembly sequence in reverse.

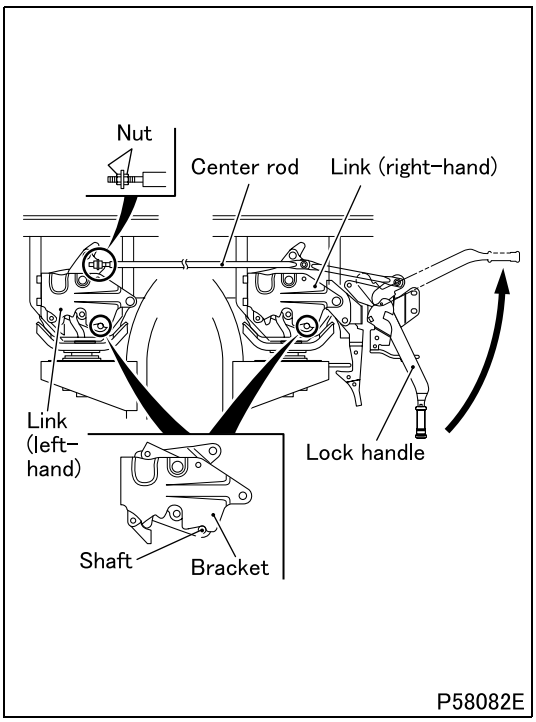
CAUTION ⚠

- **After assembly, adjust the lock handle. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact of link (right-hand) of anchor hook	Chassis grease [NLGI No. 1 (Li soap)]	As required

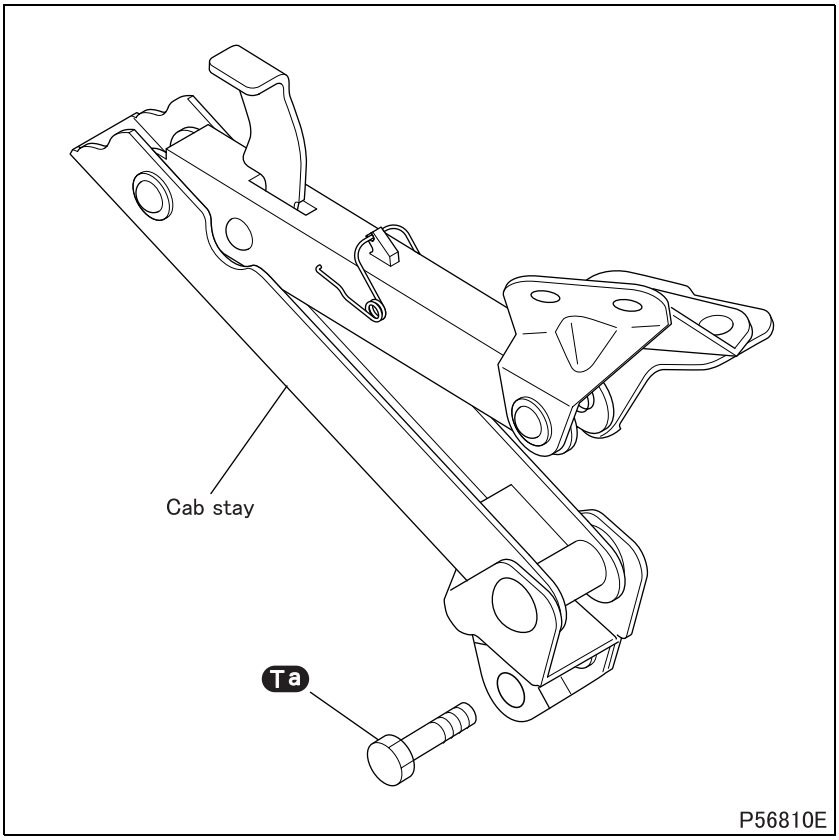
◆Installation procedure◆



■ Installation: Center rod

- Operate the lock handle in the direction shown in the illustration to unlock the left-hand and right-hand links.
- Adjust the center rod nut to bring the shafts of left-hand and right-hand links into contact with brackets.

CAB STAY



WARNING ⚠

- **Before removing the cab stay, be sure to support the cab with a crane, or equivalent, to prevent the cab from dropping.**

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Bolt (cab stay mounting)	59 to 78 {43 to 58}	–

GROUP 43 INDEX

SPECIFICATIONS **43-2**

STRUCTURE AND OPERATION
1. **Front Door Lock System** **43-3**
2. **Front Door Glass Opening and Closing Mechanism** **43-4**

TROUBLESHOOTING **43-5**

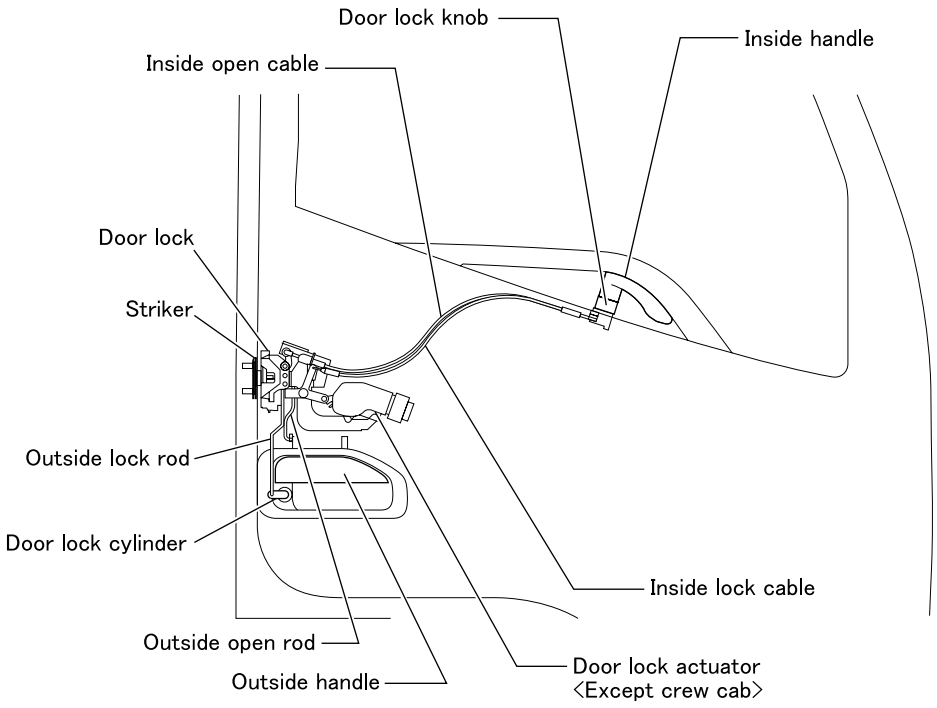
ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Adjustment of Front Door Alignment** **43-6**

FRONT DOOR **43-10**

SPECIFICATIONS

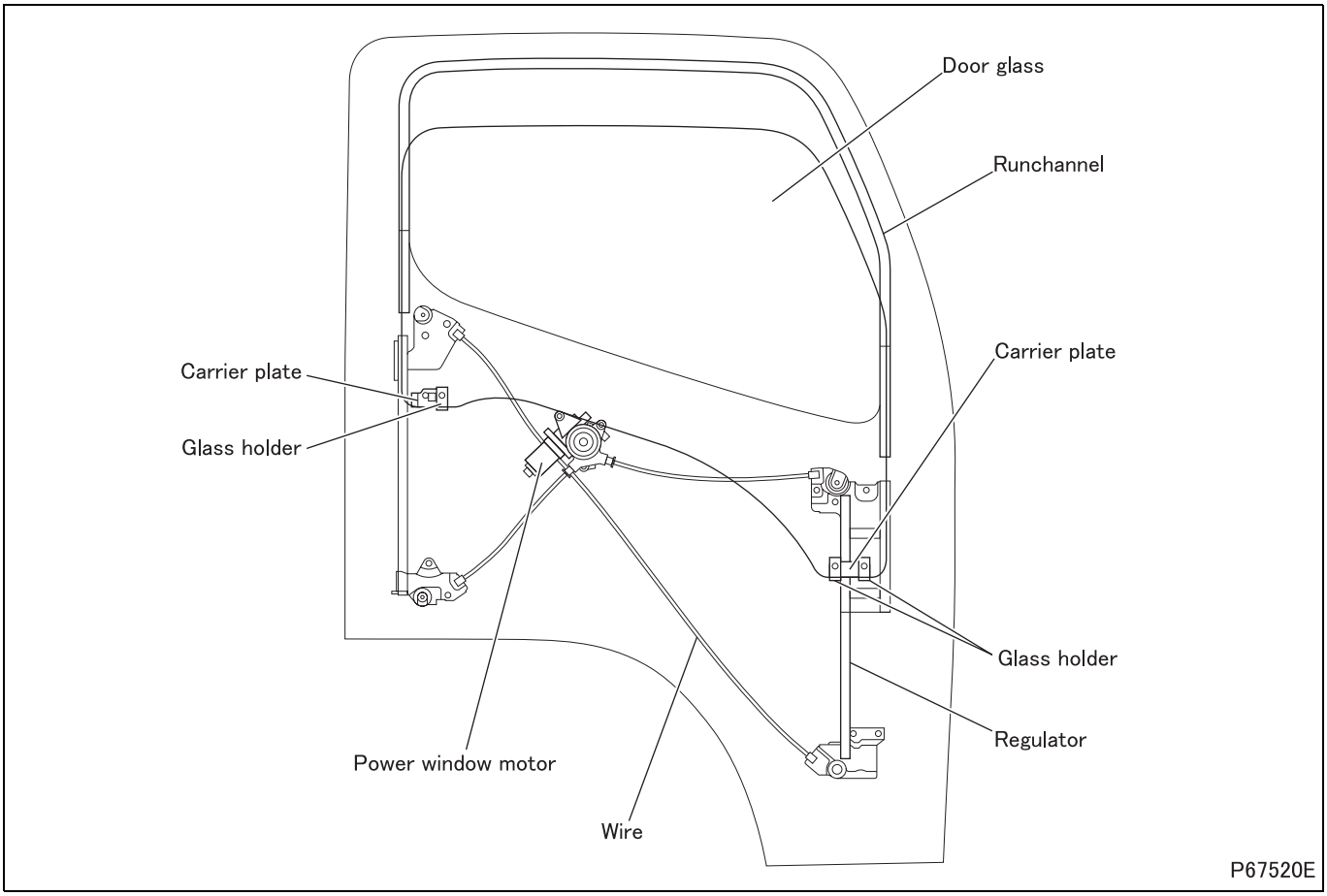
Item		Specifications
		Except crew cab
Front door	Door lock system	Auto door lock system (centralized door lock)
	Door glass opening and closing mechanism	Electrical control
Rear door	Door lock system	–
	Door glass opening and closing mechanism	–

1. Front Door Lock System



P58094E

2. Front Door Glass Opening and Closing Mechanism



- The door glass is secured to the carrier plate by the medium of glass holder.
- With the rotation of the power window motor <Electrical control type>, the carrier plate is moved up and down by means of the wire to open and close the door glass.

Door Glass Opening and Closing Mechanism

Symptoms / Possible causes	Door glass falls by gravity when vehicle is running	Regulator or motor emits noise when vehicle is running	Power window fails to operate	Power window fails to stop	Power window emits noise when in motion	Reference Gr
Power window switch faulty			O	O		Gr54
Regulator and motor assembly faulty	O		O	O	O	
Regulator and motor assembly improperly mounted					O	
Fuse or high current fuse blown			O			
Connector improperly connected, harness circuit open, or bad ground			O			
Door glass and door beltline molding unsteady		O				
Air temperature low						

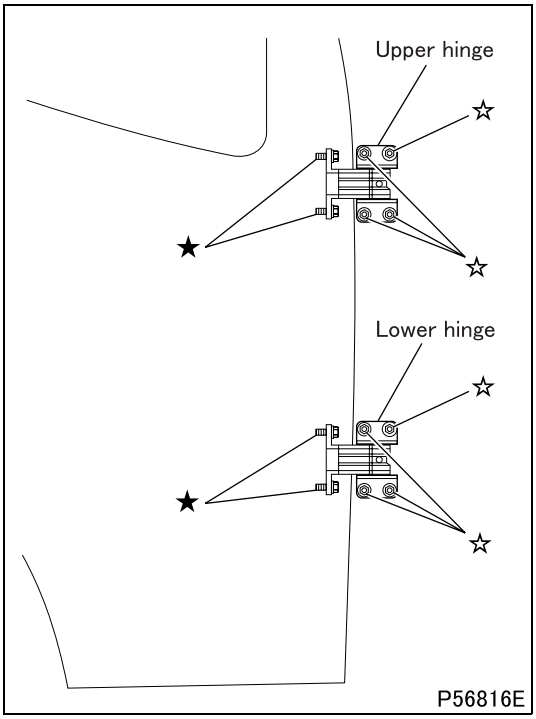
ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Adjustment of Front Door Alignment

Torque: N·m {lbf·ft}

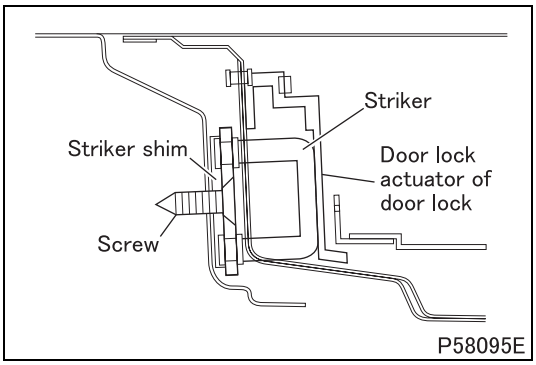
Mark	Fastener	Torque value	Remarks
–	Bolt (door mounting; ★ marked)	17 to 26 {12 to 19}	–
	Bolt (upper and lower hinge mounting; ☆ marked)		
–	Screw (striker mounting)	9 to 14 {6.5 to 10}	–

- Door alignment is adjusted by changing the positions of the upper and lower hinges and striker.
  Door alignment dimensions: See **1.3**.



1.1 Adjustment of hinge positions

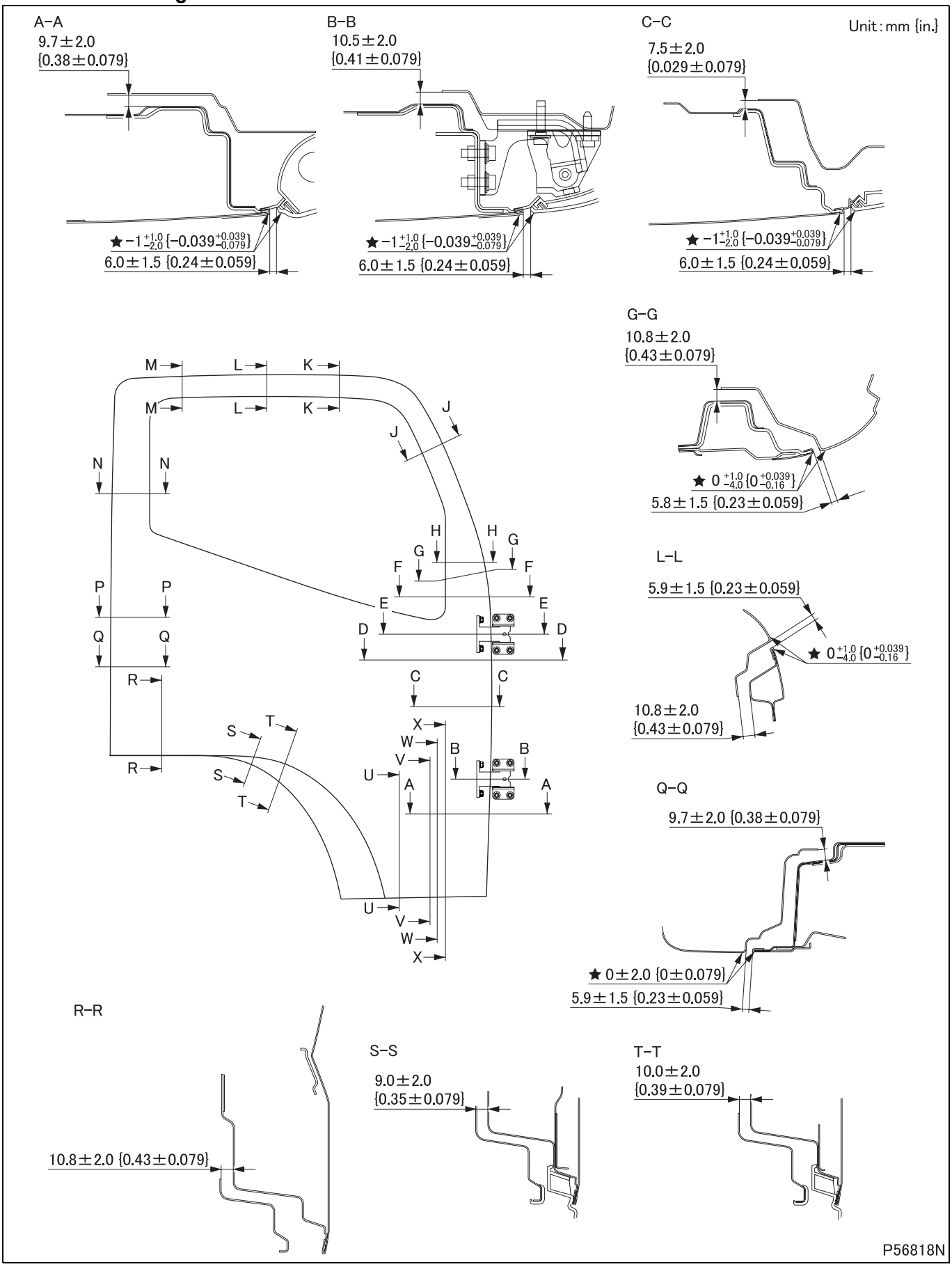
- Use ★ marked bolts to adjust gap.
- Use ☆ marked bolts to adjust flushness.



1.2 Adjustment of striker position

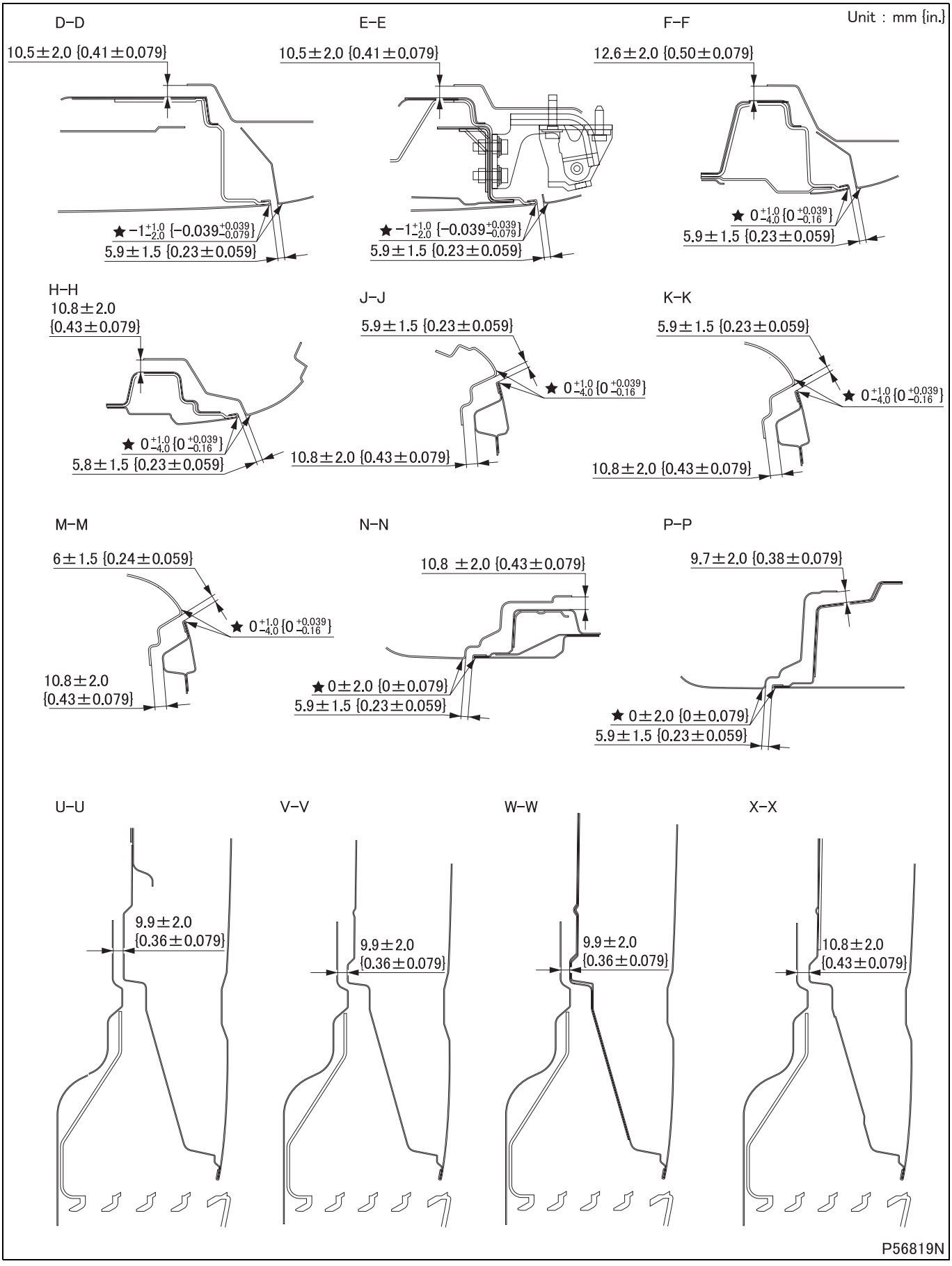
- Use the mounting screw to make the adjustment.
- To adjust the engagement of the striker with the door lock actuator or door lock, change the number of striker shims as required.

1.3 Front door alignment dimensions



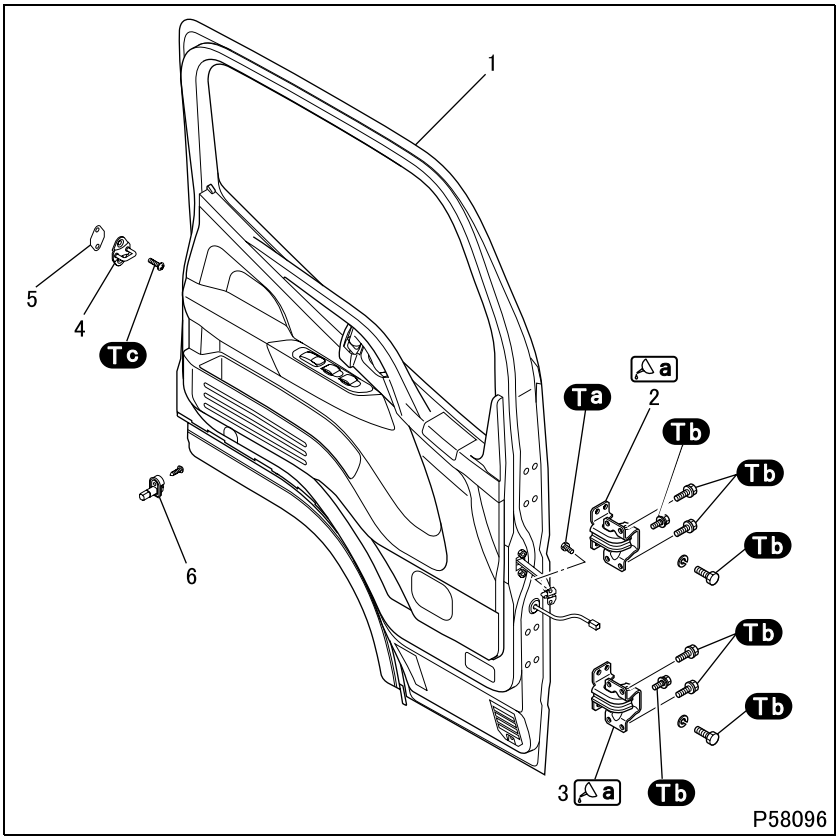
★: Flushness dimension (+ for outside of cab; – for inside of cab)

Unit : mm {in.}


D–D
10.5±2.0 {0.41±0.079}
★ −1 +1.0 −2.0 {−0.039 +0.039 −0.079}
5.9±1.5 {0.23±0.059}
E–E
10.5±2.0 {0.41±0.079}
★ −1 +1.0 −2.0 {−0.039 +0.039 −0.079}
5.9±1.5 {0.23±0.059}
F–F
12.6±2.0 {0.50±0.079}
★ 0 +1.0 −4.0 {0 +0.039 −0.16}
5.9±1.5 {0.23±0.059}
H–H
10.8±2.0
{0.43±0.079}
★ 0 +1.0 −4.0 {0 +0.039 −0.16}
5.8±1.5 {0.23±0.059}
J–J
5.9±1.5 {0.23±0.059}
★ 0 +1.0 −4.0 {0 +0.039 −0.16}
10.8±2.0 {0.43±0.079}
K–K
5.9±1.5 {0.23±0.059}
★ 0 +1.0 −4.0 {0 +0.039 −0.16}
10.8±2.0 {0.43±0.079}
M–M
6±1.5 {0.24±0.059}
★ 0 +1.0 −4.0 {0 +0.039 −0.16}
10.8±2.0
{0.43±0.079}
N–N
10.8 ±2.0 {0.43±0.079}
★ 0±2.0 {0±0.079}
5.9±1.5 {0.23±0.059}
P–P
9.7±2.0 {0.38±0.079}
★ 0±2.0 {0±0.079}
5.9±1.5 {0.23±0.059}
U–U
9.9±2.0
{0.36±0.079}
V–V
9.9±2.0
{0.36±0.079}
W–W
9.9±2.0
{0.36±0.079}
X–X
10.8±2.0
{0.43±0.079}
P56819N

M E M O

FRONT DOOR



●Removal sequence

1 Door (see later section)
2 Upper hinge
3 Lower hinge
4 Striker
5 Striker shim
6 Door switch

●Installation sequence

Follow the removal sequence in reverse.

NOTE

- **Adjust front door alignment after installation (see ON-VEHICLE INSPECTION AND ADJUSTMENT).**

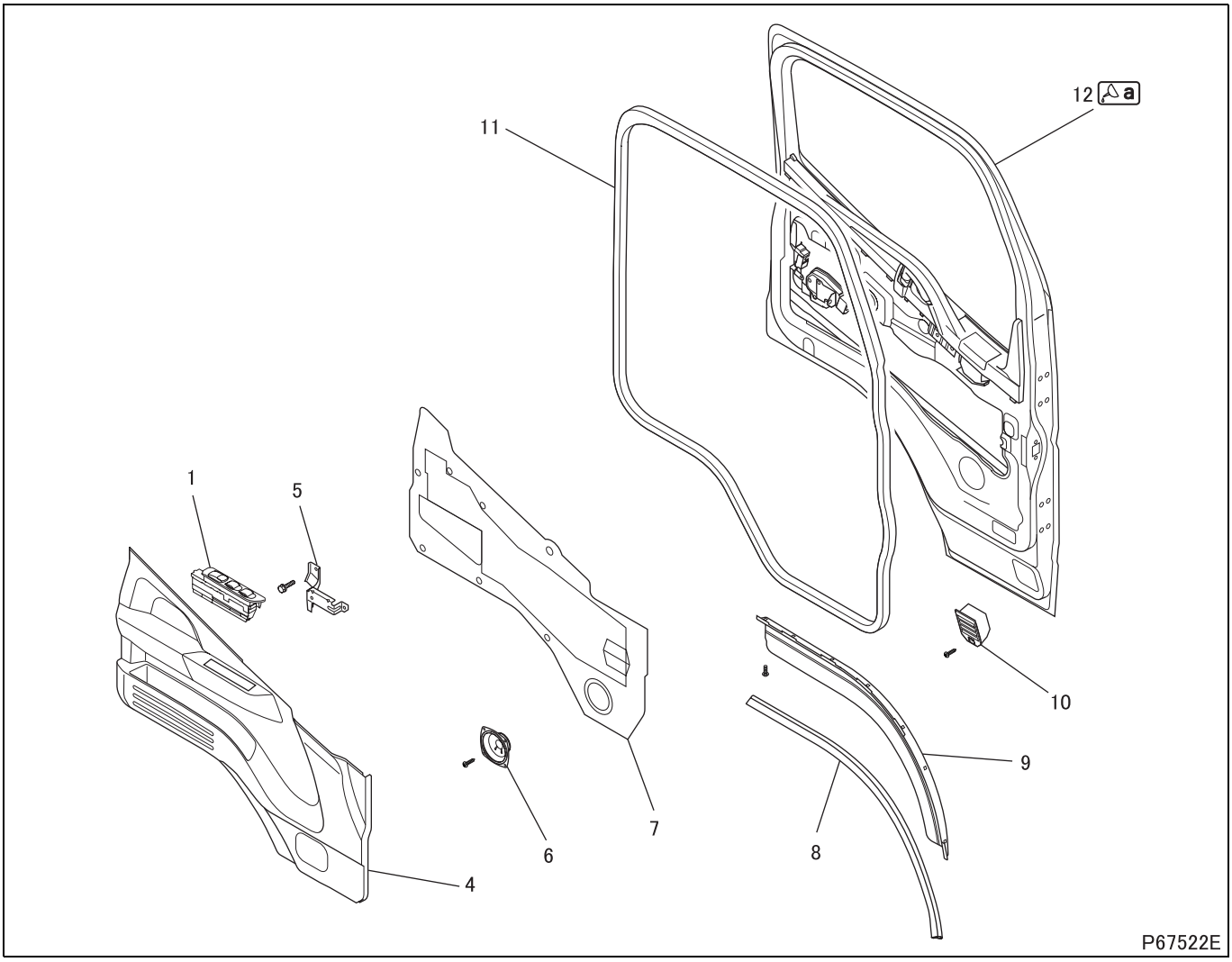
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Bolt (door mounting)	4 to 6 {2.9 to 4.3}	–
Tb	Bolt (door mounting)	17 to 26 {12 to 19}	–
	Bolt (upper and lower hinge mounting)		
Tc	Screw (striker mounting)	9 to 14 {6.5 to 10}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rotating contact parts of upper and lower hinges	Chassis grease [NLGI No. 1 (Li soap)]	As required

Door



● **Disassembly sequence**

1 Power window switch
2 Clip
3 Regulator handle
4 Lower door trim
5 Trim bracket
6 Speaker
7 Water-proof cover
8 Weatherstrip
9 Door fender
10 Air outlet garnish
11 Weatherstrip
12 Door panel (see later section)

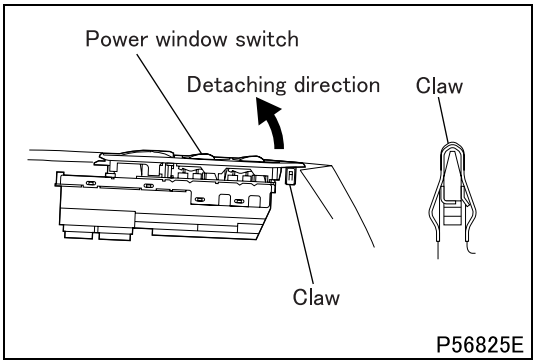
● **Assembly sequence**

Follow the disassembly sequence in reverse.

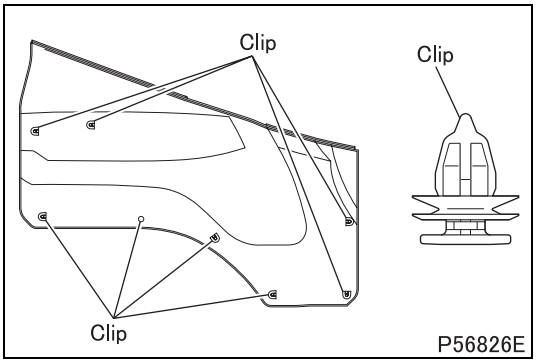
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Water-proof cover fitting surface of door Panel	Butyl tape	As required

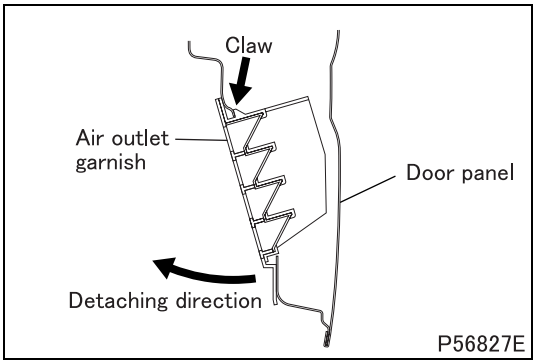
◆Removal procedure◆



■Removal: Power window switch

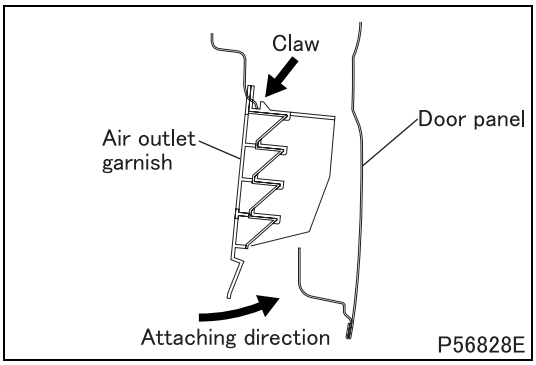


■Removal: Lower door trim



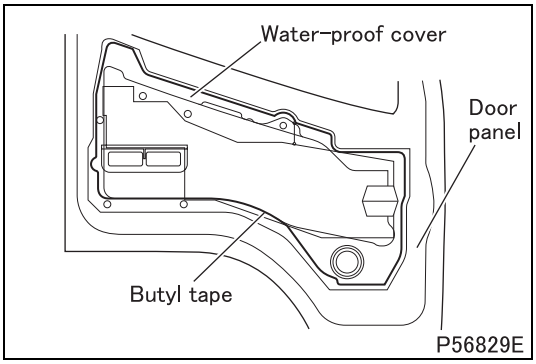
■Removal: Air outlet garnish

◆Installation procedure◆



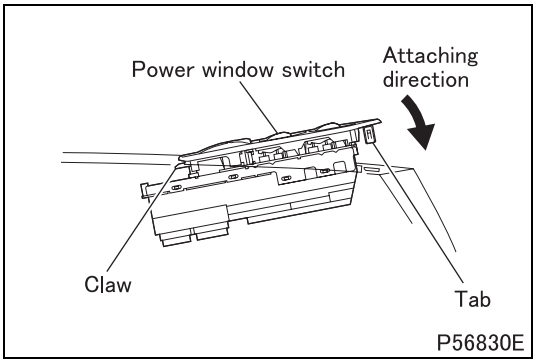
■Installation: Air outlet garnish

- Attach the air outlet garnish to the door panel in the illustrated direction, with its claw fitted in the door panel.



■**Installation: Water-proof cover**

- Apply butyl tape to the door panel as shown, then attach the water-proof cover to the door panel.

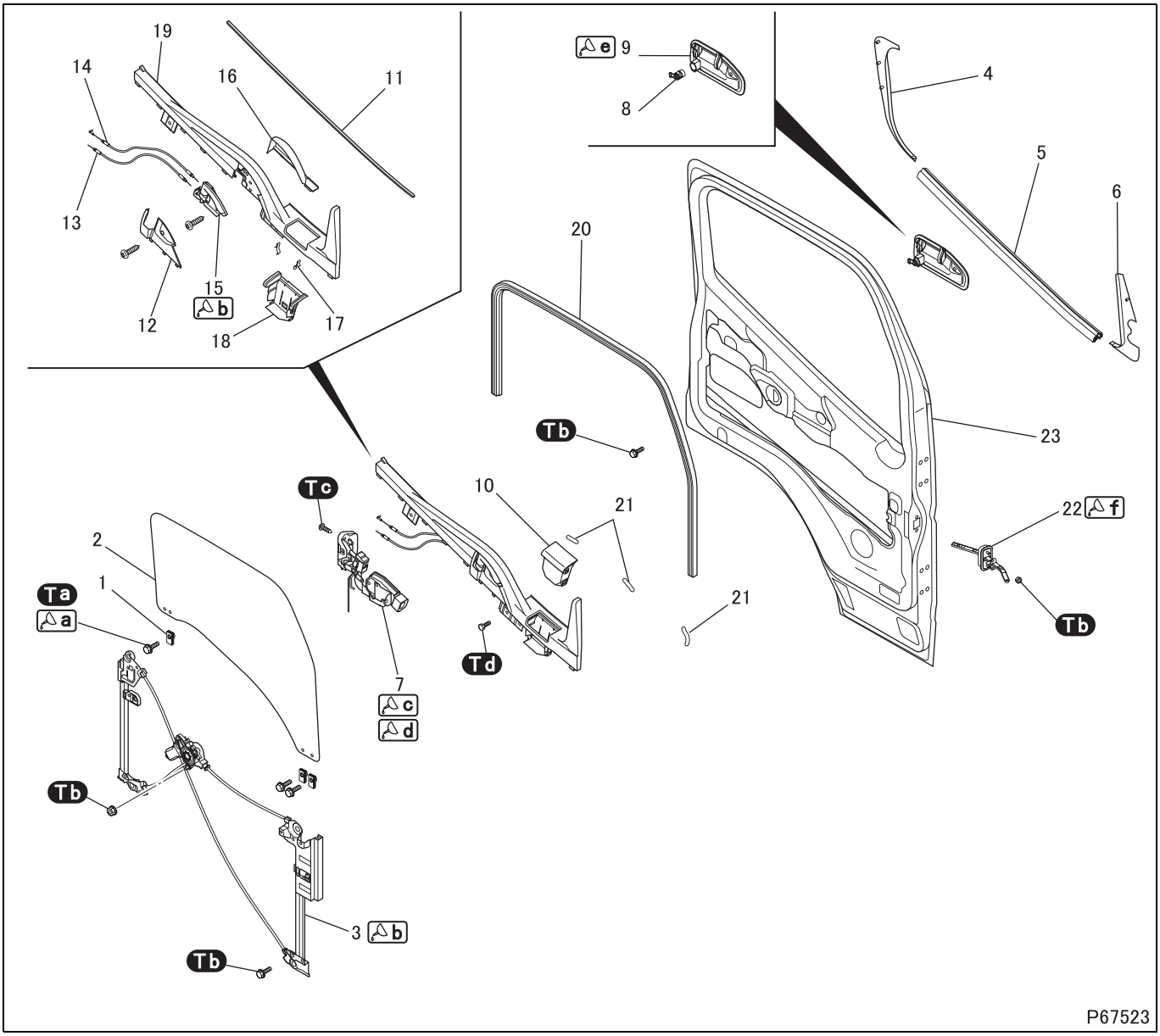


■**Installation: Power window switch**

- To install the power window switch in position, fit claw first, then tab, in the lower door trim.

FRONT DOOR

Door Panel Assembly



●Disassembly sequence

1 Glass holder
2 Door glass
3 Regulator and motor
Manual regulator
4 Sash garnish
5 Beltline molding
6 Delta garnish
7 Door lock actuator
<With auto door lock>
Door lock
<Without auto door lock>
8 Door lock cylinder
9 Outside handle
10 Ash tray
11 Weatherstrip
12 Inside handle inner cover
13 Inside lock cable
14 Inside open cable
15 Inside handle
16 Inside handle outer cover
17 Spring
18 Ash tray cover
19 Upper door trim
20 Run channel
21 Protector
22 Door check
23 Door panel

●Assembly sequence

Follow the disassembly sequence in reverse.

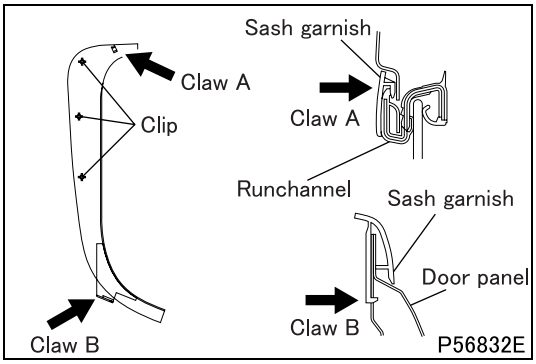
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Bolt (door glass attaching)	4 to 6 {2.9 to 4.3}	sealant
Tb	Nut (regulator and motor or manual regulator attaching)	4 to 6 {2.9 to 4.3}	–
	Bolt (regulator and motor or manual regulator attaching)		
	Bolt (outside handle attaching)		
	Nut (door check attaching)		
Tc	Screw (door lock attaching)	4.9 to 8.2 {3.7 to 6.1}	–
Td	Bolt (upper door trim attaching)	10 to 15 {7.2 to 11}	–

Lubricant and/or sealant

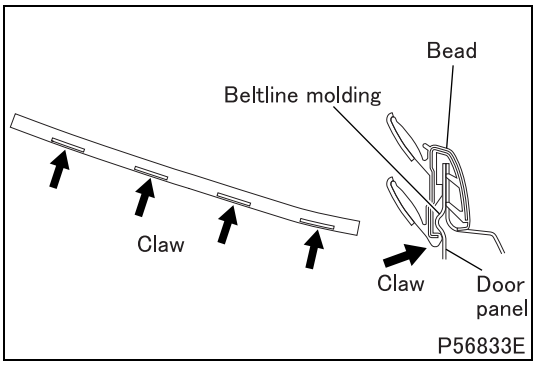
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	LOCTITE Dri-Loc 202	As required
b	Sliding contact surface of regulator and motor assembly or regulator	Kyodo Yushi MULTEMP AC-D	As required As required
c	Rotating contact surface of door lock	Kyodo Yushi MULTEMP TAS-2	As required
d	Sliding contact surface of door lock	Kyodo Yushi MULTEMP SL-DII	As required
e	Rotating contact surface of outside handle	Showa Shell Sekiyu SUNLITE GREASE LA2	As required
	Rotating contact surface of inside handle		
f	Sliding contact surface of door check	Kyodo Yushi EMALUB M	1 g {0.035 oz}

◆ Removal sequence ◆



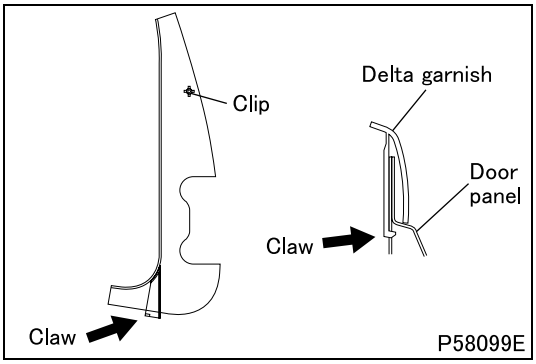
■Removal: Sash garnish

- Disengage claw A on upper part of the sash garnish from the run channel, then remove clips (3 places).
- Disengage claw B on the lower part of the sash garnish from the door panel.



■Removal: Beltline molding

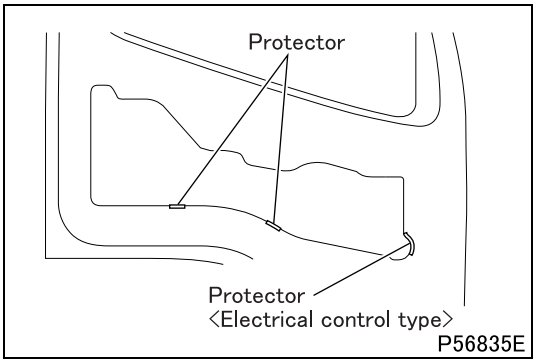
- Disengage claws (4 places) and remove the beltline molding from the door panel bead.



■**Removal: Delta garnish**

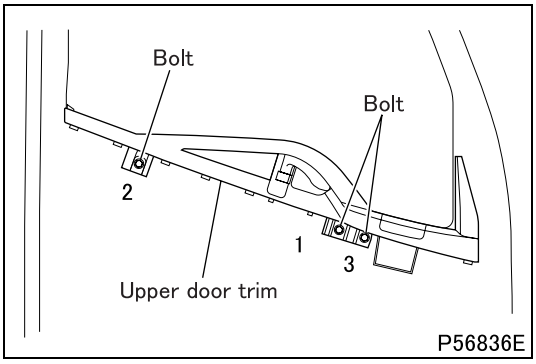
- Disengage clip (1 place) first and then claw to remove the delta garnish from the door panel.

◆**Installation procedure**◆



■**Installation: Protector**

- Fit the protectors (three on electrical control type; two on manual control type) to the door panel in the illustrated positions.

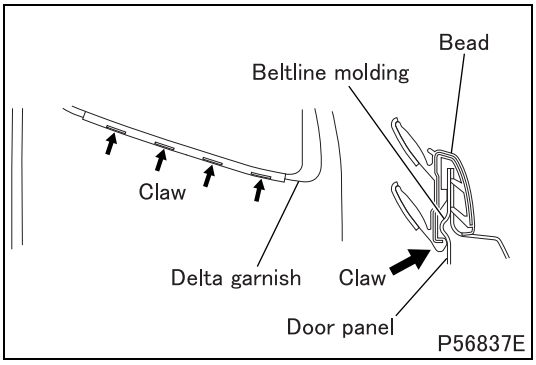


■**Installation: Upper door trim**

- Tighten bolts to specified torque in numerical order (1 to 3) as shown to secure the upper door trim.

■**Installation: Delta garnish**

- To install the delta garnish, follow the removal procedure in reverse.
  (See **"■Removal: Delta garnish"**.)

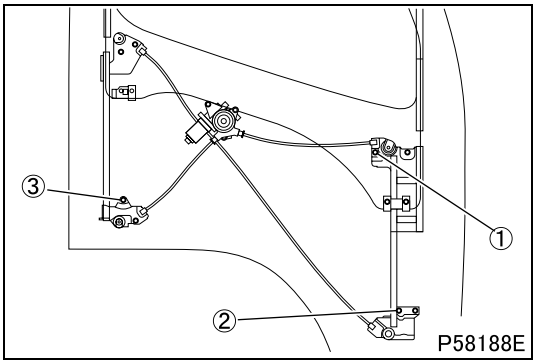


■**Installation: Beltline molding**

- Position the beltline molding with its front side applied to the delta garnish, then engage claws (4 places) with the door panel bead to secure the beltline molding in place.

■**Installation: Sash garnish**

- To install the sash garnish, follow the removal procedure in reverse.
  (See **"■Removal: Sash garnish"**.)



■**Installation: Regulator and motor or manual regulator**

- Tighten bolts (3 places) to specified torque in numerical order (1 to 3) as shown, then tighten the remaining bolts and nuts to specified torque.

GROUP 51 INDEX

STRUCTURE AND OPERATION
1. Wiper and Washer System 51-2

TROUBLESHOOTING 51-3

MIRROR 51-4

WIPER AND WASHER 51-6

FRONT COVER 51-8

FRONT GRILLE, FRONT CORNER PANEL AND HEADLIGHT 51-10

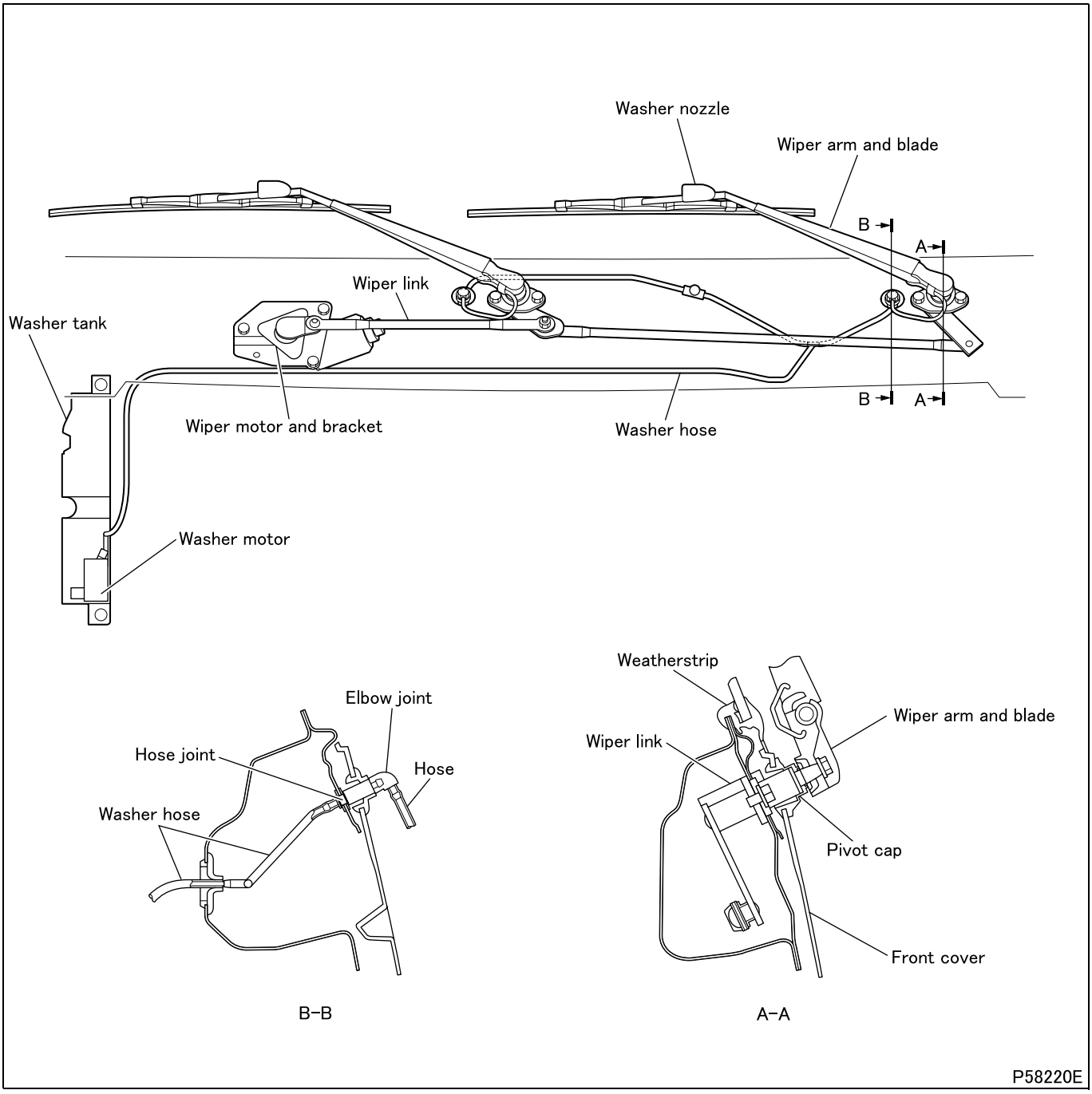
FENDER 51-14

STEP 51-15

WHEEL WELL 51-16

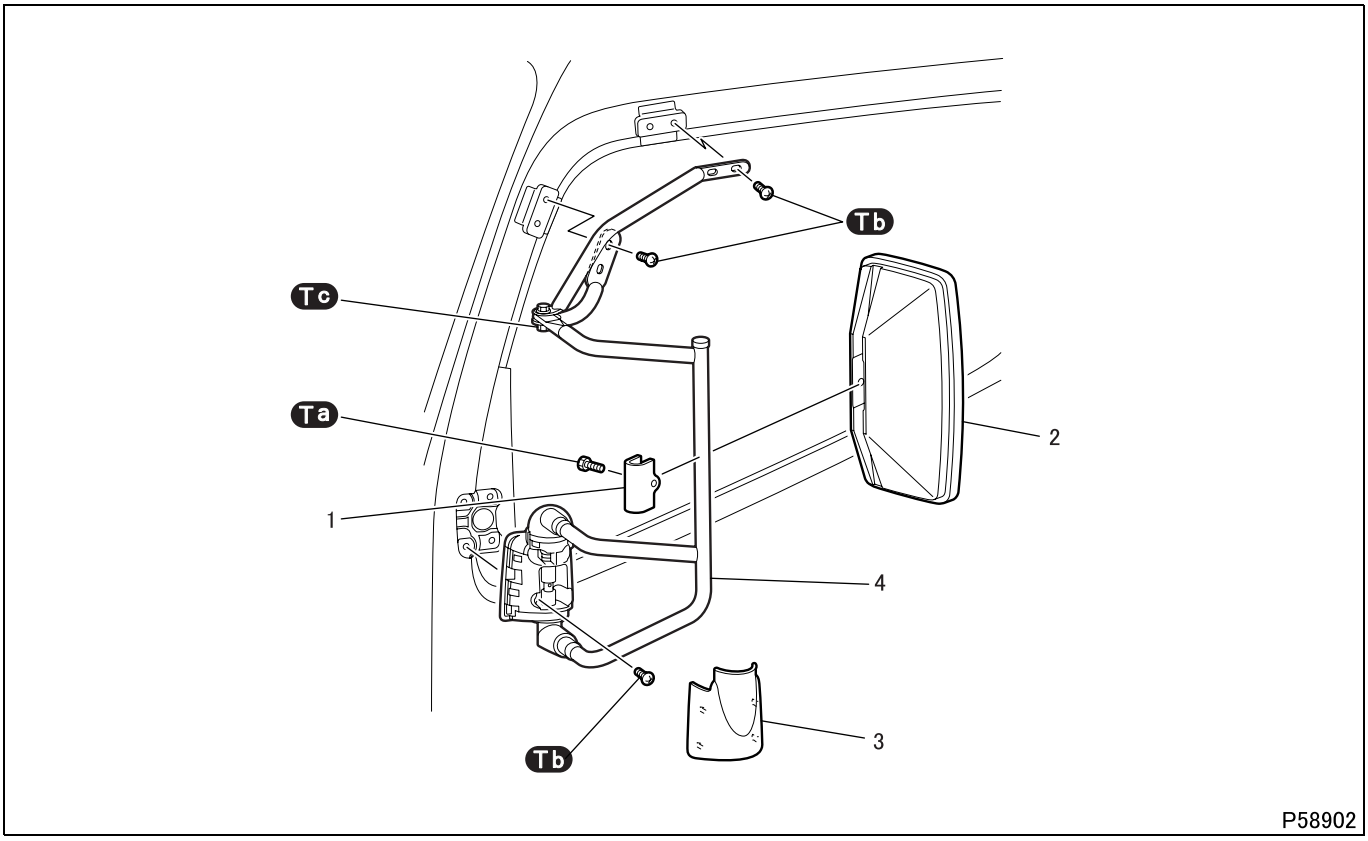
WINDSHIELD AND CAB REAR WINDOW 51-18

1. Wiper and Washer System



Wiper and washer

Symptoms / Possible causes	Wiper fails to operate	Wiper fails to stop	Wiper fails intermittently	Wiper blade stops at improper position	Wiper does not wipe well	Wiper emits noise during operation	Washer motor fails to operate	Washer injects insufficient amount of fluid	Washer fails to inject washer fluid	Wiper fails to operate in unison with washer	Reference Gr
Wiper motor faulty	O	O		O		O					Gr54
Washer motor faulty							O	O	O		
Wiper and washer switch faulty	O	O	O				O			O	
MUTIC (control unit) faulty			O							O	
Wiper relay faulty	O						O				
Fuse/high current fuse blown	O						O				
Connector improperly connected, harness circuit open, bad ground	O		O				O		O	O	
Wiper motor crank arm out of position				O							
Wiper link and wiper arm improperly connected						O					
Wipe blade defective					O	O					
Wiper arm defective					O						
Washer hose twisted								O	O		
Washer hose improperly connected								O	O		
Washer nozzle clogged								O	O		
Washer fluid insufficient									O		



●Disassembly sequence

1 Clamp
2 Mirror
3 Cover
4 Mirror stay

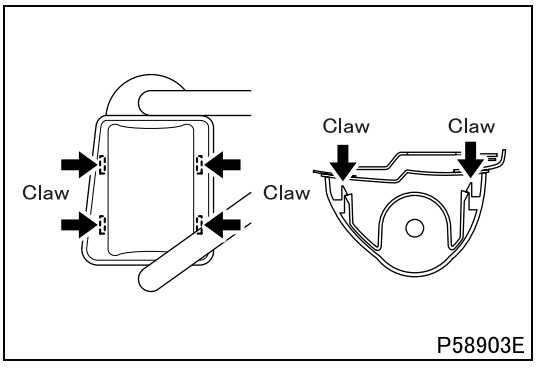
●Assembly sequence

Follow the disassembly sequence in reverse.

Torque: N·m {lbf·ft}

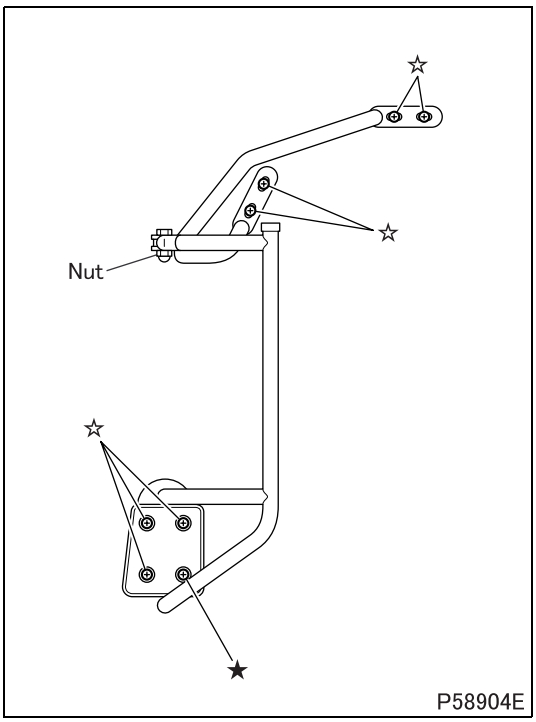
Mark	Fastener	Torque value	Remarks
Ta	Bolt (mirror mounting)	6.5 to 7.2 {4.8 to 5.3}	–
Tb	Screw (mirror stay mounting)	9 to 14 {6.6 to 10}	–
Tc	Nut (mirror stay fastening)	19 to 28 {14 to 21}	–

◆Removal procedure◆



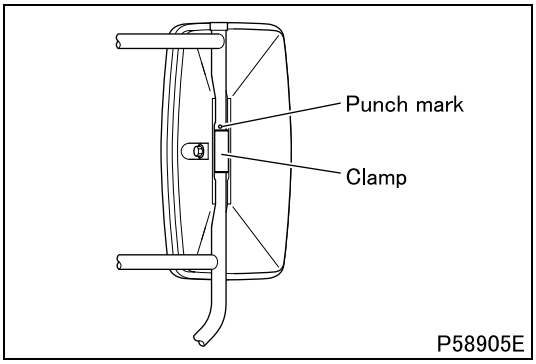
■Removal: Cover

◆Installation procedure◆



■Installation: Mirror stay

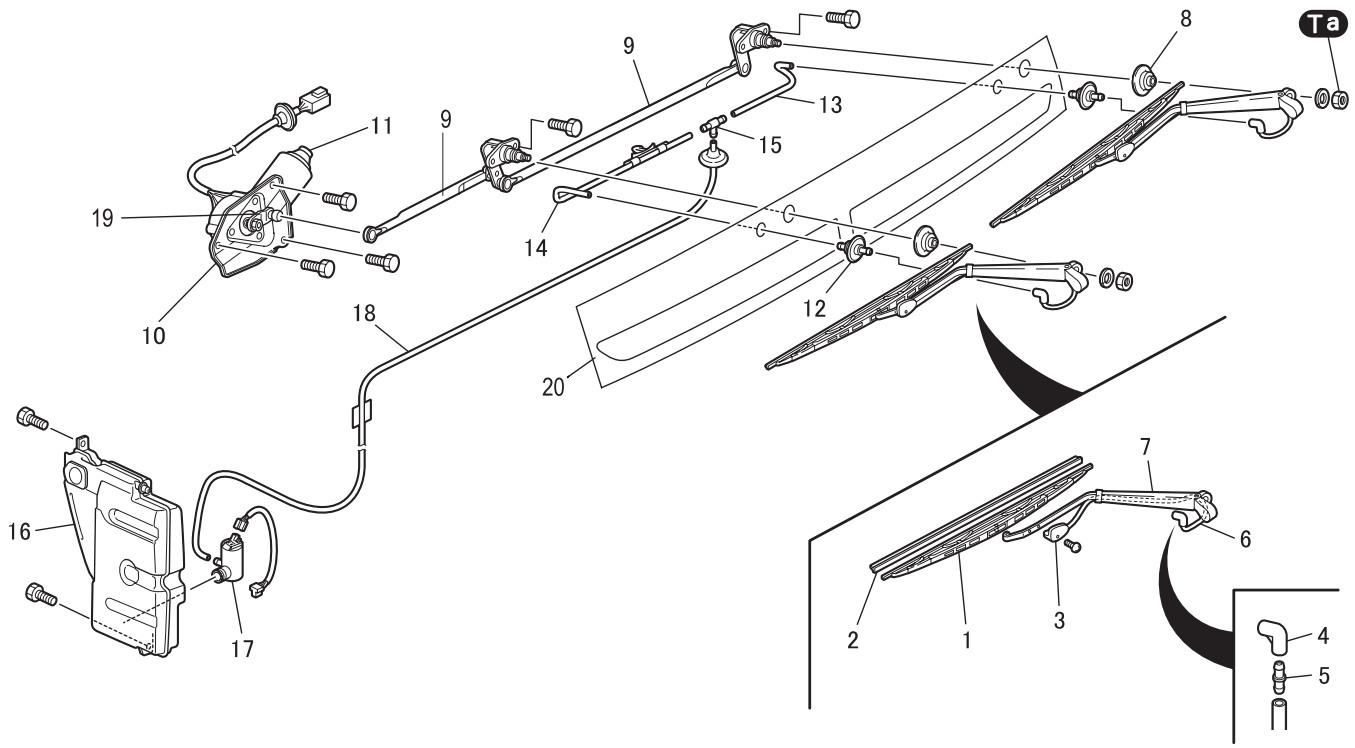
- Install the one screw marked ★ and adjust the position of the mirror stay.
- Install all the remaining seven screws marked ☆ to secure the mirror stay.
- Fasten the mirror stay nut to the specified torque.



■Installation: Mirror

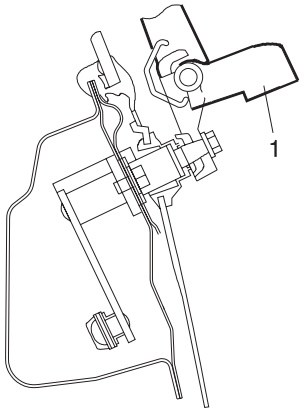
- Adjust the height of the mirror by aligning the punch mark on the mirror stay with the clamp edge as shown in the illustration.

WIPER AND WASHER



P56852

1 Wiper blade
2 Rubber blade element
3 Washer nozzle
4 Elbow joint
5 Joint
6 Hose
7 Wiper arm
8 Pivot cap
9 Wiper link
10 Wiper-motor bracket
11 Wiper motor
12 Joint
13 Washer hose
14 Washer hose
15 Joint
16 Washer tank
17 Washer motor
18 Washer hose
19 Drive arm
20 Front cover

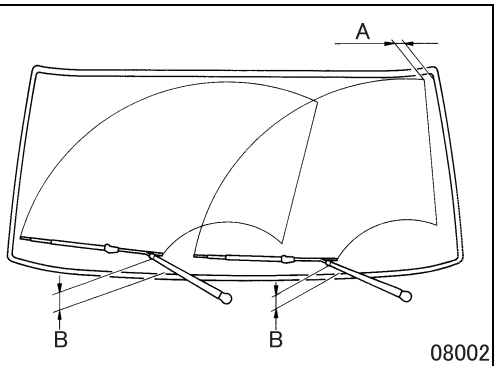


09/27/2005 f012107

1. Pivot Cover

●Disassembly sequence

1 Remove both front side covers (see FRONT COVER).
2 Open the cover over the wiper-arm pivots, mark the orientation of the wiper arms on the drives, and remove the arms.
3 Disconnect the washer nozzles.
4 Remove the front cover.
5 Mark the orientation of the wiper-link drive arm on the wiper motor, then remove the wiper link from the motor.
6 Loosen the three screws that attach the wiper-motor bracket to the cab and remove the bracket and motor assembly.
7 Gently pry the wiper-motor wiring grommet out of the cab frontwall and secure the cab harness so that it can not fall out of reach, then disconnect the electrical connector.
8 Remove the motor from the wiper-motor bracket.

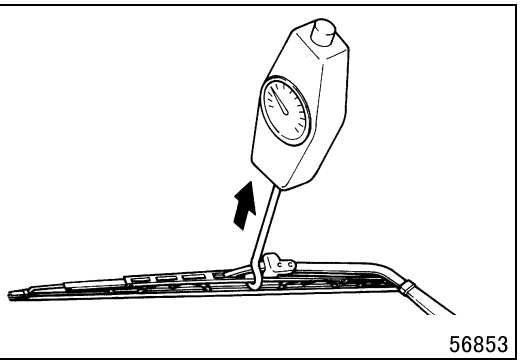


Dimension A: 50 mm (2.0 in)
Dimension B: 54 to 64 mm (2.1 to 2.5 in)

●Assembly sequence

1. Install the wiper motor on the wiper-motor bracket.
2. Connect the electrical connector. Install the rubber grommet in the cab.
3. Attach the wiper motor bracket to the cab. Tighten the mounting capscrews 11 to 16 N·m {8 to 12 lbf·ft}.
4. Cycle the wipers ON and OFF to assure that the motor is parked.
5. Attach the wiper link to the motor, making sure the orientation is correct.
6. Install the front cover. Tighten the front cover mounting capscrews 9 to 14 N·m {7 to 10 lbf·ft}.
7. Make sure to install the wiper arm in the correct park position. Measured from the top edge of the weatherstripping, the blade should not come closer than 50 mm (2.0 in). Measured from the bottom edge of the weatherstripping, the blade should be within 54 to 64 mm (2.1 to 2.5 in).
8. Tighten the wiper arm nuts 11 to 16 N·m {8 to 12 lbf·ft}.
9. Pull the windshield washer nozzles through the front panel.
10. Fasten the washer nozzles and hoses to the wiper arms.
11. Install the front side covers.
12. Check the operation of the wipers.

◆Inspection procedure◆



■Inspection: Wiper arm

1. Measure the amount of wiper arm force needed to press the blade against the windshield.
2. If the measurement is less than 5.7 N (1.3 lbf) or more than 6.7 N (1.5 lbf), replace the wiper arm.

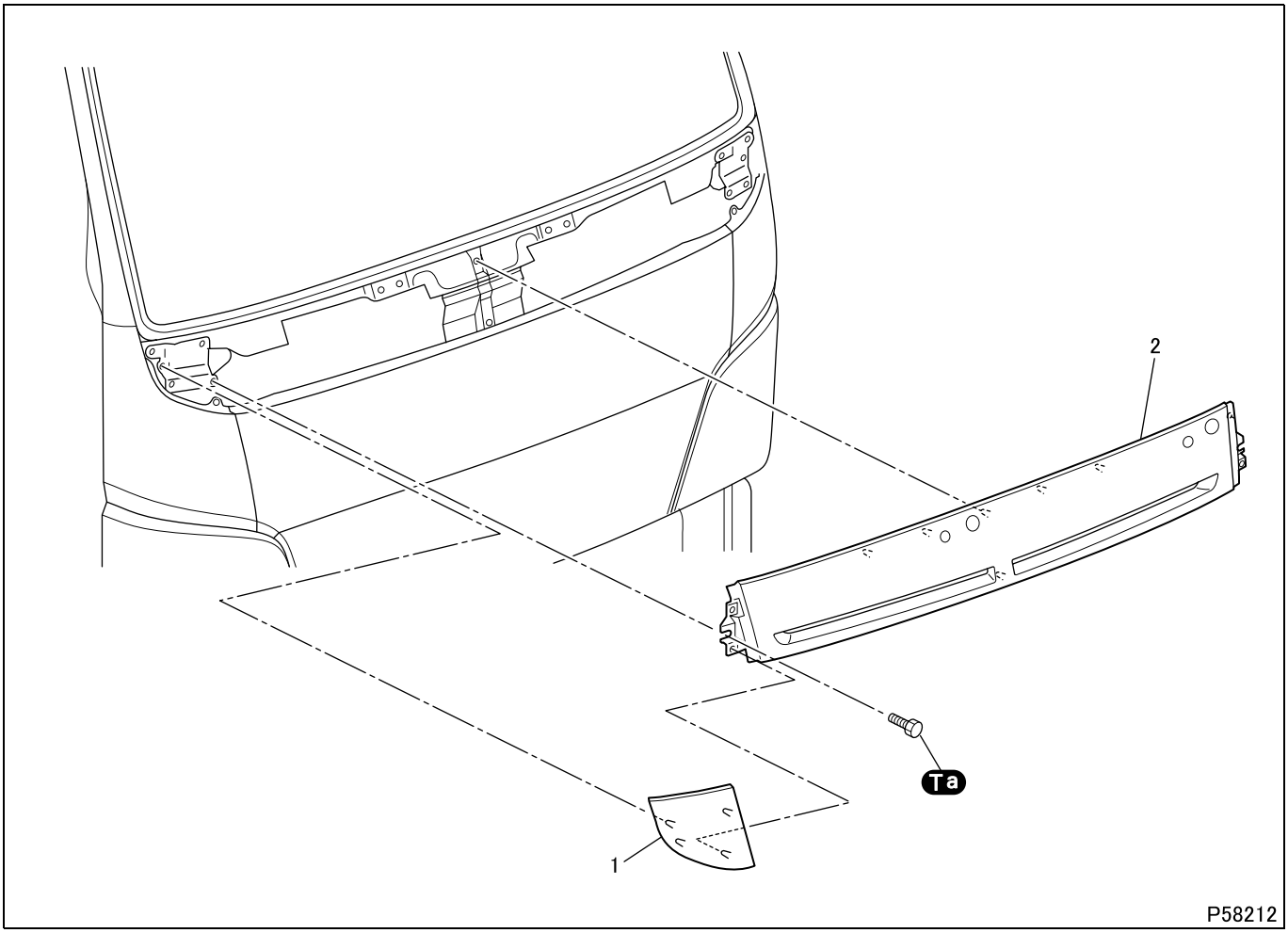
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
7	Wiper arm force to press blade against windshield	5.7 to 6.7 N {1.3 to 1.5 lbf}	–	Replace

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (wiper arm)	11 to 16 {8 to 12}	–
	Capscrew (wiper motor mounting)	11 to 16 {8 to 12}	–
	Capscrew (front cover mounting)	9 to 14 {7 to 10}	–

FRONT COVER



● **Disassembly sequence**

1 Front side cover
2 Front cover

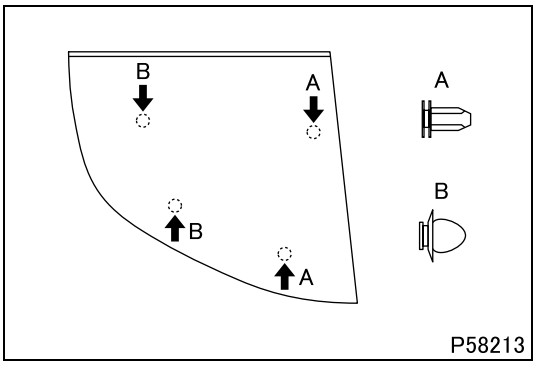
● **Assembly sequence**

Follow the disassembly sequence in reverse.

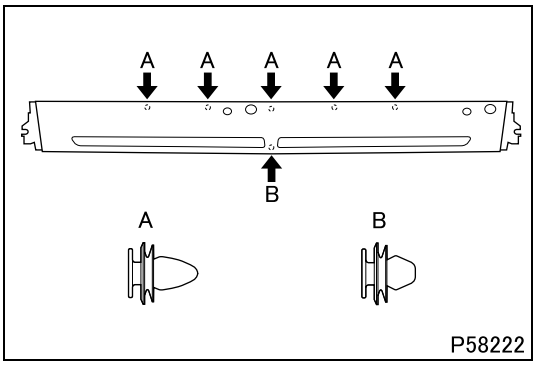
Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Capscrew (front cover mounting)	9 to 14 {6.6 to 10}	–

◆Removal procedure◆

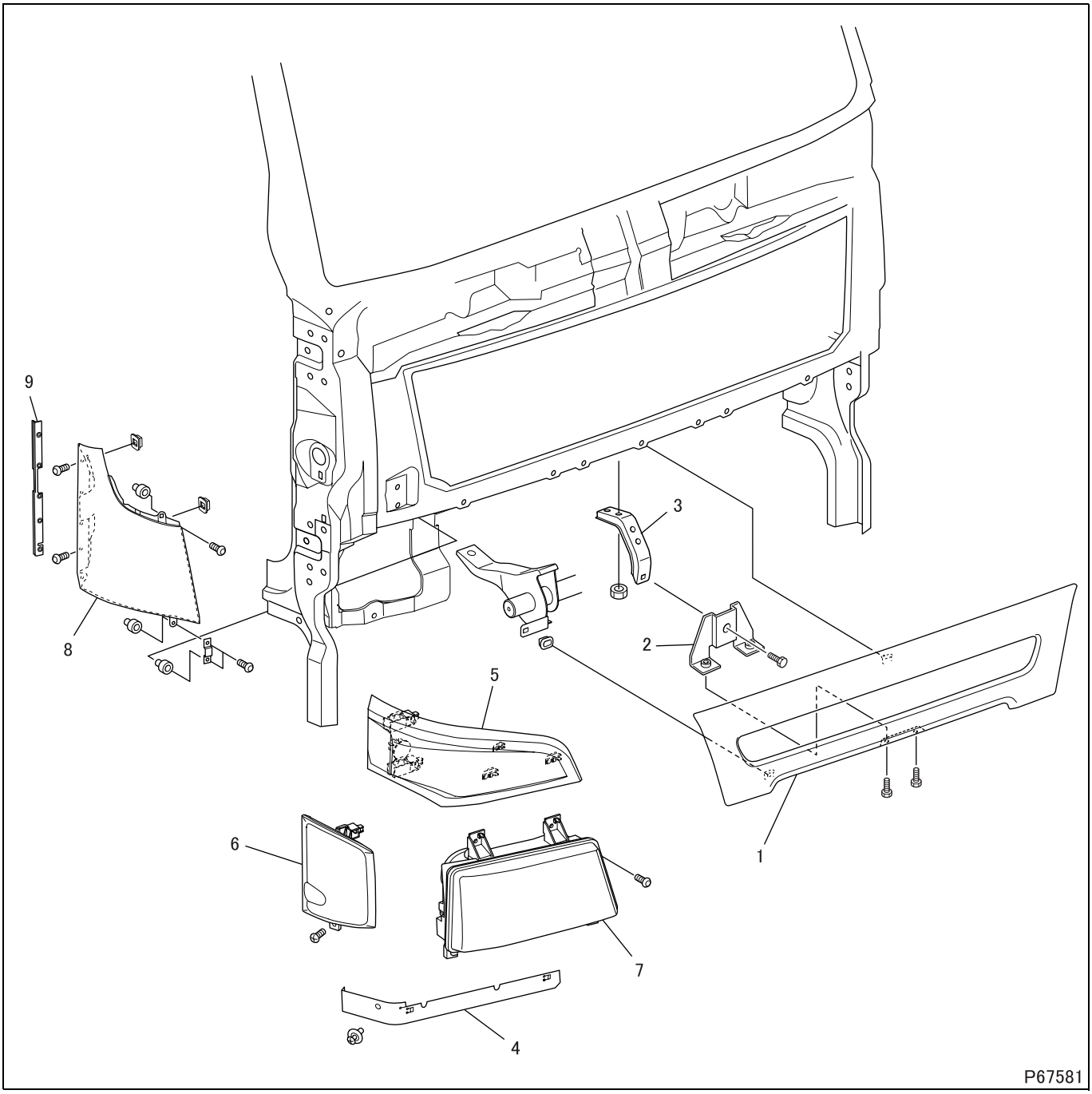


■Removal: Front side cover



■Removal: Front cover

FRONT GRILLE, FRONT CORNER PANEL AND HEADLIGHT



● **Disassembly sequence**

1 Front grille
2 Bracket
3 Bracket
4 Headlight bezel
5 Front and side turn signal lens
6 Reflector
7 Headlight
8 Front corner panel
9 Door opening seal

CAUTION ⚠

- **Do not attempt to forcibly remove the reflector, front and side turn signal lens, and headlight. The mounting fasteners could be damaged.**

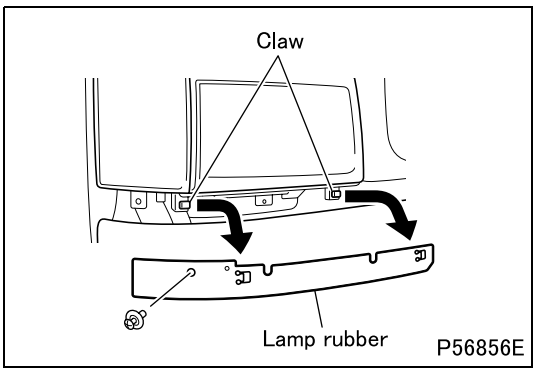
NOTE

- **Do not remove the door opening seal unless absolutely necessary.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

◆Removal procedure◆

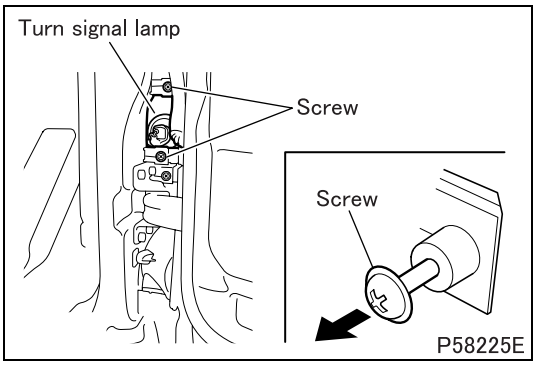


■Removal: Headlight bezel (lamp rubber)

Remove the screw and rivet. Slide the headlight bezel sideways to release it.

CAUTION ⚠

- **Do not forcibly remove the headlight bezel. It could be damaged.**

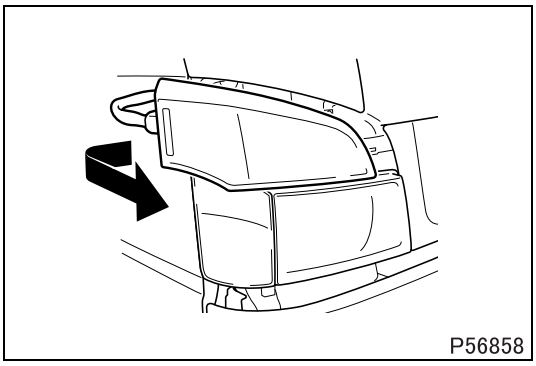


■Removal: Front and side turn signal lens

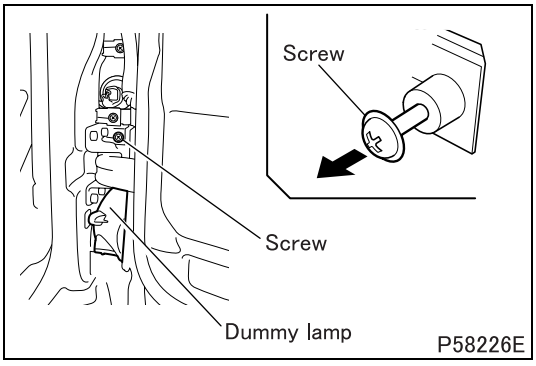
- Open the door. Loosen the two keeper screws securing the turn signal lens until they spin freely.
- Pull out the keeper screws until they are fully extended.

CAUTION ⚠

- **Unless the keeper screw is extended, the turn signal lens and reflector will catch on it and you will not be able to remove them from the vehicle without damaging them.**

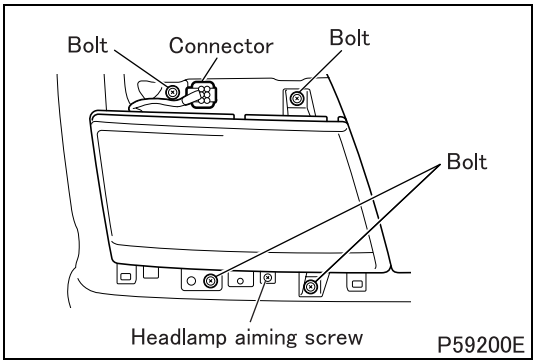


- Close the door. Move the turn signal lens sideways to remove it.
- When the turn signal lens is free, remove it from the vehicle as shown in the illustration. Then remove the connector.



■Removal: Reflector (dummy lamp)

- Open the door. Remove the screw at the bottom of the reflector and pull the reflector away from the vehicle.

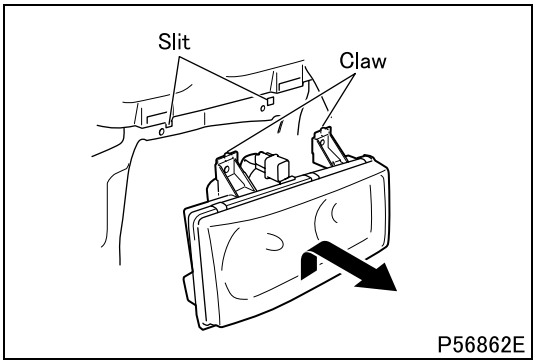


■Removal: Headlight

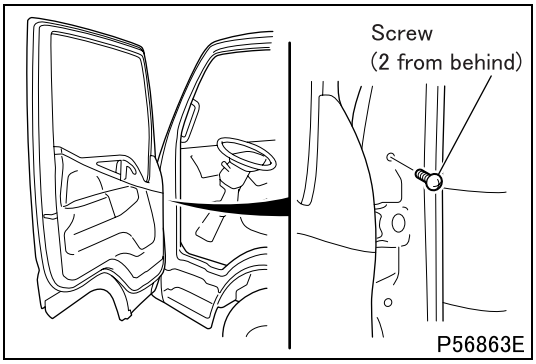
CAUTION ⚠

- **Do not turn the beam adjusting screw. This would change the beam setting and could cause an injury accident.**

- Remove the headlight bolts and connectors.



- Raise the headlight slightly to free it.Then pull it out towards you.



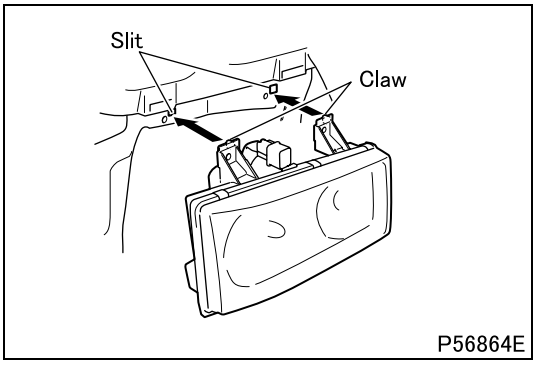
■Removal: Front corner panel

- Open the door. Remove the two screws securing the front corner panel from behind.
- Close the door. Remove the three screws securing the front corner panel from the front.
- Remove the front corner panel.

◆Installation procedure◆

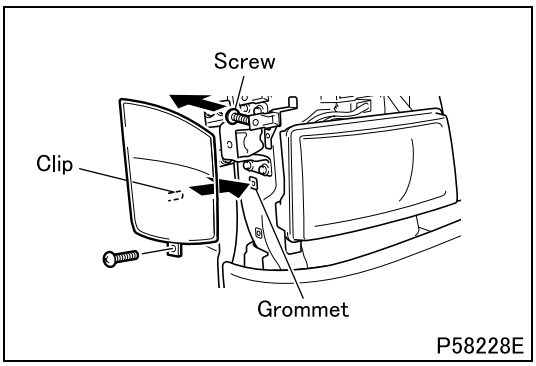
■Installation: Front corner panel

- Perform the removal procedure in reverse (see **■Removal: Front corner panel**)



■Installation: Headlight

- Inset the tabs on the headlight into the slots, and position the headlight properly.

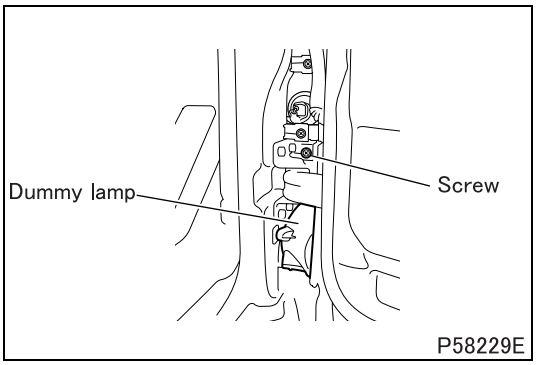


■**Installation: Reflector**

- Pull out the reflector keeper screw until it is fully extended.
- Insert the clip of the reflector into the grommet.

CAUTION ⚠

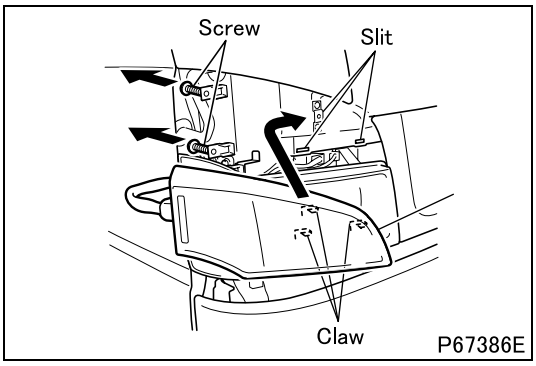
- **Do not overtighten the bottom screw. This could damage the mounting.**



- Open the door. Tighten the bottom screw until firm.

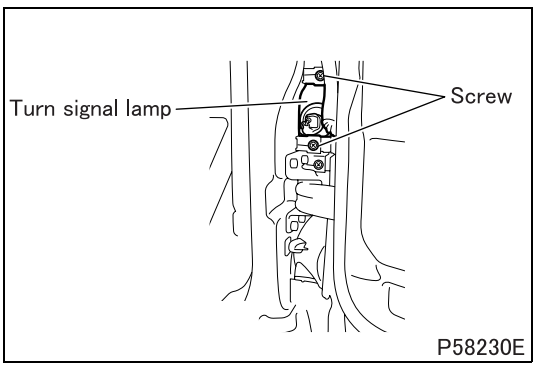
CAUTION ⚠

- **If the door is opened and the turn signal lens is not pressed fully into place, the door could hit the lens and damage it.**
- **Do not overtighten the keeper screws. This could damage the mounting.**



■**Installation: Front and side turn signal lens**

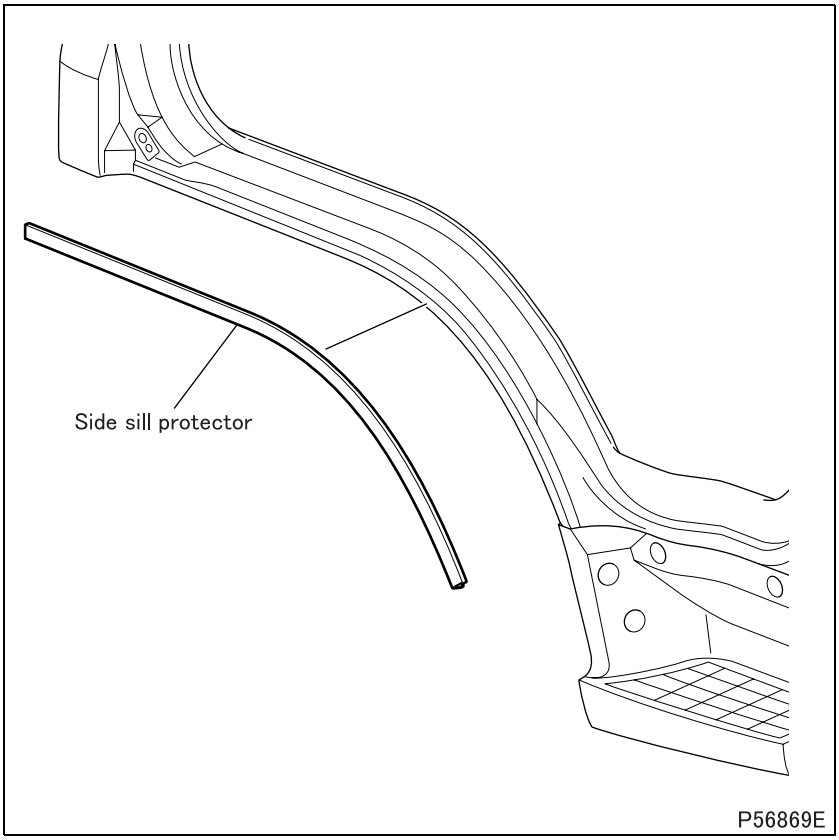
- Pull out the two turn signal keeper screws until they are fully extended.
- Align the tabs (claws) of the turn signal lens with their slots.
- Press the turns signal lens inward, toward the centerline of the vehicle.



- Open the door and tighten the two keeper screws behind the turn signal lens and the keeper screw behind the reflector.

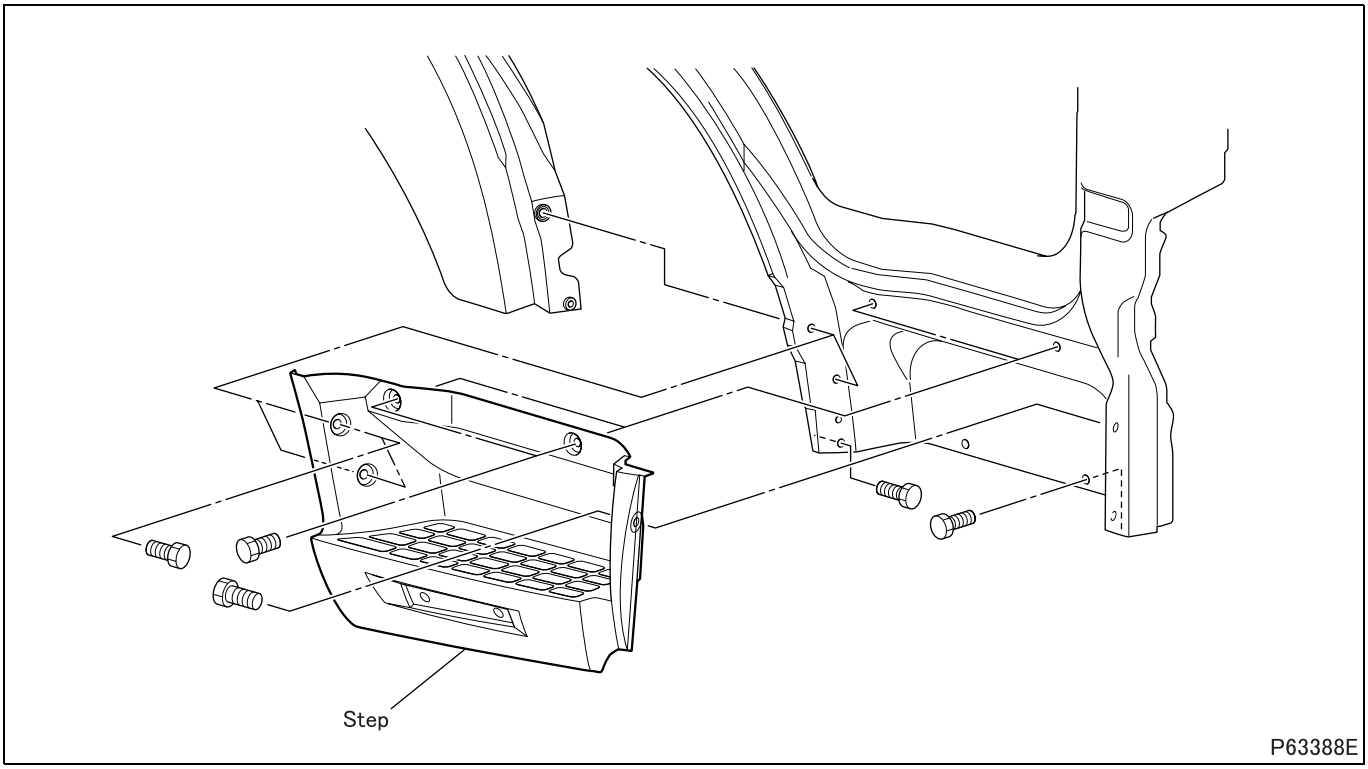
■**Installation: Headlight bezel**

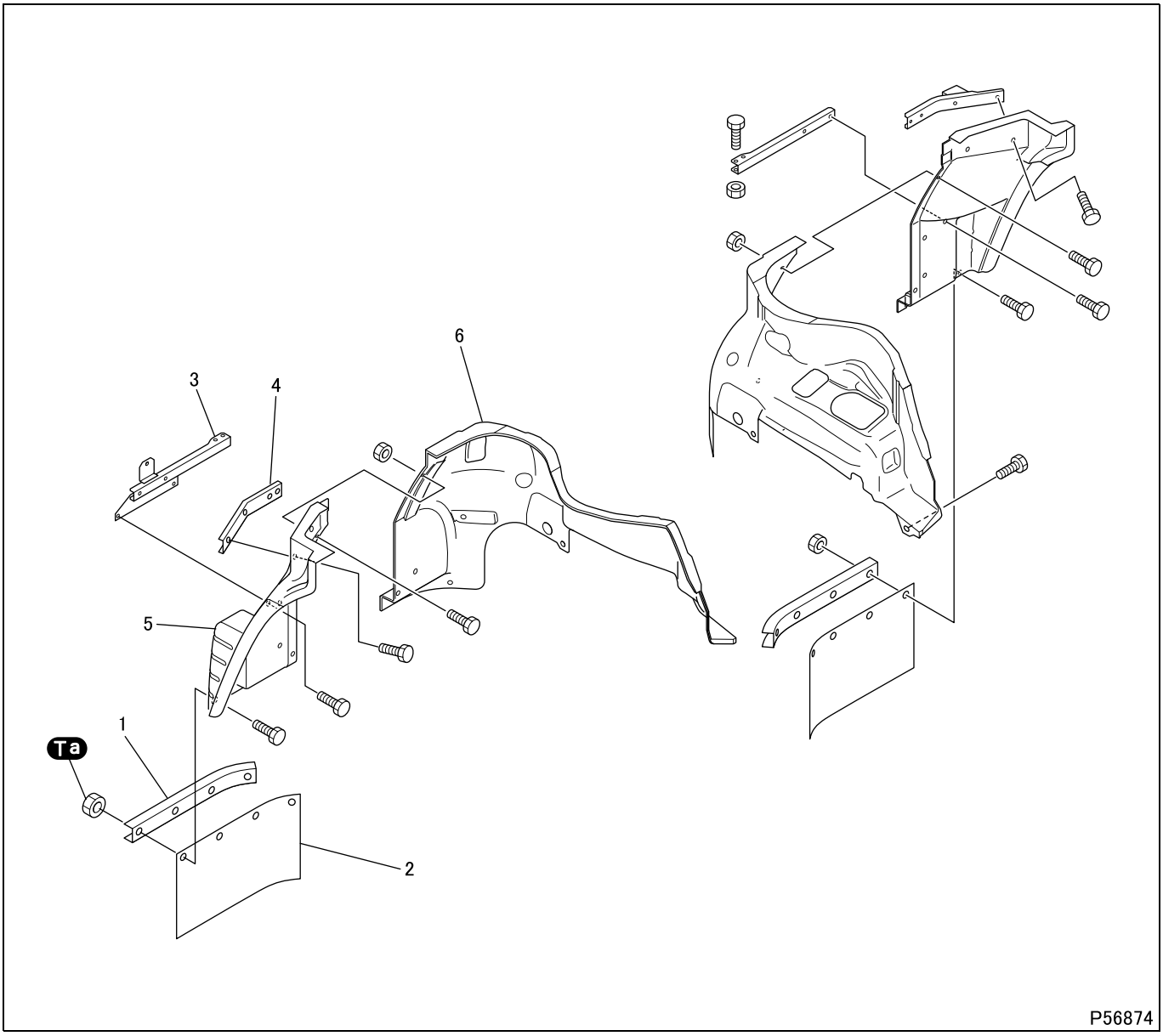
- Fit the headlight bezel under the headlight and onto the tabs by moving it toward the outside of the vehicle.
- Press in the rivet and install the screw.



NOTE

- **For details on removal and installation of the fender, see Gr43.**
- **Attach the side sill protector using double-coated adhesive tape.**


Step
P63388E



● **Removal sequence**

1 Apron support
2 Mud guard apron
3 Mud guard lower stay
4 Mud guard upper stay
5 Mud under guard
6 Lower shield panel

● **Installation sequence**

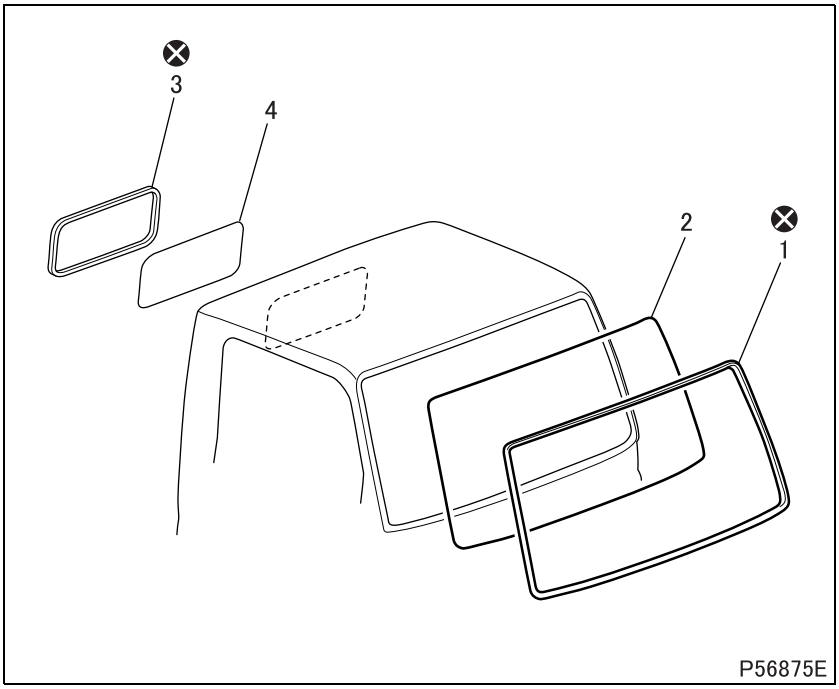
Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut (attaching apron support to mud guard apron)	3.9 to 5.9 {2.9 to 4.4}	–

M E M O

WINDSHIELD AND CAB REAR WINDOW



●Removal sequence

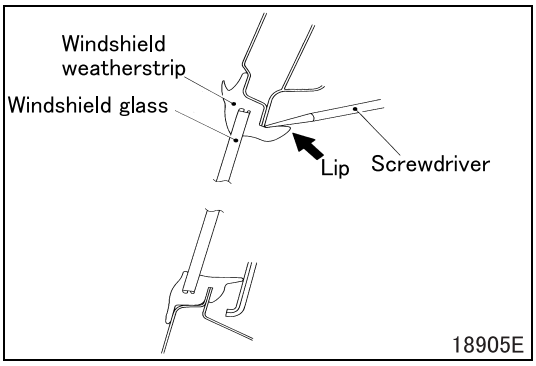
1 Windshield weatherstripping
2 Windshield glass
3 Rear window weatherstripping
4 Rear window glass

⊗: Non-reusable parts

●Installation sequence

Follow the removal sequence in reverse.

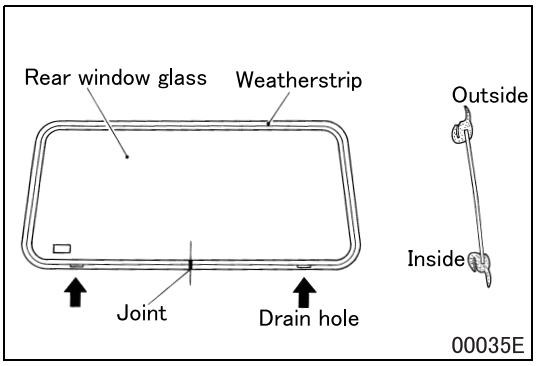
◆Removal procedure◆



■Removal: Windshield weatherstripping and windshield glass

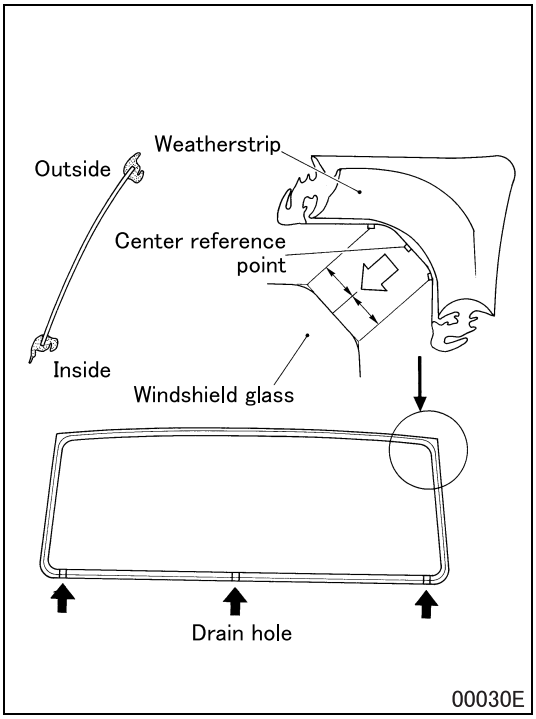
- While prying up the lip of the weatherstripping with the tip of a screwdriver, push out the windshield from inside the cab.

●Installation procedure



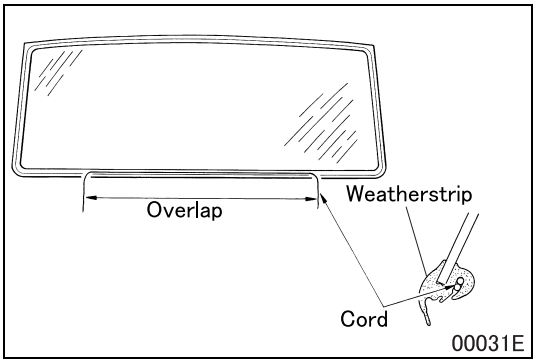
■Installation: Rear window weatherstripping and cab rear window

- Fit the rear window weatherstripping round the rear window glass so that the joint comes at the bottom center of the glass.
- Except for the point mentioned above, install the cab rear window in the same way as the windshield.

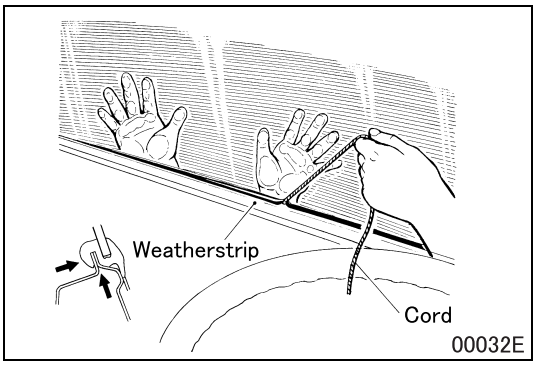


■Installation: Windshield weatherstripping and windshield glass

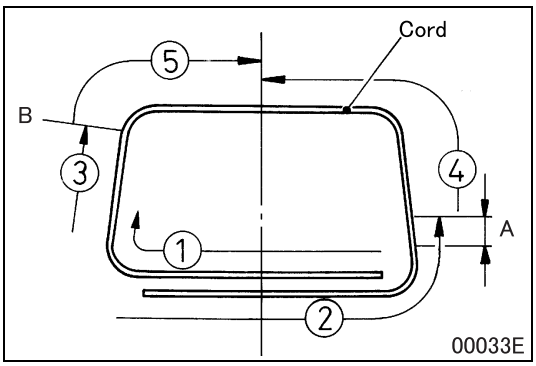
- Install the weatherstripping with its center reference point aligned with the center of the cut at each corner of the winshield.



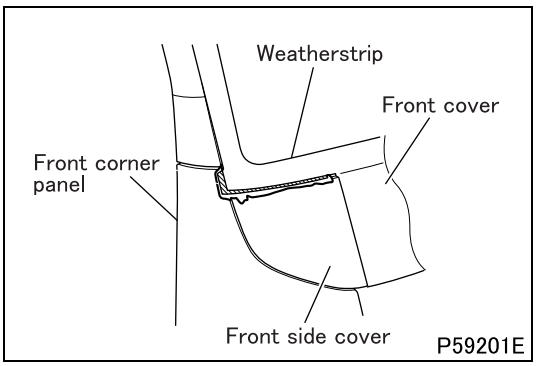
- Put a piece of strong cord in the cab flange fitting groove in the weatherstripping with its end portions overlapped.



- With the glass strongly pushed from outside, pull out the cord by its ends from inside the cab to gradually fit the flange of the cab in the inner groove of the weatherstripping.



- Pull the cord in the sequence shown. At the same time, while tapping with a rubber-headed mallet from outside the cab, settle the windshield glass in place in the weatherstripping.
  A: Approx. 100 mm {3.9 in.} from the beginning of straight portion
  B: Up to the end of straight portion



- To ensure watertightness, put the hatched part of the weatherstripping inside between the cab and the front cover, front side cover, and front corner panel.

INDEX

SEAT
<DRIVER>.....52-2
<PASSENGER>.....52-4

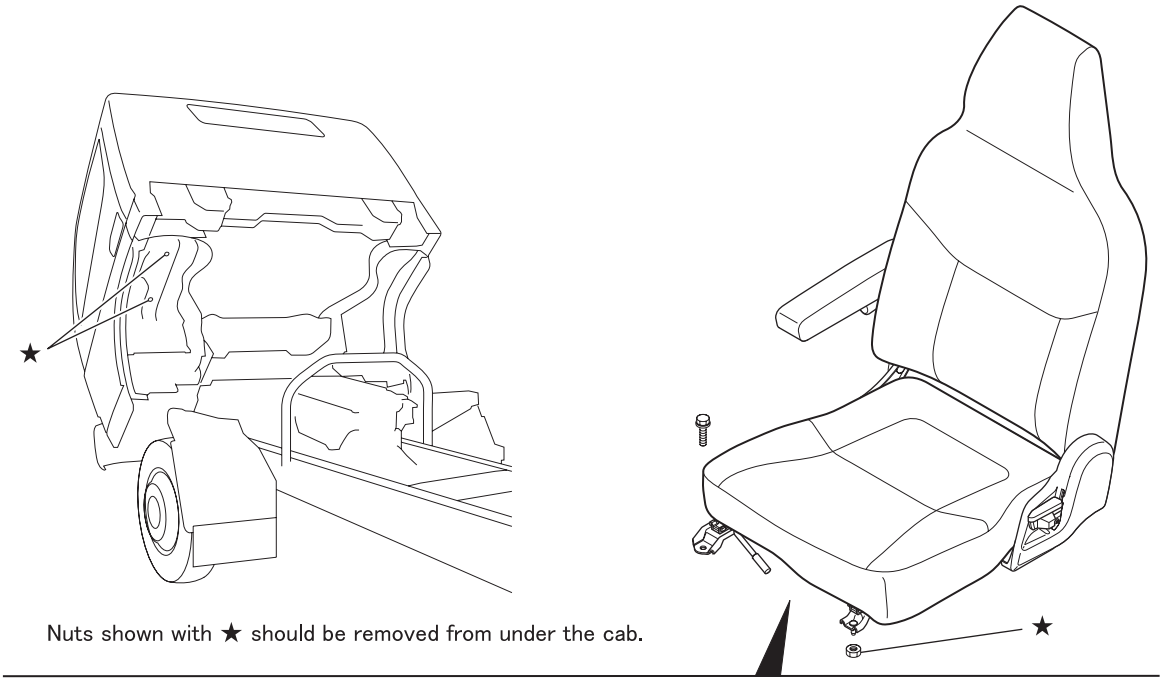
SEAT BELT..... 52-6

INSTRUMENT PANEL.....52-11

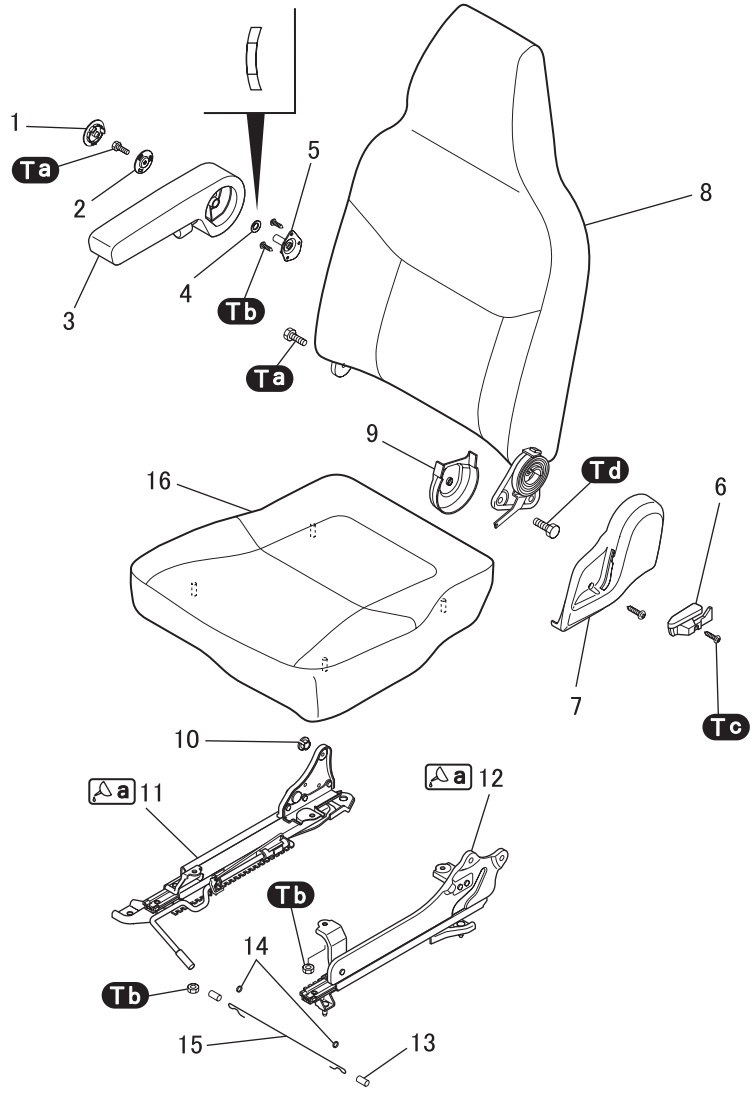
TRIM AND SCUFF PLATE.....52-31

HEAD LINING.....52-34

SEAT <DRIVER>



Nuts shown with ★ should be removed from under the cab.



P58234E

● Removal sequence

1 Cover
2 Plate
3 Armrest
4 Washer
5 Armrest bracket
6 Knob
7 Reclining cover
8 Back cushion
9 Inner cover
10 Bushing
11 Seat adjuster (right-hand)
12 Seat adjuster (left-hand)
13 Tube
14 Clip
15 Wire
16 Seat cushion

● Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **When installing the seat adjusters, be sure to engage the locking device before fitting them onto the seat cushion.**

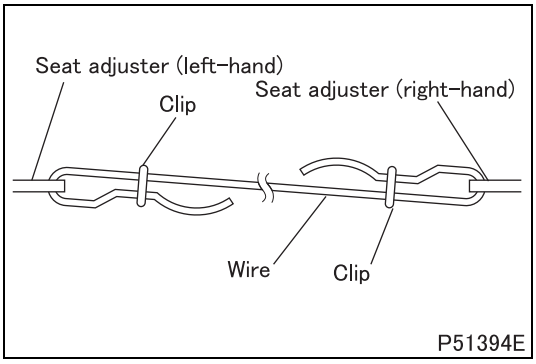
Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Screw (plate mounting)	10 to 15 {7.4 to 11}	–
	Bolt (back cushion mounting)		
Tb	Screw (armrest bracket mounting)	4 to 6 {2.95 to 4.43}	–
	Nut (seat adjuster mounting)	11 to 17 {8.11 to 12.5}	–
Tc	Screw (knob mounting)	1.4 {1.0}	–
Td	Bolt (back cushion mounting)	34.3 to 53.9 {25 to 40}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding surface of seat adjuster	Chassis grease [NLGI No. 1 (Li soap)]	As required

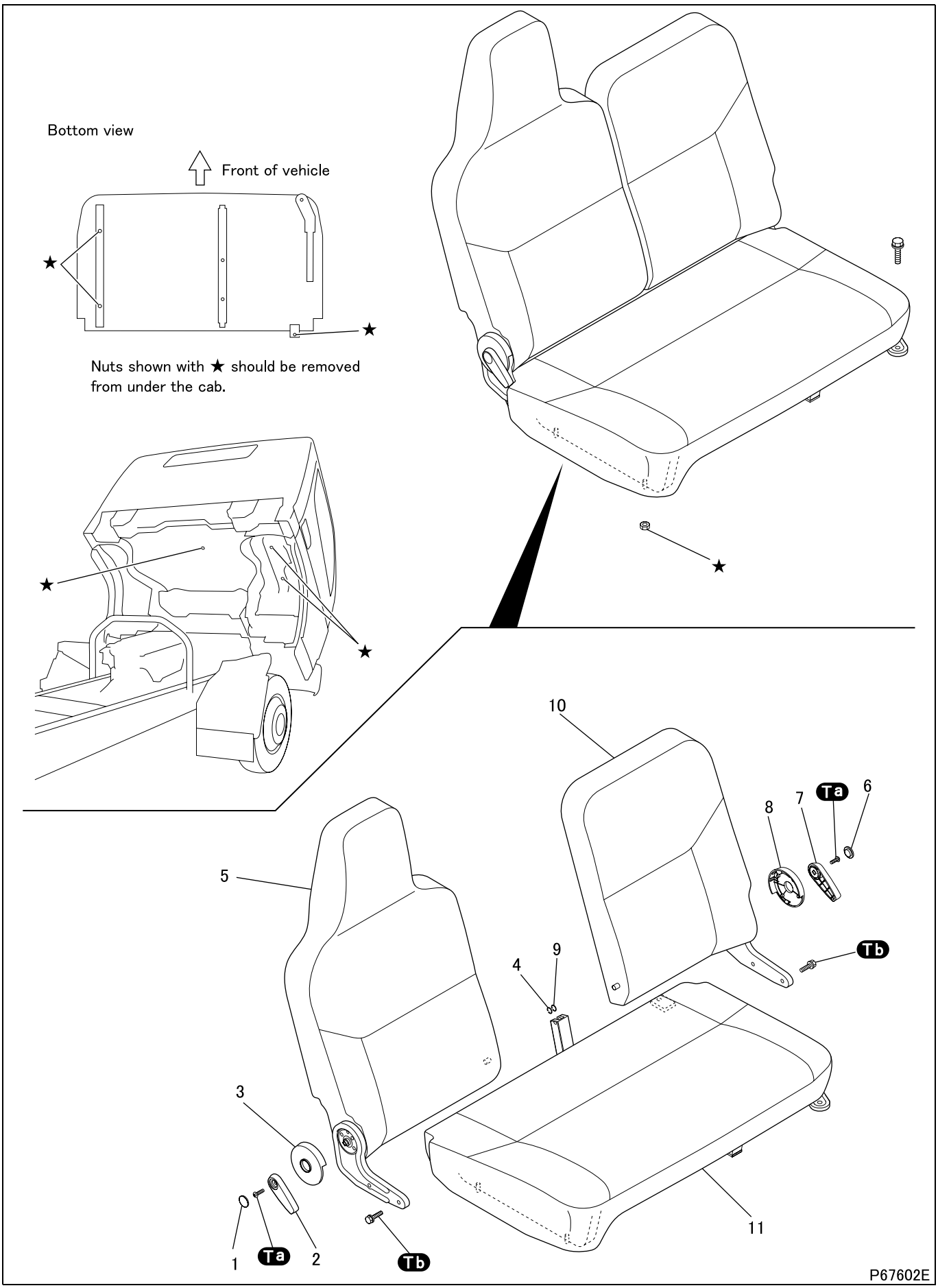
◆Installation procedure◆



■ Installation: Wire

- Install one end of the wire onto the seat adjuster (left-hand). Then, twist the wire a half turn before fitting the other end onto the seat adjuster (right-hand).

SEAT <PASSENGER>



● **Removal sequence**

1 Cap
2 Knob
3 Reclining cover (right-hand)
4 Snap ring
5 Side back cushion
6 Cap
7 Knob
8 Reclining cover (left-hand)
9 Snap ring
10 Center back cushion
11 Seat cushion

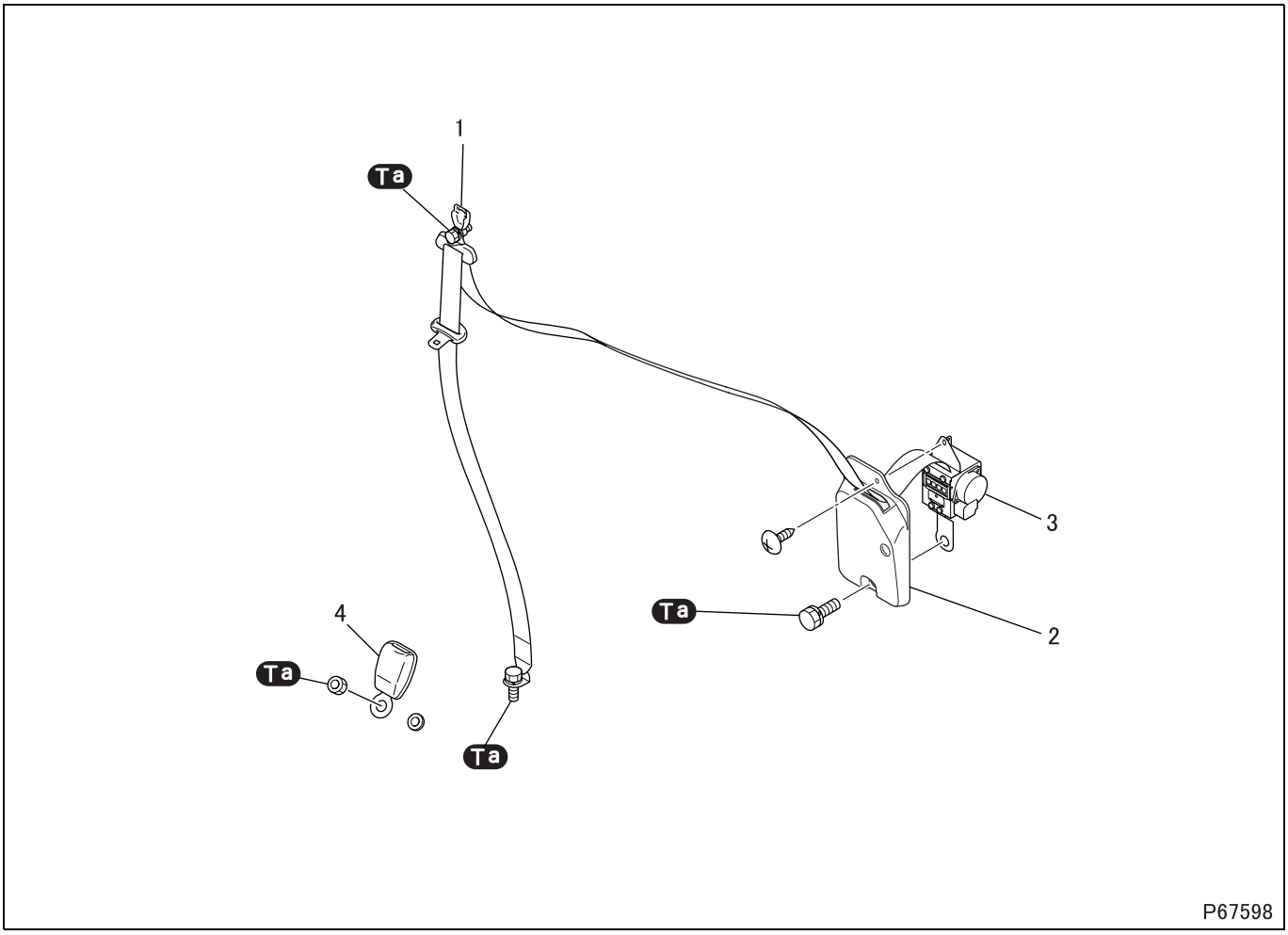
● **Installation sequence**

Follow the removal sequence in reverse.

Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Screw (knob mounting)	1.3 {0.96}	–
Tb	Bolt (back cushion mounting)	34.3 to 53.9 {25 to 40}	–

<Driver>



● Removal sequence

1 Shoulder anchor cover
2 Emergency locking retractor cover
3 Emergency locking retractor
4 Buckle

● Installation sequence

Follow the removal sequence in reverse.

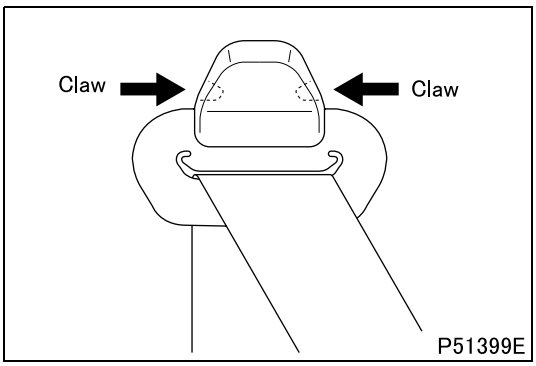
CAUTION ⚠

- **Never disassemble the emergency locking retractor, or buckle.**

Torque: N·m {lbf·ft}

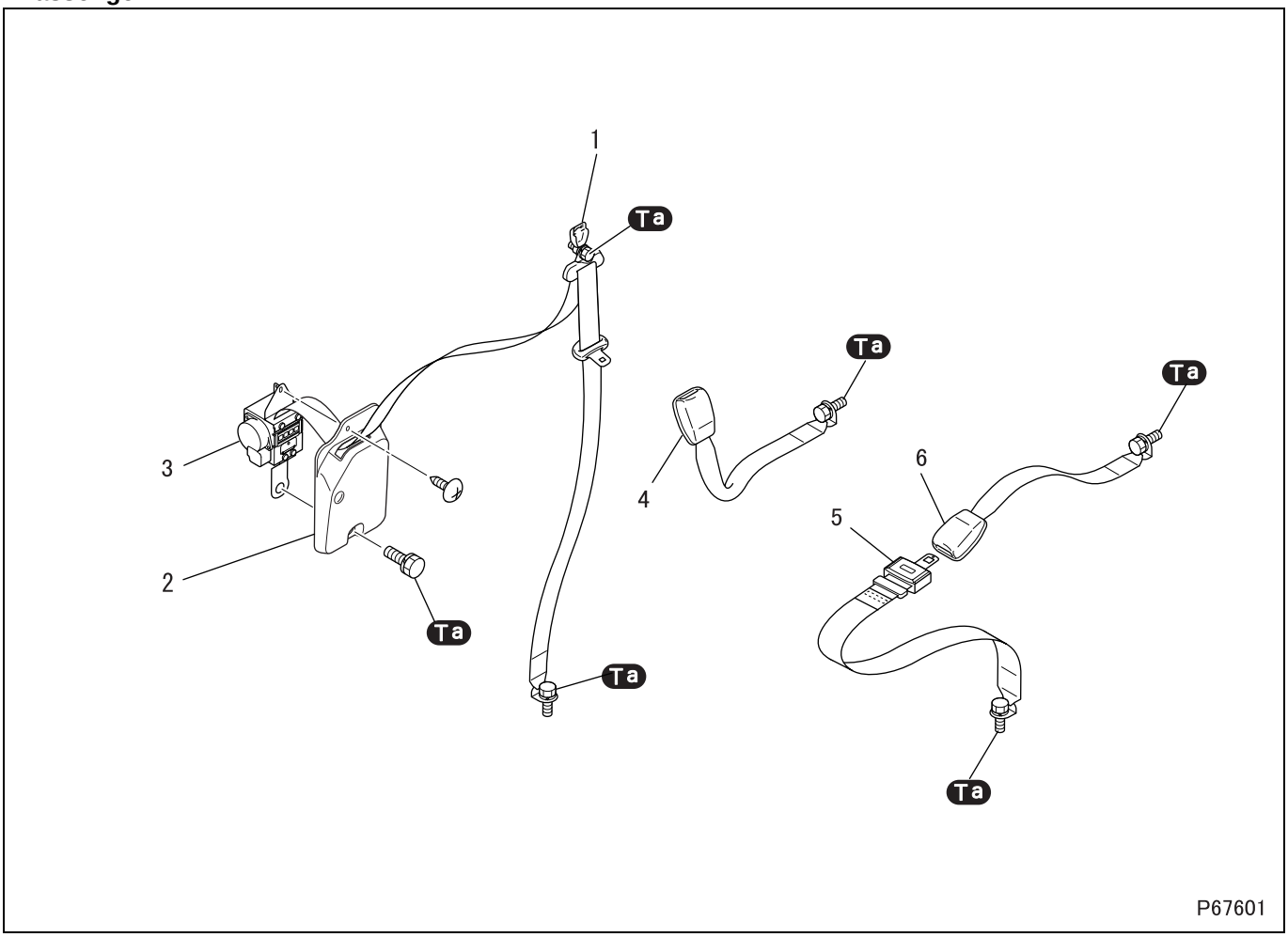
Mark	Parts to be tightened	Torque value	Remarks
Ta	Bolt (floor anchor mounting)	34 to 54 {25 to 40}	–
	Bolt (shoulder anchor mounting)		
	Bolt (emergency locking retractor mounting)		
	Nut (buckle mounting)		

◆Removal procedure◆



■ **Removal: Shoulder anchor cover**

<Passenger>



● **Removal sequence**

1 Shoulder anchor cover
2 Emergency locking retractor cover
3 Emergency locking retractor
4 Buckle
5 Tongue
6 Buckle

● **Installation sequence**

Follow the removal sequence in reverse.

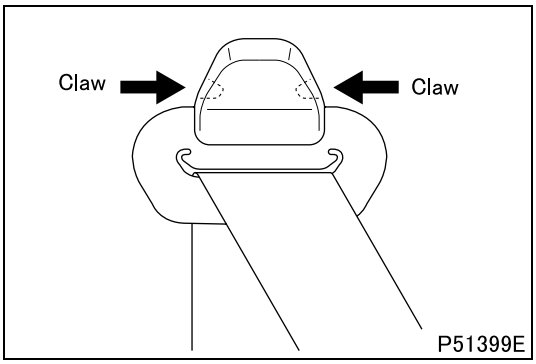
CAUTION ⚠

- **Never disassemble the emergency locking retractor, or buckle.**

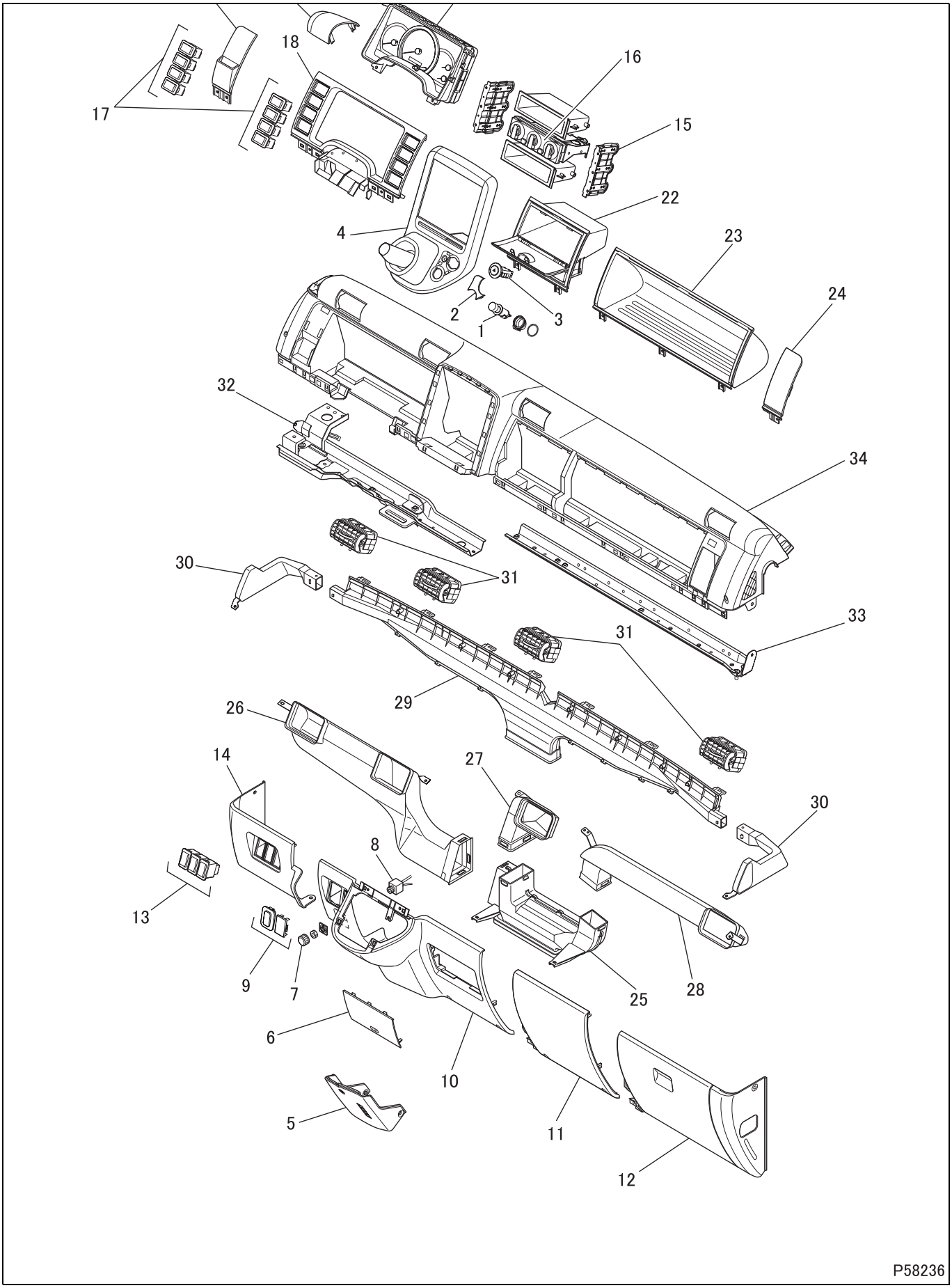
Torque: N·m {lbf·ft}

Mark	Parts to be tightened	Torque value	Remarks
Ta	Bolt (floor anchor mounting)	34 to 54 {25 to 40}	–
	Bolt (shoulder anchor mounting)		
	Bolt (emergency locking retractor mounting)		
	Bolt (buckle mounting)		
	Bolt (tongue mounting)		

◆Removal procedure◆



■ **Removal: Shoulder anchor cover**


17
18
16
15
22
4
23
2
3
1
24
32
34
30
31
33
31
29
26
14
27
30
8
13
9
7
25
28
6
10
5
11
12
P58236

- This section divides the instrument panel in 4 areas and describes removal and installation procedures for each area. For information on specific components, refer to the corresponding area descriptions. Removal/installation of components with ★ require that components belonging to other areas (shown in brackets [ ]) also need to be removed/installed. Components shown without ★ can be removed/installed without affecting other areas.

1 Cigarette lighter
2 Panel cover
3 Hazard flasher unit
4 Upper center panel
5 Shift lever cover
6 Fuse inspection cover
7 Engine idle control dial
8 Engine idle control
9 Plug
10 Lower center panel
11 Passenger's kick panel
12 Map compartment
13 Switch or plug
14 Driver's kick panel
15 Radio bracket

— Area 1 (Lower panel)

16 Climate control panel
17 Switch or plug
★ **18** Instrument cluster bezel [Area 1]
19 Instrument cluster
★ **20** Accessory box lid [Area 1]
21 Cover (brake fluid reservoir)
★ **22** Glove box [Area 1]

— Area 2 (Driver upper panel)

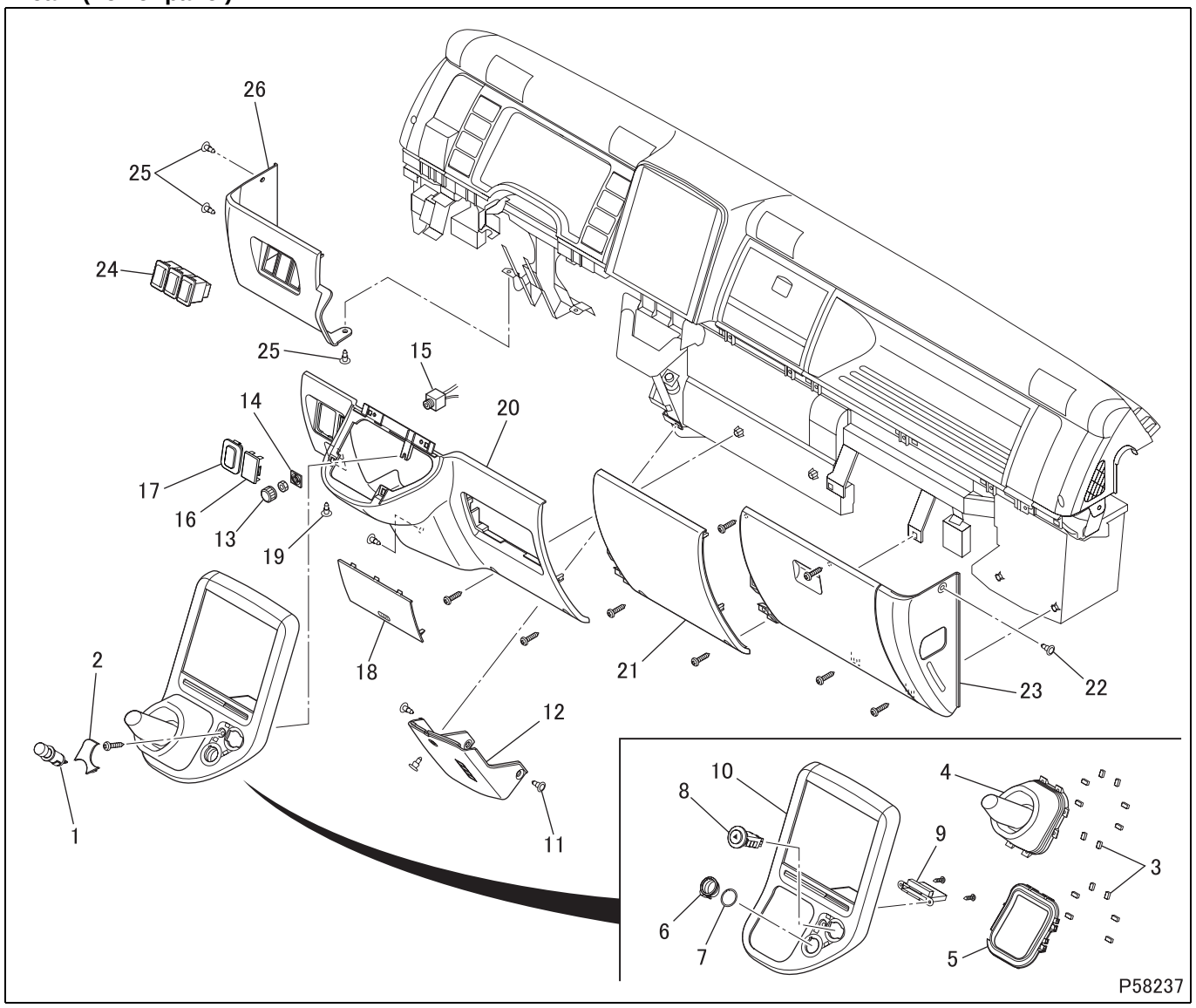
★ **23** Parcel tray [Area 1]
★ **24** Relay inspection cover [Area 1]

— Area 3 (Passenger upper panel)

★ **25** Center duct [Areas 1 to 3]
★ **26** Driver face duct [Areas 1 to 3]
★ **27** Center face duct [Areas 1 to 3]
★ **28** Passenger face duct [Areas 1 to 3]
★ **29** Front defroster duct [Areas 1 to 3]
★ **30** Side defroster duct [Areas 1 to 3]
★ **31** Air outlet grille [Areas 1 to 3]
★ **32** Driver instrument panel frame [Areas 1 to 3]
★ **33** Passenger instrument panel frame [Areas 1 to 3]
★ **34** Instrument panel [Areas 1 to 3]

— Area 4 (ducts)

Area 1 (Lower panel)



● Removal sequence

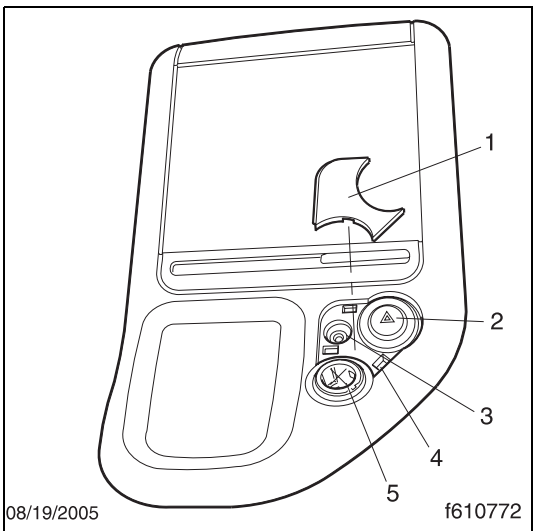
1 Cigarette lighter element
2 Panel cover
3 Speed nut (8 qty <M/T>, 6 qty <A/T>)
4 Shift lever boot <M/T>
5 A/T cover <A/T>
6 Cigarette lighter socket
7 Cigarette lighter socket retainer
8 Hazard flasher unit
9 Card holder
10 Upper center panel
11 Quick-release fastener (to shift lever cover)
12 Shift lever cover
13 Engine idle control dial
14 Plate (in engine idle control)
15 Engine idle control
16 Plug (in lower center panel)
17 Switch cover (in lower center panel)
18 Fuse inspection cover
19 Quick-release fastener (to lower center panel)
20 Lower center panel
21 Passenger's kick panel
22 Quick-release fastener (to passenger's kick panel)
23 Map compartment
24 Switch or plug (in driver's kick panel)
25 Quick-release fastener (to driver's kick panel)
26 Driver's kick panel

M/T: Manual transmission
A/T: Automatic transmission

● Installation sequence

Follow the removal sequence in reverse.

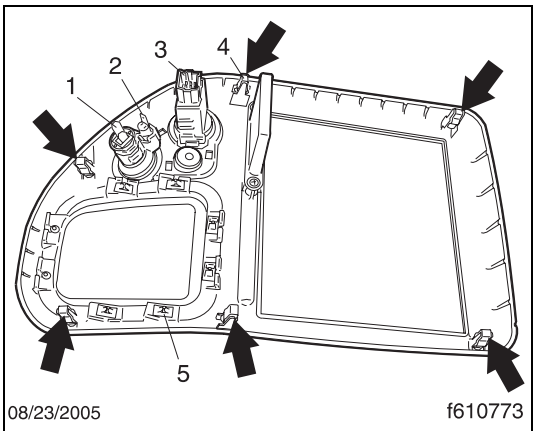
◆Removal procedure◆



1. Panel cover
2. Hazard flasher
3. Fastener hole
4. Insert for panel cover
5. Cigarette lighter element

■ Removal: Panel cover

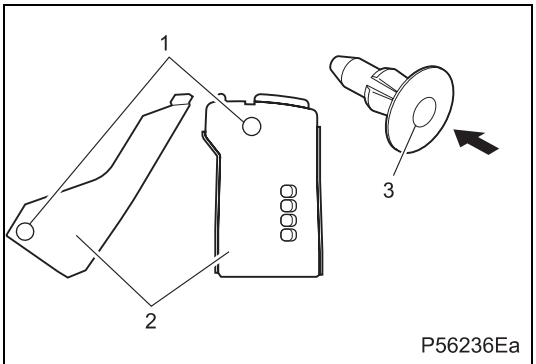
1 Pry off the panel cover. The prongs release with light pressure.
2 Remove the screw behind the panel cover.
3 Remove the cigarette lighter element.



1. Cigarette lighter power
2. Cigarette lighter GND
3. Hazard flasher connector
4. Spring clip
5. Speed nut

■ Removal: Upper center panel

1 Pry out the upper center panel, held on by spring clips (shown by arrows) and speed nuts.
2 Pull the upper center panel from the dash.
3 Disconnect the three electrical connectors behind the upper center panel (two for the cigarette lighter, one for the hazard flasher).
4 Remove the cigarette lighter socket and socket retainer from the upper center panel.
5 Remove the upper center panel from the dash.

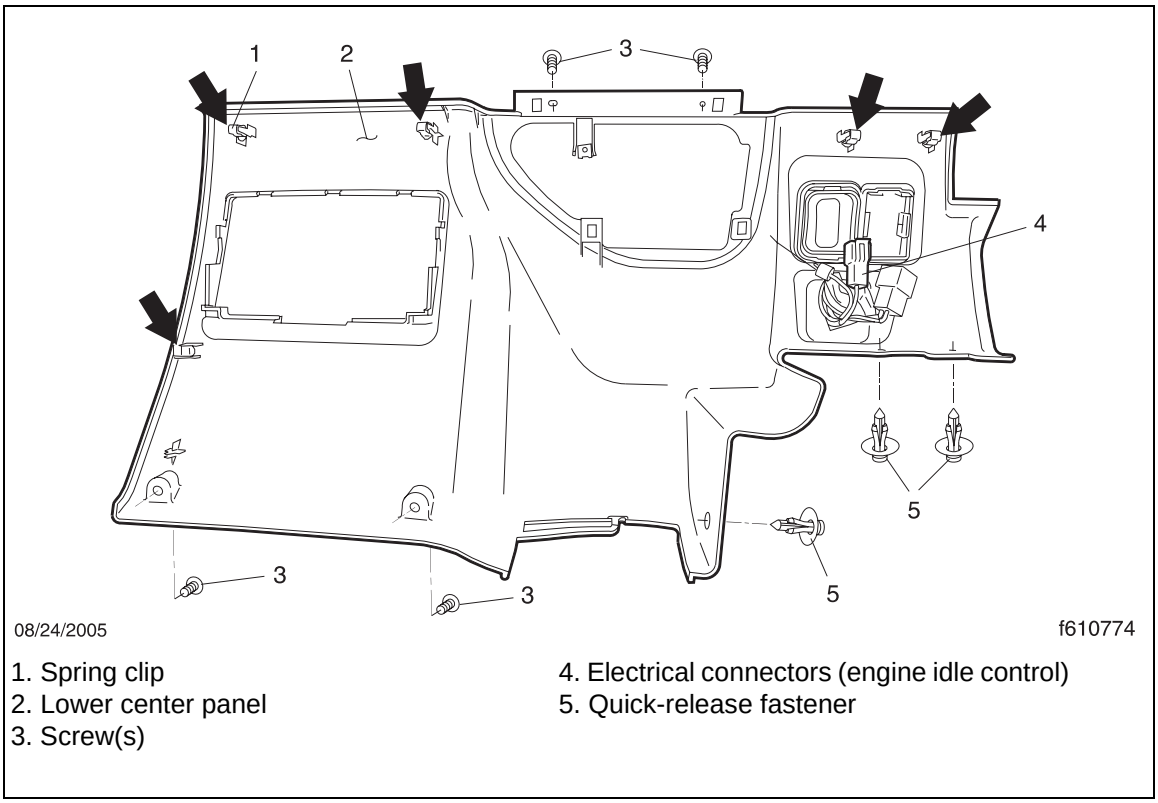


1. Quick-release fastener
2. Shift lever cover
3. Center button (locked)

■ **Removal: Shift lever cover**

1 Push in on the center button to remove the three quick-release fasteners from the shift lever cover.

2 Remove the shift lever cover from the dash.



1. Spring clip
2. Lower center panel
3. Screw(s)
4. Electrical connectors (engine idle control)
5. Quick-release fastener

■ **Removal: Lower center panel**

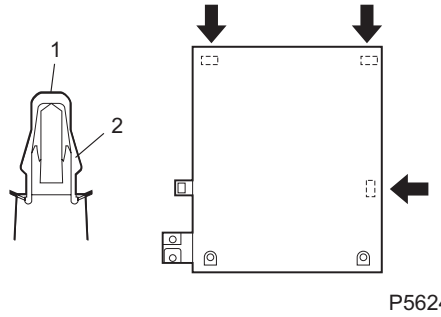
1 Remove the four screws from the lower center panel.

2 Push in on the center button to remove the three quick-release fasteners from the lower center panel.

3 Pry out the lower center panel, held on by spring clips (shown by arrows).

4 From behind the lower center panel, disconnect the two electrical connectors for the engine idle control.

5 Remove the lower center panel from the dash.

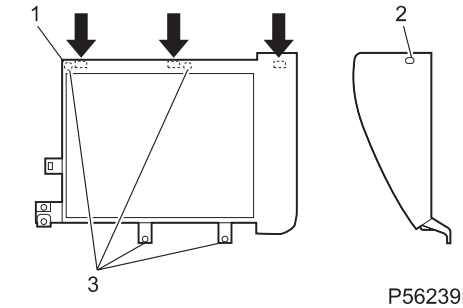


P56242Ea

1. Spring clip
2. Claw of spring clip

■ **Removal: Passenger's kick panel**

1 Remove the two screws on the bottom of the passenger's kick panel.
2 Release the claws of the three spring clips on the passenger's kick panel (locations shown by arrows).
3 Remove the passenger's kick panel from the dash.

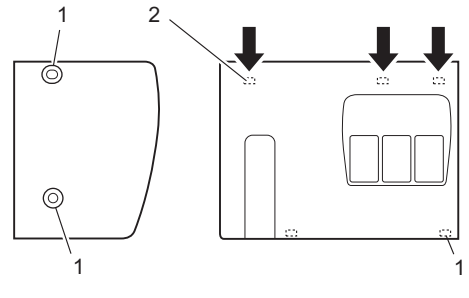


P56239Ea

1. Spring clip
2. Quick-release fastener
3. Screws

■ **Removal: Map compartment**

1 Open the map compartment and remove the two screws that attach the map compartment to the brackets that extend downwards from the parcel tray.
2 Remove the quick-release fastener from the side panel of the map compartment (above the washer fluid level check window).
3 Remove the two screws from the brackets at the bottom of the map compartment.
4 Release the claws of the three spring clips from the top of the map compartment and remove the map compartment from the dash (locations shown by arrows).



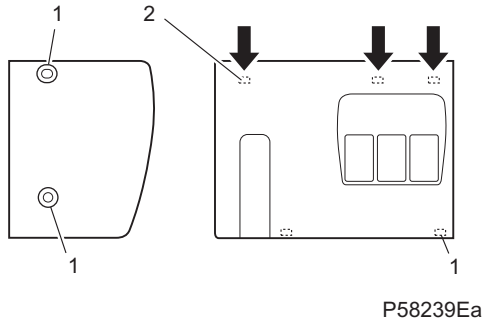
P58239Ea

1. Quick-release fastener
2. Spring clip

■ **Removal: Driver's kick panel**

1 Remove the switches installed in the driver's kick panel. Disconnect the electrical connectors behind the panel.
2 Remove the three quick-release fasteners, one at the bottom of the driver's kick panel, and the other two on the side of the panel.
3 Release the claws of the three spring clips from the top of the driver's kick panel (locations shown by arrows).
4 Remove the driver's kick panel from the dash.

◆Installation procedure◆

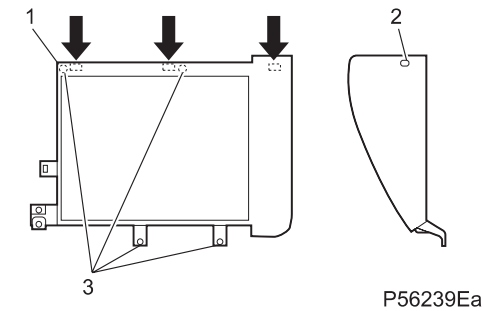


P58239Ea

1. Quick-release fastener
2. Spring clip

■ Installation: Driver's kick panel

1. Position the driver's kick panel on the lower dash, as removed.
2. Fasten the three spring clips (locations shown by arrows) at the top of the driver's kick panel. Make sure the claws engage.
3. Install one quick-release fastener at the bottom of the driver's kick panel and two more on the side of the panel. Press in the center button to lock the fasteners.
4. Install the switches in the driver's kick panel, as removed. Connect the electrical connectors behind the panel.
5. Tug gently on the driver's kick panel to make sure it is securely in place.

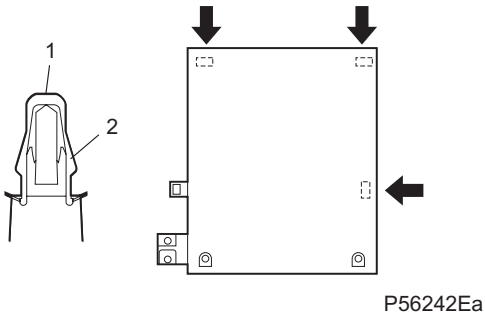


P56239Ea

1. Spring clip
2. Quick-release fastener
3. Screws

■ Installation: Map compartment

1. Position the map compartment on the lower dash, as removed.
2. Fasten the three spring clips (locations shown by arrows) at the top of the map compartment. Make sure the claws engage.
3. Install the the two screws on the brackets at the top of the map compartment and tighten until firm.
4. Install the the two screws on the brackets at the bottom of the map compartment and tighten until firm.
5. Install one quick-release fastener on the side panel of the map compartment, as removed. Press in the center button to lock the fastener.
6. Tug gently on the driver's kick panel to make sure it is securely in place.

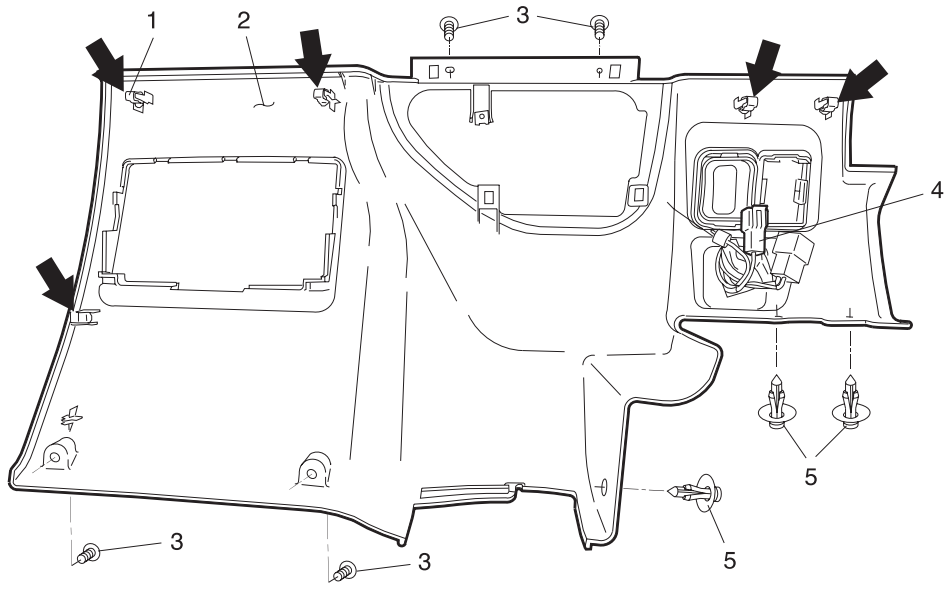


P56242Ea

1. Spring clip
2. Claw of spring clip

■ Installation: Passenger's kick panel

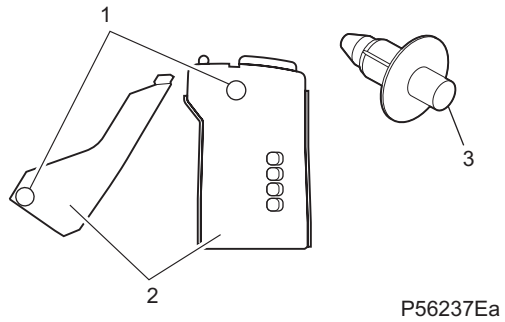
1. Position the passenger's kick panel on the dash.
2. Fasten the spring clips on the passenger's kick panel (locations shown by arrows) into the dash. Make sure the claws engage.
3. Install the two screws at the bottom of the passenger's kick panel and tighten them until firm.



1. Spring clip
2. Lower center panel
3. Screw(s)
4. Electrical connectors (engine idle control)
5. Quick-release fastener

■ **Installation: Lower center panel**

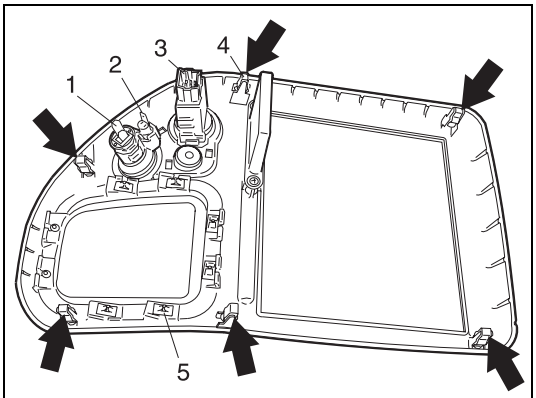
1 Before installing the lower center panel, connect the two electrical connectors for the engine idle control.
2 Fasten the five spring clips (shown by arrows) at the top and side of the lower center panel.
3 Install the four screws on the lower center panel and tighten until firm.
4 Install three quick-release fasteners on lower center panel, as removed. Press in the center button to lock the fasteners.



1. Quick-release fastener
2. Shift lever cover
3. Center button (released)

■ **Installation: Shift lever cover**

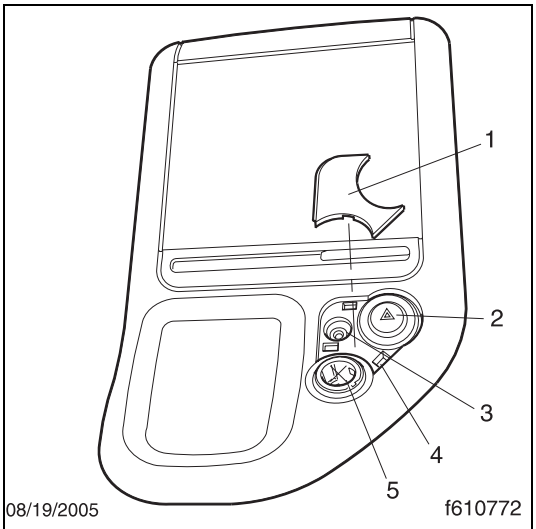
1 Position the shift lever cover on the dash, as removed.
2 Install the three quick-release fasteners on the shift lever cover. Press in the center button to lock the fasteners.



1. Cigarette lighter power
2. Cigarette lighter GND
3. Hazard flasher connector
4. Spring clip
5. Speed nut

■ Installation: Upper center panel

1 Connect the three electrical connectors behind the upper center panel (two for the cigarette lighter, one for the hazard flasher).
2 Position the upper center panel on the dash, as removed.
3 Attach the speed nuts and fasten the spring clips (shown by arrows).
4 Install the cigarette lighter socket and socket retainer on the upper center panel.

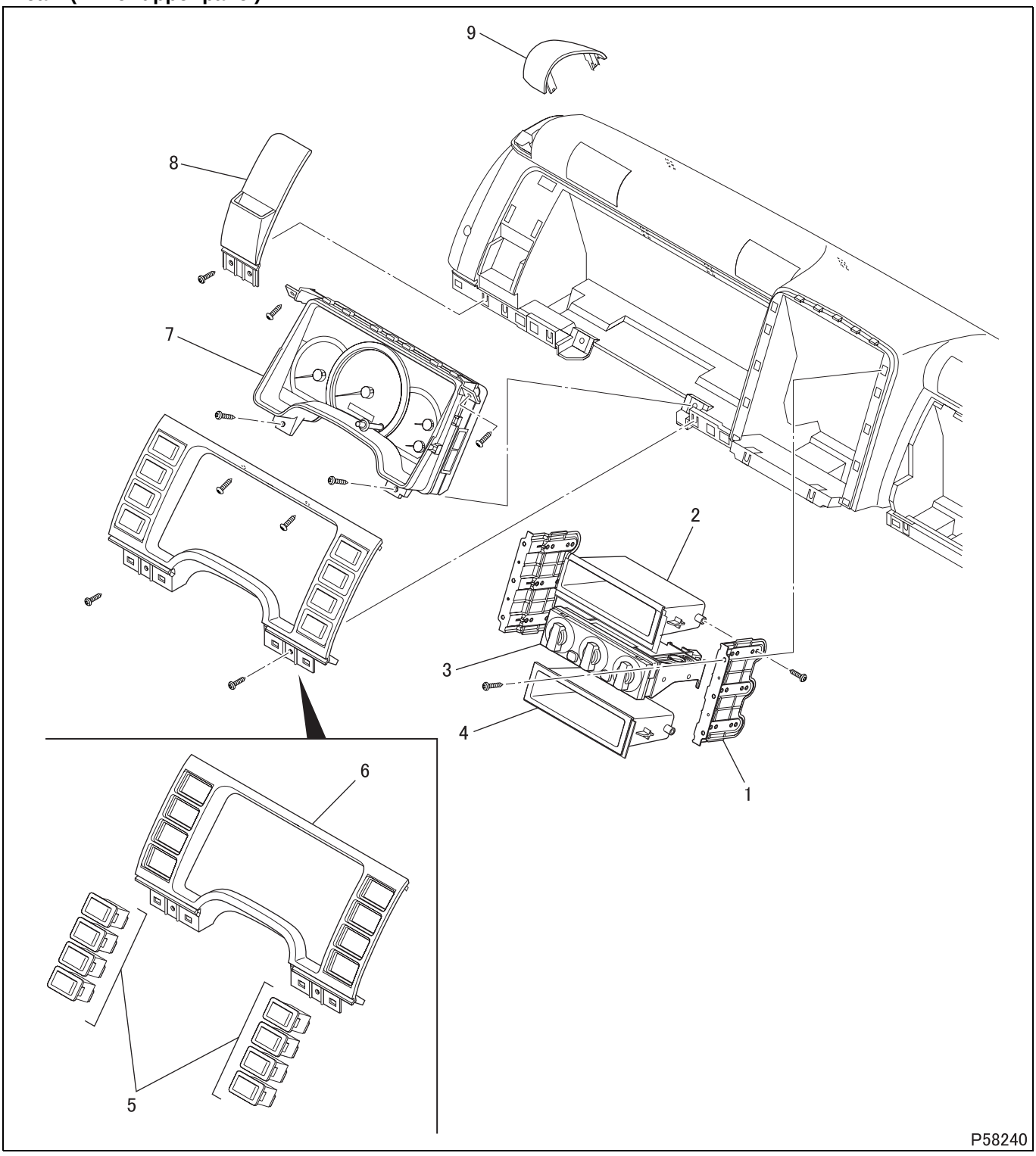


1. Panel cover
2. Hazard flasher
3. Fastener hole
4. Insert for panel cover
5. Cigarette lighter element

■ Installation: Panel cover

1 Install the screw behind the panel cover.
2 Install the panel cover. Make sure the prongs are firmly attached to the upper center panel.
3 Install the cigarette lighter element.

Area 2 (Driver upper panel)



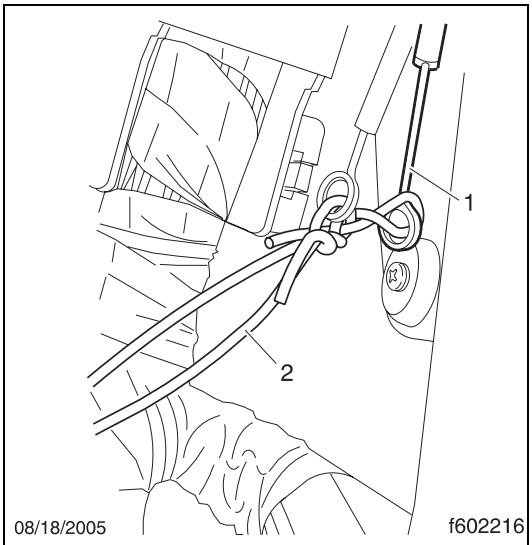
● Removal sequence

1 Radio bracket
2 Radio case
3 Climate control panel
4 Box for optional accessory
5 Switch or plug
6 Instrument cluster bezel
7 Instrument cluster
8 Accessory box lid
9 Cover (Brake fluid reservoir)

● Installation sequence

Follow the removal sequence in reverse.

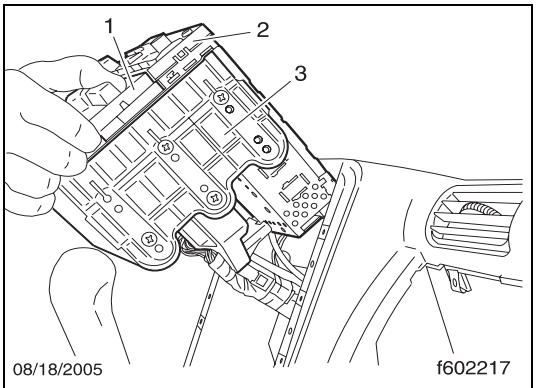
◆Removal procedure◆



1. Climate control cable
2. Guide wire

■Removal: Climate control cables

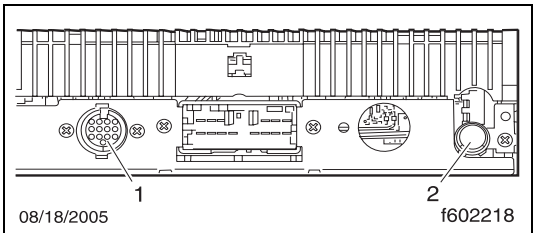
1. Chock the tires, set the parking brake, and shift the transmission into N (neutral). Disconnect the batteries.
2. From underneath the dash, disconnect the two climate control cables (white and black). Mark the installion locations of the climate control cables, and install guide wires to the ends of the cables as shown in the illustration.
3. Remove the upper center panel.
   3.1 Pry off the panel cover. The prongs release with light pressure.
   3.2 Remove the screw behind the panel cover.
   3.3 Pry out the upper center panel, held on by speed clips.
   3.4 Disconnect the three electrical connectors behind the upper center panel (two for the cigarette lighter, one for the hazard flasher).



1. Climate control panel
2. Radio
3. Radio bracket

■Removal: Radio bracket

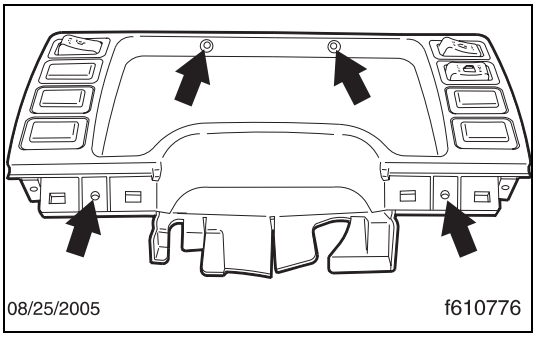
1. Remove the six screws, three on each side, that attach the face of the radio bracket to the upper dash panel.
2. Remove the two screws, one on each side, that attach the radio to the radio bracket (as shown). Be careful not to pull the radio out so far that the climate control cables and their guide wires get completely removed from the dash.



1. Power Supply Connector
2. Antenna Connector

■Removal: Radio connectors

1. Disconnect the antenna and power supply connectors from the back of the radio, as shown.
2. Remove the radio from the radio bracket.

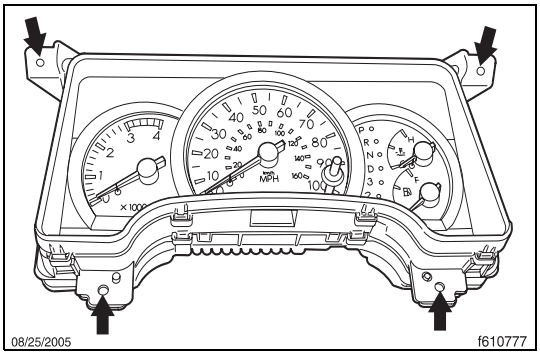


■ **Removal: Instrument cluster bezel**

NOTE

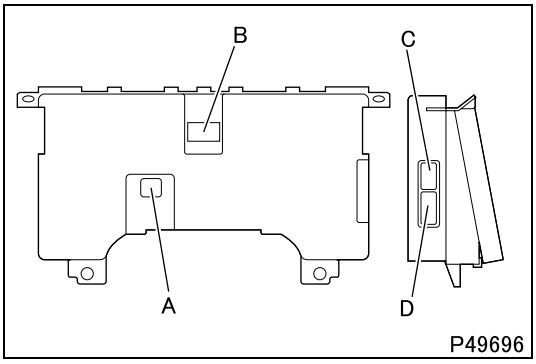
- **Before doing these procedures, make sure that the following panels are removed (see area 1 for procedures): upper center panel, lower center panel, driver's kick panel.**

1. Remove the four screws (arrows) that attach the instrument cluster bezel to the instrument panel.
2. Remove the instrument cluster bezel from the instrument panel.



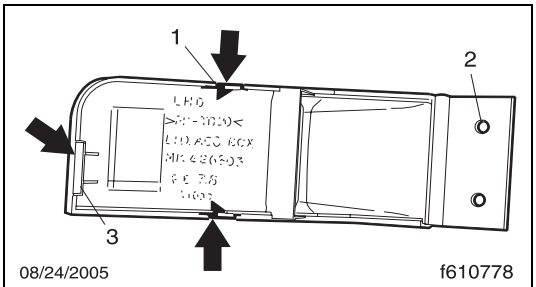
■ **Removal: Instrument cluster**

1. Remove the four screws (arrows) that attach the instrument cluster to the instrument panel.
2. Pull the instrument cluster away from the instrument panel to gain access to the connectors on the back and side of the cluster.



■ **Removal: Instrument cluster connectors**

1. Disconnect the cab harness connectors **A** and **B** from the rear panel of the instrument cluster, and disconnect connectors **C** and **D** from the side panel of the instrument cluster, as shown.
2. Remove the instrument cluster from the vehicle.

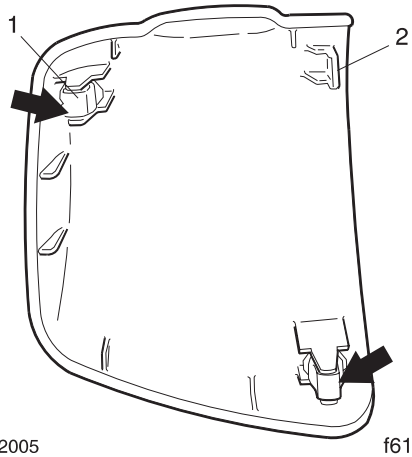


Release the prongs (arrows).

1. Single-prong fastener
2. Screw hole
3. Double-prong fastener

■ **Removal: Accessory box lid**

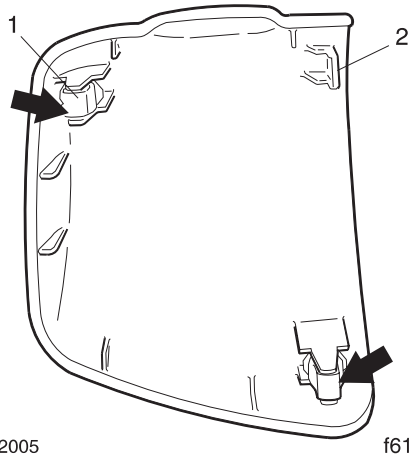
1. Remove the two screws that attach the lower end of the accessory box lid to the instrument panel.
2. Release the two single-prong fasteners on the sides of the accessory box lid.
3. Release the double-prong fastener on the upper end of the accessory box lid.



Release the speed clips (arrows).

1. Speed clip
2. Tab

◆Installation procedure◆



Tug gently on the cover to make sure the speed clips (arrows) are engaged.

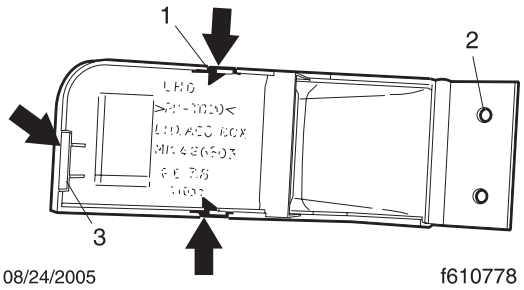
1. Speed clip
2. Tab

■ Removal: Cover (brake fluid reservoir)

1. Release the tab at the right front of the cover.
2. Release the two speed clips and remove the cover from the instrument panel.

■ Installation: Cover (brake fluid reservoir)

1. Insert the tab at the right front of the cover into the slot in the instrument panel.
2. Connect the two speed clips on the cover to the corresponding slots in the instrument panel. Tug gently on the cover to make sure that the speed clips are engaged.



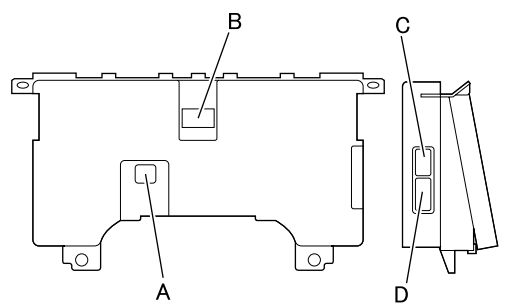
08/24/2005 f610778

Make sure the prongs (arrows) lock into the slots in the instrument panel.

1. Single-prong fastener
2. Screw hole
3. Double-prong fastener

■ Installation: Accessory box lid

1. Insert the prongs on the back of the accessory box lid into the slots in the instrument panel.
2. Install the two screws that attach the accessory box lid to the instrument panel and tighten until firm.



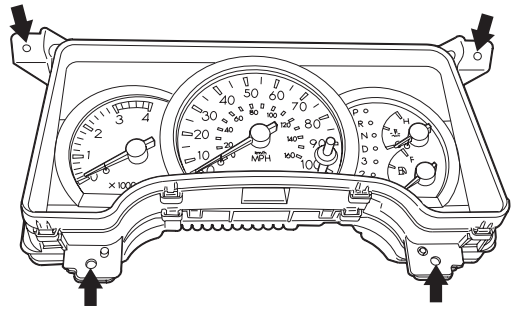
P49696

■ Installation: Instrument cluster connectors

1. Connect the cab harness connectors **A** and **B** to the rear panel of the instrument cluster, as shown.
2. Connect the cab harness connectors **C** and **D** to the side panel of the instrument cluster, as shown.

Number of pins on connector

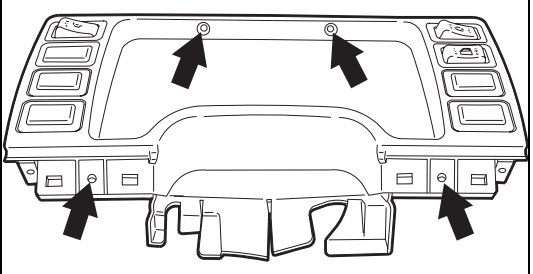
A	B	C	D
10	20	18	22



08/25/2005 f610777

■ Installation: Instrument cluster

1. Place the instrument cluster, with connectors attached, into the instrument panel and align the screw holes.
2. Install the four screws (arrows) that attach the instrument cluster to the instrument panel. Tighten the screws until firm.



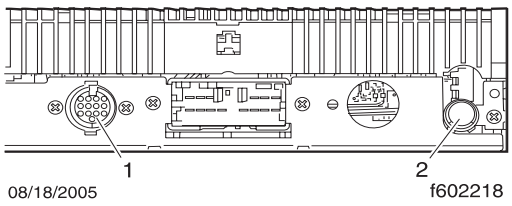
08/25/2005 f610776

■ Installation: Instrument cluster bezel

1. Place the instrument cluster bezel over the instrument cluster and align the screw holes.
2. Install the four screws (arrows) that attach the instrument cluster bezel to the instrument cluster. Tighten the screws until firm.

NOTE

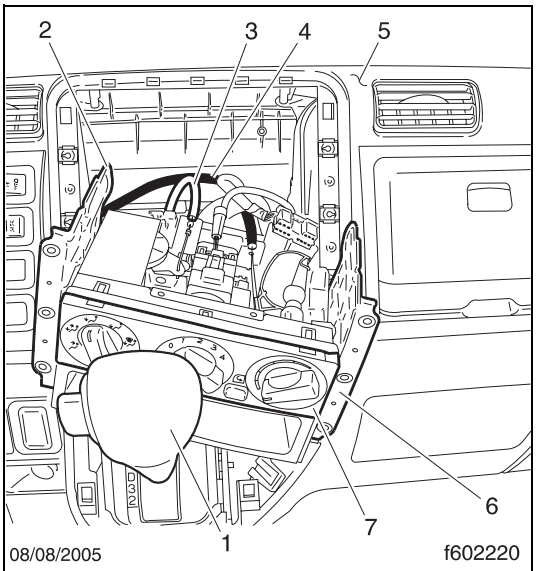
- **Install the upper and lower center panels and the driver's kick panel. See area 1 for procedures.**



1. Power Supply Connector
2. Antenna Connector

■Installation: Radio connectors

1. Install the radio in the radio case. Connect the power supply and antenna connectors.
2. Tighten the radio mounting screws until firm.



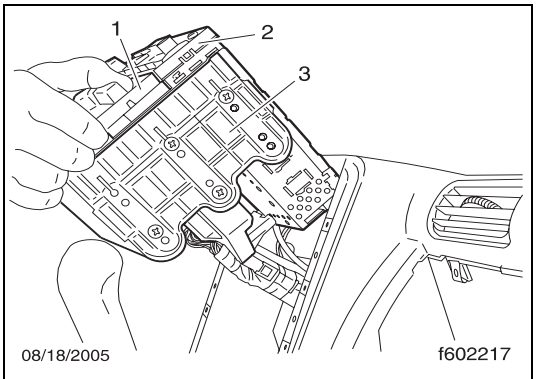
1. Shift Lever
2. Radio Bracket, L/H Side
3. White Climate Control Cable
4. Black Climate Control Cable
5. Instrument Panel
6. Radio Bracket, R/H Side
7. Climate Control Panel

■Installation: Climate control cables

NOTE

- **Two persons are needed for this step.**

1. One person guides the radio bracket/climate control assembly into the hole in the instrument panel. The other person pulls on the guide wires to bring the climate control cables through.
2. Hold the guide wires in place until the radio bracket is installed.



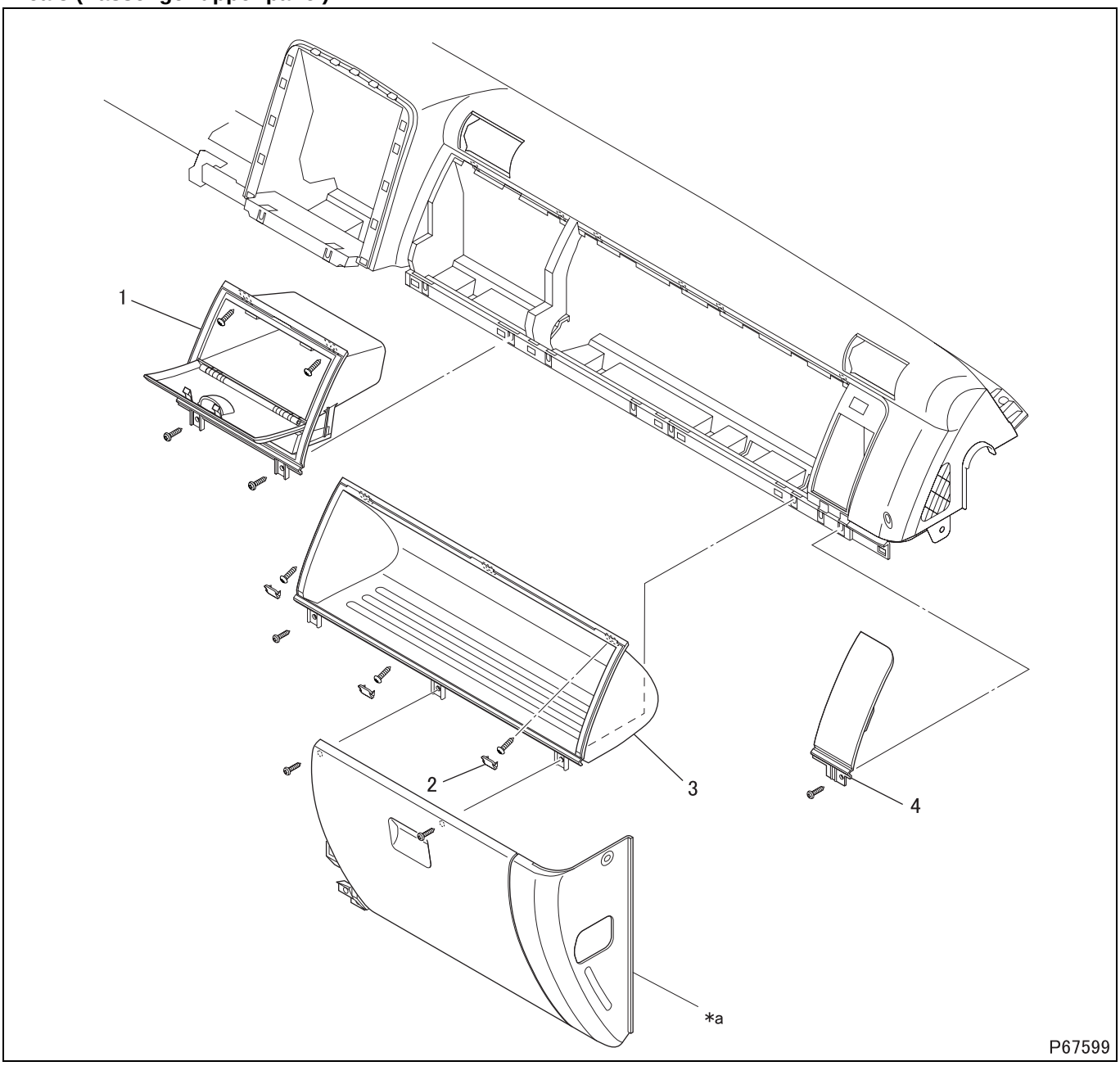
1. Climate Control Panel
2. Radio
3. Radio Bracket

■Installation: Radio bracket

1. Attach the face of the radio bracket to the upper dash panel. Tighten the radio bracket mounting screws until firm.
2. Remove the guide wires and connect the climate control cables, as removed.
3. Install the upper center panel.
   3.1 Connect the three electrical connectors behind the upper center panel (two for the cigarette lighter, one for the hazard flasher).
   3.2 Position the upper panel cover on the instrument panel. Make sure the speed clips engage.
   3.3 Install the screw next to the hazard flasher.
   3.4 Snap on the panel cover. Make sure the prongs all engage in the slots provided.
4. Shift the transmission into P (park). Connect the batteries and remove the chocks from the tires.

M E M O

Area 3 (Passenger upper panel)



● **Removal sequence**

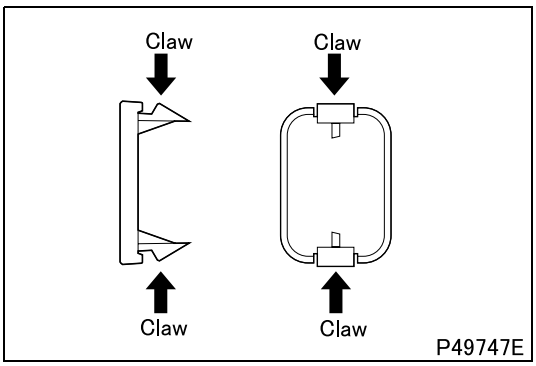
1 Glove box
2 Plug
3 Parcel tray
4 Relay inspection cover

***a**: Map compartment

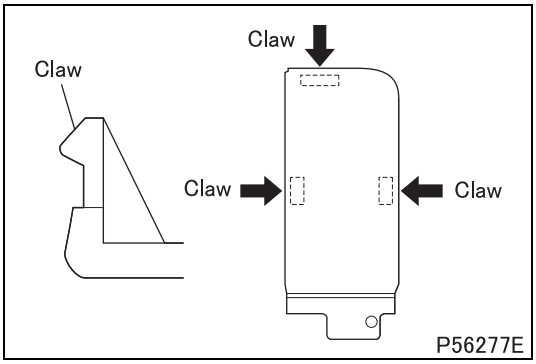
● **Installation sequence**

Follow the removal sequence in reverse.

◆Removal procedure◆

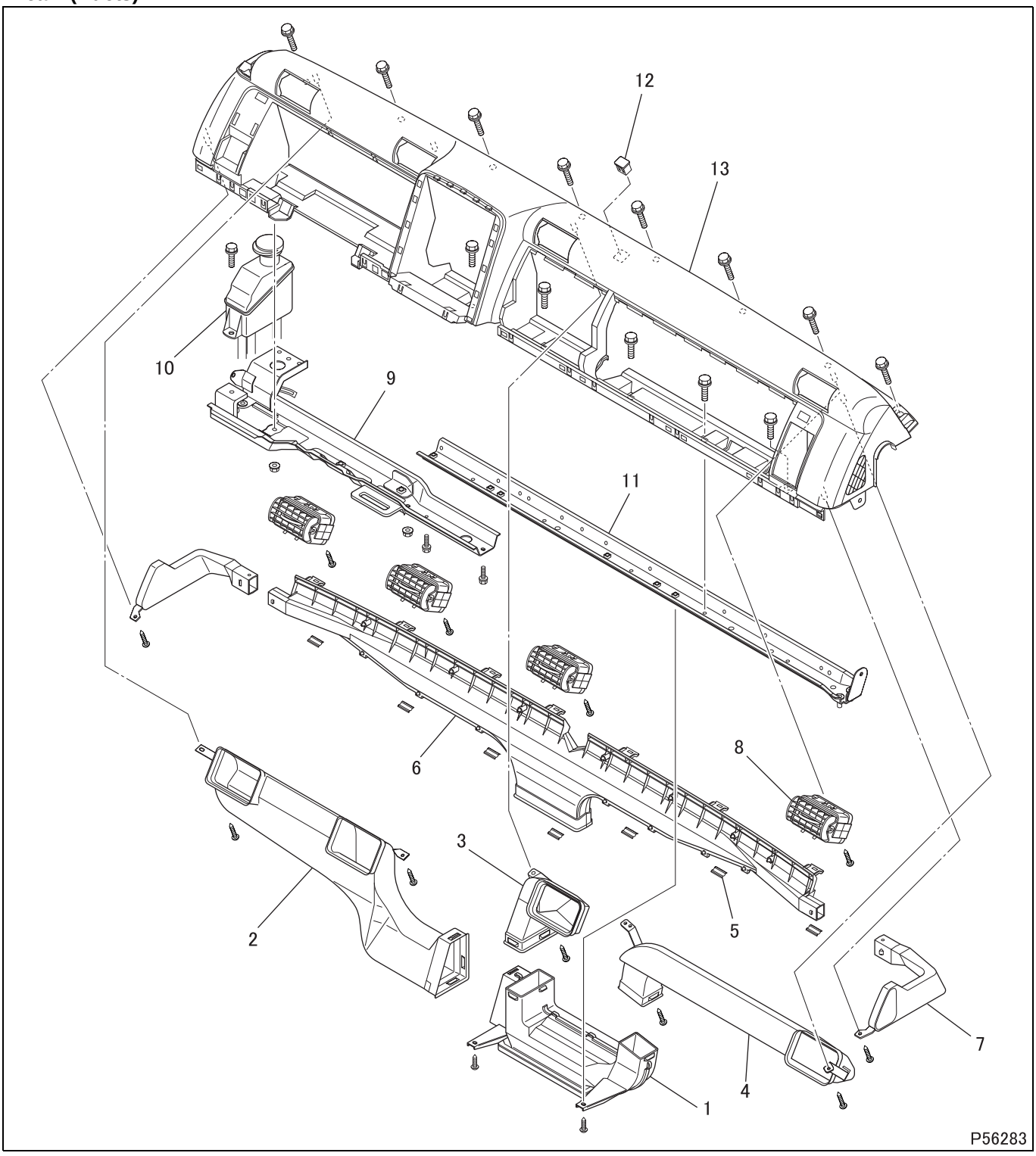


■ Removal: Plug



■ Removal: Relay inspection cover

Area 4 (Ducts)



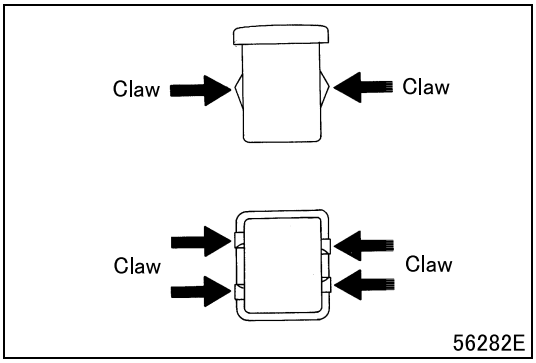
● **Removal sequence**

1 Center duct
2 Driver face duct
3 Center face duct
4 Passenger face duct
5 Clip (× 7)
6 Front defroster duct
7 Side defroster duct
8 Air outlet grille
9 Driver instrument panel frame
10 Brake fluid tank
11 Passenger instrument panel frame
12 Plug
13 Instrument panel

● Installation sequence

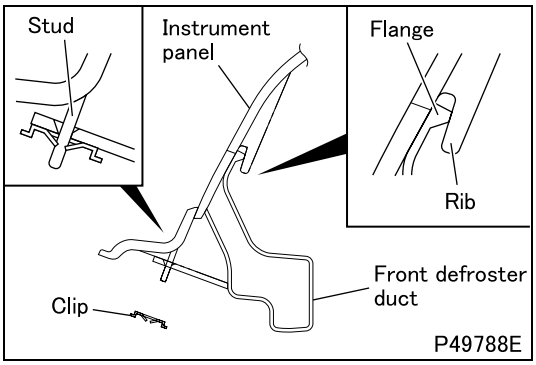
Follow the removal sequence in reverse.

◆Removal procedure◆



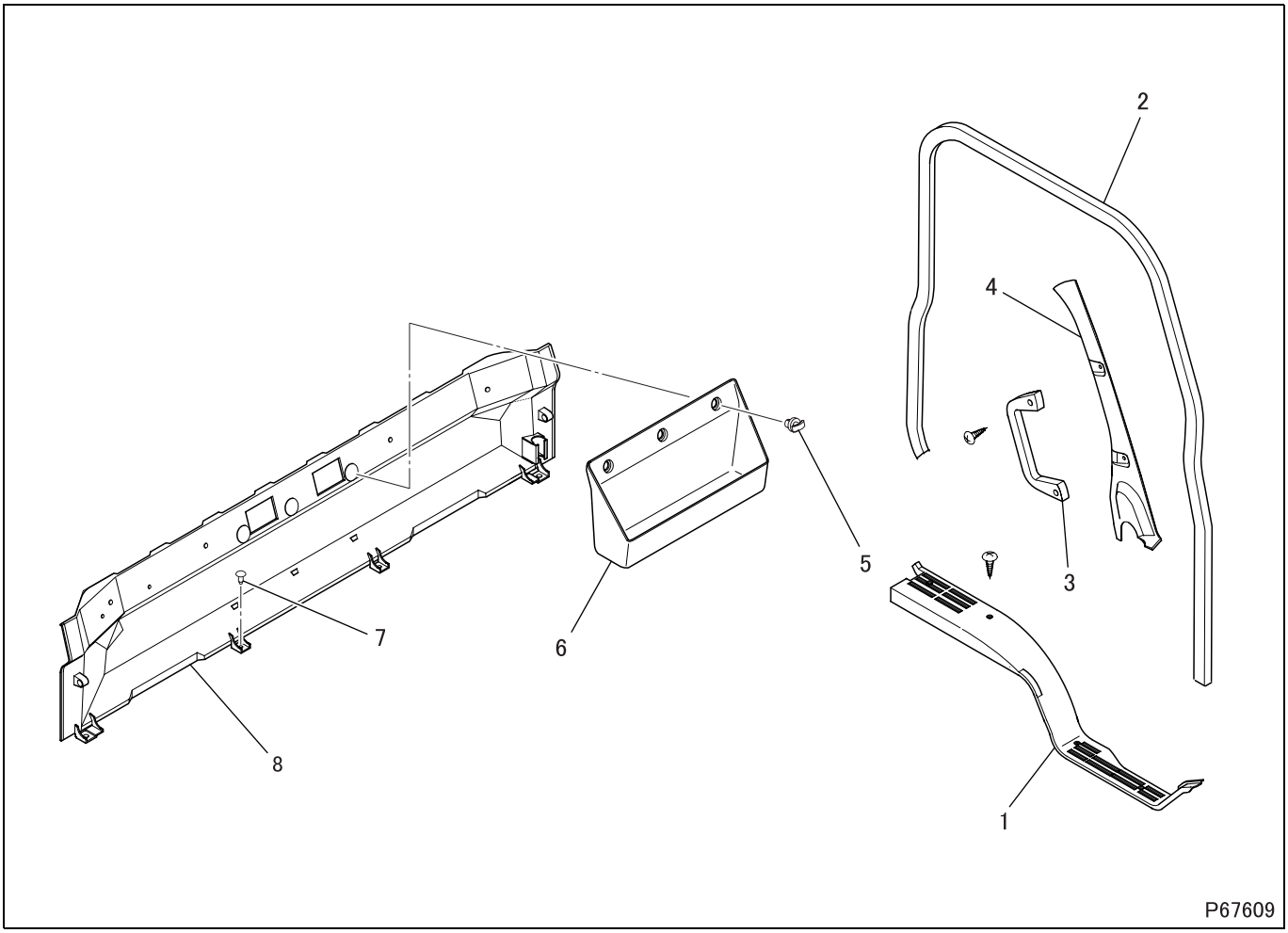
■ **Removal: Plug**

◆Installation procedure◆



■ **Installation: Front defroster duct**

- Insert the front defroster duct flanges into the instrument panel ribs.
- Insert the instrument panel studs into the front defroster duct holes and clip them together.



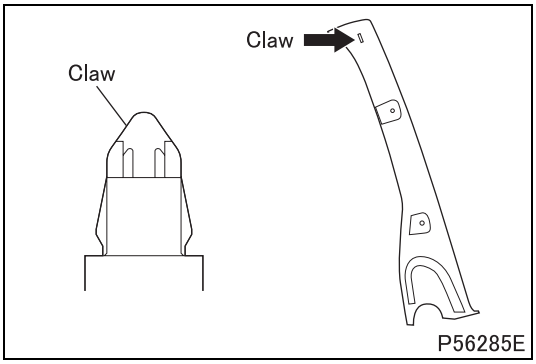
● **Removal sequence**

1 Scuff plate
2 Weatherstrip
3 Grip
4 Front pillar trim
5 Hook (× 3)
6 Back panel tray
7 Clip
8 Lower rear trim

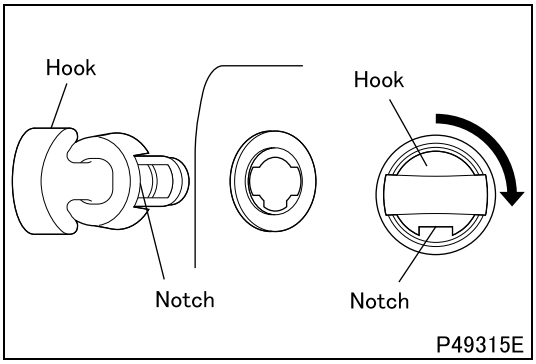
● **Installation sequence**

Follow the removal sequence in reverse.

◆**Removal procedure**◆



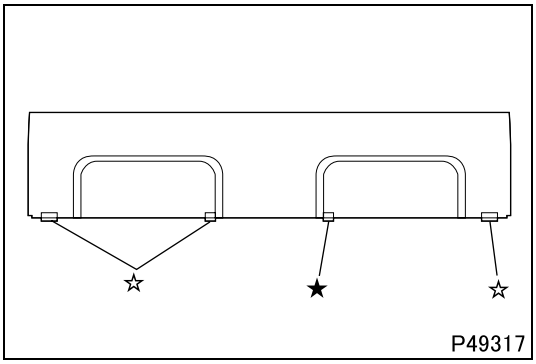
■ **Removal: Front pillar trim**



■ **Removal: Hook**

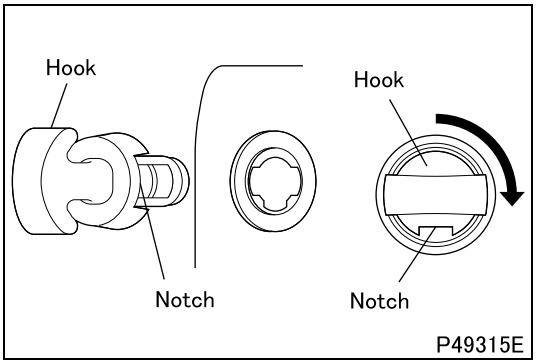
- Turn the hook 90° to disengage it.

◆Installation procedure◆



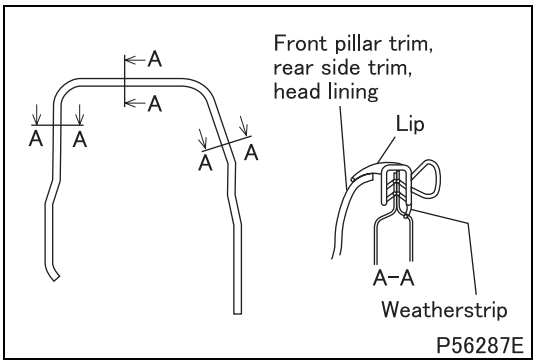
■ **Installation: Lower rear trim**

- Locate the lower rear trim correctly in position by installing a clip into the hole ★.
- Install 3 clips into the holes ☆ to completely fix the lower rear trim in position.



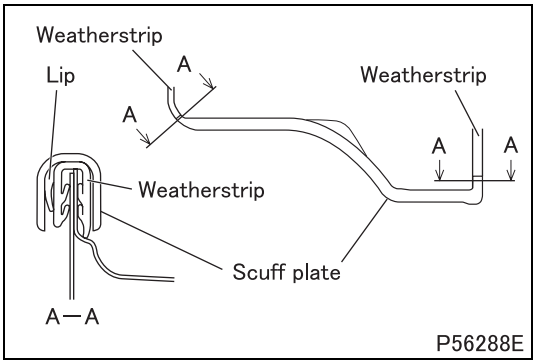
■ **Installation: Hook**

- With the notch facing in the illustrated direction, insert the hook into the lower rear trim.
- To engage the hook, turn it 90° until the notch faces downwards.



■ **Installation: Weatherstrip**

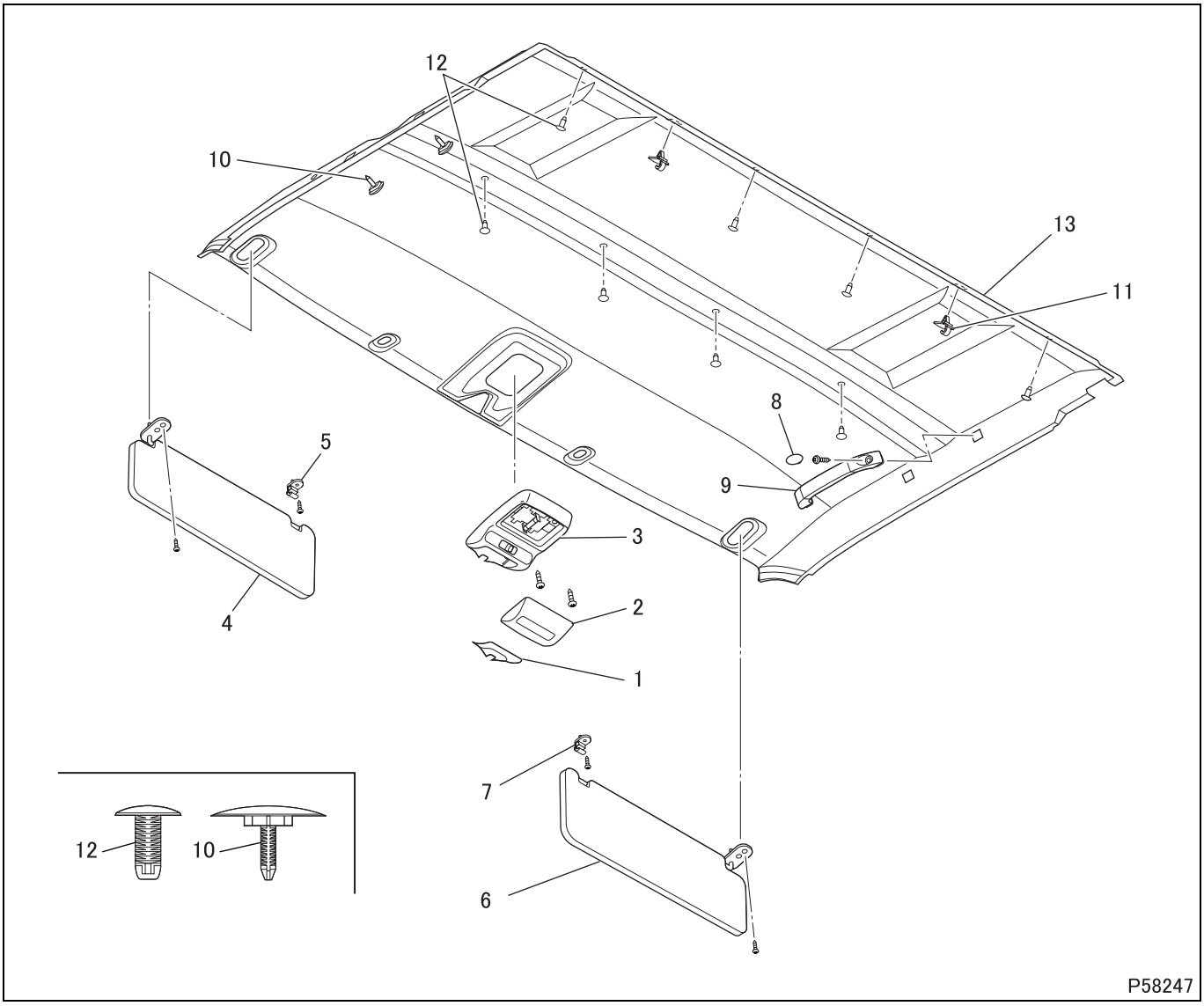
- Install the weatherstrip in such a manner that the lip of the strip holds down the front pillar trim, rear side trim, and head lining.



■ **Installation: Scuff plate**

- Install the scuff plate in such a manner that it holds down the lip of the weatherstrip.

HEAD LINING



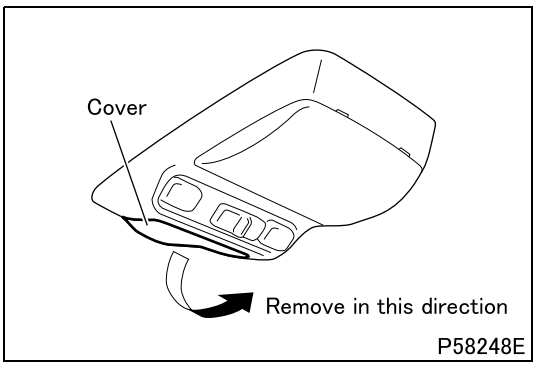
● **Removal sequence**

1 Cover
2 Lens
3 Room lamp
4 Sun visor (left-hand)
5 Sun visor hook
6 Sun visor (right-hand)
7 Sun visor hook
8 Cap
9 Grip
10 Plug
11 Coat hanger
12 Clip (× 8)
13 Head lining

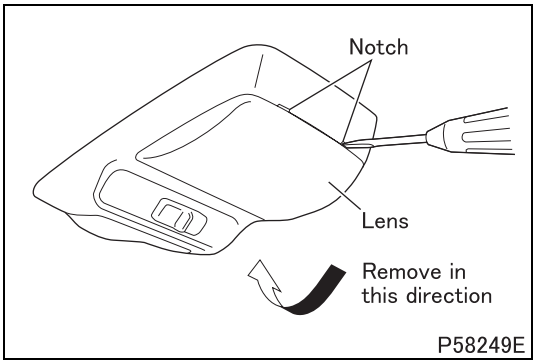
● **Installation sequence**

Follow the removal sequence in reverse.

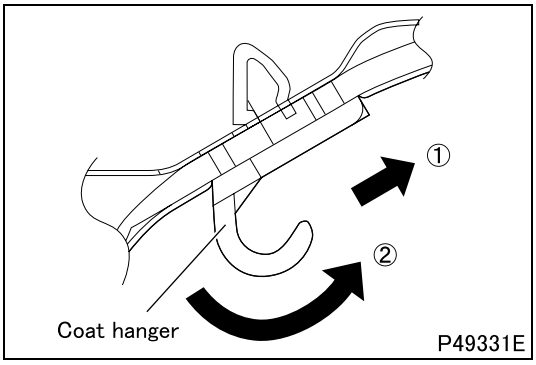
◆Removal procedure◆



■ **Removal: Cover**



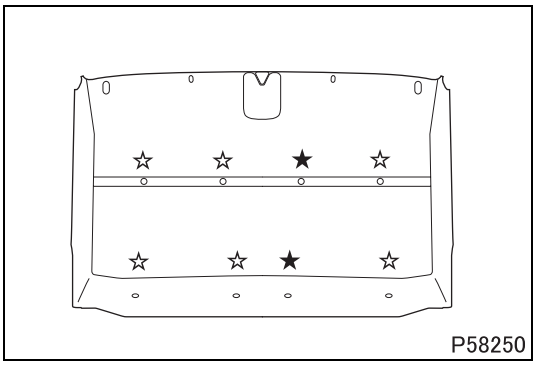
■ **Removal: Lens**



■ **Removal: Coat hanger**

- Remove the coat hanger from the head lining by pulling it in the direction of “2” while pressing it in the direction of “1”.

◆Installation procedure◆



■ **Installation: Head lining**

- Locate the head lining correctly onto the cab by installing clips at the locations ★ (× 2). Install clips at the locations ☆ (× 6).

GROUP 54 INDEX

HOW TO READ THIS GROUP 1

54-00A GENERAL

PRECAUTIONS FOR MAINTENANCE OPERATION 54-00A-2

54-00B SPECIFICATIONS

SPECIFICATIONS..... 54-00B-2

54-00C STRUCTURE AND OPERATION

1. Starter 54-00C-2
2. Alternator..... 54-00C-3
3. Headlamps..... 54-00C-6
4. Meter Cluster..... 54-00C-7
5. Daytime Running Light System..... 54-00C-14
6. Wiper Control 54-00C-16
7. Starter Continuous Energizing Preventing Function and Preheating Function..... 54-00C-18

54-00D TROUBLESHOOTING

TROUBLESHOOTING 54-00D-2

54-01 POWER, CHARGE AND GROUND CIRCUIT

HIGH-CURRENT FUSE BOX..... 54-01-2

FUSE BOX 54-01-4

(110) POWER CIRCUIT 54-01-6

(115) RESERVE POWER CIRCUIT 54-01-16

(125) BATTERY CHARGING CIRCUIT..... 54-01-17

(130) GROUND..... 54-01-18

54-02 STARTING CIRCUIT

(210) ENGINE STARTING CIRCUIT..... 54-02-2

(215) ENGINE STOPPING CIRCUIT.....(See Gr13E)

(220) ENGINE PREHEATING CIRCUIT . 54-02-4

54-03 LIGHTING CIRCUIT

(310) HEADLAMP CIRCUIT 54-03-2

(313) DAYTIME RUNNING LIGHT CIRCUIT..... 54-03-4

(320) TAIL, CLEARANCE AND LICENSE PLATE LAMPS CIRCUIT 54-03-6

(325) STOP LAMP CIRCUIT..... 54-03-7

(330) TURN SIGNAL AND HAZARD LAMP CIRCUIT..... 54-03-8

(340) BACKUP LAMP CIRCUIT 54-03-10

(345) CAB LAMP CIRCUIT..... 54-03-12

(348) ILLUMINATION LAMP CIRCUIT..... 54-03-13

(349) IDENTIFICATION LAMP AND SIDE MARKER LAMP CIRCUIT..... 54-03-14

(352) VAN BODY DOME LIGHT CIRCUIT..... 54-03-15

54-04 METER CIRCUIT

(401) METER CLUSTER INTERNAL CIRCUIT..... 54-04-2

(410) TACHOMETER CIRCUIT .....(See Gr13E)

(412) SPEEDOMETER CIRCUIT 54-04-4

(420) FUEL GAUGE CIRCUIT 54-04-5

(425) WATER TEMPERATURE GAUGE CIRCUIT..... 54-04-6

54-05 INDICATOR AND WARNING LAMP CIRCUIT

(510) PARKING BRAKE INDICATOR CIRCUIT 54-05-2
(515) BRAKE WARNING CIRCUIT..... 54-05-4
(535) ENGINE OIL LEVEL WARNING CIRCUIT 54-05-6
(536) ENGINE OIL PRESSURE WARNING CIRCUIT 54-05-7
(537) OVERHEATING WARNING CIRCUIT 54-05-8
(540) BRAKE PAD WARNING CIRCUIT 54-05-9
(550) CAB TILT WARNING CIRCUIT ... 54-05-10
(566) FUEL FILTER WARNING CIRCUIT 54-05-11

54-06 CAB SIDE ELECTRICAL CIRCUIT

(610) CIGARETTE LIGHTER CIRCUIT .. 54-06-2
(612) AUDIO CIRCUIT 54-06-3
(614) WIPER AND WASHER CIRCUIT 54-06-4
(616) HORN CIRCUIT 54-06-5
(620) AIR-CONDITIONER CIRCUIT 54-06-6
(622) POWER WINDOW AND CENTRAL DOOR LOCK CIRCUIT 54-06-8
(629) MIRROR HEATER CIRCUIT..... 54-06-9

54-07 CHASSIS SIDE ELECTRICAL CIRCUIT

(710) EXHAUST BRAKE CIRCUIT 54-07-2

54-08 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

(850) TRANSMISSION POWER TAKE-OFF CIRCUIT..... 54-08-2

54-09 OTHER CIRCUIT

(905) JOINT CONNECTOR (J/C)..... 54-09-2
(907) DIAGNOSIS SWITCH AND MEMORY CLEAR SWITCH..... 54-09-7
COMMON RAIL SYSTEM ELECTRIC CIRCUIT DIAGRAM .....(See Gr13E)
EXHAUST GAS RECIRCULATION ELECTRIC CIRCUIT DIAGRAM ..... (See Gr17)
AUTOMATIC TRANSMISSION SYSTEM ELECTRIC CIRCUIT DIAGRAM ..... (See Gr23)
ANTI-LOCK BRAKE SYSTEM ELECTRIC CIRCUIT DIAGRAM .....(See Gr35E)

54-10 ELECTRICAL EQUIPMENT INSTALLATION POSITIONS

Cab side

[A] SWITCH 54-10-2
[B] RELAY AND ELECTRONIC CONTROL UNIT 54-10-5
[C] FUSE, METER, SENSOR, BUZZER, MOTOR AND ACTUATOR..... 54-10-6
[D] AIR-CONDITIONER <OPTION>..... 54-10-7
[E] DOOR 54-10-8
[F] ROOF..... 54-10-9
[J] JOINTS OF MAIN HARNESS CONNECTORS..... 54-10-10

Engine and transmission

[R] ENGINE 54-10-11
[S] TRANSMISSION..... 54-10-12

Chassis side

T SWITCH AND SENSOR 54-10-14
U FUSE, RELAY AND CONNECTORS.....54-10-15
V MAGNETIC VALVE AND MOTOR.. 54-10-17
W BUZZER AND CONNECTORS 54-10-17

54-11 INSPECTION OF ELECTRICAL EQUIPMENT

#001 to #179 SWITCH 54-11-2
#180 to #249 RELAY 54-11-8
#250 to #349 SENSOR 54-11-10
#350 to #409 CONTROL UNIT 54-11-11
#410 to #509 MOTOR 54-11-12
#510 to #539 ACTUATOR 54-11-13
#560 to #609 MAGNETIC VALVE 54-11-14
#610 to #649 BUZZER, HORN 54-11-15
#650 to #699 LAMP 54-11-17
#750 to #859 OTHER..... 54-11-18
#860 BATTERY..... 54-11-20
#890 METER 54-11-23

54-12 STARTER AND ALTERNATOR

#930 STARTER..... 54-12-2
#940 ALTERNATOR 54-12-16

54-13 ON-VEHICLE INSPECTION AND ADJUSTMENT

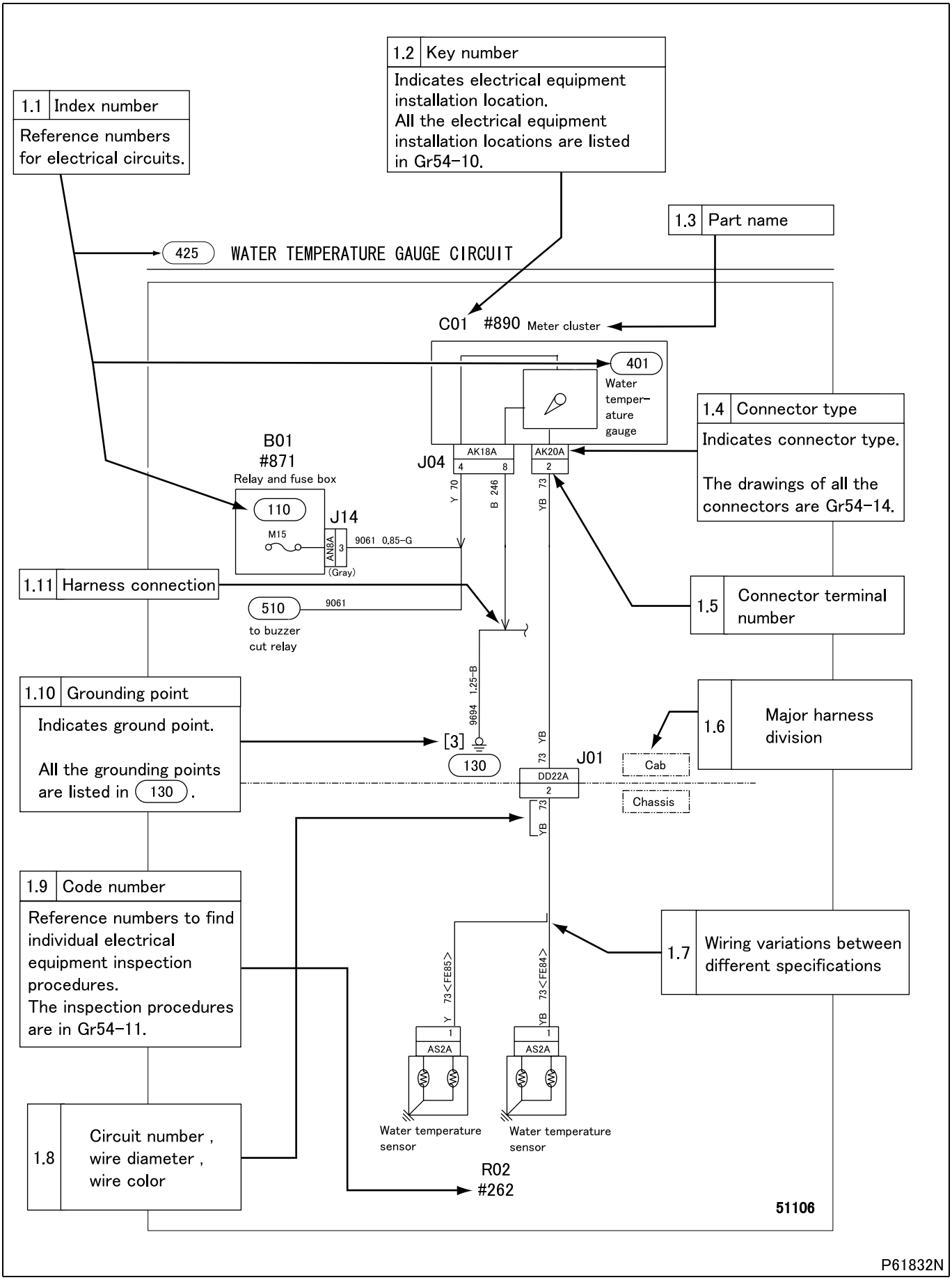
#950 INSPECTION OF ALTERNATOR .. 54-13-2
#951 INSPECTION OF REGULATOR 54-13-3
#955 INSPECTION OF PREHEATING SYSTEM..... 54-13-4
#956 INSPECTION OF STARTER CONTINUOUS ENERGIZING PREVENTING FUNCTION..... 54-13-8
#960 HEADLAMP AIMING 54-13-12

54-14 CONNECTOR CONFIGURATION CHART

CONNECTOR CONFIGURATION CHART 54-14-2

HOW TO READ THIS GROUP

HOW TO READ CIRCUITS (ELECTRICAL)



1.1 Index number: (100) to (999)

- Index numbers are used as reference numbers for electrical circuits. Each electrical circuit has been assigned its own index number.

1.2 Key number: A01 to Z99

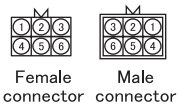
- Key numbers indicate parts installation locations. The installation location of a part can be easily found using its key number shown in a circuit diagram.
  All of the electrical equipment installation locations are listed in Gr54-10.

1.3 Part name

1.4 Connector type (type indication)

- A list of the connectors used is included in Gr54-14.

1.5 Connector terminal number



Connector terminal numbering starts with the upper left corner for female connectors and with the upper right corner for male connectors.

P50678E

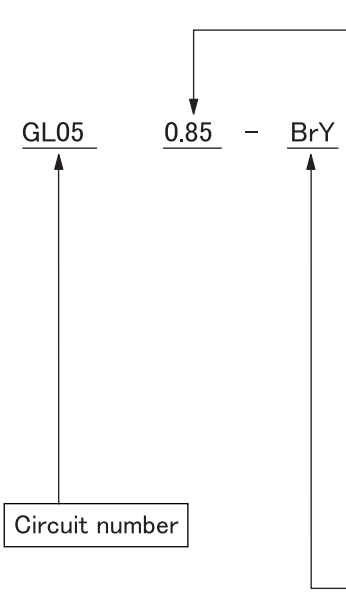
1.6 Major harness division

- Major harness divisions are shown.

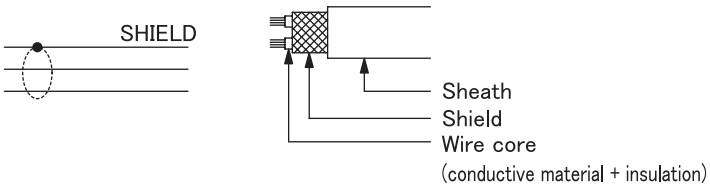
1.7 Wiring variations between different specifications

- Variations in wiring/circuit between different vehicle specifications are clearly indicated as shown.

1.8 Circuit number, wire diameter, wire color



"Wire diameter" represents the cross section of the wire's conductive material. For example, "0.85" corresponds to 0.85 mm^2. On the circuit diagrams, the unit "mm^2" is omitted. Wires with a conductive cross section of 0.5 mm^2 are shown without the wire diameter or unit. As indicated below, shielding wires are marked with "SHIELD," and shielded wires are circled by a dotted line.



On the circuit drawings, twisted wires are indicated as shown below.

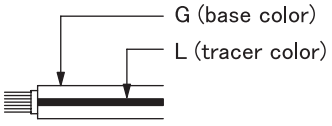
Wire colors are represented by the first letter of the color.
Colors that all start with the letter "B" are indicated as follows.

- BLACK → B
- BLUE → L
- BROWN → Br

Wires that have both base and tracer colors are indicated by two letters.

RY (Yellow tracer on Red base)

GL (Blue tracer on Green base)



P50680E

1.9 Code number: #001 to #999

- Code numbers are reference numbers to find individual electrical equipment inspection procedures. The inspection procedure for a electrical equipment can be found using its code number shown in a circuit diagram.

HOW TO READ THIS GROUP

1.10 Grounding point: [1] to [99]

- Locations where wires are grounded to the vehicle. All of the grounding points are listed in (130).

1.11 Harness connection

- The arrow in the wiring diagram indicates where harnesses are connected, and NOT the flow of electricity.

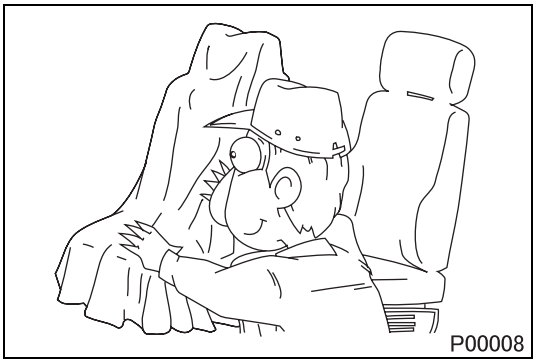
Wire color

Wire color		Base color + tracer											
B	Black	BW	Black/ white	BY	Black/ yellow	BR	Black/red	BG	Black/ green	BL	Black/ blue		
Br	Brown	BrW	Brown/ white	BrB	Brown/ black	BrY	Brown/ yellow	BrR	Brown/ red	BrG	Brown/ green		
G	Green	GW	Green/ white	GR	Green/ red	GY	Green/ yellow	GB	Green/ black	GL	Green/ blue	GO	Green/ orange
Gr Gy	Gray	GrL GyL	Gray/ blue	GrR GyR	Gray/ red								
L	Blue	LW	Blue/ white	LR	Blue/red	LY	Blue/ yellow	LB	Blue/ black	LO	Blue/ orange	LG	Blue/ green
Lg	Light green	LgR	Light green/ red	LgY	Light green/ yellow	LgB	Light green/ black	LgW	Light green/ white				
O	Orange	OL	Orange/ blue	OB	Orange/ black	OG	Orange/ green						
P	Pink	PB	Pink/ black	PG	Pink/ green	PL	Pink/ blue	PN	Pink/ white				
Pu	Purple												
R	Red	RW	Red/ white	RB	Red/ black	RY	Red/ yellow	RG	Red/ green	RL	Red/blue	RO	Red/ orange
Sb	Sky blue												
V	Violet	VY	Violet/ yellow	VW	Violet/ white	VR	Violet/red	VG	Violet/ green				
W	White	WR	White/ red	WB	White/ black	WL	White/ blue	WG	White/ green	WO	White/ orange		
Y	Yellow	YR	Yellow/ red	YB	Yellow/ black	YG	Yellow/ green	YL	Yellow/ blue	YW	Yellow/ white	YO	Yellow/ orange
		YP	Yellow/ pink	YV	Yellow/ violet								

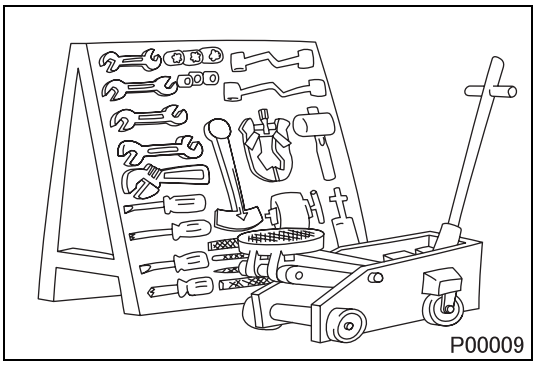
GROUP 54-00A GENERAL

PRECAUTIONS FOR MAINTENANCE OPERATION

- Before performing service operations, inquire into the customer's complaints and ascertain the condition by checking the total distance travelled, the conditions under which the vehicle is operated, and other relevant factors about the vehicle. And note the necessary information. This information will help you to service the vehicle efficiently.
- Check the location of the fault, and identify its cause. Based on your findings, determine whether parts must be removed or disassembled. Then, follow the service procedure given in this manual.


P00008

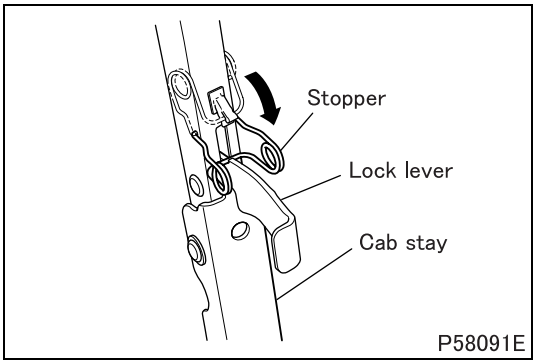
- Perform service operations on a level surface. Before starting, take the following preparatory steps:
  - To prevent soiling and damage, place covers over the seats, trim and floor in the cab and over the paintwork of the body.


P00009

- Prepare all the general and special tools necessary for the job.

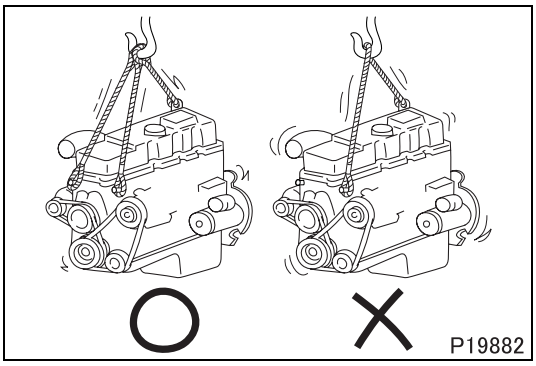
WARNING ⚠

- **Special tools must be used wherever specified in this manual. Do not attempt to use other tools since they could cause injuries and/or vehicle damage.**

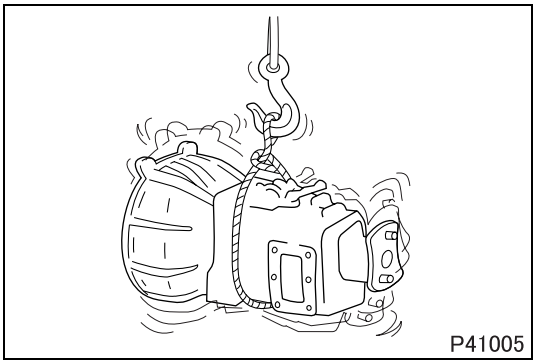


P58091E

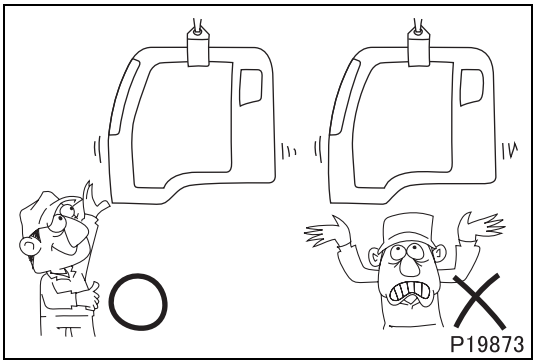
- After tilting the manual tilt type cab, be sure to engage the stopper with the lock lever to lock the cab stay securely.


P19882

- Take extreme care when removing/installing heavy items such as engine, transmission and axle. When lifting heavy items using a cable etc., observe the following precautions.
  - Identify the mass of the item being lifted. Use tha cable that is strong enough to support the mass.

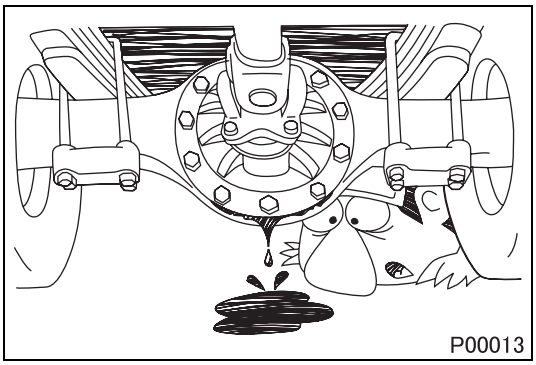


- If lifting eyes are not provided on the item being lifted, tie a cable around the item taking into account the item's center of gravity.

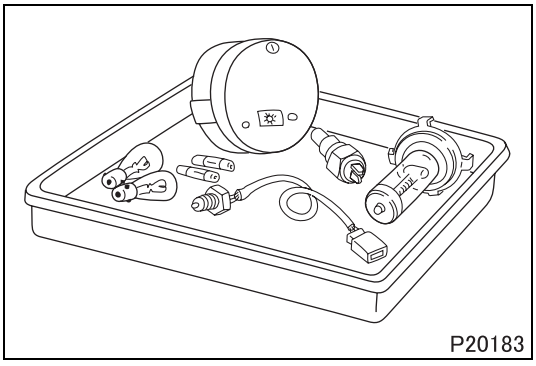


- Do not allow anyone to pass or stay under a lifted item which may possibly fall.

- Never work in shoes that have oily soles.
  When working with a partner or in a group, use pre-arranged signals and pay constant attention to safety. Be careful not to touch switches and levers unintentionally.

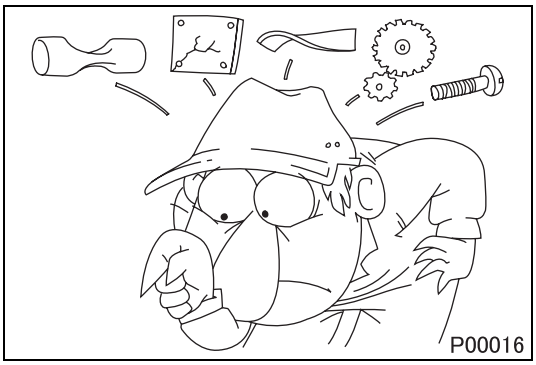


- Inspect for oil leakage etc. before washing the vehicle. If the order is reversed, any oil leakage or fault that may exist could go unnoticed during inspection.

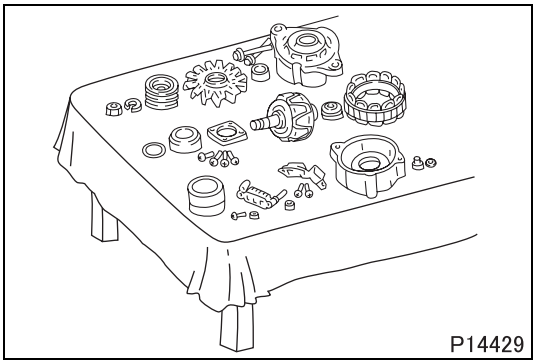


- Prepare replacement parts ready for installation.

- Oil seals, packings, O-rings and other rubber parts, gaskets, and split pins must be replaced with new ones after removal. Use only approved replacement parts.



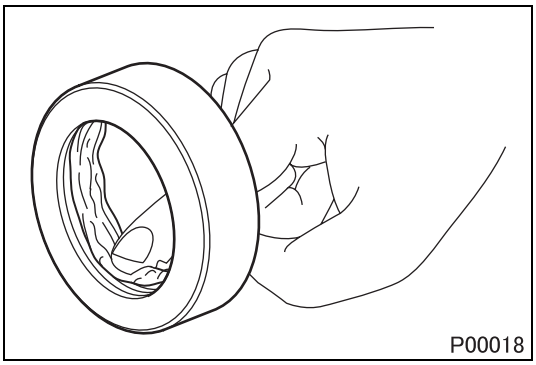
- When disassembling parts, visually check them for wear, cracks, damage, deformation, deterioration, rust, corrosion, defective rotation, fatigue, clogging and any other possible defect.



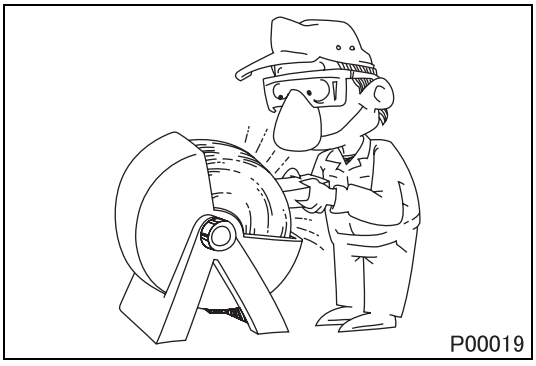
- To facilitate correct reassembly of parts, make alignment marks on them before disassembly and arrange disassembled parts neatly. Make punch marks and other alignment marks where they will not detract from parts' functionality and appearance.
- After removing parts from the vehicle, cover the area to keep it free of dust.

CAUTION ⚠

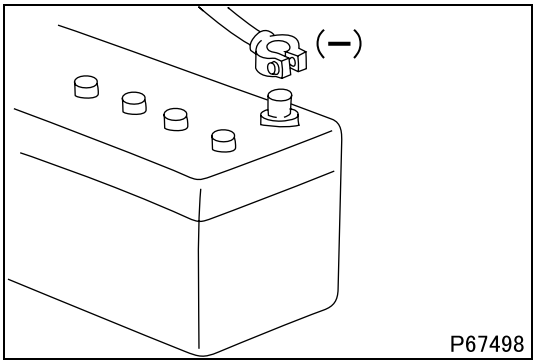
- **Be careful not to mix up identical parts, similar parts and parts that have left/right alignments.**
- **Keep new replacement parts and original (removed) parts separate.**



- Apply the specified oil or grease to U-seals, oil seals, dust seals and bearings before reassembly.
- Always use the specified oils and greases when performing inspection or replacement. Immediately wipe away any excess oil or grease with a rag.



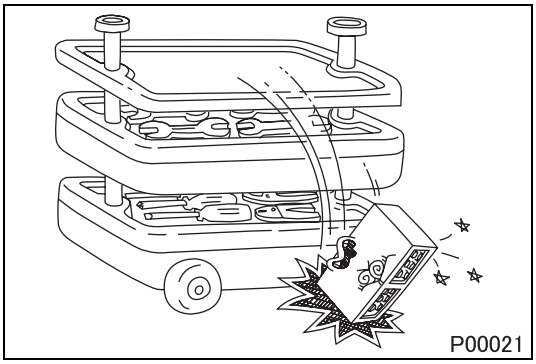
- Wear safety goggles when using a grinder or welder. Wear gloves when necessary, and watch out for sharp edges and other items that might wound your hands.



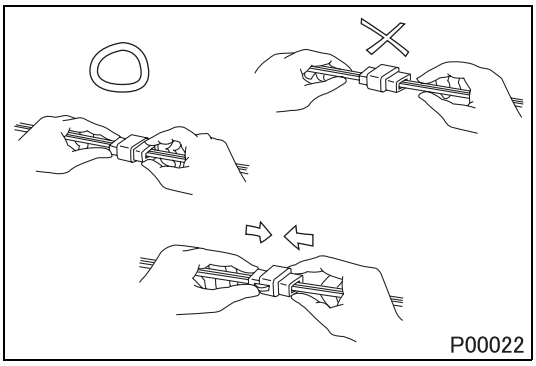
- Before working on the electrical system, disconnect the (–) battery cable to prevent short circuits.

CAUTION ⚠

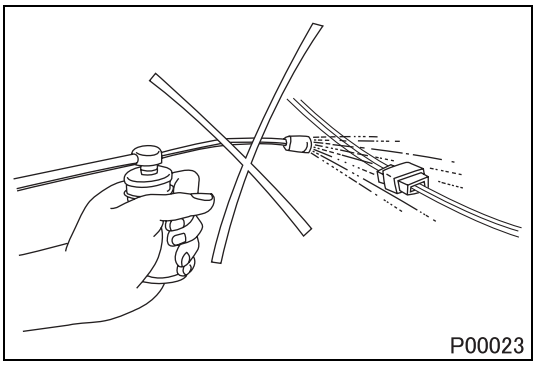
- **Make sure the starter switch and lighting switches are OFF before disconnecting or connecting battery cable. Semiconductor components may otherwise be damaged.**



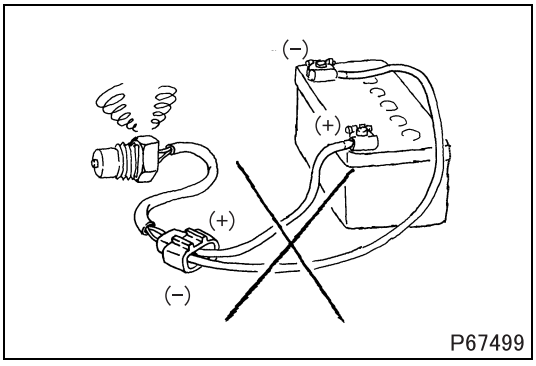
- Carefully handle sensors relays, and other items that are sensitive to shock and heat. Do not remove or paint the cover of any control unit.



- When separating connectors, grasp the connectors themselves rather than the harnesses.
- To separate locking connectors, first push them in the direction of the arrows. To reconnect locking connectors, push them together until they click.

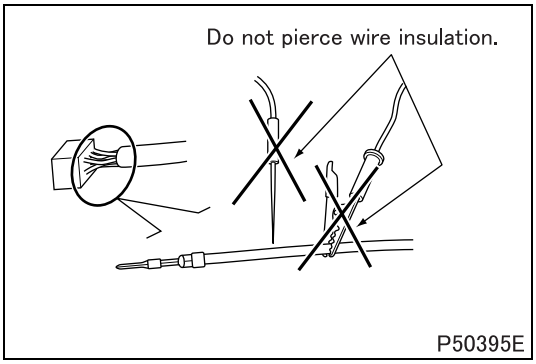


- Before washing the vehicle, cover electrical parts to keep them dry. (Use plastic sheets or the like.) Keep water away from harness connectors and sensors and immediately wipe off any water that gets on them.



- When applying a voltage to a part for inspection purposes, check that the (+) and (–) cables are connected properly then gradually increase the voltage from zero. Do not exceed the specified voltage.
  Remember that control units and sensors do not necessarily operate on the battery voltage.

1. Handling Precautions for Electric Circuits



CAUTION ⚠

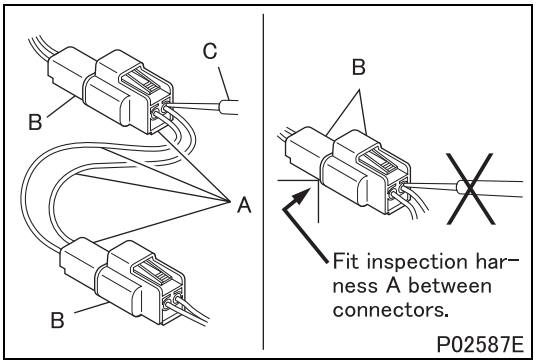
- **Do not pierce wire insulation with test probes or alligator clips when performing electrical inspections. Doing so can, particularly with the chassis harness, hasten corrosion.**

1.1 Inspection of harnesses

(1) Inspections with connectors fitted together

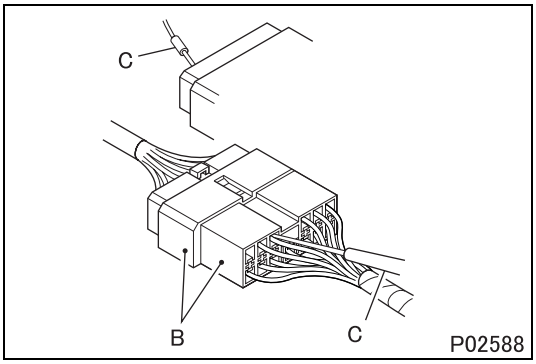
(1.1) Waterproof connectors

- Connect an inspection harness and connector **A** between the connectors **B** of the circuit to be inspected. Perform the inspection by applying a test probe **C** to the connectors of the inspection harness. Do not insert the test probe **C** into the wire-entry sides of the waterproof connectors since this would damage their waterproof seals and lead to rust.



(1.2) Non-waterproof connectors

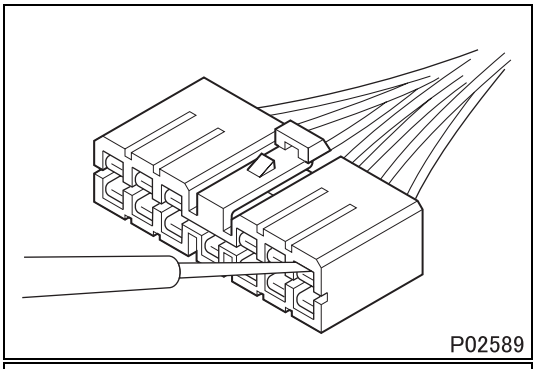
- Perform the inspection by inserting a test probe **C** into the wire-entry sides of the connectors. An extra-narrow probe is required for control unit connectors, which are smaller than other types of connector. Do not force a regular-size probe into control unit connectors since this would cause damage.



(2) Inspections with connectors separated

(2.1) Inspections on female terminals

- Perform the inspection by carefully inserting a test probe into the terminals. Do not force the test probe into the terminals since this could deform them and cause poor connections.

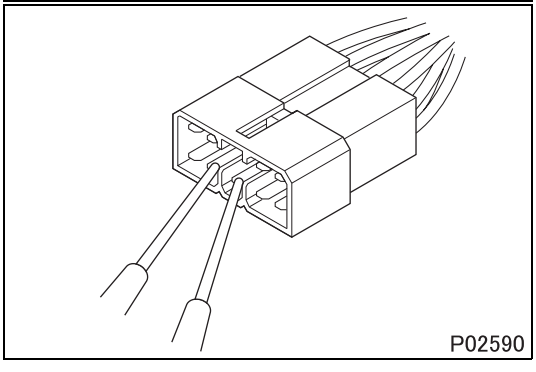


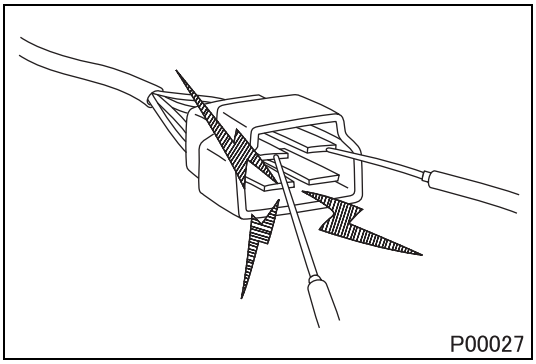
(2.2) Inspections on male terminals

- Perform the inspection by applying test probes directly to the pins.

CAUTION ⚠

- **Be careful not to short-circuit pins together with the test probes. With control unit connectors, short-circuiting of pins can cause damage to the control unit's internal circuitry.**

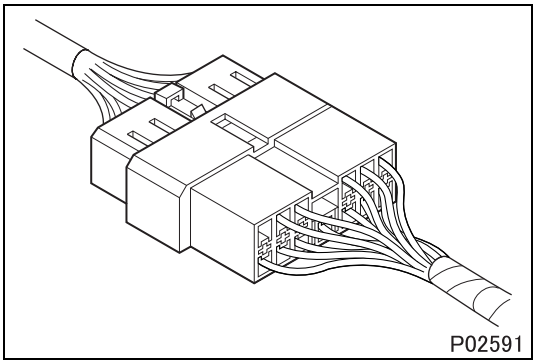




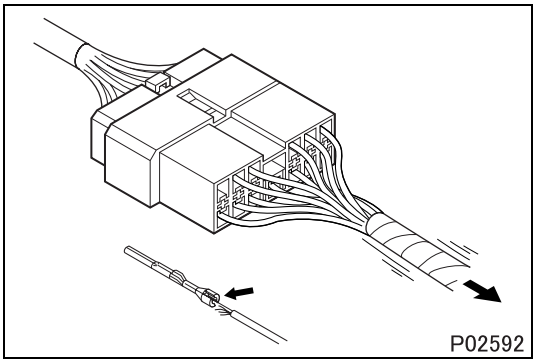
- When using a multimeter to check continuity, do not allow the test probes to touch the wrong terminals.

1.2 Inspection of connectors

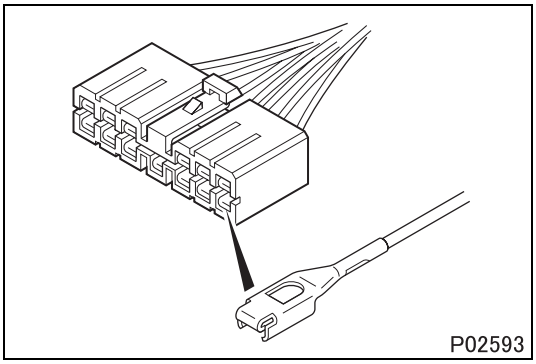
(1) Visual inspection



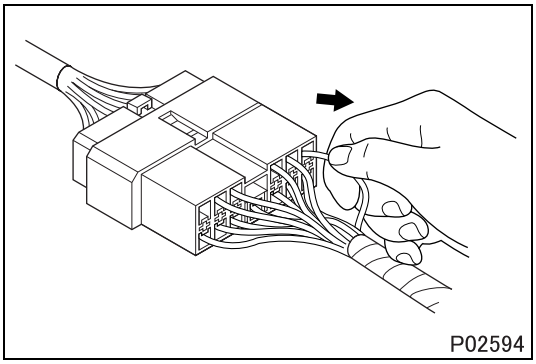
- Check that the connectors are fitted together securely.



- Check whether wires have been separated from their terminals due to pulling of the harness.

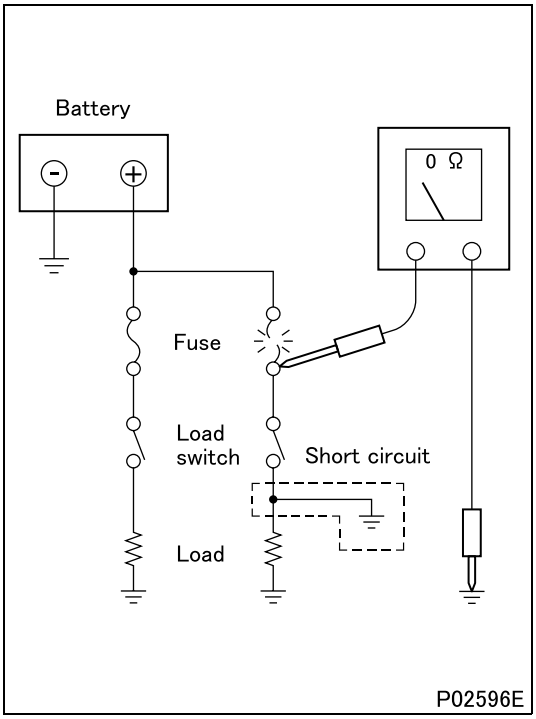


- Check that male and female terminals fit together tightly.
- Check for defective connections caused by loose terminals, by rust on terminals, or by contamination of terminals by foreign substances.


P02594

(2) Checking for loose terminals

- If connector terminal retainers become damaged, male and female terminals may not mate with each other when the connector bodies are fitted together. To check for such terminals, gently pull each wire and see whether any terminals slip out of their connector housings.

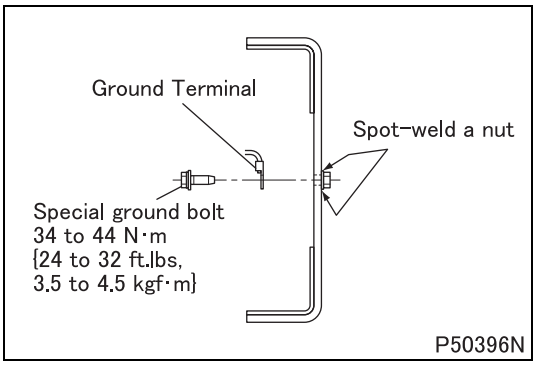


P02596E

1.3 Inspections when a fuse blows

- Remove the fuse, then measure the resistance between ground and the fuse's load side.
  Next, close the switch of each circuit connected to the fuse. If the resistance measurement between any switch and ground is zero, there is a short circuit between the switch and the load. If the resistance measurement is not zero, the circuit is not currently short-circuited; the fuse probably blew due to a momentary short circuit.

- The main causes of short circuits are as follows:
  - Harnesses trapped between chassis parts
  - Harness insulation damage due to friction or heat
  - Moisture in connectors or circuitry
  - Human error (accidental short-circuiting of components)

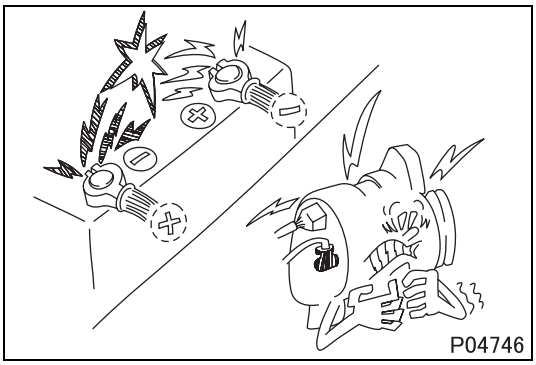


P50396N

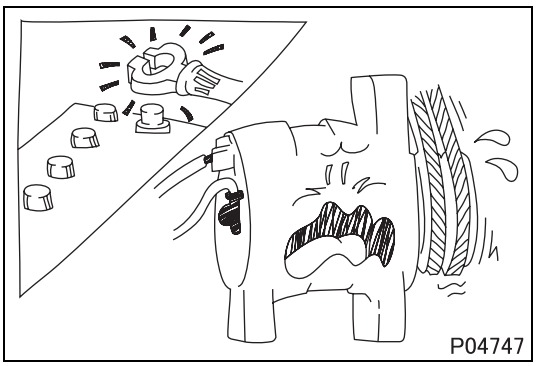
1.4 Inspection of chassis ground

- A special ground bolt is used to tighten a ground terminal. When servicing the ground point, be sure to follow the procedures described below:
  - When reinstalling the ground bolt
    Tighten the ground bolt to the specified torque.
  - When relocating the ground point
    A special ground bolt must be used. Spot-weld a nut to a frame and tighten the ground bolt to the specified torque. Be sure to apply touch-up paint to the welded point.

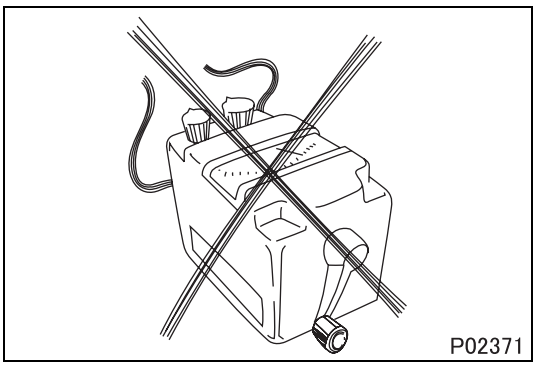
2. Service Precautions for Alternators



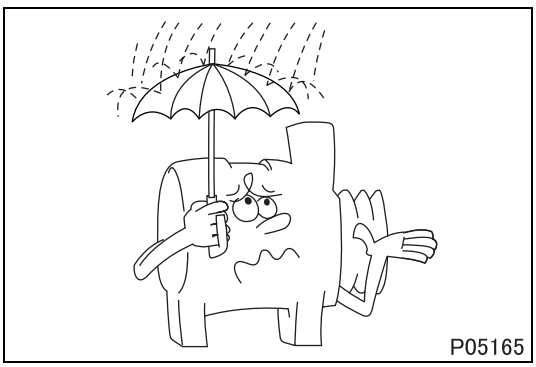
- When servicing alternators, observe the following precautions:
  - Never reverse the polarity of battery connections.
    If the polarity of the battery connections were to be reversed, a large current would flow from the battery to the alternator, damaging the diodes and regulator.



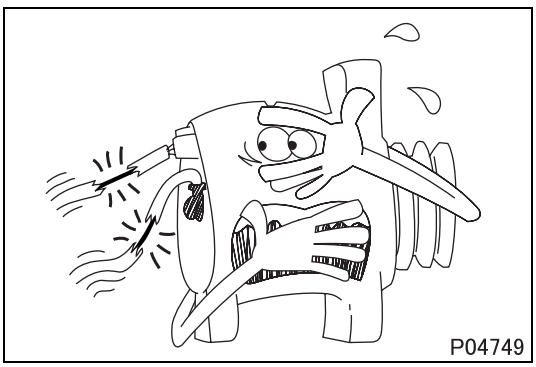
- Never disconnect the battery cables with the engine running.
  Disconnection of the battery cables during engine operation would cause a surge voltage, leading to deterioration of the diodes and regulator.



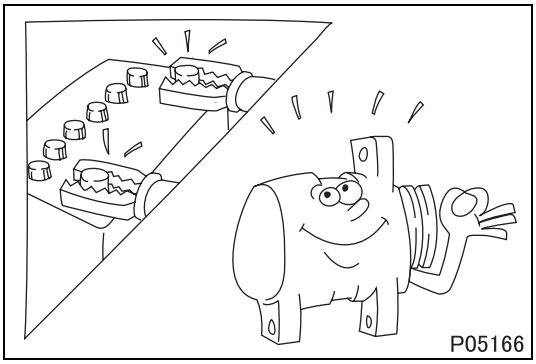
- Never perform inspections using a high-voltage multimeter.
  The use of a high-voltage multimeter could damage the diodes and regulator.



- Keep alternators dry.
  Water on alternators can cause internal short circuits and damage.

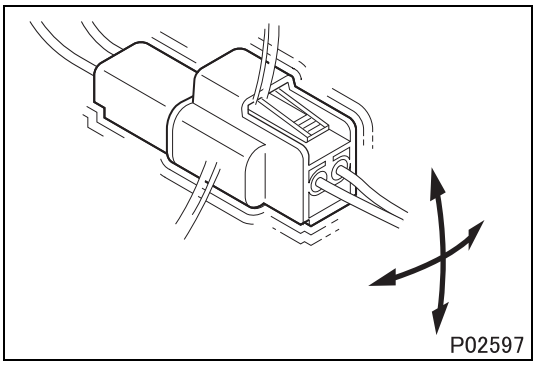


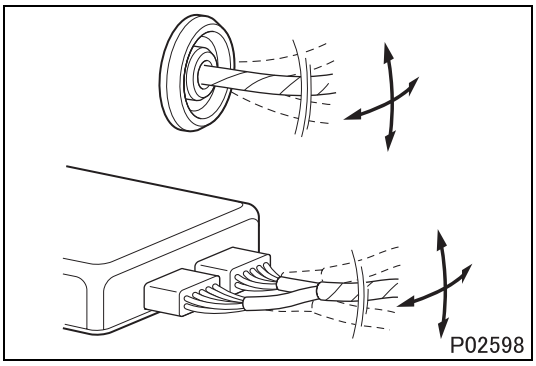
- Never operate an alternator with the B and L terminals short-circuited. Operation with the B and L terminals connected together would damage the diode trio.

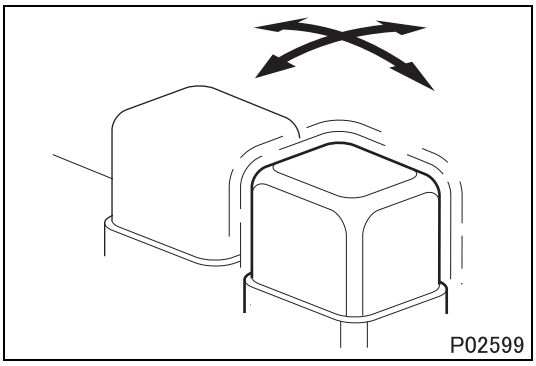


- Disconnect the battery cables (+) and (–) before quick-charging the battery with a quick charger.
  Unless the battery cables are disconnected, quick-charging can damage the diodes and regulator.

3. Intermittent Faults





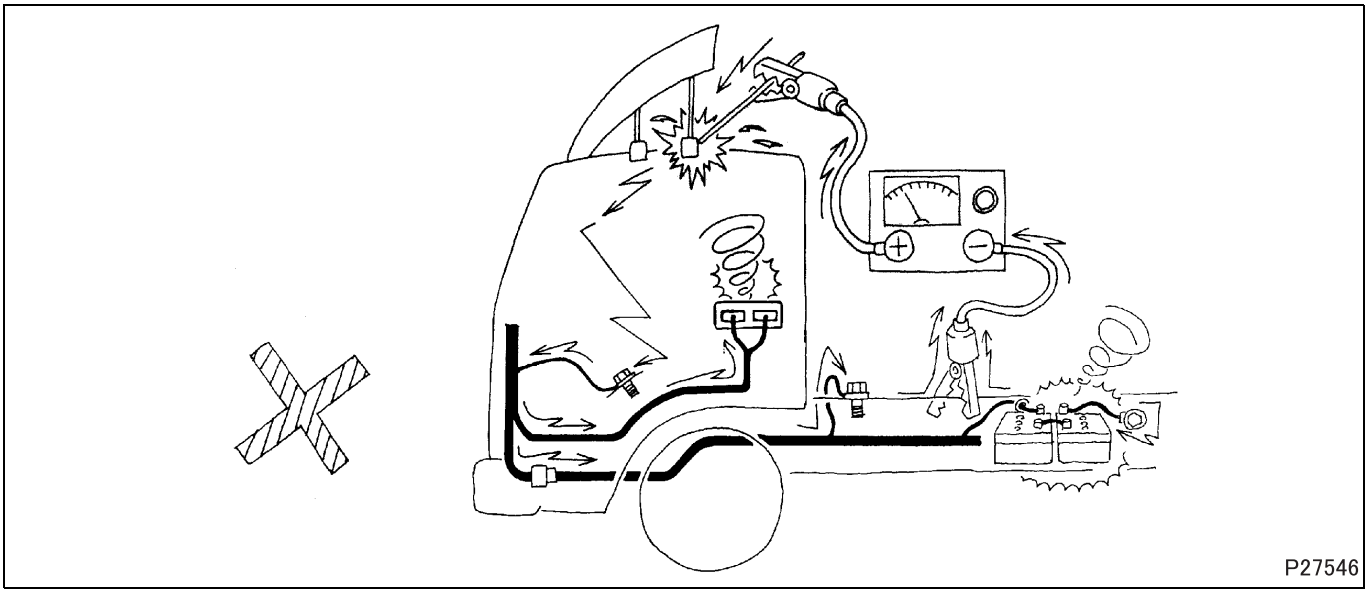


- An intermittent fault typically occurs only under certain operating conditions. Once these conditions have been identified, the cause of the intermittent fault can be ascertained easily. First, ask the customer about the vehicle operating conditions and weather conditions under which the fault occurs. Also ask about the frequency with which the fault occurs and about the fault symptoms. Then, reproduce the fault based on this information.
  In accordance with the conditions under which the fault occurs, determine whether the fault is caused by vibration, heat or other factors. if vibration is a possible factor, see if the fault can be reproduced by performing the following checks on individual connectors and other parts:
  - Gently move connectors up and down and to left and right.
  - Gently move wiring harnesses up and down and to left and right.
  - Gently wiggle sensors and other devices by hand.
  - Gently wiggle wiring harnesses on suspension systems and other moving parts.

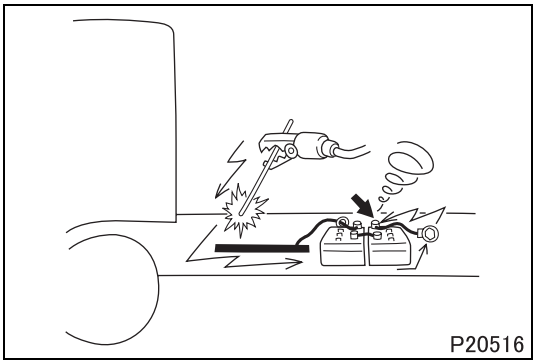
- Connectors and other parts to be checked are those included or given as likely fault locations in inspection procedures corresponding to diagnosis codes and/or fault symptoms.

4. Precautions for Arc Welding

- When arc welding is performed, current from the welder flows to ground via the vehicle's metal parts. Unless appropriate steps are taken, this current can damage control units, other electrical devices and wiring harnesses. And any electrical device near the point on the vehicle to which the (–) cable of the welder is connected, might be largely damaged.



- Current flows backward as shown below.



4.1 From battery (–) cable

To prevent damage to the battery and to electrical devices that are connected directly to the battery, it is essential to disconnect the battery's (–) cable.

4.2 Procedure

- Turn the starter switch to the LOCK position.
  ↓
- Disconnect the battery's (–) cable.
  ↓
- Cover all parts of the vehicle that may be damaged by welding sparks.
  ↓
- Connect the welder's (–) cable to the vehicle as close as possible to the area being welded. Do not connect the welder's (–) cable to the cab if the frame is being welded, and vice versa.
  ↓
- Set the welding current in accordance with the part being welded.

GROUP 54-00B SPECIFICATIONS

SPECIFICATIONS

Battery

Item		Specifications
Model		130E41L
Voltage × Quantity	V	12 × 2
Capacity (5-hour rating)	Ah	92

Alternator

Item		Specifications
Manufacturer		Mitsubishi Electric
Type		Alternator with built-in regulator (without brush, external fan)
Model		A4TU1593
Output	V-A	12–100

Starter

Item			Specifications
Starter	Manufacturer		Mitsubishi Electric
	Model		M8T55371
	Output	V-kW	12–3.0
	Reduction gear mechanism		Planetary gears
	Magnetic switch operating voltage	V	8 or less
Starter relay	Model		U1X11672
	Excitation current	V-A	12–4
	Closing voltage	V	8 or less
	Opening voltage	V	3.5 or less
	Allowable cutoff current	A	200
Glow relay	Model		U1T11872
	Excitation current	V-A	12–4
	Closing voltage	V	8 or less
	Opening voltage	V	3.5 or less
	Allowable cutoff current	A	60
	Temperature fuse capacity	A	127
Glow plug	Model		Sheathed type
	Excitation current	V-A	11–5

Lighting

Item			Specifications
Headlamp	Model		Unconventional, rectangular, 2-lamp-system, semi-sealed beam
	Type		Parabola reflector type
	Upper beam (HIGH)	W	HB2 halogen 60/55 (HIGH/LOW)
	Lower beam (LOW)	W	
	Parking lamp	W	5
Front side turn signal lamp (serving also as hazard warning lamp)		W	21
Clearance and side marker lamp		W	7.5
Rear combination lamp	Stop and tail lamp (stop/tail)	W	21/5 (double filament type)
	Rear turn signal lamp (serving also as hazard warning lamp)	W	21
	Backup lamp	W	21
License plate lamp		W	7.5
Identification lamp		W	7.5
Cab lamp		W	10

Meter

Item			Specifications
Meter cluster	Manufacturer		DENSO
	Voltage	V	12
	Speedometer indicating range	km/h {MPH}	Meter reading $^{+2}_{0}$ to $^{+6.5}_{0}$ { $^{+2}_{0}$ to $^{+3}_{0}$ }
	Tachometer indicating range	rpm	Meter reading ± 150
	Water temperature gauge indicating range		<M/T> 103°C {217°F}, 70 to 96°C {158 to 205°F}, 50°C {122°F}, C, H — P58273N <A/T> 103°C {217°F}, 70 to 96°C {158 to 205°F}, 50°C {122°F}, C, H — P57939N
	Meter warning buzzer — Rated current	mA	50 or less
	Meter warning buzzer — Sound pressure	dB	60 $^{+6}_{0}$ (at 1 m {3.3 ft.})

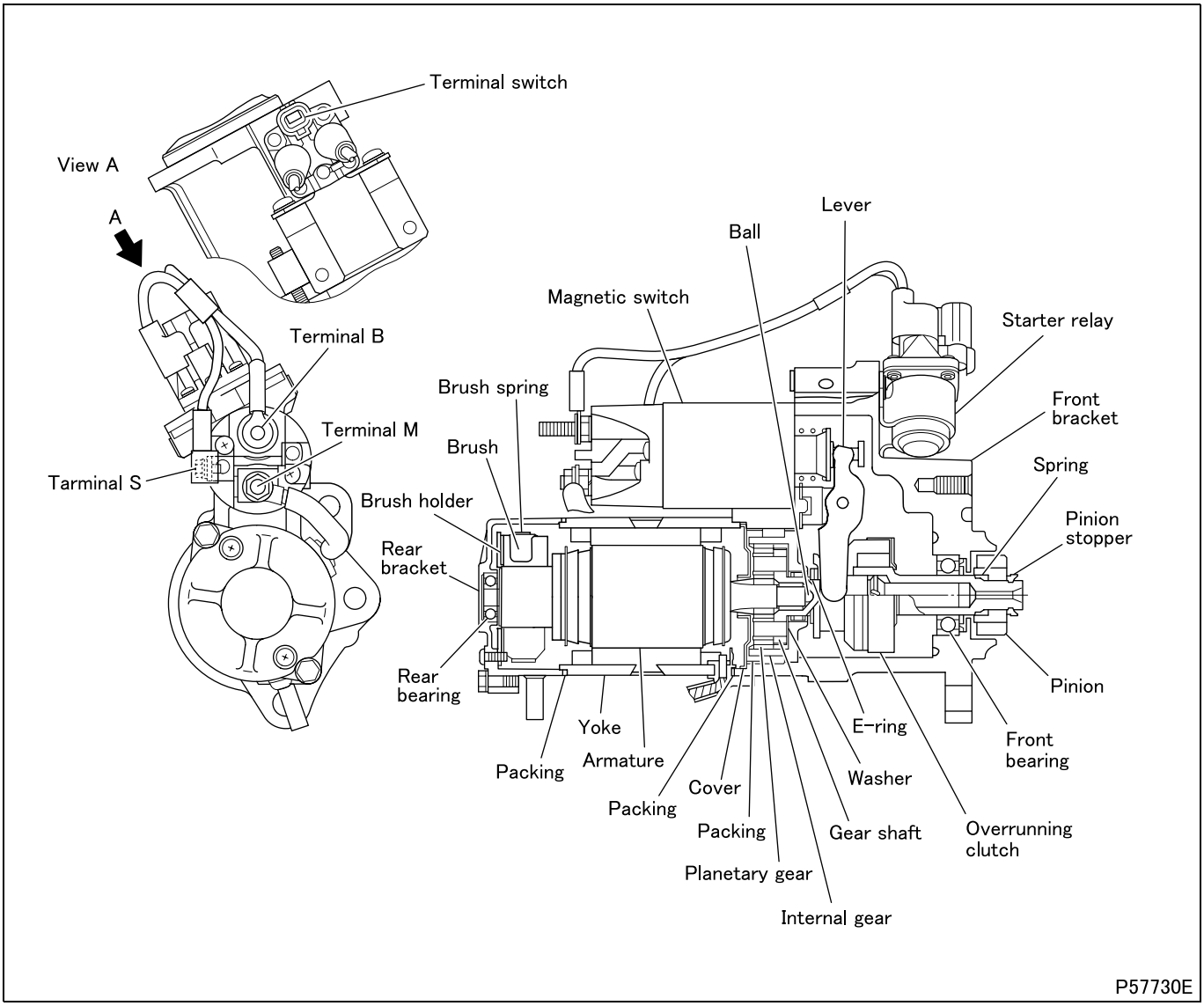
A/T: Automatic transmission
M/T: Manual transmission

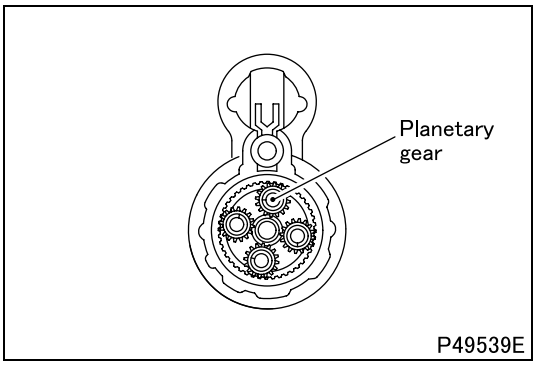
Relay, Radio, Motor, Horn, Buzzer

Item			Specifications
Minimum operating voltage of relay		V	8 or less
Loudspeaker	Rated input	W	15
	Maximum input	W	25
	Impedance	Ω	4 ± 0.6
Wiper motor	Rated voltage	V	12
	No-load current	A	4 or less
	Bound current	A	30 or less
Washer motor	Rated voltage	V	12
	Rated current	A	3.8 or less
Power window motor	Rated voltage	V	12
	Rated current	A	5 or less
Electric horn	Rated voltage	V	12
	Current consumption	A	3 or less
	Sound pressure	dB	110 ± 5 (at 2 m {6.6 ft.})
Back buzzer	Rated voltage	V	12
	Rated current	mA	50 or less
	Sound pressure	dB	85 ± 10 (at 1 m {3.3 ft.})
Cab tilt buzzer	Rated voltage	V	12
	Rated current	mA	66 or less
	Sound pressure	dB	73 ± 10 (at 1 m {3.3 ft.})
Hydraulic warning buzzer (only attached hydraulic brake)	Rated voltage	V	12
	Rated current	mA	100 or less
	Sound pressure	dB	90 to 105 (at 1 m {3.3 ft.})

GROUP 54-00C
STRUCTURE AND OPERATION

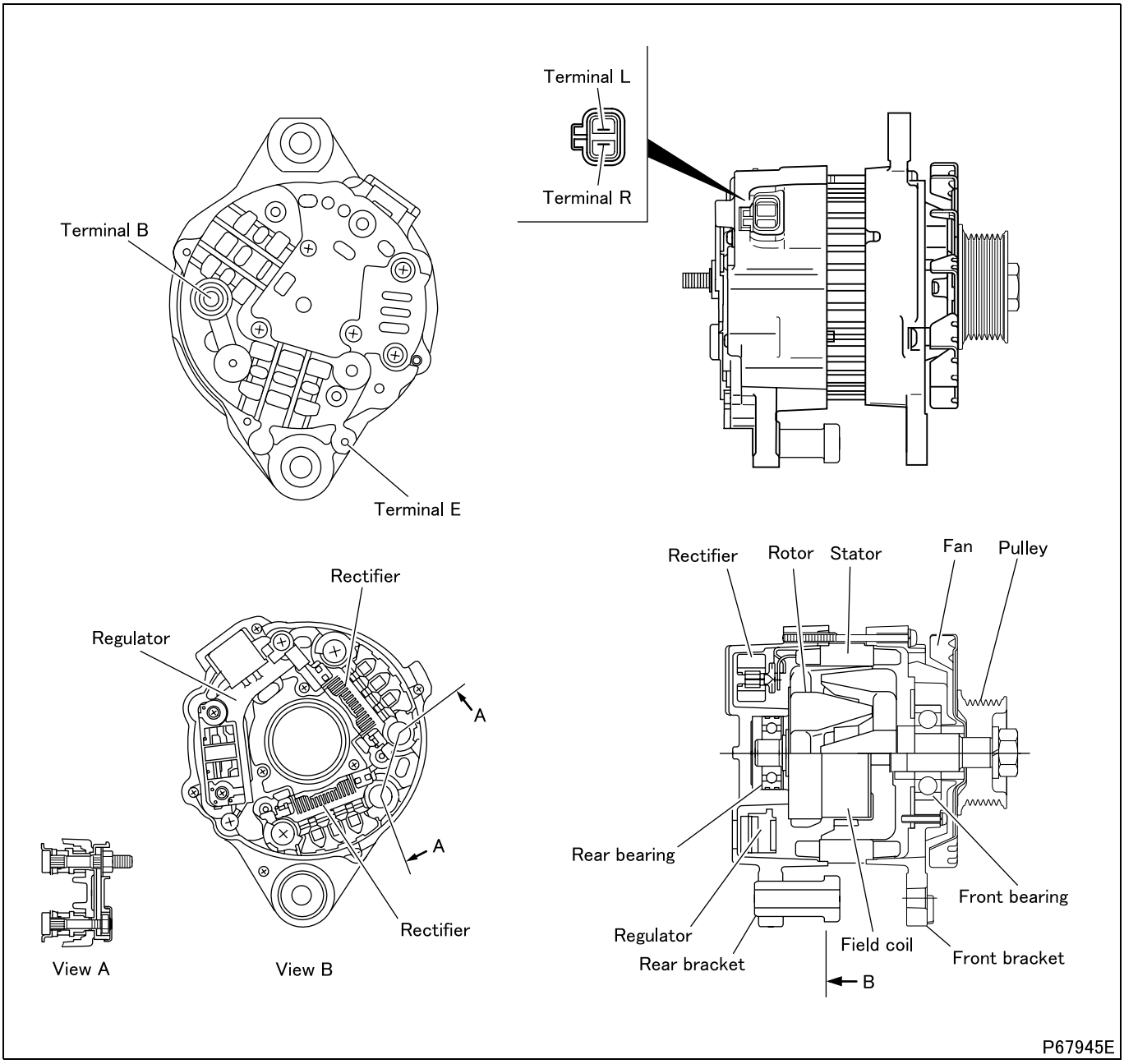
1. Starter

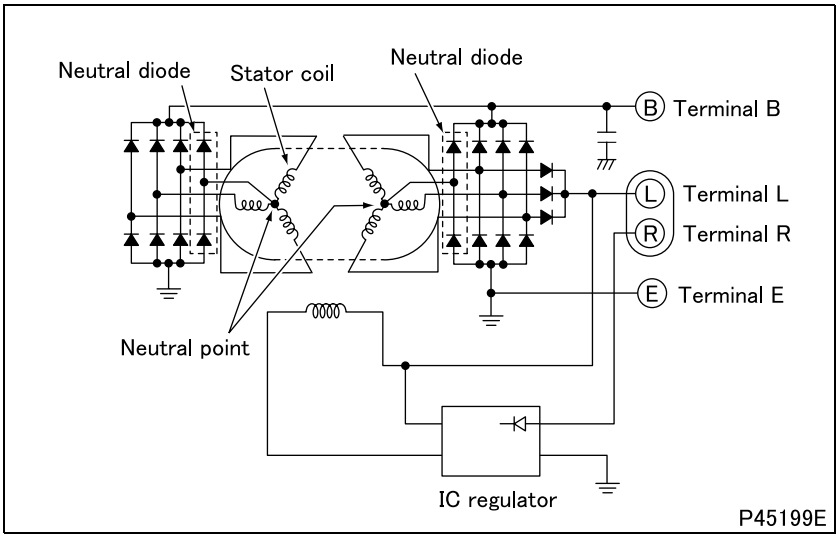




- This starter uses planetary gears as its reduction gearing mechanism.

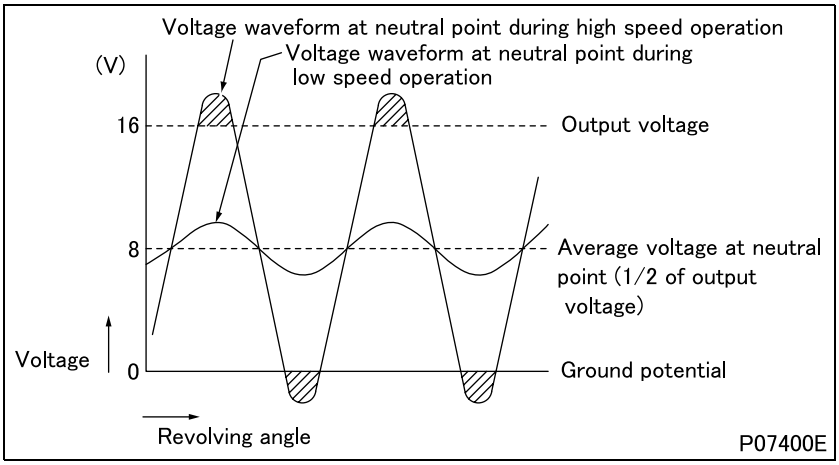
2. Alternator





2.1 Features of alternator with neutral diodes

- The alternator is the same as the current alternator except that neutral diodes have been added.
- These neutral diodes enable this alternator to provide higher DC output during operation at high speeds than the alternator without neutral diodes.

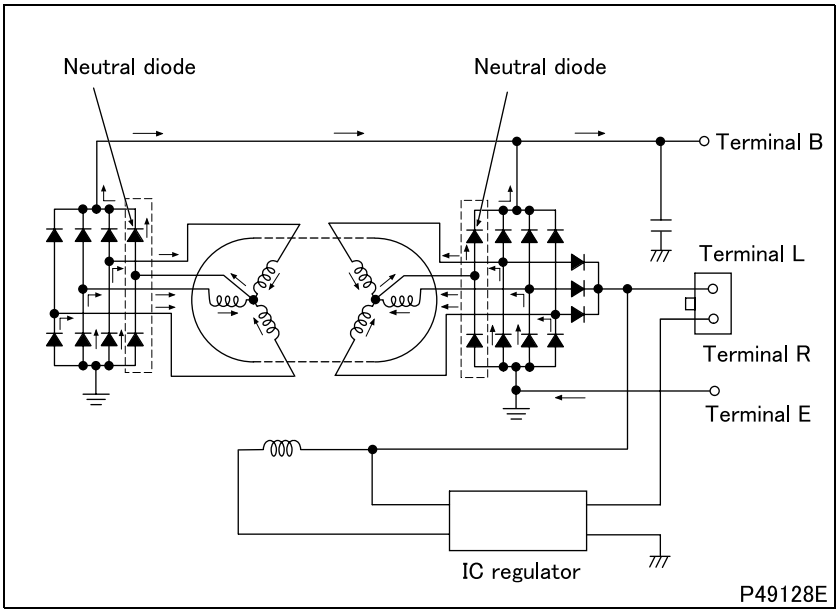


2.2 Variations of voltage at neutral point and operation of neutral diodes

- The potential at the neutral point varies up and down with the neutral point DC voltage (1/2 of output voltage) as a center as shown.
- When the alternator is operated at high speeds, the voltage at the neutral point can increase to exceed the output voltage (16V) and decrease to become lower than the ground voltage (0V). To adjust these over-voltage and under-voltage (shaded portions of diagram) the current from the excess voltages is taken by neutral diodes and added to the DC output.

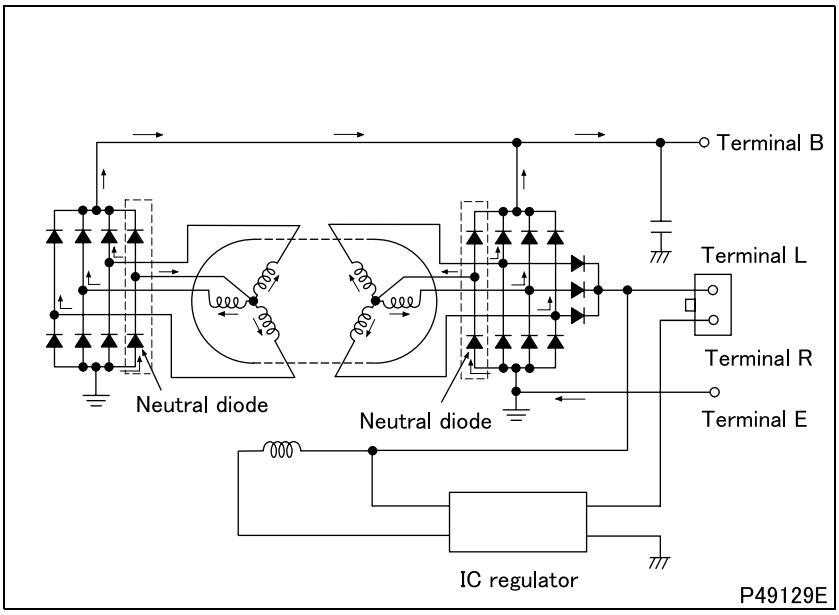
The operation of neutral diodes for each voltage and potential is as follows.

- When the voltage at neutral point is in the range from 0 to 16V, the other six diodes are operated. Neutral diodes are not operated.



2.3 When the voltage at neutral point exceeds 16V

- The positive neutral diode adds extra output to the DC output for supply to each electric equipment.

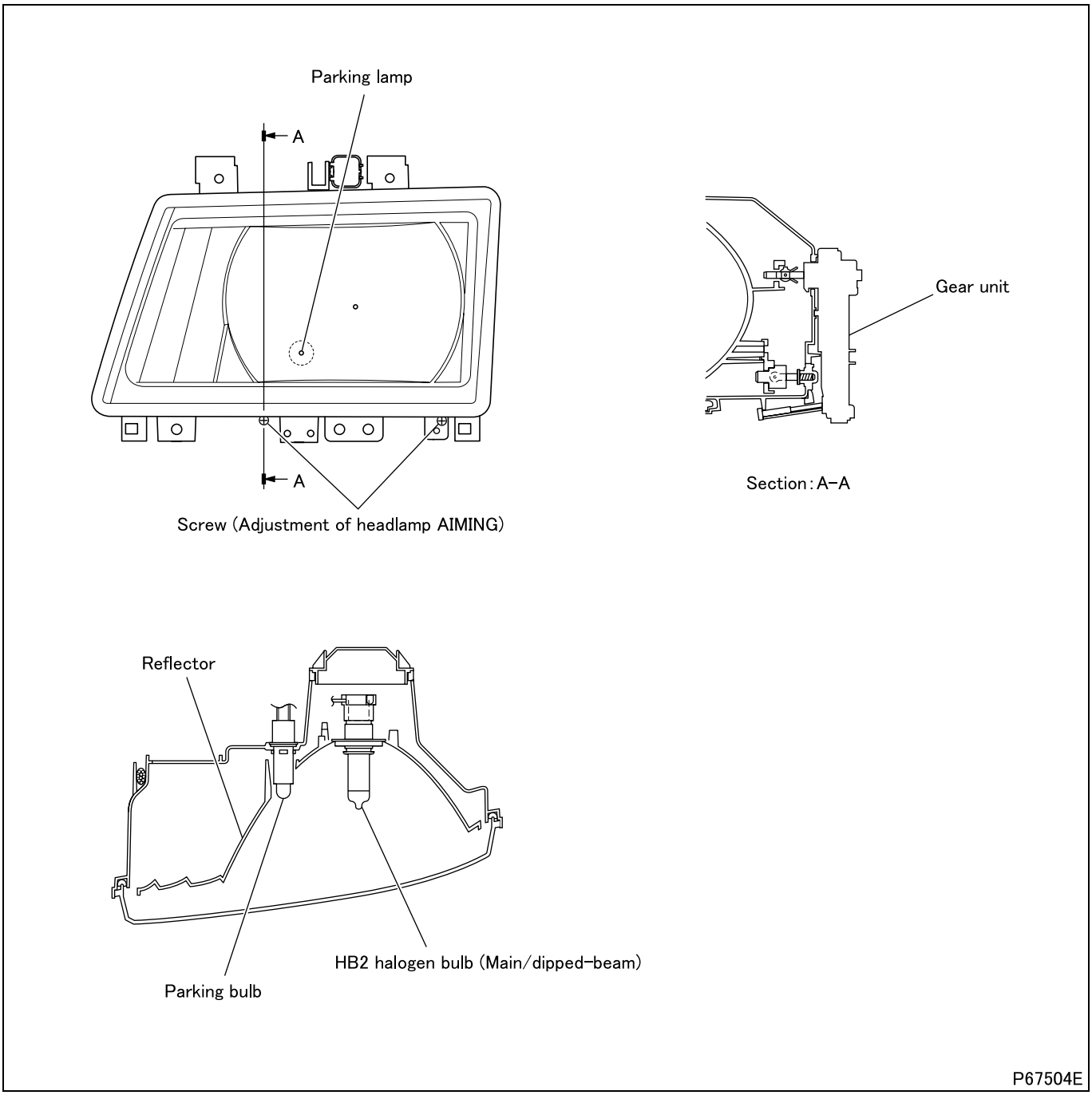


2.4 When the voltage at neutral point drops below 0V

- The negative neutral diode supplies the output from neutral point through other three diodes.

3. Headlamps

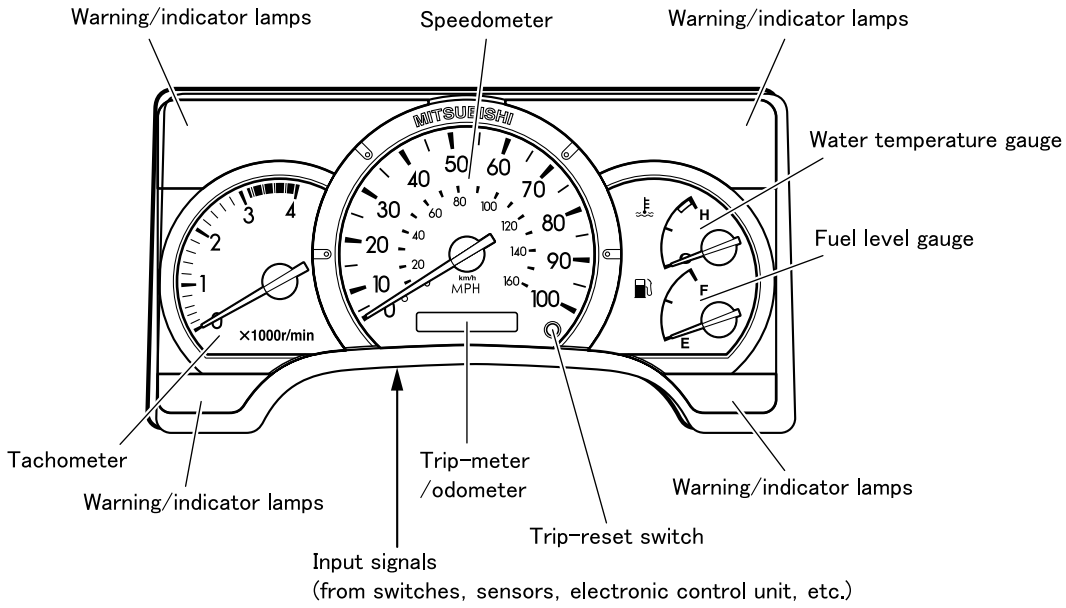
<Unconventional, rectangular 2-lamp halogen headlamp>



(Left headlamps are shown in this illustration)

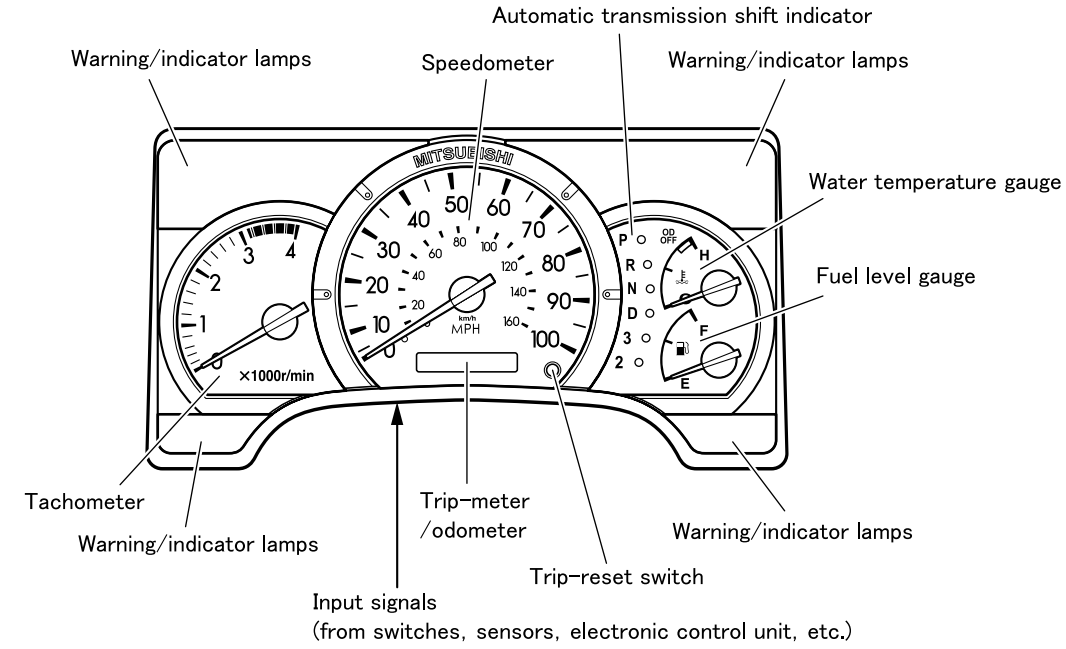
4. Meter Cluster

<Manual transmission>



P64157E

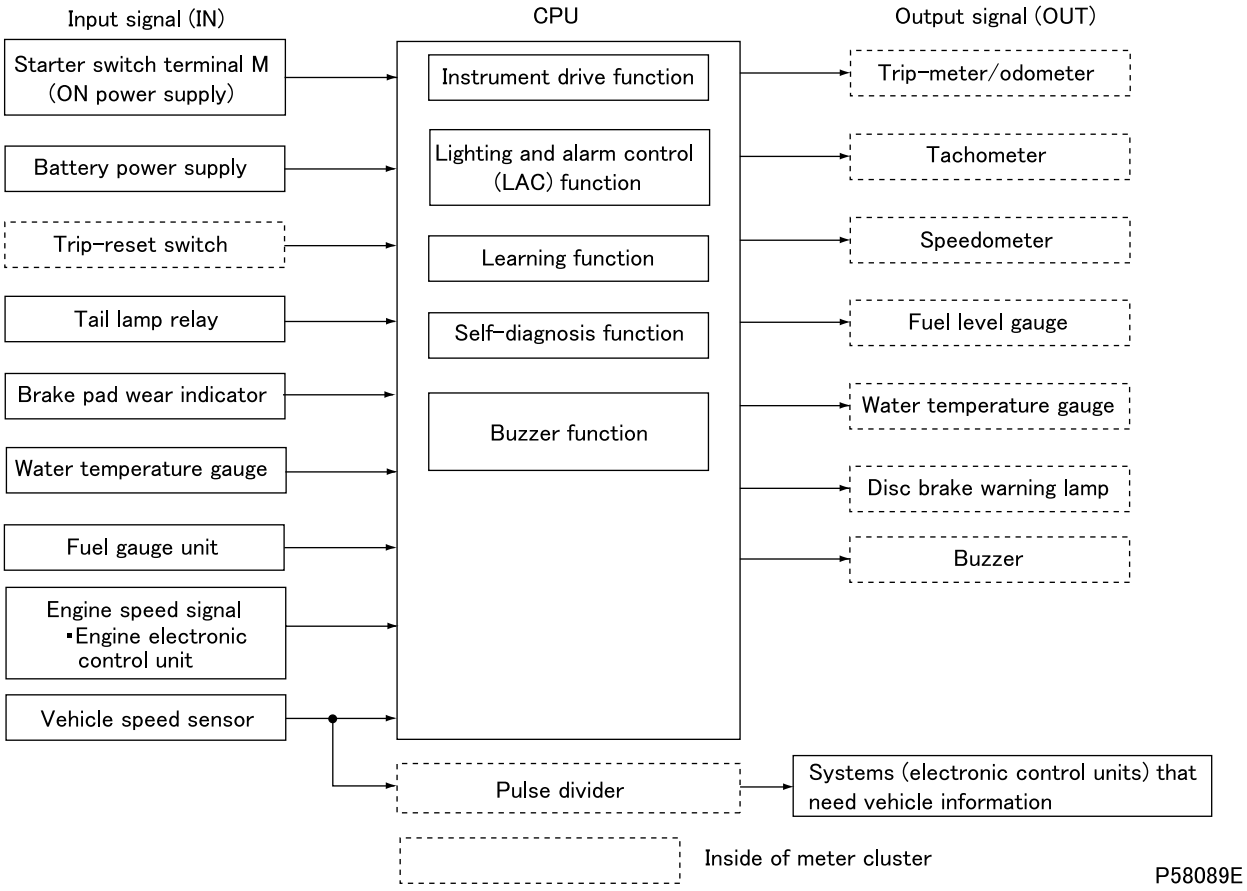
<Automatic transmission>



P64158E

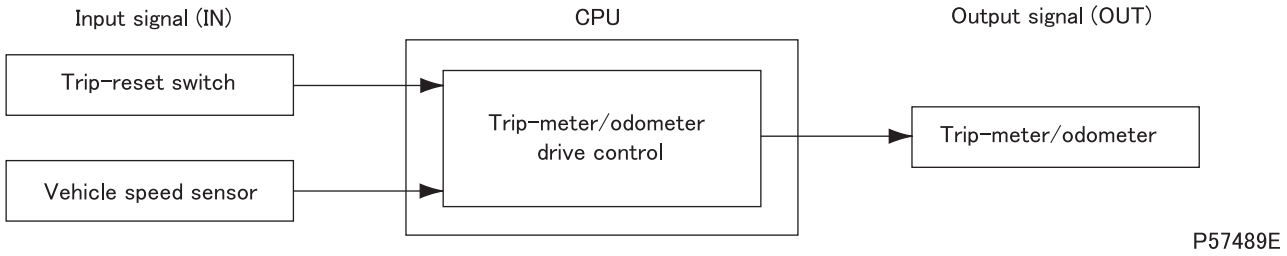
- The meter cluster incorporates a CPU, which contains the lighting and alarm control (LAC) function, learning function, and self-diagnosis function.

4.1 Electronic control unit in the meter cluster system block diagram

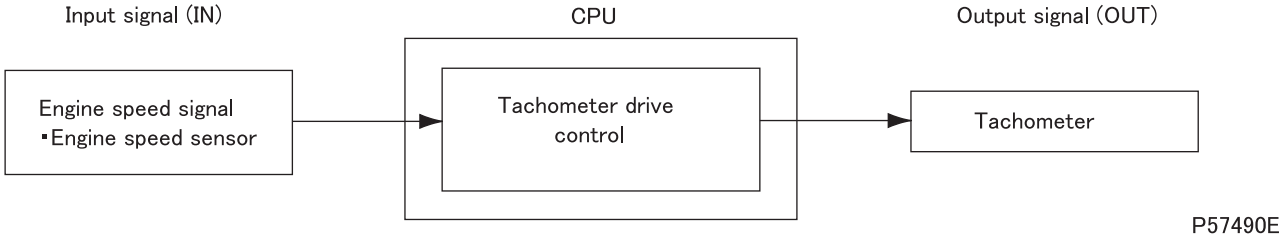


4.2 Instrument drive function

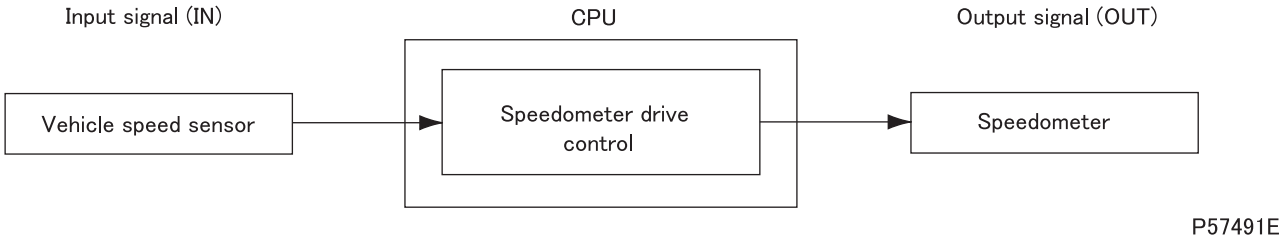
(1) Trip-meter/odometer



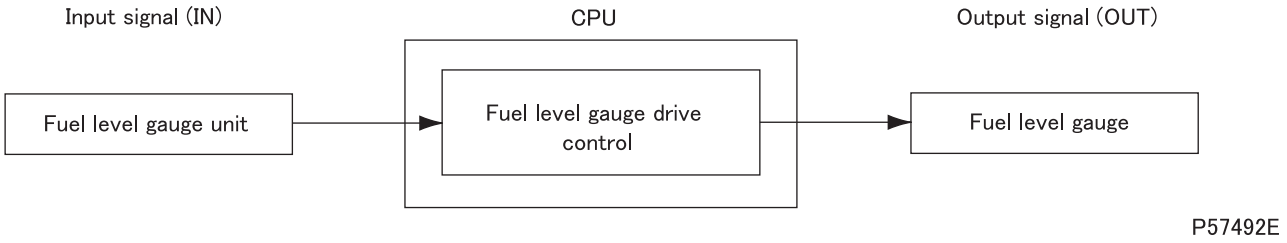
(2) Tachometer



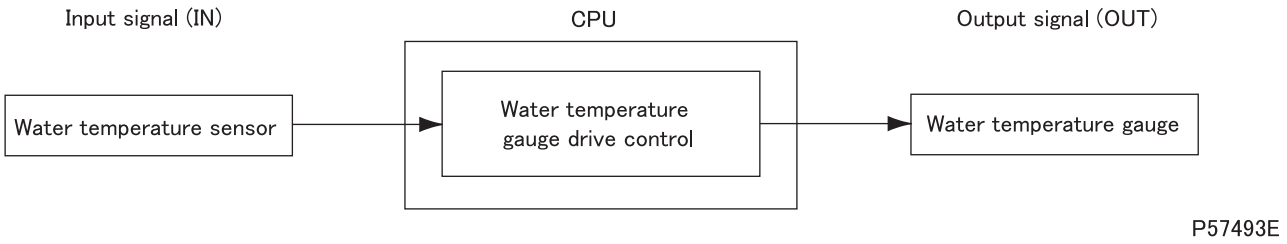
(3) Speedometer



(4) Fuel level gauge

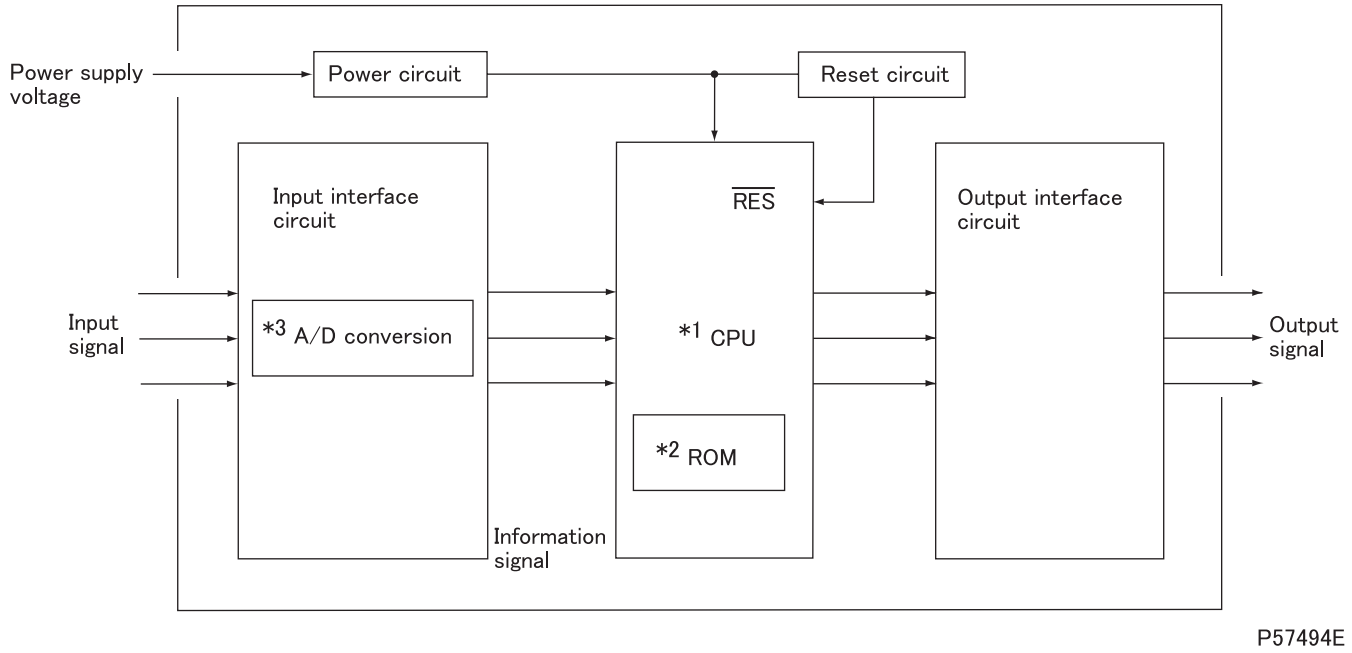


(5) Water temperature gauge



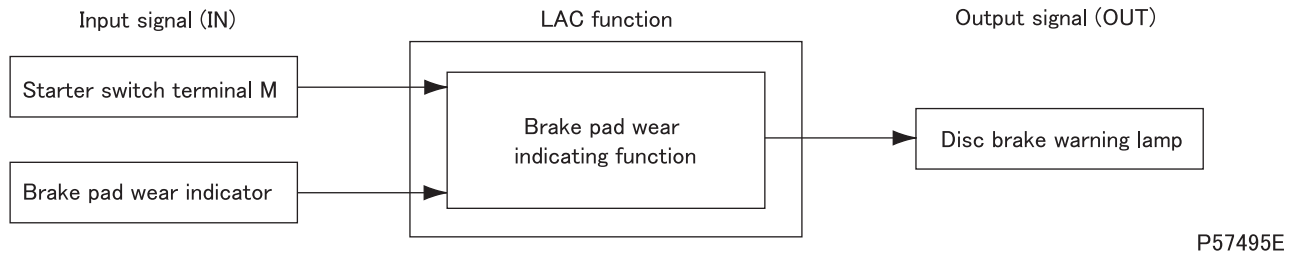
4.3 Lighting and alarm control (LAC) function

(1) Internal structure of LAC



- Internally, the LAC is essentially made up of the input interface circuit, *1CPU, *2ROM, and output interface circuit.
  - *1CPU:
    An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM, makes a decision and sends commands to the outputs.
  - *2ROM:
    An abbreviation for Read-Only Memory. Its contents are only for reading. It stores fixed data and programs, and such retained information is not deleted even after power is cut off.
- Information sources such as the sensor and switch send input signals to the input interface circuit.
- The input interface circuit performs *3A/D conversion of the input signals, and the converted signals are transmitted to the CPU as information signals.
  - *3A/D conversion:
    An abbreviation for Analog/Digital conversion. It converts analog signals to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

(2) LAC function system block diagram



(3) Brake pad wear indicating function

- The LAC function determines ON or OFF state of the brake pad wear indicator, and causes the disc brake warning lamp to turn on if necessary.

4.4 Learning function

- The learning function makes the electronic control unit in the meter cluster recognize the specifications of the vehicle, without which the meter cluster cannot provide proper indications.
- There are the following two learning items:
  - "With" or "without" brake pad wear indicator.
  - "With" or "without" clutch disc wear indicator.

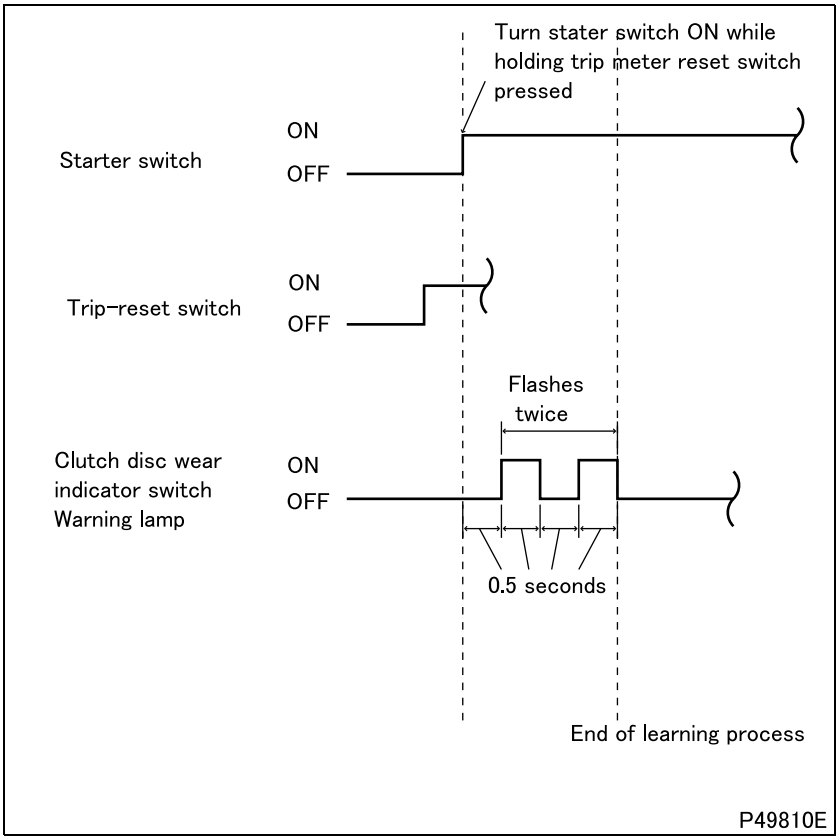
CAUTION ⚠

- **When making the electronic control unit recognize "with" for the clutch disc wear indicator, make sure that there is no open circuit in any of the relevant switch circuits. If any circuit is found open, replace the corresponding switch.**

(1) Learning operation

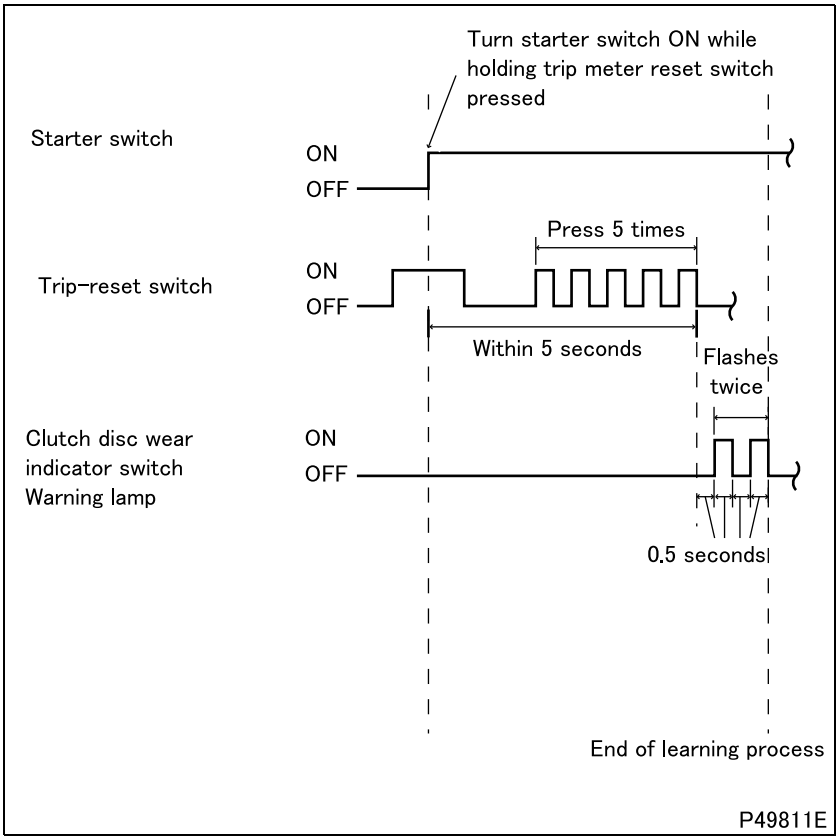
- The learning operation method differs depending on the odometer reading as follows:
  - Less than 3 km/h {1.86 mph} (for when the meter cluster is replaced with a new one).
  - 3 km/h {1.86 mph} or more (for when re-learning is required due to such a reason as wrong initial learning).

(2) Learning operation for odometer reading of less than 3 km/h {1.86 mph}



- Turn the starter switch to ON while holding the trip meter reset switch pressed, then release the reset switch.
- A 0.5 seconds later, the clutch disc wear indicator lamp will flash twice, indicating completion of the learning process.
- If "without" is learned for the clutch disc wear indicator, the indicator lamp neither flashes nor illuminates.

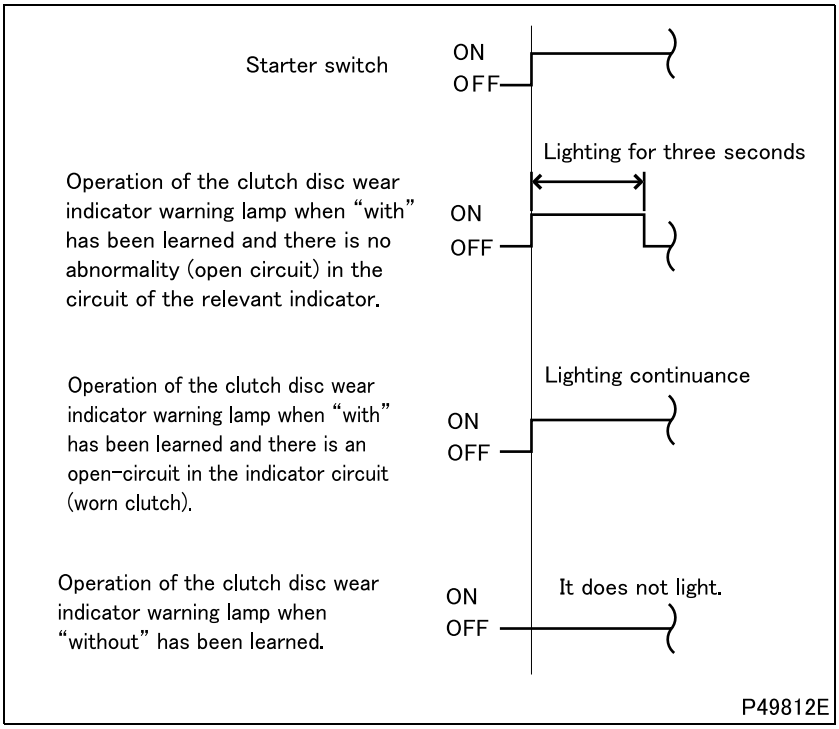
(3) Learning operation for odometer reading of 3 km/h {1.86 mph} or more



- Turn the starter switch to ON while holding the trip-reset switch pressed, then release the reset switch.
- Within 0.5 seconds after turning the starter switch to ON, press again the trip-reset switch 5 times.
- If “without” is learned for the clutch disc wear indicator, the indicator lamp neither flashes nor illuminates.

(4) Learning result confirmation and open-circuit checking

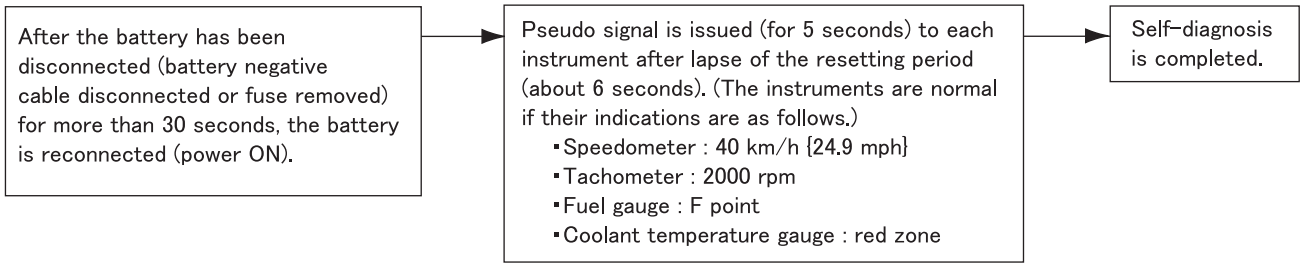
- After every learning operation, turn the starter switch to OFF and then to ON again to make sure that the indicator lamp for which “equipment” has been learnt illuminates.



- The open-circuit checking function checks that the indicator lamp(s) for which “equipment” has been learned illuminates normally when the starter switch is turned to ON.

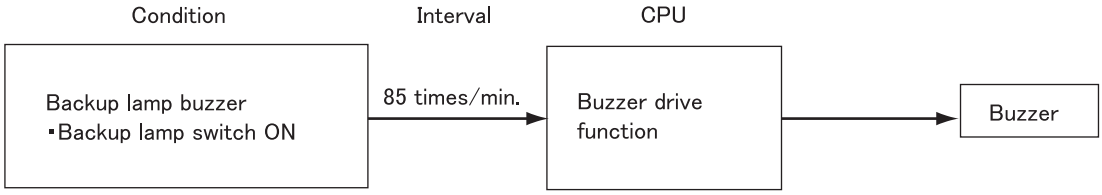
4.5 Self-diagnosis function

- The CPU performs the self-diagnosis function by sending a pseudo signal to each instrument, determining whether the instrument responds normally to the signal.



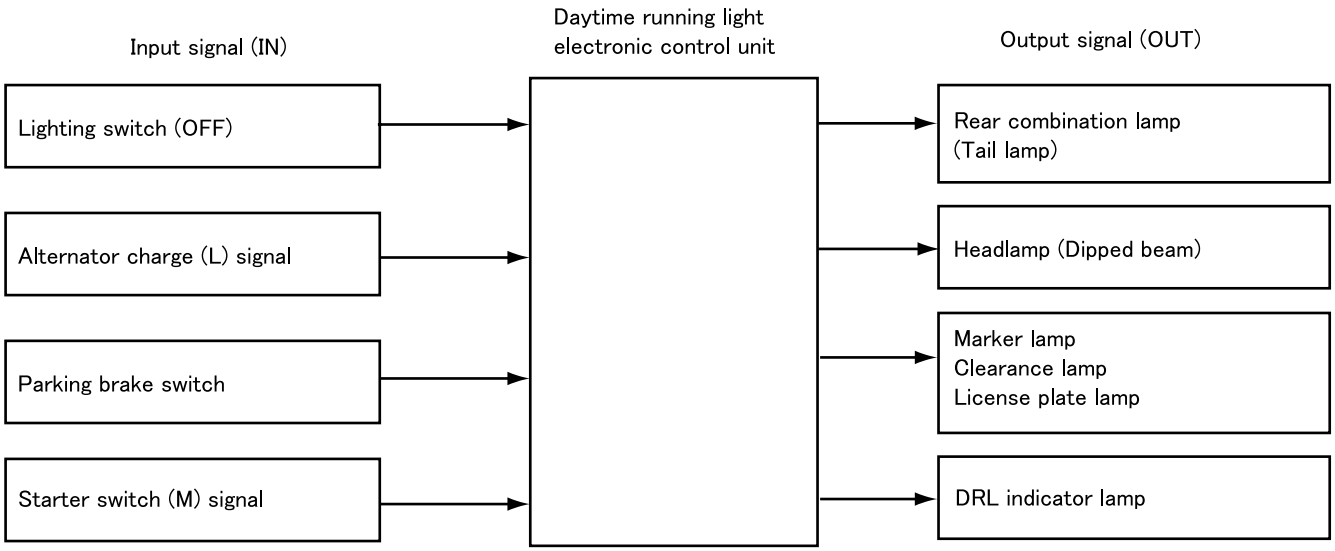
P57496N

4.6 Buzzer sounding function



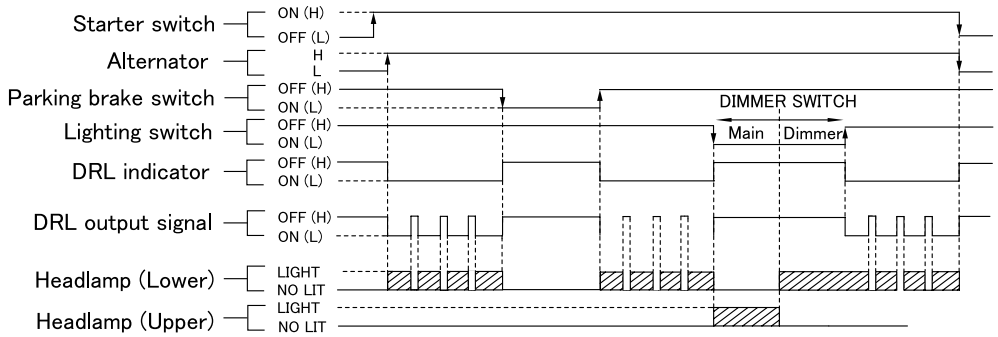
P62494E

5. Daytime Running Light System



- In a daytime running light system, regardless the position of lighting switch while engine is running, the low beam of the headlamp and the tail lamp of the rear combinations, position lamp, license plate lamp will light on.
- Except for that the lighting switch is OFF or when the passing switch is ON, the same lamps as usual switch operation will light.

5.1 Timing chart

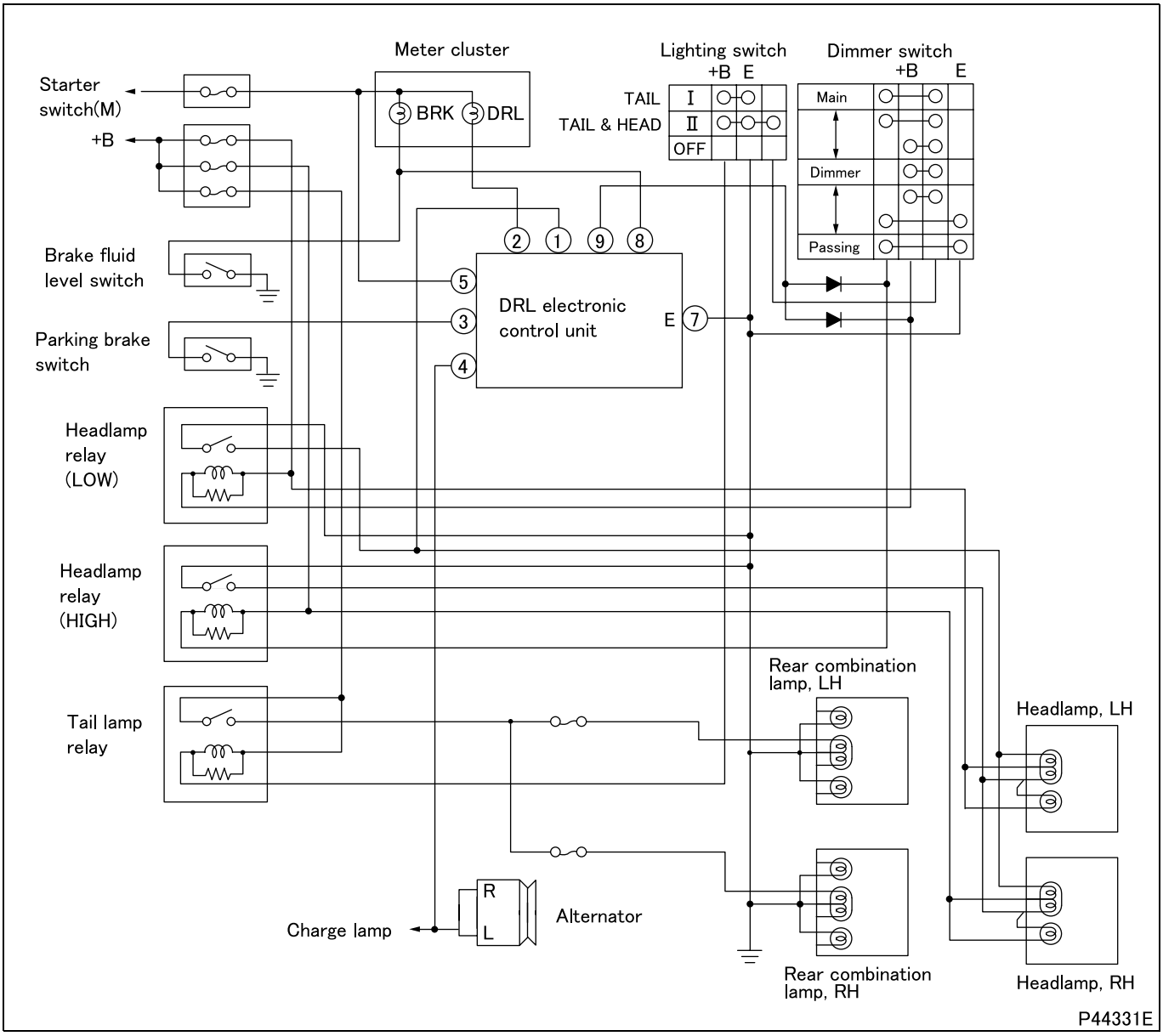


Headlamps repeat ON/OFF operations at 120 Hz according to the above timing chart. Because of the cyclic ON/OFF operations, the headlamps are dimmer than when the headlamp switch is ON.

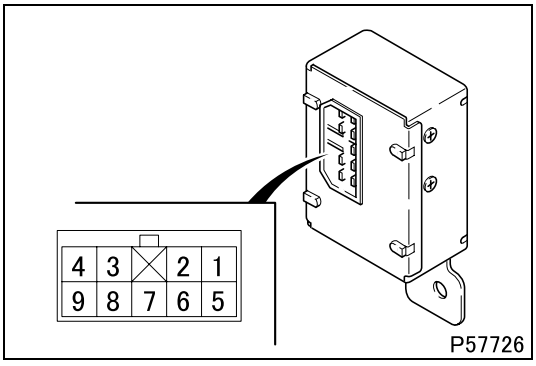
Explanation of timing chart

- After the engine starts, when alternator begins generating electricity with starter switch in the ON position, headlamps light.
- When parking brake switch is ON, the DRL turns off to switch off the headlamps.

5.2 Daytime running light electronic control unit circuit diagram



5.3 DRL electronic control unit



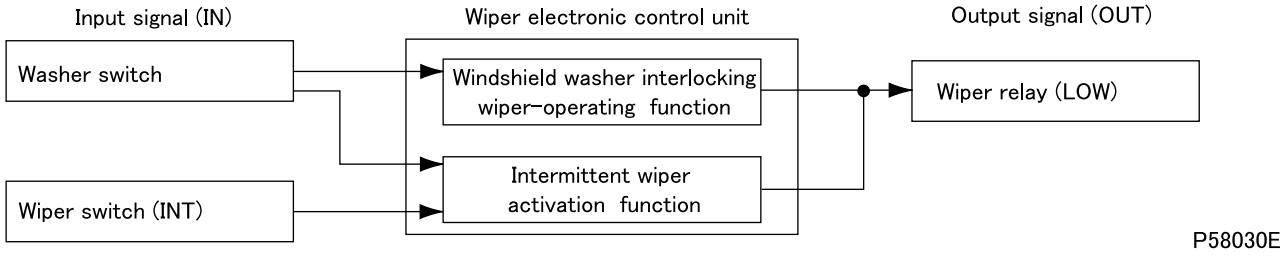
Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Head lamp (low beam)	6	–
2	DRL indicator lamp	7	Ground
3	Parking brake switch	8	Parking brake indicator lamp
4	Alternator L terminal	9	Lighting switch
5	Starter switch M terminal	–	–

6. Wiper Control

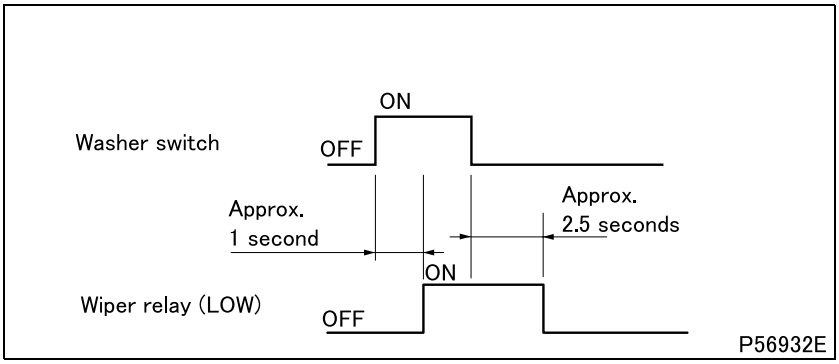
6.1 Outline

- This wiper electronic control unit is an integrated control unit controlling the following functions.
  - Windshield washer interlocking wiper-operating function.
  - Intermittent wiper activation function.

(1) System function schematic

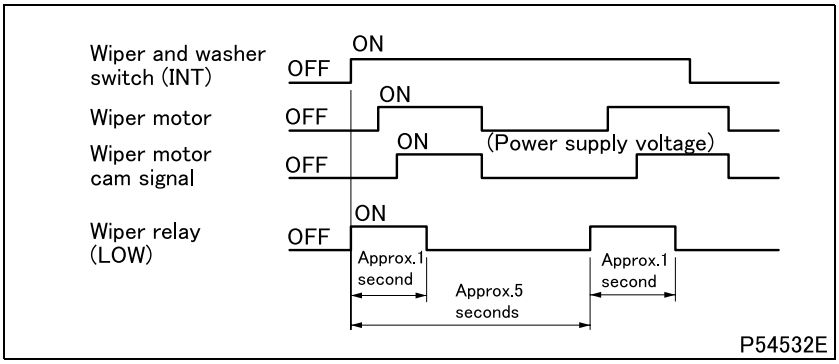


6.2 Windshield washer interlocking wiper-operating function



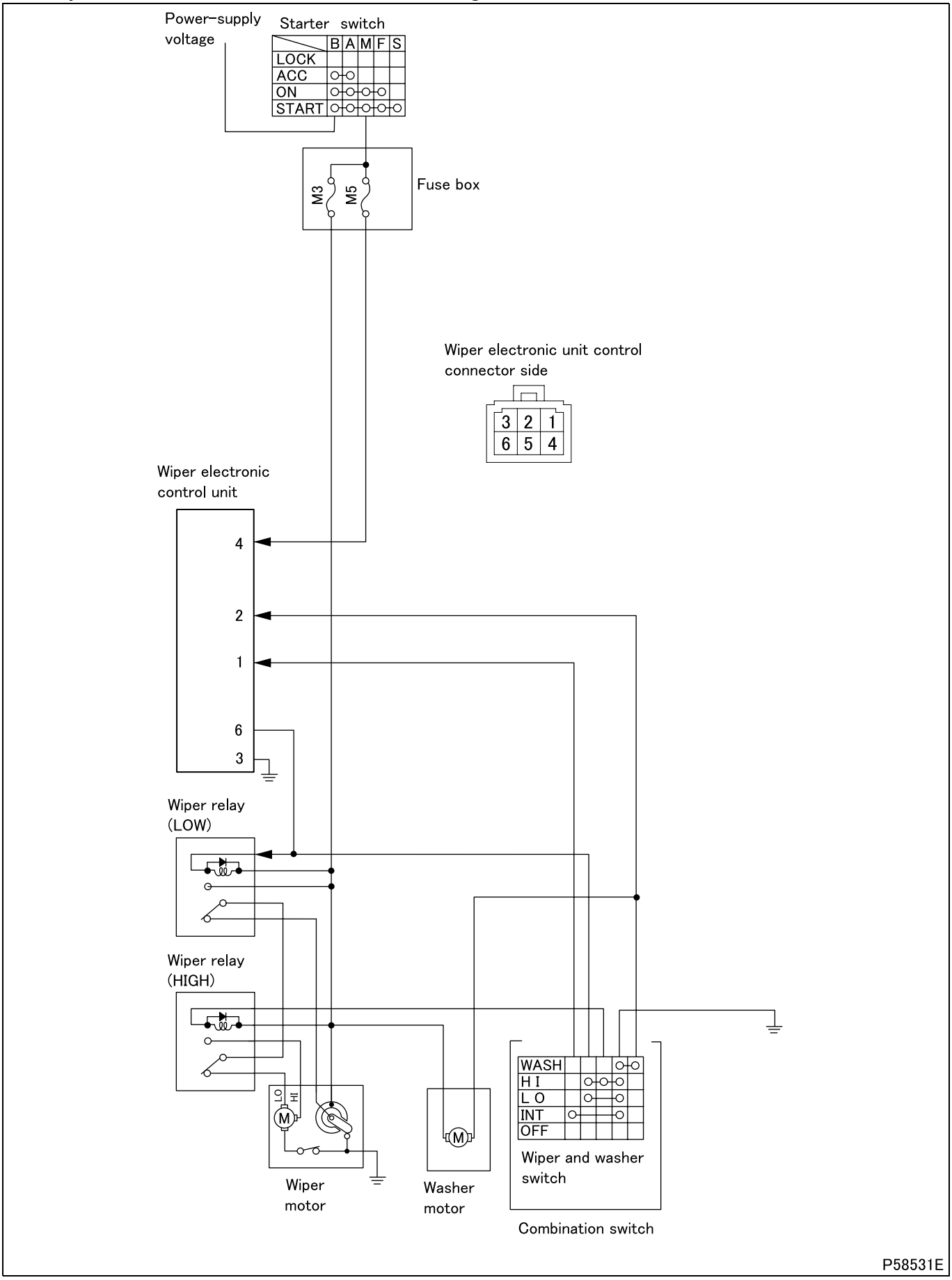
- This function causes the windshield wipers to operate a few times at low speed when the windshield washer switch is turned ON.
- As shown in the drawing, the wiper electronic control unit introduces a short delay between detecting the ON condition of the wiper and washer switch (washer switch) and activating the wiper relay.

6.3 Intermittent wiper activation function



- Wiper electronic control unit causes intermittent wiper operation to take place as shown in the drawing.

6.4 Wiper electronic control unit connection diagram

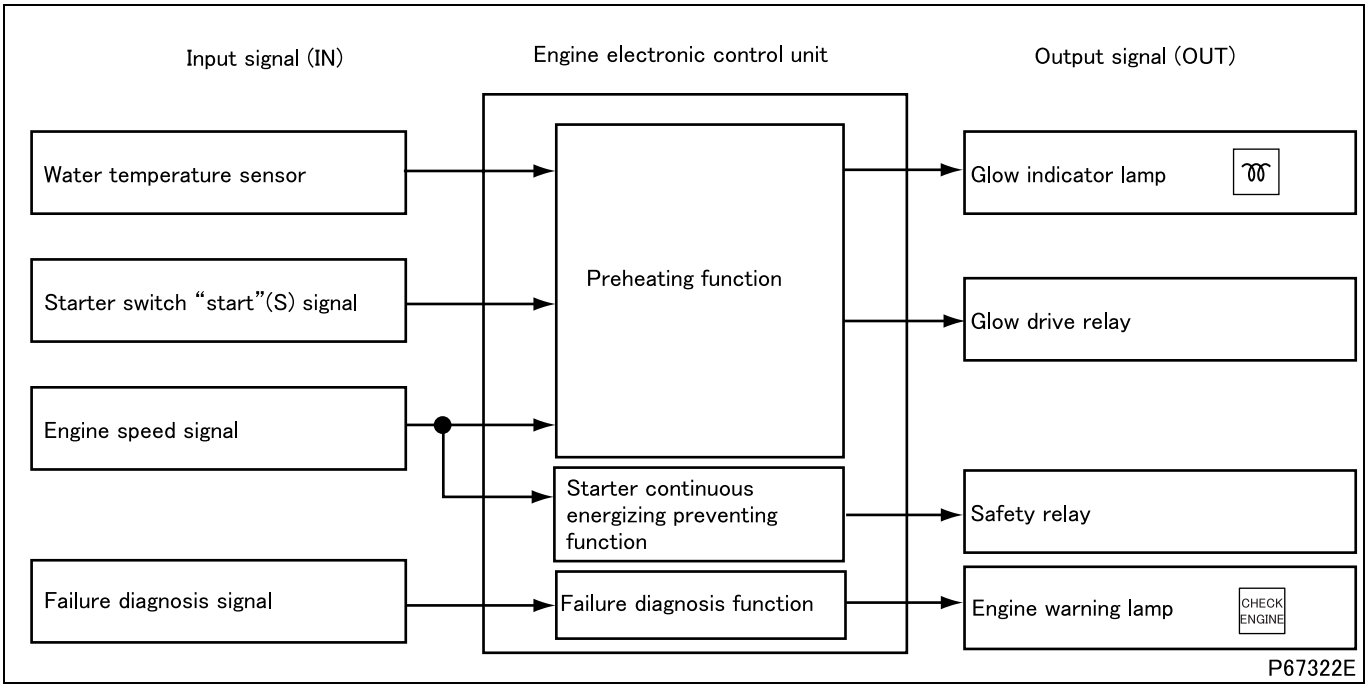


7. Starter Continuous Energizing Preventing Function and Preheating Function

7.1 Outline

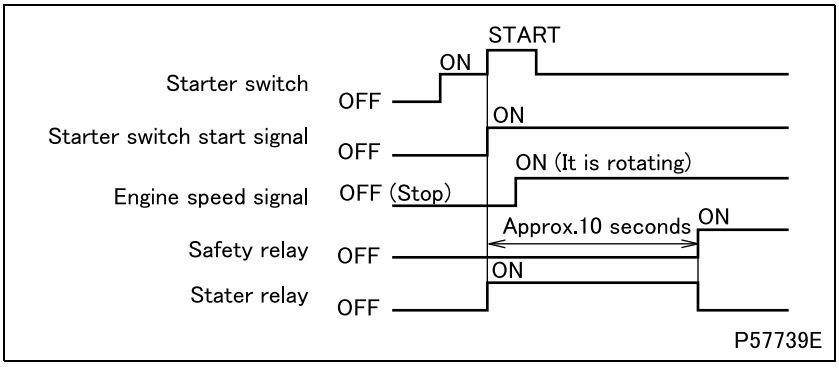
- These functions are controlled by the engine electronic control unit.

(1) System function schematic



Information signal	Parts name	Major function and operation
Engine water temperature signal	Water temperature sensor	Engine water temperature detection
Starter switch "start" (S) signal	Starter switch	Start position detection
Engine speed signal	Engine speed sensor	Engine speed detection
Failure diagnosis signal	Diagnosis switch	Output of diagnosis code
	Memory clear switch	Erasure of diagnosis code Transmission of past diagnostic code
Engine warning signal	Engine warning lamp	Abnormality of each function
Safety relay activation signal	Safety relay	Release of starter continuous energizing

7.2 Starter continuous energizing preventing function

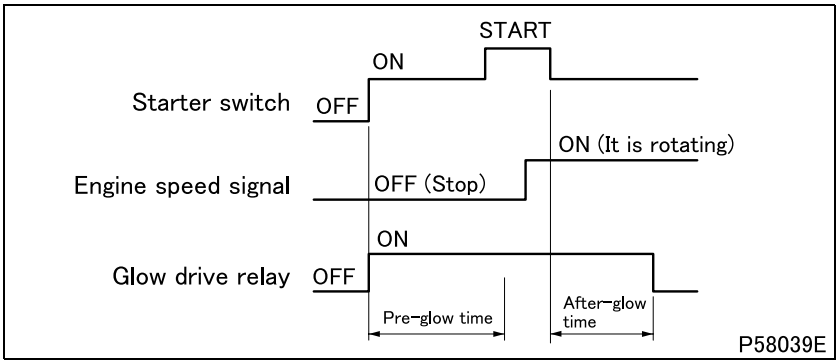


- This function is provided to prevent starter over-run.
- If the starter operates for longer than a predetermined period following engine startup, the Engine electronic control unit deems that it has been energized continuously for too long. The Engine electronic control unit then stops the flow of current to the starter and starter relay, thereby preventing the starter from seizing.

- If the engine electronic control unit determines, based on the engine speed signal it receives, that the engine has run at or above the specified speed for longer than the specified time period after start-up, the unit trips the safety relay open.

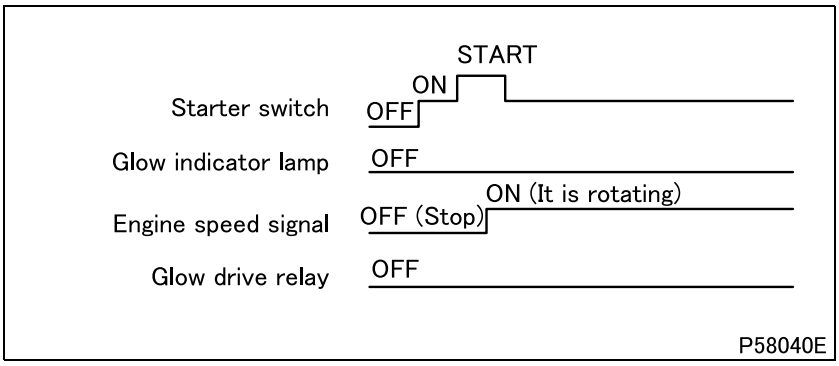
7.3 Preheating function

- This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
  Engine electronic control unit the entire function as follows:



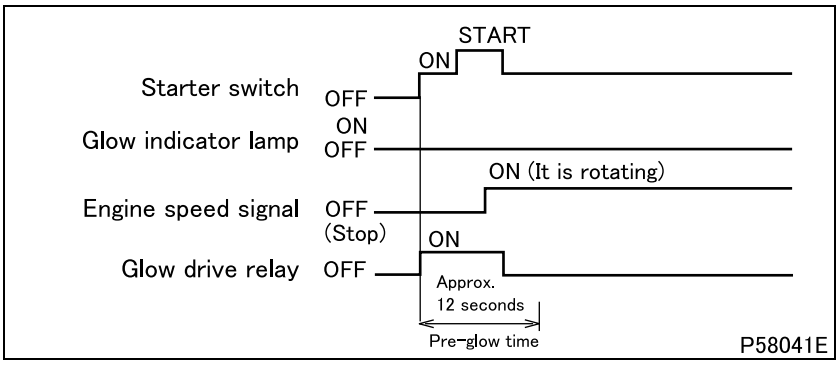
(1) Pre-glow and After-glow

The preheating is operated with a pre-glow before the engine starts and an after-glow after the engine starts. They are controlled by the starter switch (S terminal) signal, engine water temperature signal and the engine speed signal.

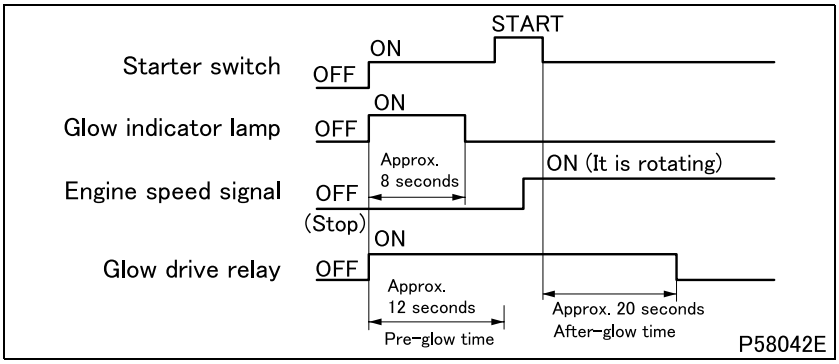


(2) Operation mode

- When the engine coolant temperature is 60°C {140°F} or more.



- When the engine coolant temperature is 0 to 60°C {32 to 140°F}.



- When the engine coolant temperature is 0°C {32°F} or less.

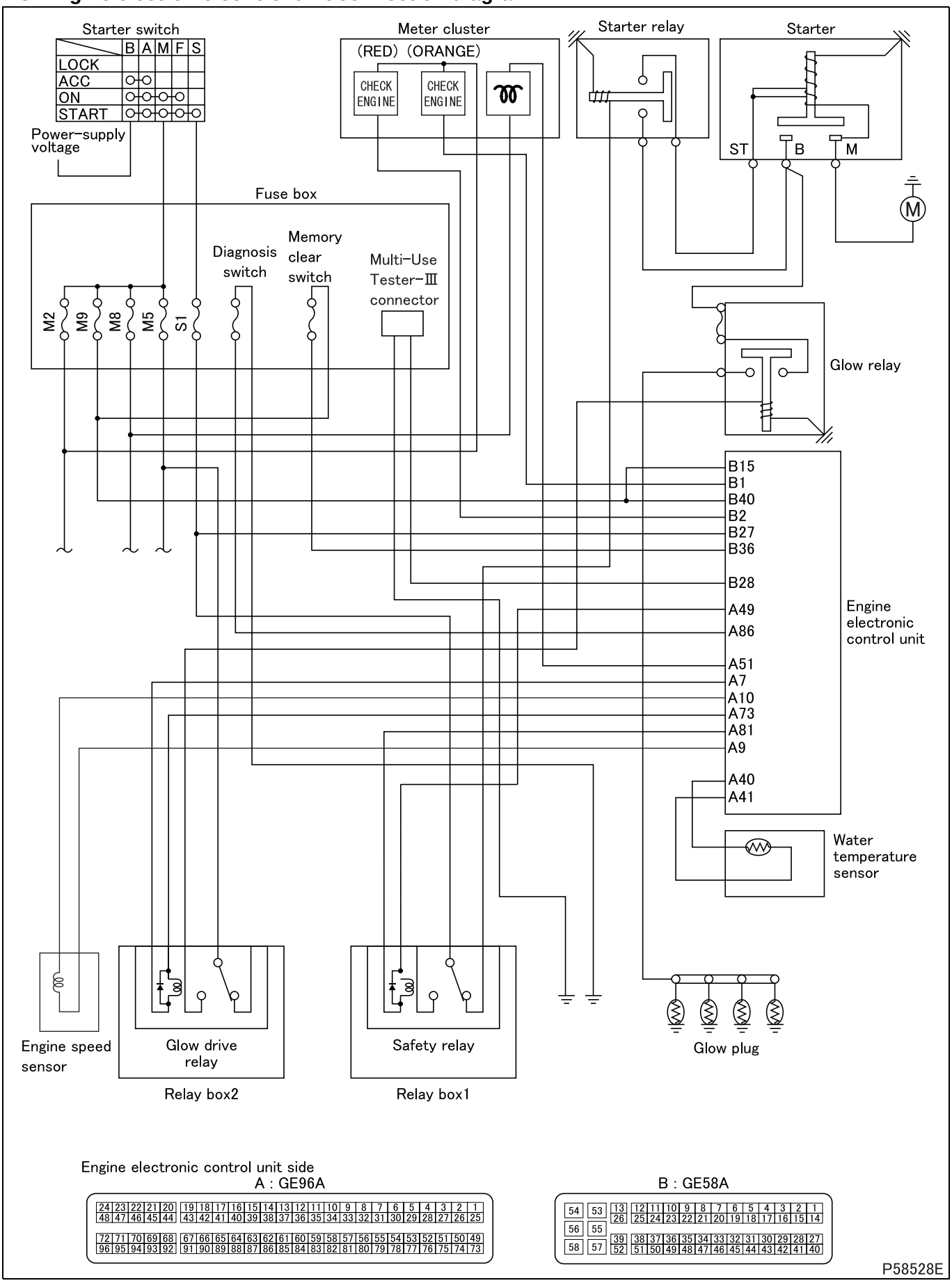
7.4 Fault diagnosis function

- While the starter switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found faulty, an indication is made in the meter cluster to alert the driver, the fault location is memorized in the form of a diagnosis code, and backup control necessitated by the fault is initiated.
- While the backup control is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

7.5 Engine electronic control unit connection diagram



GROUP 54-00D TROUBLESHOOTING

1. Power and Charging

Symptoms / Possible causes		Battery electrolyte decreases too early.	Battery overheating.	Battery is normal but over-discharged.	Charge warning lamp does not light when starter switch is turned ON, with engine stopped.	Alternator is normal but battery over-discharged.	Reference Gr
Connector connection faulty, harness broken, grounding faulty				O		O	
Fuse blown				O	O	O	
V-belts loose				O		O	Gr14
V-belts damaged				O		O	Gr14
Battery faulty		O				O	
Alternator	Stator coil broken			O			
	Stator coil short-circuited with core			O			
	Field coil broken			O			
	Rectifier faulty			O			
	Regulator faulty		O	O	O		
	Wiring faulty			O			
Meter cluster faulty					O		

2. Engine Starting

Symptoms / Possible causes		Starter does not operate.	Starter operates but engine does not start: Pinion does not engage with ring gear.	Starter operates but engine does not start: Pinion engages with ring gear but does not rotate.	Starter operates but engine does not start: Flywheel rotates but engine does not start.	Engine does not stop.	Engine cannot be preheated.	Engine is hard to start.	Engine warm-up function does not operate.	Reference Gr
Connector connection faulty, harness broken, grounding faulty		O			O	O	O		O	
High-current fuse blown		O								
Fuse blown		O				O	O		O	
Battery insufficiently charged		O		O						
Starter	Magnetic switch contacts stuck or fused together	O								
	Open circuit in magnetic switch coil	O								
	Overrunning clutch malfunctioning			O						
	Pinion worn or damaged		O							
Starter relay defective		O								
Starter switch defective		O				O				
Flywheel ring gear worn or damaged			O							Gr11
Glow plugs defective							O	O		
Glow relay defective							O	O		
Safety relay defective		O								
Water temperature sensor defective							O	O	O	
Engine electronic control unit defective		O					O	O	O	Gr13E
Exhaust brake system defective								O	O	Gr35
Faulty connection of connecting plate							O	O		
Transmission neutral switch defective									O	
Neutral start relay defective <A/T>		O								
Inhibitor switch defective <A/T>		O								
Warm-up switch defective									O	

A/T: Automatic transmission

3. Lighting

Symptoms / Possible causes		Headlamp				Tail lamp does not light.	Stop lamp does not light.	Identification lamp, clearance and side marker lamp does not light.	Parking lamp does not light.	License plate lamp does not light.	Backup lamp does not light.	Back buzzer does not sound.	Reference Gr
		Does not light.	Dim.	Does not switch to main beam.	Does not switch to dipped beam.								
Connector connection faulty, harness broken, grounding faulty		O				O	O	O	O	O	O	O	
Fuse blown		O				O	O	O	O	O	O	O	
Battery capacity insufficient			O										
Alternator output insufficient			O										
Bulb burnt-out		O				O	O	O	O	O	O	O	
Power (wattage) of bulb is lower than specified value													
Power (wattage) of bulb is higher than specified value													
Combination switch	Lighting switch faulty	O				O		O	O	O		O	
	Turn signal lamp switch faulty												
	Dimmer switch faulty			O	O								
Relay box	Headlamp relay (HIGH, LOW) faulty	O		O	O								
	Tail lamp relay faulty					O		O	O	O		O	
	Stop lamp relay faulty						O						
Stop lamp switch faulty							O						
Flasher unit faulty													
Backup lamp switch faulty											O		
Back buzzer faulty													
Cab lamp switch faulty													
Cab lamp faulty													
Door switch faulty													
Hazard warning lamp switch faulty													
Rheostat switch faulty													

Symptoms / Possible causes		Turn signal lamp (serving also as hazard warning lamp)					Cab lamp does not light.	Interior illumination lamps for meters, radio system, etc. do not light.	Reference Gr
		Does not blink.	Stay ON.	Blinks too slowly.	Blinks too quickly.	Blinks irregularly.			
Connector connection faulty, harness broken, grounding faulty		O					O	O	
Fuse blown		O					O		
Battery capacity insufficient			O						
Alternator output insufficient			O						
Bulb burnt-out		O			O		O	O	
Power (wattage) of bulb is lower than specified value					O				
Power (wattage) of bulb is higher than specified value				O					
Combination switch	Lighting switch faulty							O	
	Turn signal lamp switch faulty								
	Dimmer switch faulty								
Relay box	Headlamp relay (HIGH, LOW) faulty								
	Tail lamp relay faulty							O	
	Stop lamp relay faulty								
	Turn signal lamp relay faulty	O							
Stop lamp switch faulty									
Flasher unit faulty		O	O	O	O	O			
Backup lamp switch faulty									
Back buzzer faulty									
Cab lamp switch faulty							O		
Cab lamp faulty							O		
Door switch faulty							O		
Hazard warning lamp switch faulty		O	O						
Rheostat switch faulty								O	

Symptoms / Possible causes		Van body dome light does not light.	Daytime running light system does not operate after engine starts, and headlamps do not light.	Reference Gr
Connector connection faulty, harness broken, grounding faulty		O	O	
Fuse blown		O		
Battery capacity insufficient				
Alternator output insufficient				
Bulb burnt-out		O		
Power (wattage) of bulb is lower than specified value				
Power (wattage) of bulb is higher than specified value				
Combination switch	Lighting switch faulty	O		
	Turn signal lamp switch faulty			
	Dimmer switch faulty			
Relay box	Headlamp relay (HIGH, LOW) faulty		O	
	Tail lamp relay faulty		O	
	Stop lamp relay faulty			
	Turn signal lamp relay faulty			
	Daytime running light relay		O	
Stop lamp switch faulty				
Flasher unit faulty				
Backup lamp switch faulty				
Back buzzer faulty				
Cab lamp switch faulty				
Cab lamp faulty				
Door switch faulty				
Hazard warning lamp switch faulty				
Rheostat switch faulty				
Van body dome light relay faulty		O		
Van body dome light switch faulty		O		
Daytime running light electronic control unit faulty			O	

4. Meter

Symptoms / Possible causes		Pointer does not move.	Pointer movement unstable.	Indication error large.	Abnormal noise from meter.	Reference Gr
Connector connection faulty, harness broken, grounding faulty		O	O			
Fuse blown		O				
Internal circuits of meter cluster faulty		O	O	O		
Printed wiring board of meter cluster faulty		O				
Tachometer	Engine speed sensor coil open-circuited	O				
	Engine speed sensor improperly mounted	O	O			
	Tachometer faulty	O	O	O	O	
Speedometer or tachograph	Vehicle speed sensor faulty	O				
	Vehicle speed sensor improperly mounted		O			
	Specified tires not used			O		Gr31
	Tires worn or inflation pressure incorrect			O		Gr31
	Specified L-joint of transmission not used (difference in gear ratio)			O		Gr22
	Specified speedometer gear of transmission not used (difference in gear ratio)			O		Gr22
	Installation angle of speedometer gear bushing on transmission incorrect (not set at correct gear ratio position)			O		Gr22
	Speedometer or tachograph faulty	O	O	O	O	
Water temperature gauge	Water temperature sensor faulty	O		O		
	Water temperature gauge faulty	O		O		
	Thermostat does not close	O				Gr14
Fuel gauge	Fuel level sensor faulty	O		O		
	Fuel gauge faulty	O		O		

5. Cigarette Lighter and Audio

Symtoms / Possible causes	Cigarette lighter			Audio	Reference Gr
	Does not glow.	Does not return.	Night lamp does not light up.	Radio does not work.	
Connector connection faulty, harness disconnection, grounding faulty	O		O	O	
Fuse blown	O		O	O	
Cigarette lighter faulty	O	O			
Tail lamp relay faulty			O		
Antenna and antenna cable connection faulty				O	
Radio amplifier faulty				O	
Radio tuner faulty				O	
Cassette deck head and pinch roller faulty					
Speaker faulty				O	
Left and right speaker impedance different					

6. Accessory Noise Generation Source

Accessory	Noise	Symptoms
Alternator	Whistling	High pitch sound when accelerator pedal suddenly pressed (Stops soon after engine stopped)
Water temperature gauge	Scratching	Occurs when engine running (Continues for a while after engine stops)
Engine oil pressure switch	Rattling	Depends on engine speed (Does not occur during idling)
Fuel level sensor	Scratching	Occurs when engine suddenly revved, while running on rough roads, or starter switch turned ON
Flasher unit	Banging	When turn signal blinks
Horn	Hissing	Occurs when horn button pressed or released
Wiper motor	Whining	Depends on windshield wiper speed
Washer motor	Whining	When windshield washer operates

7. Horn

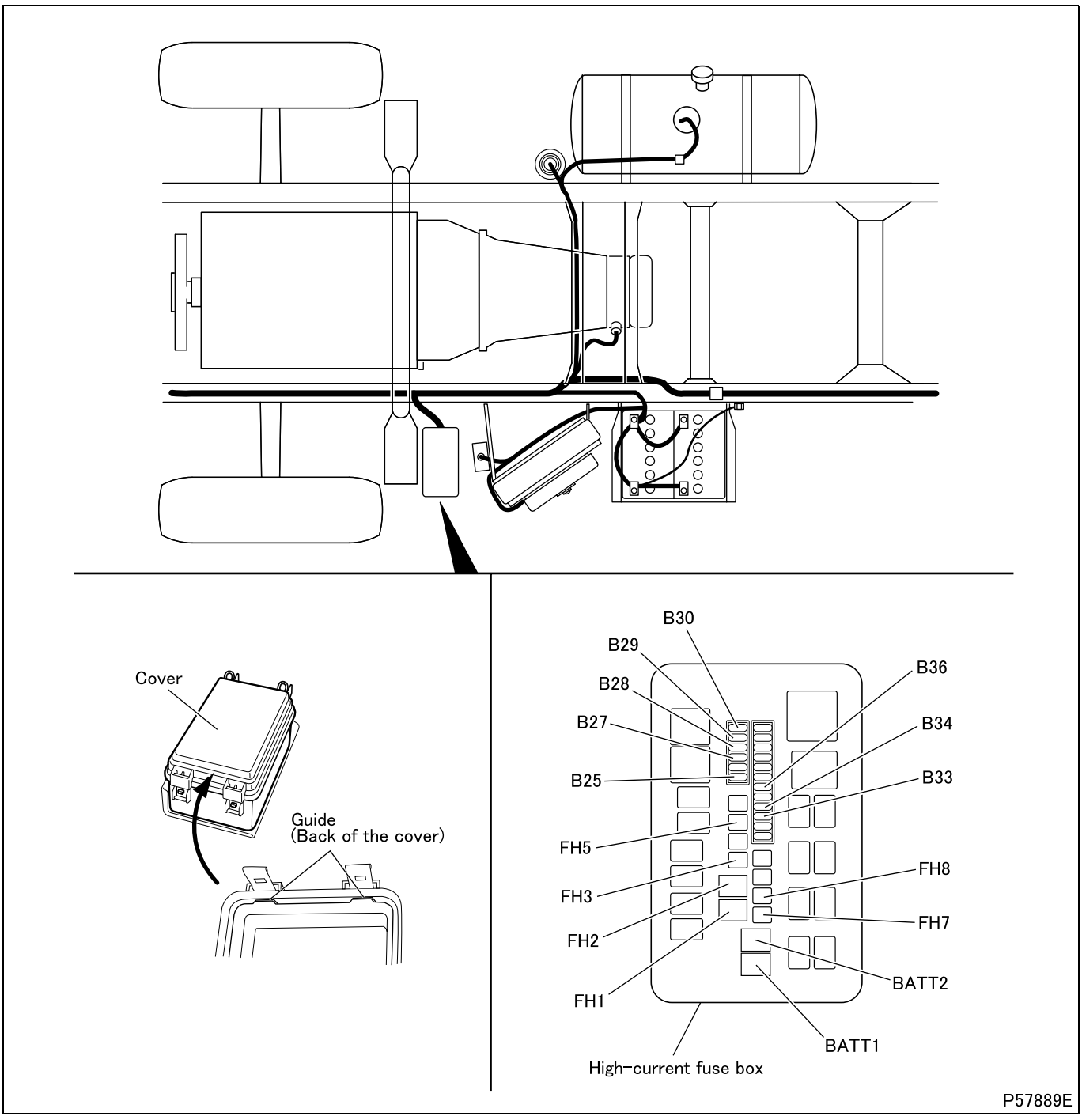
Symptoms / Possible causes	Horn				Reference Gr
	No sound	Continuous sound	Small sound	Sound quality poor	
Connector connection faulty, harness disconnection, grounding faulty	O				
Fuse blown	O				
Horn switch faulty	O	O			
Horn faulty	O		O	O	
Horn stay warped			O	O	
Battery voltage insufficient	O		O		

8. PREHEATING SYSTEM (See #955)

9. STARTER CONTINUOUS ENERGIZING PREVENTING FUNCTION (See #956)

GROUP 54-01 POWER, CHARGE, AND GROUND CIRCUIT

HIGH-CURRENT FUSE BOX



WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative (–) cable of the battery and insulate it with tape before removing high-current fuses. (See #860.)**
- **With the negative (–) cable of the battery connected, battery voltage is always applied to each fuse. The battery voltage is applied to the fuses under the following conditions: Always (directly connected to the battery)**

CAUTION ⚠

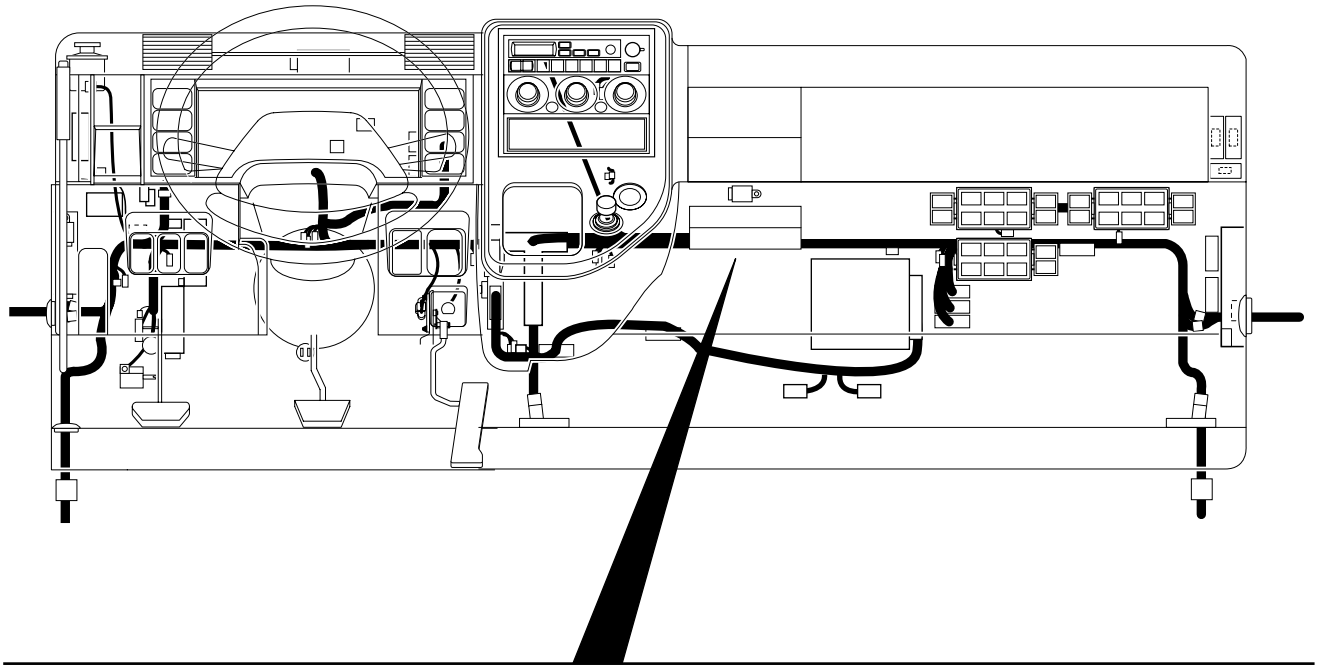
- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use the fuse with the specified ampere.**
- **When installing the cover on the high-current fuse box, lightly press the cover directly down until the guide on the cover securely fits in the guide on the fuse box. Do not push the cover inward with excessive force, as doing so could easily damage the guides.**

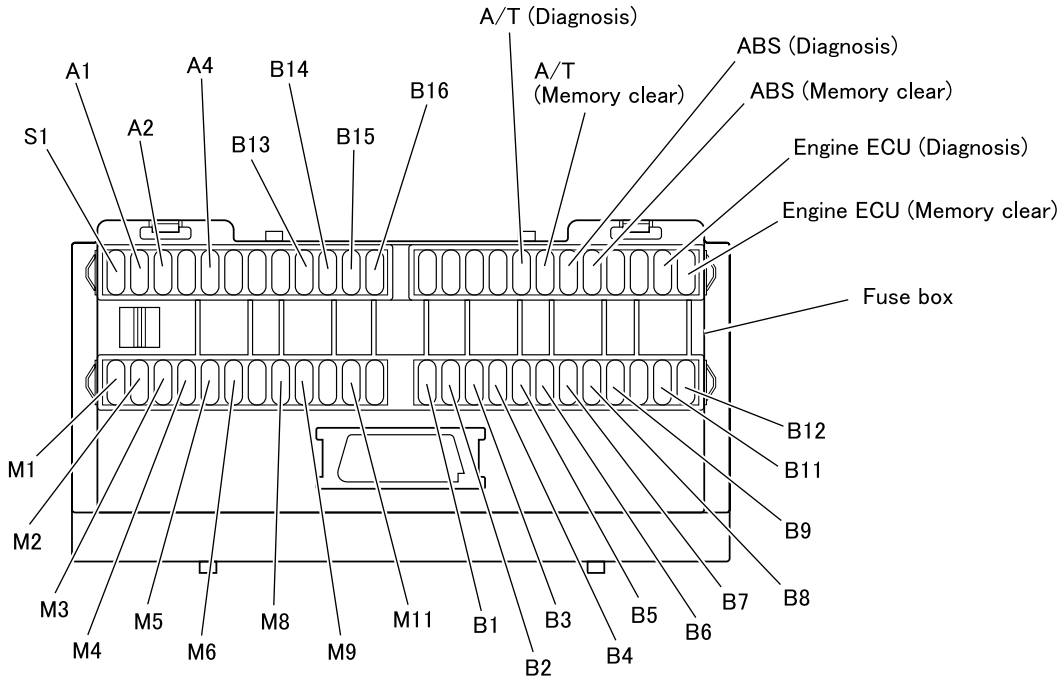
High-current fuse box

Fuse No.	Main load	Capacity
FH1	Fuse box (S1, A1 to A5, M1 to M12)	60A
FH2	Fuse box (B1 to B12)	60A
FH3	Fuse box (B13 to B16)	40A
FH5	Hydraulic booster	60A
FH7	ABS motor	40A
FH8	ABS solenoid	40A
B25	Tail lamp	15A
B27	Horn	10A
B28	Air-conditioner	10A
B29	Condenser fan	25A
B30	Blower fan	30A
B33	Van body dome light	10A
B34	ATF cooler fan	20A
B36	Engine electronic drive unit	20A
BATT1	Alternator	120A
BATT2	Alternator	120A

ABS: Anti-lock brake system
ATF: Automatic transmission fluid

FUSE BOX





ECU : Electronic control unit
A/T : Automatic transmission

P57900E

CAUTION ⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use the fuse with the specified ampere.**

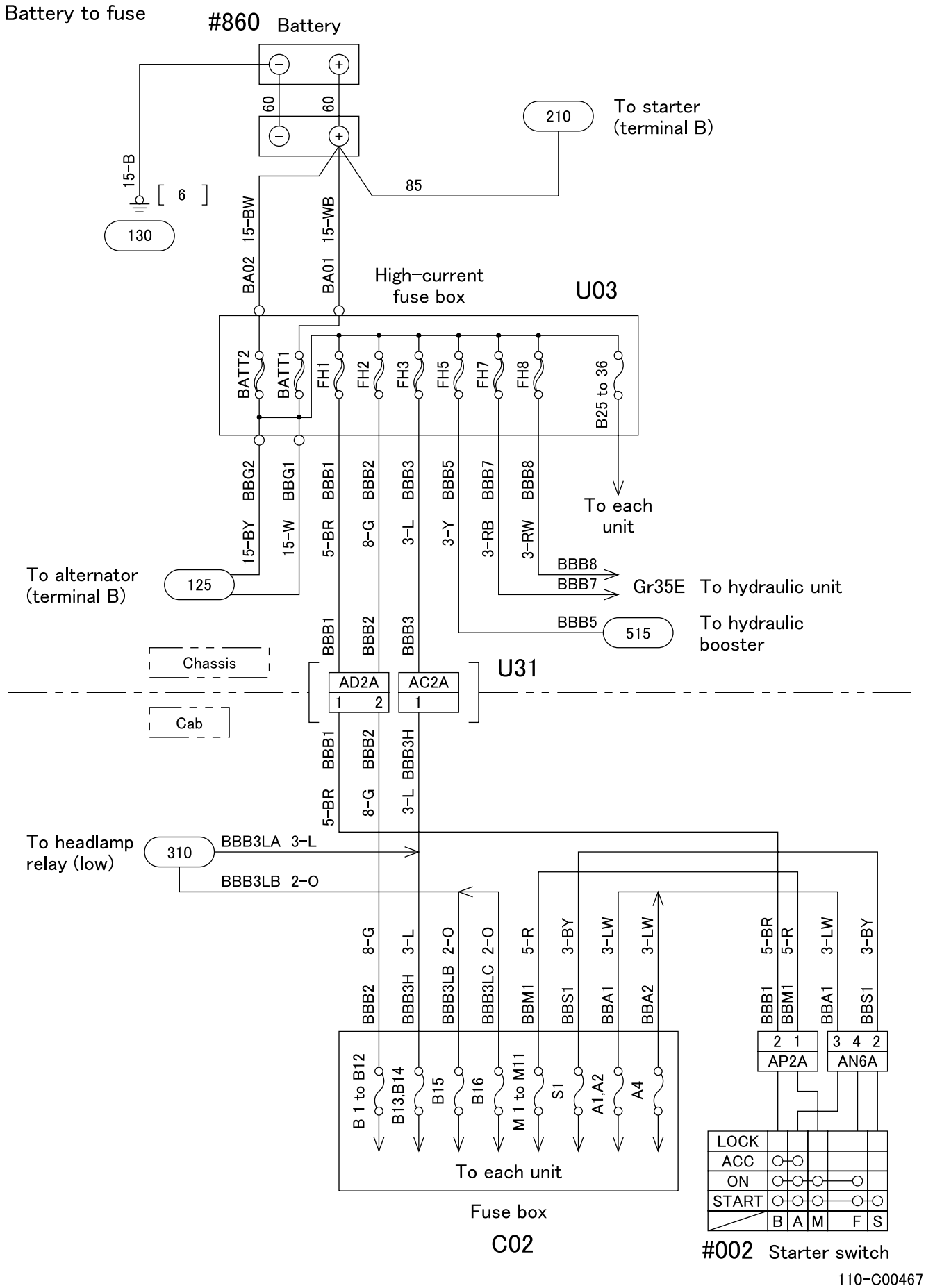
Fuse box

Fuse No.	Main load	Capacity
A1	Cigarette lighter	15A
A2	Audio	10A
A4	Opt (ACC)	10A
B1	Stop lamp	15A
B2	Meter	10A
B3	Turn signal lamp	15A
B4	Opt (B)	10A
B5	Audio	10A
B6	Cab lamp	10A
B7	Power window (driver)	30A
B8	Power window (assistant)	30A
B9	Engine electronic control unit	20A
B11	Mirror heater	20A
B12	Automatic transmission	10A
B13	Tester	15A
B14	Headlamp (HI)	20A
B15	Headlamp (LH/LO)	20A
B16	Headlamp (RH/LO)	20A
M1	Backup lamp	10A
M2	Meter	10A
M3	Wiper	15A
M4	Opt (M)	10A
M5	Relay control	10A
M6	Automatic transmission	10A
M8	Exhaust brake	10A
M9	Engine electronic control unit	5A
M11	ABS	10A
S1	Starter	10A

Diagnosis fuse

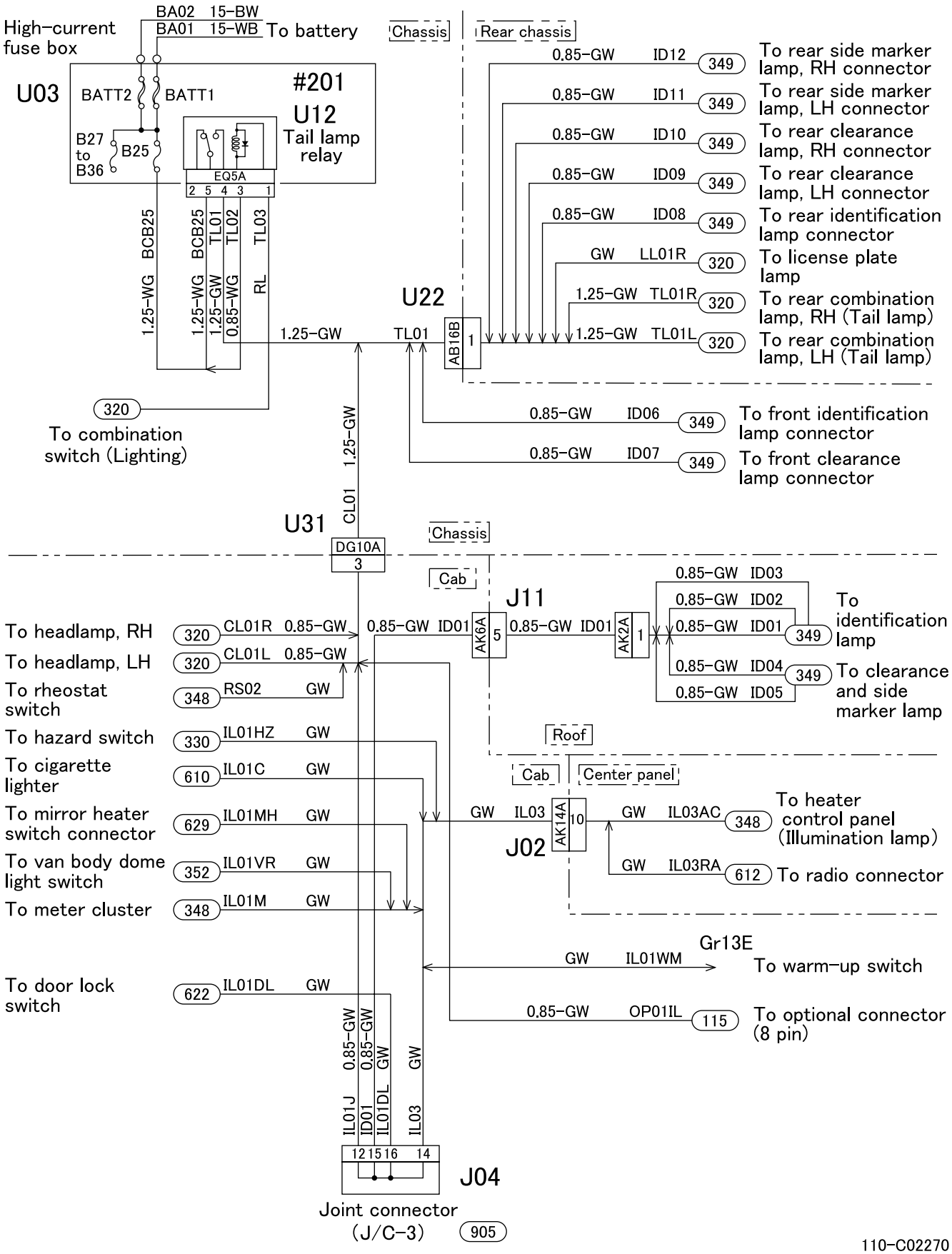
Fuse No.	Main load	Capacity
A/T	Diagnosis	5A
A/T	Memory clear	10A
ABS	Diagnosis	5A
ABS	Memory clear	10A
Engine ECU	Diagnosis	5A
Engine ECU	Memory clear	10A

ABS: Anti-lock brake system
A/T: Automatic transmission
ECU: Electronic control unit


Battery to fuse
#860 Battery
60
60
210
To starter
(terminal B)
85
15-B
[6]
130
15-BW
15-WB
BA02
BA01
High-current
fuse box
U03
BATT2
BATT1
FH1
FH2
FH3
FH5
FH7
FH8
B25 to 36
BBG2
BBG1
BBB1
BBB2
BBB3
BBB5
BBB7
BBB8
To each
unit
15-BY
15-W
5-BR
8-G
3-L
3-Y
3-RB
3-RW
BBB8
BBB7
Gr35E
To hydraulic unit
To alternator
(terminal B)
125
BBB5
515
To hydraulic
booster
Chassis
Cab
U31
AD2A
1 2
AC2A
1
BBB1
BBB2
BBB3H
5-BR
8-G
3-L
To headlamp
relay (low)
310
BBB3LA 3-L
BBB3LB 2-O
BBB2
BBB3H
BBB3LB
BBB3LC
BBM1
BBS1
BBA1
BBA2
8-G
3-L
2-O
2-O
5-R
3-BY
3-LW
3-LW
B 1 to B12
B13,B14
B15
B16
M 1 to M11
S1
A1,A2
A4
To each unit
Fuse box
C02
BBB1
BBM1
BBA1
BBS1
5-BR
5-R
3-LW
3-BY
2 1
AP2A
3 4 2
AN6A
LOCK
ACC
ON
START
B A M F S
#002 Starter switch

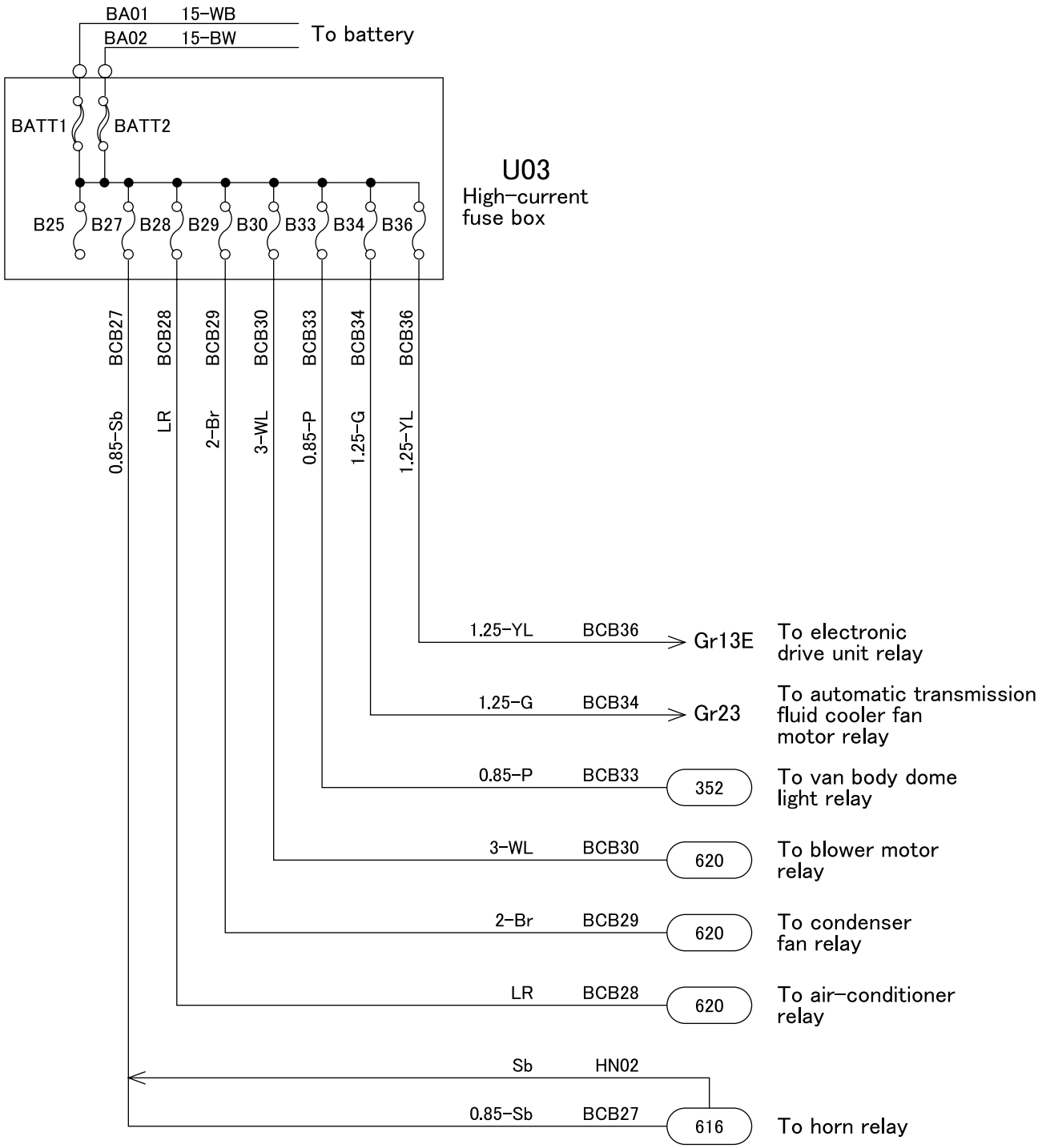
110-C00467

High-current fuse box
(Fuse B25)



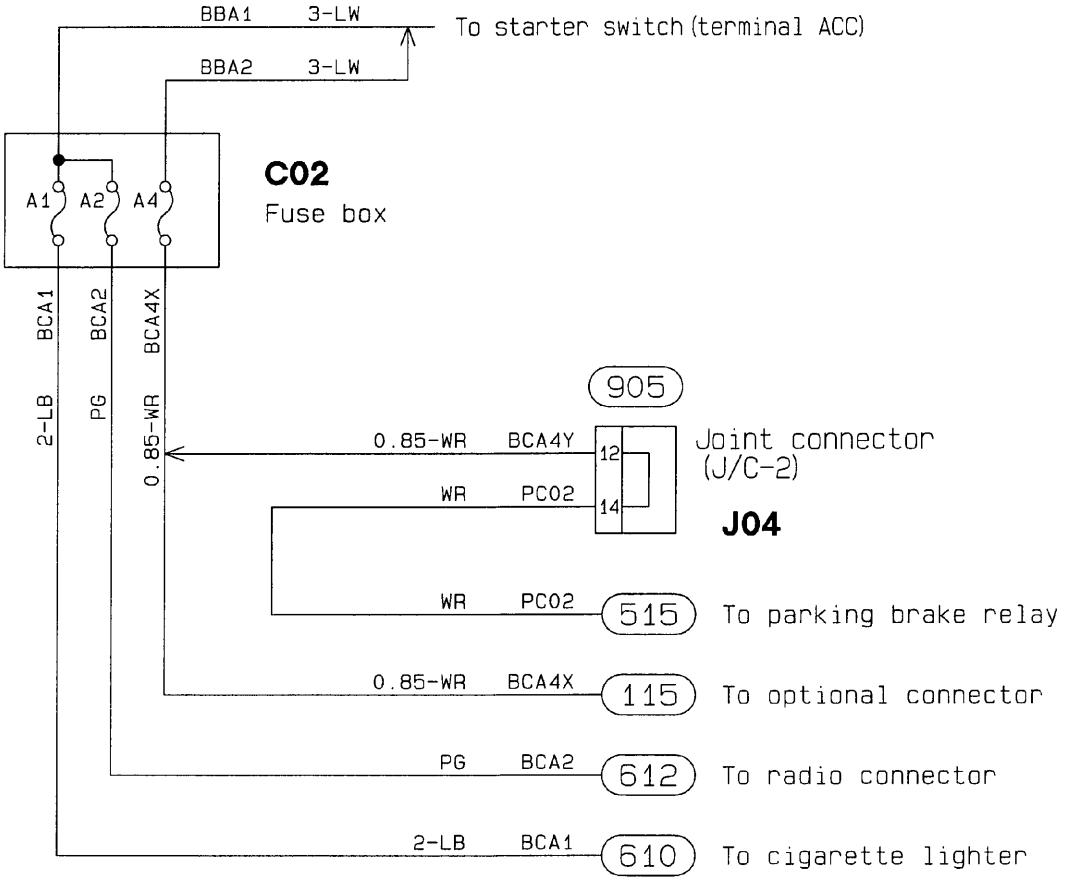
110-C02270

High-current fuse box
(Fuse B27 to B36)

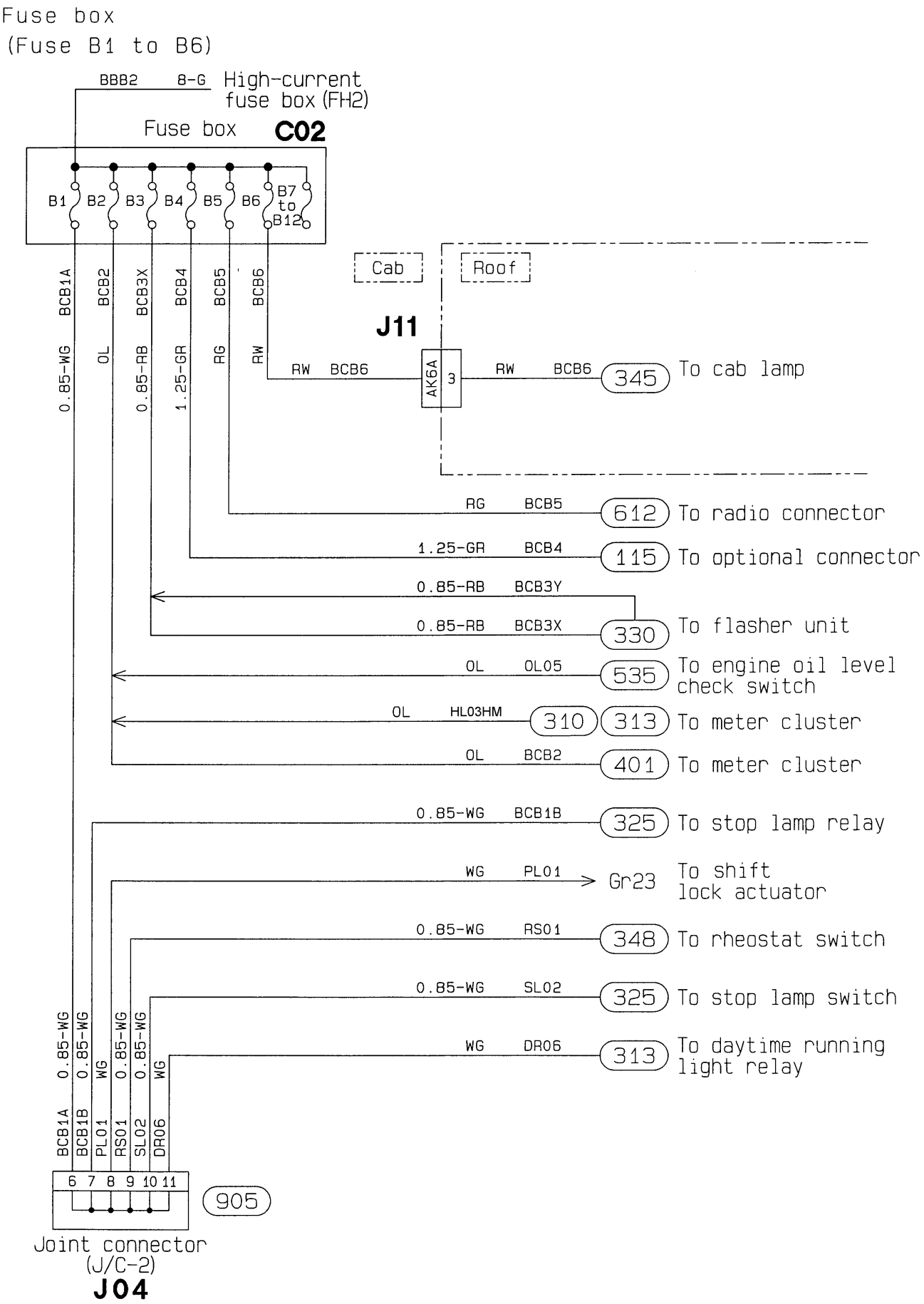


110-C00473

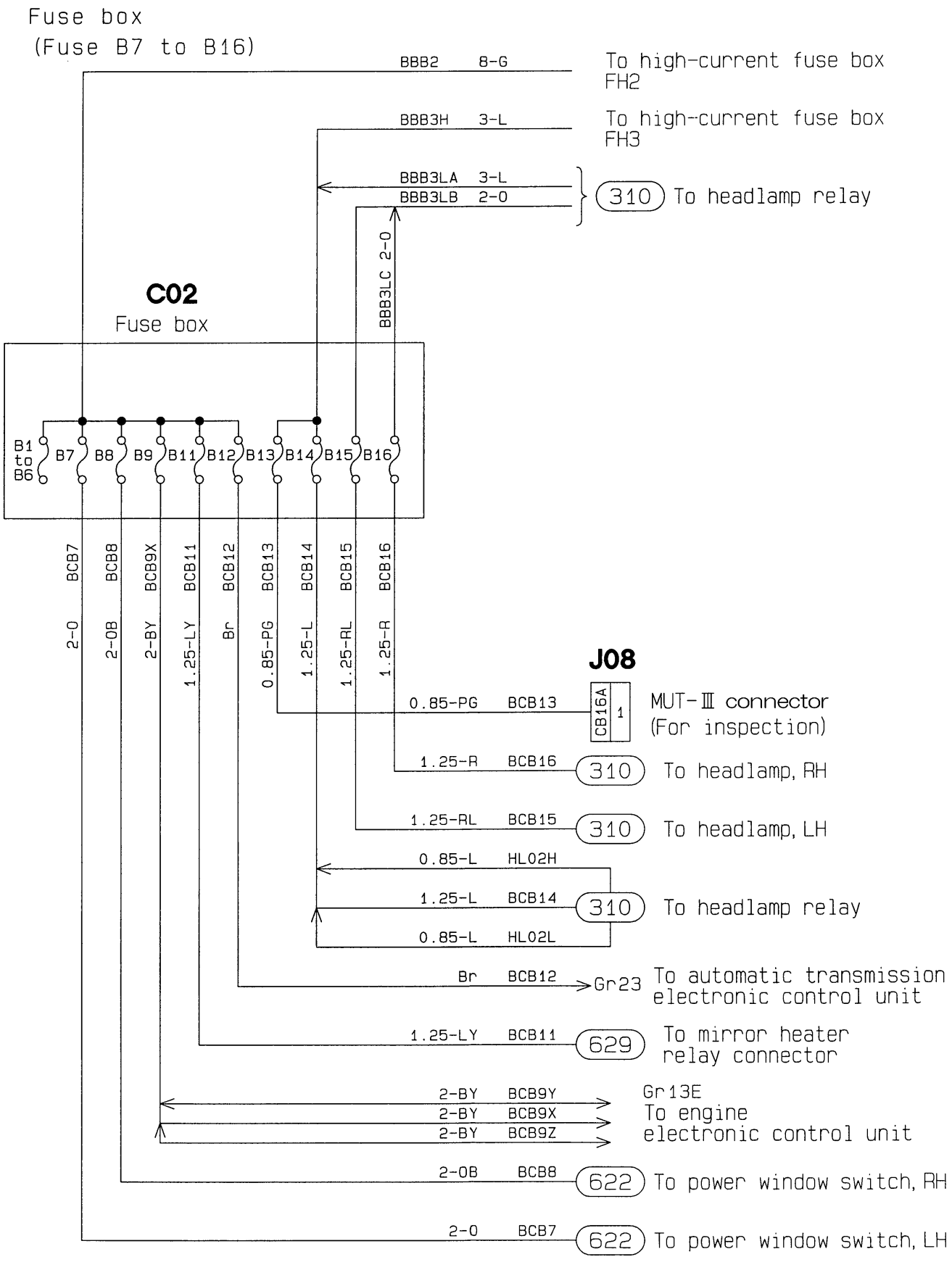
Fuse box
(Fuse A1 to A4)



C00469


Fuse box
(Fuse B1 to B6)
BBB2 8-G High-current fuse box (FH2)
Fuse box C02
B1 B2 B3 B4 B5 B6 B7 to B12
Cab
Roof
J11
AK6A 3
RW BCB6
RW BCB6 345 To cab lamp
RG BCB5 612 To radio connector
1.25-GR BCB4 115 To optional connector
0.85-RB BCB3Y
0.85-RB BCB3X 330 To flasher unit
OL OL05 535 To engine oil level check switch
OL HL03HM 310 313 To meter cluster
OL BCB2 401 To meter cluster
0.85-WG BCB1B 325 To stop lamp relay
WG PL01 Gr23 To shift lock actuator
0.85-WG RS01 348 To rheostat switch
0.85-WG SL02 325 To stop lamp switch
WG DR06 313 To daytime running light relay
BCB1A 0.85-WG
BCB1B 0.85-WG
PL01 WG
RS01 0.85-WG
SL02 0.85-WG
DR06 WG
6 7 8 9 10 11
905
Joint connector (J/C-2)
J04

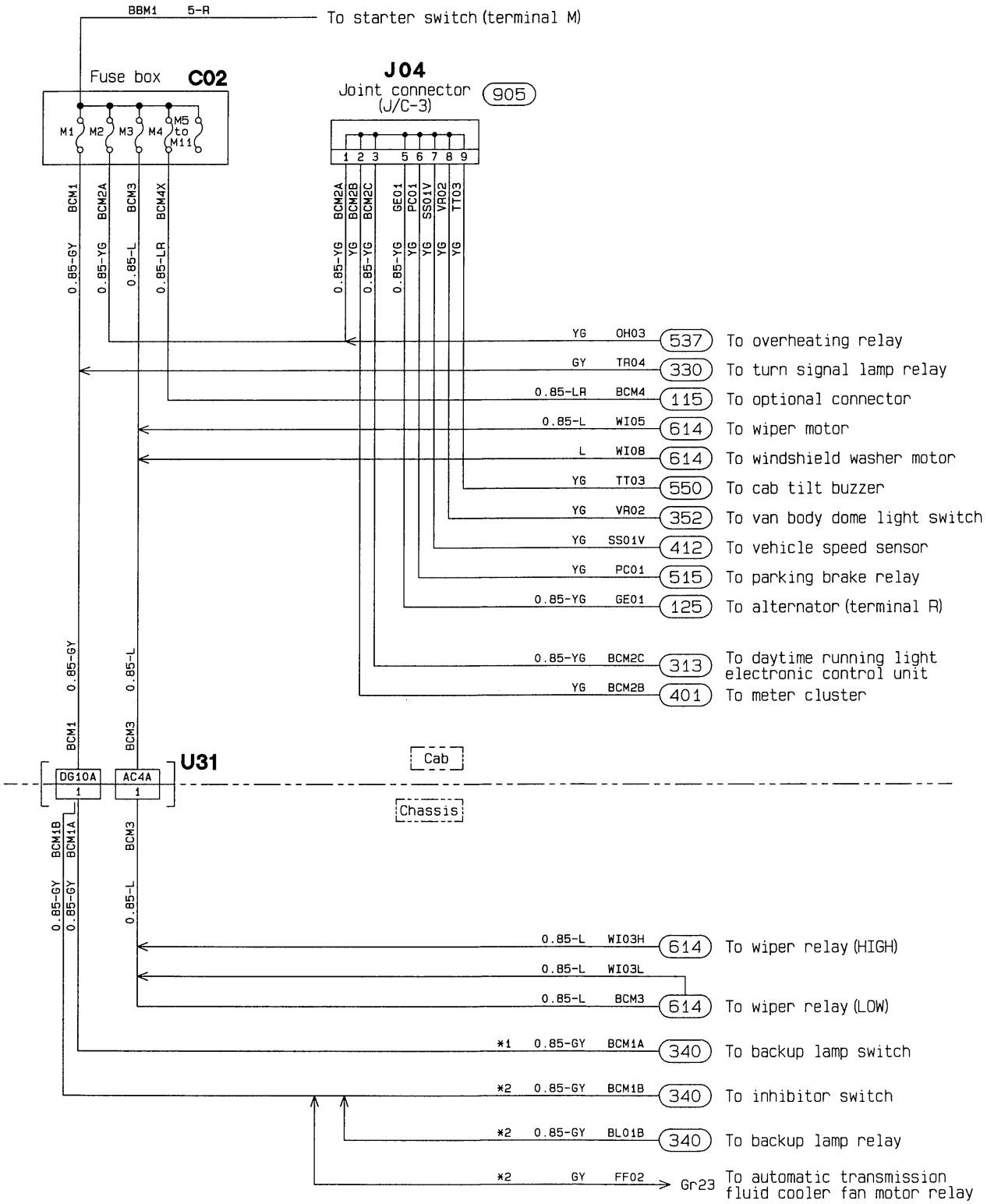
C02271



MUT : Multi-Use Tester

C00471

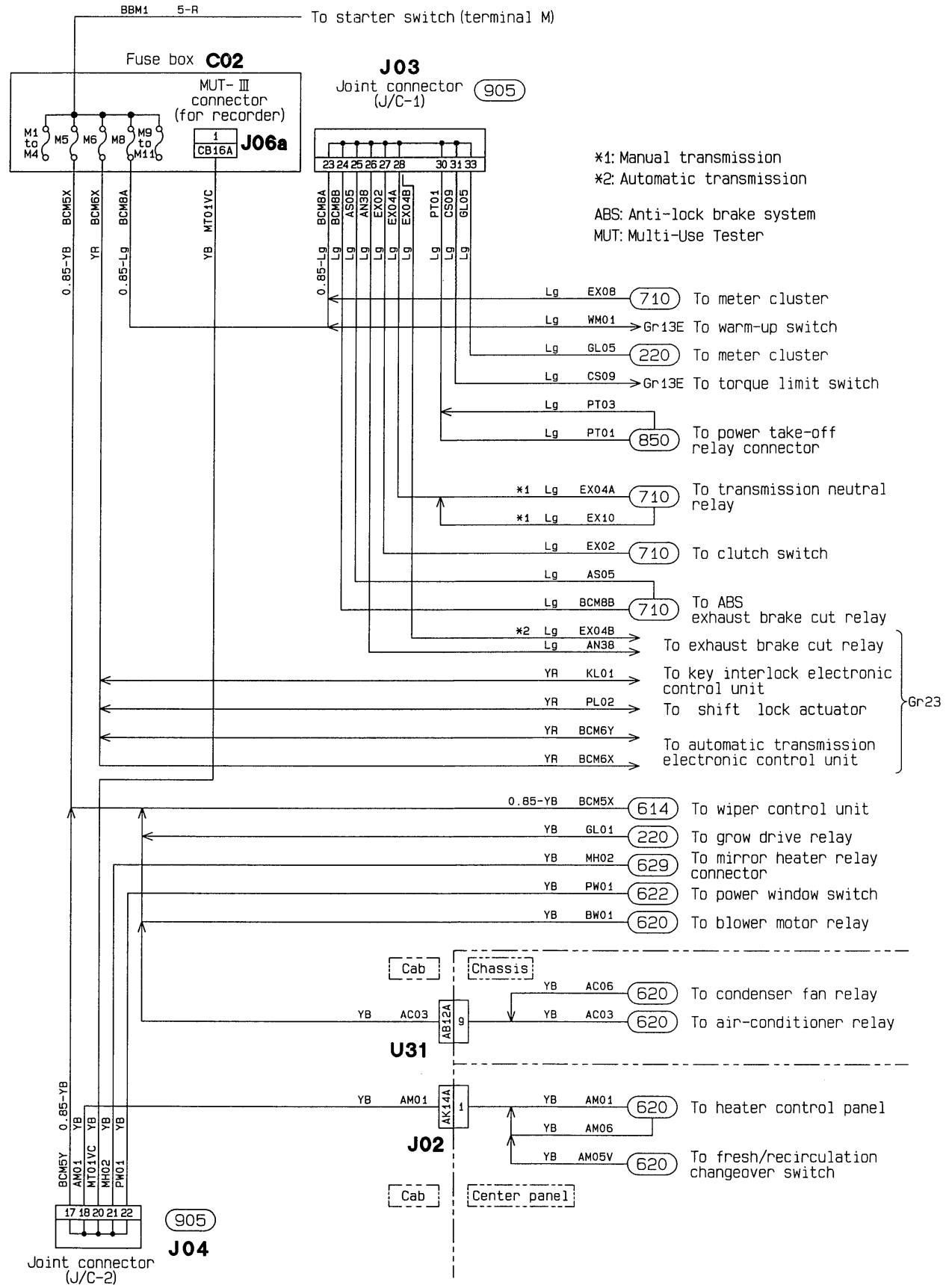
Fuse box
(Fuse M1 to M4)



*1 : Manual transmission
*2 : Automatic transmission

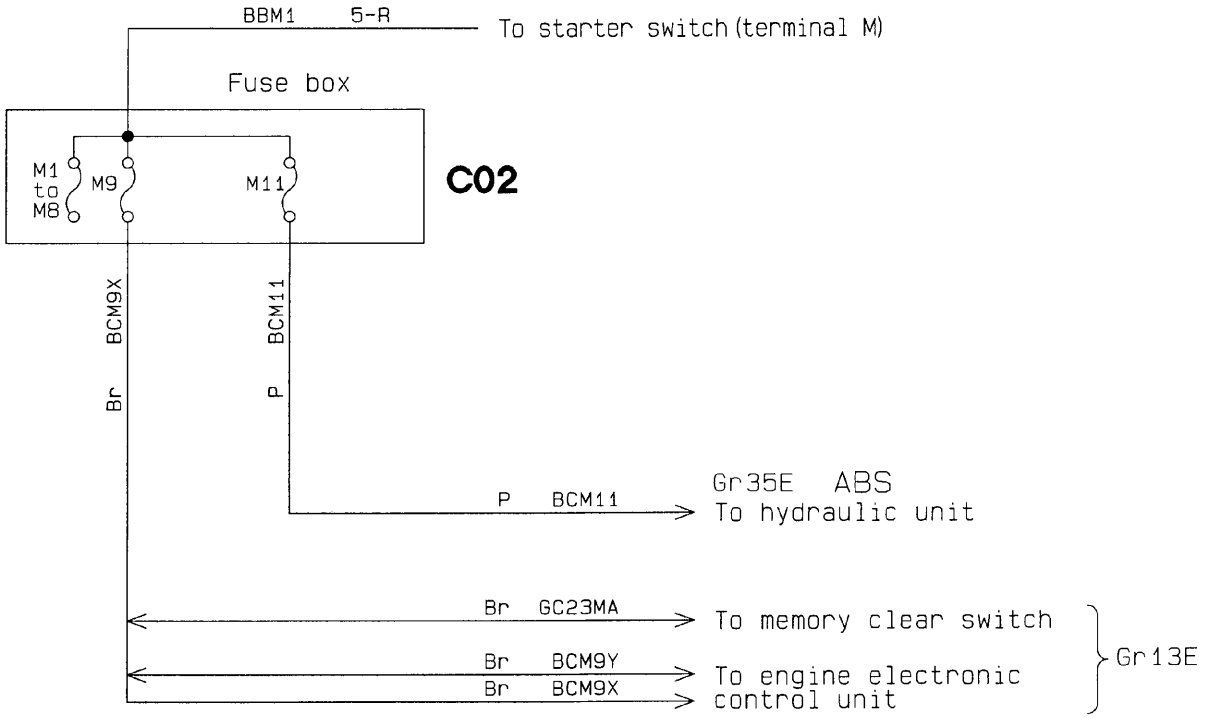
C02272

Fuse box
(Fuse M5 to M8)



C02273

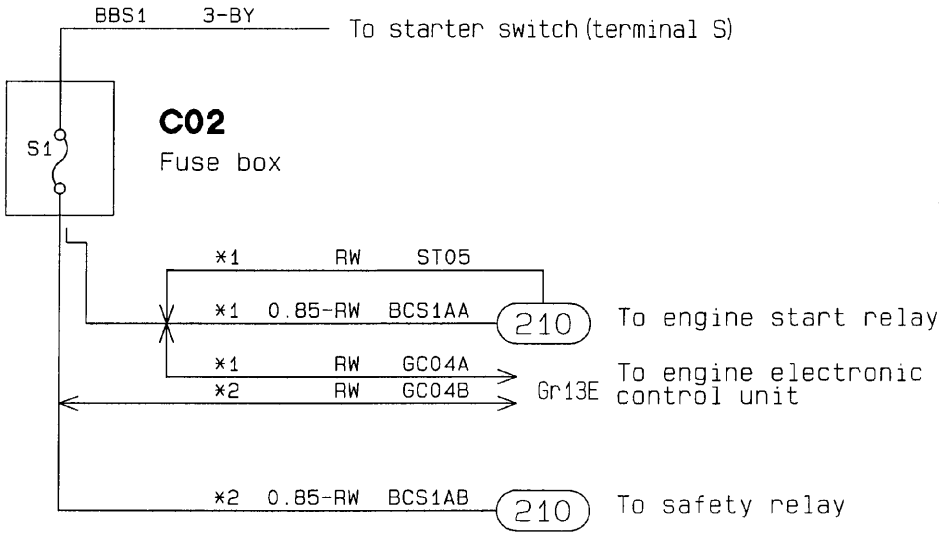
Fuse box
(Fuse M9 to M11)



ABS: Anti-lock brake system

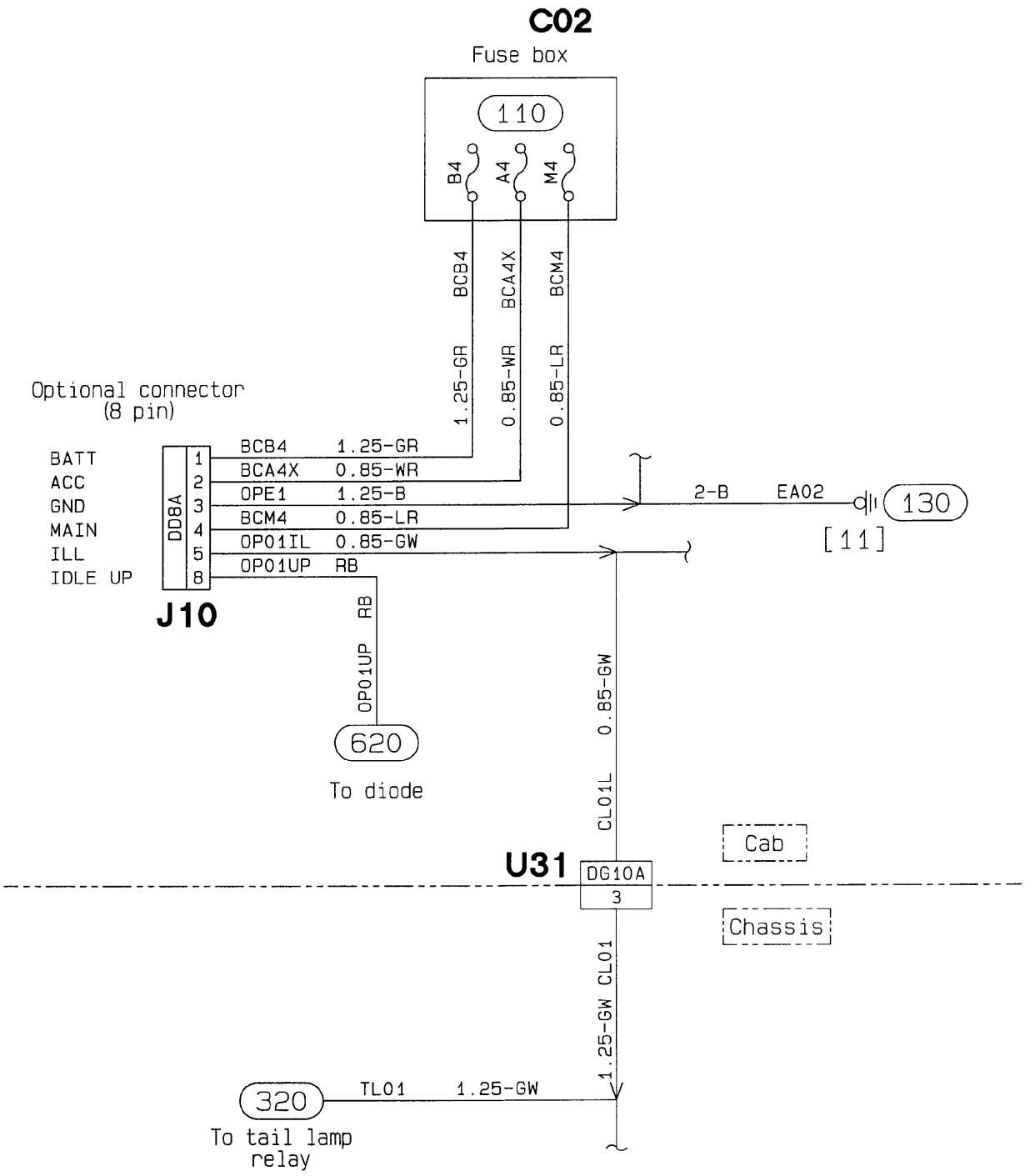
C00476

Fuse box
(Fuses S1)

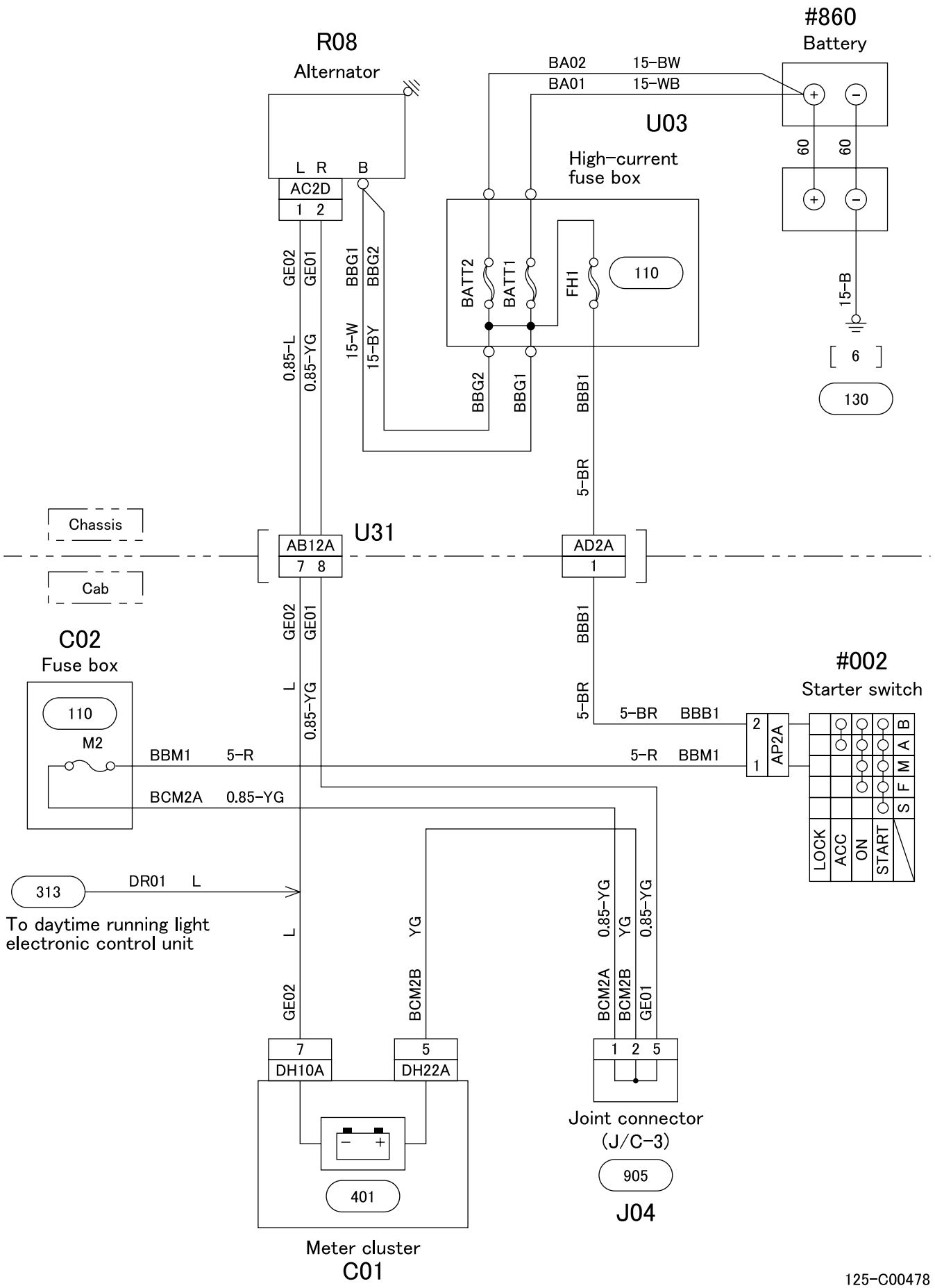


*1 : Manual transmission
*2 : Automatic transmission

C00468

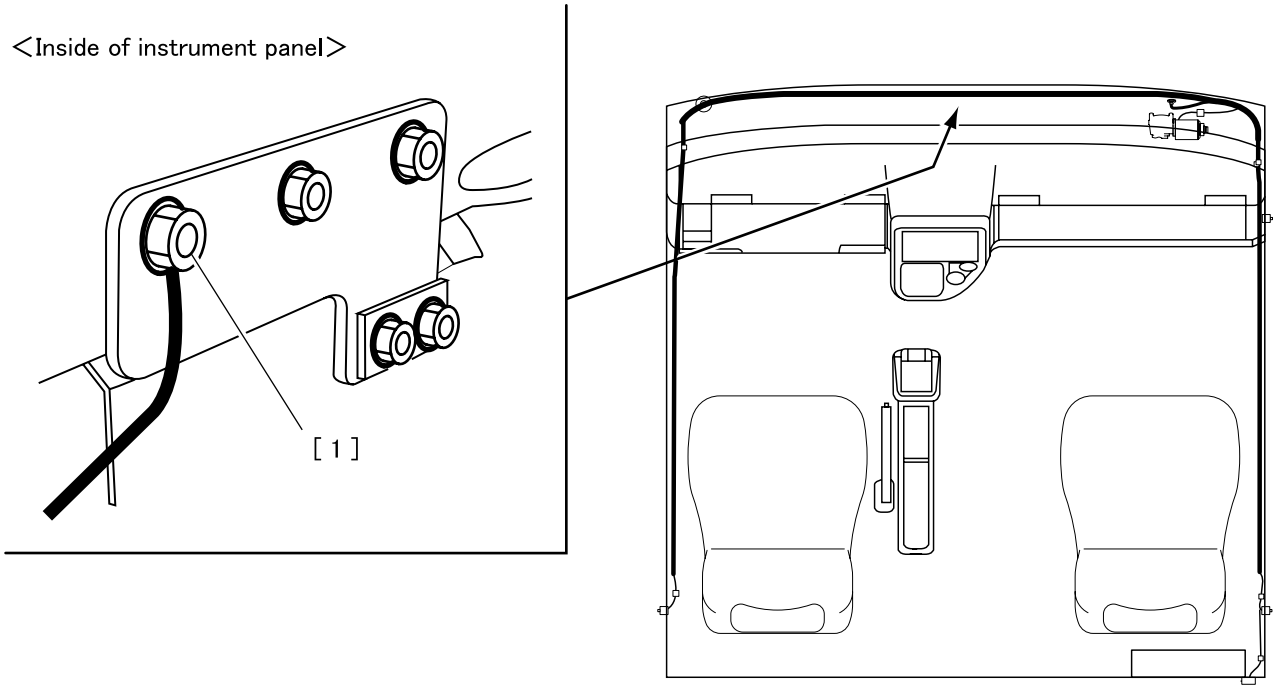

C02
Fuse box
110
B4
A4
M4
BCB4
BCA4X
BCM4
1.25-GR
0.85-WR
0.85-LR
Optional connector
(8 pin)
BATT
ACC
GND
MAIN
ILL
IDLE UP
DD8A
1
2
3
4
5
8
BCB4 1.25-GR
BCA4X 0.85-WR
OPE1 1.25-B
BCM4 0.85-LR
OP01IL 0.85-GW
OP01UP RB
J10
2-B EA02
130
[11]
RB
OP01UP
620
To diode
0.85-GW
CL01L
Cab
U31
DG10A
3
Chassis
1.25-GW CL01
320
TL01 1.25-GW
To tail lamp
relay

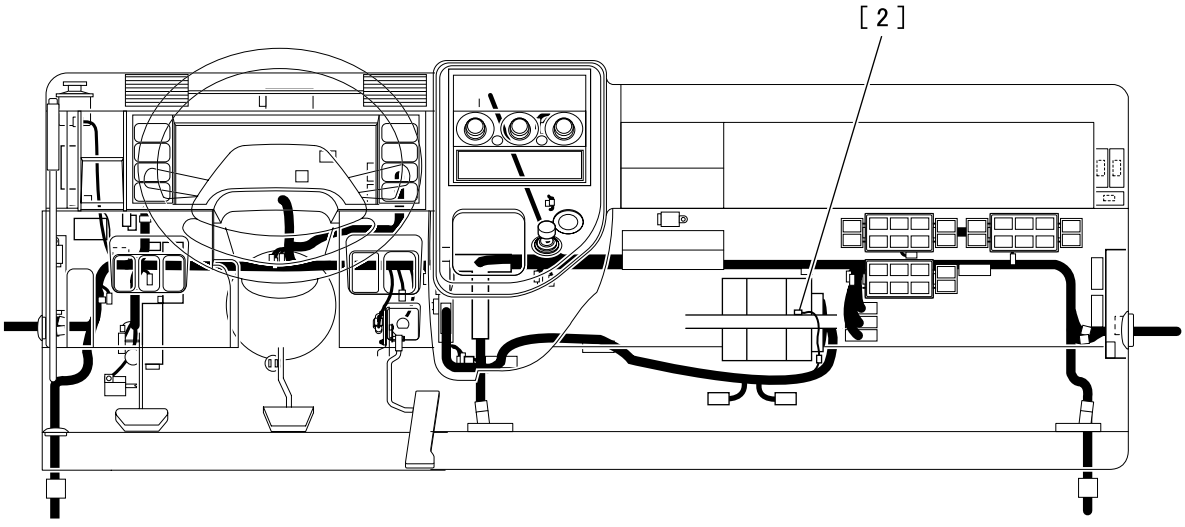
C00477


#860
Battery
R08
Alternator
BA02 15-BW
BA01 15-WB
U03
High-current fuse box
L R B
AC2D
1 2
GE02 GE01
BBG1 BBG2
0.85-L 0.85-YG
15-W 15-BY
BATT2 BATT1 FH1
110
BBG2 BBG1 BBB1
60 60
15-B
6
130
5-BR
Chassis
Cab
U31
AB12A
7 8
AD2A
1
C02
Fuse box
110
M2
BBM1 5-R
BCM2A 0.85-YG
5-BR BBB1
5-R BBM1
2 1 AP2A
#002
Starter switch
LOCK ACC ON START S F M A B
313
DR01 L
To daytime running light electronic control unit
L GE02
YG BCM2B
0.85-YG YG 0.85-YG
BCM2A BCM2B GE01
7 DH10A
5 DH22A
1 2 5
Joint connector (J/C-3)
905
J04
401
Meter cluster
C01

125-C00478

[1] to [2] Cab ground

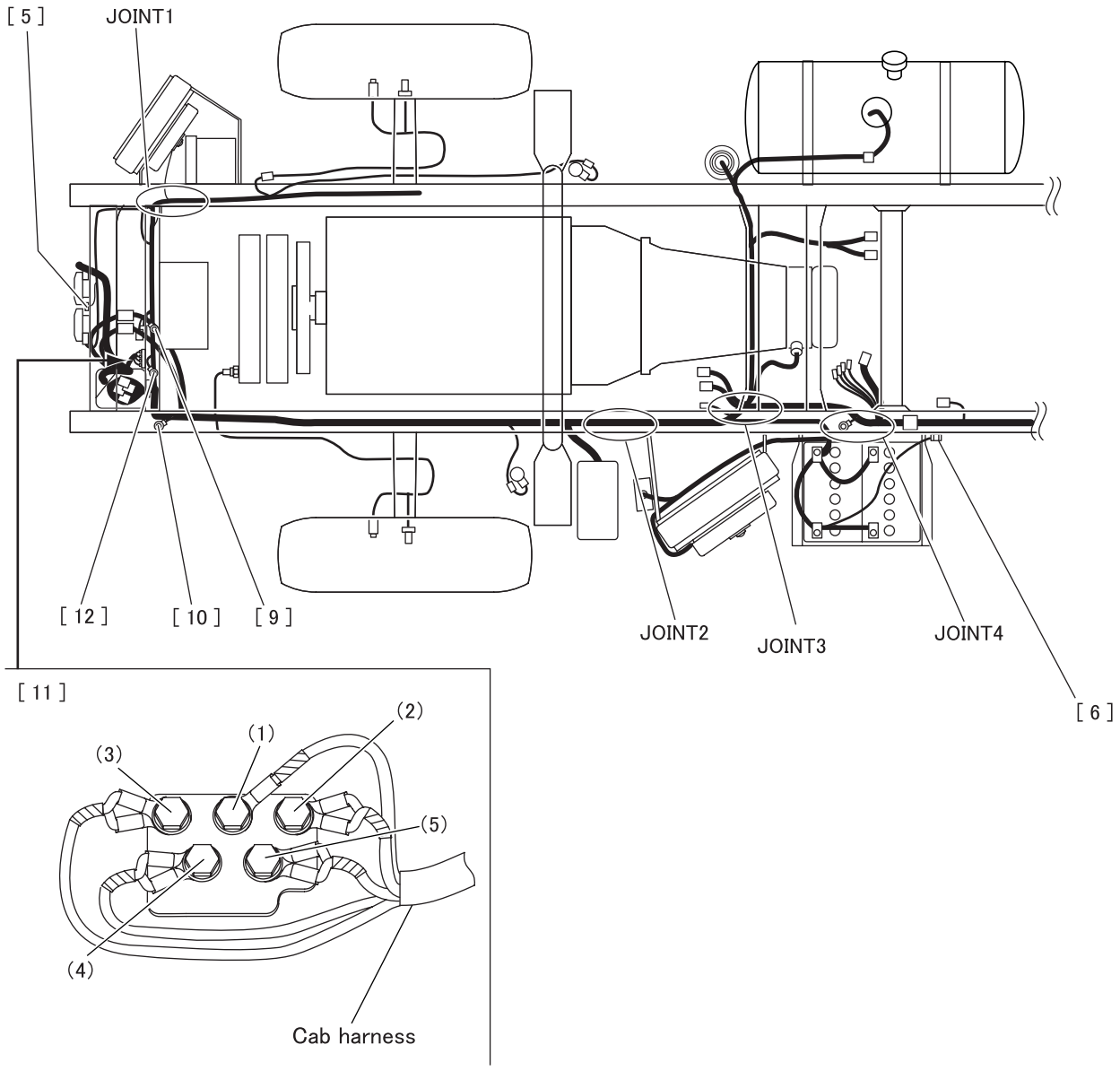




L00174

Location	Circuit No.	Wire diameter-wire color	Destination	Remarks
[1]	EA09	2-B	Joint connector (J/C-3)	–
	EA10	5-B	Frame ground	–
[2]	GCE5	1.25-B	Joint connector (J/C-3)	Engine electronic control unit case ground

[5] to [12] Chassis ground

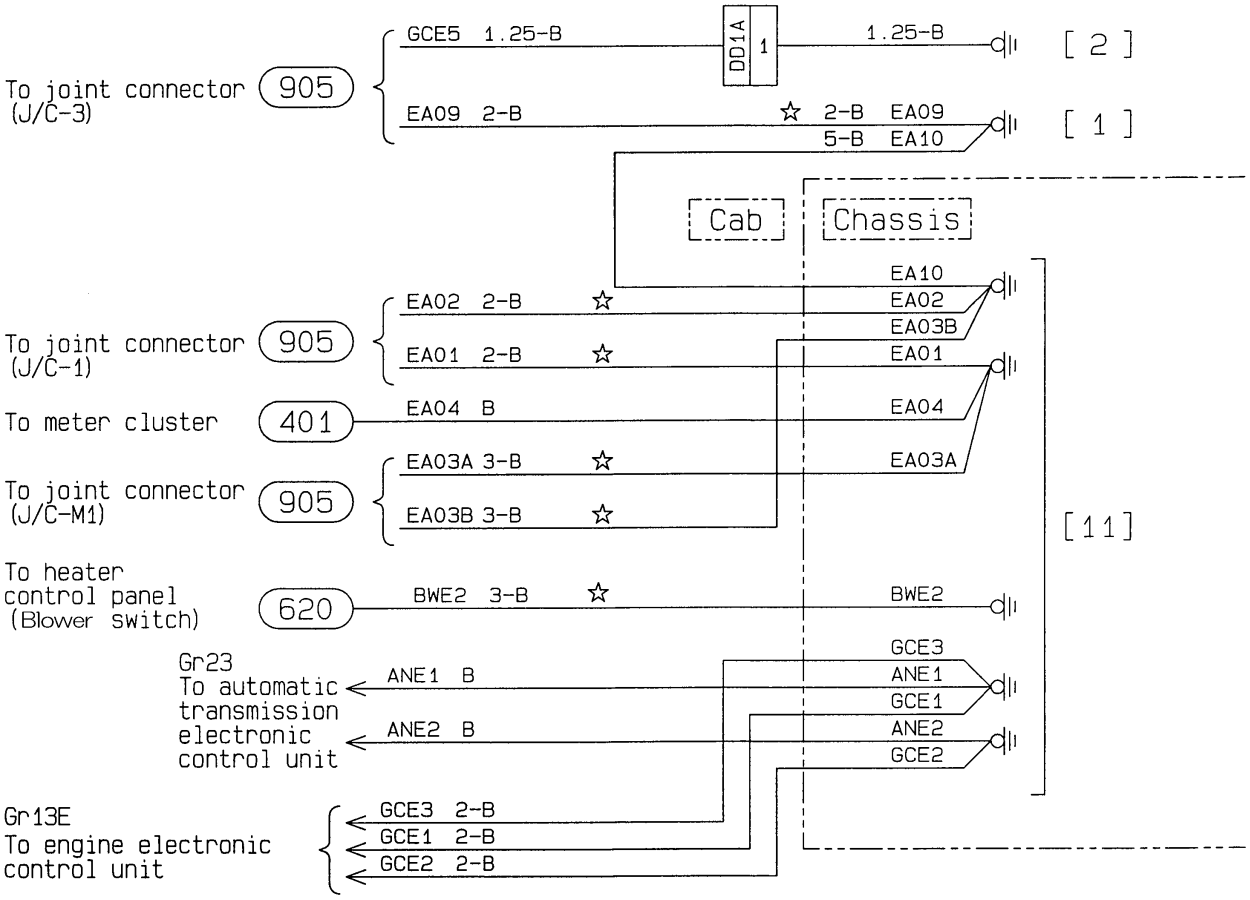


L01272

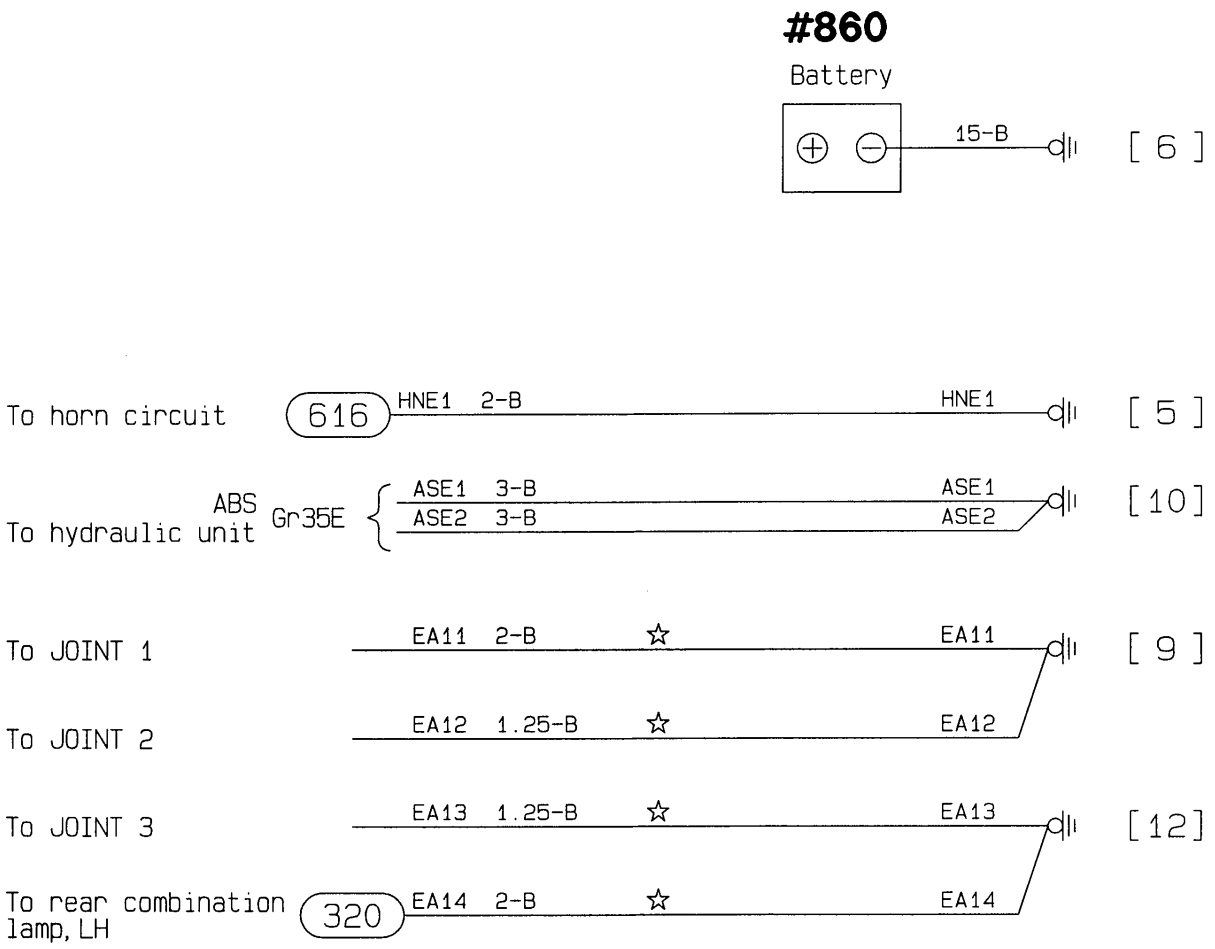
Location	Circuit No.	Wire diameter-wire color	Destination	Remarks
[5]	HNE1	2-B	Horn bracket	–
[6]	–	15-B	Battery	Battery ground (Frame ground)
[9]	EA11	2-B	Joint1	Frame ground
	EA12	1.25-B	Joint2	Frame ground
[10]	ASE1	3-B	Hydraulic unit	–
	ASE2	3-B	Hydraulic unit	–
[11](5)	ANE1	B	Automatic transmission electronic control unit	Automatic transmission
[11](4)	ANE2	B	Automatic transmission electronic control unit	Automatic transmission
[11](1)	BWE2	3-B	Center panel harness	–
[11](2)	EA01	2-B	Joint connector (J/C-1)	(Cab)
[11](3)	EA02	2-B	Joint connector (J/C-1)	(Cab)
[11](2)	EA03A	3-B	Joint connector (J/C-M1)	(Cab)
[11](3)	EA03B	3-B	Joint connector (J/C-M1)	(Cab)
[11](2)	EA04	B	Combination meter	(Cab)
[11](3)	EA10	5-B	Cab ground	–
[11](5)	GCE1	2-B	Engine electronic control unit	–
[11](4)	GCE2	2-B	Engine electronic control unit	–
[11](5)	GCE3	2-B	Engine electronic control unit	–
[12]	EA13	1.25-B	Joint3	Frame ground
	EA14	2-B	Rear chassis harness	Frame ground

Entire ground

- This diagram indicates grounding points.
- See the following pages for branching of grounding (wiring for ☆).
  (in circuit No. order)



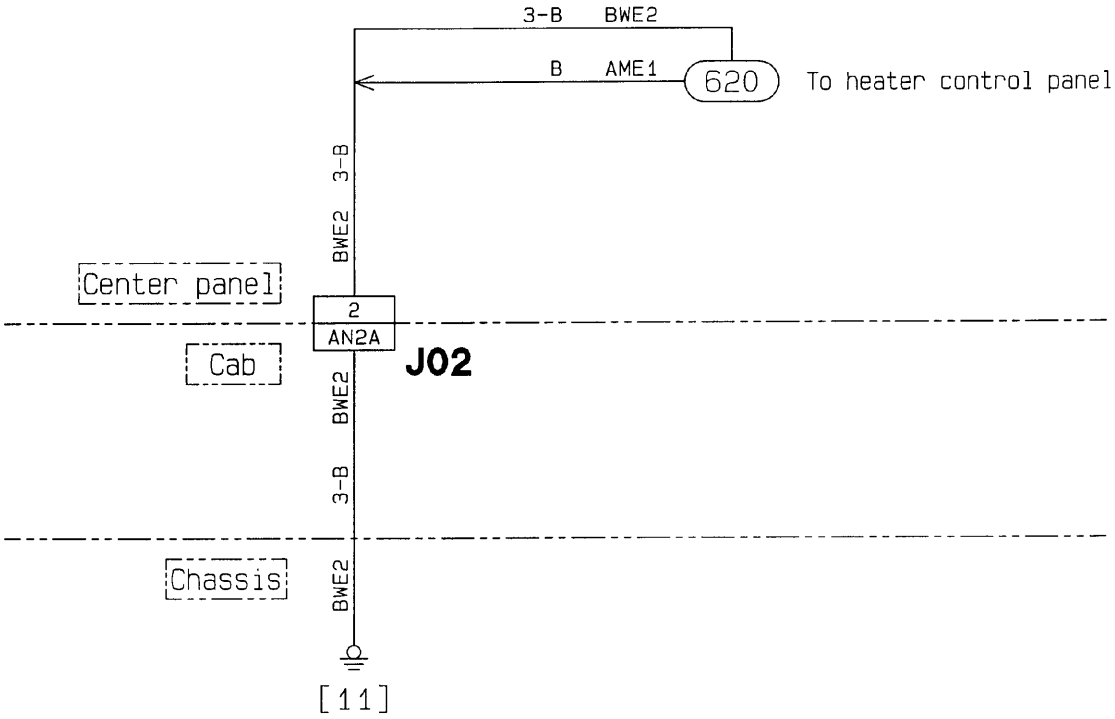
C02274-1



ABS : Anti-lock brake system

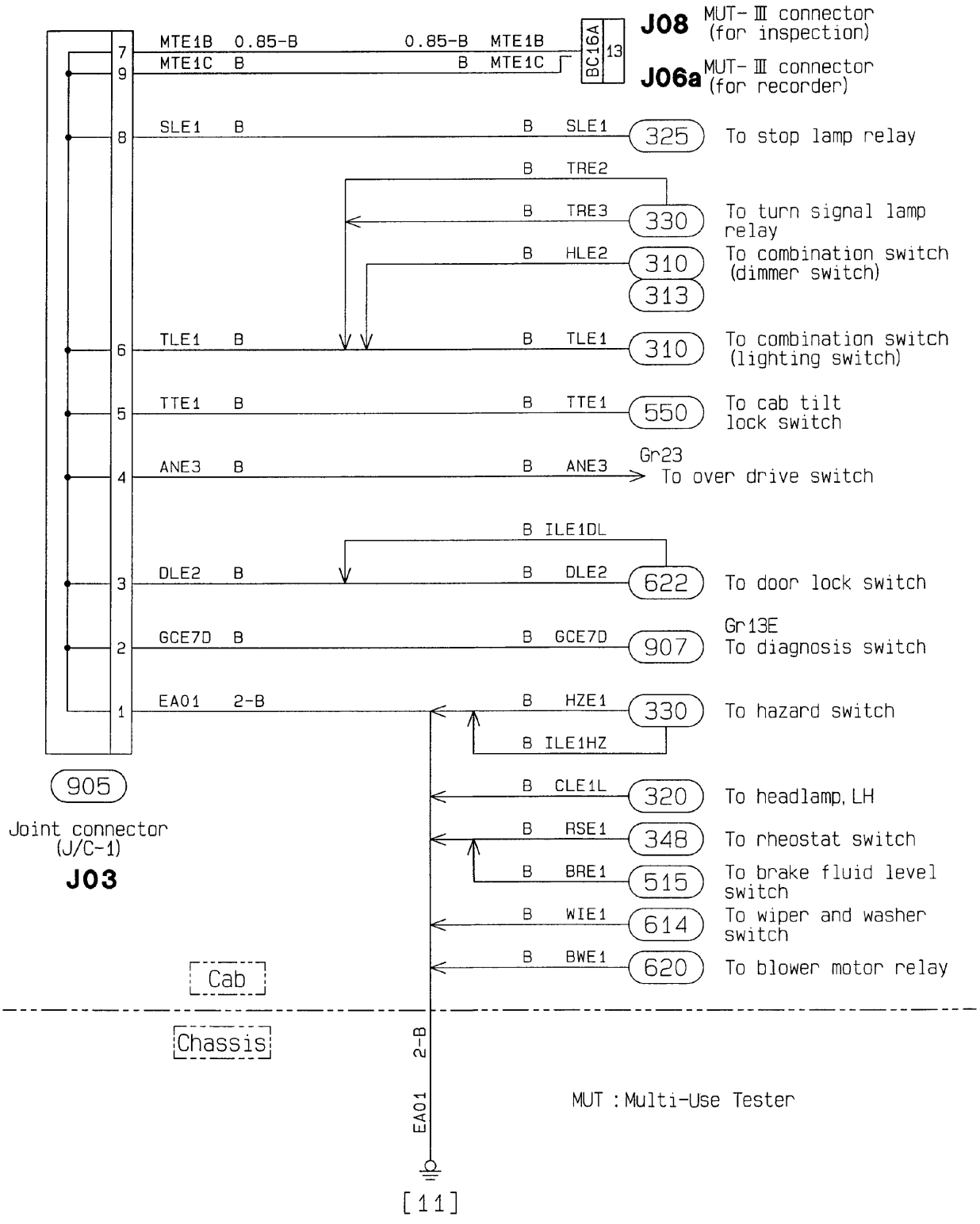
C02274-2

Circuit No.BWE2 chassis ground



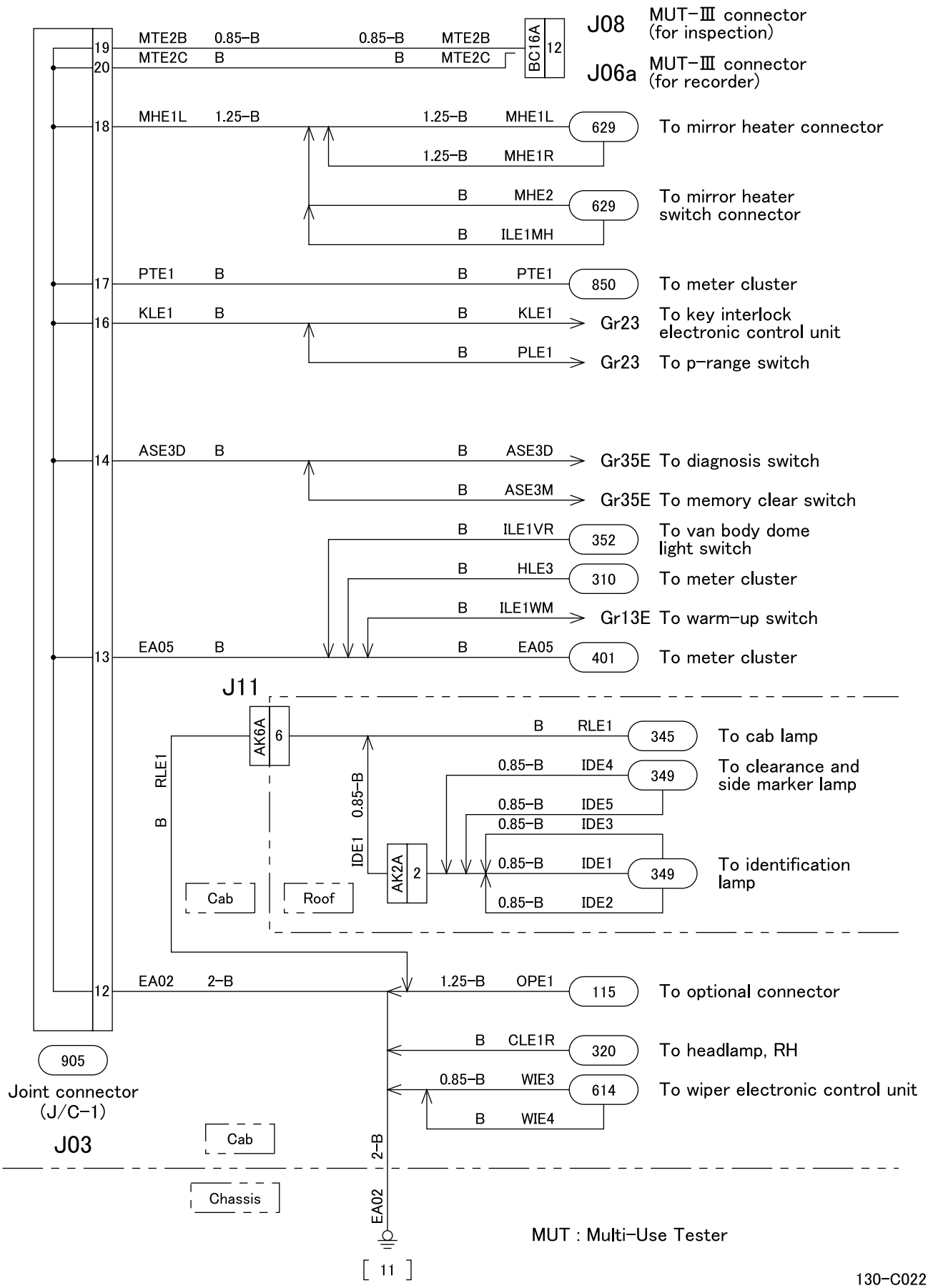
C00480

Circuit No.EA01 chassis ground



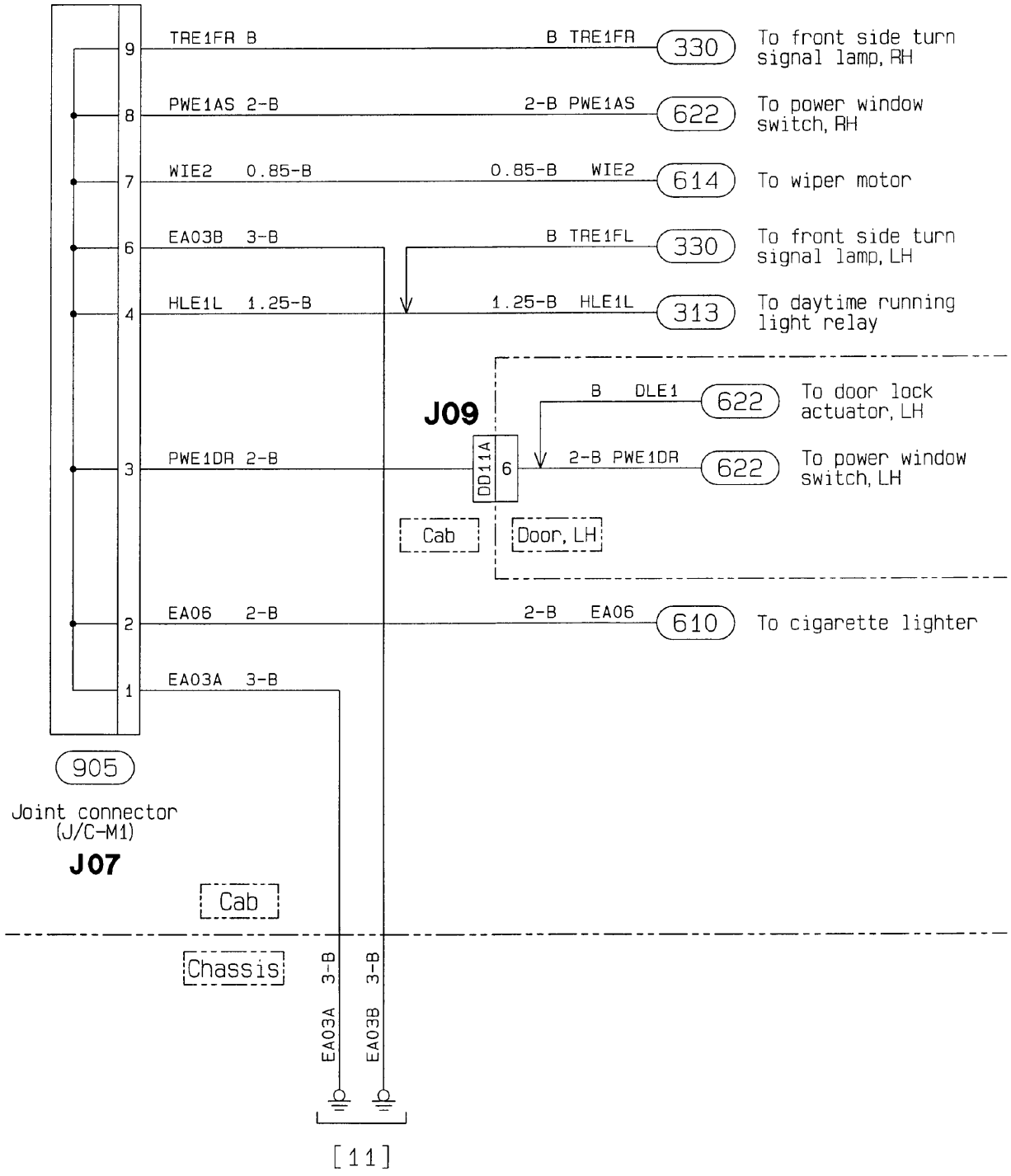
C00481

Circuit No.EA02 chassis ground



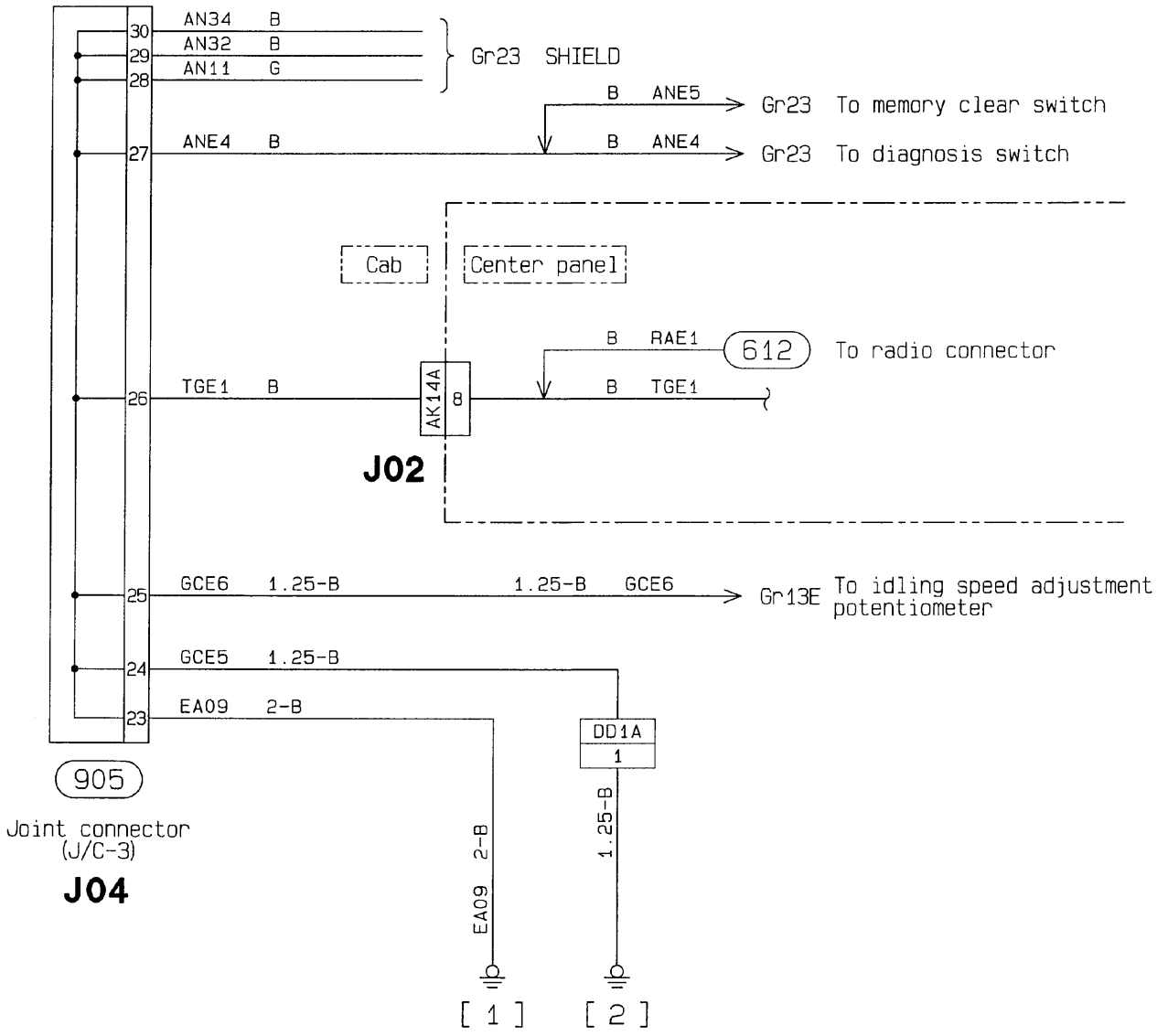
130-C02275

Circuit No.EA03A, EA03B chassis ground



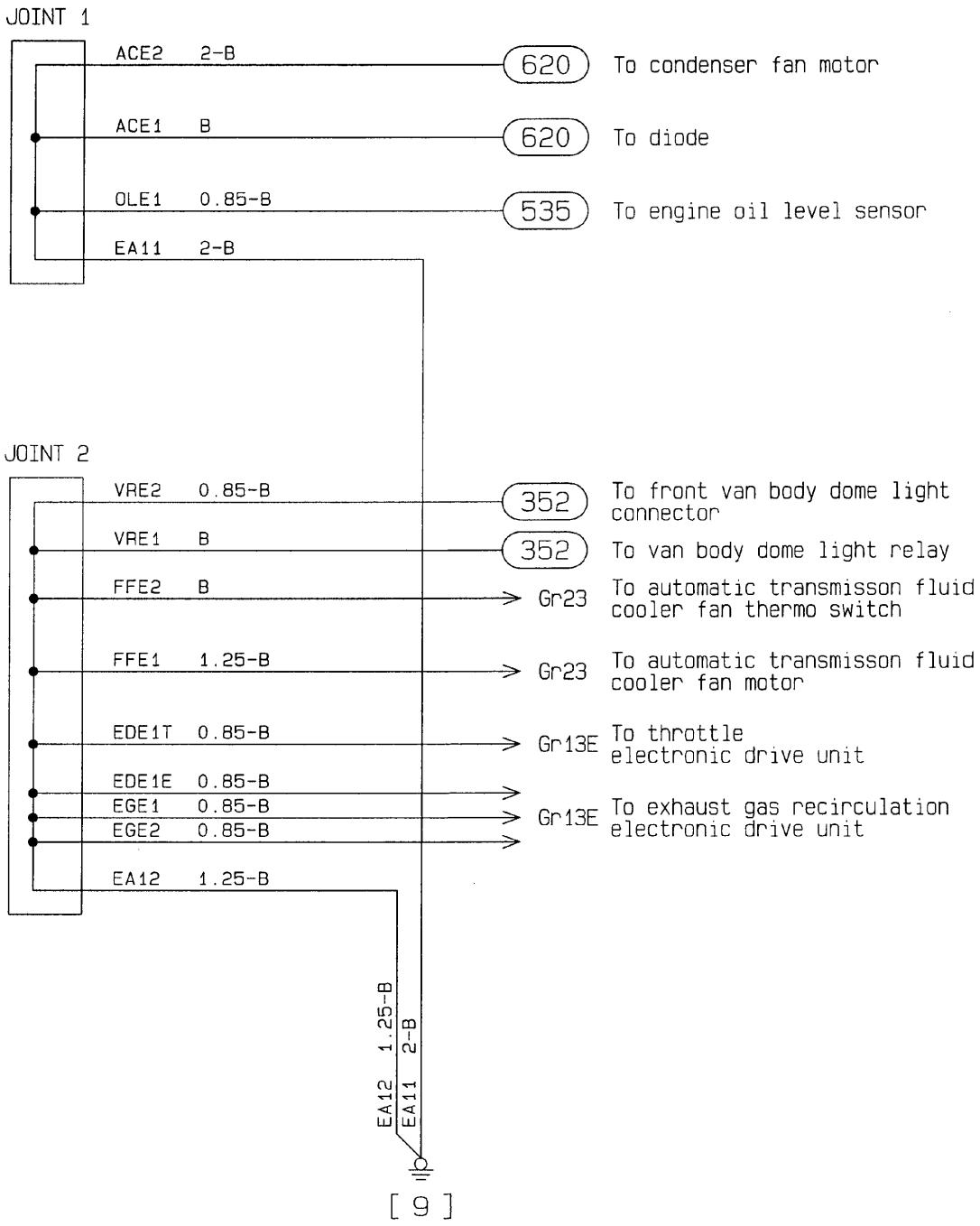
C00483

Circuit No.EA09 cab ground



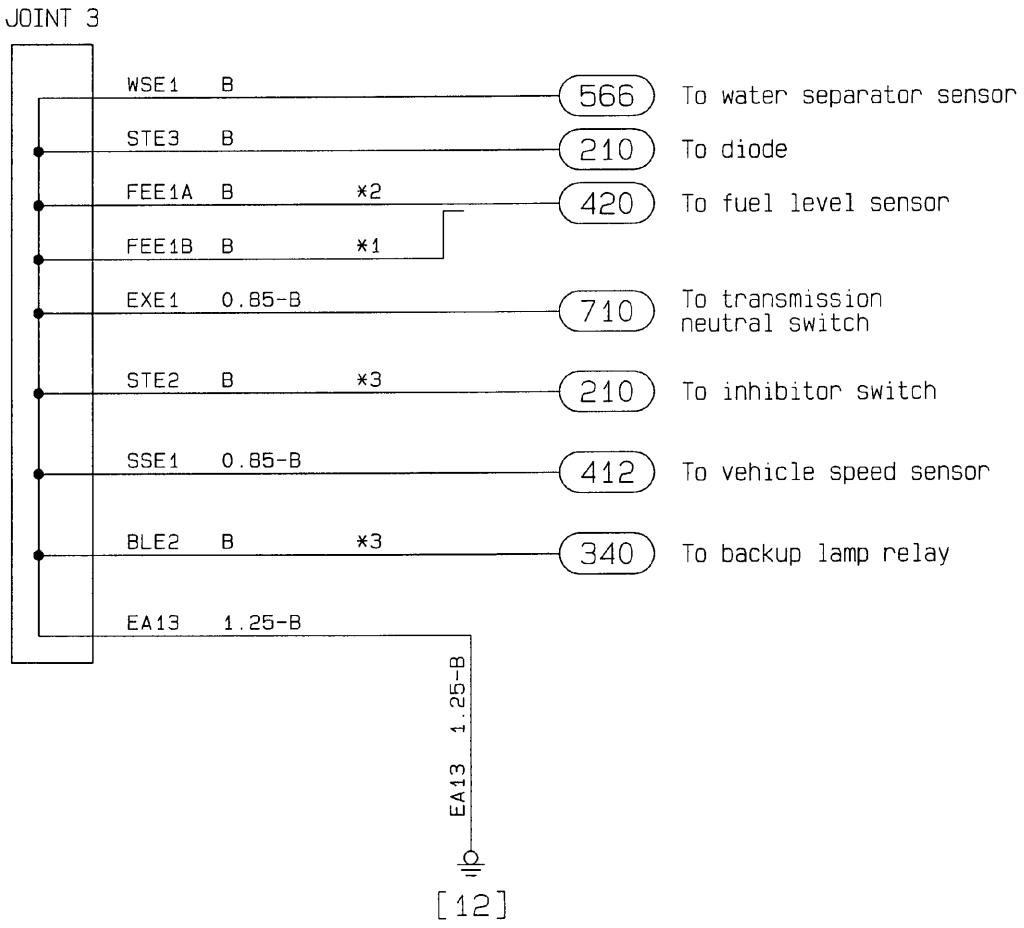
C00484

Circuit No.EA11, EA12 chassis ground



C00485

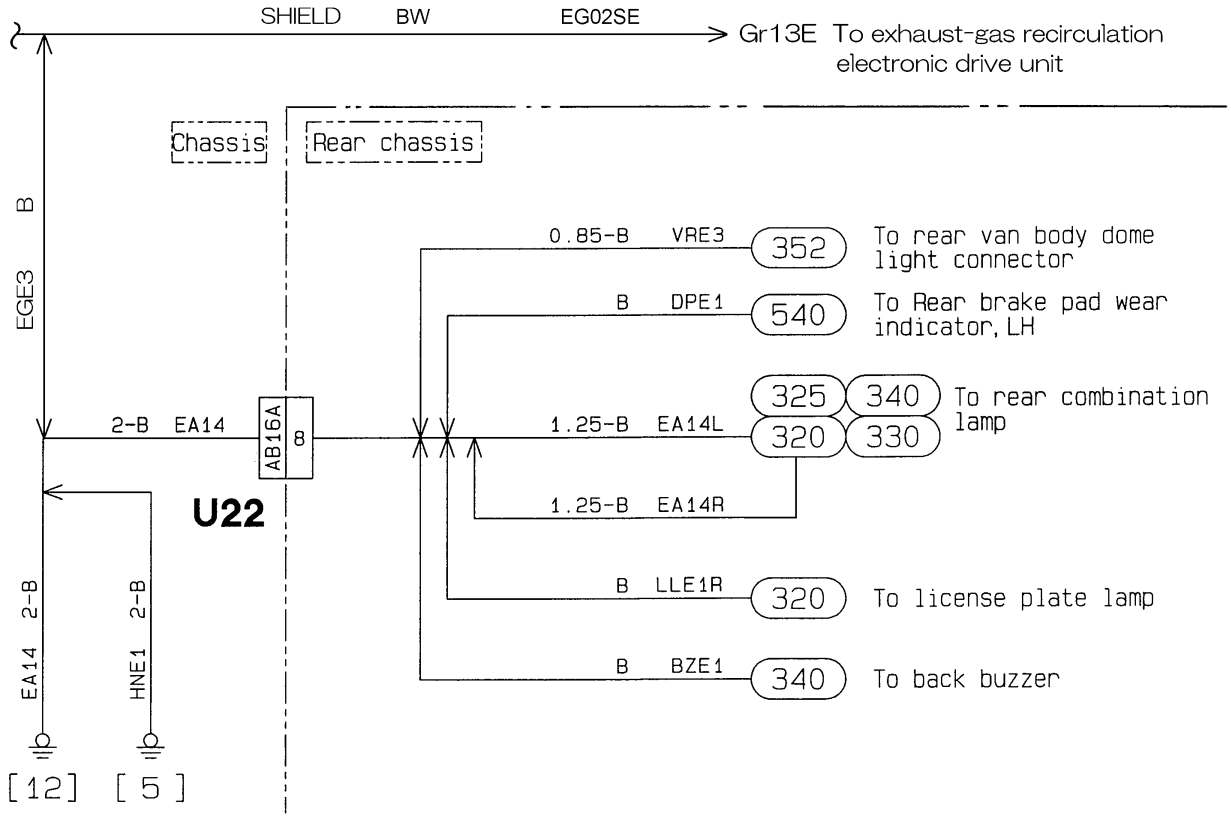
Circuit No.EA13 chassis ground



*1 : Fuel tank equipped rear overhang
*2 : Except *1
*3 : Automatic transmission

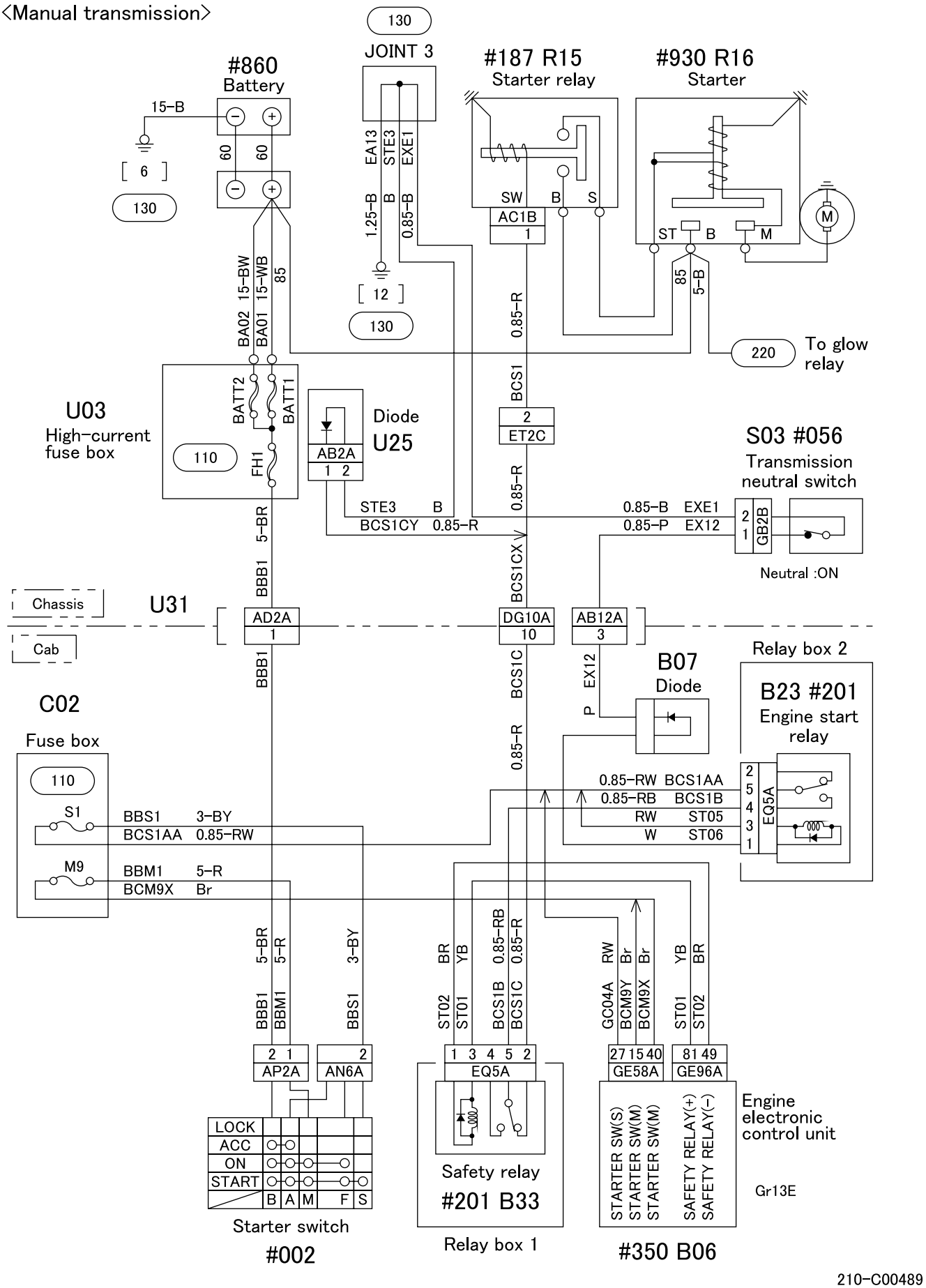
C00486

Circuit No.EA14 chassis ground



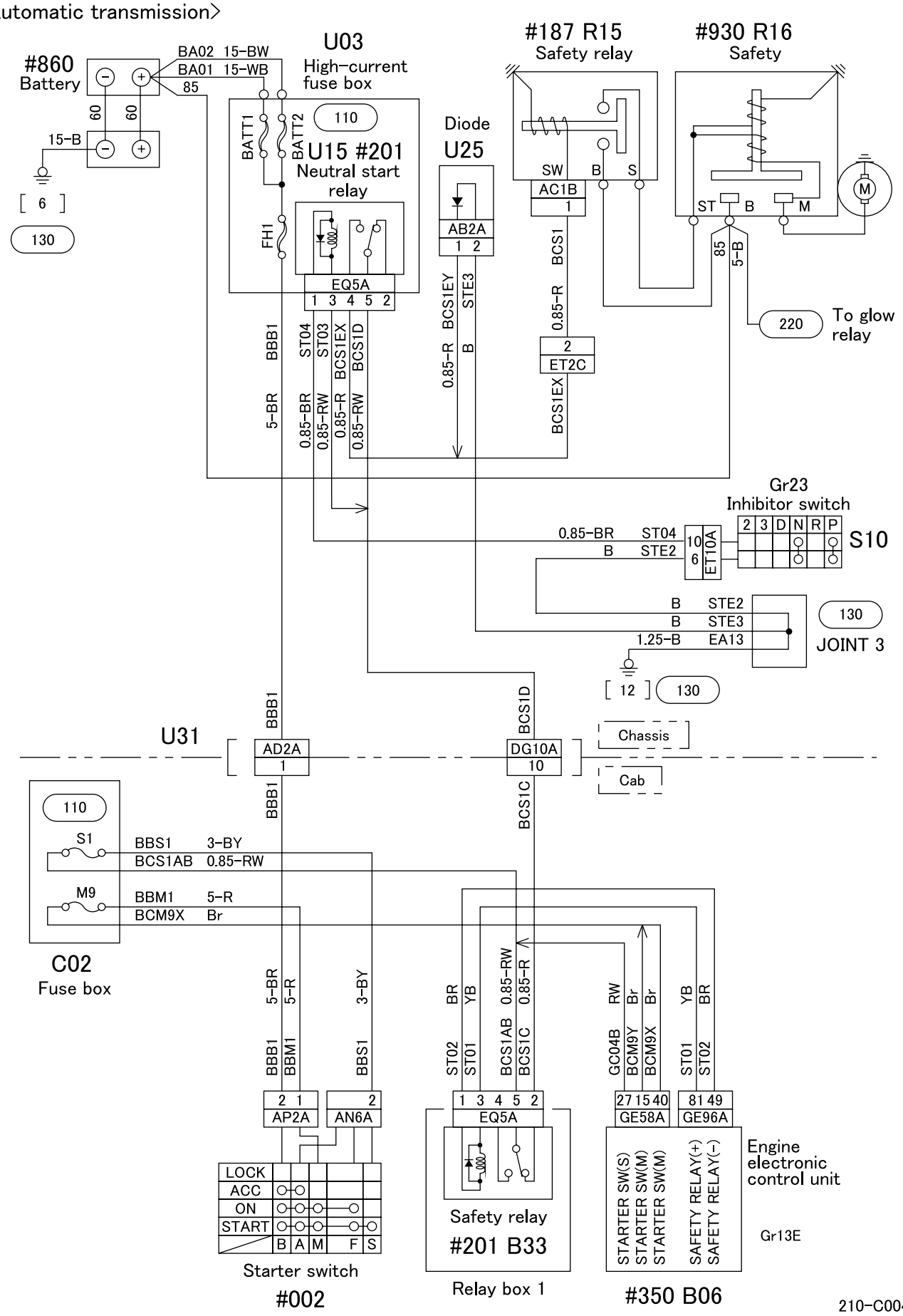
C02276

GROUP 54-02 STARTING CIRCUIT


<Manual transmission>
130
JOINT 3
#860
Battery
#187 R15
Starter relay
#930 R16
Starter
15-B
[6]
130
60
60
EA13
STE3
EXE1
1.25-B
B
0.85-B
SW
B
S
AC1B
1
ST
B
M
[12]
130
BA02
15-BW
BA01
15-WB
85
0.85-R
85
5-B
220
To glow relay
U03
High-current fuse box
BATT2
BATT1
FH1
110
Diode
U25
AB2A
1 2
BCS1
2
ET2C
S03 #056
Transmission neutral switch
STE3 B
BCS1CY 0.85-R
0.85-B EXE1
0.85-P EX12
2
1
GB2B
Neutral :ON
5-BR
BBB1
BCS1CX
Chassis
Cab
U31
AD2A
1
DG10A
10
AB12A
3
Relay box 2
B07
Diode
P EX12
B23 #201
Engine start relay
C02
Fuse box
110
S1
BBS1 3-BY
BCS1AA 0.85-RW
M9
BBM1 5-R
BCM9X Br
0.85-RW BCS1AA
0.85-RB BCS1B
RW ST05
W ST06
2
5
4
3
1
EQ5A
BCS1C
0.85-R
5-BR
5-R
3-BY
BBB1
BBM1
BBS1
BR
YB
0.85-RB
ST02
ST01
BCS1B
RW
Br
GC04A
BCM9Y
BCM9X
2 1
AP2A
2
AN6A
1 3 4 5 2
EQ5A
27 15 40
GE58A
81 49
GE96A
LOCK
ACC
ON
START
B A M F S
Starter switch
#002
Safety relay
#201 B33
Relay box 1
STARTER SW(S)
STARTER SW(M)
STARTER SW(M)
SAFETY RELAY(+)
SAFETY RELAY(-)
Engine electronic control unit
#350 B06
Gr13E

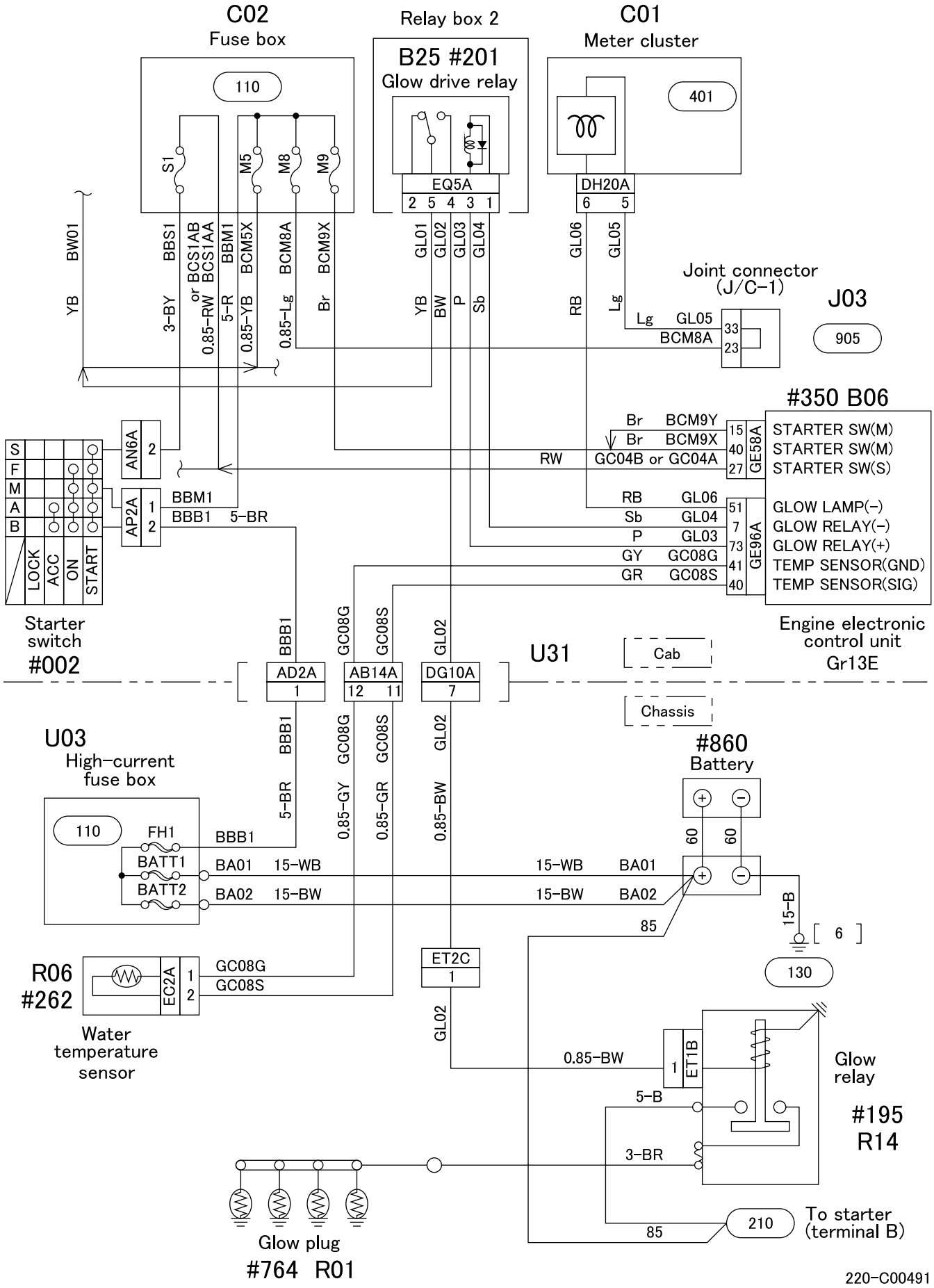
210-C00489

<Automatic transmission>



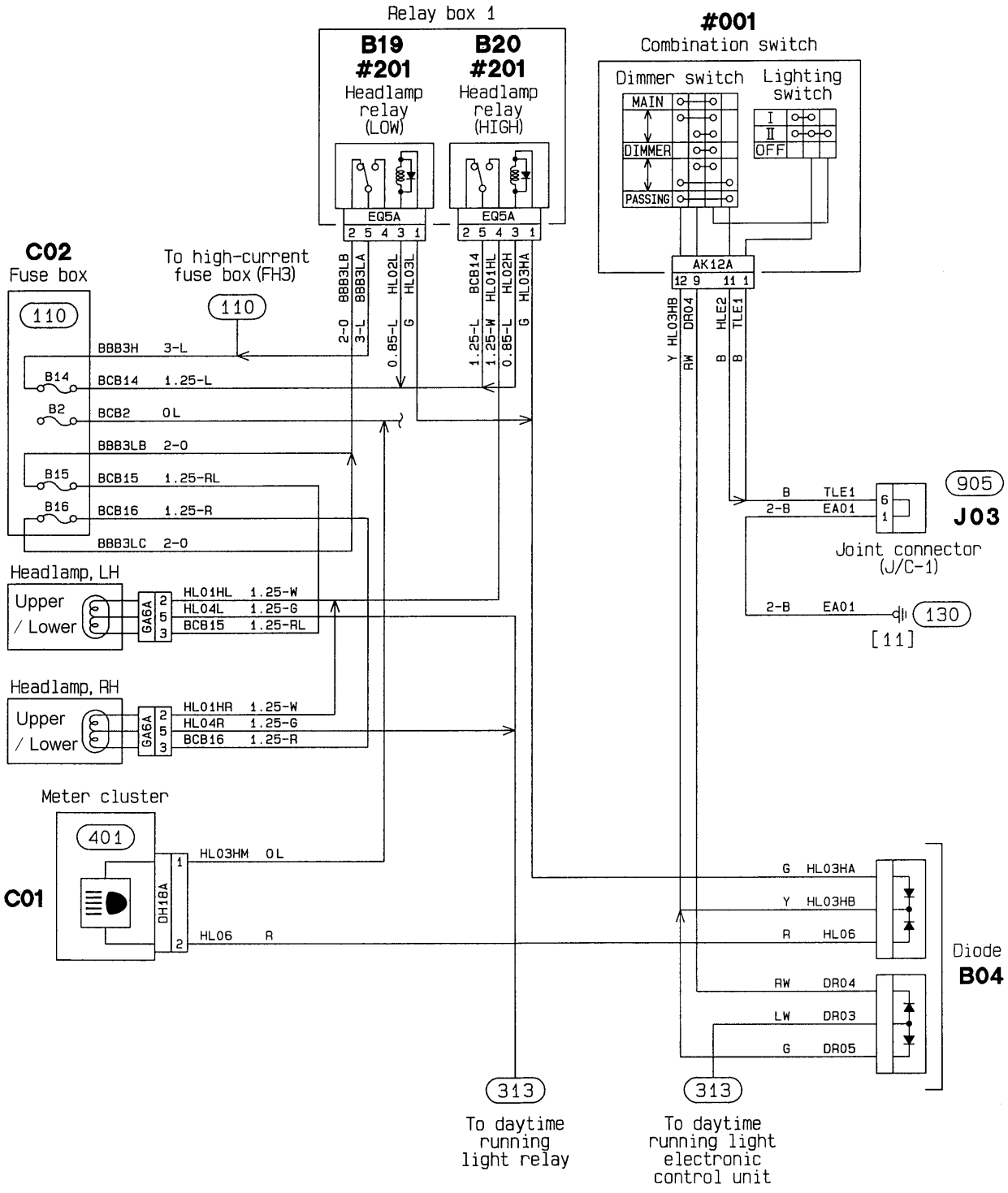
210-C00490

220 ENGINE PREHEATING CIRCUIT



220-C00491

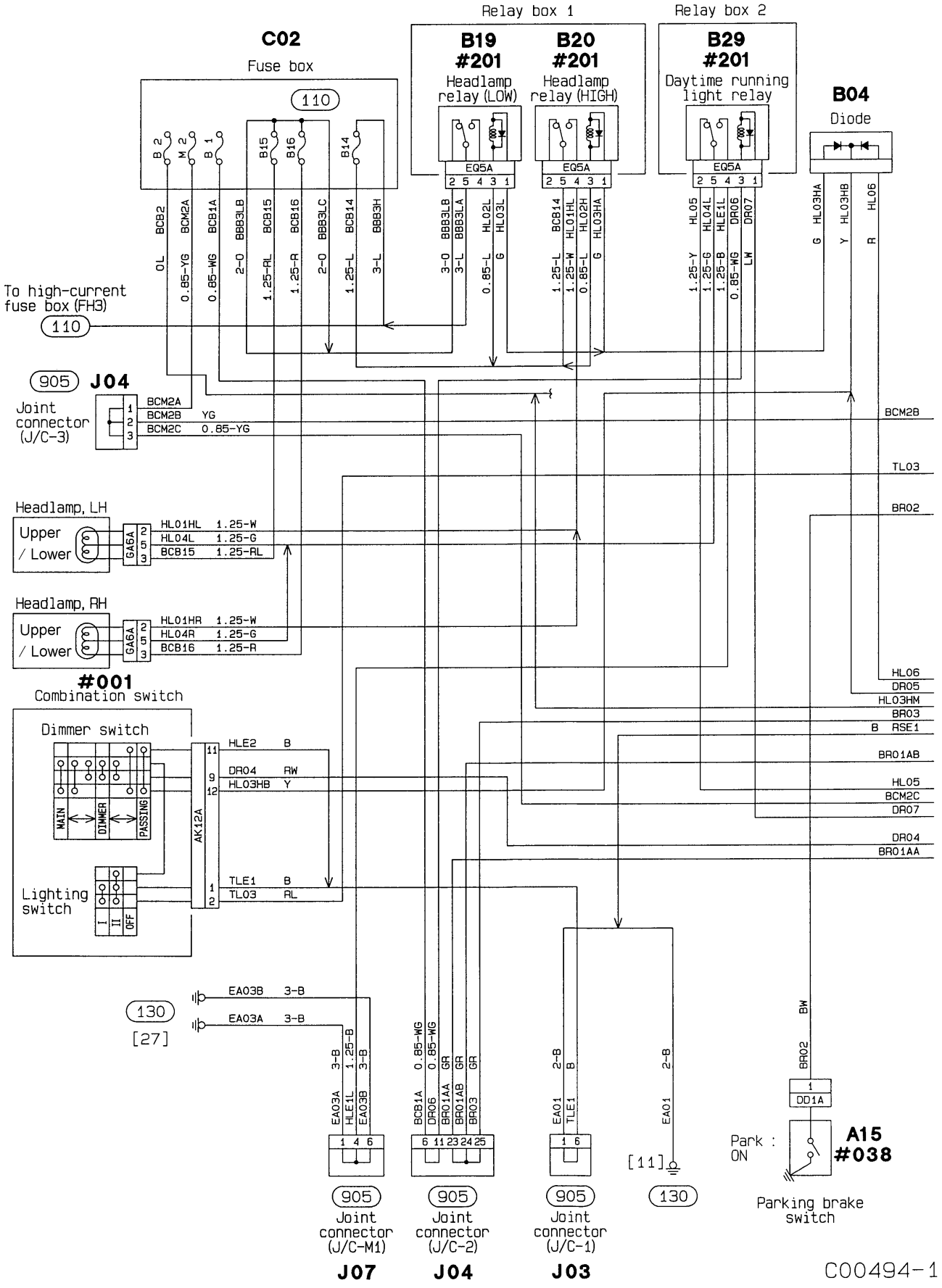
GROUP 54-03 LIGHTING CIRCUIT

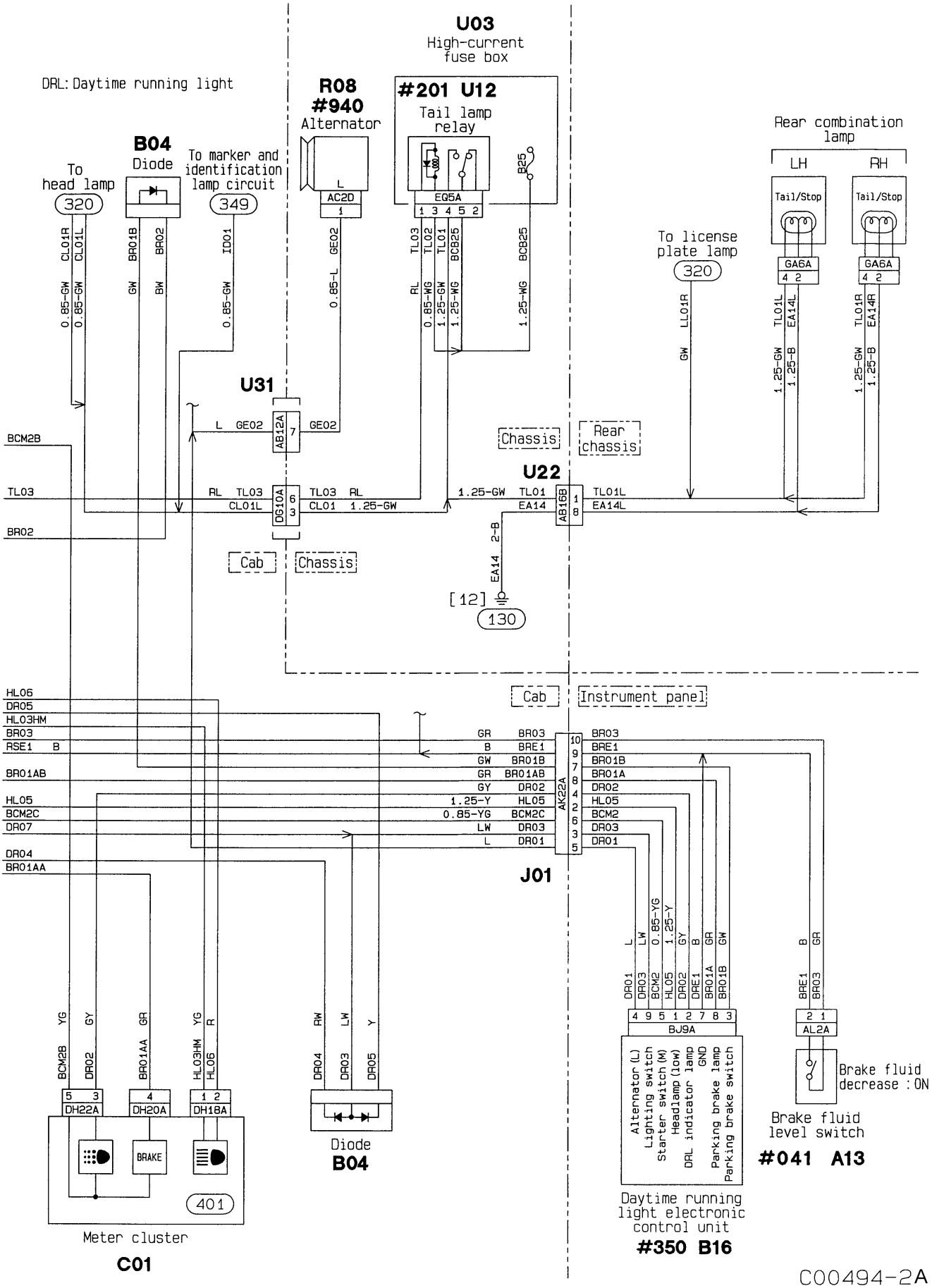

Relay box 1
B19
#201
Headlamp relay (LOW)
B20
#201
Headlamp relay (HIGH)
EQ5A
2 5 4 3 1
#001
Combination switch
Dimmer switch
Lighting switch
MAIN
DIMMER
PASSING
I
II
OFF
AK12A
12 9 11 1
C02
Fuse box
To high-current fuse box (FH3)
110
BBB3H 3-L
B14 BCB14 1.25-L
B2 BCB2 0L
BBB3LB 2-0
B15 BCB15 1.25-RL
B16 BCB16 1.25-R
BBB3LC 2-0
Headlamp, LH
Upper / Lower
GA6A
HL01HL 1.25-W
HL04L 1.25-G
BCB15 1.25-RL
Headlamp, RH
HL01HR 1.25-W
HL04R 1.25-G
BCB16 1.25-R
Meter cluster
401
C01
DH18A
HL03HM 0L
HL06 R
B TLE1
2-B EA01
905
J03
Joint connector (J/C-1)
2-B EA01
130
[11]
G HL03HA
Y HL03HB
R HL06
RW DR04
LW DR03
G DR05
Diode
B04
313
To daytime running light relay
313
To daytime running light electronic control unit

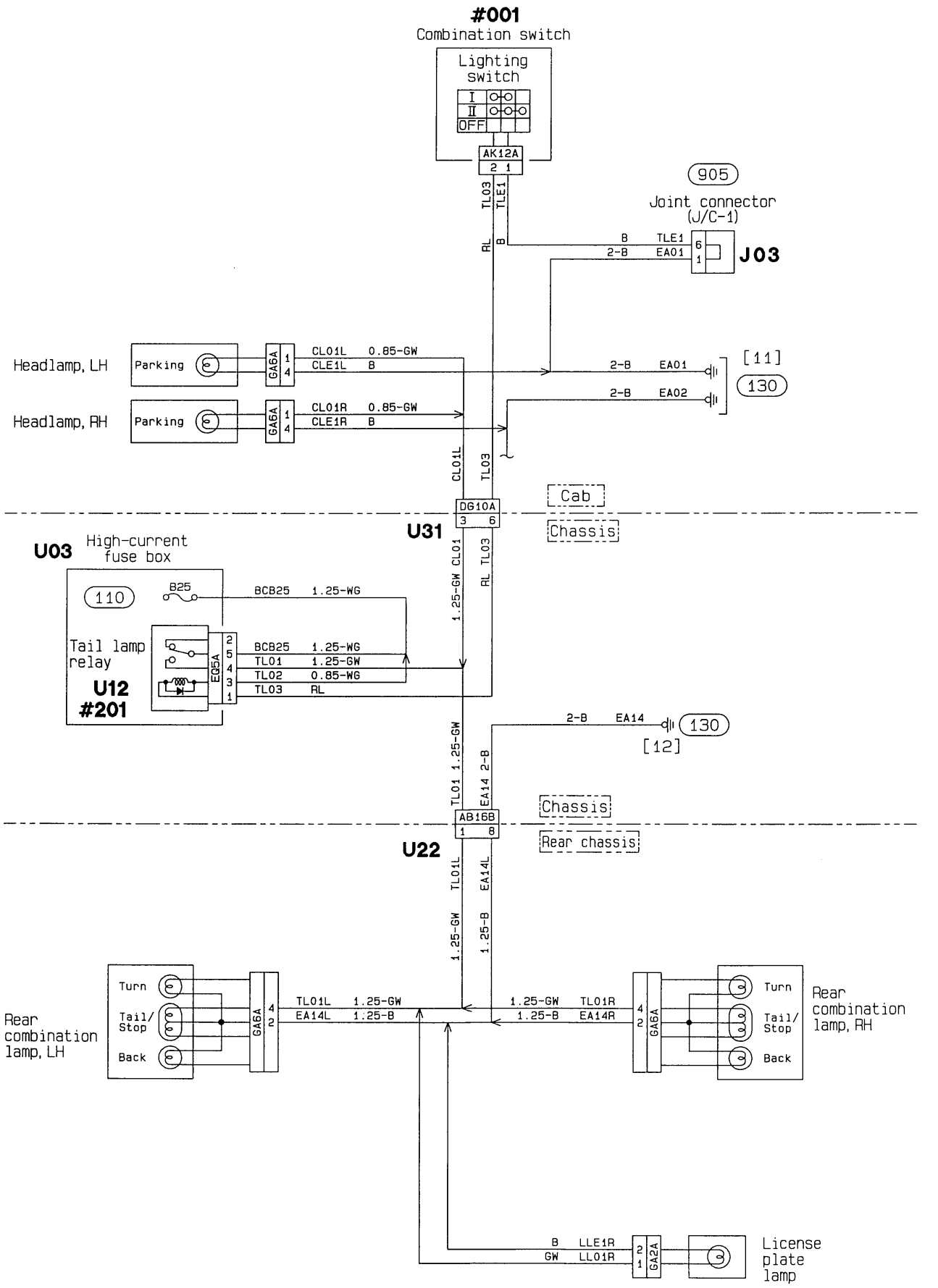
C00493

M E M O

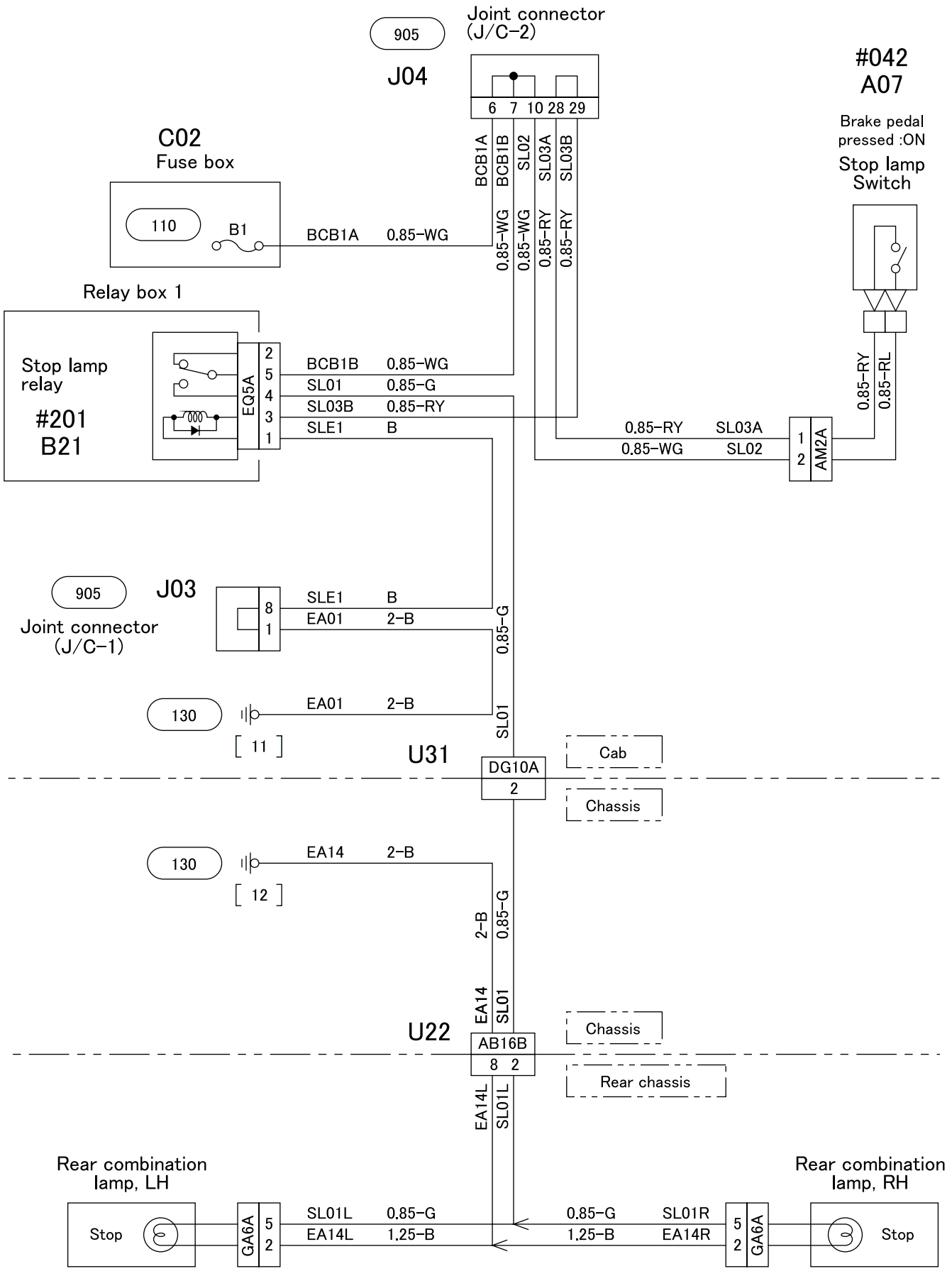
313 DAYTIME RUNNING LIGHT CIRCUIT




DRL: Daytime running light
U03
High-current fuse box
R08
#940
Alternator
#201 U12
Tail lamp relay
B04
Diode
To head lamp
320
To marker and identification lamp circuit
349
Rear combination lamp
LH
RH
Tail/Stop
GA6A
To license plate lamp
320
U31
U22
Chassis
Rear chassis
Cab
Chassis
[12]
130
Cab
Instrument panel
J01
Meter cluster
C01
Diode
B04
Daytime running light electronic control unit
#350 B16
Brake fluid level switch
#041 A13
Brake fluid decrease : ON
BRAKE
401
C00494-2A

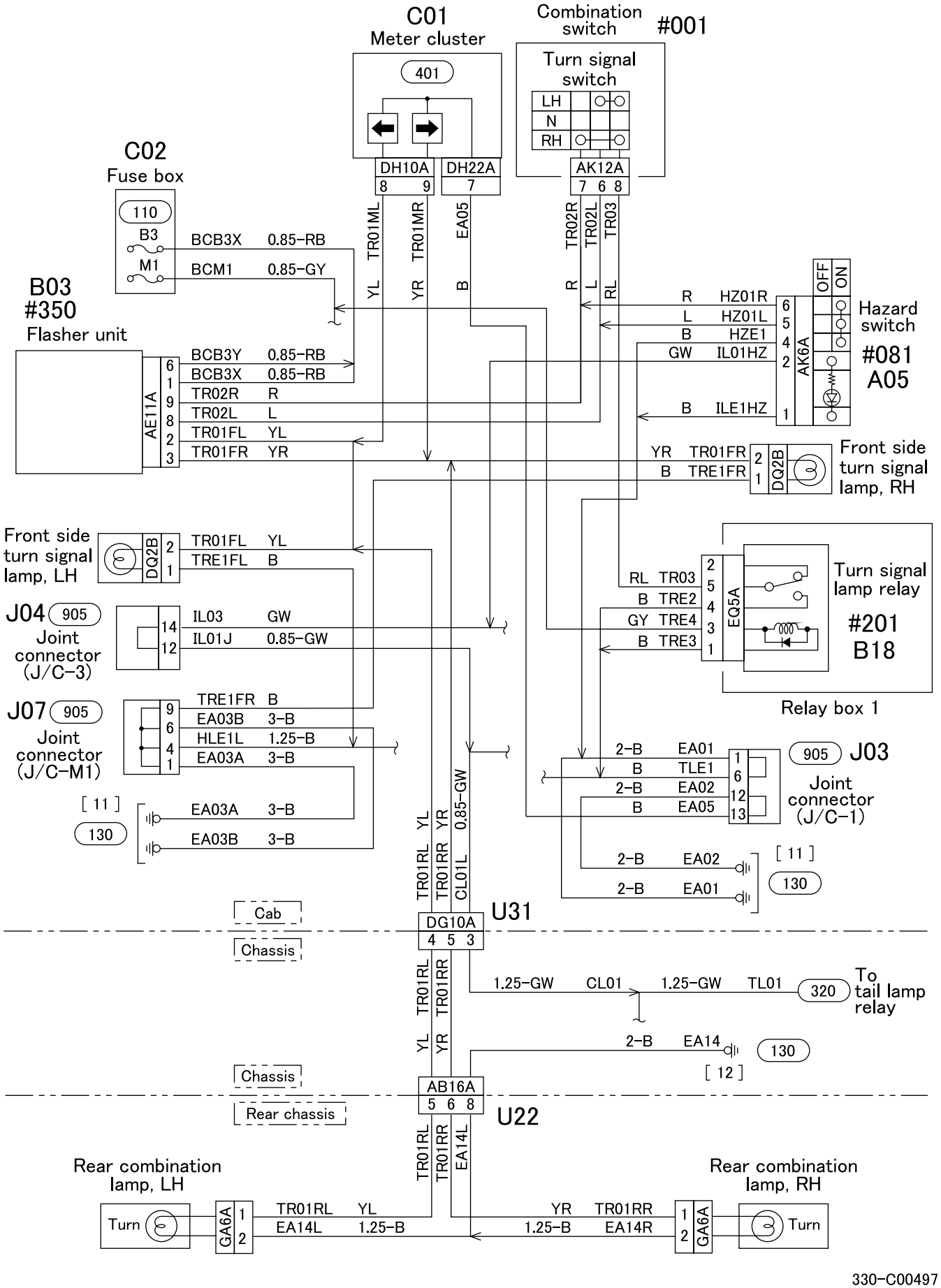

#001
Combination switch
Lighting switch
I
II
OFF
AK12A
2 1
905
Joint connector (J/C-1)
J03
TL03
TLE1
RL
B
TLE1
EA01
2-B
6
1
Headlamp, LH
Parking
GA6A
CL01L
0.85-GW
CLE1L
B
Headlamp, RH
CL01R
CLE1R
2-B
EA01
EA02
[11]
130
CL01L
TL03
Cab
DG10A
3 6
U31
Chassis
U03
High-current fuse box
110
B25
BCB25
1.25-WG
Tail lamp relay
U12
#201
EQ5A
TL01
TL02
0.85-WG
1.25-GW CL01
RL TL03
EA14
2-B
[12]
TL01 1.25-GW
EA14 2-B
AB16B
1 8
Rear chassis
U22
TL01L
EA14L
1.25-B
Rear combination lamp, LH
Turn
Tail/ Stop
Back
Rear combination lamp, RH
LLE1R
LL01R
GW
GA2A
License plate lamp

C02277


905
J04
Joint connector
(J/C-2)
6 7 10 28 29
#042
A07
Brake pedal
pressed :ON
Stop lamp
Switch
C02
Fuse box
110
B1
BCB1A 0.85-WG
BCB1A
BCB1B
SL02
SL03A
SL03B
0.85-WG
0.85-WG
0.85-RY
0.85-RY
Relay box 1
Stop lamp
relay
#201
B21
EQ5A
2
5
4
3
1
BCB1B 0.85-WG
SL01 0.85-G
SL03B 0.85-RY
SLE1 B
0.85-RY SL03A
0.85-WG SL02
1
2
AM2A
0.85-RY
0.85-RL
905
Joint connector
(J/C-1)
J03
8
1
SLE1 B
EA01 2-B
0.85-G
130
EA01 2-B
[11]
SL01
U31
DG10A
2
Cab
Chassis
130
EA14 2-B
[12]
2-B
0.85-G
EA14
SL01
U22
AB16B
8 2
Chassis
Rear chassis
EA14L
SL01L
Rear combination
lamp, LH
Stop
GA6A
5
2
SL01L 0.85-G
EA14L 1.25-B
0.85-G SL01R
1.25-B EA14R
Rear combination
lamp, RH
Stop

325-C00496

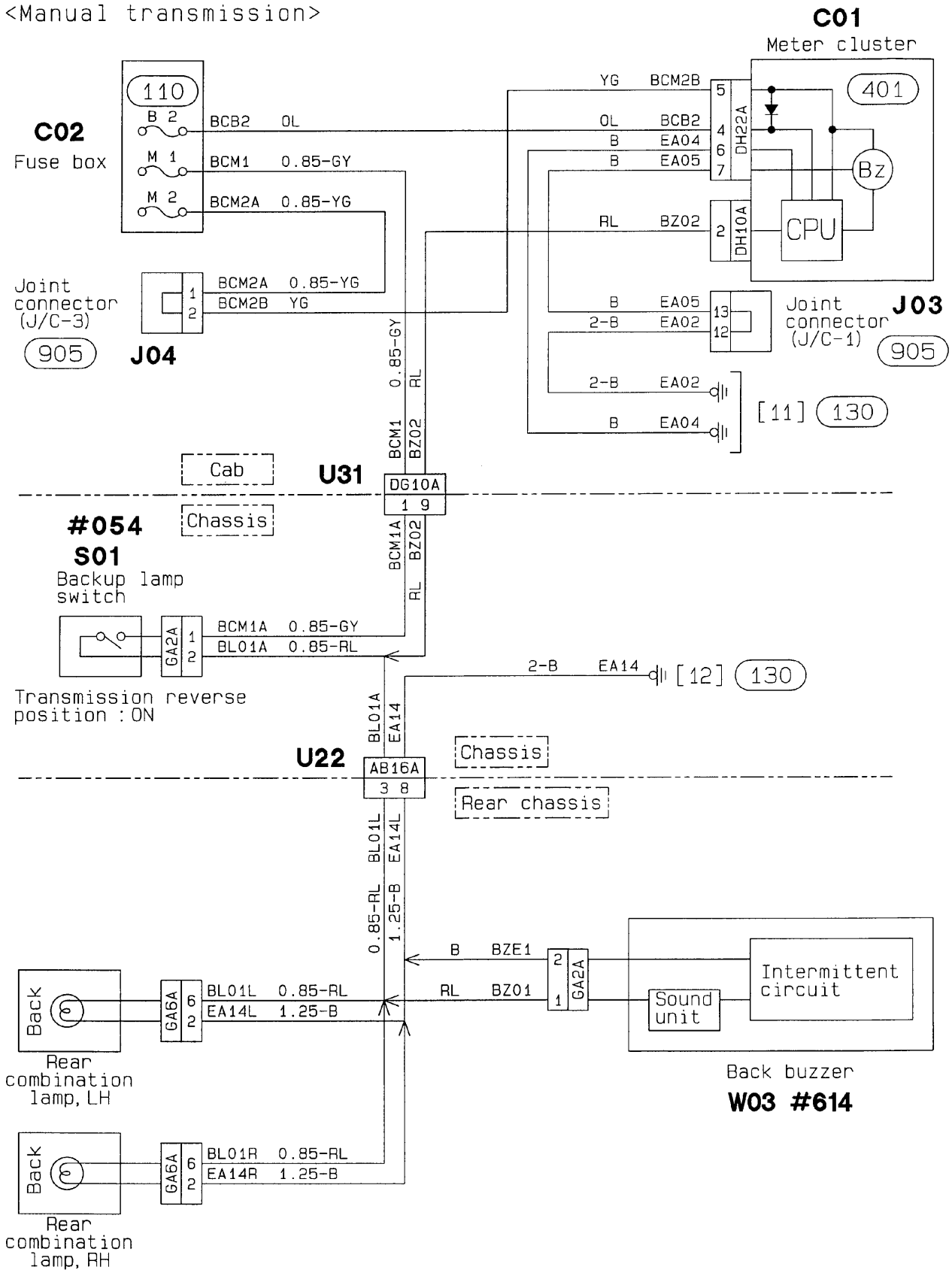
330 TURN SIGNAL AND HAZARD LAMP CIRCUIT



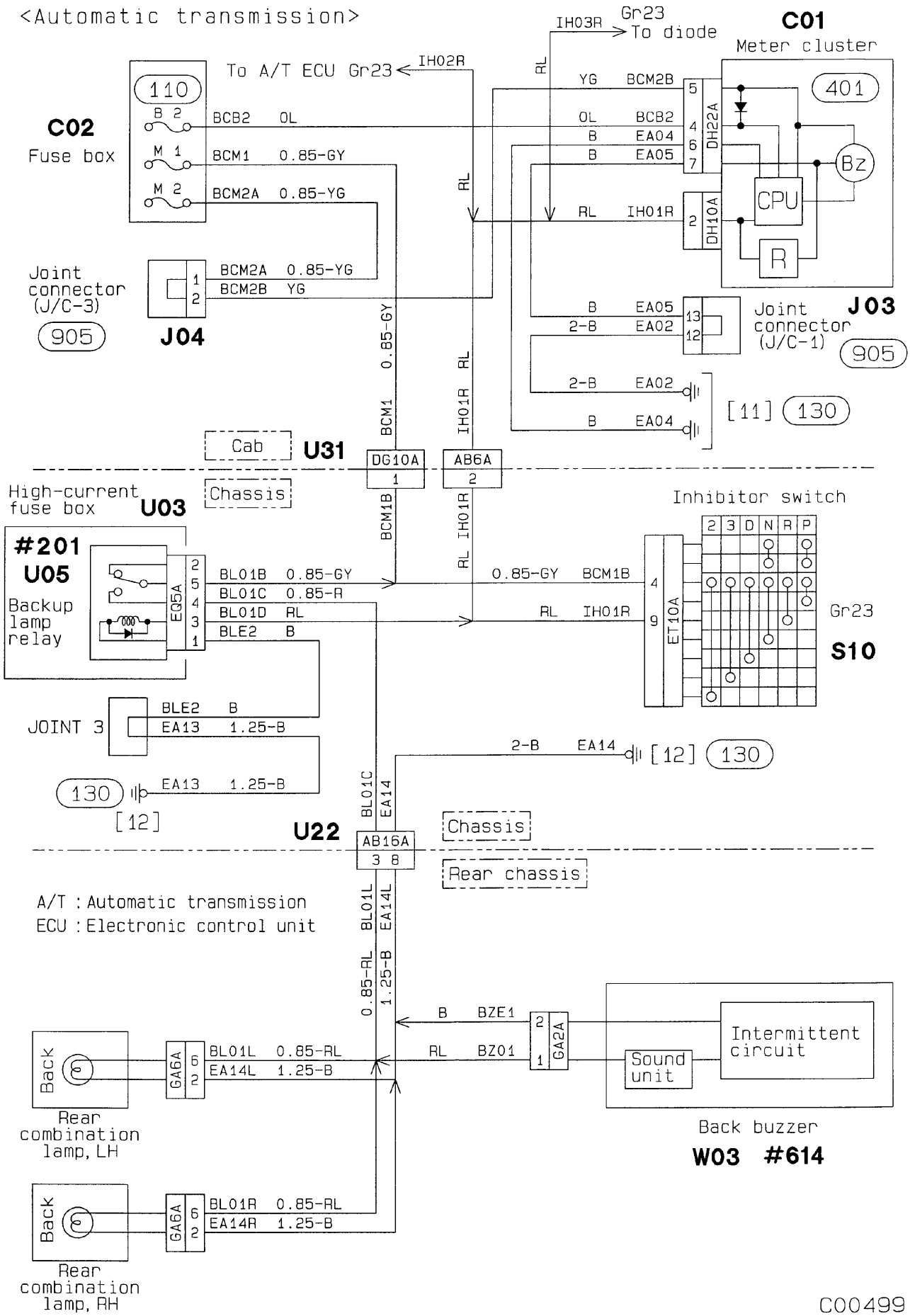
330-C00497

M E M O

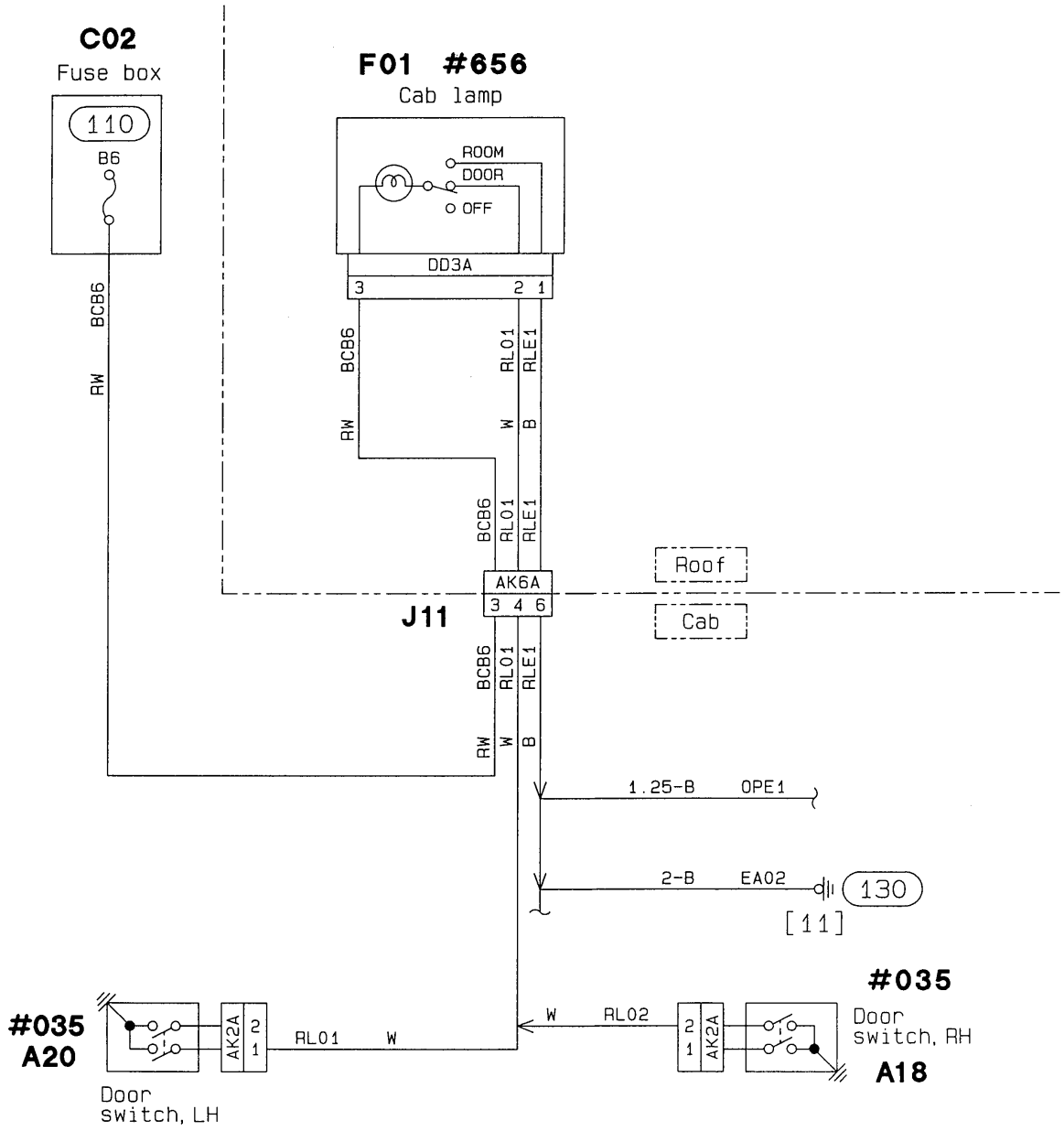
340 BACKUP LAMP CIRCUIT



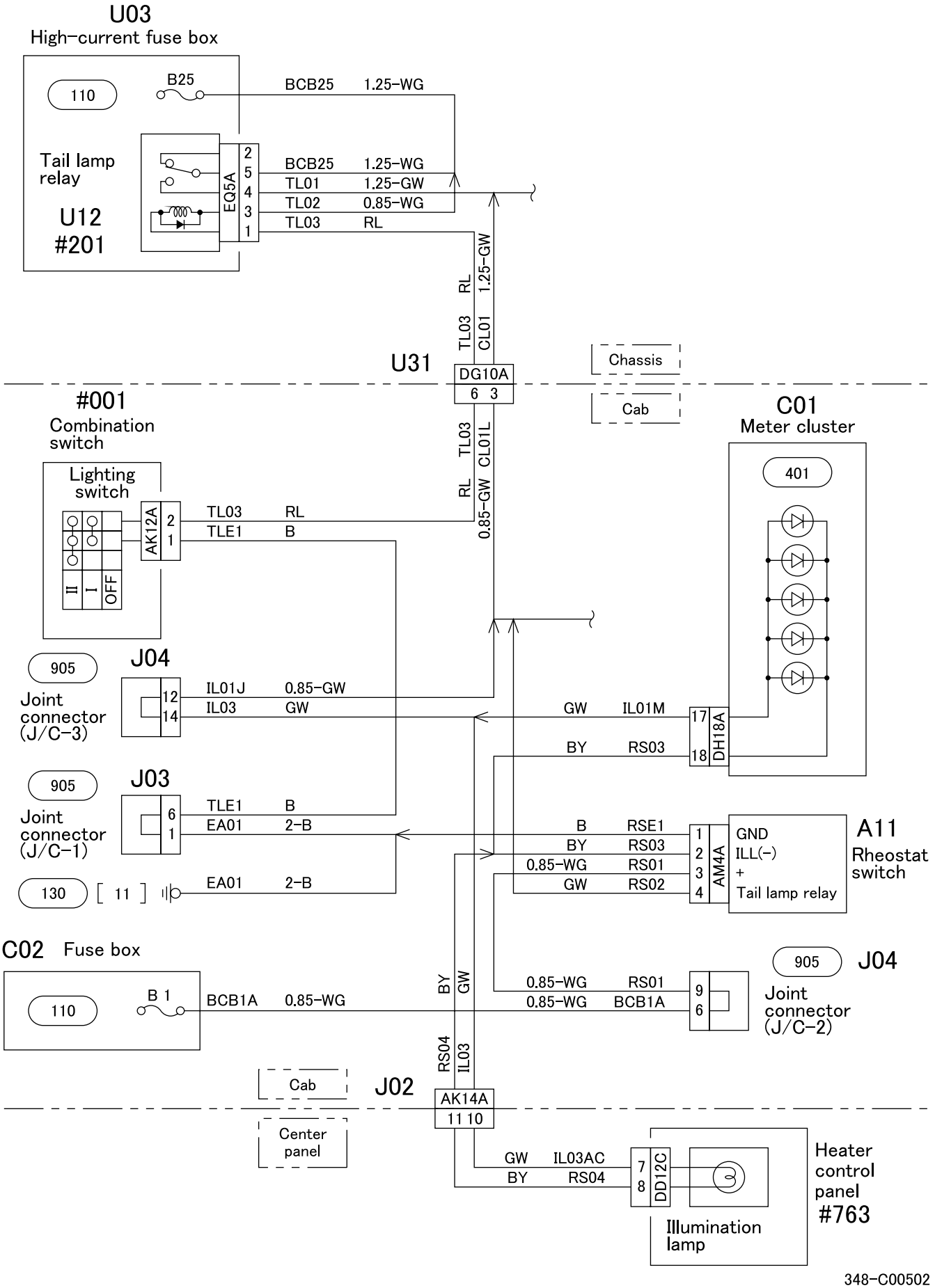
C00498


<Automatic transmission>
C01
Meter cluster
401
IH03R
Gr23
To diode
To A/T ECU Gr23
IH02R
110
C02
Fuse box
B 2
M 1
M 2
BCB2 OL
BCM1 0.85-GY
BCM2A 0.85-YG
YG BCM2B
OL BCB2
B EA04
B EA05
RL IH01R
DH22A
DH10A
CPU
R
Bz
Joint connector (J/C-3)
905
J04
BCM2A 0.85-YG
BCM2B YG
Joint connector (J/C-1)
J03
905
B EA05
2-B EA02
2-B EA02
B EA04
[11] 130
Cab
U31
Chassis
DG10A
AB6A
BCM1
IH01R
0.85-GY
RL
High-current fuse box
U03
#201
U05
Backup lamp relay
EQ5A
BL01B 0.85-GY
BL01C 0.85-R
BL01D RL
BLE2 B
Inhibitor switch
2 3 D N R P
ET10A
0.85-GY BCM1B
RL IH01R
Gr23
S10
JOINT 3
BLE2 B
EA13 1.25-B
130
EA13 1.25-B
[12]
2-B EA14
[12] 130
U22
AB16A
3 8
BL01C
EA14
Chassis
Rear chassis
A/T : Automatic transmission
ECU : Electronic control unit
BL01L
EA14L
0.85-RL
1.25-B
B BZE1
RL BZ01
GA2A
Intermittent circuit
Sound unit
Back buzzer
W03 #614
Back
GA6A
BL01L 0.85-RL
EA14L 1.25-B
Rear combination lamp, LH
BL01R 0.85-RL
EA14R 1.25-B
Rear combination lamp, RH

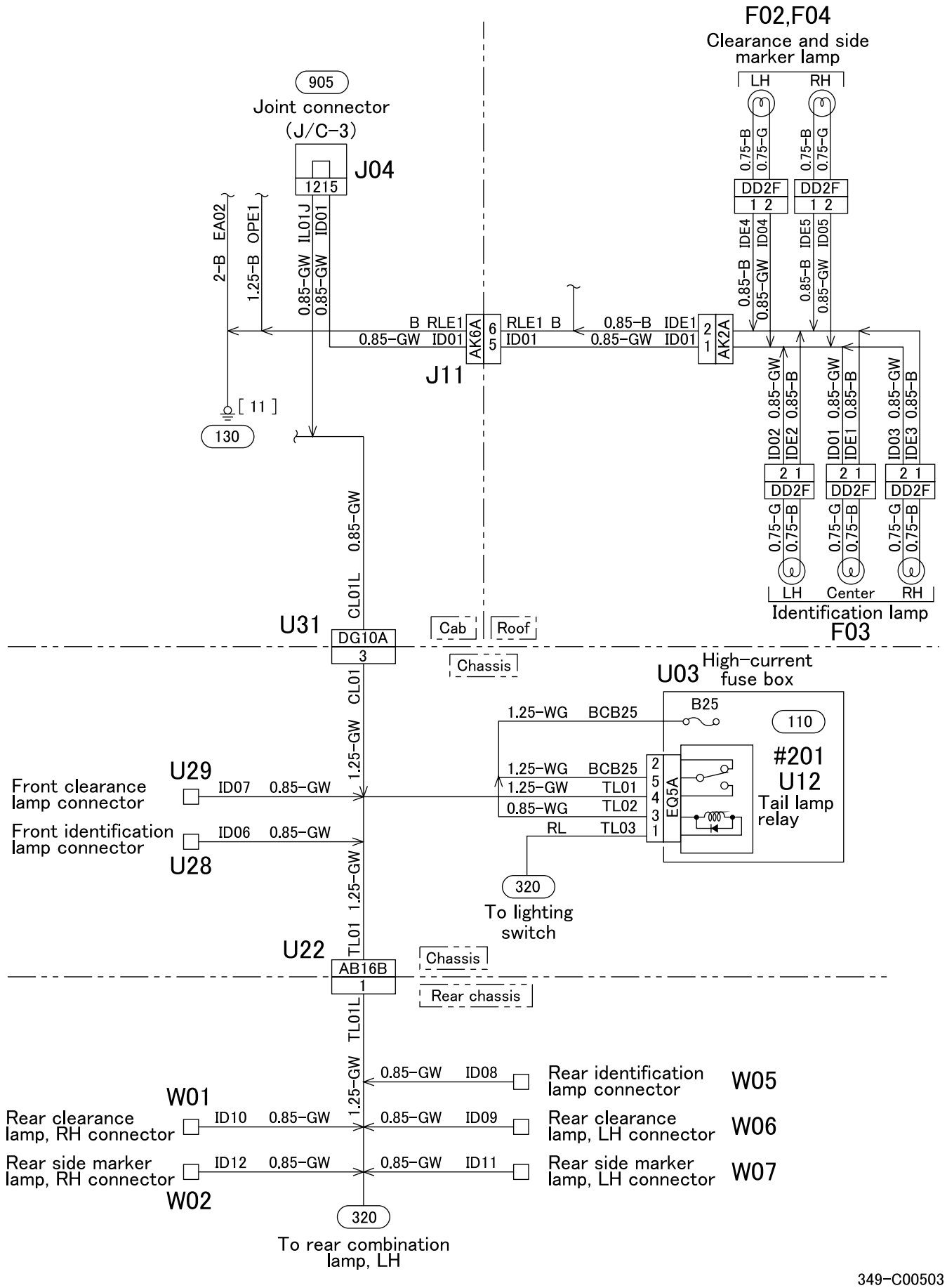
C00499


C02
Fuse box
110
B6
BCB6
RW
F01 #656
Cab lamp
ROOM
DOOR
OFF
DD3A
3
2 1
BCB6
RW
RL01
RLE1
W
B
AK6A
3 4 6
J11
Roof
Cab
1.25-B OPE1
2-B EA02
130
[11]
#035
A20
AK2A
2
1
RL01 W
Door
switch, LH
W RL02
#035
Door
switch, RH
A18

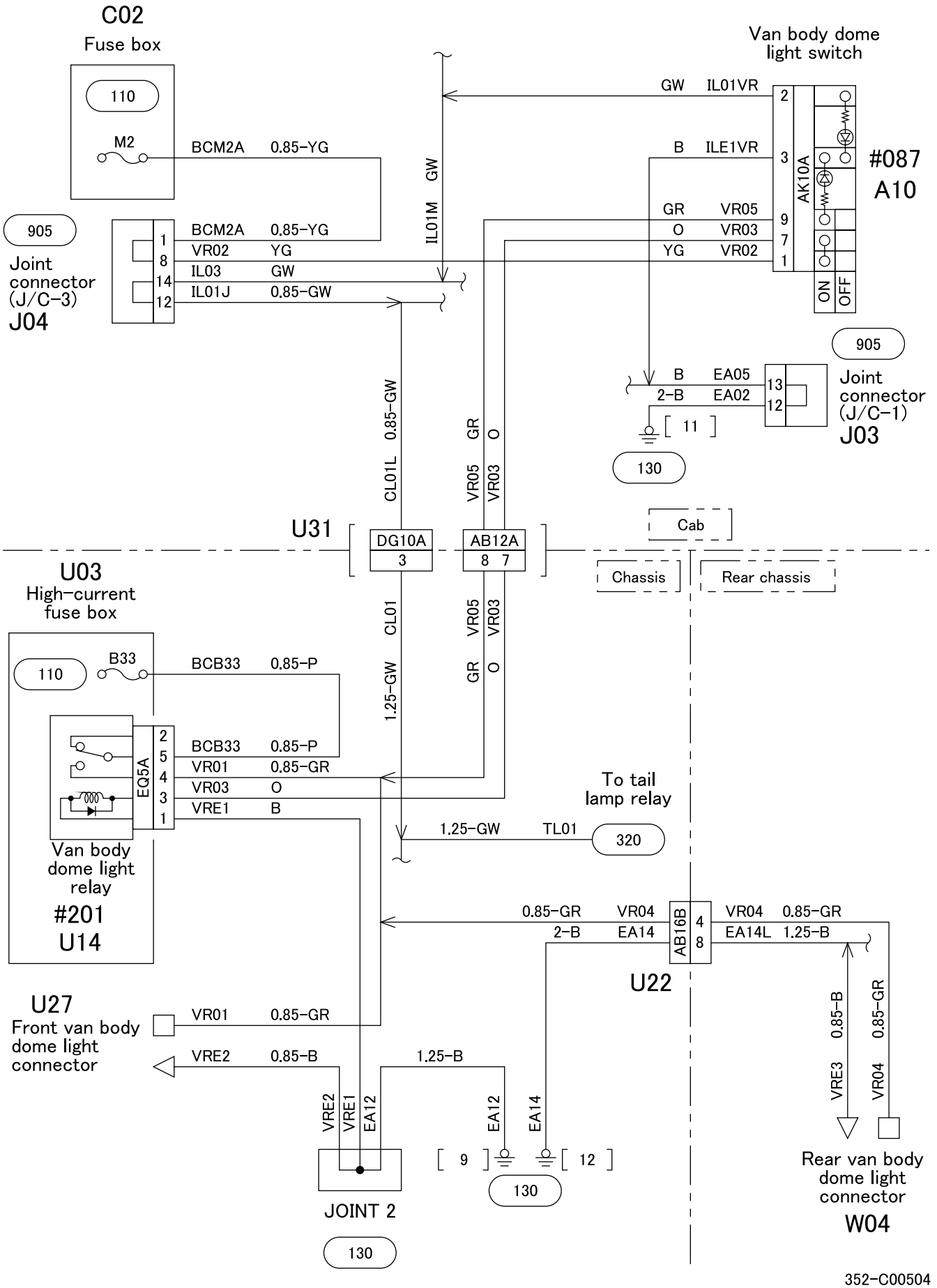
C02278


U03
High-current fuse box
110
B25
BCB25 1.25-WG
Tail lamp relay
U12
#201
EQ5A
2
5
4
3
1
BCB25 1.25-WG
TL01 1.25-GW
TL02 0.85-WG
TL03 RL
RL 1.25-GW
TL03 CL01
U31
DG10A
6 3
Chassis
Cab
#001
Combination switch
Lighting switch
AK12A
2
1
TL03 RL
TLE1 B
OFF
I
II
RL TL03
0.85-GW CL01L
C01
Meter cluster
401
905
Joint connector (J/C-3)
J04
12
14
IL01J 0.85-GW
IL03 GW
GW IL01M
BY RS03
17
18
DH18A
905
Joint connector (J/C-1)
J03
6
1
TLE1 B
EA01 2-B
B RSE1
BY RS03
0.85-WG RS01
GW RS02
1
2
3
4
AM4A
GND
ILL(-)
+
Tail lamp relay
A11
Rheostat switch
130
[11]
EA01 2-B
C02 Fuse box
110
B 1
BCB1A 0.85-WG
BY GW
0.85-WG RS01
0.85-WG BCB1A
9
6
905
J04
Joint connector (J/C-2)
RS04 IL03
Cab
Center panel
J02
AK14A
11 10
GW IL03AC
BY RS04
7
8
DD12C
Heater control panel
#763
Illumination lamp

348-C00502


F02,F04
Clearance and side marker lamp
LH
RH
905
Joint connector (J/C-3)
J04
1215
2-B EA02
1.25-B OPE1
0.85-GW IL01J
0.85-GW ID01
0.75-B
0.75-G
DD2F
1 2
IDE4 ID04
IDE5 ID05
0.85-B
0.85-GW
B RLE1
0.85-GW ID01
AK6A
6
5
RLE1 B
ID01
0.85-B IDE1
0.85-GW ID01
2
1
AK2A
J11
[11]
130
ID02 IDE2
ID01 IDE1
ID03 IDE3
2 1
LH
Center
RH
Identification lamp
F03
U31
DG10A
3
CL01L 0.85-GW
Cab
Roof
Chassis
CL01 1.25-GW
U03
High-current fuse box
B25
110
#201
U12
Tail lamp relay
1.25-WG BCB25
1.25-GW TL01
0.85-WG TL02
RL TL03
EQ5A
2
5
4
3
1
320
To lighting switch
U29
Front clearance lamp connector
ID07 0.85-GW
U28
Front identification lamp connector
ID06 0.85-GW
TL01 1.25-GW
U22
AB16B
1
Chassis
Rear chassis
TL01L 1.25-GW
W01
Rear clearance lamp, RH connector
ID10 0.85-GW
Rear side marker lamp, RH connector
ID12 0.85-GW
W02
0.85-GW ID08
Rear identification lamp connector
W05
0.85-GW ID09
Rear clearance lamp, LH connector
W06
0.85-GW ID11
Rear side marker lamp, LH connector
W07
320
To rear combination lamp, LH

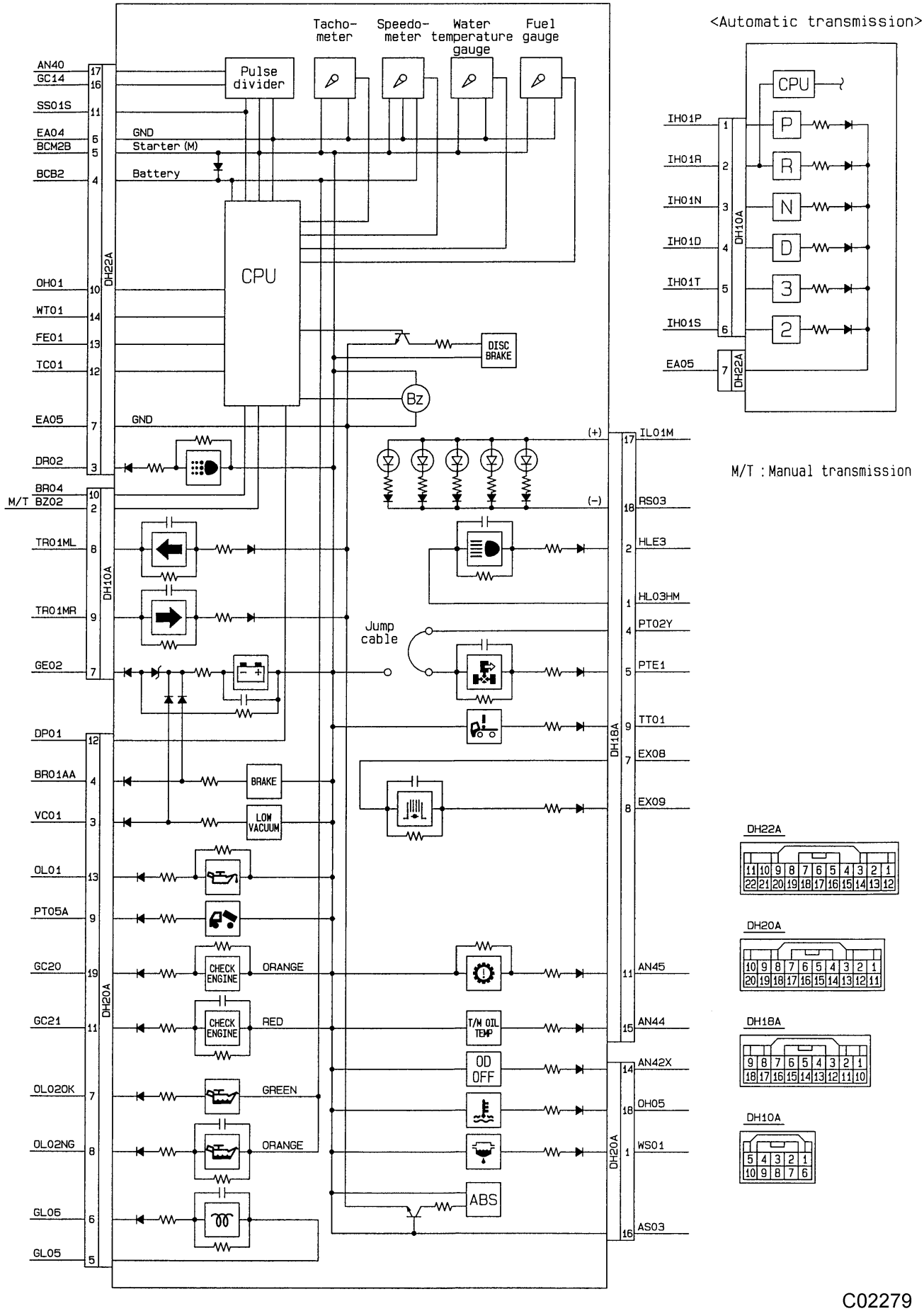
349-C00503


C02
Fuse box
110
M2
BCM2A 0.85-YG
905
Joint connector (J/C-3)
J04
1
8
14
12
BCM2A 0.85-YG
VR02 YG
IL03 GW
IL01J 0.85-GW
IL01M GW
Van body dome light switch
GW IL01VR
B ILE1VR
GR VR05
O VR03
YG VR02
2
3
9
7
1
AK10A
ON
OFF
#087
A10
905
Joint connector (J/C-1)
J03
B EA05
2-B EA02
13
12
11
130
CL01L 0.85-GW
GR VR05
O VR03
U31
DG10A
3
AB12A
8 7
Cab
Chassis
Rear chassis
U03
High-current fuse box
110
B33
BCB33 0.85-P
CL01 1.25-GW
VR05 GR
VR03 O
EQ5A
2
5
4
3
1
BCB33 0.85-P
VR01 0.85-GR
VR03 O
VRE1 B
Van body dome light relay
#201
U14
To tail lamp relay
1.25-GW TL01
320
0.85-GR VR04
2-B EA14
AB16B
4
8
VR04 0.85-GR
EA14L 1.25-B
U22
U27
Front van body dome light connector
VR01 0.85-GR
VRE2 0.85-B
1.25-B
VRE2
VRE1
EA12
EA12
EA14
9
12
130
JOINT 2
130
VRE3 0.85-B
VR04 0.85-GR
Rear van body dome light connector
W04

352-C00504

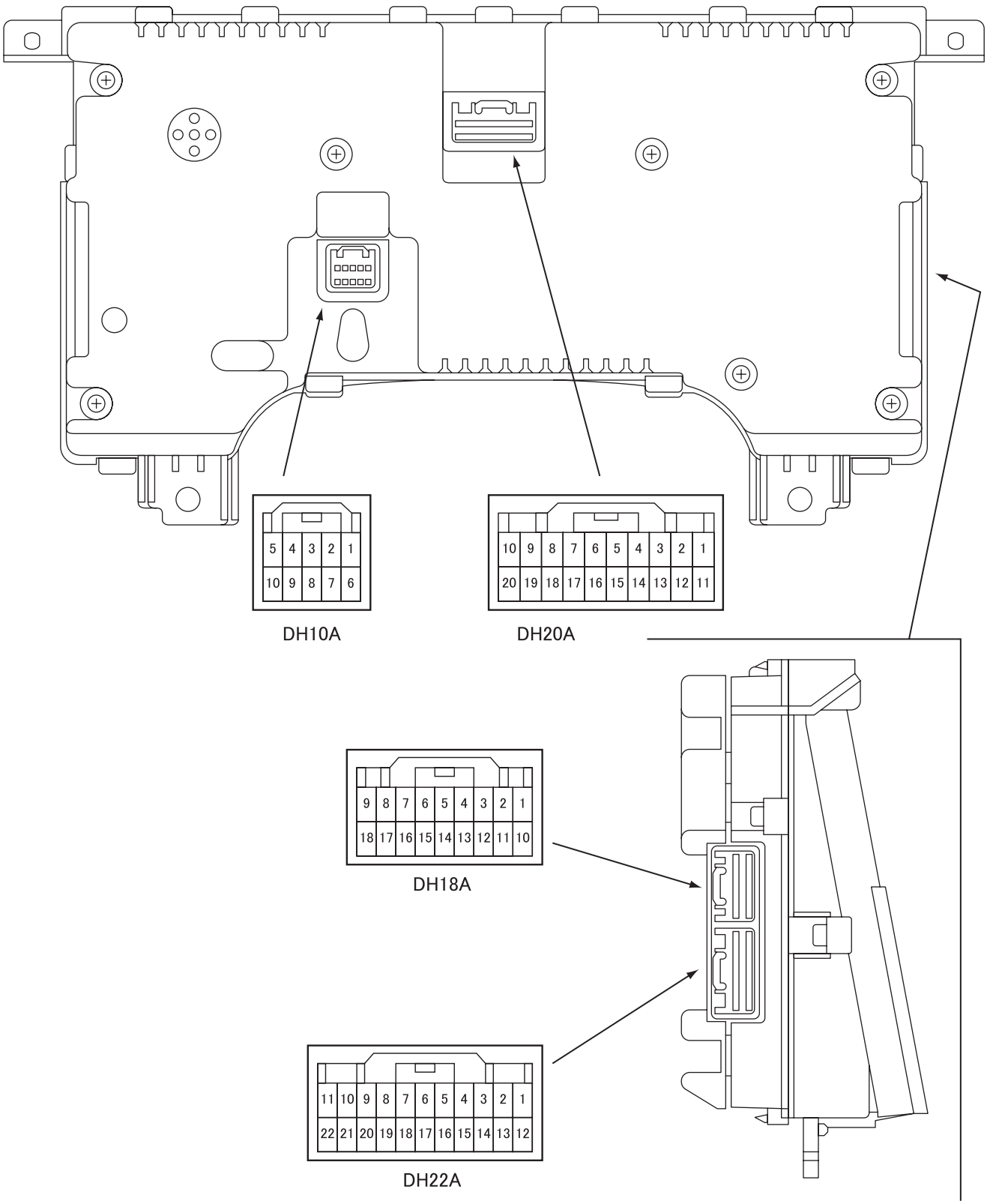
GROUP 54-04 METER CIRCUIT

401 METER CLUSTER INTERNAL CIRCUIT

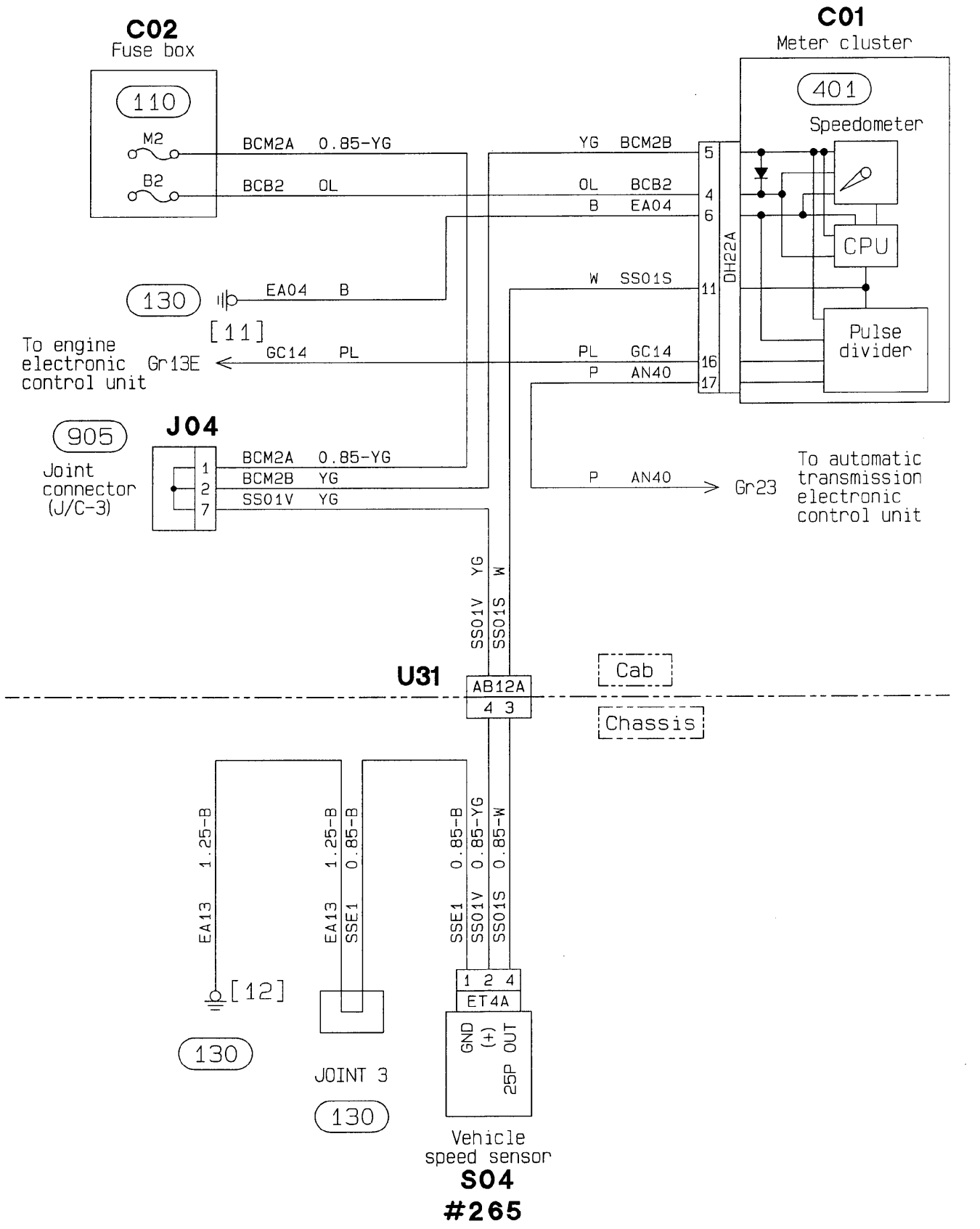


C02279

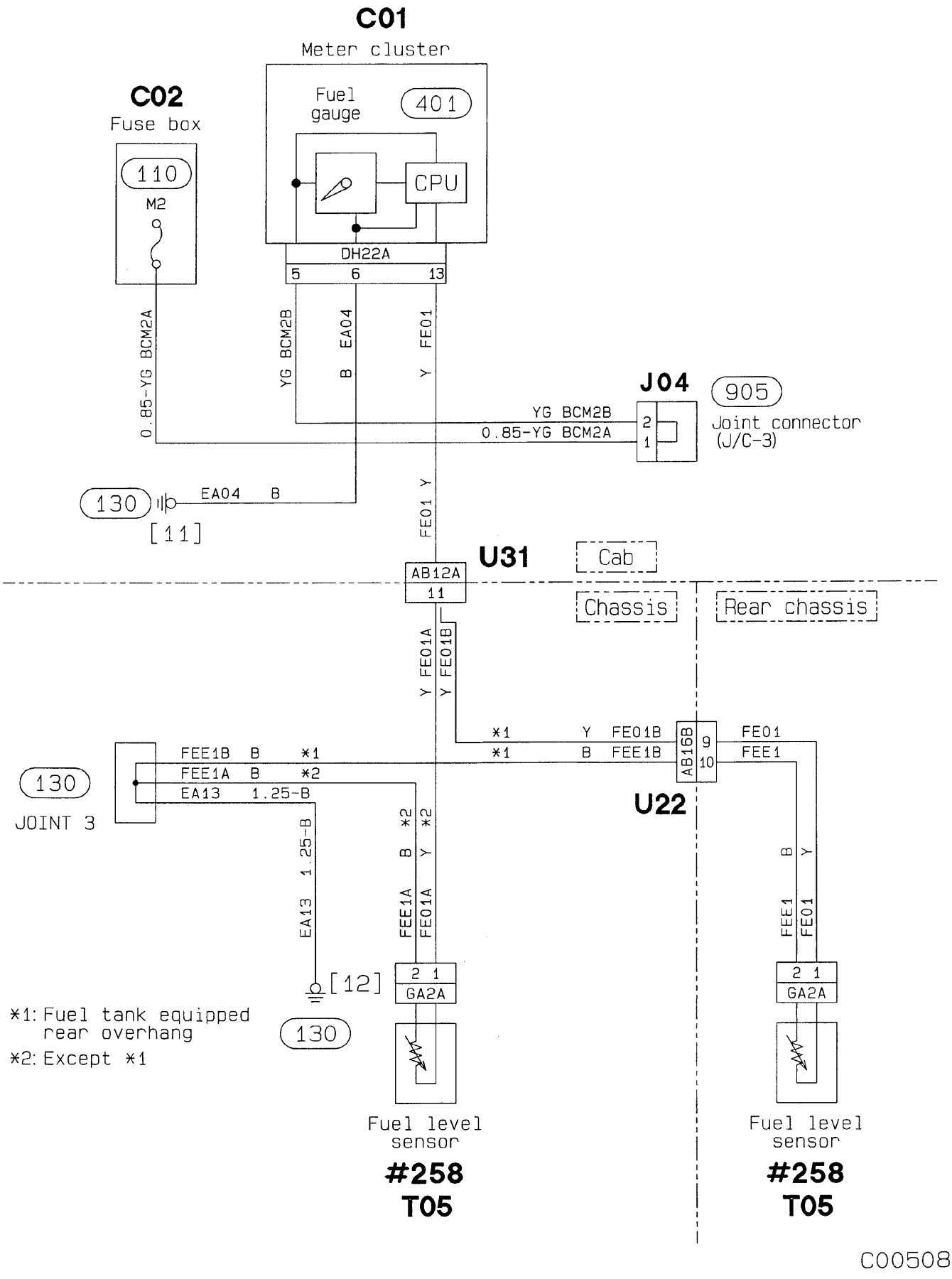
Meter cluster backward view



Because a CPU is built into the meter, the inner part of the meter body cannot be disassembled.

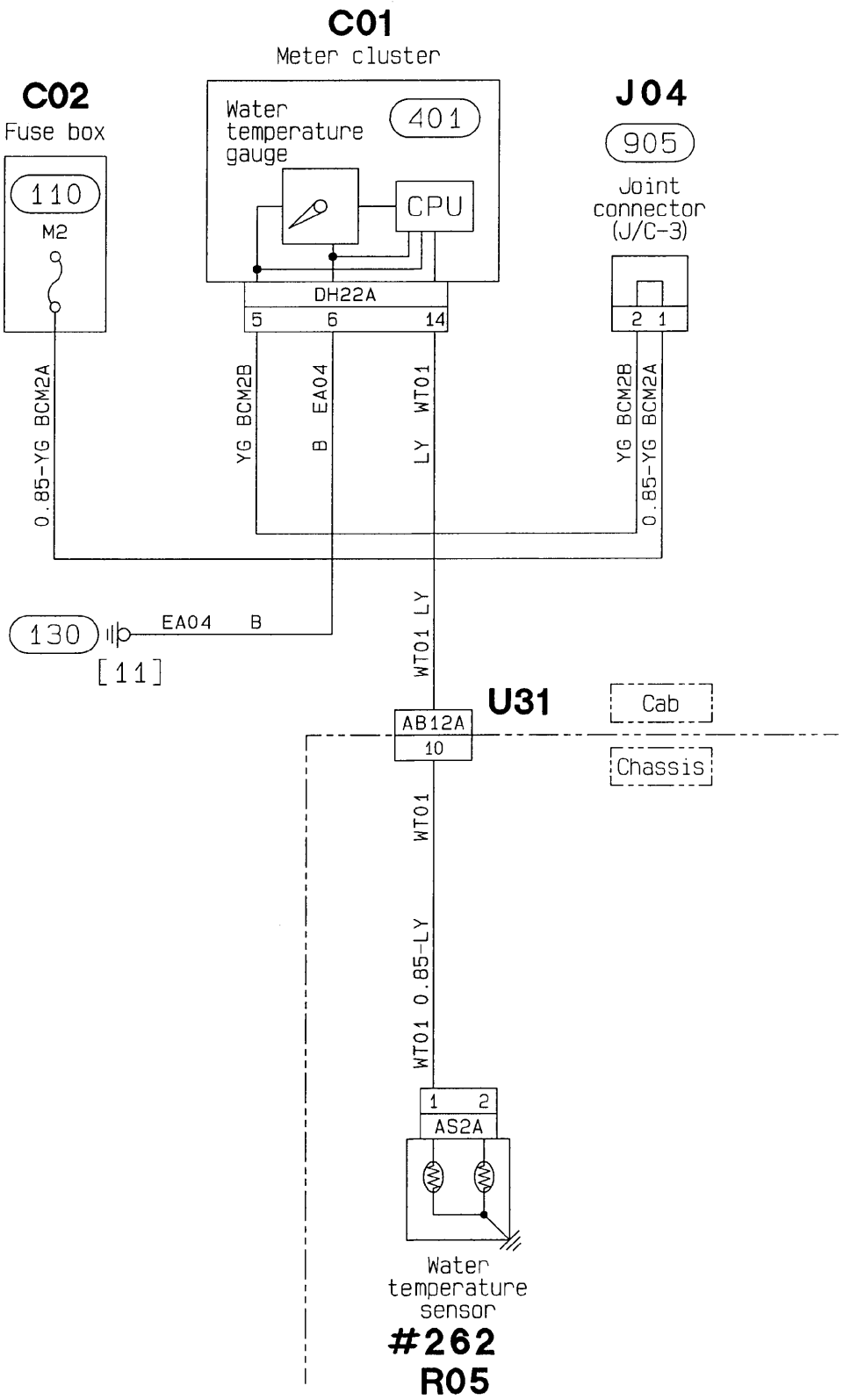

C02
Fuse box
110
M2
B2
BCM2A 0.85-YG
BCB2 OL
C01
Meter cluster
401
Speedometer
YG BCM2B
OL BCB2
B EA04
5
4
6
DH22A
CPU
Pulse divider
W SS01S
11
130
EA04 B
[11]
To engine electronic control unit
Gr13E
GC14 PL
PL GC14
P AN40
16
17
905
Joint connector (J/C-3)
J04
1
2
7
BCM2A 0.85-YG
BCM2B YG
SS01V YG
P AN40
Gr23
To automatic transmission electronic control unit
SS01V YG
SS01S W
U31
AB12A
4 3
Cab
Chassis
EA13 1.25-B
[12]
130
EA13 1.25-B
SSE1 0.85-B
JOINT 3
130
SSE1 0.85-B
SS01V 0.85-YG
SS01S 0.85-W
1 2 4
ET4A
GND (+)
25P OUT
Vehicle speed sensor
S04
#265

C00506


C01
Meter cluster
Fuel gauge
401
CPU
DH22A
5
6
13
C02
Fuse box
110
M2
0.85-YG BCM2A
YG BCM2B
B EA04
Y FE01
J04
905
Joint connector (J/C-3)
YG BCM2B
0.85-YG BCM2A
2
1
130
EA04 B
[11]
FE01 Y
U31
Cab
AB12A
11
Chassis
Rear chassis
Y FE01A
Y FE01B
*1 Y FE01B
*1 B FEE1B
AB16B
9
10
FE01
FEE1
FEE1B B *1
FEE1A B *2
EA13 1.25-B
130
JOINT 3
U22
EA13 1.25-B
FEE1A B *2
FE01A Y *2
[12]
2 1
GA2A
130
*1: Fuel tank equipped rear overhang
*2: Except *1
Fuel level sensor
#258
T05
FEE1 B
FE01 Y
Fuel level sensor
#258
T05

C00508

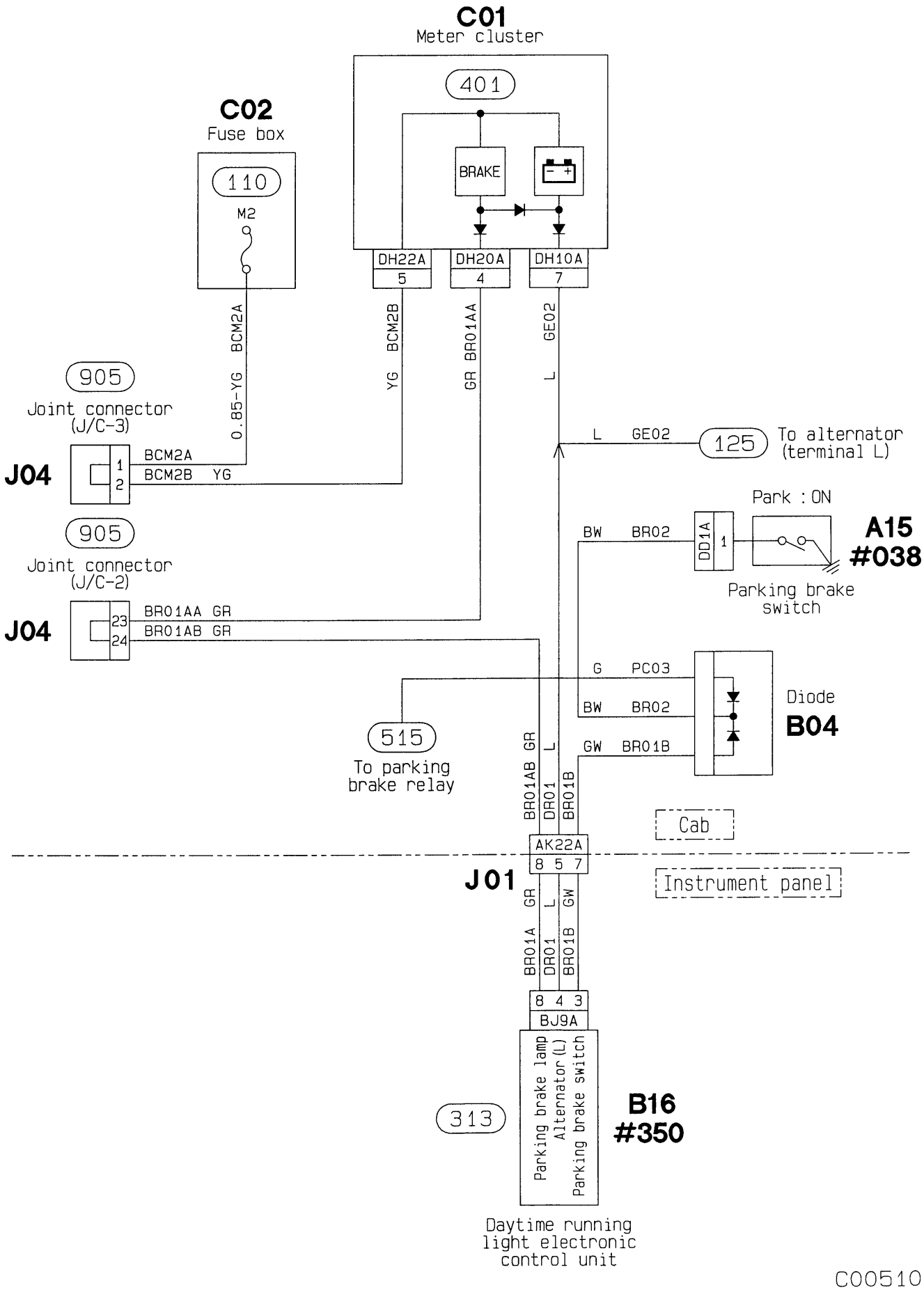
425 WATER TEMPERATURE GAUGE CIRCUIT



C00509

GROUP 54-05 INDICATOR AND WARNING LAMP CIRCUIT

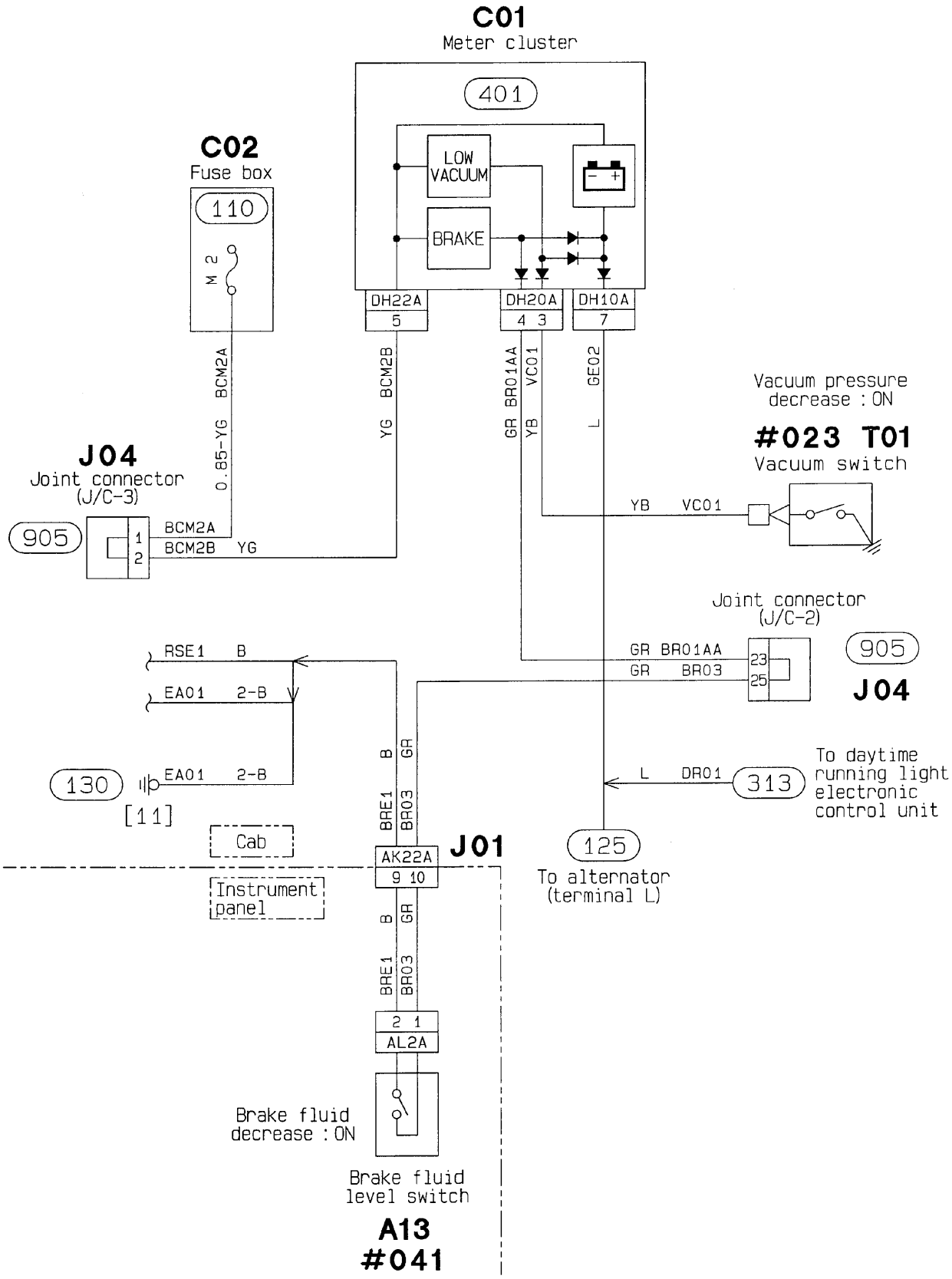
510 PARKING BRAKE INDICATOR CIRCUIT



M E M O

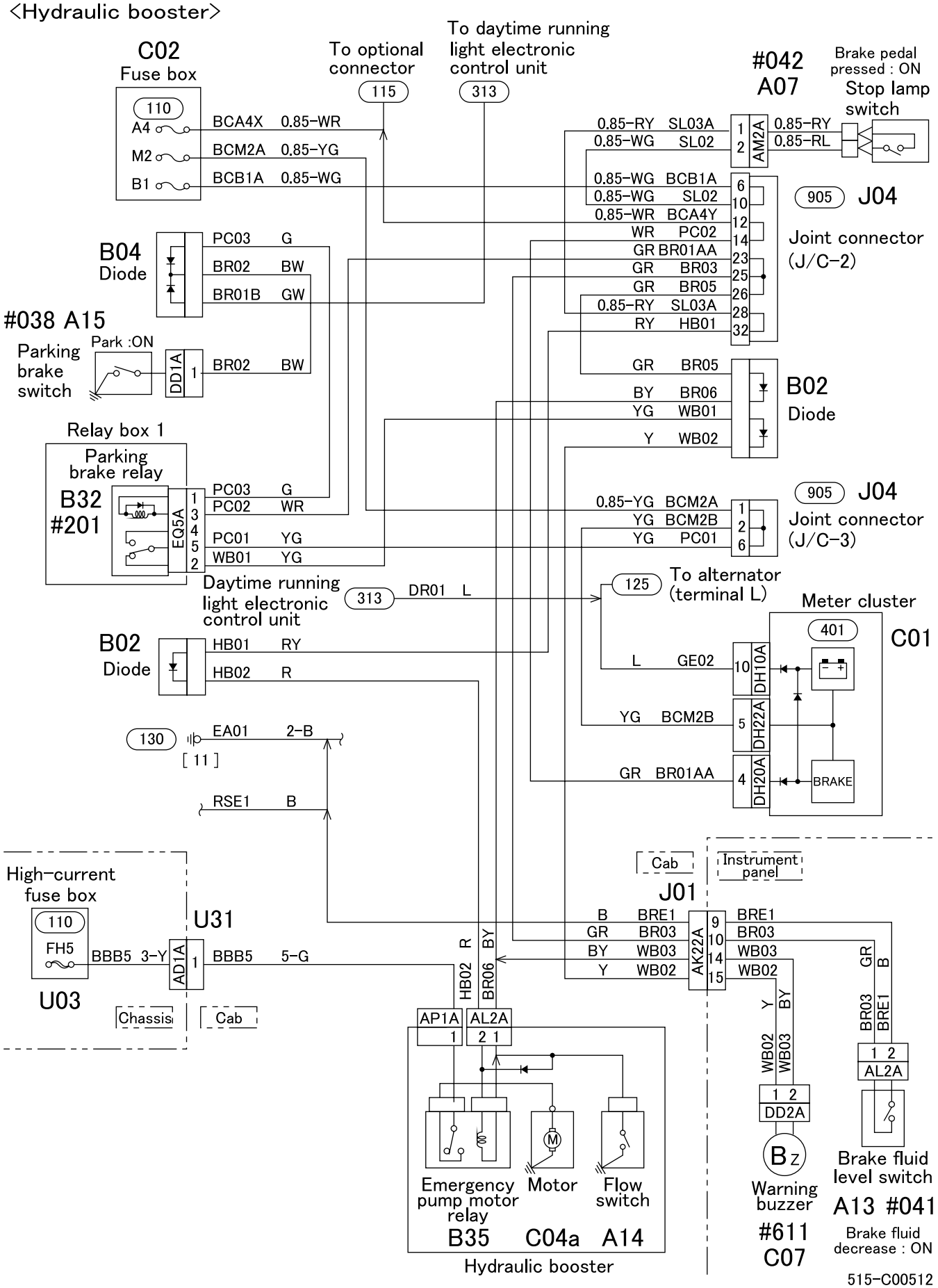
515 BRAKE WARNING CIRCUIT

<Except hydraulic booster>



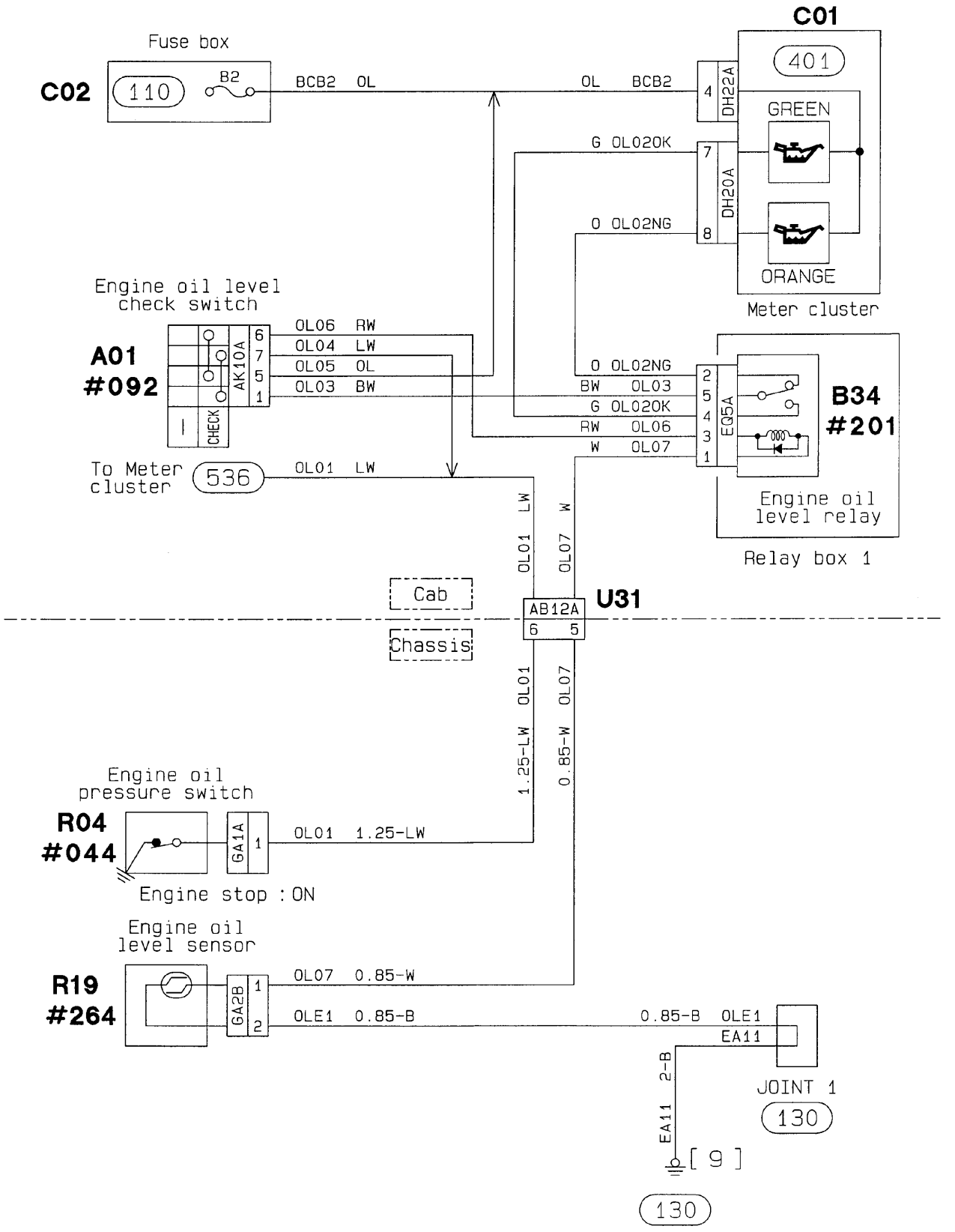
C00511

<Hydraulic booster>

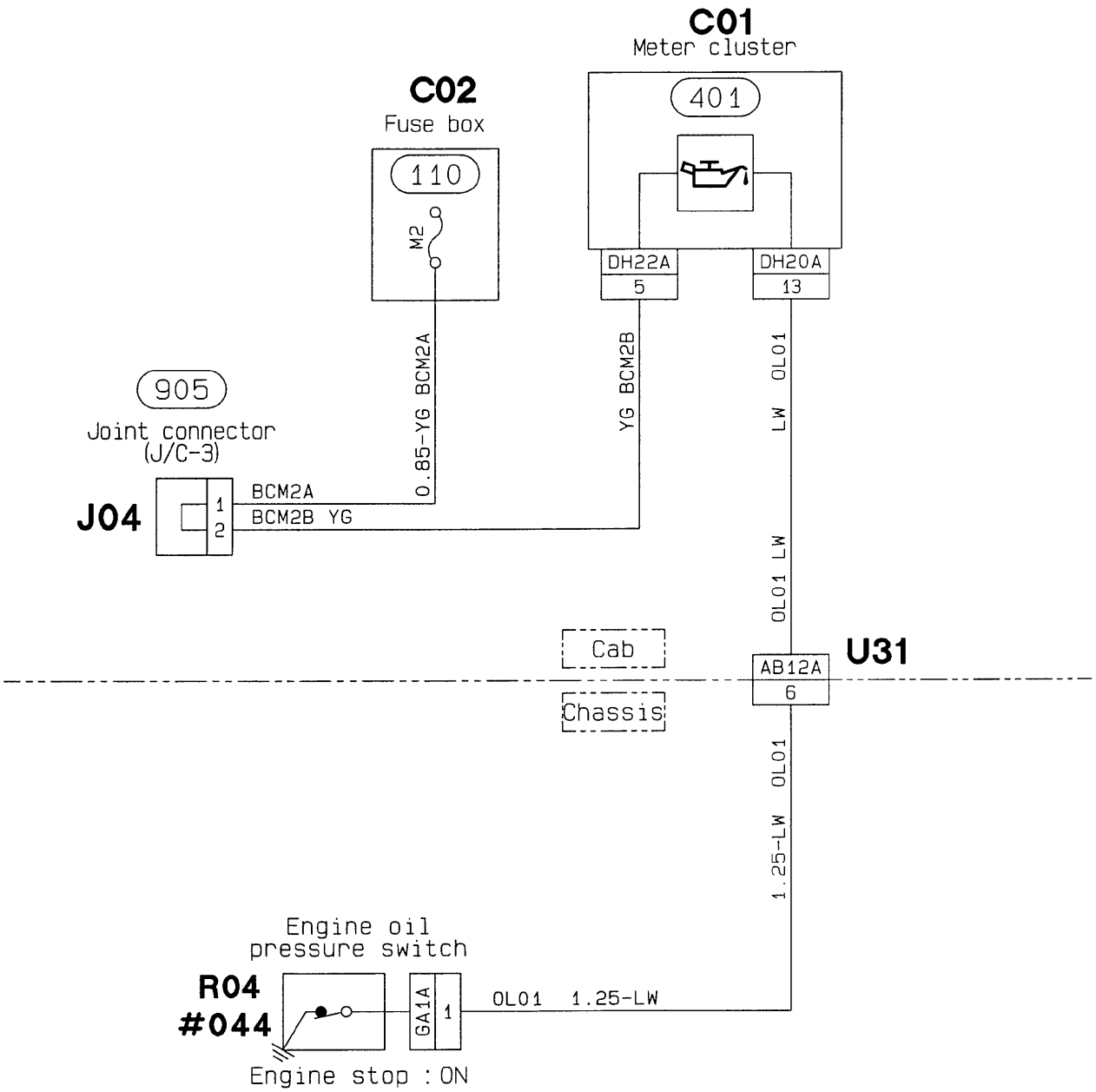


515-C00512

535 ENGINE OIL LEVEL WARNING CIRCUIT

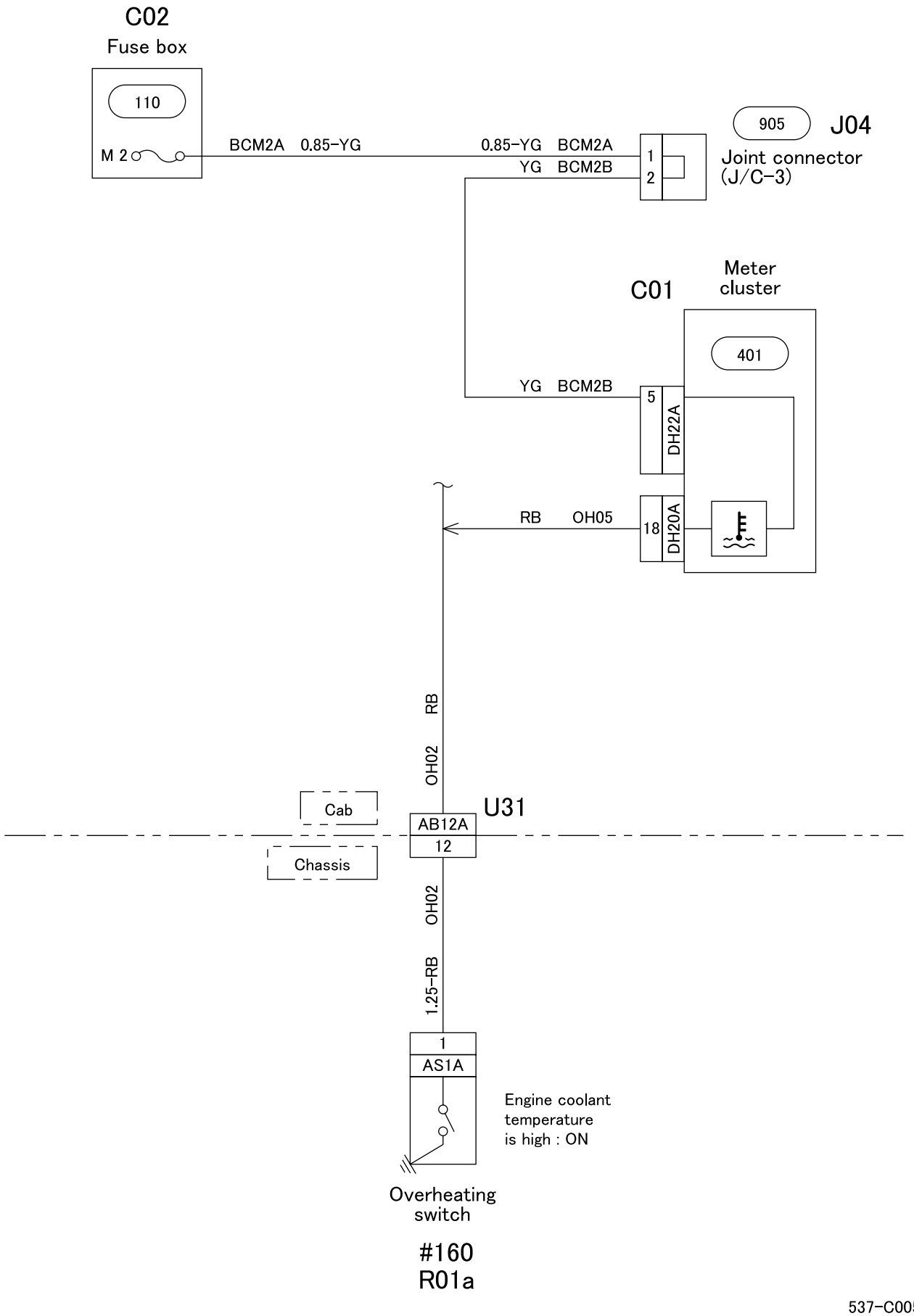


C00513

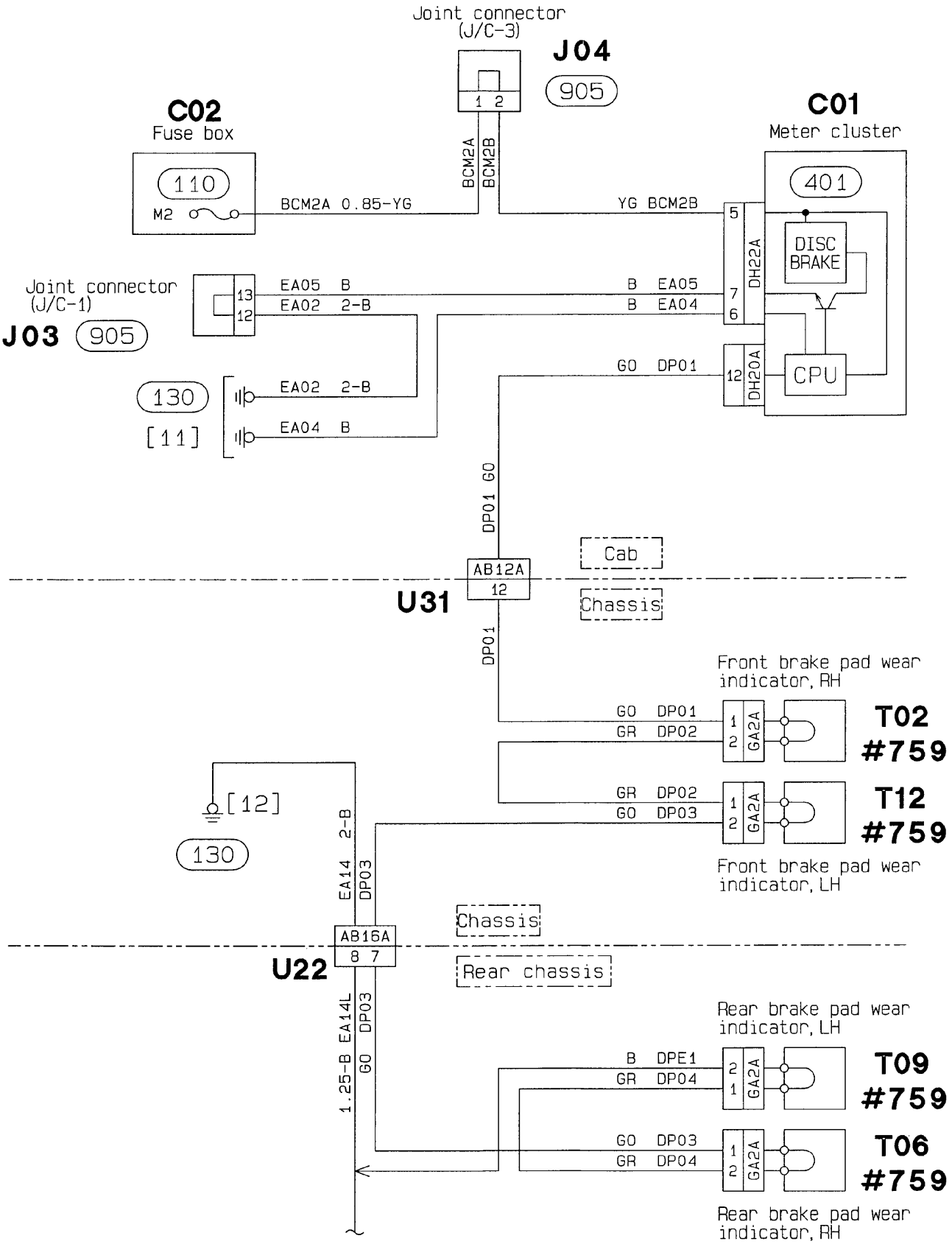

C01
Meter cluster
401
C02
Fuse box
110
M2
DH22A
5
DH20A
13
0.85-YG BCM2A
YG BCM2B
LW OL01
905
Joint connector
(J/C-3)
J04
1
2
BCM2A
BCM2B YG
OL01 LW
Cab
Chassis
U31
AB12A
6
1.25-LW OL01
Engine oil
pressure switch
R04
#044
GA1A
1
OL01 1.25-LW
Engine stop : ON

C00514

537 OVERHEATING WARNING CIRCUIT

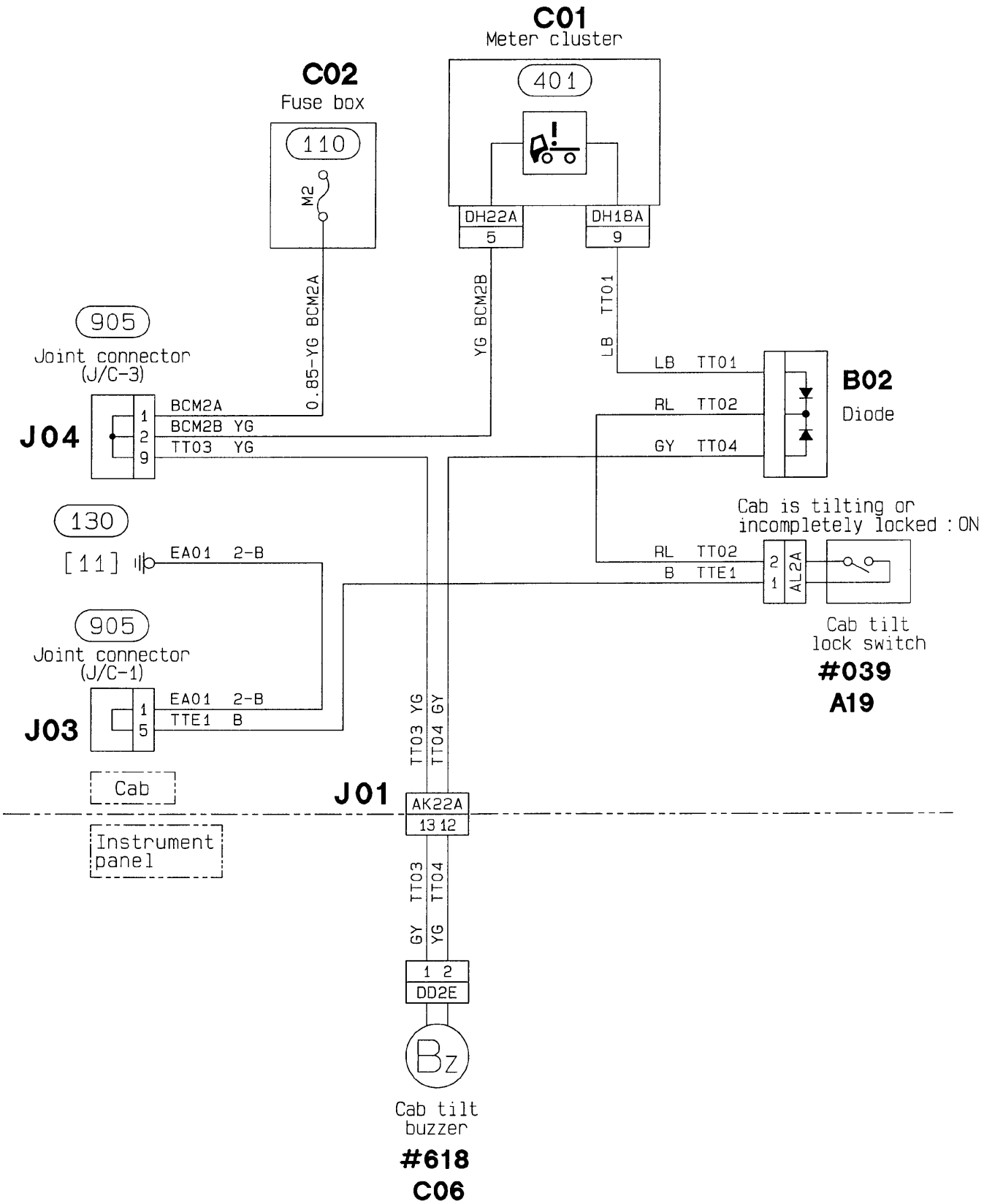


537-C00515

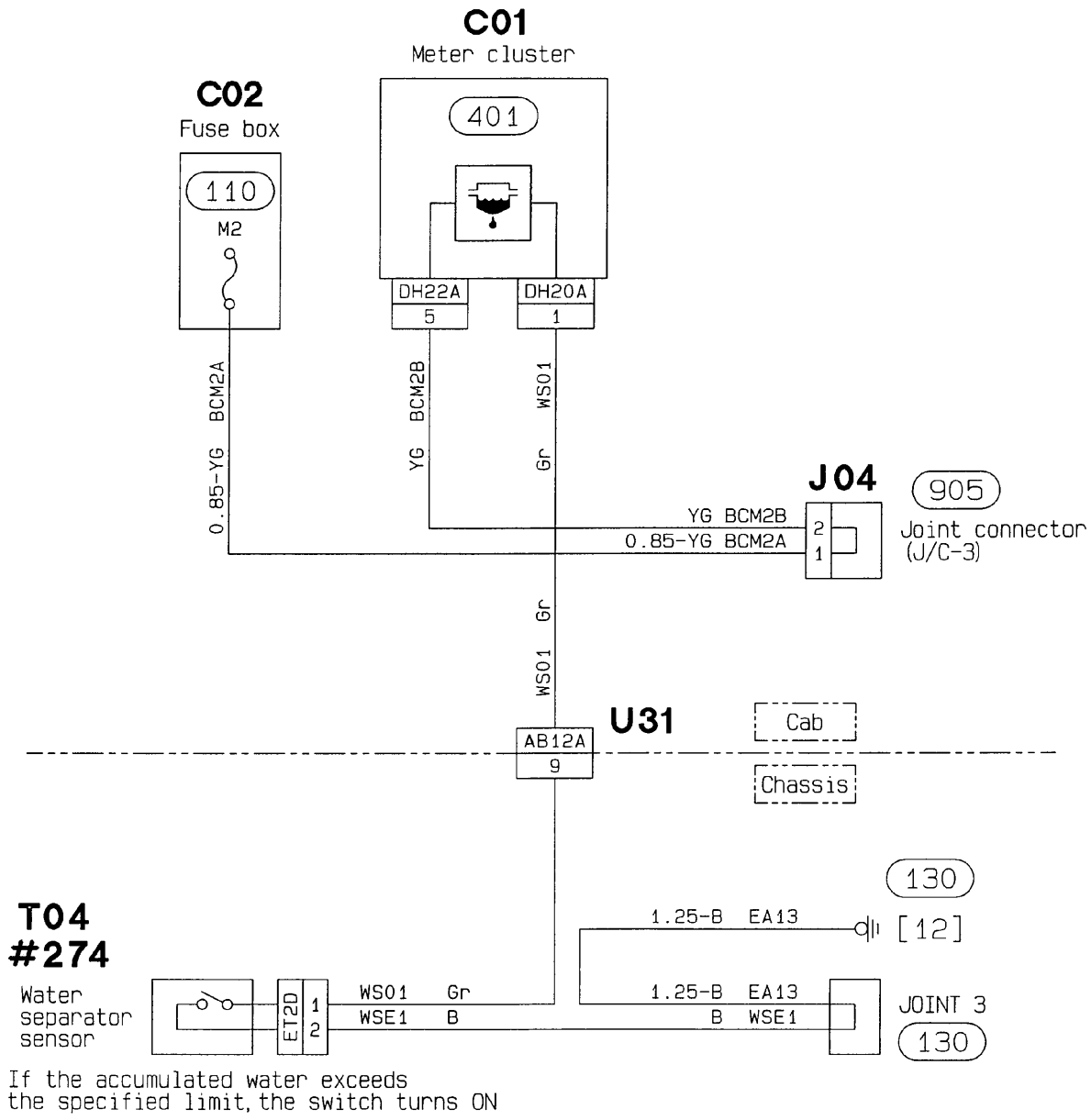

Joint connector
(J/C-3)
J04
905
1 2
C02
Fuse box
110
M2
BCM2A 0.85-YG
BCM2A
BCM2B
YG BCM2B
C01
Meter cluster
401
5
DH22A
DISC
BRAKE
Joint connector
(J/C-1)
J03
905
13
12
EA05 B
EA02 2-B
B EA05
B EA04
7
6
130
[11]
EA02 2-B
EA04 B
GO DP01
12
DH20A
CPU
DP01 GO
AB12A
12
Cab
U31
Chassis
DP01
Front brake pad wear
indicator, RH
GO DP01
GR DP02
1
2
GA2A
T02
#759
GR DP02
GO DP03
T12
#759
Front brake pad wear
indicator, LH
[12]
130
EA14 2-B
DP03
Chassis
AB16A
8 7
U22
Rear chassis
Rear brake pad wear
indicator, LH
1.25-B EA14L
GO DP03
B DPE1
GR DP04
2
1
T09
#759
GO DP03
GR DP04
T06
#759
Rear brake pad wear
indicator, RH

C00516

550 CAB TILT WARNING CIRCUIT

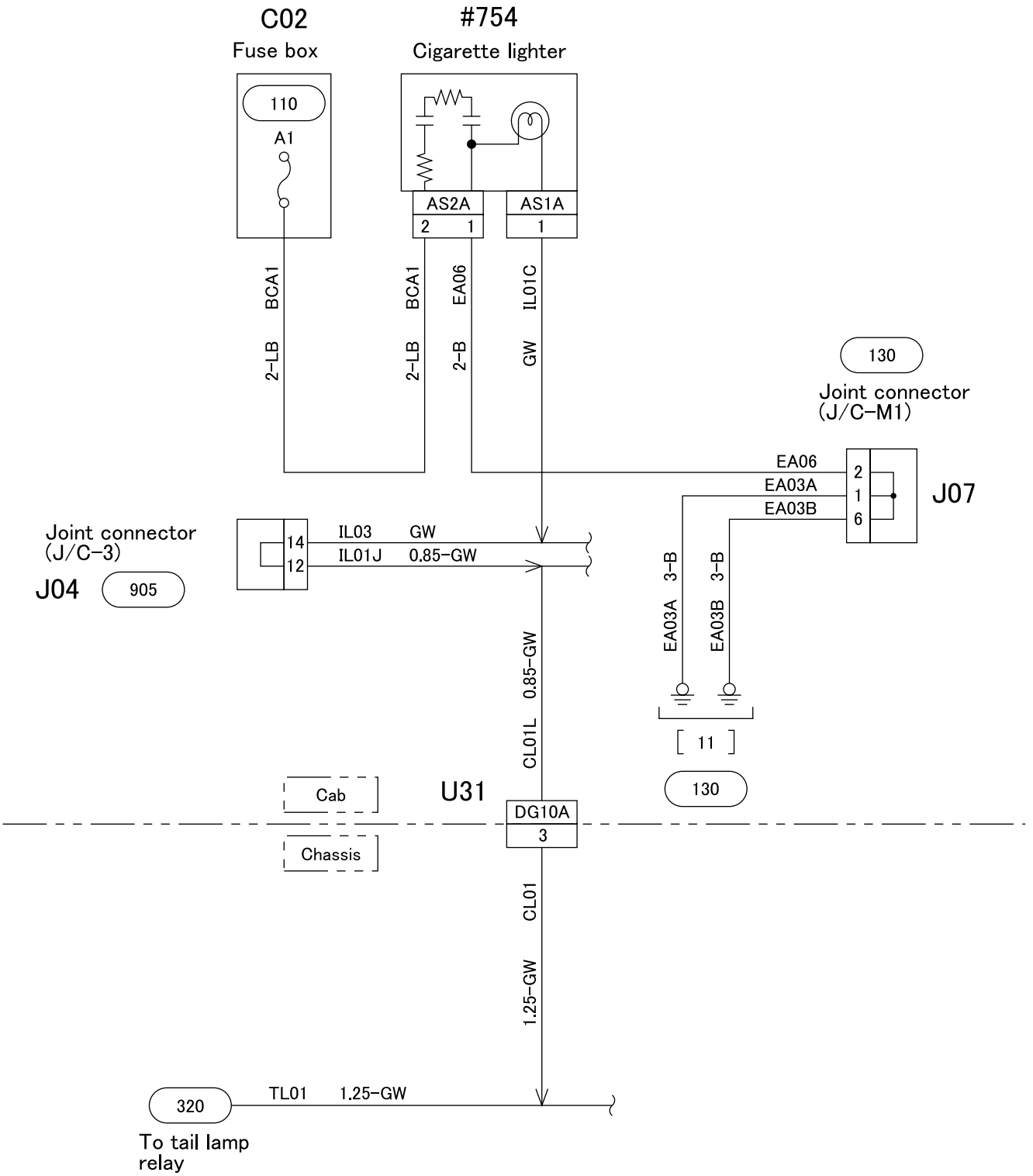


C00517

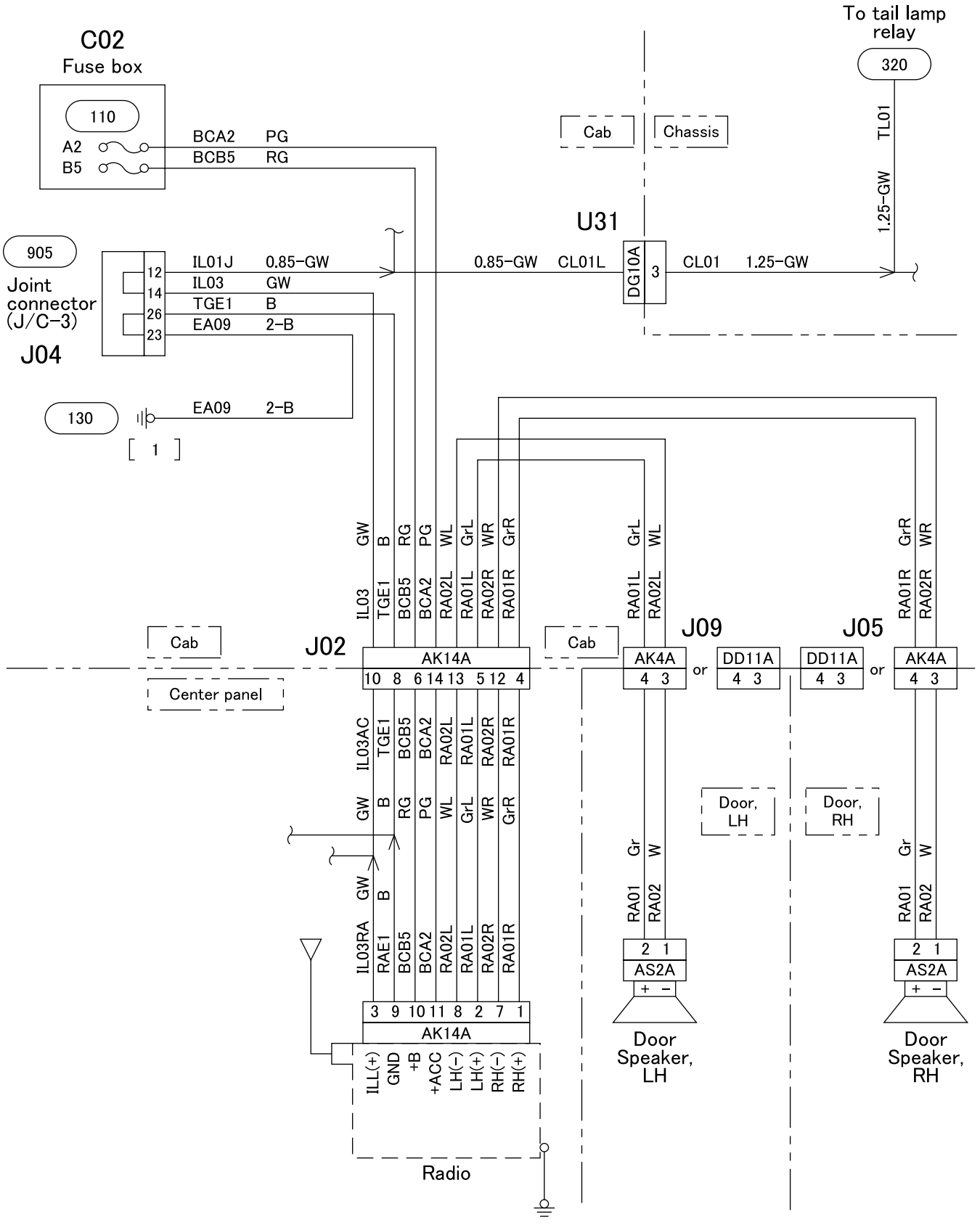

C01
Meter cluster
401
C02
Fuse box
110
M2
DH22A
5
DH20A
1
0.85-YG BCM2A
YG BCM2B
WS01 Gr
J04
905
YG BCM2B
0.85-YG BCM2A
2
1
Joint connector
(J/C-3)
WS01 Gr
U31
AB12A
9
Cab
Chassis
130
1.25-B EA13
[12]
T04
#274
Water
separator
sensor
ET2D
1
2
WS01 Gr
WSE1 B
1.25-B EA13
B WSE1
JOINT 3
130
If the accumulated water exceeds
the specified limit, the switch turns ON

C00518

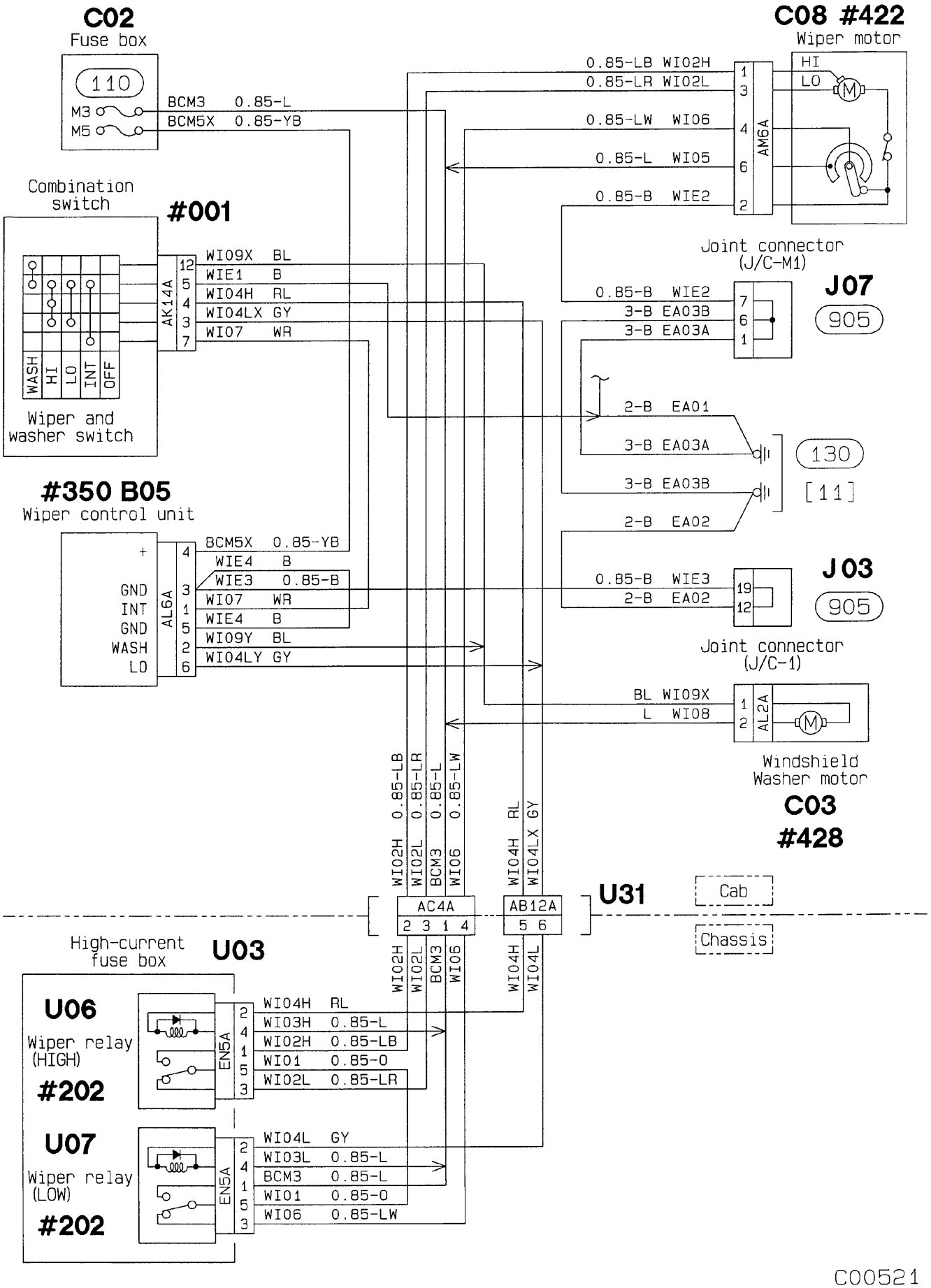
GROUP 54-06 CAB SIDE ELECTRICAL CIRCUIT


C02
Fuse box
#754
Cigarette lighter
110
A1
AS2A
2 1
AS1A
1
BCA1
2-LB
BCA1
2-LB
EA06
2-B
IL01C
GW
130
Joint connector
(J/C-M1)
EA06
EA03A
EA03B
2
1
6
J07
Joint connector
(J/C-3)
J04
905
14
12
IL03 GW
IL01J 0.85-GW
EA03A 3-B
EA03B 3-B
11
130
CL01L 0.85-GW
Cab
U31
DG10A
3
Chassis
CL01
1.25-GW
320
TL01 1.25-GW
To tail lamp
relay

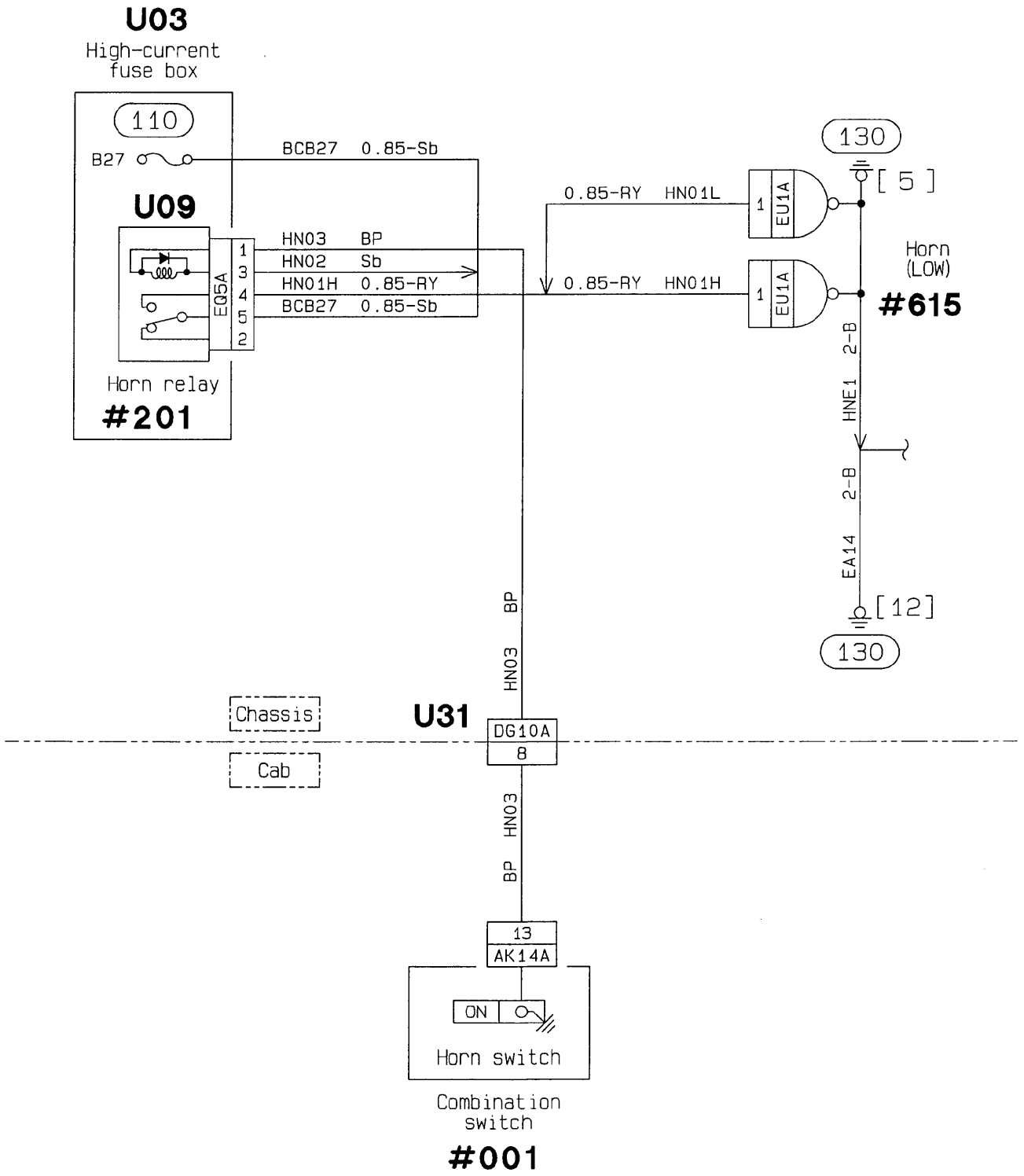
610-C00519


C02
Fuse box
110
A2
B5
BCA2 PG
BCB5 RG
To tail lamp relay
320
TL01
1.25-GW
Cab
Chassis
U31
905
Joint connector (J/C-3)
J04
12
14
26
23
IL01J 0.85-GW
IL03 GW
TGE1 B
EA09 2-B
0.85-GW CL01L
DG10A
3
CL01 1.25-GW
130
EA09 2-B
1
Cab
J02
AK14A
10 8 6 14 13 5 12 4
Center panel
IL03 TGE1 BCB5 BCA2 RA02L RA01L RA02R RA01R
GW B RG PG WL GrL WR GrR
IL03AC
IL03RA
RAE1
GW
B
Cab
RA01L RA02L
GrL WL
J09
AK4A
4 3
or
DD11A
4 3
J05
RA01R RA02R
GrR WR
Door, LH
Door, RH
Gr W
RA01 RA02
2 1
AS2A
+ −
Door Speaker, LH
Door Speaker, RH
3 9 10 11 8 2 7 1
AK14A
ILL(+) GND +B +ACC LH(−) LH(+) RH(−) RH(+)
Radio

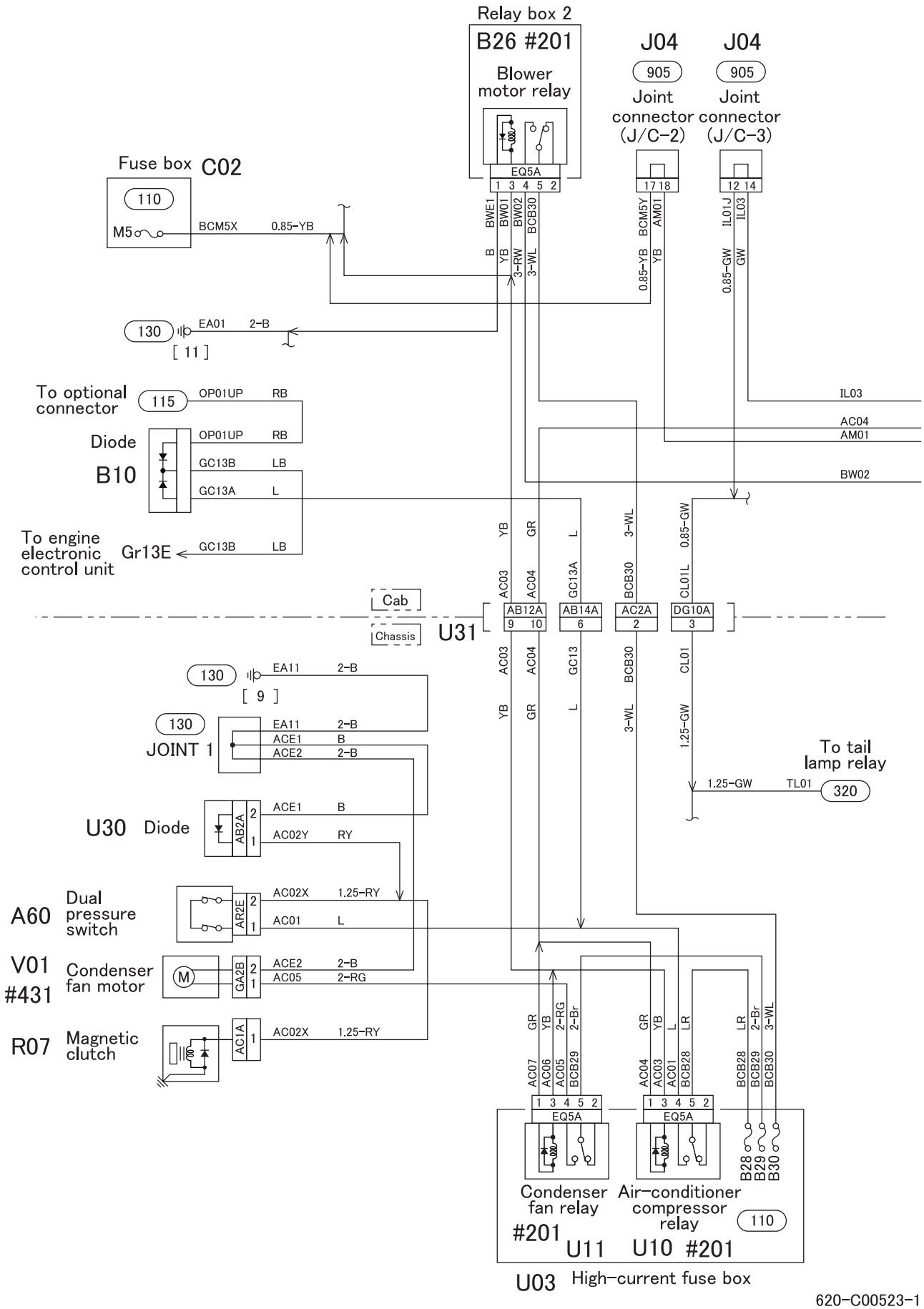
612-C00520


C02
Fuse box
110
M3
M5
BCM3 0.85-L
BCM5X 0.85-YB
C08 #422
Wiper motor
HI
LO
AM6A
0.85-LB WI02H
0.85-LR WI02L
0.85-LW WI06
0.85-L WI05
0.85-B WIE2
Combination switch
#001
AK14A
WI09X BL
WIE1 B
WI04H RL
WI04LX GY
WI07 WR
WASH
HI
LO
INT
OFF
Wiper and washer switch
Joint connector (J/C-M1)
J07
905
0.85-B WIE2
3-B EA03B
3-B EA03A
2-B EA01
3-B EA03A
3-B EA03B
2-B EA02
130
[11]
#350 B05
Wiper control unit
AL6A
+
GND
INT
GND
WASH
LO
BCM5X 0.85-YB
WIE4 B
WIE3 0.85-B
WI07 WR
WIE4 B
WI09Y BL
WI04LY GY
J03
905
0.85-B WIE3
2-B EA02
Joint connector (J/C-1)
BL WI09X
L WI08
AL2A
Windshield Washer motor
C03
#428
WI02H 0.85-LB
WI02L 0.85-LR
BCM3 0.85-L
WI06 0.85-LW
WI04H RL
WI04LX GY
AC4A
AB12A
U31
Cab
Chassis
High-current fuse box
U03
U06
Wiper relay (HIGH)
#202
EN5A
WI04H RL
WI03H 0.85-L
WI02H 0.85-LB
WI01 0.85-O
WI02L 0.85-LR
U07
Wiper relay (LOW)
#202
WI04L GY
WI03L 0.85-L
BCM3 0.85-L
WI01 0.85-O
WI06 0.85-LW

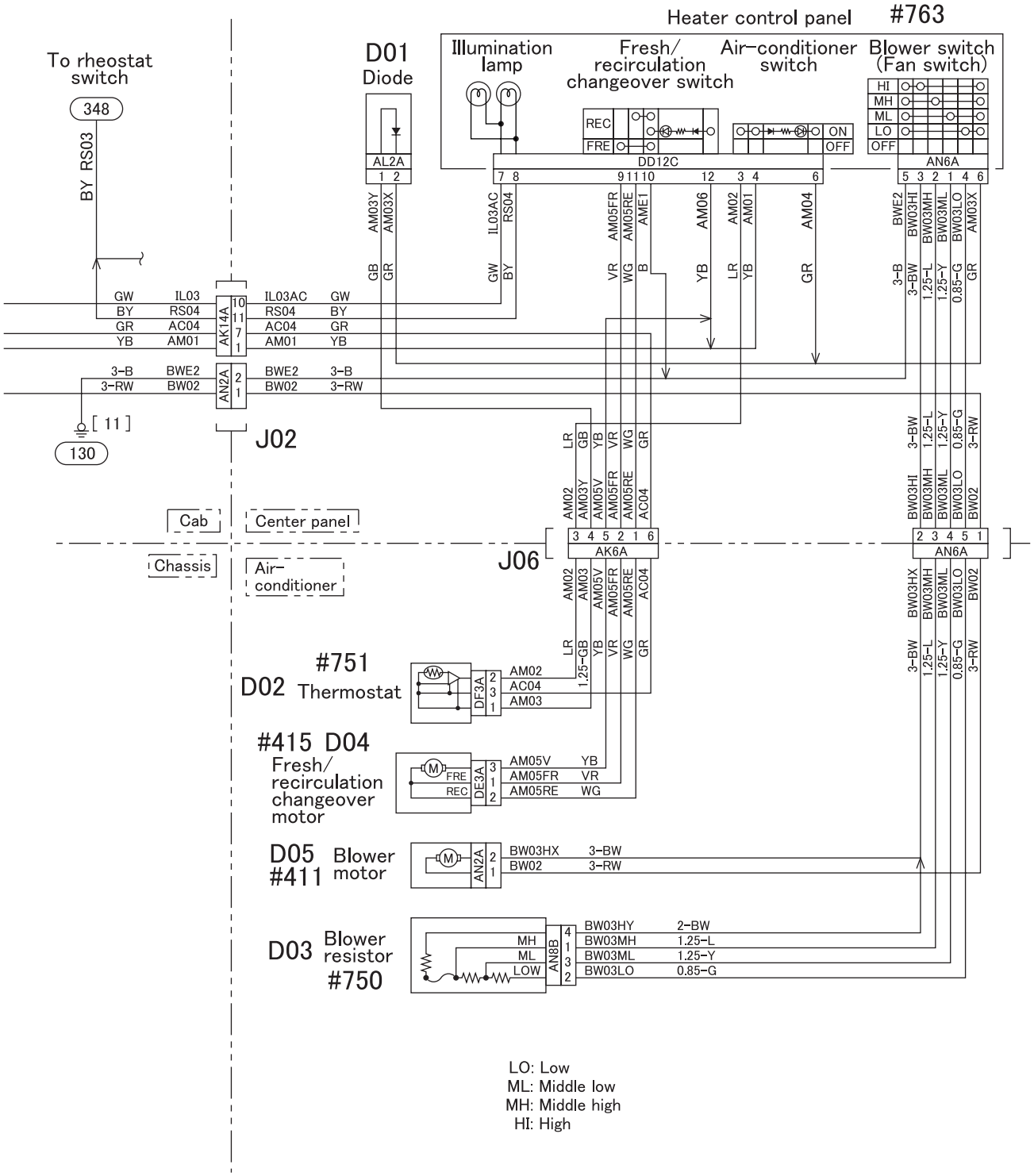
C00521


U03
High-current fuse box
110
B27
BCB27 0.85-Sb
U09
EQ5A
1
3
4
5
2
HN03 BP
HN02 Sb
HN01H 0.85-RY
BCB27 0.85-Sb
Horn relay
#201
130
[5]
0.85-RY HN01L
0.85-RY HN01H
1
EU1A
Horn (LOW)
#615
2-B
HNE1
2-B
EA14
[12]
130
BP
HN03
Chassis
Cab
U31
DG10A
8
BP HN03
13
AK14A
ON
Horn switch
Combination switch
#001

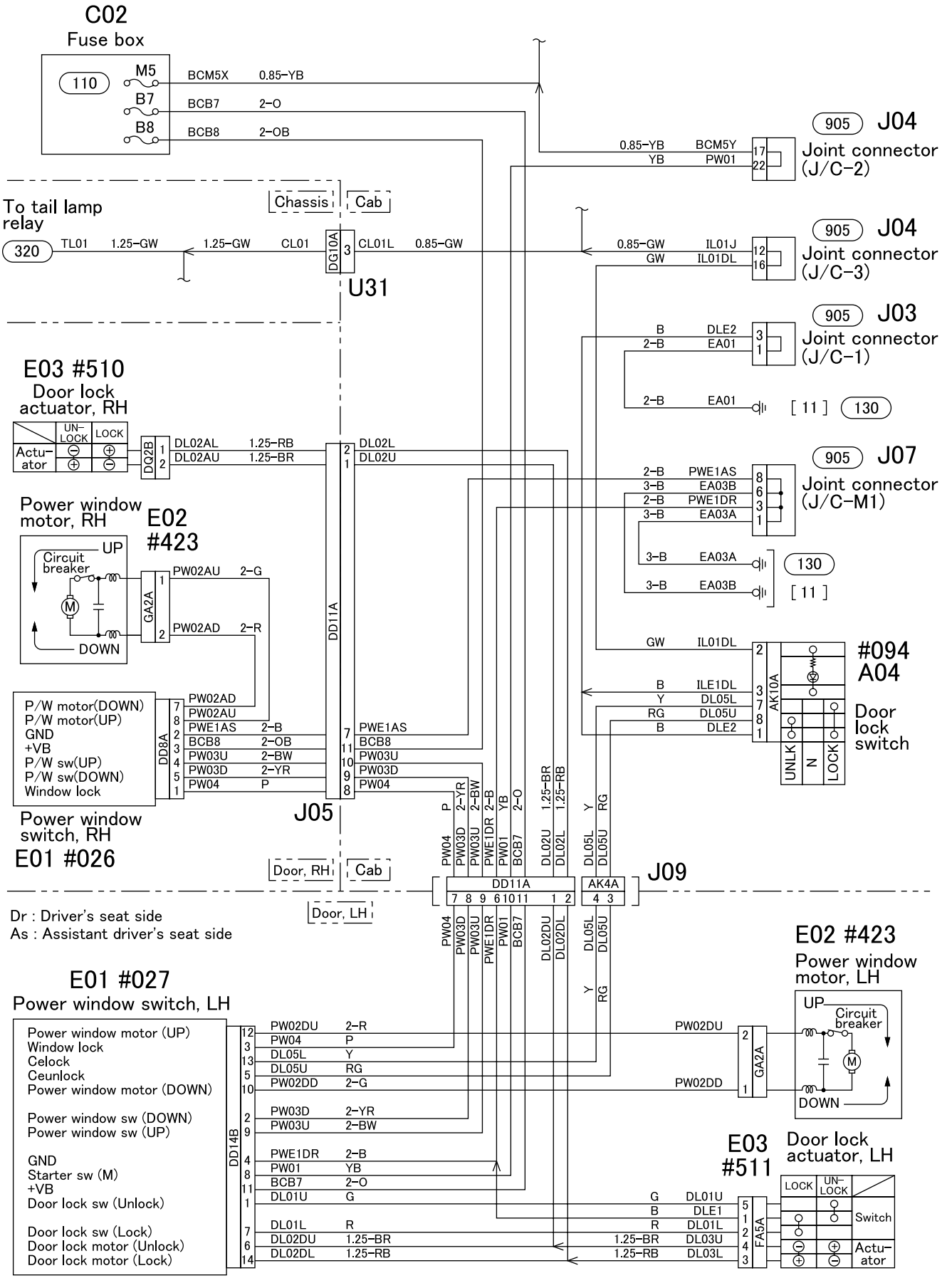
C00522


Relay box 2
B26 #201
Blower motor relay
EQ5A
1 3 4 5 2
J04
905
Joint connector (J/C-2)
17 18
J04
905
Joint connector (J/C-3)
12 14
Fuse box C02
110
M5
BCM5X
0.85-YB
BWE1
BW01
BW02
BCB30
B
YB
3-RW
3-WL
BCM5Y
AM01
0.85-YB
YB
IL01J
IL03
0.85-GW
GW
130
EA01
2-B
[11]
To optional connector
115
OP01UP
RB
Diode
B10
OP01UP
RB
GC13B
LB
GC13A
L
To engine electronic control unit
Gr13E
GC13B
LB
IL03
AC04
AM01
BW02
YB
GR
L
3-WL
0.85-GW
AC03
AC04
GC13A
BCB30
CL01L
Cab
Chassis
U31
AB12A
9 10
AB14A
6
AC2A
2
DG10A
3
130
EA11
2-B
[9]
130
JOINT 1
EA11
2-B
ACE1
B
ACE2
2-B
AC03
AC04
GC13
BCB30
CL01
YB
GR
L
3-WL
1.25-GW
To tail lamp relay
1.25-GW
TL01
320
U30 Diode
AB2A
2
1
ACE1
B
AC02Y
RY
A60 Dual pressure switch
AR2E
2
1
AC02X
1.25-RY
AC01
L
V01 #431 Condenser fan motor
M
GA2B
2
1
ACE2
2-B
AC05
2-RG
R07 Magnetic clutch
AC1A
1
AC02X
1.25-RY
GR
YB
2-RG
2-Br
AC07
AC06
AC05
BCB29
GR
YB
L
LR
AC04
AC03
AC01
BCB28
LR
2-Br
3-WL
BCB28
BCB29
BCB30
1 3 4 5 2
EQ5A
1 3 4 5 2
EQ5A
B28
B29
B30
Condenser fan relay
#201
U11
Air-conditioner compressor relay
U10 #201
110
U03 High-current fuse box

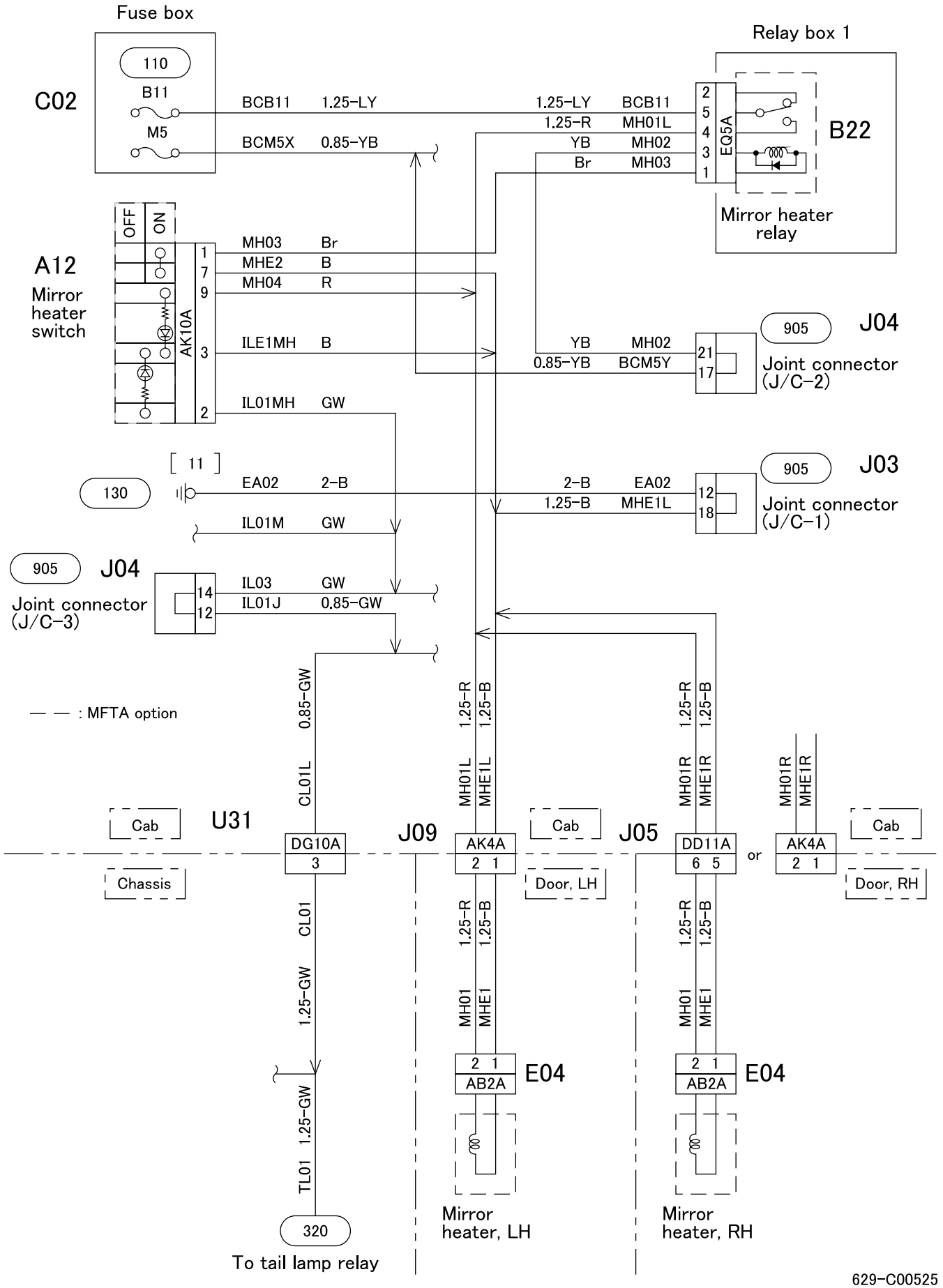
620-C00523-1


Heater control panel #763
To rheostat switch
348
BY RS03
D01 Diode
AL2A
Illumination lamp
Fresh/ recirculation changeover switch
REC
FRE
Air-conditioner switch
ON
OFF
Blower switch (Fan switch)
HI
MH
ML
LO
OFF
DD12C
AN6A
AM03Y AM03X
IL03AC RS04
AM05FR AM05RE AME1
AM06
AM02 AM01
AM04
BWE2 BW03HI BW03MH BW03ML BW03LO AM03X
GB GR
GW BY
VR WG B
YB
LR YB
GR
3-B 3-BW 1.25-L 1.25-Y 0.85-G GR
GW IL03 IL03AC GW
BY RS04 RS04 BY
GR AC04 AC04 GR
YB AM01 AM01 YB
AK14A
3-B BWE2 BWE2 3-B
3-RW BW02 BW02 3-RW
AN2A
[11]
130
J02
Cab
Center panel
Chassis
Air-conditioner
J06
AK6A
AN6A
AM02 AM03Y AM05V AM05FR AM05RE AC04
LR GB YB VR WG GR
3-BW 1.25-L 1.25-Y 0.85-G 3-RW
BW03HI BW03MH BW03ML BW03LO BW02
AM02 AM03 AM05V AM05FR AM05RE AC04
LR 1.25-GB YB VR WG GR
BW03HX BW03MH BW03ML BW03LO BW02
3-BW 1.25-L 1.25-Y 0.85-G 3-RW
#751
D02 Thermostat
DF3A
AM02
AC04
AM03
#415 D04
Fresh/ recirculation changeover motor
DE3A
FRE
REC
AM05V YB
AM05FR VR
AM05RE WG
D05 #411 Blower motor
BW03HX 3-BW
BW02 3-RW
D03 Blower resistor #750
AN8B
MH
ML
LOW
BW03HY 2-BW
BW03MH 1.25-L
BW03ML 1.25-Y
BW03LO 0.85-G
LO: Low
ML: Middle low
MH: High
HI: High

620-C00523-2


C02
Fuse box
110
M5
B7
B8
BCM5X 0.85-YB
BCB7 2-O
BCB8 2-OB
905 J04
Joint connector (J/C-2)
0.85-YB BCM5Y 17
YB PW01 22
To tail lamp relay
320
TL01 1.25-GW
1.25-GW CL01
DG10A 3
CL01L 0.85-GW
Chassis
Cab
U31
905 J04
Joint connector (J/C-3)
0.85-GW IL01J 12
GW IL01DL 16
905 J03
Joint connector (J/C-1)
B DLE2 3
2-B EA01 1
2-B EA01
[11]
130
E03 #510
Door lock actuator, RH
UN-LOCK
LOCK
Actu-ator
DQ2B 1 2
DL02AL 1.25-RB
DL02AU 1.25-BR
DL02L
DL02U
905 J07
Joint connector (J/C-M1)
2-B PWE1AS 8
3-B EA03B 6
2-B PWE1DR 3
3-B EA03A 1
3-B EA03A
130
3-B EA03B
[11]
Power window motor, RH
E02 #423
UP
Circuit breaker
DOWN
GA2A 1 2
PW02AU 2-G
PW02AD 2-R
DD11A
GW IL01DL
#094
A04
Door lock switch
AK10A
UNLK
N
LOCK
B ILE1DL
Y DL05L
RG DL05U
B DLE2
P/W motor(DOWN)
P/W motor(UP)
GND
+VB
P/W sw(UP)
P/W sw(DOWN)
Window lock
DD8A
PW02AD
PW02AU
PWE1AS 2-B
BCB8 2-OB
PW03U 2-BW
PW03D 2-YR
PW04 P
PWE1AS
BCB8
PW03U
PW03D
PW04
Power window switch, RH
E01 #026
J05
Door, RH
Cab
Door, LH
J09
DD11A
AK4A
Dr : Driver's seat side
As : Assistant driver's seat side
E01 #027
Power window switch, LH
Power window motor (UP)
Window lock
Celock
Ceunlock
Power window motor (DOWN)
Power window sw (DOWN)
Power window sw (UP)
GND
Starter sw (M)
+VB
Door lock sw (Unlock)
Door lock sw (Lock)
Door lock motor (Unlock)
Door lock motor (Lock)
DD14B
PW02DU 2-R
PW04 P
DL05L Y
DL05U RG
PW02DD 2-G
PW03D 2-YR
PW03U 2-BW
PWE1DR 2-B
PW01 YB
BCB7 2-O
DL01U G
DL01L R
DL02DU 1.25-BR
DL02DL 1.25-RB
E02 #423
Power window motor, LH
UP
Circuit breaker
DOWN
GA2A
PW02DU
PW02DD
E03 #511
Door lock actuator, LH
LOCK
UN-LOCK
Switch
Actu-ator
FA5A
G DL01U
B DLE1
R DL01L
1.25-BR DL03U
1.25-RB DL03L

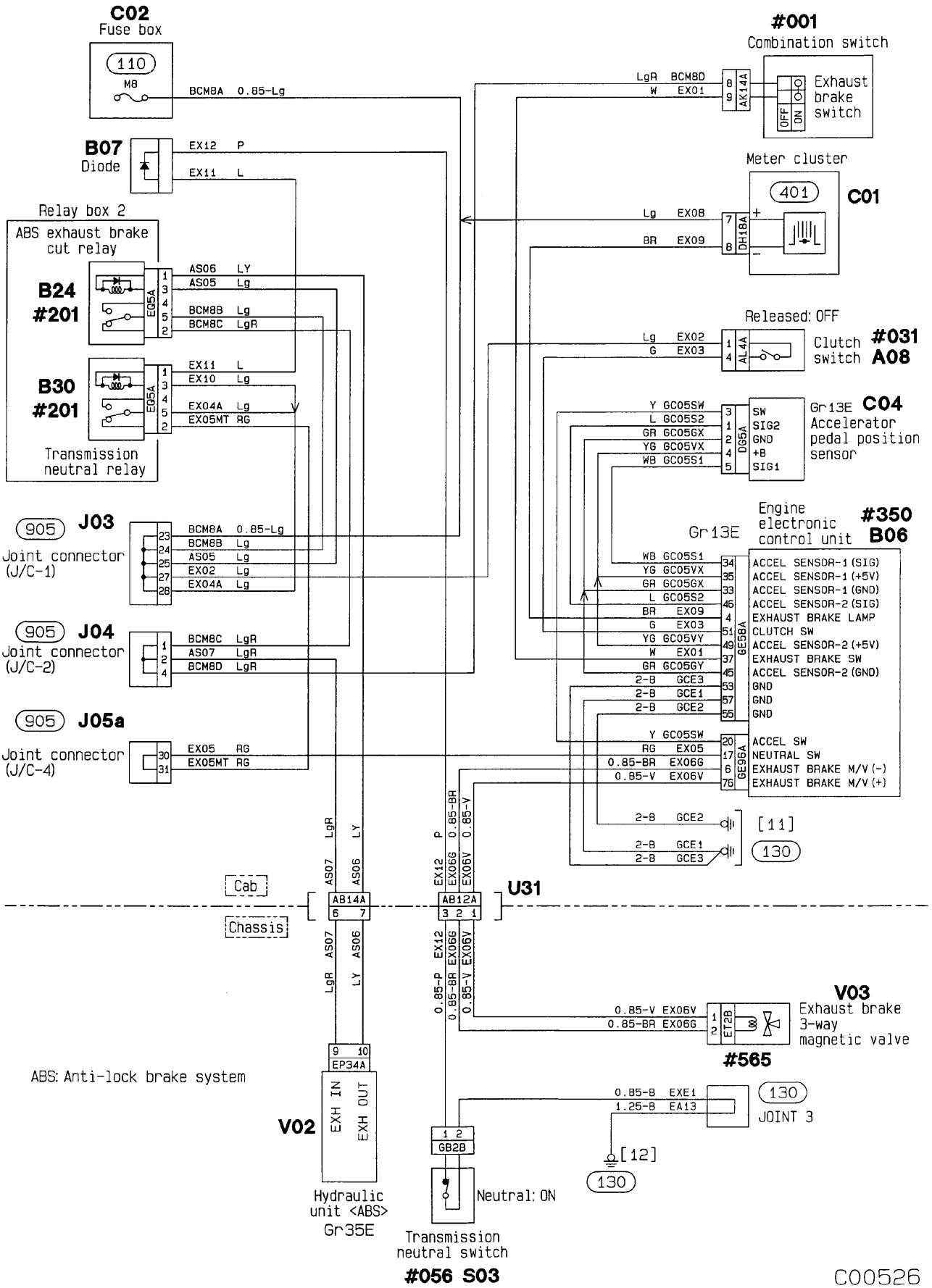
622-C00524


Fuse box
110
B11
M5
C02
BCB11 1.25-LY
BCM5X 0.85-YB
Relay box 1
2
5
4
3
1
EQ5A
B22
Mirror heater relay
1.25-LY BCB11
1.25-R MH01L
YB MH02
Br MH03
OFF
ON
A12
Mirror heater switch
AK10A
1
7
9
3
2
MH03 Br
MHE2 B
MH04 R
ILE1MH B
IL01MH GW
905
J04
Joint connector (J/C-2)
21
17
YB MH02
0.85-YB BCM5Y
[11]
130
EA02 2-B
IL01M GW
905
J03
Joint connector (J/C-1)
12
18
2-B EA02
1.25-B MHE1L
905
J04
Joint connector (J/C-3)
14
12
IL03 GW
IL01J 0.85-GW
— — : MFTA option
0.85-GW CL01L
1.25-R 1.25-B MH01L MHE1L
1.25-R 1.25-B MH01R MHE1R
MH01R MHE1R
Cab
U31
Chassis
DG10A
3
J09
AK4A
2 1
Door, LH
J05
DD11A
6 5
or
AK4A
2 1
Door, RH
CL01
1.25-GW
1.25-R 1.25-B MH01 MHE1
2 1
AB2A
E04
TL01 1.25-GW
320
To tail lamp relay
Mirror heater, LH
Mirror heater, RH

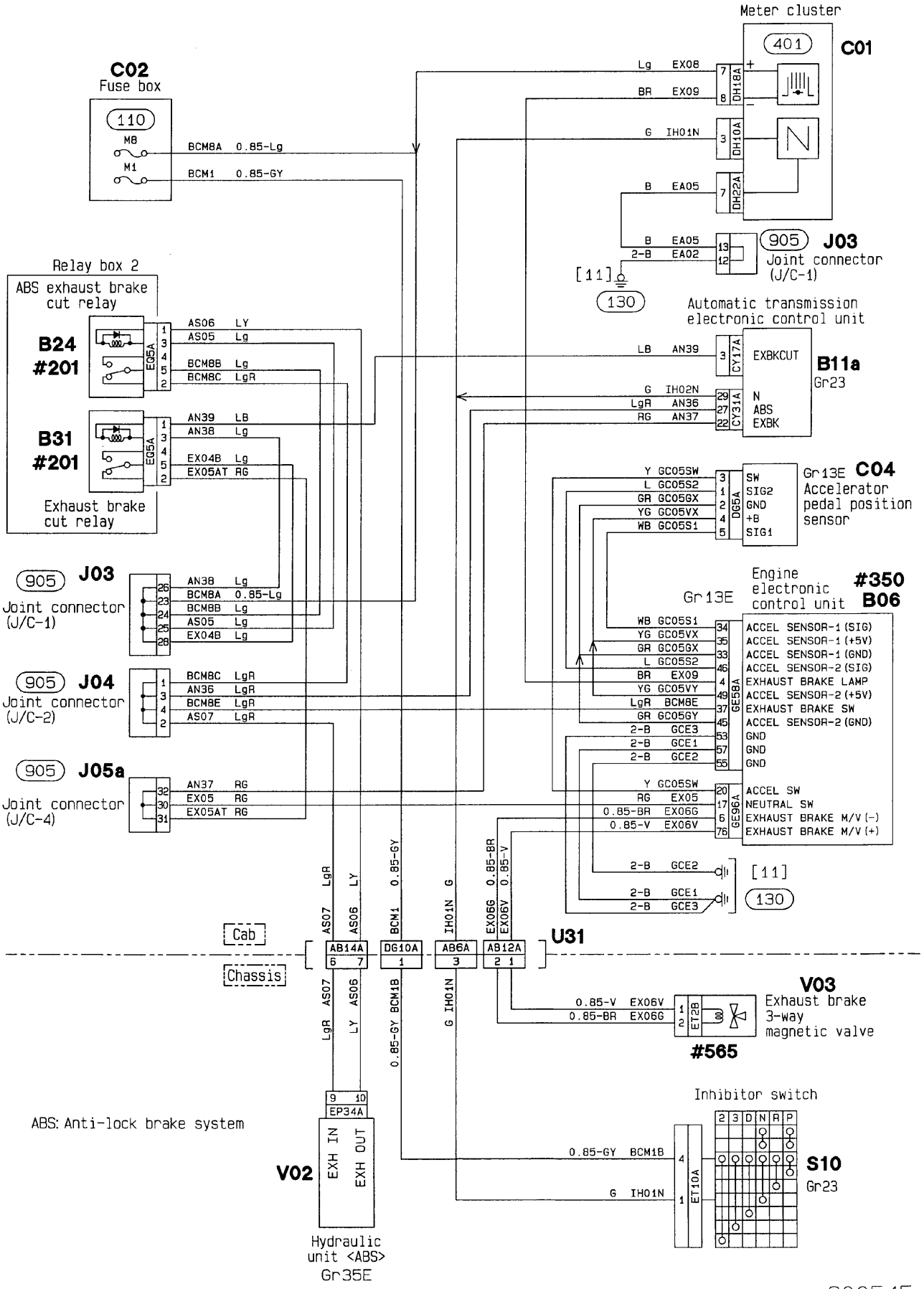
629-C00525

GROUP 54-07 CHASSIS SIDE ELECTRICAL CIRCUIT

<Manual transmission>

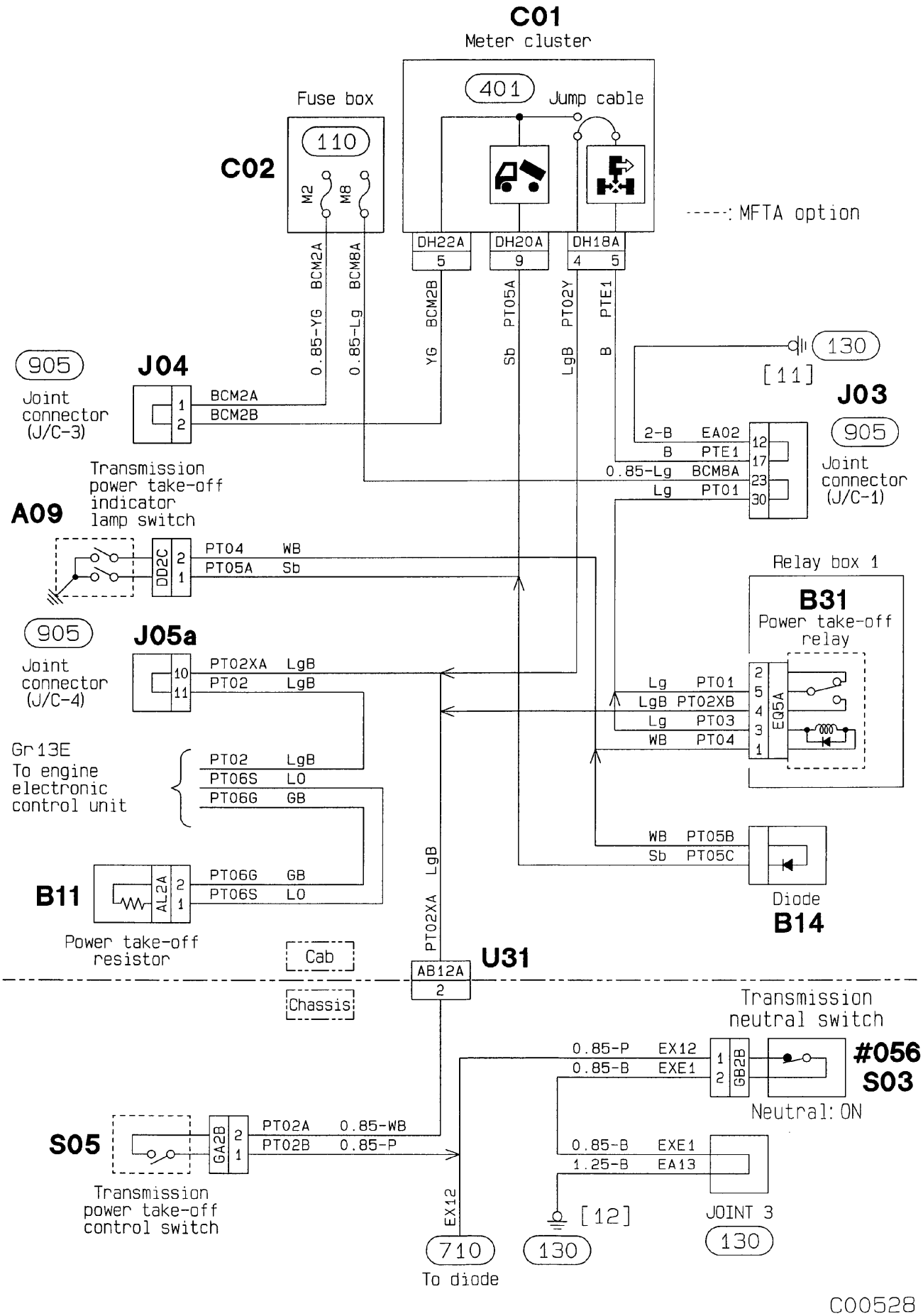


<Automatic transmission>



C00545

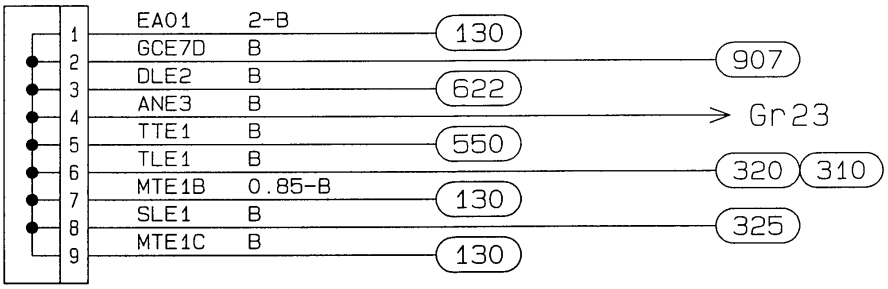
GROUP 54-08 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

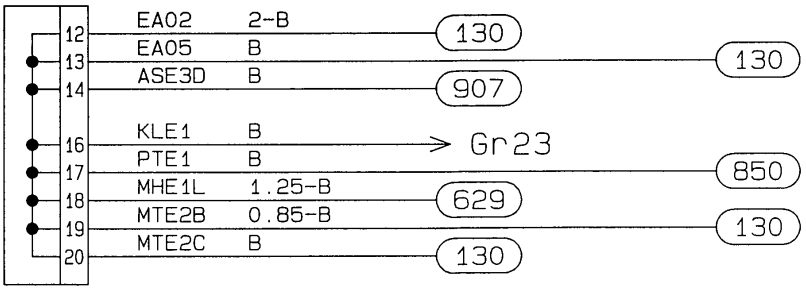

C01
Meter cluster
401
Jump cable
Fuse box
110
C02
M2
M8
-----: MFTA option
DH22A 5
DH20A 9
DH18A 4 5
0.85-YG BCM2A
0.85-Lg BCM8A
YG BCM2B
Sb PT05A
LgB PT02Y
B PTE1
130
[11]
J03
905
Joint connector (J/C-3)
J04
BCM2A
BCM2B
Transmission power take-off indicator lamp switch
A09
DD2C
PT04 WB
PT05A Sb
2-B EA02
B PTE1
0.85-Lg BCM8A
Lg PT01
Joint connector (J/C-1)
Relay box 1
B31
Power take-off relay
EQ5A
Lg PT01
LgB PT02XB
Lg PT03
WB PT04
905
Joint connector (J/C-4)
J05a
PT02XA LgB
PT02 LgB
Gr13E
To engine electronic control unit
PT02 LgB
PT06S LO
PT06G GB
WB PT05B
Sb PT05C
Diode
B14
B11
AL2A
PT06G GB
PT06S LO
Power take-off resistor
Cab
Chassis
PT02XA LgB
U31
AB12A 2
Transmission neutral switch
0.85-P EX12
0.85-B EXE1
GB2B
#056
S03
Neutral: ON
S05
GA2B
PT02A 0.85-WB
PT02B 0.85-P
Transmission power take-off control switch
0.85-B EXE1
1.25-B EA13
JOINT 3
130
EX12
[12]
710
To diode
130
C00528

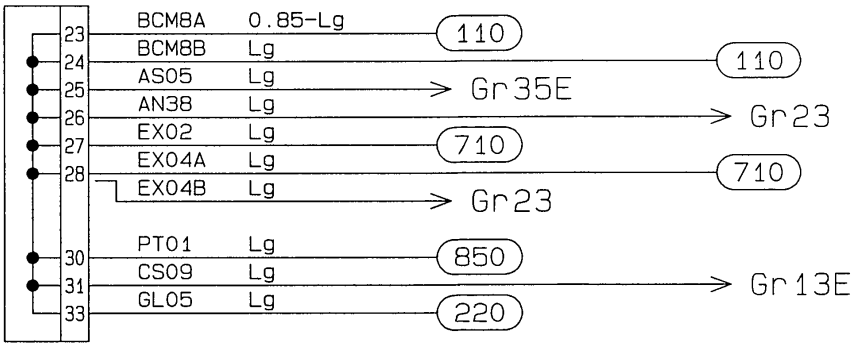
GROUP 54-09 OTHER CIRCUIT

(J/C-1)

1	2	3	4	5	6	7	8	9	10	11
EA01	GCE7D	DLE2	ANE3	TTE1	TLE1	MTE1B	SLE1	MTE1C		—
12	13	14	15	16	17	18	19	20	21	22
EA02	EA05	ASE3D	—	KLE1	PTE1	MHE1L	MTE2B	MTE2C		—
23	24	25	26	27	28	29	30	31	32	33
BCM8A	BCM8B	AS05	AN38	EX02	EX04A EX04B	—	PT01	CS09		GL05



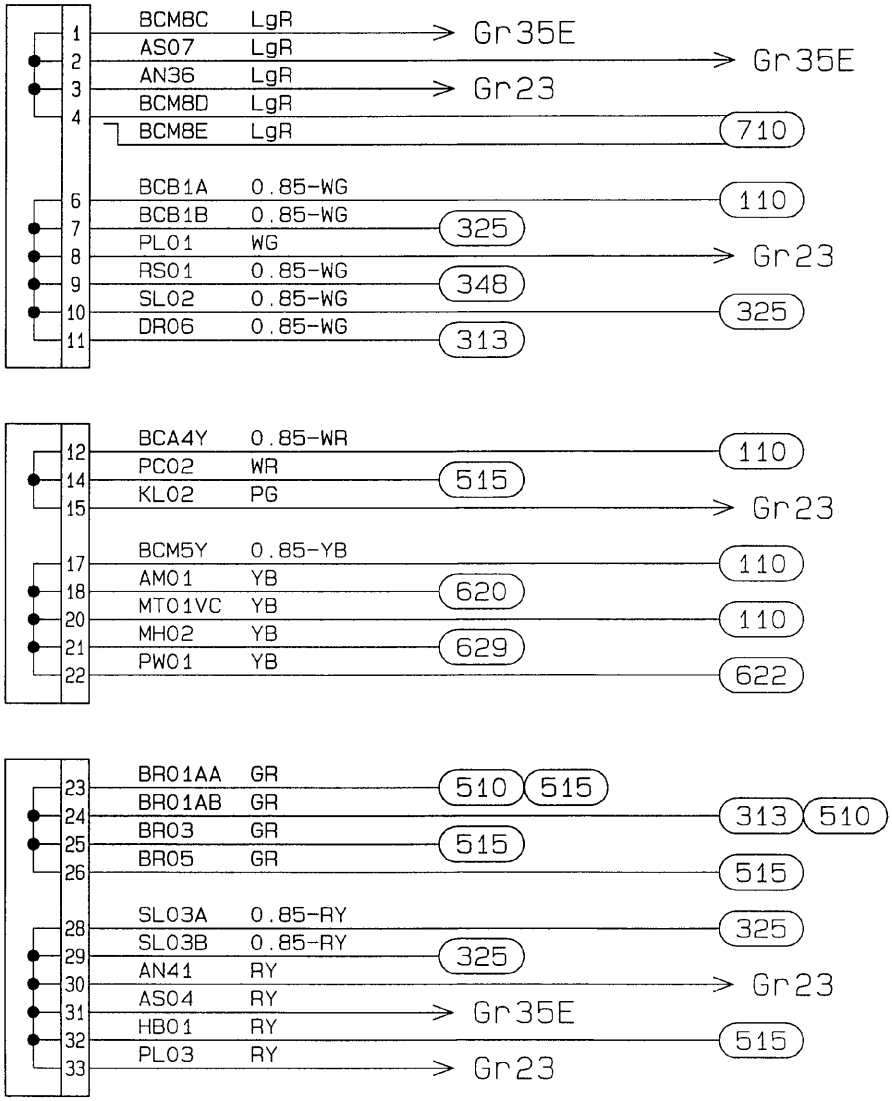




C02280

(J/C-2)

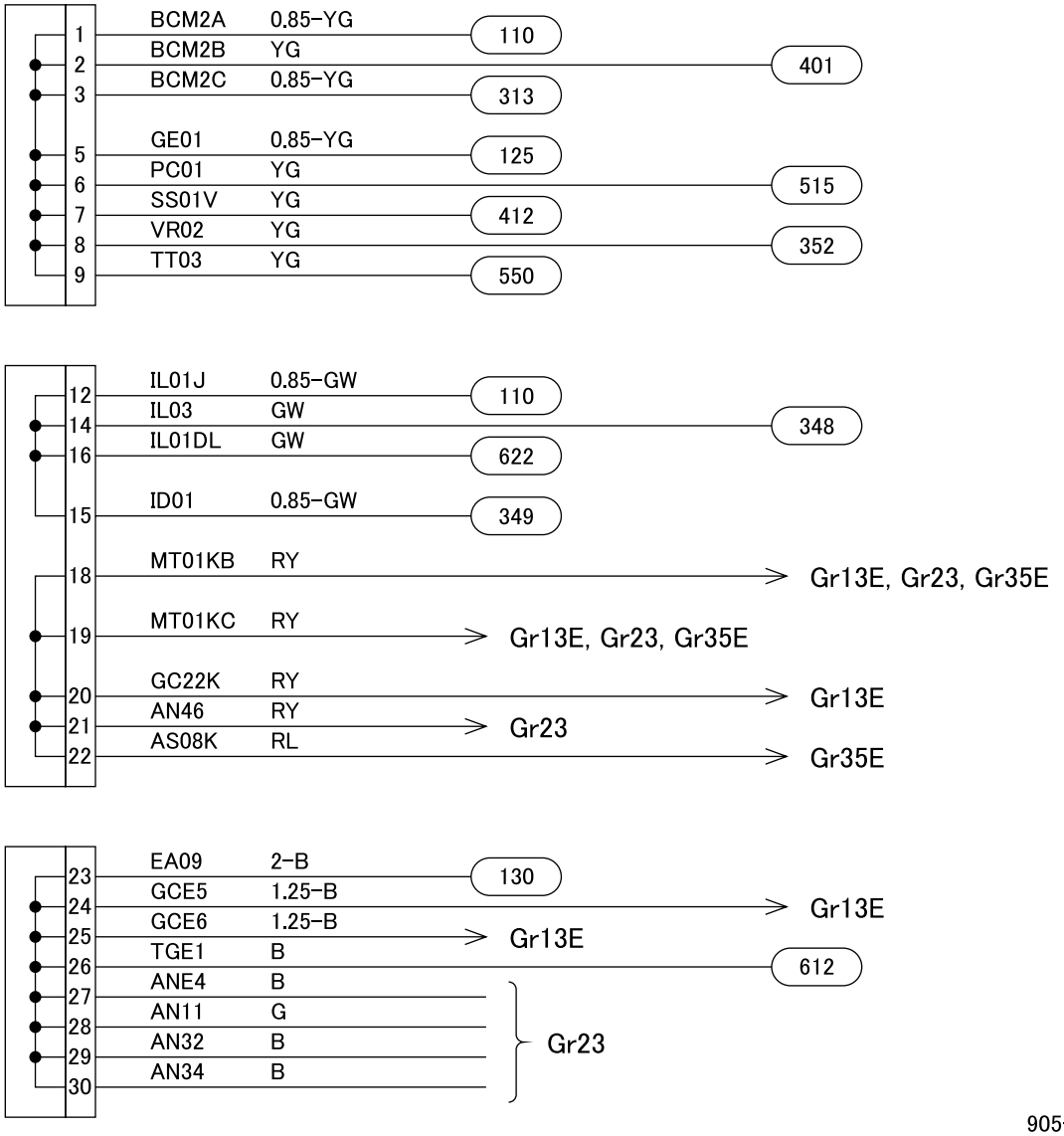
1	2	3	4	5	6	7	8	9	10	11
BCM8C	AS07	AN36	BCM8D BCM8E		BCB1A	BCB1B	PL01	RS01	SL02	DR06
12	13	14	15	16	17	18	19	20	21	22
BCA4Y	—	PC02	KL02		BCM5Y	AM01	—	MT01VC	MH02	PW01
23	24	25	26	27	28	29	30	31	32	33
BR01AA	BR01AB	BR03	BR05		SL03A	SL03B	AN41	AS04	HB01	PL03



C00530

(J/C-3)

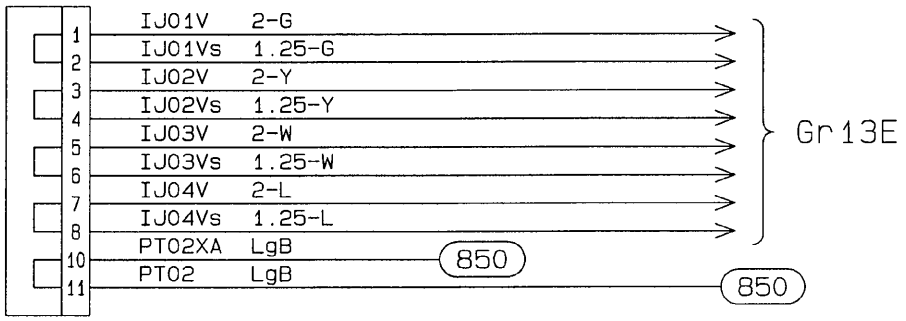
1	2	3	4	5	6	7	8	9	10	11
BCM2A	BCM2B	BCM2C	—	GE01	PC01	SS01V	VR02	TT03		—
12	13	14	15	16	17	18	19	20	21	22
IL01J		IL03	ID01	IL01DL	—	MT01KB	MT01KC	GC22K	AN46	AS08K
23	24	25	26	27	28	29	30	31	32	33
EA09	GCE5	GCE6	TGE1	ANE4	AN11	AN32	AN34	—		—

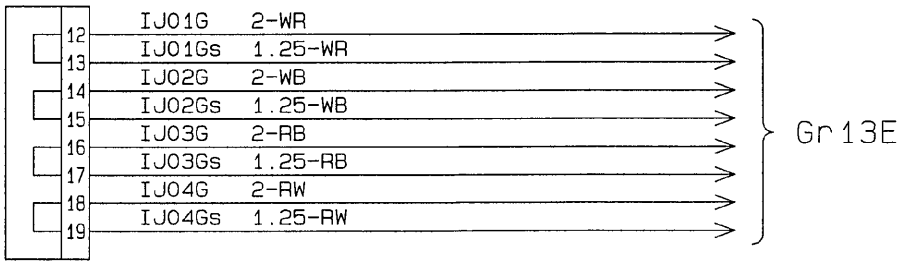


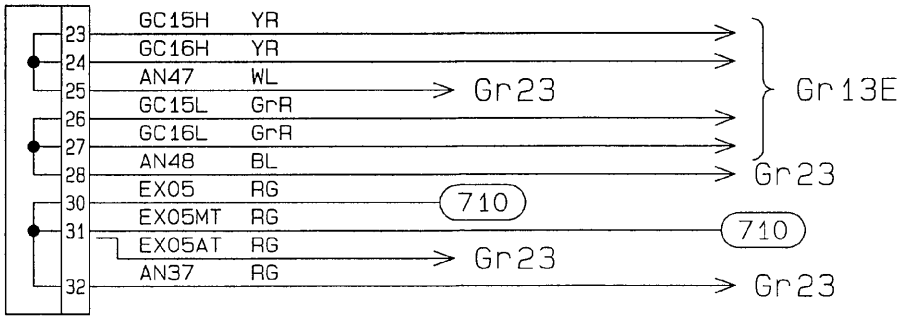
905-C02281

(J/C-4)

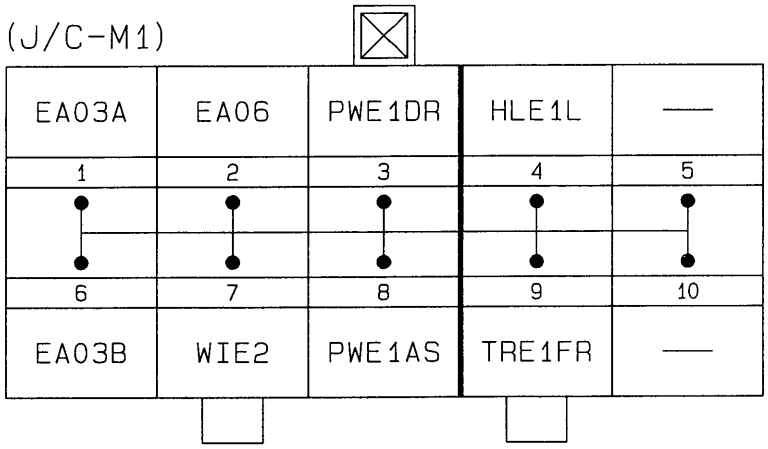
1	2	3	4	5	6	7	8	9	10	11
IJ01V	IJ01Vs	IJ02V	IJ02Vs	IJ03V	IJ03Vs	IJ04V	IJ04Vs		PT02XA	PT02
12	13	14	15	16	17	18	19	20	21	22
IJ01G	IJ01Gs	IJ02G	IJ02Gs	IJ03G	IJ03Gs	IJ04G	IJ04Gs		—	—
23	24	25	26	27	28	29	30	31	32	33
GC15H	GC16H	AN47	GC15L	GC16L	AN48		EX05	EX05AT EX05MT	AN37	—

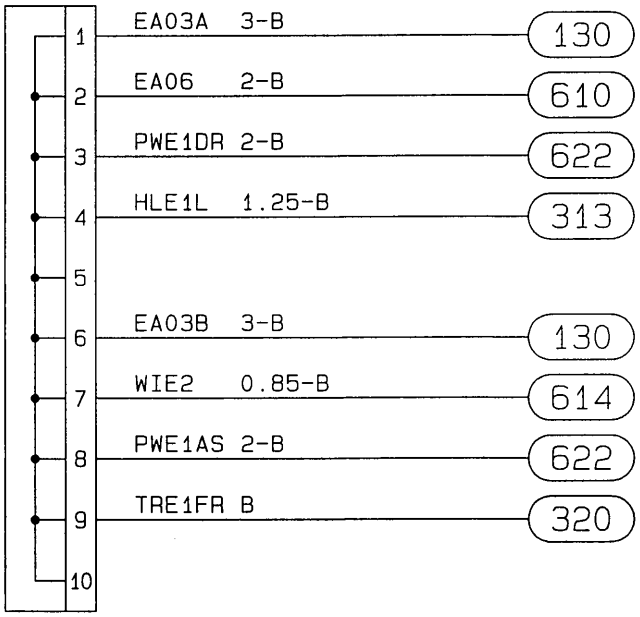




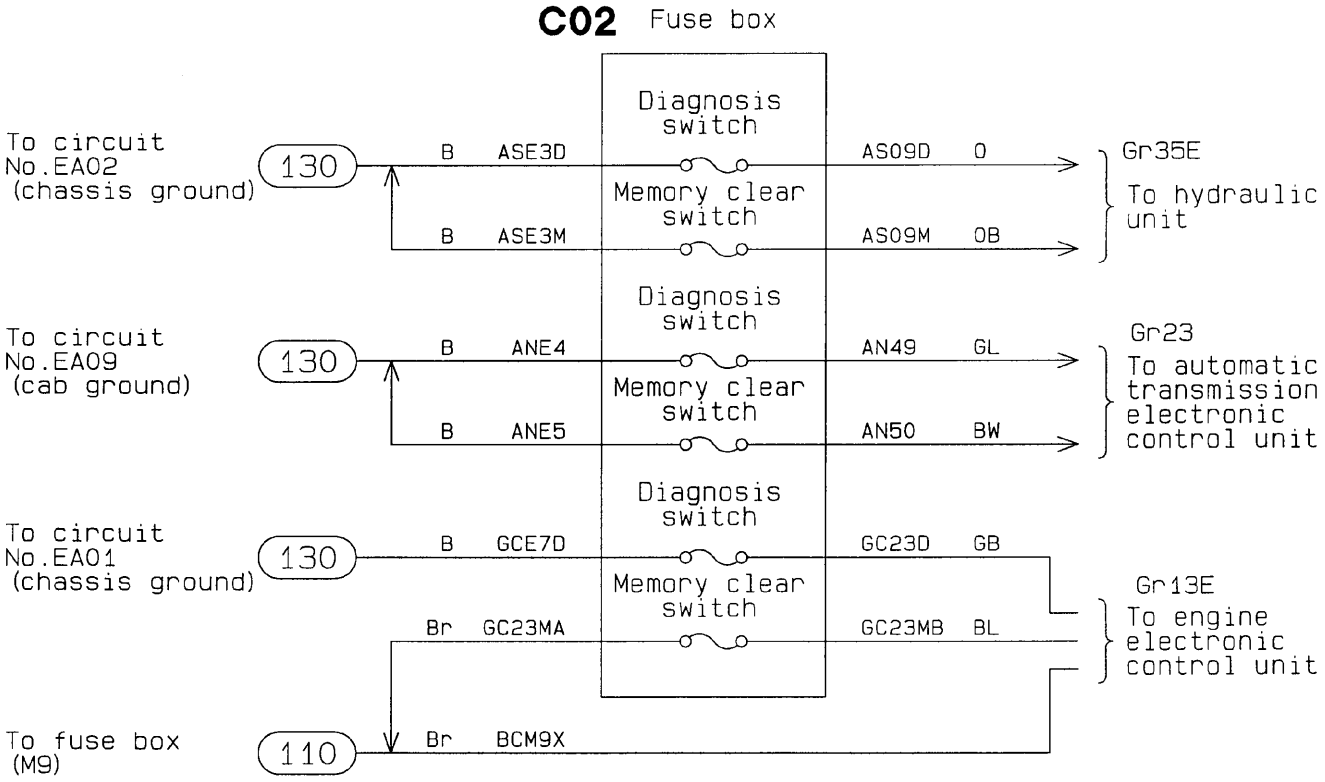


C00532


(J/C-M1)
EA03A
EA06
PWE1DR
HLE1L
—
1
2
3
4
5
6
7
8
9
10
EA03B
WIE2
PWE1AS
TRE1FR
—


1
2
3
4
5
6
7
8
9
10
EA03A 3-B
130
EA06 2-B
610
PWE1DR 2-B
622
HLE1L 1.25-B
313
EA03B 3-B
130
WIE2 0.85-B
614
PWE1AS 2-B
622
TRE1FR B
320

C00533



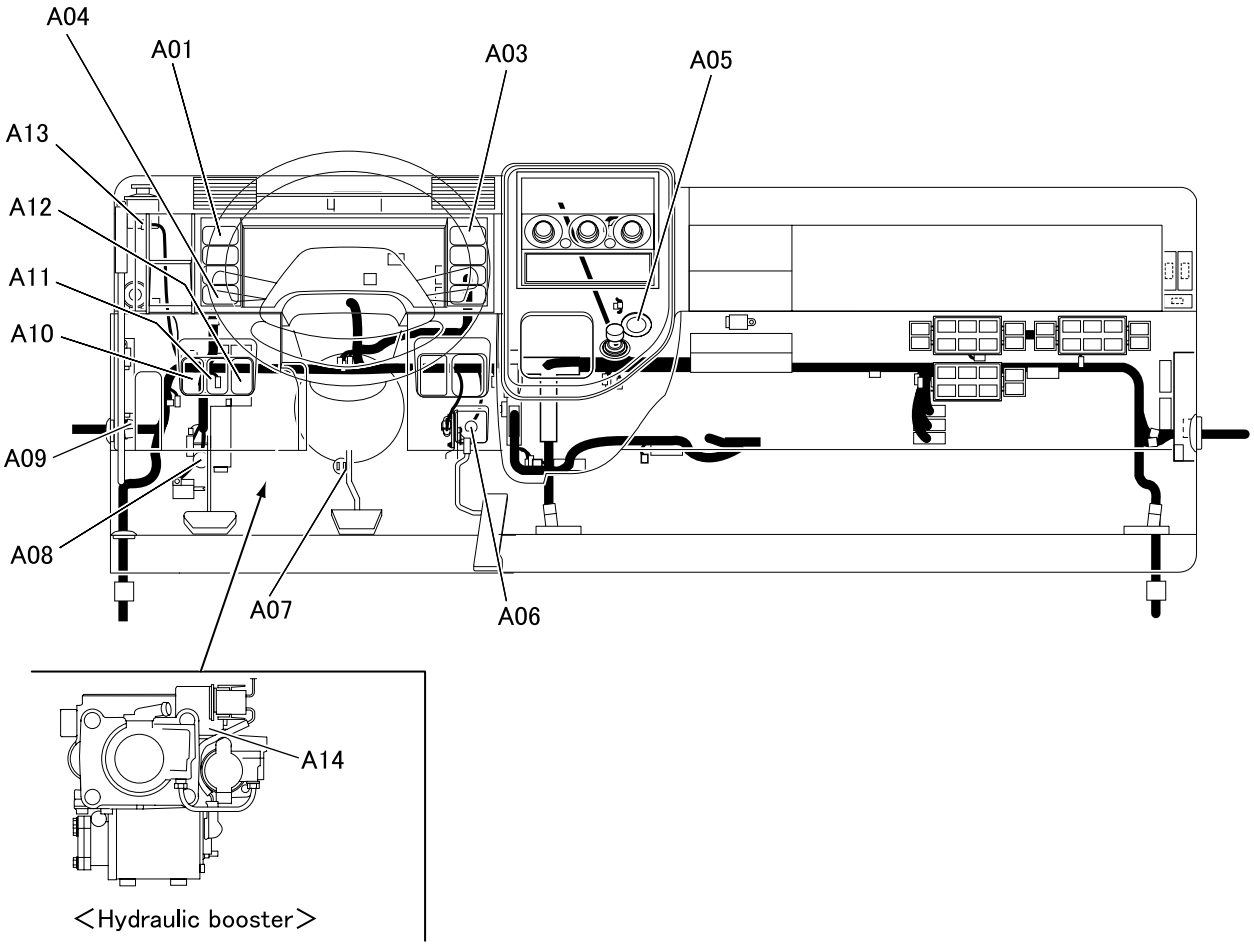
The fuse is substituted for diagnosis switch and the memory clear switch.

C00534

GROUP 54-10 ELECTRICAL EQUIPMENT INSTALLATION POSITIONS

A SWITCH

A01 to 14



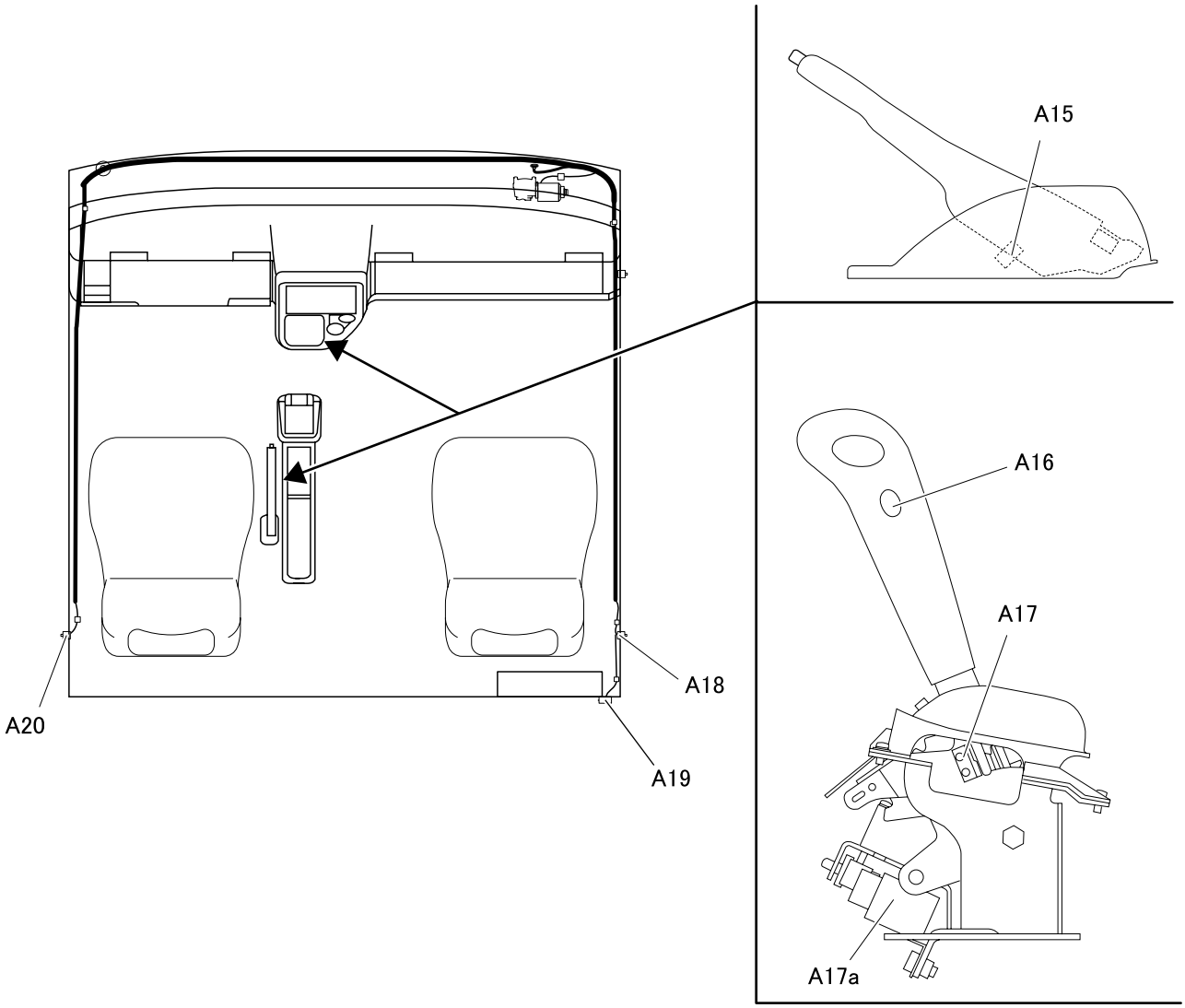
No relevant parts in a missing number

A01 Engine oil level check switch
A03 Warming switch
A04 Door lock switch
A05 Hazard switch
A06 Idling speed adjustment potentiometer
A07 Stop lamp switch
A08 Clutch switch
A09 T/M PTO indicator lamp switch
A10 Van body dome light switch
A11 Rheostat switch
A12 Mirror heater switch
A13 Brake fluid level switch
A14 Flow switch <With hydraulic booster>

PTO : Power take-off
T/M : Transmission

L01265

A15 to 22



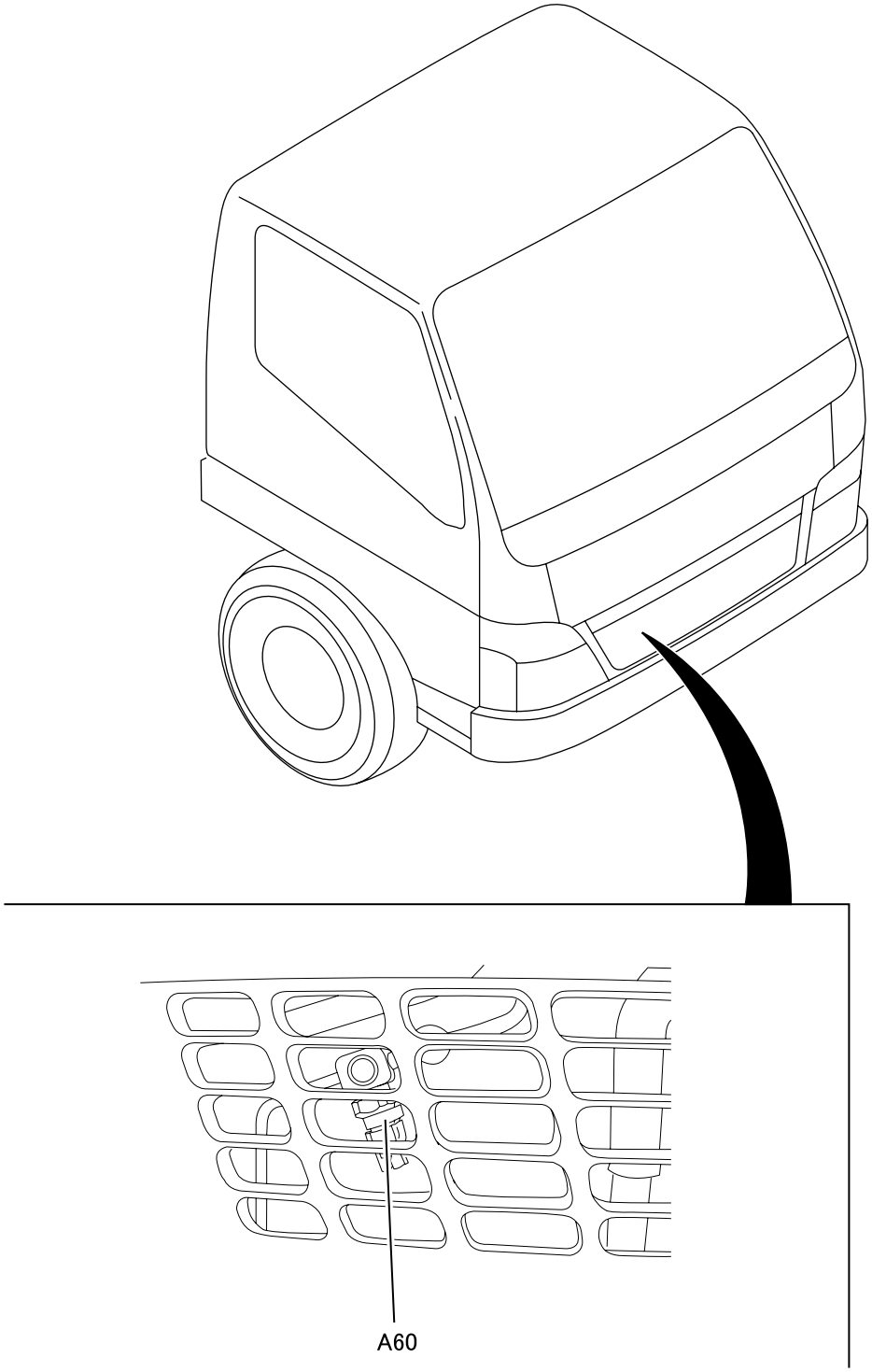
No relevant parts in a missing number

A15 Parking brake switch
A16 O/D switch <A/T>
A17 P range switch <A/T>
A17a Shift lock actuator <A/T>
A18 Front door switch, RH
A19 Cab tilt lock switch
A20 Front door switch, LH

A/T : Automatic transmission
O/D : Over drive

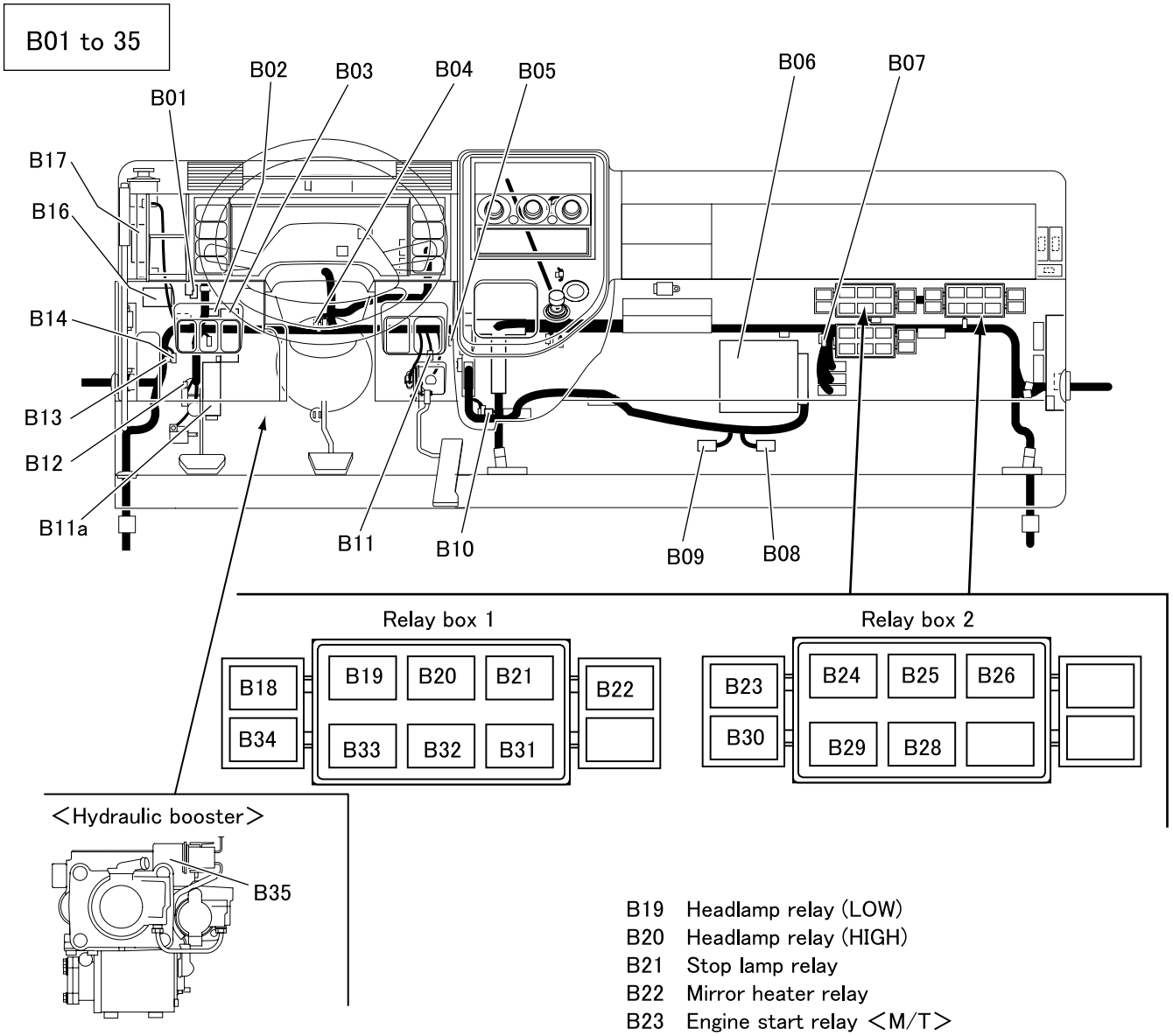
L01266

A60



A60 Dual pressure switch ＜With air−conditioner＞

L00160



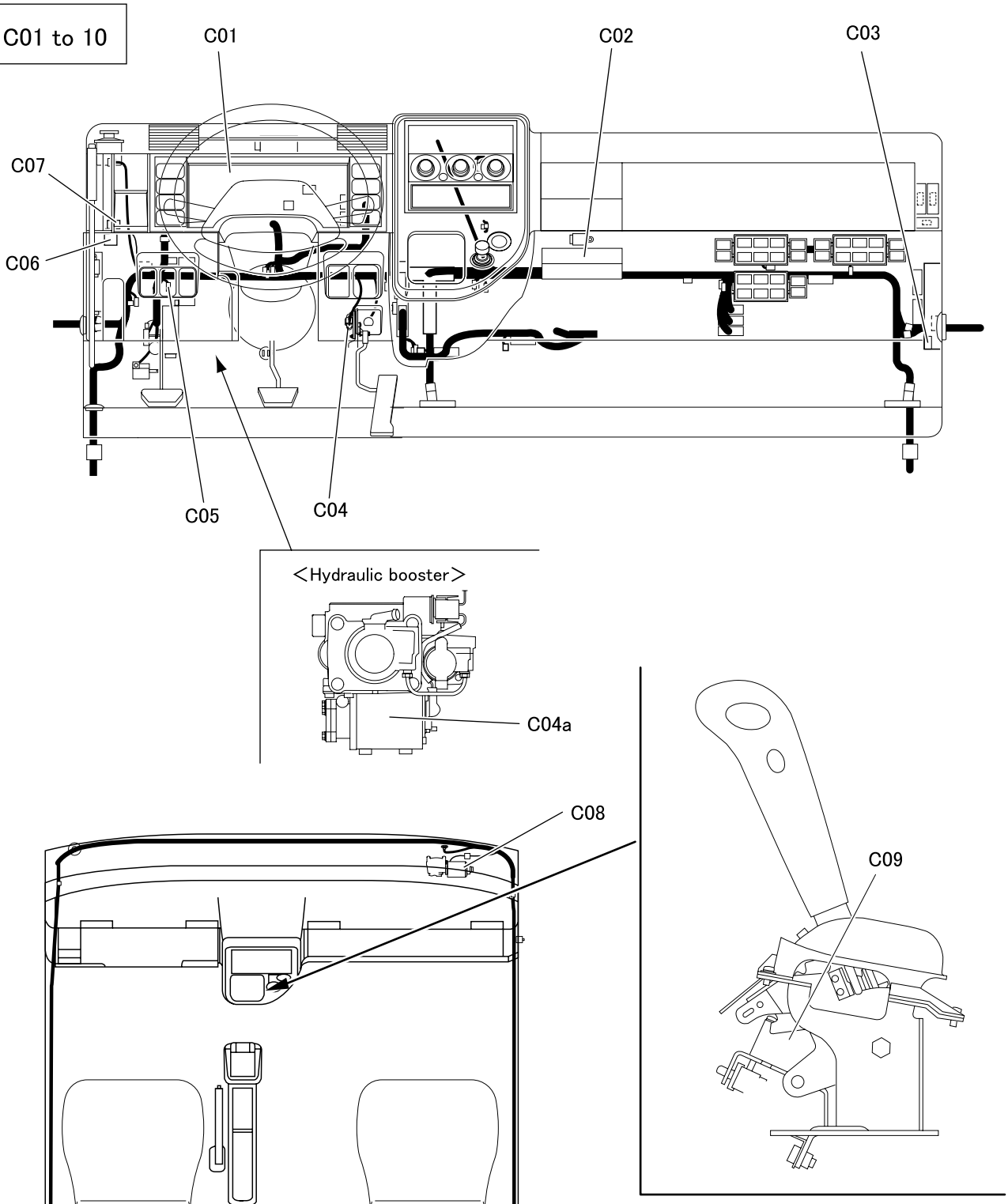
No relevant parts in a missing number

B01 Diode
B02 Diode
B03 Flasher unit
B04 Diode
B05 Wiper electronic control unit
B06 Engine ECU
B07 Diode
B08 Resistor unit
B09 Resistor unit
B10 Diode
B11 PTO resistor
B11a A/T ECU
B12 Diode
B13 Fuel injection rate adjustment unit
B14 Diode
B16 Daytime running light ECU
B17 Key interlock control unit
B18 Turn signal lamp relay
B19 Headlamp relay (LOW)
B20 Headlamp relay (HIGH)
B21 Stop lamp relay
B22 Mirror heater relay
B23 Engine start relay <M/T>
B24 ABS exhaust brake cut relay
B25 Glow drive relay
B26 Blower motor relay
B28 Overheating relay
B29 Daytime running light relay
B30 T/M neutral relay <M/T>
B31 Exhaust brake cut relay <A/T>
PTO relay <M/T>
B32 Parking brake relay <With hydraulic booster>
B33 Safety relay
B34 Engine oil level relay
B35 Emergency pump motor relay
<With hydraulic booster>

A/T : Automatic transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
M/T : Manual transmission
PTO : Power take-off
T/M : Transmission

L01267

C01 to 10



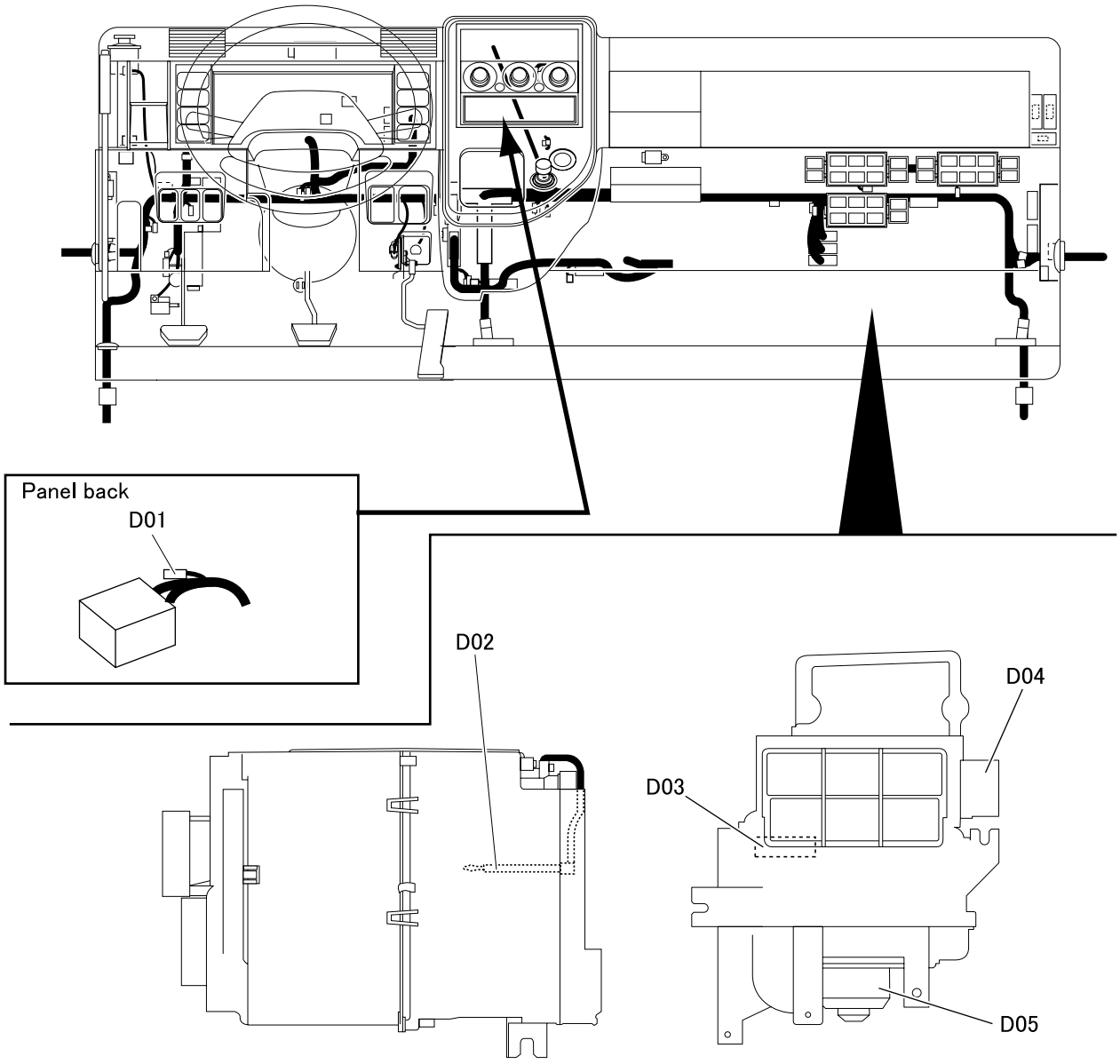
No relevant parts in a missing number

C01 Meter cluster
C02 Fuse box
C03 Windshield washer motor
C04 Accelerator pedal position sensor
C04a Motor <With hydraulic booster>
C05 G sensor <ABS>
C06 Cab tilt buzzer
C07 Warning buzzer
C08 Wiper motor
C09 Shift lock actuator <A/T>

ABS: Anti-lock brake system
A/T: Automatic transmission

L00161

D01 to 05

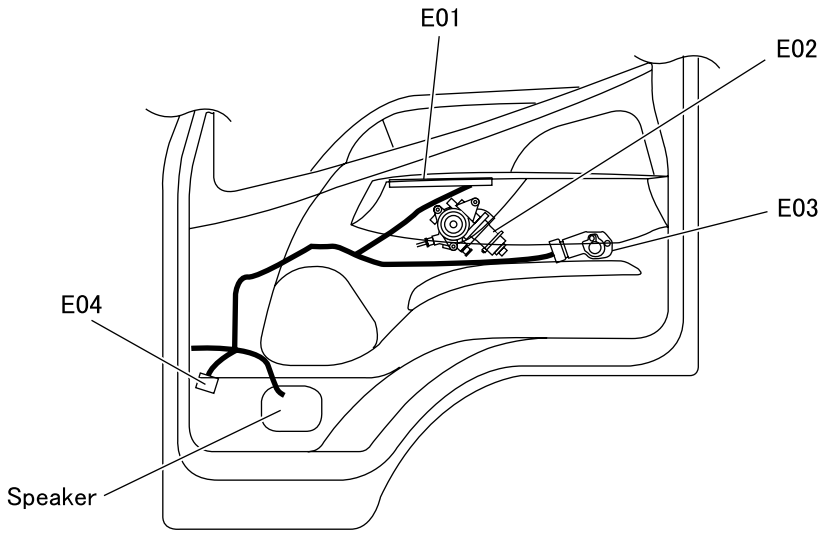


No relevant parts in a missing number

D01 Diode
D02 Thermostat
D03 Blower resistor
D04 Fresh/recirculation changeover motor
D05 Blower motor

L00162

E01 to 04



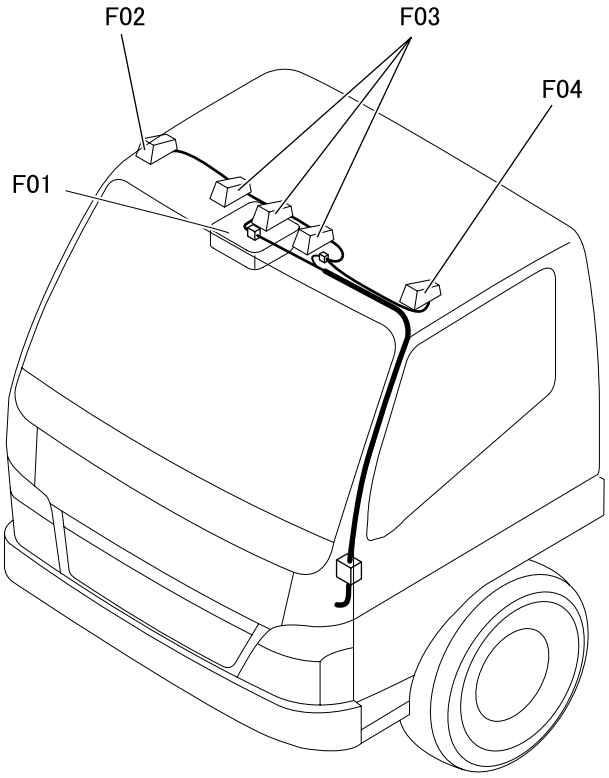
This illustrations show the right side door, the left side door is symmetrical.

No relevant parts in a missing number

E01 Power window switch
E02 Power window motor
E03 Door lock actuator
E04 Mirror heater connector

L00163

F01 to 05



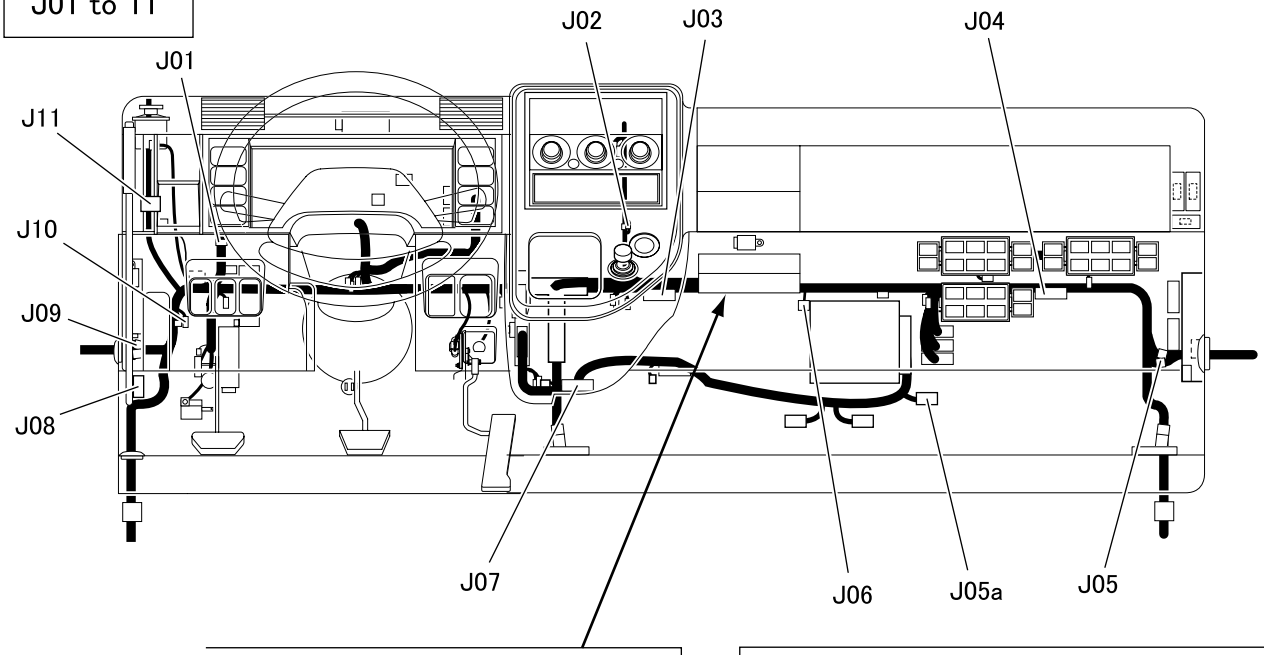
No relevant parts in a missing number

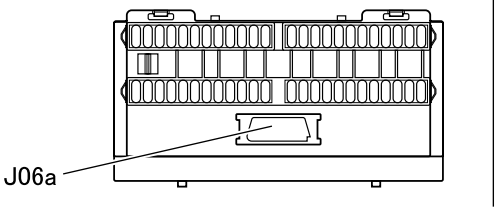
F01 Cab lamp
F02 Clearance and side marker lamp, RH
F03 Identification lamp
F04 Clearance and side marker lamp, LH

L01268

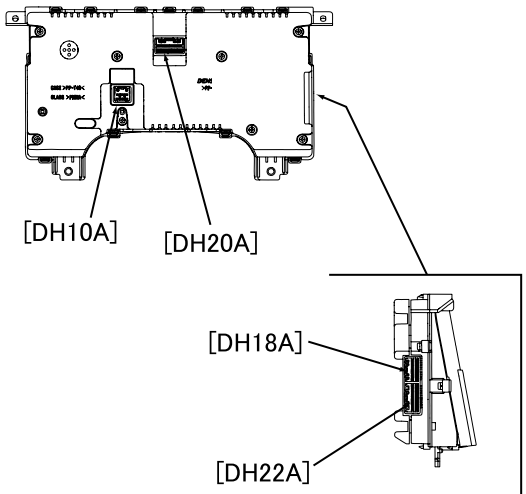
J JOINTS OF MAIN HARNESS CONNECTORS

J01 to 11





Meter cluster backward view



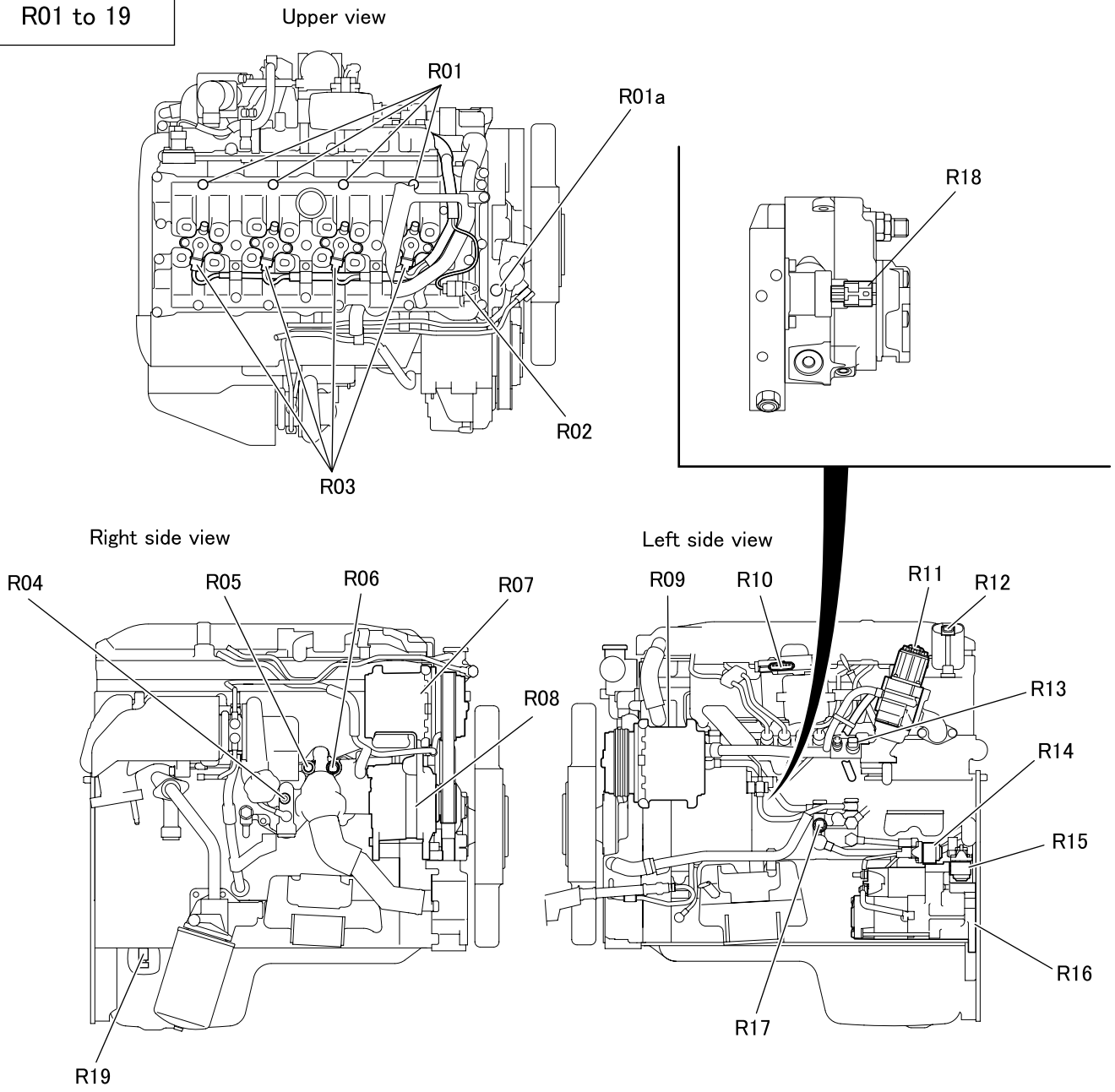
No relevant parts in a missing number

J01 Connection of cab harness and instrument panel harness
J02 Connection of cab harness and center panel harness
J03 Joint connector (J/C-1)
J04 Joint connector (J/C-2, 3)
J05 Connection of cab harness and door harness, RH
J05a Joint connector (J/C-4)
J06 Connection of center panel harness and air-conditioner harness
J06a Multi-Use Tester-Ⅲ connector (for recorder)
J07 Joint connector (J/C-M1)
J08 Multi-Use Tester-Ⅲ connector (for inspection)
J09 Connection of cab harness and door harness, LH
J10 Optional connector
J11 Connection of cab harness and roof harness

Indicate by connector type [ ]. [connector type]

L00165

R01 to 19

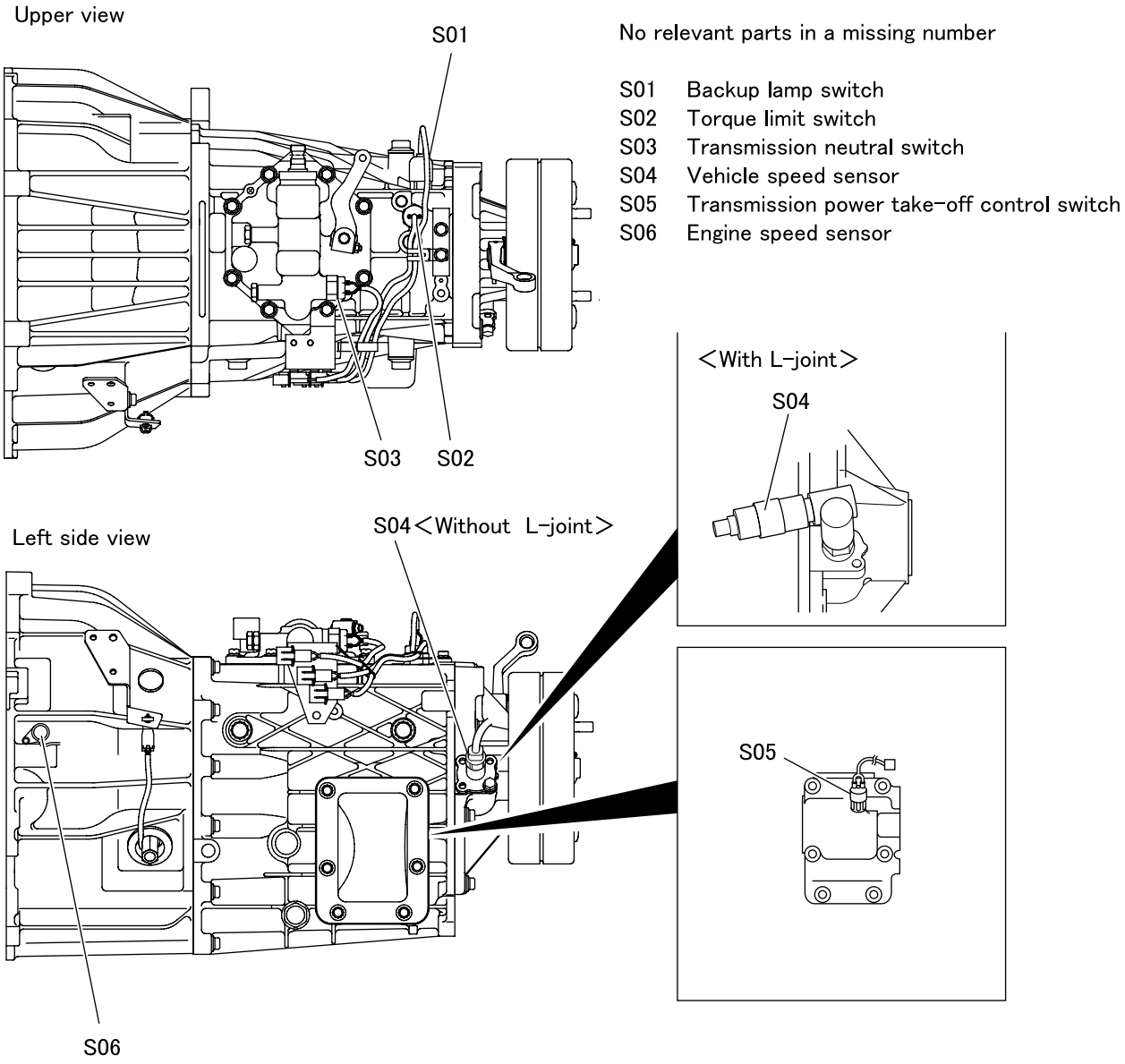


No relevant parts in a missing number

R01	Glow plug	R11	EGR valve (building into motor, position sensor)
R01a	Overheating switch		
R02	Cylinder recognition sensor	R12	Boost pressure sensor
R03	Injectors	R13	Common rail pressure sensor
R04	Engine oil pressure switch	R14	Glow relay
R05	Water temperature sensor (connects to water temperature gauge)	R15	Starter relay
		R16	Starter
R06	Water temperature sensor (connects to engine ECU)	R17	Fuel temperature sensor
		R18	MPROP (rail pressure control valve)
R07	Magnetic clutch	R19	Engine oil level sensor
R08	Alternator		
R09	Magnetic clutch <Freezer>	ECU : Electronic control unit	
R10	Intake throttle (building into motor, position sensor)	EGR : Exhaust gas recirculation	

L00154

S01 to 12 ＜Manual transmission＞



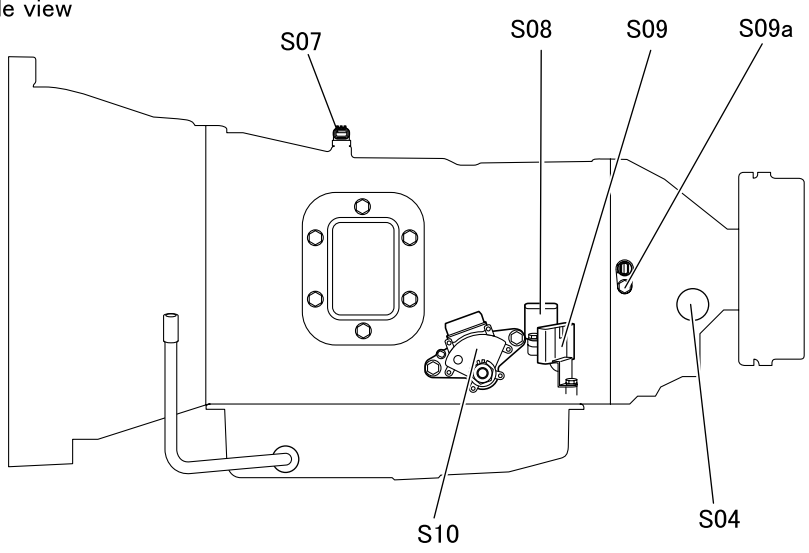
No relevant parts in a missing number

S01 Backup lamp switch
S02 Torque limit switch
S03 Transmission neutral switch
S04 Vehicle speed sensor
S05 Transmission power take-off control switch
S06 Engine speed sensor

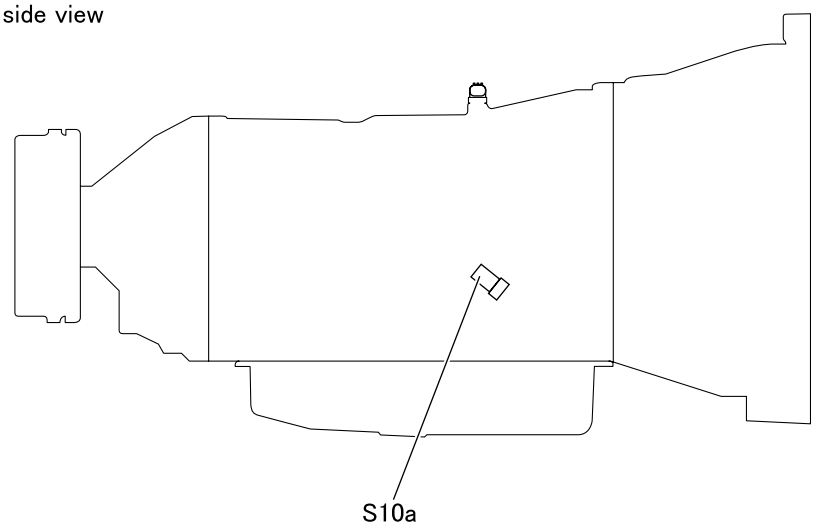
L00155

S01 to 12 ＜Automatic transmission＞

Left side view



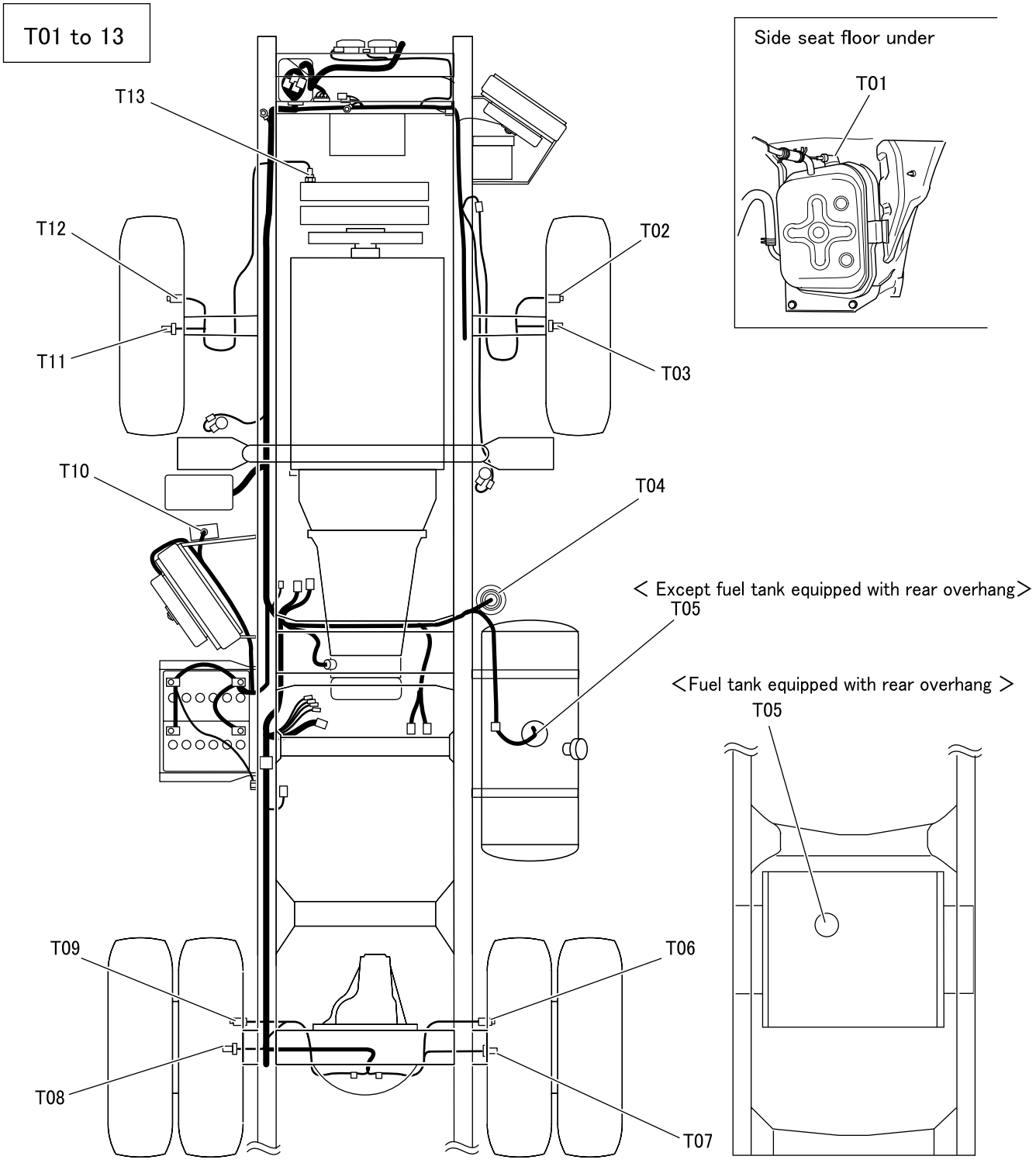
Right side view



No relevant parts in a missing number

S04 Vehicle speed sensor
S07 Turbine revolution sensor
S08 A/T solenoid connector
S09 A/T solenoid connector
S09a Output speed sensor
S10 Inhibitor switch
S10a A/T fluid temperature sensor

A/T : Automatic transmission

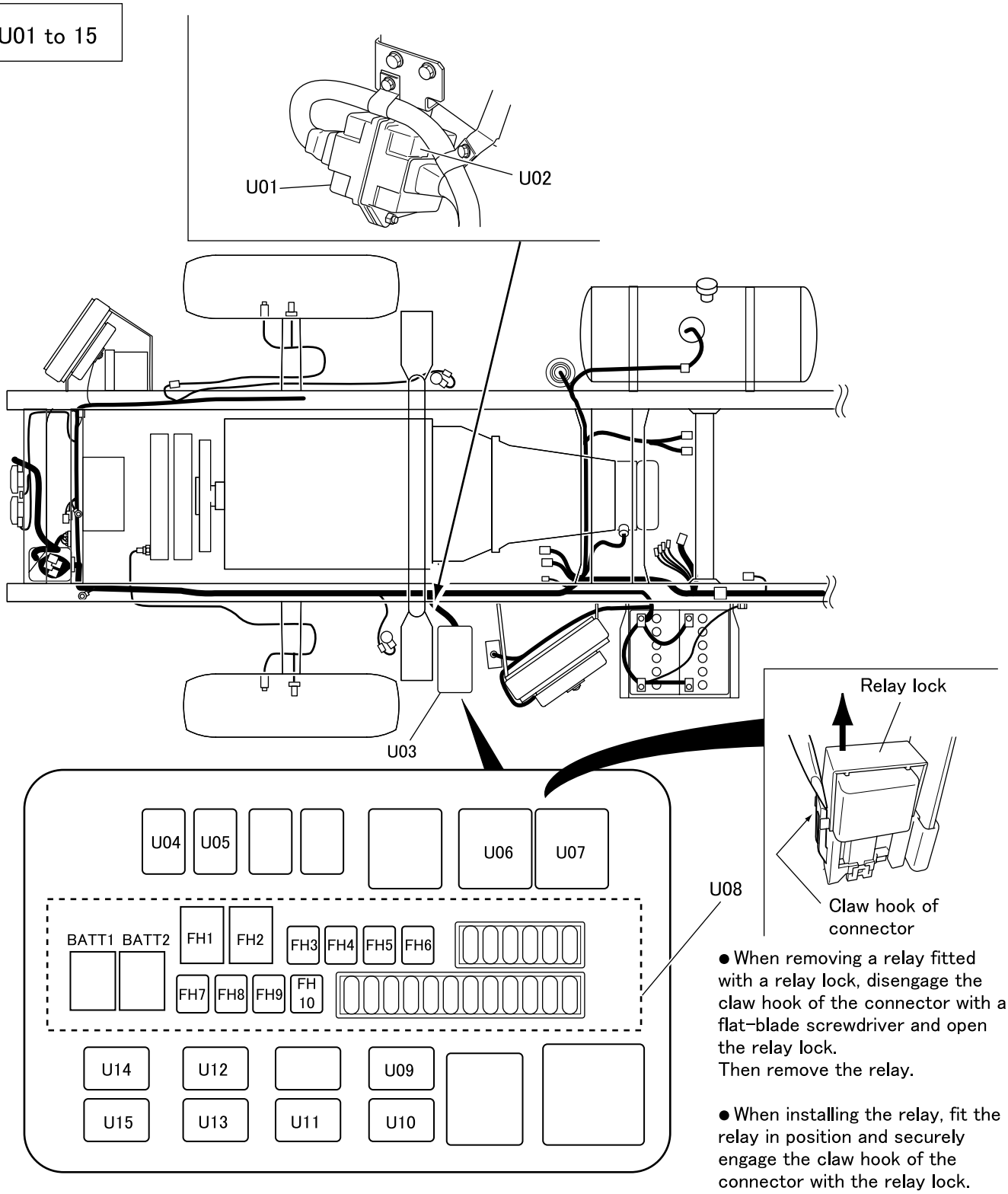


No relevant parts in a missing number

T01	Vacuum switch	T08	Rear wheel speed sensor, LH
T02	Front brake pad wear indicator, RH	T09	Rear brake pad wear indicator, LH
T03	Front wheel speed sensor, RH	T10	Automatic transmission fluid cooler fan thermo switch
T04	Water separator sensor	T11	Front wheel speed sensor, LH
T05	Fuel level sensor	T12	Front brake pad wear indicator, LH
T06	Rear brake pad wear indicator, RH	T13	Boost air temperature sensor
T07	Rear wheel speed sensor, RH		

L00170

U01 to 15



- When removing a relay fitted with a relay lock, disengage the claw hook of the connector with a flat-blade screwdriver and open the relay lock.
Then remove the relay.

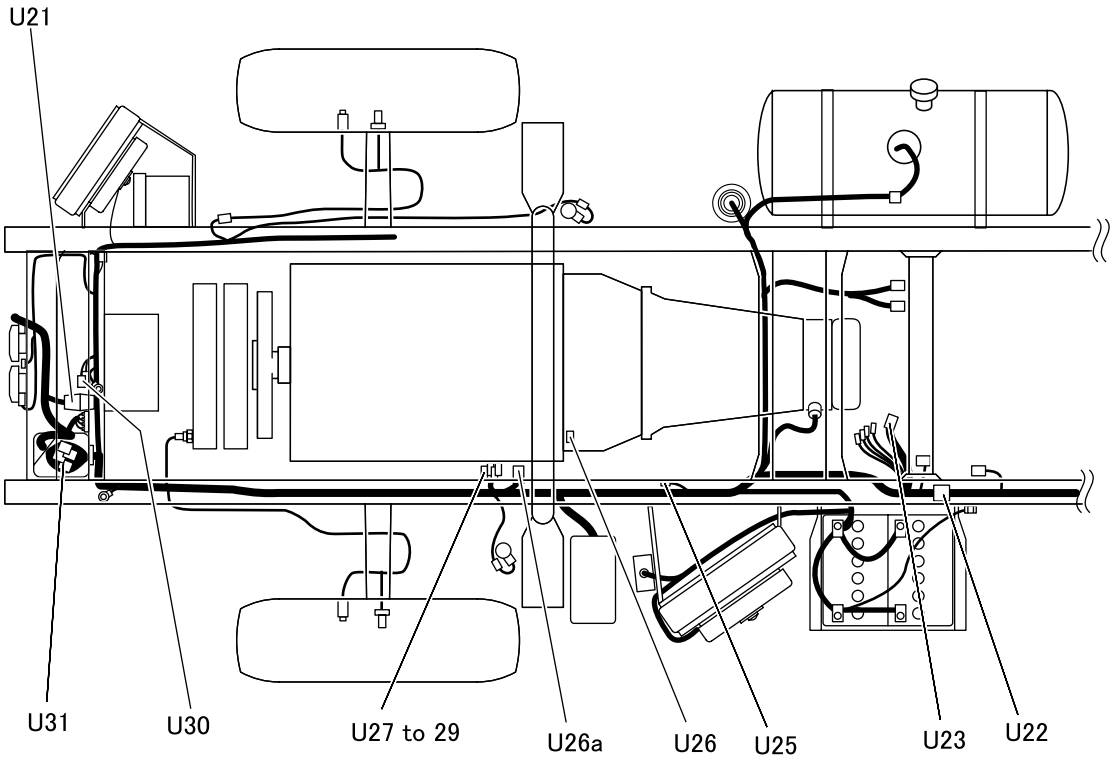
- When installing the relay, fit the relay in position and securely engage the claw hook of the connector with the relay lock.

U01 Throttle EDU
U02 EGR EDU
U03 High-current fuse box
U04 ATF cooler fan motor relay
U05 Backup lamp relay <A/T>
U06 Wiper relay (HIGH)
U07 Wiper relay (LOW)
U08 High-current fuse
U09 Horn relay
U10 Air-conditioner compressor relay
U11 Condenser fan relay
U12 Tail lamp relay
U13 EDU relay
U14 Van body dome light relay
U15 Neutral start relay <A/T>

ATF : Automatic transmission fluid
A/T : Automatic transmission
EDU : Electronic drive unit
EGR : Exhaust gas recirculation

L01269

U21 to 31



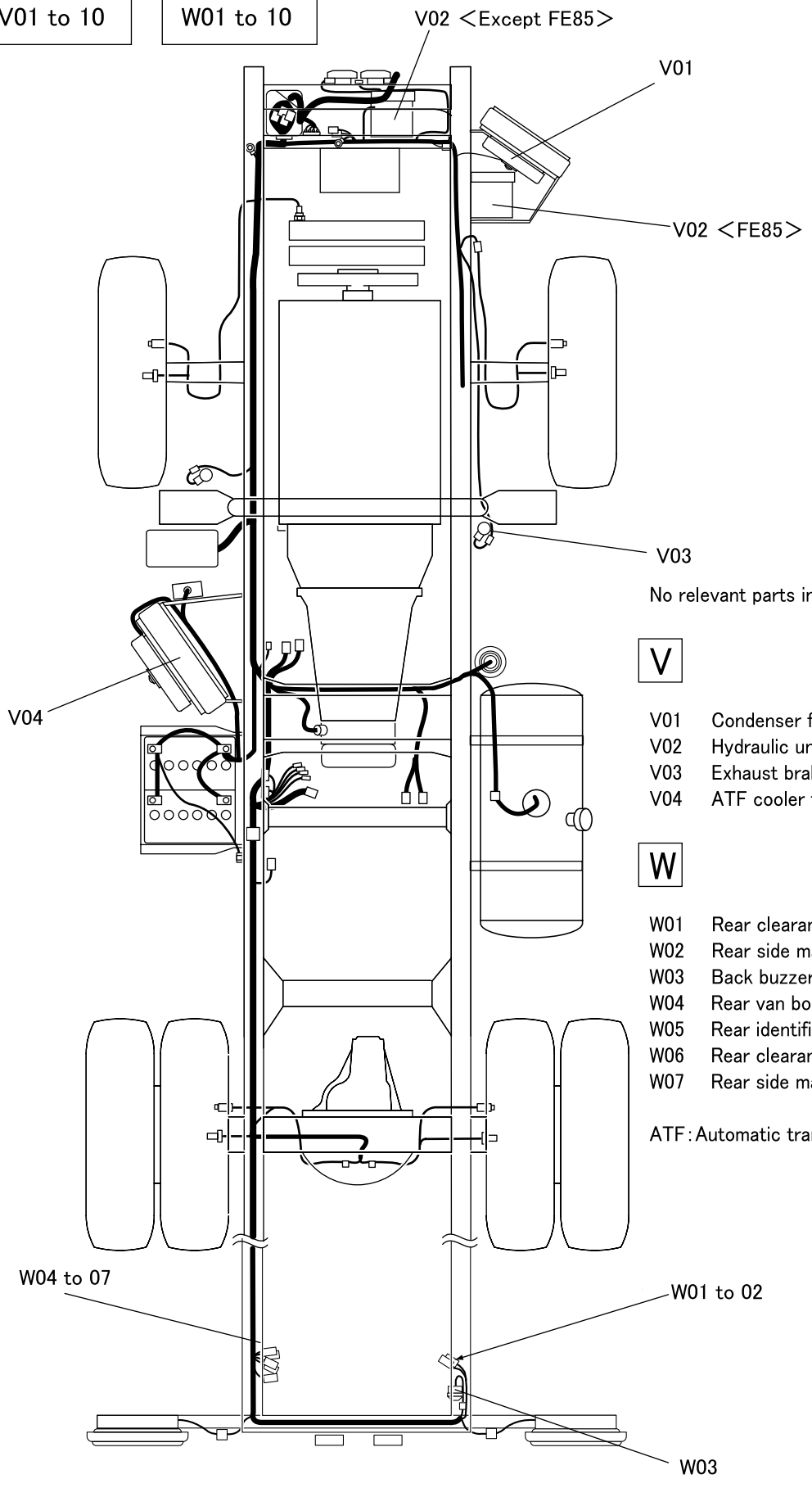
No relevant parts in a missing number

U21 Connection of cab harness and engine harness
U22 Connection of chassis harness and rear chassis harness
U23 Connection of chassis harness and transfer control harness
U25 Diode
U26 Connection of chassis harness and starter harness
U26a Joint connector
U27 Front van body dome light connector
U28 Front identification lamp connector
U29 Front clearance lamp connector
U30 Diode
U31 Connection of chassis harness and cab harness or engine harness

L01270

V01 to 10

W01 to 10



No relevant parts in a missing number

V

V01 Condenser fan motor
V02 Hydraulic unit
V03 Exhaust brake 3-way magnetic valve
V04 ATF cooler fan motor

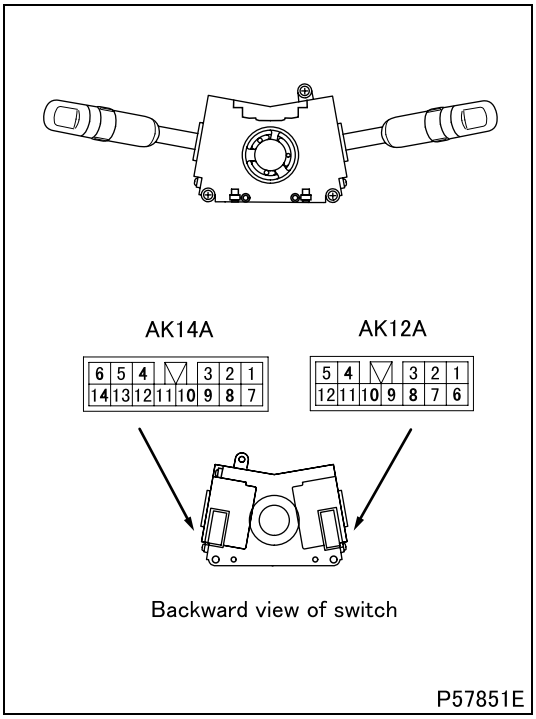
W

W01 Rear clearance lamp, RH connector
W02 Rear side marker lamp, RH connector
W03 Back buzzer
W04 Rear van body dome light connector
W05 Rear identification lamp connector
W06 Rear clearance lamp, LH connector
W07 Rear side marker lamp, LH connector

ATF : Automatic transmission fluid

L01271

GROUP 54-11 INSPECTION OF ELECTRICAL EQUIPMENT



#001 Inspection of combination switch

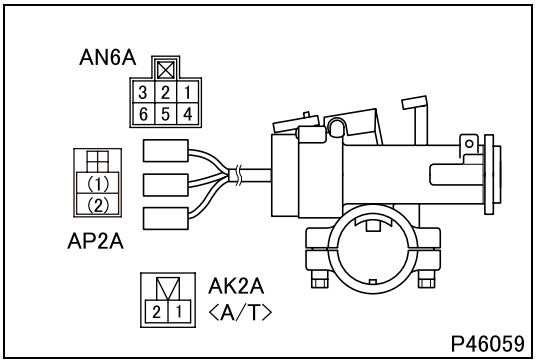
AK12A connector connection table

Switch position			Continuity terminal
Lighting switch	OFF		–
	I		1–2
	II	Dimmer	1–9
		Main	1–9–12
Dimmer switch	Passing		11–12
Turn signal lamp switch	LH		6–8
	N (neutral)		–
	RH		7–8

AK14A connector connection table

Switch position		Continuity terminal
Wiper and washer switch	OFF	–
	INT (interval)	5–7
	LO (low)	3–5
	HI (high)	3–4–5
	WASH (washer)	5–12
Horn switch	OFF	–
	ON	13-body ground
Exhaust brake switch	ON	8–9
	OFF	–

- If any fault is found, replace the switch. (See Gr37.)



#002 Inspection of starter switch

AP2A, AN6A connector connection table

Switch position	Continuity terminal
LOCK	–
ACC	(2)–3
ON	(1)–(2)–3–4
START	(1)–(2)–2–3–4

- Terminal numbers within parentheses ( ) show terminals of AP2A.

AK2A connector connection table
<Key interlock solenoid (A/T)>

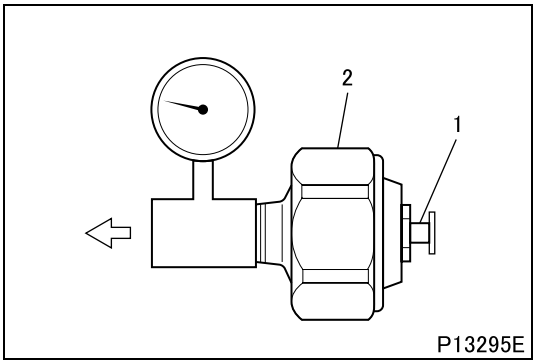
Shift position	Continuity terminal	Remarks
P range: OFF	–	The key must be turned to the lock direction
Without P range: ON	(+) 2–1 (–)	The key must not be turned to the lock direction

A/T: Automatic transmission

- If any fault is found, replace the switch. (See Gr37.)

#011 Inspection of rheostat switch

- The rheostat switch contains a control circuit, because of this it is difficult to inspect the rheostat switch independently, therefore you should inspect the rheostat switch indirectly by inspecting the system harness and the related parts.
- If no fault is found in the related parts but the system is faulty, replace the switch.



#023 Inspection of vacuum switch

- Perform the following checks, and if any fault is found, replace the switch. (See Gr35A.)

(1) Inspection without applying negative pressure

- Make sure that there is no continuity between terminals 1 and 2 (body).

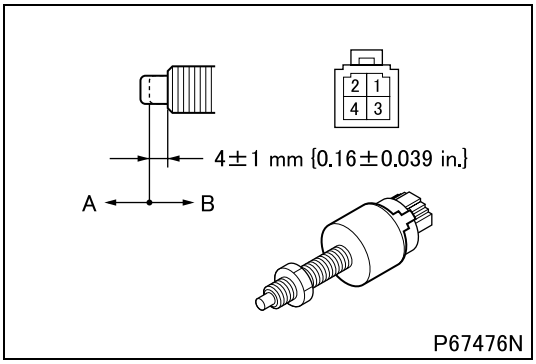
(2) Inspection by applying negative pressure

- Gradually apply negative pressure to the switch starting from 0 kPa {0 psi, 0 kgf/cm^2}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals 1 and 2 (body), and make sure to confirm if the value meets the standard.

Standard value	$-(47\ ^{+3.3}_{-4.0})$ kPa {$-(13.8\ ^{+0.98}_{-1.18})$ in.Hg, $-(350\ ^{+25}_{-30})$ mmHg}

#026, #027 Inspection of power window switch

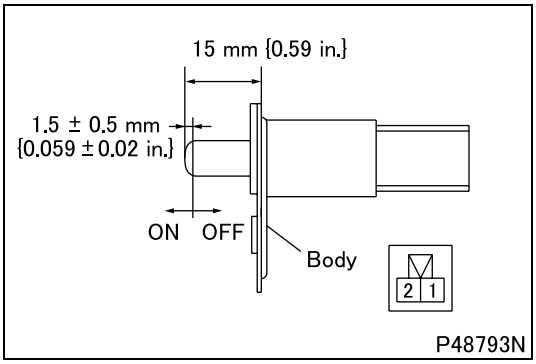
- Because it is not easy to check these swtches individually, determine quality of the switches indirectly by checking related parts, such as harnesses, power window motor, etc. in the system.
- If there is nothing abnormal in related parts, but still something wrong with the system, then replace the switches. (See Gr43.)



#031 Inspection of clutch switch

Switch position	Continuity terminal
A	1–4
B	2–3

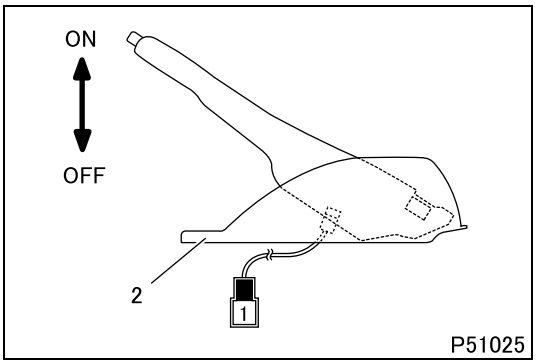
- If any fault is found, replace the switch. (See Gr21.)



#035 Inspection of door switch

Switch position	Continuity terminal
OFF	–
ON	1-body, 2-body

- If any fault is found, replace the switch. (See Gr43.)

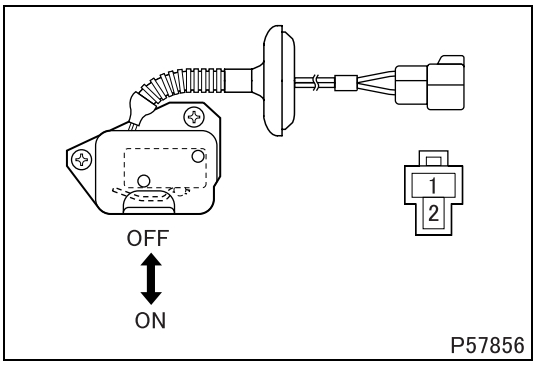


#038 Inspection of parking brake switch

- Measure continuity between terminals 1 and 2 (body) ground.

Pull the parking brake lever	Continuity exists
Release the parking brake lever	Continuity does not exist

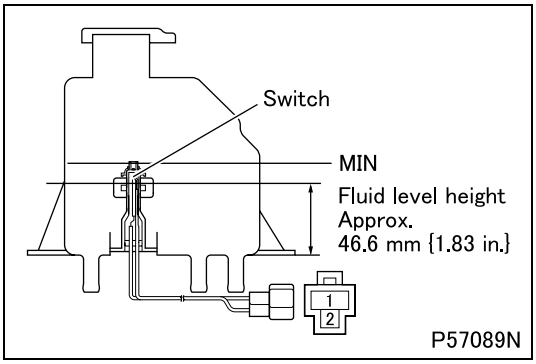
- If any fault is found, replace the switch. (See Gr36.)



#039 Inspection of cab tilt lock switch

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the switch. (See Gr42.)



#041 Inspection of brake fluid level switch

- Gradually drain brake fluid from the brake fluid tank.

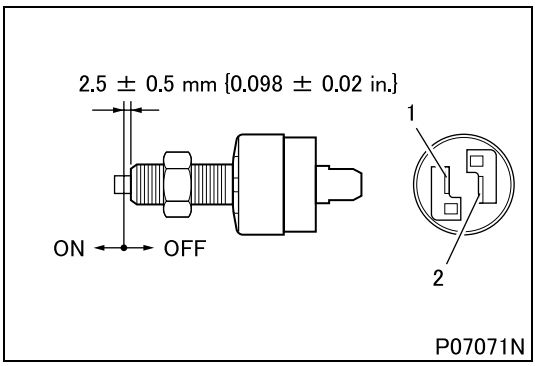
CAUTION ⚠

- **Brake fluid contains ingredients that dissolve paint on the bodywork of a vehicle. Quickly wipe off brake fluid when it is spilled.**

- Measure height of the switch when continuity is detected between terminals 1 and 2.

Standard value	46.6 mm {1.83 in.}

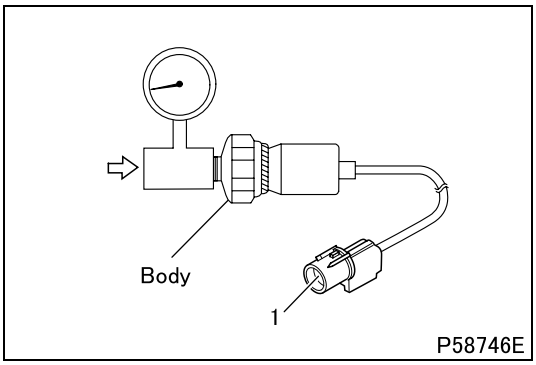
- If the measured value deviates from the standard value, replace the brake fluid tank. (See Gr52.)



#042 Inspection of stop lamp switch

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the switch. (See Gr35A.)



#044 Inspection of engine oil pressure switch

- Perform the following checks, and if any fault is found, replace the switch. (See Gr12.)

(1) Inspection without applying air pressure

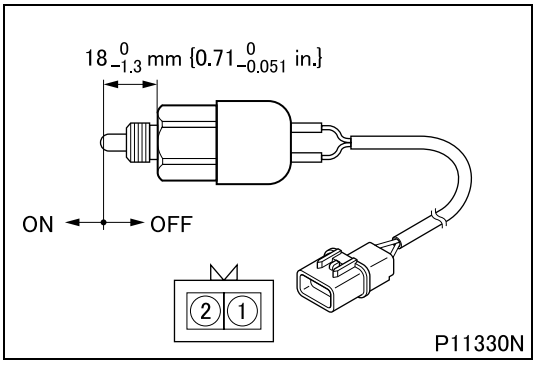
- Make sure that there is continuity between terminals 1 and body.

(2) Inspection by applying air pressure

- Gradually apply air pressure to the switch starting from 0 kPa {0 psi, 0 kgf/cm^2}.

- Measure the degree of air pressure at the moment when continuity is not detected between terminals 1 and body, and make sure to confirm if the value meets the standard.

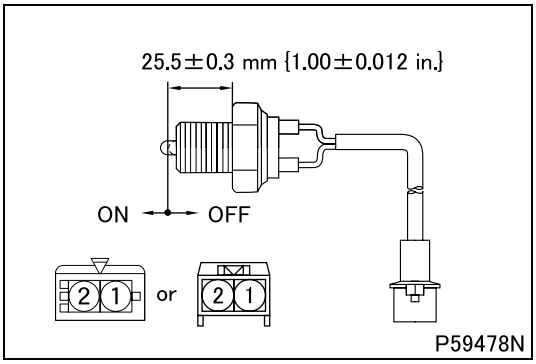
Standard value (operating pressure)	50 ± 10 kPa {7.1 ± 1.4 psi, 0.5 ± 0.1 kgf/cm^2}



#054 Inspection of switch

Switch position	Continuity terminal
OFF	–
ON	1–2

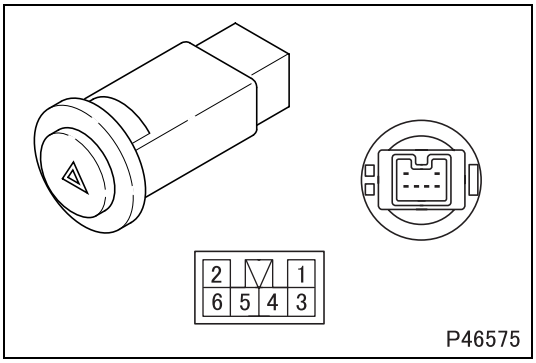
- If any fault is found, replace the switch.
  - Backup lamp switch. (See Gr22.)



#056 Inspection of transmission neutral switch

Switch position	Continuity terminal
OFF	–
ON	1–2

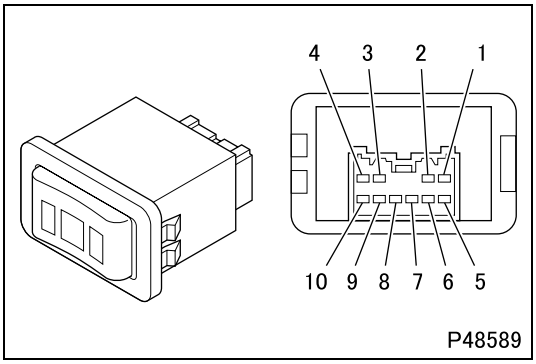
- If any fault is found, replace the switch. (See Gr22.)



#081 Inspection of hazard switch

Switch position	Continuity terminal	Night illumination
OFF	–	(+) 2-1 (–)
ON	4–5–6	

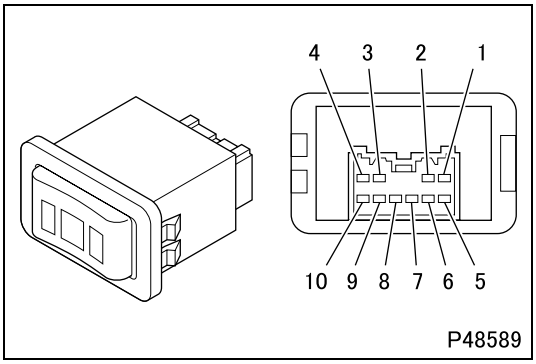
- If any fault is found, replace the switch. (See Gr52.)



#087 Inspection of van body dome light switch

Switch position	Continuity terminal	Operation illumination	Night illumination
OFF	1–8	–	(+) 2-3 (–)
ON	1–7	(–) 3–9 (+)	

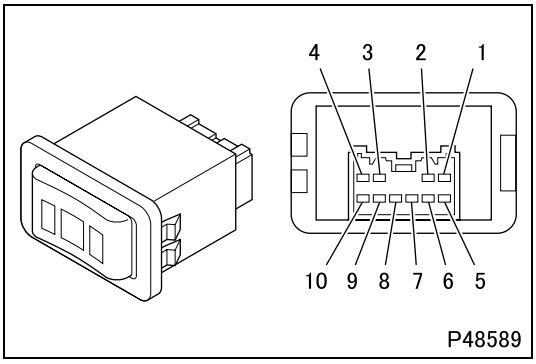
- If any fault is found, replace the switch.



#089 Inspection of switch

Switch position	Continuity terminal	Night illumination
OFF	1–8	(+) 2-3 (–)
ON	1–7	

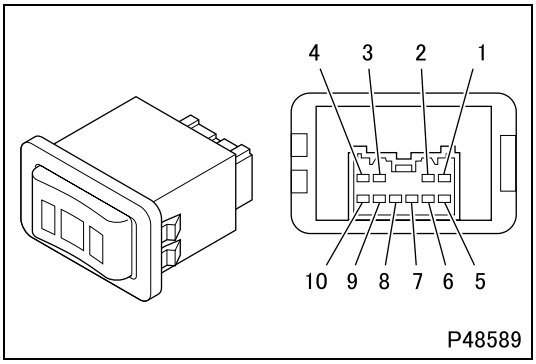
- If any fault is found, replace the switch. (See Gr52.)
  - Warm-up switch



#092 Inspection of engine oil level check switch

Switch position	Continuity terminal
–	–
CHK	1–7, 5–6

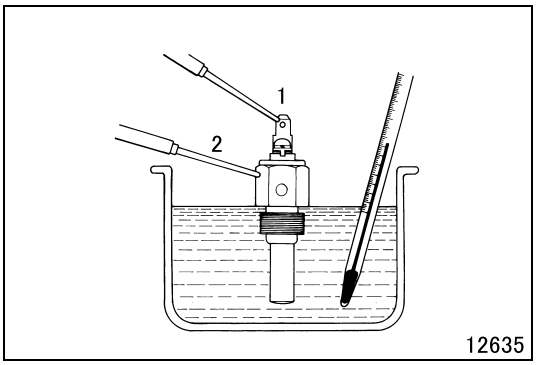
- If any fault is found, replace the switch. (See Gr52.)



#094 Inspection of door lock switch

Switch position	Continuity terminal	Night illumination
LOCK	1–7	(+) 2-3 (–)
Neutral	–	
UNLK	1–8	

- If any fault is found, replace the switch. (See Gr43.)

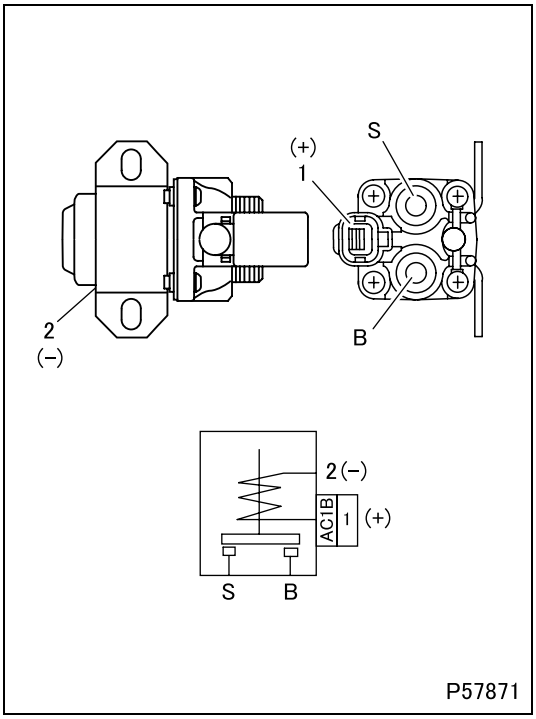


#160 Inspection of overheating switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals 1 and 2 (body) respectively.

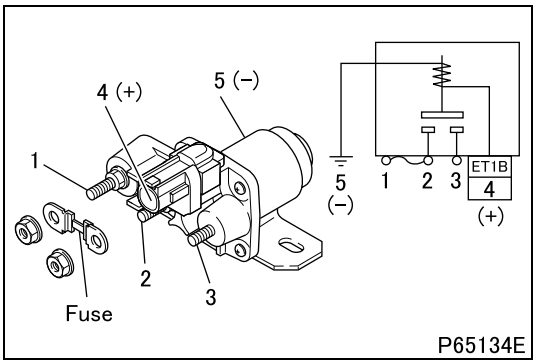
Standard Value	When temperature increase (OFF→ON)	110 ± 2°C {230 ± 36°F}
	When temperature decrease (ON→OFF)	110 ± 4°C {230 ± 39°F}

- If the measured value deviates from the standard value, replace the switch. (See Gr14.)



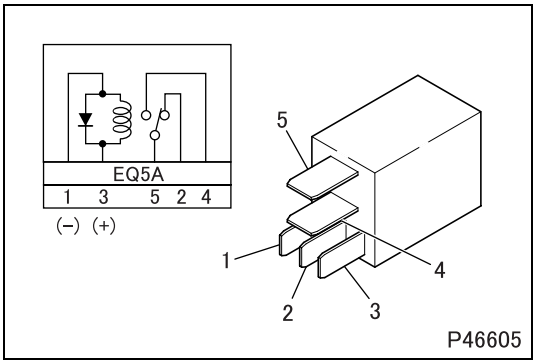
#187 Inspection of starter relay

- Perform continuity check and operation check, and if any fault is found, replace the relay.



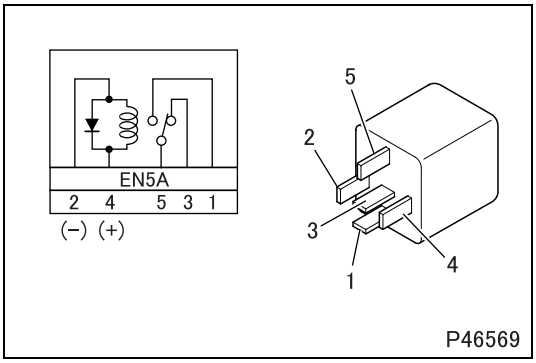
#195 Inspection of glow relay

- Perform continuity check and operation check, and if any fault is found, replace the relay.



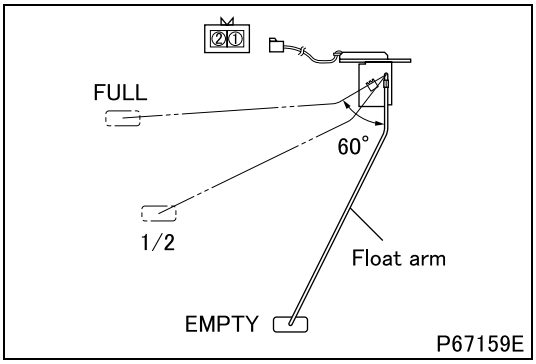
#201 Inspection of relay (normally open type 5 pin)

- Perform continuity check and operation check, and if any fault is found, replace the relay.



#202 Inspection of relay (normally open type 5 pin)

- Perform continuity check and operation check, and if any fault is found, replace the relay.

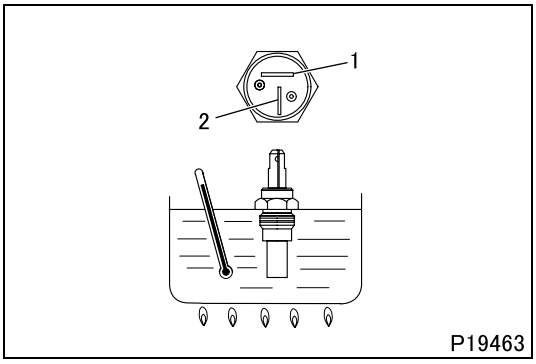


#258 Inspection of fuel level sensor

- Measure resistance values between terminals 1 and 2 when bringing the float arm into contact with stoppers (at EMPTY and FULL positions) and placing it at the midpoint position.

Standard value	at FULL position	0^{+2}_{0} Ω
	at 1/2 position	50 ± 3 Ω
	at EMPTY position	150 ± 10 Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr13A.)



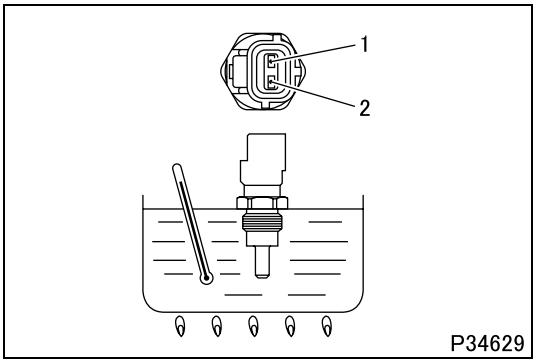
#262 Inspection of water temperature sensor

<For water temperature gauge>

- Dip the sensor in a container filled with engine oil.
- Raise the oil temperature to the specified one while stirring oil.
- Measure resistance values between terminals 1 and 2 and body.
  Terminal 1: water temperature gauge connected side
  Terminal 2: Is not use

Standard value	1 and body (water temperature gauge connected side)	50°C {122°F}	153.9 Ω (reference value)
		80°C {176°F}	$51.9^{+4.9}_{-4.4}$ Ω
		100°C {212°F}	$27.4^{+1.9}_{-1.2}$ Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr14.)

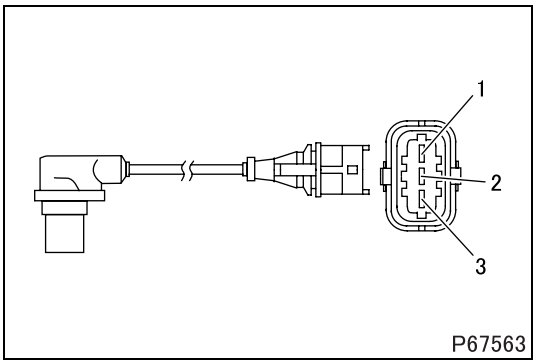


<For engine control>

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	2.45 ± 0.14 kΩ
	80°C {176°F}	322.2 Ω (reference value)
	110°C {230°F}	147.1 ± 2 Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr14.)

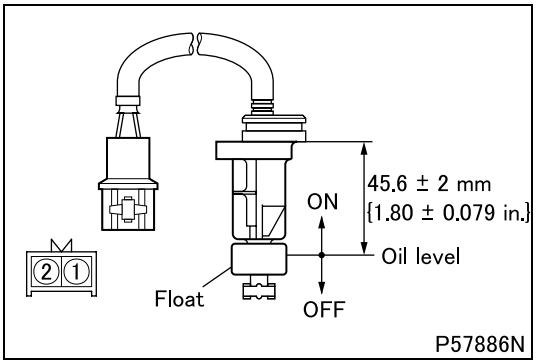


#263 Inspection of engine speed sensor

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	860 ± 86 Ω

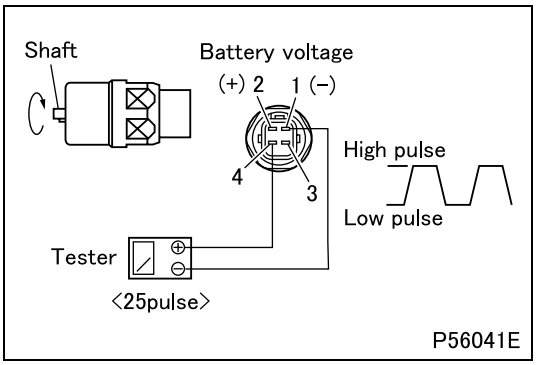
- If the measured value deviates from the standard value, replace the sensor. (See Gr13E.)



#264 Inspection of engine oil level sensor

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the sensor. (See Gr12.)

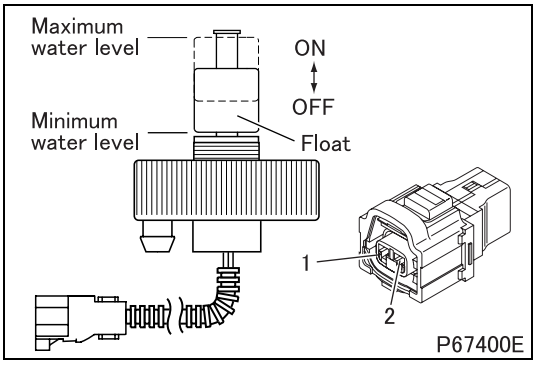


#265 Inspection of vehicle speed sensor

- Rotate the sensor shaft with the battery voltage applied between terminals 1 and 2.
- Measure the maximum value (high pulse voltage) and the minimum value (low pulse voltage) of the voltage generated at each terminal.

Standard value	Between 25 pulse output terminals 1 and 4	Low pulse voltage	0.5 V or less
		High pulse voltage	8 ± 1 V

- If the measurement is not within the range of the standard value, replace the sensor. (See Gr22.)



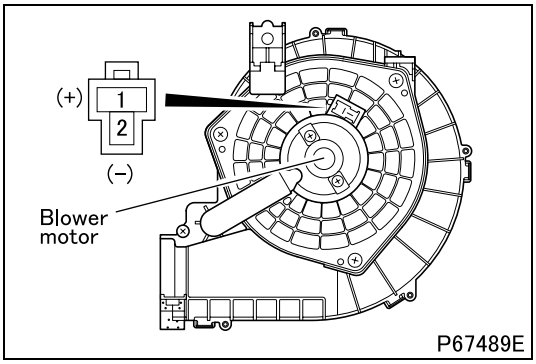
#274 Inspection of water separator sensor

Condition	Continuity terminal
ON (when coolant quantity is approx. 100 cm^3 {6.10 cu.in.})	1–2
OFF	–

- If any fault is found, replace the sensor (See Gr13A.)

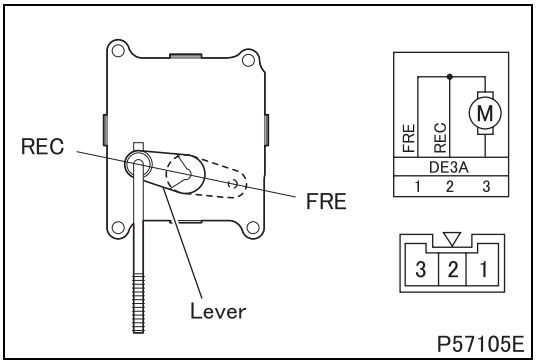
#350 Inspection of control unit and other units

- Since the units alone cannot be readily checked in the off-vehicle state, check the harness, switch and other related parts in each system.
- If any fault is not found in the related parts, and the problem still remains in the system, replace the control units or other units.



#411 Inspection of blower motor

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the motor. (See Gr55.)



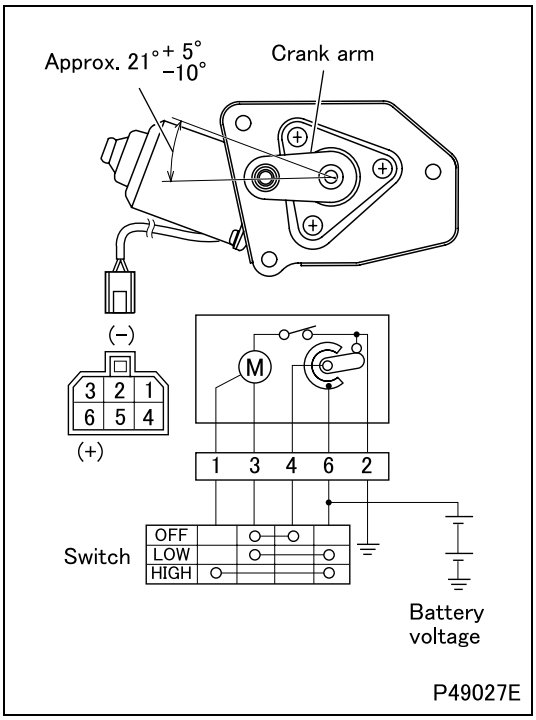
#415 Inspection of fresh/recirculation changeover motor

- Perform the following checks, and if any fault is found, replace the motor. (See Gr55.)
- Make sure that the motor operates when battery voltage is applied between each terminal.

Lever position	Terminal
REC (inside air)	(+) 3–2 (–)
FRE (outside air)	(+) 3–1 (–)

CAUTION ⚠

- **Stop applying battery voltage if the lever stops spontaneously at the REC or FRE position.**



#422 Inspection of wiper motor

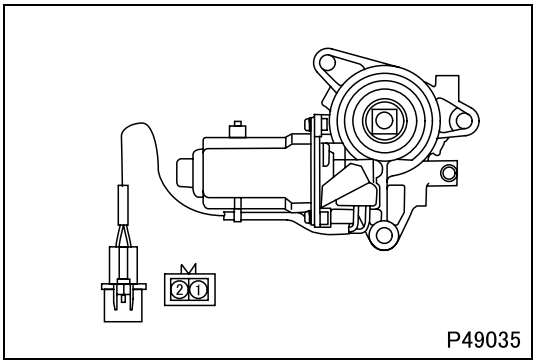
- Connect a switch to wiper motor as shown.
- Check the motor for correct operation as follows. If any fault is found, replace the motor. (See Gr51.)

(1) Inspection of motor operation

- Set switch to HIGH position to check that the motor rotates at high speed.
- Set switch to LOW position to check that the motor rotates at low speed.

(2) Inspection of automatic stop position

- Set switch to LOW position to let the motor rotate at low speed.
- When the crank arm is in a position other than automatic stop position (outside the angles shown), set switch to OFF position.
- Check to see that the crank arm stops at the automatic stop position (within the angles range shown).

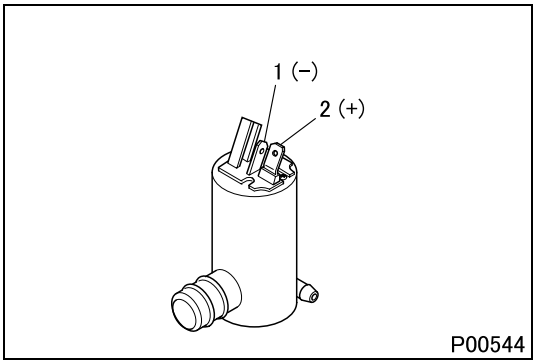


#423 Inspection of power window motor

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.

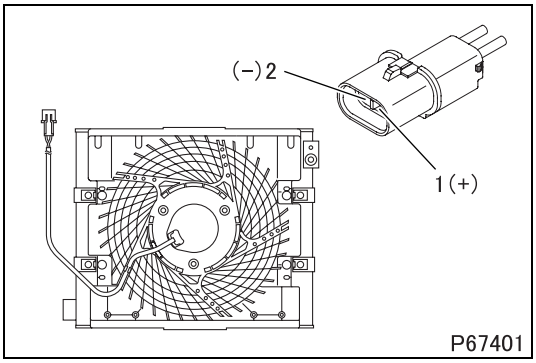
Rotation direction	Terminal
Left	(+) 2–1 (–)
Right	(+) 1–2 (–)

- If any fault is found, replace the motor and the regulator as a set. (See Gr43.)



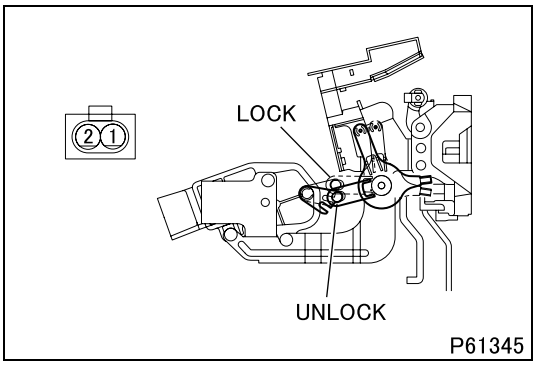
#428 Inspection of windshield washer motor

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the motor. (See Gr51.)



#431 Inspection of condenser fan motor

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the motor. (See Gr55.)



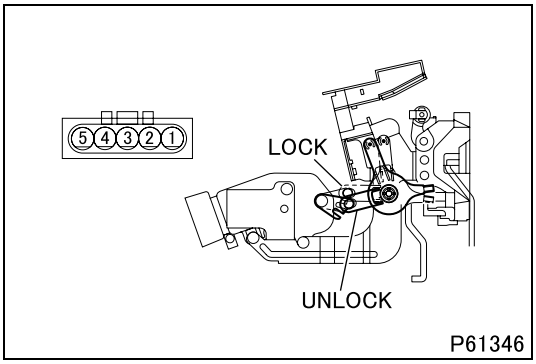
#510 Inspection of door lock actuator (on assistant driver's side)

- Apply battery voltage between each terminals confirm that the actuator operates.

Switch position	Terminal
LOCK	(+) 1–2 (–)
UNLOCK	(+) 2–1 (–)

- If any fault is found, replace the actuator. (See Gr43.)

#560 to #609 MAGNETIC VALVE

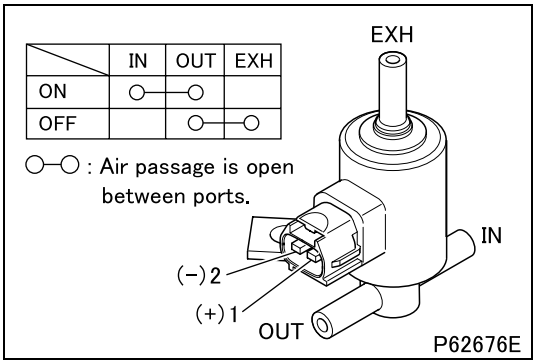


#511 Inspection of door lock actuator (on driver's side)

- Apply battery voltage between each terminals confirm that the actuator operates.

Switch position	Continuity terminal	Terminal
LOCK	1–2	(+) 3–4 (–)
UNLOCK	1–5	(+) 4–3 (–)

- If any fault is found, replace the actuator. (See Gr43.)



#565 Inspection of 3-way magnetic valve

- Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation check

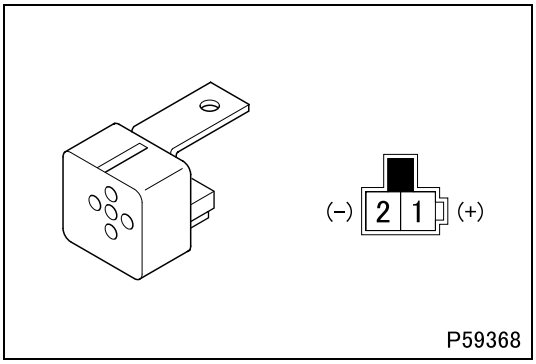
- Gradually apply DC current between terminals 1 and 2 starting from 0 V.

Measure the voltage at which the 3-way magnetic valve operates. (Determine ON/OFF of the magnetic valve by operating noises.)

Standard value (minimum operating voltage)	11 V or less

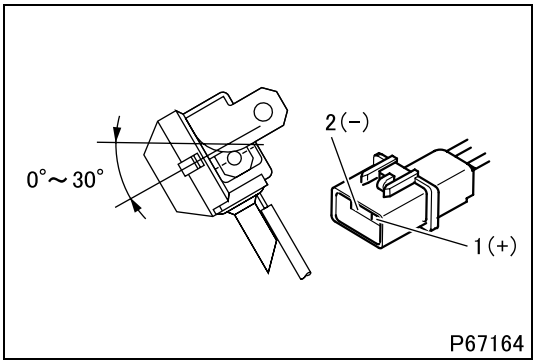
(2) Inspection of continuity and air tightness

- Negative pressure when inspected: –100 kPa {–29.5 in.Hg, –750 mmHg}



#611 Inspection of warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the buzzer.



#614 Inspection of back buzzer

[Inspection]

- Make sure to confirm if the buzzer intermittently sounds by applying the battery voltage between terminals 1 and 2.
- If any fault is found, replace the buzzer.

[Installation]

- Install the back buzzer to the frame in the range of angles as illustrated.

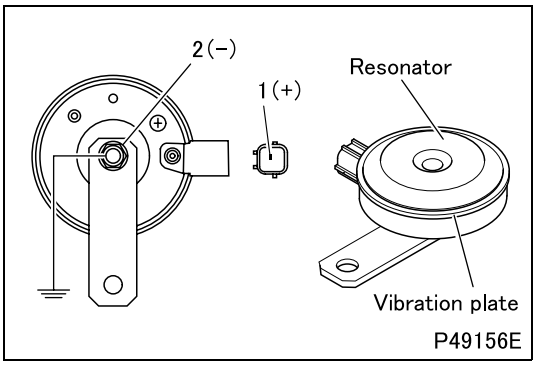
CAUTION ⚠

- **Beware that if the installed angle of the buzzer is out of the range as illustrated, water in the buzzer will not be drained normally.**

#615 Inspection of electric horn

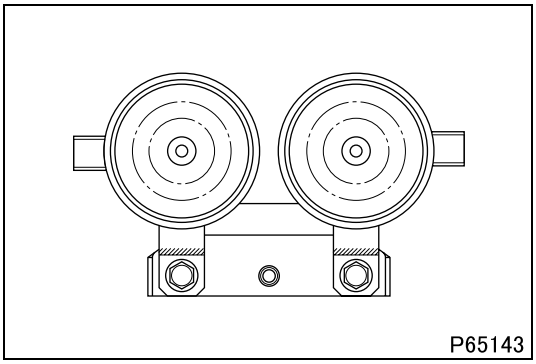
CAUTION ⚠

- **Bending the stay changes the sound quality of the horn, degrading the horn performance.**
- **Never bend or damage the stay.**



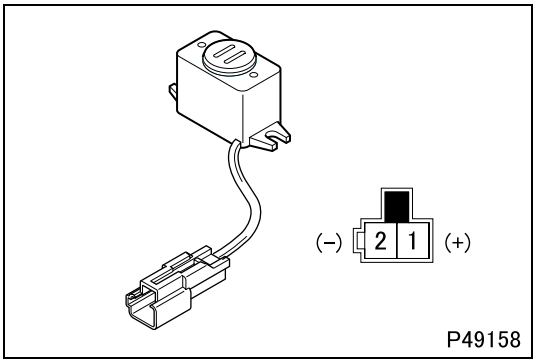
[Inspection]

- Make sure to confirm whether the horn sounds by applying the battery voltage between terminals 1 and 2 (body).
- Remove foreign substances adhered to the resonator and diaphragm.
- If any fault is found, replace the horn.



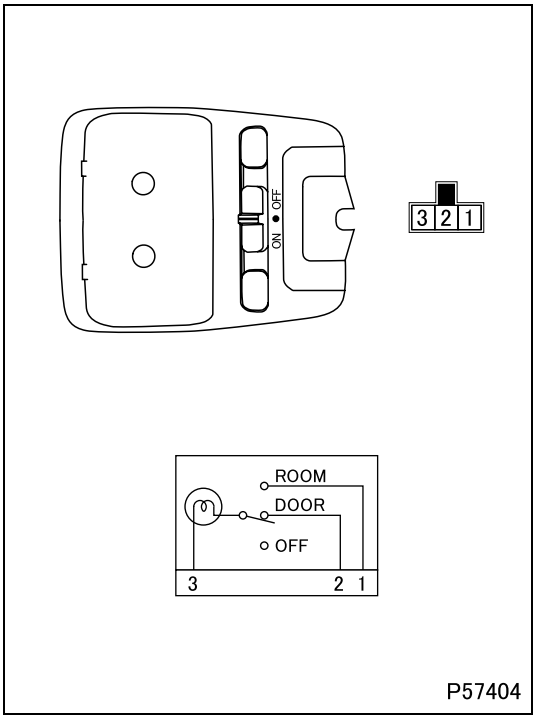
[Installation]

- Install in the direction as illustrated.



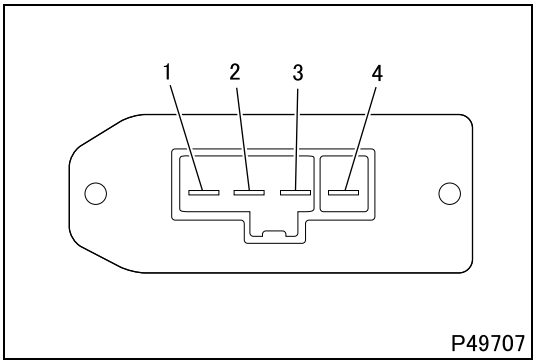
#618 Inspection of cab tilt buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the buzzer.



#656 Inspection of cab lamp

- If any fault is found, replace the lamp.

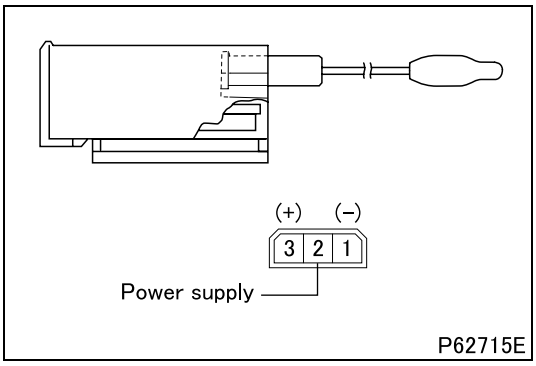


#750 Inspection of blower resistor

- Measure resistance values between each terminals.

Position	Terminal	Standard value
MEDIUM HIGH	1–4	0.24 Ω
MEDIUM LOW	3–4	0.93 Ω
LOW	2–4	1.5 Ω

- If the measured value deviates from the standard value, replace the blower resistor. (See Gr55.)

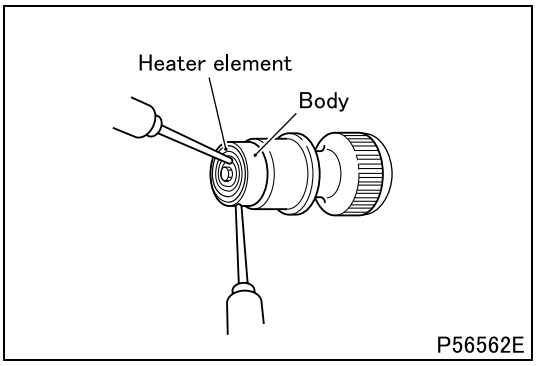


#751 Inspection of thermostat

- Measure resistance values between each terminals 1 and 3 at the specified temperature.

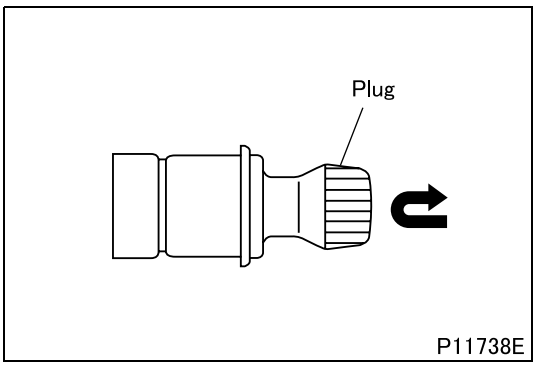
Switch position	Continuity terminal
OFF (4.2°C)	–
ON (5.2°C)	1–3

- If any fault is found, replace the thermostat. (See Gr55.)



#754 Inspection of cigarette lighter

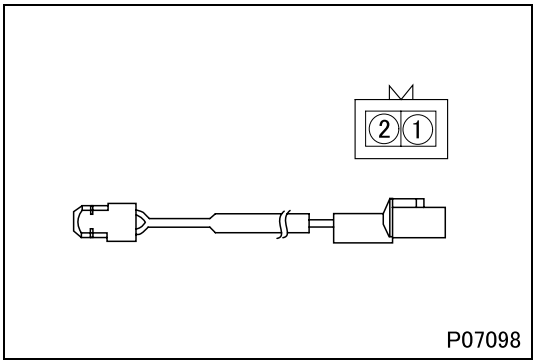
- Perform the following checks, and if any fault is found, replace the cigarette lighter. (See Gr52.)
- Make sure that there is continuity between heater element and body.



- Make sure that when plug is pushed in by hand, it immediately returns to its original position.
- Place the starter switch at ACC or ON position.
- Push plug into the socket in the cab.
- Measure the time required for plug to automatically return.

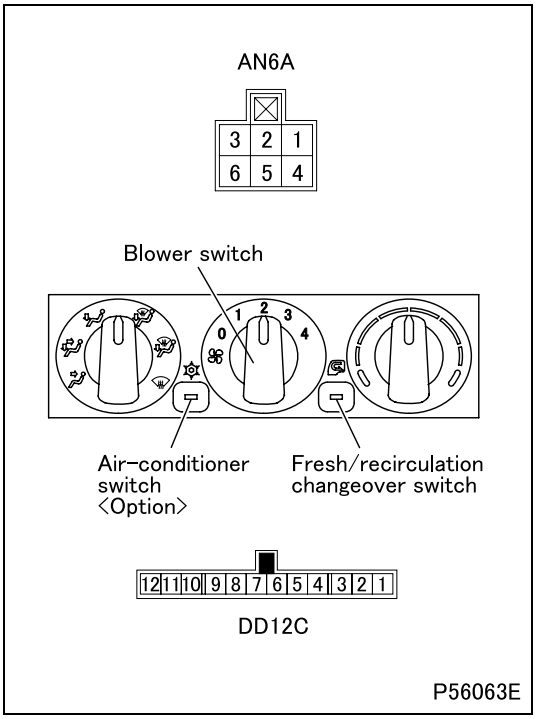
Standard value	15 ± 5 seconds

- Check to see that heater element is red-hot.



#759 Inspection of brake pad wear indicator

- Make sure that there is continuity between terminals 1 and 2.
- If any fault is found, replace the brake pad wear indicator. (See Gr35A.)



#763 Inspection of heater control panel

- Perform the following checks, and if any fault is found, replace the heater control panel. (See Gr52.)

(1) Blower switch <AN6A connector>

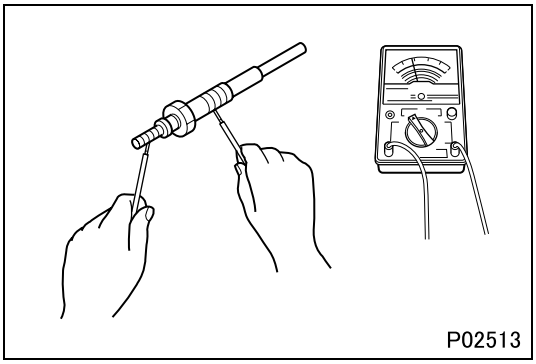
Switch position	Continuity terminal
0 : OFF	–
1 : LO (LOW)	4–5–6
2 : ML (MEDIUM LOW)	1–5–6
3 : MH (MEDIUM HIGH)	2–5–6
4 : HI (HIGH)	3–5–6

(2) Fresh/recirculation changeover switch <DD12C connector>

Switch position	Continuity terminal	Operation illumination	Night illumination
OFF : Fresh air	9–10	–	(+) 7–8 (–)
ON : recirculation air	10–11	(+) 12–10 (–)	

(3) Air-conditioner switch <DD12C connector>

Switch position	Continuity terminal	Operation illumination	Night illumination
OFF	–	–	(+) 7–8 (–)
ON	3–4–6	(+) 3–6 (–) (+) 4–6 (–)	



#764 Inspection of glow plug

- Measure resistance value of glow plug as shown.

Standard value (cold resistance of glow plug)	Approx. 1.0 Ω

- If the measured value deviates from the standard value, replace the glow plug. (See Gr11.)

#860 BATTERY

DANGER ⚠

- **Since flammable hydrogen gas is generated by the battery be sure to obey the following warnings:**
  - **Do not short-circuit the (+) and (–) terminals on the battery.**
  - **Keep sparks and lit cigarettes away from the battery.**
  - **Do not wear metal objects on your arms and lean over battery.**
- **Because the battery electrolyte is made of diluted sulfuric acid and is corrosive, when handling battery wear safety glasses and rubber gloves to protect the eyes and hands.**

WARNING ⚠

- **Make sure that you disconnect the negative battery cable (–) first when you disconnect battery cables.**

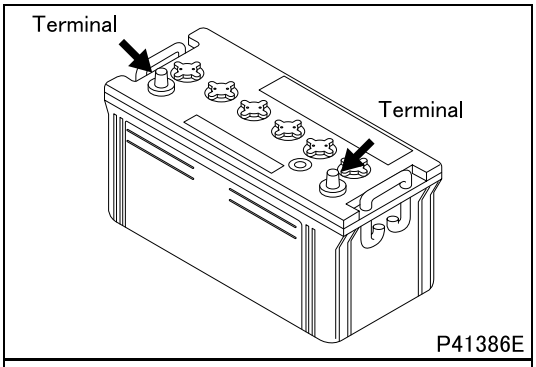
CAUTION ⚠

- **Make sure that all electrical switches of the vehicle are OFF before connecting battery cables.**
- **Make sure that you connect battery cable (+) before you connect battery cable (–).**
- **To prevent a short-circuit be sure that disconnected battery cables do not accidentally touch the battery terminals.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Specific gravity of battery electrolyte (20°C {68°F})	1.280	1.220	Charge or replace

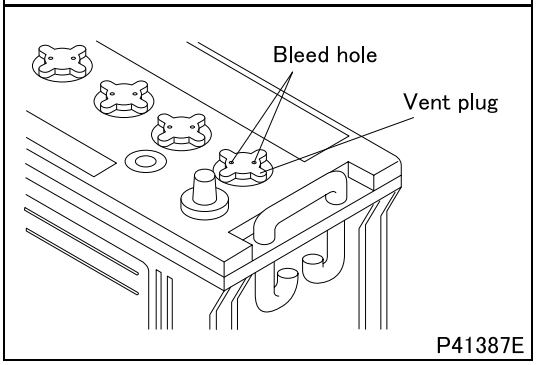
◆Service procedure◆



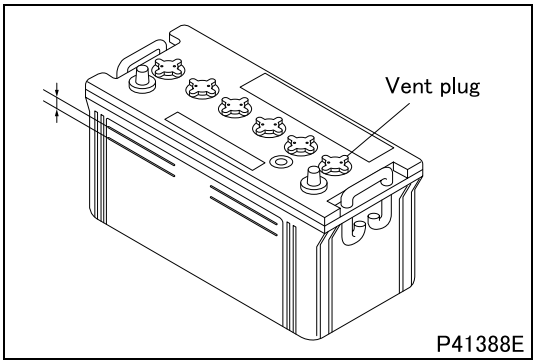
Inspection of battery

(1) Visual inspection

- If terminal is corroded, scrub off the corrosion with a wire brush.
- If cracks or defects are found on battery, replace it since the cracks or defects can cause liquid spills.

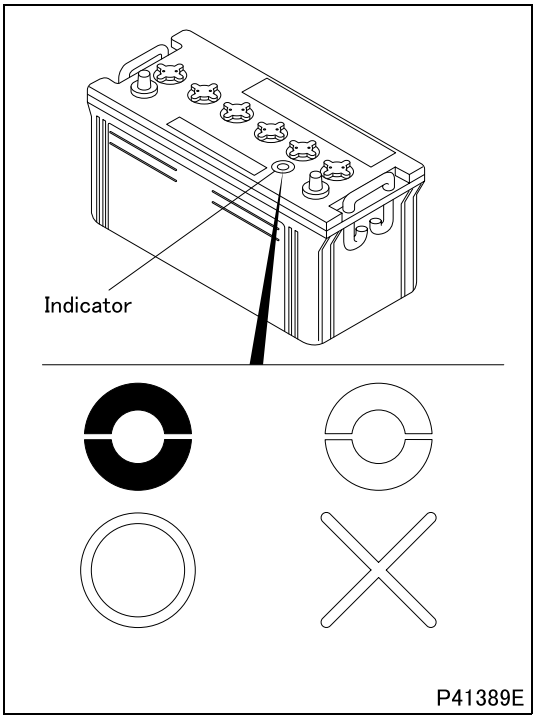


- If bleed hole of vent plug is clogged, clean the hole.



(2) Inspection of fluid level

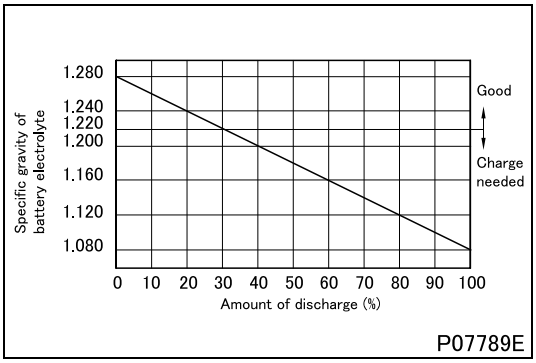
- Make sure that the battery electrolyte level is between UPPER and LOWER.
- If the level is below LOWER, remove vent plug and fill the battery with distilled water or battery replenisher to UPPER.



(3) Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator.

Blue : Good
White : Charge or replace



(4) Charging

- Although, as a rule, battery charging should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect battery cable (–).
- Remove vent plug before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	Value of 5-hour rating capacity / 10	*Amount of discharge (Ah) / Charge current (A) ×1.2 (to 1.5)	45 {113}
Quick charge	Value of 5-hour rating capacity / 1.5	0.5	55 {131}

* Amount of discharge (Ah) =

$$\text{5-hour rating capacity (Ah)} \times \frac{\text{Amount of discharge (\%)}}{100}$$

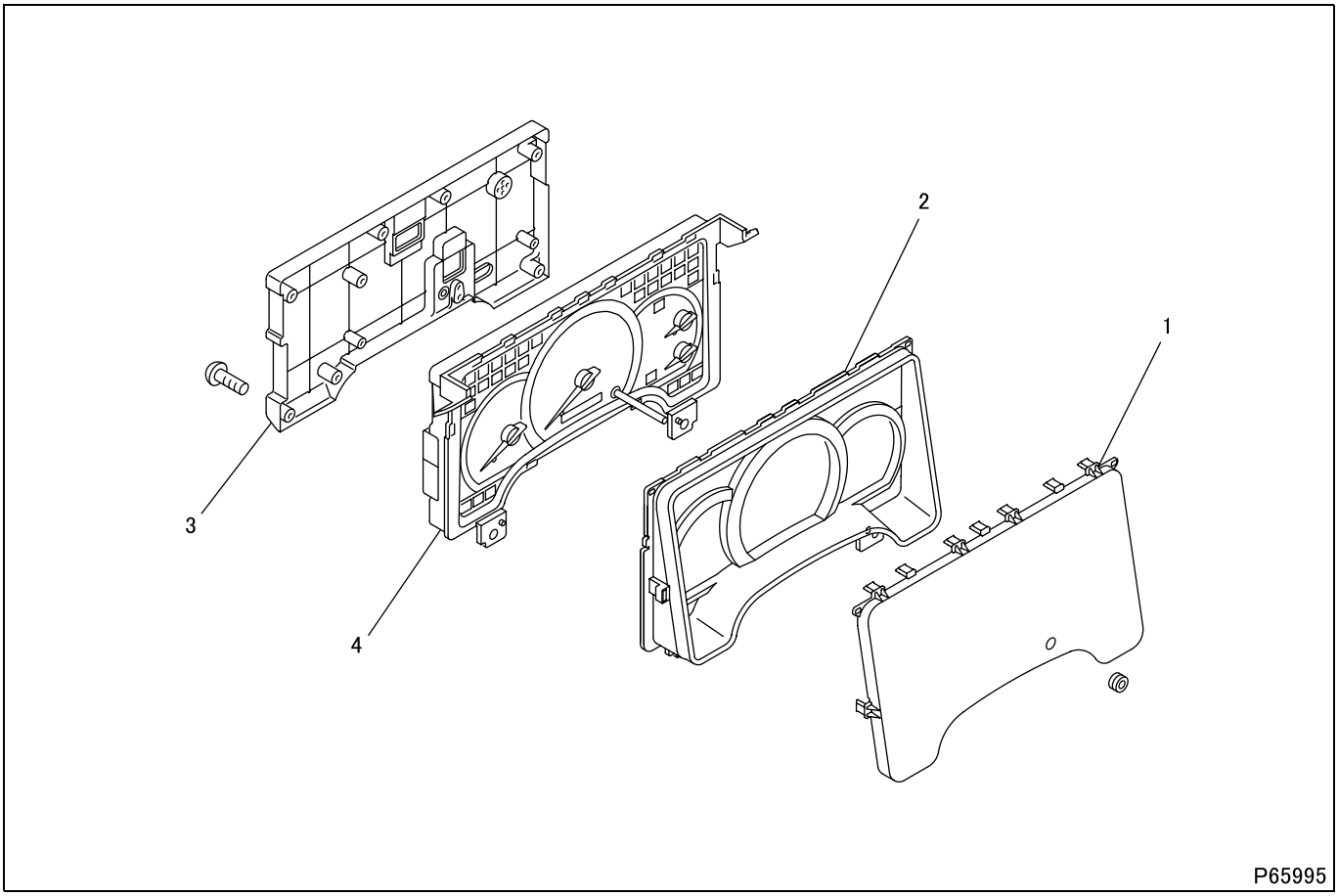
- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.

DANGER ⚠

- **Keep naked light away from the battery while charging to prevent explosion.**
- **It is dangerous to generate sparks while charging the battery.**
- **Do not charge battery if the electrolyte level is below LOWER LEVEL, since it can cause early deterioration, heating, or explosion. Make sure to add the fluid to the specified level before charging.**

WARNING ⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **After charging the battery, tighten vent plug, wash away sulfuric acid from the battery using water, and dry the surface.**



● **Disassembly sequence**

1 Meter glass
2 Plate
3 Cover
4 Body

● **Assembly sequence**

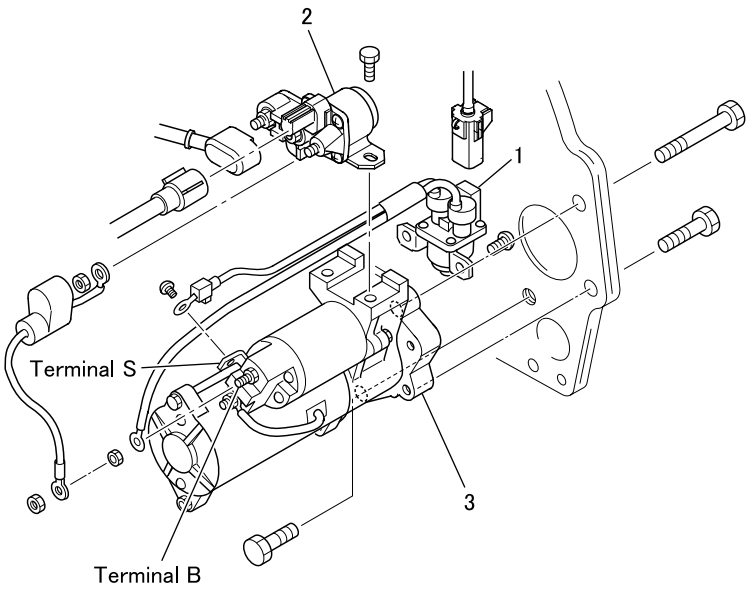
Follow the disassembly sequence in reverse.

◆**Inspection procedure**◆

■ **Inspection: Meters**

- Each sensor signal is converted into digital signal in the meter cluster and then the value is indicated by the corresponding meter on the cluster. Therefore, a single meter inspection cannot be performed.
  Each meter should be checked indirectly by checking its related harnesses and parts.
- If the related harnesses and parts are normal but the meter indication is faulty, replace the meter cluster.

GROUP 54-12 STARTER AND ALTERNATOR



P67168E

B:Connected to terminal B
S:Connected to terminal S
1 Chassis harness
2 Starter cable
3 Starter relay
4 Glow relay
5 Starter

● Removal sequence

WARNING ⚠

- **Before removing the starter, disconnect the (–) battery cable and insulate the cable and the (–) battery terminal with tape.**
- **It is dangerous to leave the (–) battery cable connected since the battery cable voltage is always present at terminal B.**

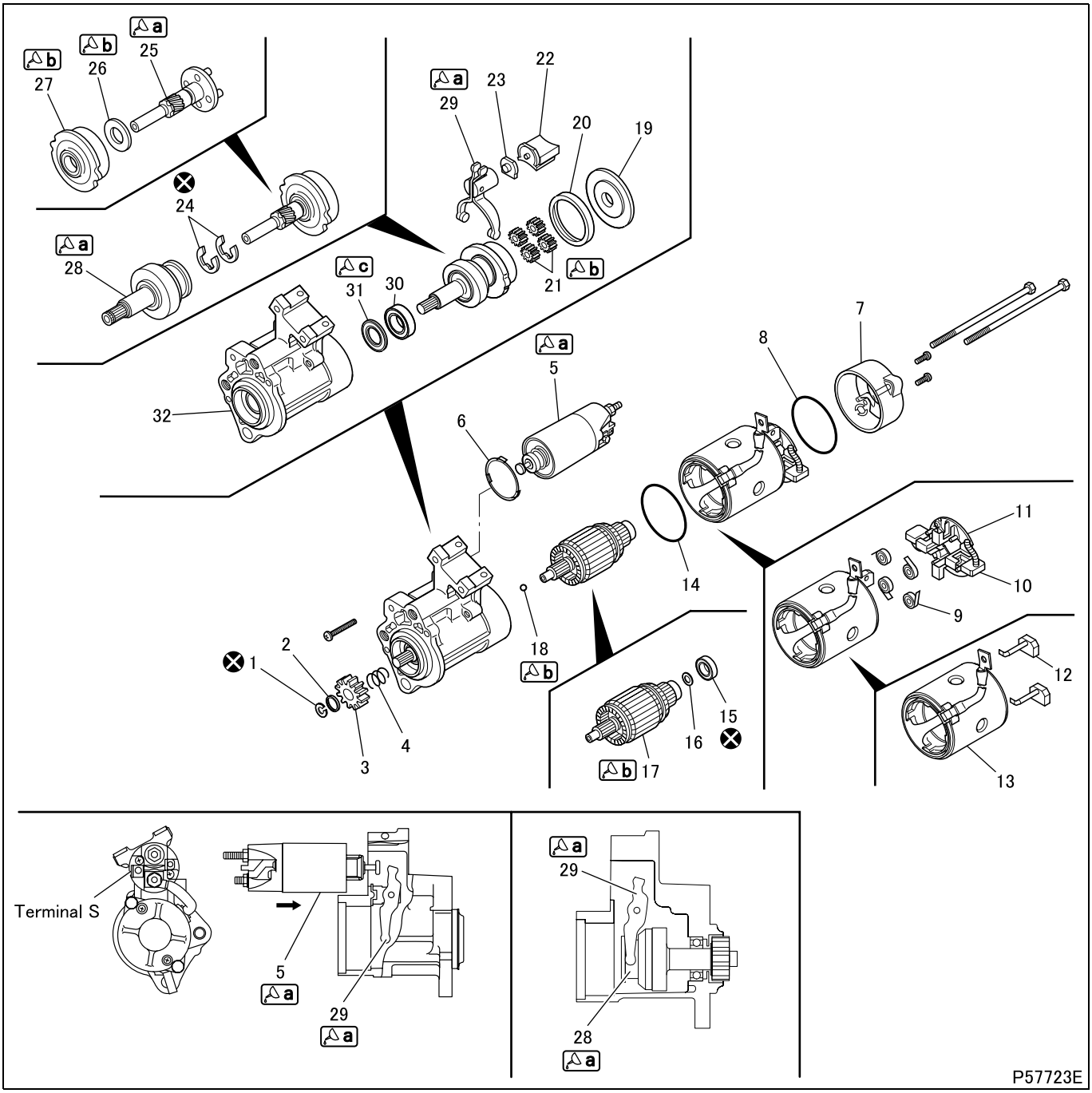
1. Disconnect the batteries at the negative terminal.
2. Tilt the cab.
3. Remove the power and ground cables from the starter. Remove the ground cable clamp from the starter.
4. Remove the starter cable (item 2) from the magnetic switch.
5. Disconnect the chassis harness connector (item 1) from the glow relay. Disconnect the starter harness connector from the vehicle harness at the left front top of the trans.
6. Remove the glow relay from the top of the starter.
7. Remove the starter from the engine.

● Installation sequence

1. Install the starter onto the engine. (Use Blue LocTite or Permatex on the starter mounting bolts). Tighten to 20 lb.ft.
2. Install the power and ground cables. Install the power cable clamp.
3. Install the glow relay onto the starter with the 2 bolts.
4. Attach the chassis harness connector (item 1) to the front of the glow relay (item 4) and to the vehicle harness at the left front top of the trans.
5. Attach the starter cable (item 2) to the front of the glow relay.
6. Reconnect the batteries.
7. Tilt the cab and check starter for proper operation.

M E M O

#930 STARTER



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch
6 Shim
7 Rear bracket
8 Packing
9 Brush spring
10 Brush (–)
11 Brush holder
12 Brush (+)
13 Yoke
14 Packing
15 Rear bearing
16 Washer
17 Armature
18 Ball
19 Cover
20 Rubber packing
21 Planetary gear
22 Rubber packing
23 Plate
24 E-ring
25 Gear shaft
26 Washer
27 Internal gear
28 Overrunning clutch
29 Lever
30 Front bearing
31 Oil seal
32 Front bracket

⊗: Non-reusable parts

CAUTION ⚠

- **Do not remove the rear bearing unless defects are evident.**
- **When the armature is removed, the ball may come out with it. Take care not to lose the ball.**
- **It is not necessary to remove the pinion when only the motor section needs to be disassembled for inspection, like when inspecting brushes and related parts.**
- **Be sure to remove the pinion before disassembling any other parts.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Whenever the magnetic switch is replaced, the pinion gap must be adjusted.**

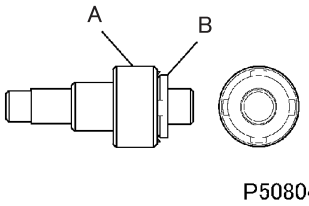
Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
–	Pinion gap			0.5 to 2.0 {0.02 to 0.079}	–	Adjust
–	No-load characteristics	With 11 V applied	Current	180 A or less	–	Inspect
			Rotation speed	3800 rpm or higher	–	
9	Brush spring pressure			29.2 to 39.4 N {6.6 to 8.9 lbs, 3 to 4 kgf}	13.7 N {3.1 lbs, 1.4 kgf}	Replace
10, 12	Brush length			18 {0.71}	11 {0.43}	Replace
17	Commutator outside diameter			32 {1.26}	31.4 {1.24}	Replace
	Runout of commutator periphery			–	0.1 {0.0039} or higher	
	Mold depth between segments			–	0.2 {0.0079} or less	Correct or replace

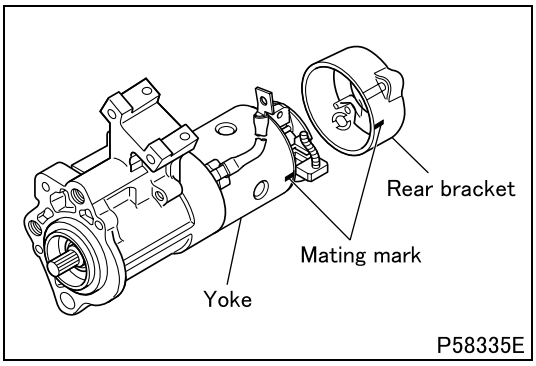
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lever contact surface of magnetic switch	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
	Sliding surfaces of gear shaft and overrunning clutch		
	Splines of overrunning clutch		
	Sliding surfaces of lever and overrunning clutch		
b	Sliding surfaces of armature and gear shaft	Molykote AG650	As required
	Ball		
	Teeth of planetary gear and internal gear		
	Washer		
c	Oil seal	Multipurpose grease [NLGI No.2 (Li soap)] or grease attached to oil seal	As required

Special tools

Mark	Tool name and shape	Part No.	Application
ⓒa	Bearing remover and installer **A**: Bearing remover and installer **B**: Bearing installer  P50804	MH063596 **A**: MH063614 **B**: MH063618	Removal and installation of front bearing

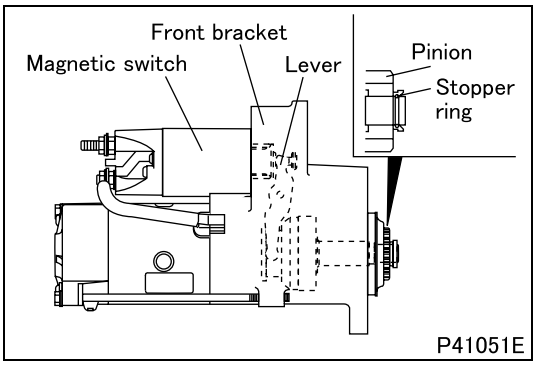
◆Work before disassembly◆



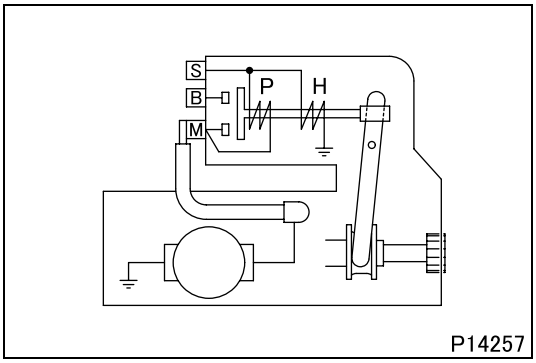
P58335E

■ **Mating mark: Rear bracket and yoke**

◆Disassembly procedure◆



P41051E



P14257

■ **Disassembly: Pinion**

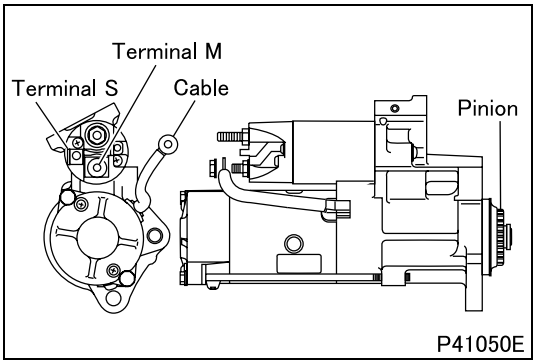
- For removal of the pinion, current must be supplied to the starter such that the pinion springs out.

WARNING ⚠

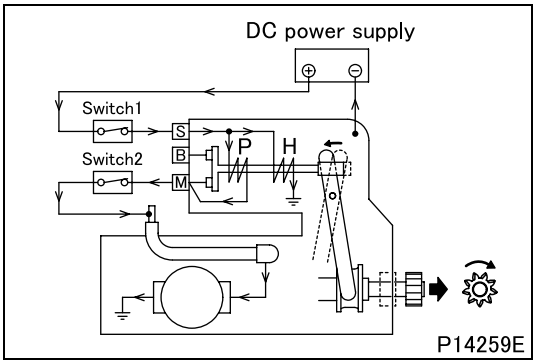
- **When the starter is energized, the pinion will spring out and rotate. Be careful not to touch it with your hands.**
- **The magnetic switch may become very hot during inspections. Be careful when touching it.**

CAUTION ⚠

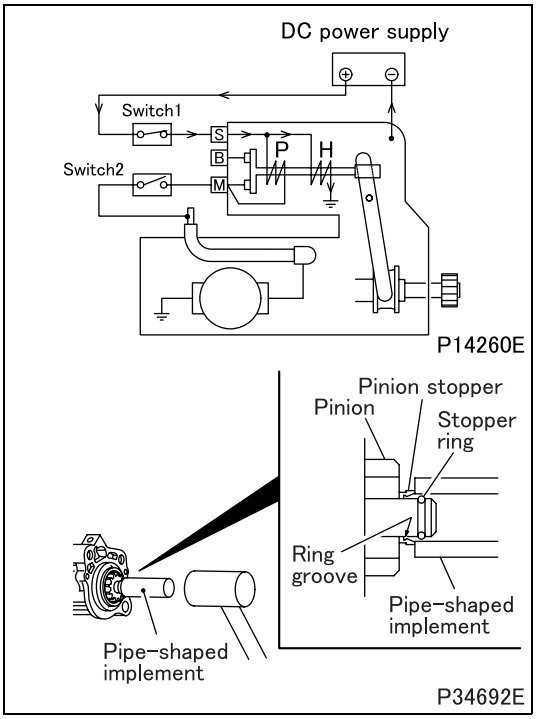
- **Do not energize the pull-in coil P for longer than 10 seconds, and do not energize the holding coil H for longer than 30 seconds. If these periods are exceeded, the coils may overheat and burn out.**
- **To make the pinion spring out, be sure to energize the starter such that its parts are positioned correctly. If the starter is not energized and the lever is pulled to make the pinion come out, the front bracket and/or lever may be damaged by the shock inflicted upon them when the stopper ring is removed.**
- **When current is supplied to the starter, a large current (100 A or higher) will flow. For inspection purposes, use booster cables or similarly thick cables. It is also important to ensure that all connections are secure.**



- Connect the starter as illustrated.



- The following operations are performed with current supplied to the starter. Thus, the entire procedure for removal of the pinion must be completed within 30 seconds.
  - Turn ON switches 1 and 2 to supply current to the starter. The pinion will spring out and rotate.



- After the pinion starts to rotate, quickly (within five seconds) turn OFF switch 2 to stop the pinion's rotation.

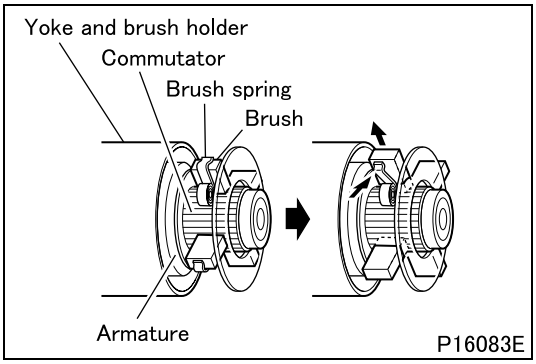
CAUTION ⚠

- **When switches 1 and 2 are turned ON, the pull-in coil P and holding coil H are both energized. The circuit is connected such that no voltage is applied to starter terminal B, so current flows to the pull-in coil while the pinion rotates. To prevent the pull-in coil from burning out, it is essential to turn OFF switch 2 quickly (within five seconds) after the pinion starts to rotate.**

- Apply a pipe-shaped implement to the pinion stopper.
- Using a hammer, lightly tap the pipe-shaped implement to remove the stopper ring from the ring groove of the pinion stopper.
- Remove the stopper ring and pinion.
- Turn OFF switch 1 to de-energize the starter.

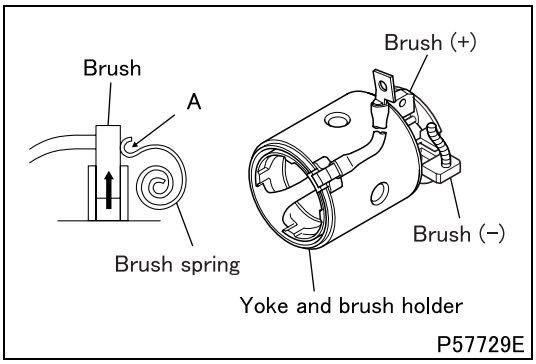
CAUTION ⚠

- **When the starter is de-energized, the mechanism will attempt to pull in the pinion. Thus, the stopper ring may slip back into the ring groove of the pinion stopper. If this happens, energize the starter and go through the pinion removal procedure again.**



■ **Disassembly: Yoke and brush holder**

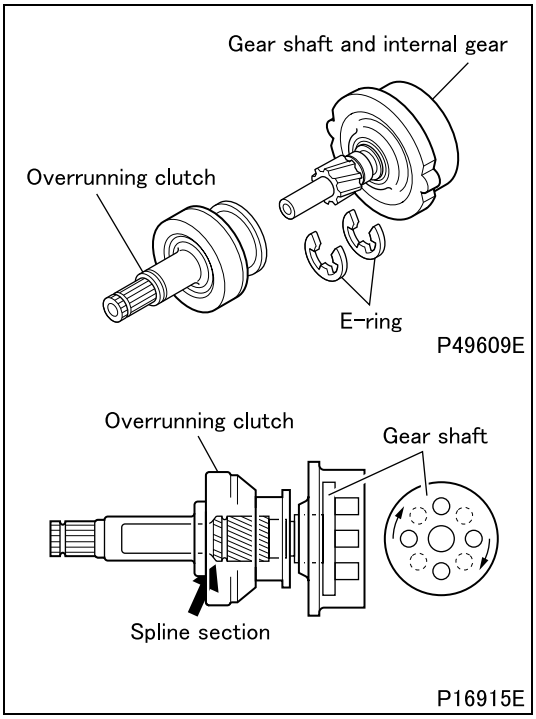
- Use the following method to remove the yoke and brush holder in order to prevent the commutator of the armature from being damaged by the brushes.
  - Lift the brushes away from the commutator and hold them lifted by applying the brush springs against the sides of the brush springs.



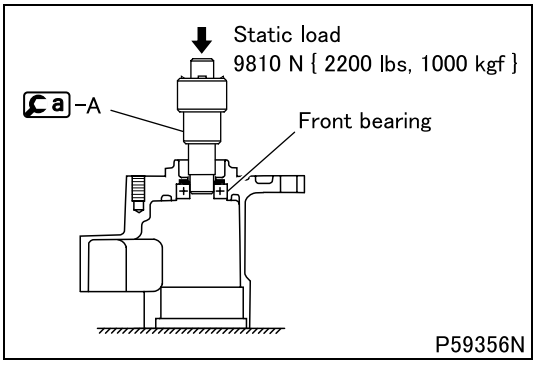
- Pull part A of each brush spring and pull up the brushes.
- Hold the brushes in position with the brush springs as illustrated.
- Remove the yoke and brush holder.

■ **Disassembly: Gear shaft and internal gear**

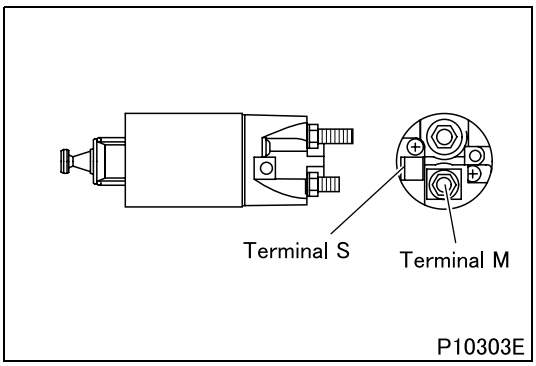
- Remove the E-rings and then the gear shaft and internal gear from the overrunning clutch.
  Proceed as follows if the gear shaft cannot be removed due to interference of the splined section of gear shaft with internal parts of the overrunning clutch.
  - Press the gear shaft against the overrunning clutch.
  - Turn the gear shaft approx. 1/8 of a turn to change the position of splined section.



■ **Disassembly: Front bearing**



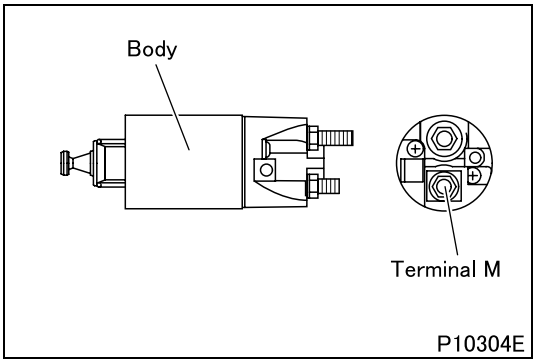
◆Inspection procedure◆



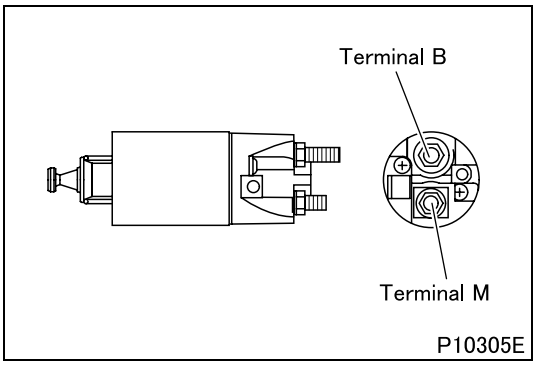
■**Inspection: Magnetic switch**

(1) Test for coil open circuit

- Check that continuity exists between terminals S and M.

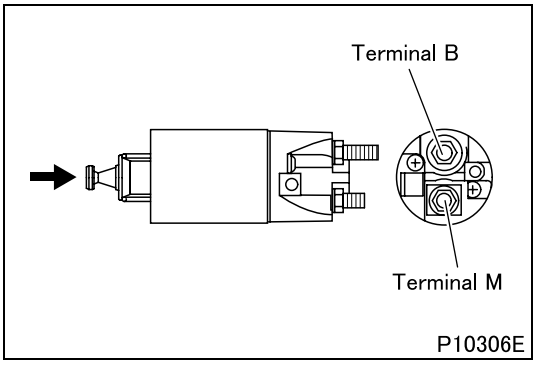


- Check that continuity exists between terminal M and the body.



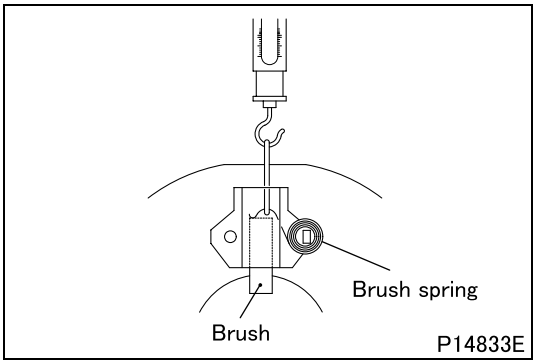
(2) Test for fused-together contacts

- Check that continuity does not exist between terminals B and M.



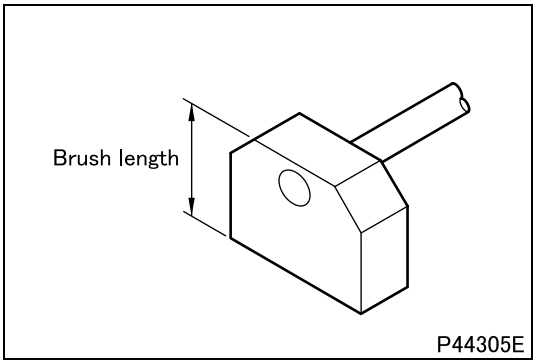
(3) Test for contact-to-contact continuity

- Push in the end of the magnetic switch to close the internal contacts. Then, check that continuity exists between terminals B and M.



■ **Inspection: Brush spring**

- Using new brushes, measure the load required to separate each brush spring from its brush.
- If either measurement is lower than the specified limit, replace the brush springs.



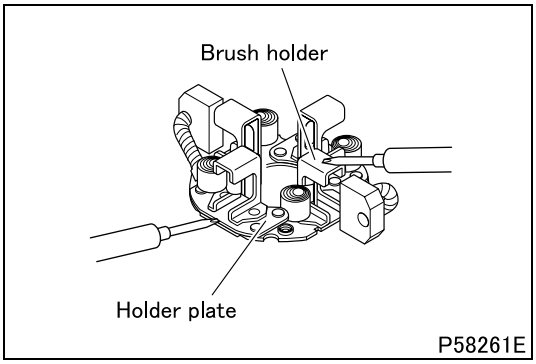
■ **Inspection: Brush (–)**

(1) Brush length

- If either brush (–) is shorter than the limit, it must be replaced.

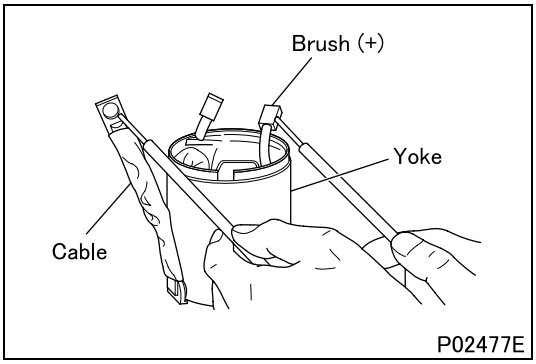
(2) Commutator contact surface of brush

- If the commutator contact surface of either brush is rough or unevenly worn, rectify it with emery paper (#300 to 500).



■ **Inspection: Brush holder**

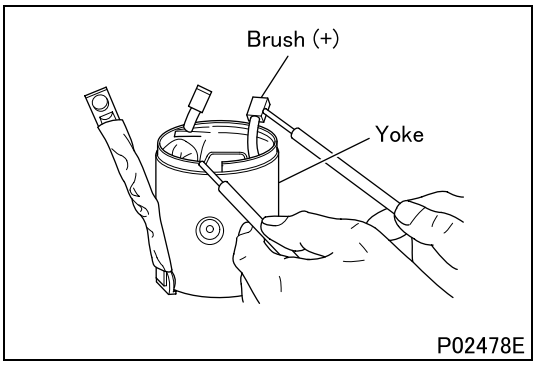
- Thoroughly clean the (+) brush holder and the (–) holder plate, then, check that continuity does not exist between them.
- If continuity exists, there is a short circuit and the brush holder must be replaced.



■ **Inspection: Yoke**

(1) Test for coil open circuit

- Check that continuity exists between the cable and the (+) brush.
- If there is no continuity, there is an open circuit and the yoke or (+) brush must be replaced.

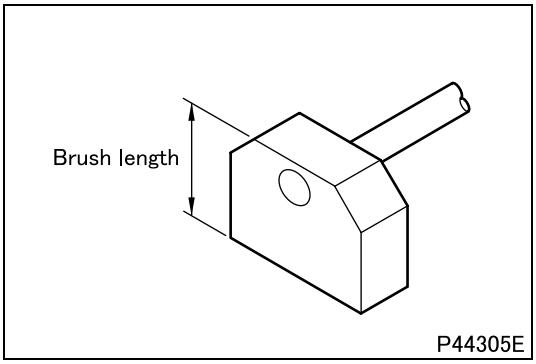


(2) Test for coil grounding

- Check that continuity does not exist between the yoke and the (+) brush.
- If continuity exists, the coil is grounded. Inspect the insulation, and replace the yoke and the (+) brush if the insulation cannot be rectified.

CAUTION ⚠

- **The coil may be grounded to the yoke due to the accumulation of worn-off metal particles from the brushes and/or armature.**



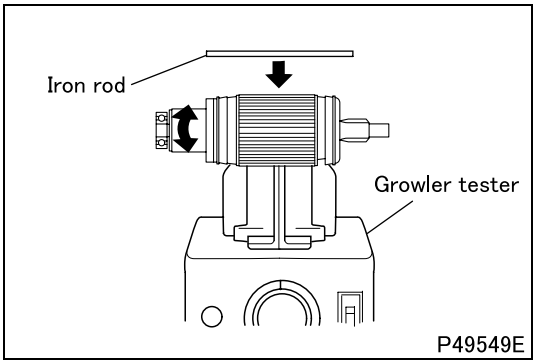
■ **Inspection: Brush (+)**

(1) Brush length

- If either brush (+) is shorter than the limit, it must be replaced.

(2) Commutator contact surface of brush

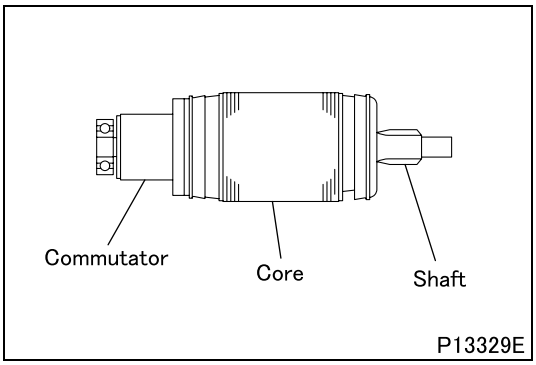
- If the commutator contact surface of either brush is rough or unevenly worn, rectify it with emery paper (#300 to 500).



■ **Inspection: Armature**

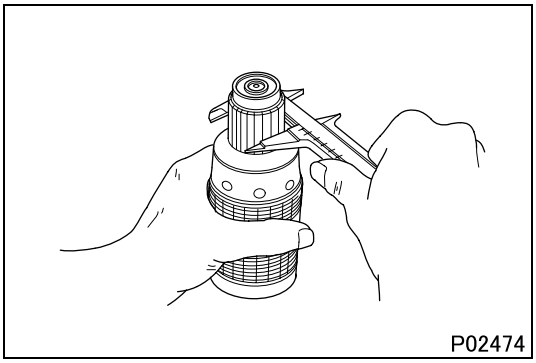
(1) Test for coil short circuit

- Hold an iron rod parallel with the armature.
- Slowly rotate the armature by hand.
- If the iron rod vibrates or is pulled toward the armature, the coil is short-circuited and the armature must be replaced.



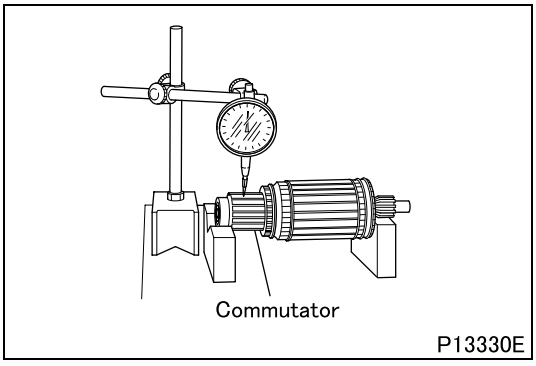
(2) Test for coil grounding

- Check that continuity does not exist between the commutator and the core (or shaft).
- If continuity exists, the coil is grounded and the armature must be replaced.



(3) Commutator outside diameter

- If the measurement is out of specification, replace the armature.

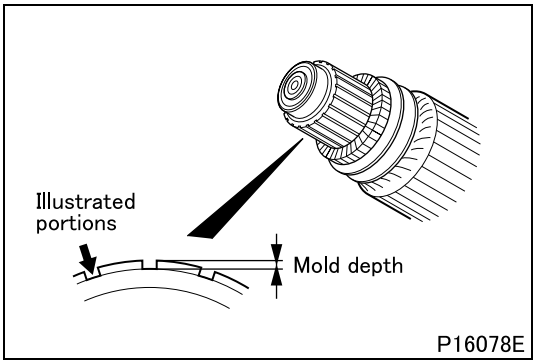


(4) Runout of commutator periphery

- If the reading exceeds the specified limit, rectify the commutator of the armature, making sure the outside diameter stays within specification.

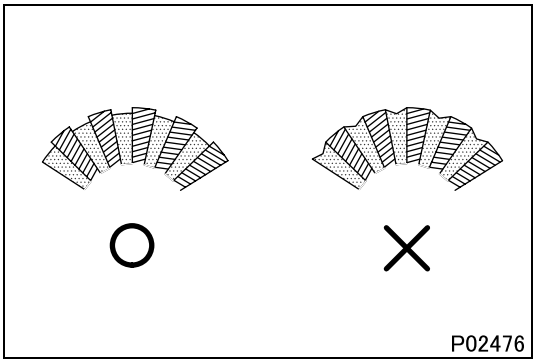
(5) Condition of commutator surface

- If the surface is rough or has stepped wear, rectify it with emery paper (#300 to 500).
- After rectifying the surface, check the extent of commutator runout.



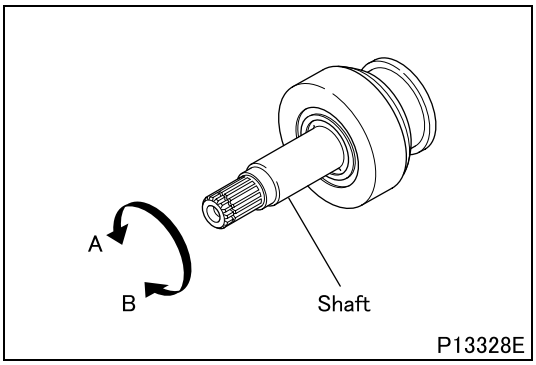
(6) Mold depth between segments

- If the measurement is lower than the specified limit, rectify or replace the armature.
- To rectify the armature, grind the illustrated portions.



- If the mold is worn as illustrated, rectify or replace the armature.

○: Acceptable
×: Unacceptable

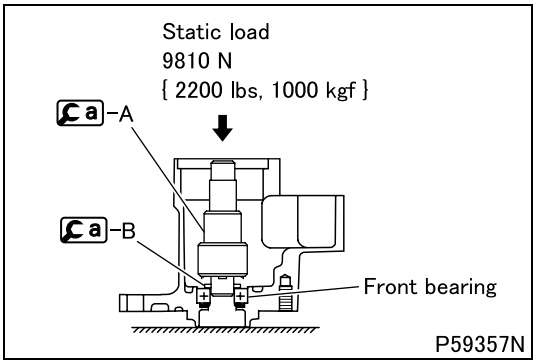


■ Inspection: Overrunning clutch

If the following inspections reveal any abnormality, replace the overrunning clutch.

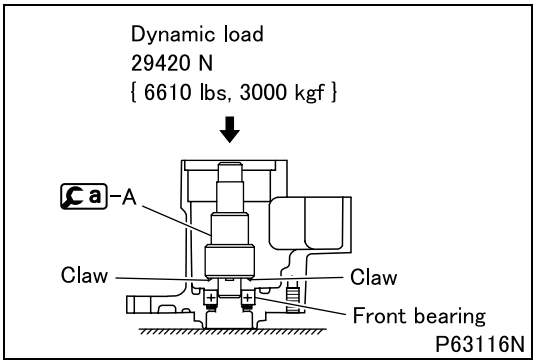
- Turn the shaft in direction B and check that it rotates smoothly.
- Turn the shaft in direction A and check that it locks.

◆Assembly procedure◆



■ Assembly: Front bearing

- Press-fit the front bearing using Ca-A and Ca-B.



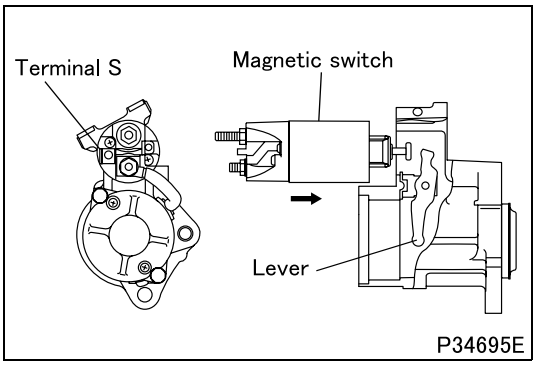
- After the press fitting, caulk the front bearing using the claw on a -A.

CAUTION ⚠

- **Avoid re-caulking previously caulked points.**

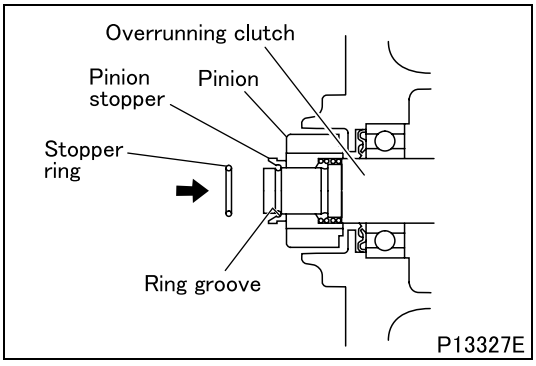
■ Assembly: Yoke and brush holder

- To install the yoke and brush holder, follow the removal sequence in reverse.
  (See "**■ Disassembly: Yoke and brush holder**".)



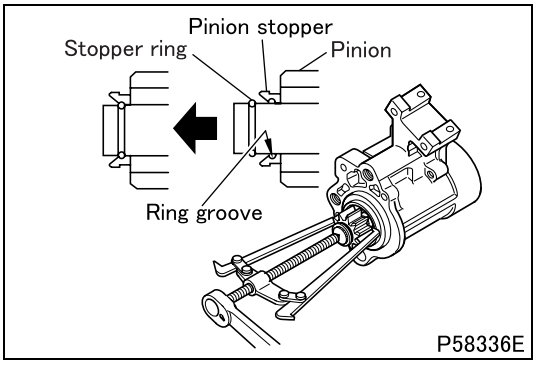
■ Assembly: Magnetic switch

- Fit the magnetic switch onto the lever with terminal S aligned as illustrated.



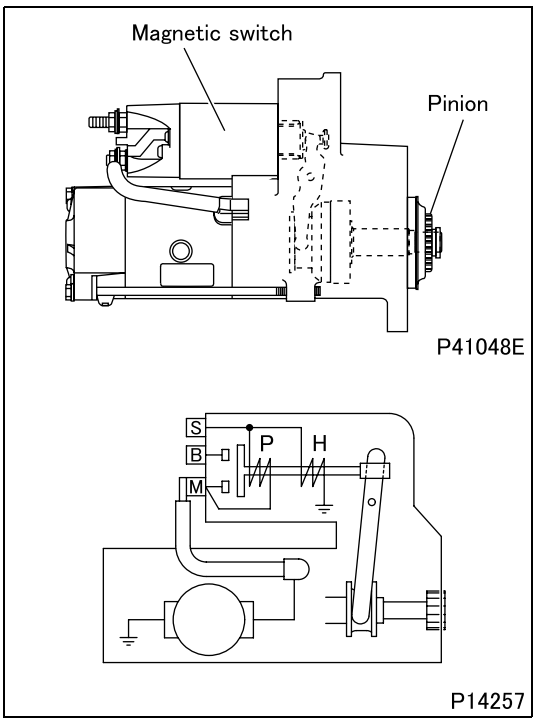
■ Assembly: Pinion

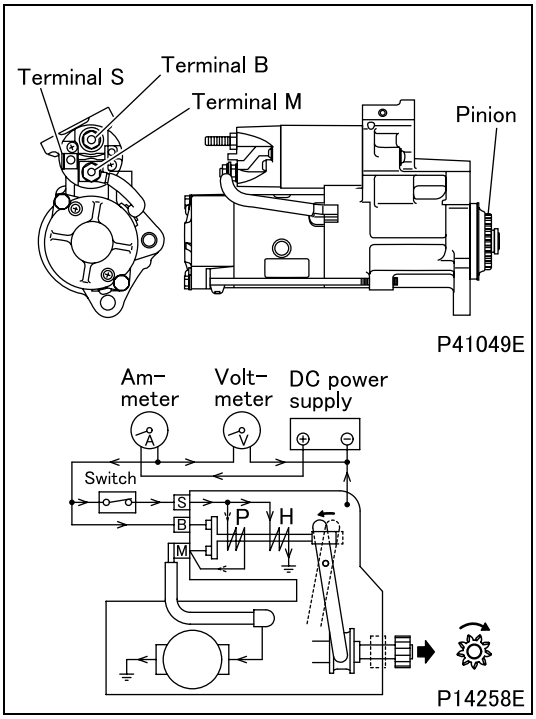
- For installation of the pinion, it is not necessary to supply current to the starter.
  - Fit the pinion stopper and pinion onto the overrunning clutch, making sure they are oriented as illustrated.
  - Fit the stopper ring into the ring groove of the overrunning clutch.



- Pull the pinion hard and securely fit the stopper ring into the ring groove of the pinion stopper.

◆Inspection after assembly◆





■ Inspection: Performance and pinion gap

- After assembling the starter, perform inspections with current supplied to it.

WARNING ⚠

- **When the starter is energized, the pinion will spring out and rotate. Be careful not to touch it with your hands.**
- **The magnetic switch may become very hot during inspections. Be careful when touching it.**

CAUTION ⚠

- **Do not energize the pull-in coil P for longer than 10 seconds, and do not energize the holding coil H for longer than 30 seconds. If these periods are exceeded, the coils may overheat and burn out.**
- **When current is supplied to the starter, a large current (100 A or higher) will flow. For inspection purposes, booster cables or similarly thick cables must therefore be used. It is also important to ensure that all connections are secure.**

(1) Performance test

- Connect the starter as illustrated.
- Set the voltage to 11 volts DC.

CAUTION ⚠

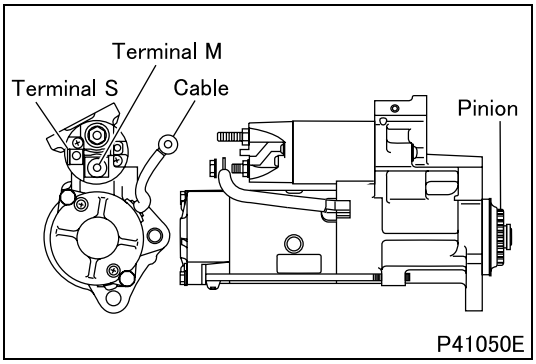
- **The voltage applied must not exceed 12 V.**

- The following operations are performed with current supplied to the starter. Thus, the entire test (consisting of measurement of the current flowing through the starter and measurement of the starter's rotational speed) must be completed within 30 seconds.
  - Turn ON the switch to supply current to the starter. The pinion will spring out and rotate.

CAUTION ⚠

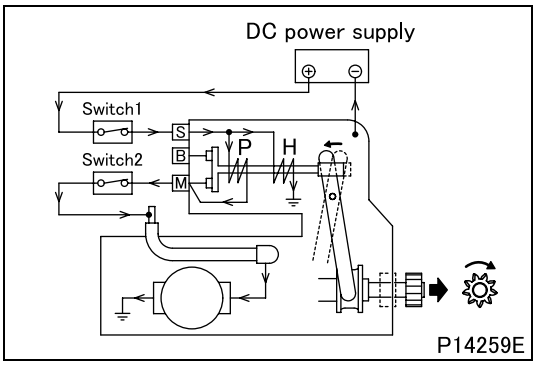
- **When the switch is turned ON, the pull-in coil P and holding coil H are both energized. When the large current from the DC power supply flows from terminal B to terminal M, the supply of current to the pull-in coil P is cut; only the holding coil H remains energized. To prevent the holding coil from burning out, it is essential to complete all operations within 30 seconds.**

  - Measure the current and the starter's rotational speed. To measure the rotational speed, shine a stroboscope on the pinion.
  - Turn OFF the switch to de-energize the starter.
- If either measurement is out of specification, disassemble and inspect the starter again.

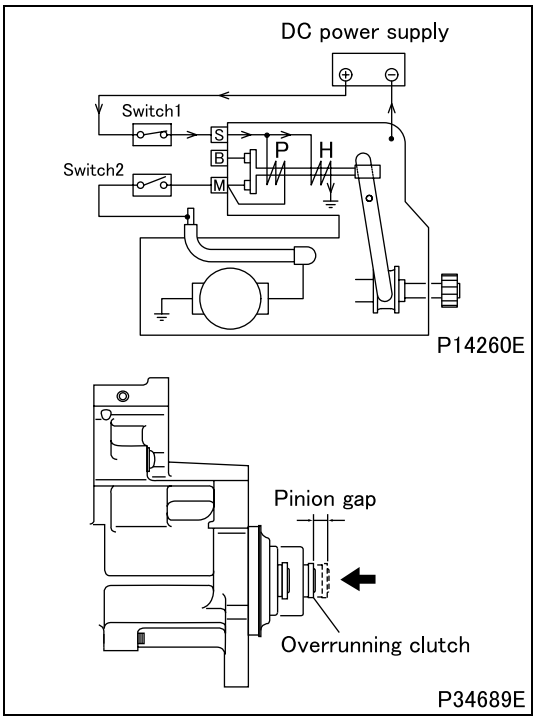


(2) Pinion gap

- Connect the starter as illustrated.



- The following operations are performed with current supplied to the starter. Thus, the entire procedure for measurement of the pinion gap must be completed within 30 seconds.
  - Turn ON switches 1 and 2 to supply current to the starter. The pinion will spring out and rotate.

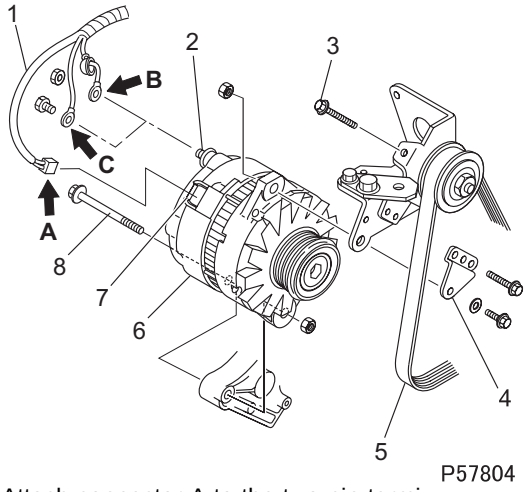


  - After the pinion starts to rotate, quickly (within five seconds) turn OFF switch 2 to stop the pinion's rotation.

CAUTION ⚠

- **When switches 1 and 2 are turned ON, the pull-in coil P and holding coil H are both energized. The circuit is connected such that no voltage is applied to starter terminal B, so current flows to the pull-in coil while the pinion rotates. To prevent the pull-in coil from burning out, it is essential to turn OFF switch 2 quickly (within five seconds) after the pinion starts to rotate.**

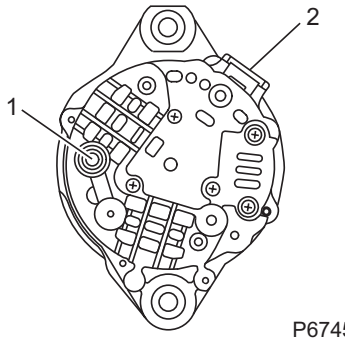
  - Pull out the end of the overrunning clutch and then lightly push in the end of the overrunning clutch and measure the amount of movement in the axial direction, i.e., the pinion gap.
  - Turn OFF switch 1 to de-energize the starter.
- If the measurement is out of specification, replace the lever.



P57804

Attach connector A to the two-pin terminal (L, R) and connectors B and C to terminal B, as shown.

1. Chassis harness
2. Terminal B
2. Alternator adjusting bolt
4. Alternator bracket
5. Drive belt
6. Alternator
7. Two-pin terminal (L, R)
8. Alternator mounting bolt



P67458Ea

1. Terminal B
2. Two-pin terminal (L, R)

● Alternator removal

1 Set the parking brake, chock the front tires, and disconnect the batteries.
2 Remove the chassis harness from the alternator. Disconnect connectors A, B, and C from the alternator terminals. Mark both connectors and terminals for ease of installation.
3 Remove the alternator adjusting bolt from the alternator, loosening the drive belt.
4 Remove the drive belt from the alternator pulley.

WARNING ⚠

- **To prevent possible injury, disconnect the negative terminal (–) of the battery and insulate it with tape before removing the alternator.**

5 Remove the alternator mounting bolt and remove the alternator from the vehicle.

● Alternator installation

1 Support the alternator and attach the alternator mounting bolt, as removed.
2 Attach the alternator bracket, as removed.
3 Loop the drive belt over the alternator pulley and install the alternator adjusting bolt.
4 Tighten the bolt until the drive belt deflection is correct.
5 To check drive belt deflection, apply a force of 22 lb (98 N) to a point midway between the pulleys. The belt should not deflect more than the breadth of a finger.
6 Connect the chassis harness to the alternator, as removed. Attach connector A to the two-pin terminal (L, R) and connectors B and C to terminal B, as shown.
7 Spray any exposed terminal connectors with dielectric red enamel.
8 Connect the batteries.
9 Start the engine and test the alternator output as shown in the table below.
10 Remove the chocks from the tires.

CAUTION ⚠

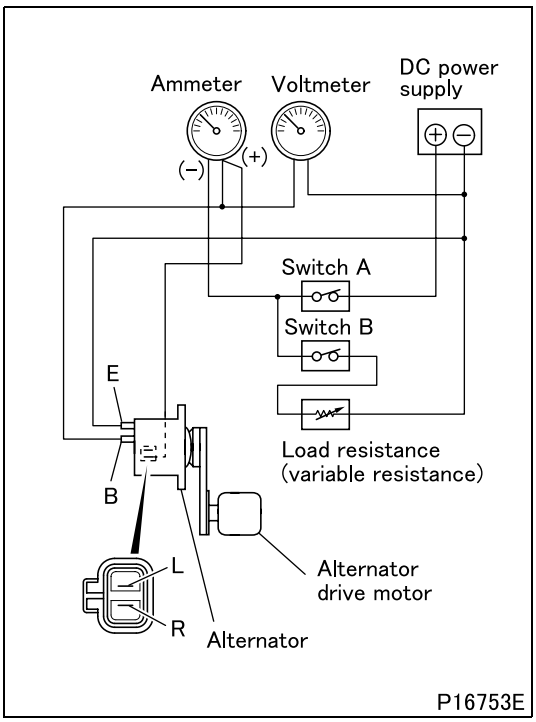
With the negative terminal (–) of the battery connected, always apply battery voltage to terminal B. Applying voltage at any other terminal could short out the alternator.

Service standards

Maintenance test	Test speed	Acceptable output	Remedy
Alternator current output (When the alternator is hot* and producing 13.5 V)	1500 rpm	51.5 amps or more	If amperage is not acceptable, inspect the alternator
	2500 rpm	82.5 amps or more	
	5000 rpm	104 amps or more	
Regulator adjusted voltage (5 amp loading)	5000 rpm	14.4 to 15.0 V	If voltage is not acceptable, replace the alternator

* The alternator is considered “hot” when it has been running for 30 minutes at a speed of 5000 rpm under normal temperature conditions.

◆Inspection procedure◆



● Alternator inspection

Alternator current output (bench test)

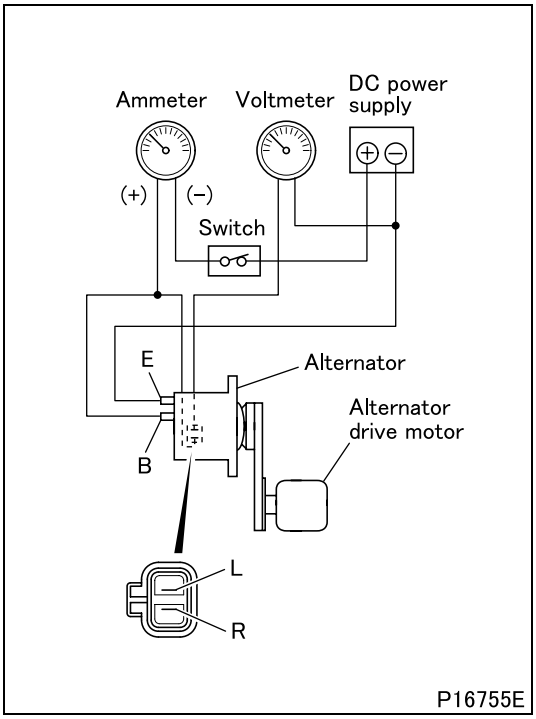
1 Connect the alternator, using the test setup as shown in the illustration.

CAUTION ⚠

To prevent alternator damage, use wires of sufficient thickness and check each connection for tightness.

- Connect the positive lead of the DC power supply to Switch A and the negative lead to the variable resistor, the voltmeter and the alternator E terminal.
- Connect the positive lead of the voltmeter to the alternator B terminal and the negative lead to the DC power supply.
- Connect the positive lead of the ammeter to the alternator (terminal B and terminal R of the two-pin connector) and the negative lead to the two switches (A and B).
- Connect the variable resistor to the DC power supply and to switch B.
- Connect alternator terminal B to the voltmeter and ammeter, terminal E to the DC power supply, and terminal R to the ammeter.

2 Increase the resistance to the maximum (condition under which the load current hardly flows).
3 Turn switch A and switch B ON.
4 Run the alternator at 5000 rpm for 30 minutes. Adjust the resistance load to meet the specified standard of 104 amperes (amps).
5 Measure the output in amps at each alternator test speed: 1500 rpm, 2500 rpm, 5000 rpm.
6 If the measured value deviates from the value in the service standards table, replace the alternator.



Regulator adjusted voltage (bench test)

1 Connect the alternator, using the test setup as shown in the illustration.

- Connect the positive lead of the DC power supply to the switch and the negative lead to alternator terminal E and the voltmeter.
- Connect the positive lead of the voltmeter to alternator terminal L and the negative lead to the DC power supply.
- Connect the positive lead of the ammeter to the alternator (terminal B and terminal R of the two-pin connector) and the negative lead to the switch.
- Connect alternator terminals B and R to the ammeter, terminal L to the voltmeter and terminal E to the DC power supply.

2 Turn the switch ON.

3 Run the alternator at low speed.

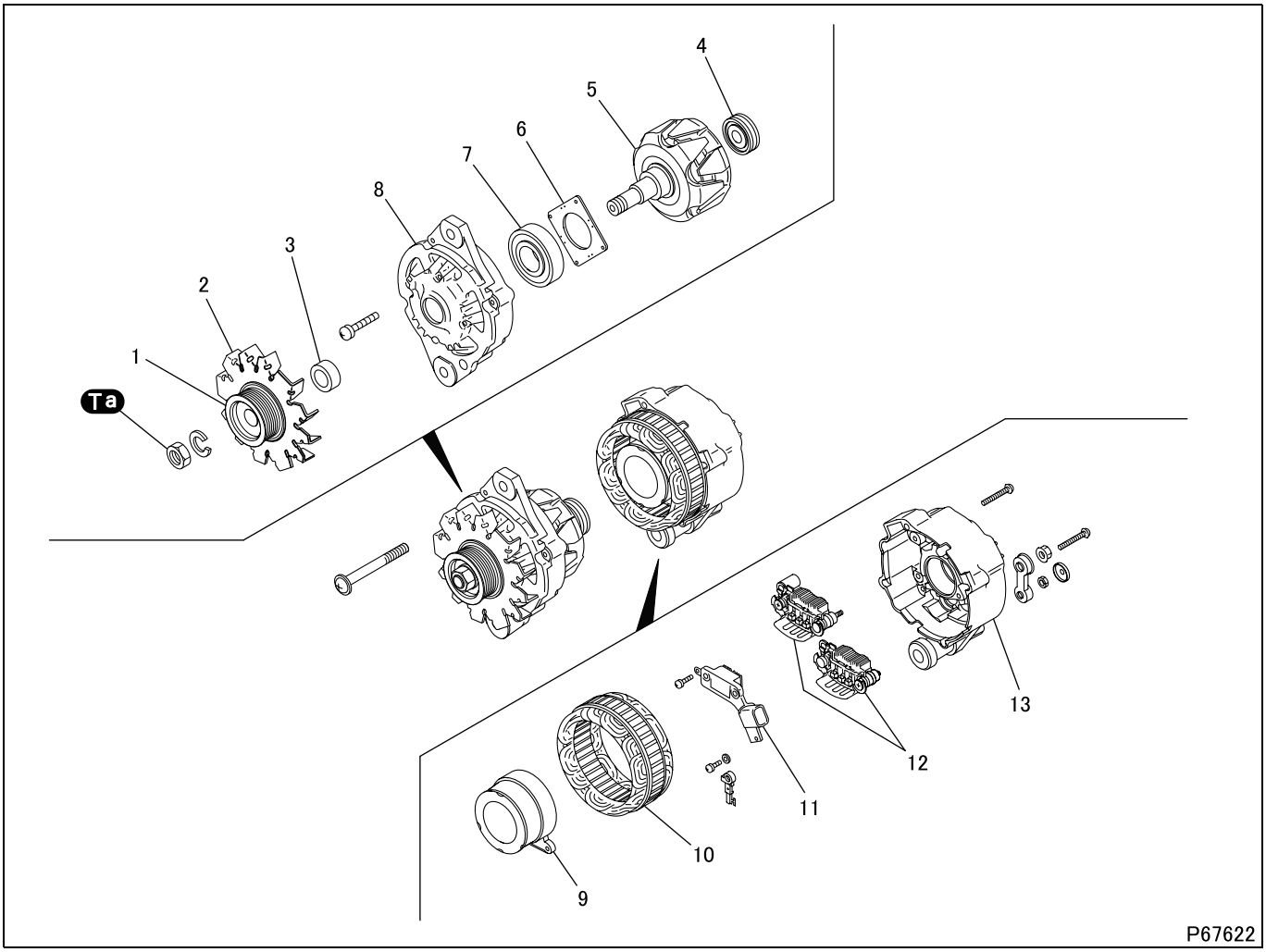
4 Increase the speed of the alternator to 5000 rpm. Make sure that the current is 10 amps or less at 5000 rpm.

5 Measure the adjusted voltage at this speed.

6 If the measured value is higher or lower than the standard value, replace the alternator.

M E M O

#940 ALTERNATOR



● **Disassembly sequence**

1 Pulley
2 Fan
3 Spacer
4 Rear bearing
5 Rotor
6 Cover
7 Front bearing
8 Front bracket
9 Field coil
10 Stator
11 Regulator
12 Rectifier
13 Rear bracket

NOTE

- **Do not remove the rear and front bearing, stator unless faulty.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

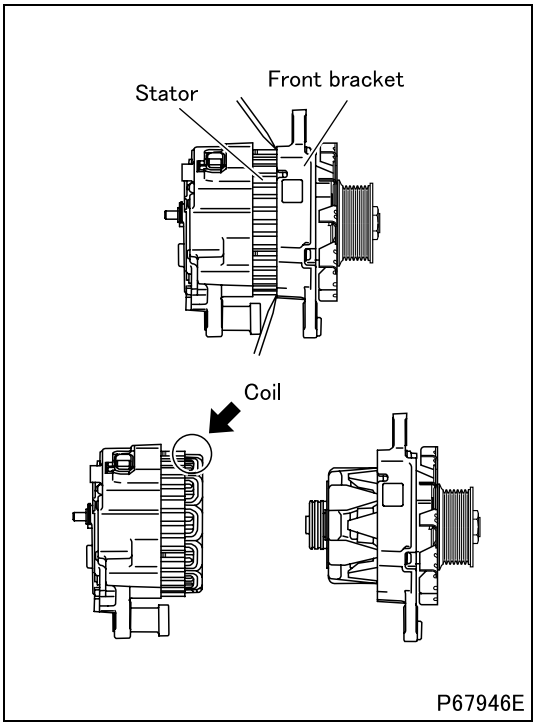
Tightening torque (Unit: N·m {ft. lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Pulley mounting)	132 to 162 {97 to 120, 13 to 17}	–

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
9	Field coil resistance (at 20°C {68°F})	1.9 to 2.3 Ω	–	Replace

◆Disassembly procedure◆

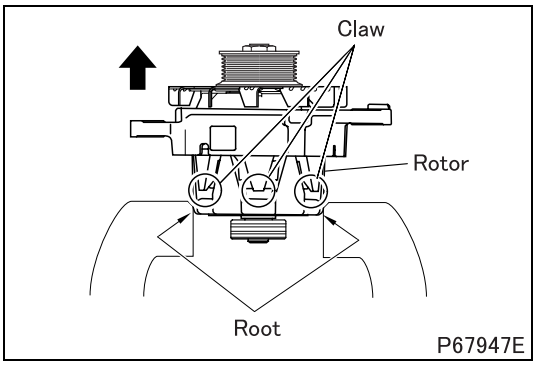


■ **Disassembly: Rotor and front bracket**

- Insert a screwdriver between front bracket and stator.
- Use the screwdriver to pry rotor and front bracket away from stator and rear bracket.

CAUTION ⚠

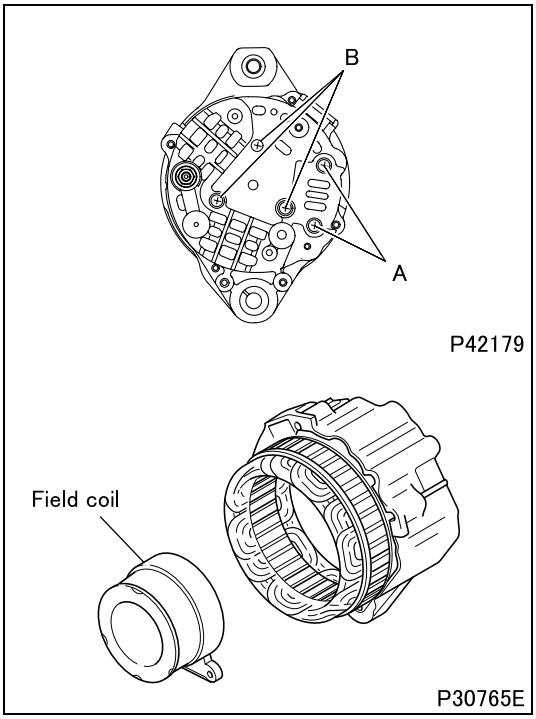
- **Be careful not to insert the screwdriver too deep or it will damage coil of stator and might cause a short-circuit.**



■ **Disassembly: Pulley**

CAUTION ⚠

- **Make sure to grip the root of the core claws when you hold the rotor in a vice. Gripping claws can damage them.**



■ **Disassembly: Field coil**

- Remove screw **A** (2 places).

CAUTION ⚠

- **If screw B are removed first, the weight of field coil may be placed on the joining portion with regulator which is fixed with screw A, causing break of the joining portion. To avoid this, remove screw A first.**

- Remove screw **B** (3 places).

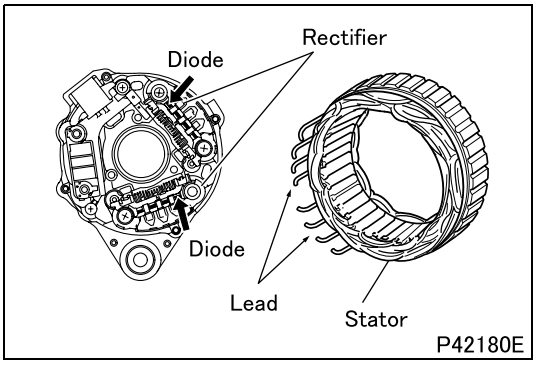
CAUTION ⚠

- **If screw B are removed, the field coil will fall under its own weight. Keep the field coil supported by your hand.**

- Remove field coil.

CAUTION ⚠

- **Do not remove the field coil forcibly. Otherwise the portion that joins with the regulator may be caught by the stator coil.**



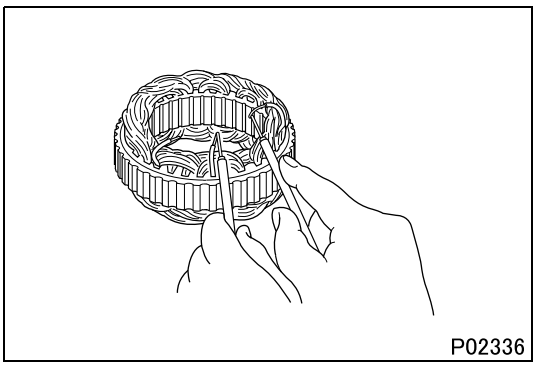
■ **Disassembly: Stator**

- Disconnect lead of stator from rectifier. The lead is soldered to diode of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION ⚠

- **Unsolder within as short a time period as possible (within 5 seconds), otherwise diode can be easily damaged by heat.**

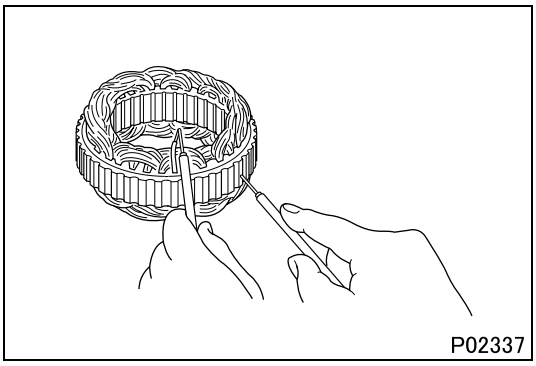
◆Inspection procedure◆



■ **Inspection: Stator**

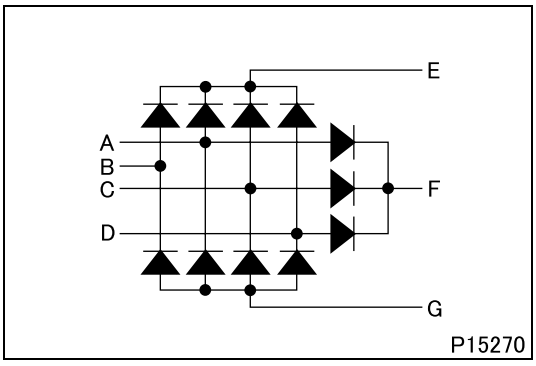
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead has broken.



(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wire has short-circuited.

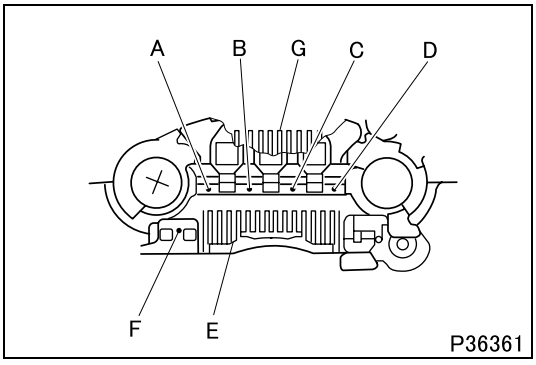


■ **Inspection: Rectifier**

- Check the function of diodes within rectifier properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0 Ω in both cases, the diode has shorted.

  A, B, C, D: Lead connecting area of stator coil
  E, G: Heat sink area
  F: Regulator connecting area



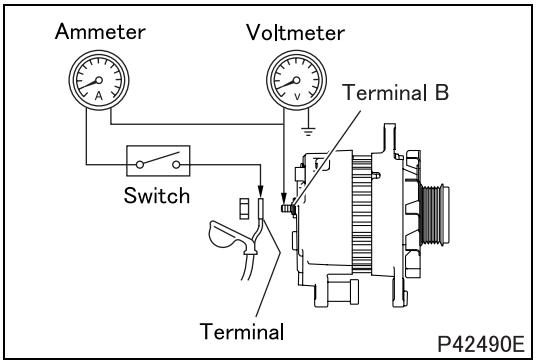
- Inspection should be conducted twice, changing over the positive probe and the negative probe of the tester.

CAUTION ⚠

- **When inspecting using a tester, the current flowing through the rectifier is smaller than usual. Therefore, an incorrect resistance value may be indicated on the tester.**
  Additionally, incorrect indications become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

GROUP 54-13 ON-VEHICLE INSPECTION AND ADJUSTMENT

#950 INSPECTION OF ALTERNATOR



Performance test

- Connect the meters to the alternator as shown.

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative battery cable and insulate the cable and the negative battery terminal with tape before working on the wiring. With the negative (–) battery cable connected, battery voltage is always applied to terminal B.**
- **To connect to switch, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch and make sure that voltmeter indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to the speed indicated below and measure the alternator's output current.
  Approx. 2400 rpm
- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

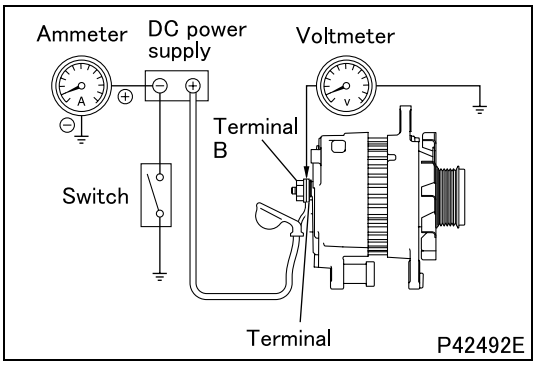
Voltage	Output current
12 V	100 A

NOTE

- **The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Adjusting voltage	14.7 ± 0.3 V	–	Replace



- Connect the meters to the alternator as shown.

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative battery cable and insulate the cable and the negative battery terminal with tape before working on the wiring. With the negative (–) battery cable connected, battery voltage is always applied to terminal B.**
- **To connect to switch, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch and then start the engine.
- If the output current is 5 amperes or less when the engine speed is raised to the appropriate speed indicated below, then measure the voltage at terminal B.
  Approx. 2400 rpm

CAUTION ⚠

- **If the output current is in the range from 5 to 10 amperes, the measured value (regulated voltage) will be slightly lower.**
  14.4 V ± 0.3 V

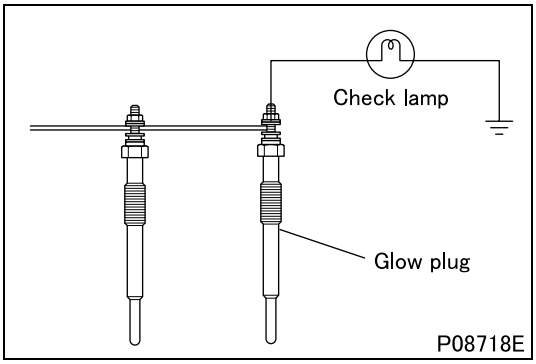
- If the output current is 5 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

#955 INSPECTION OF PREHEATING SYSTEM

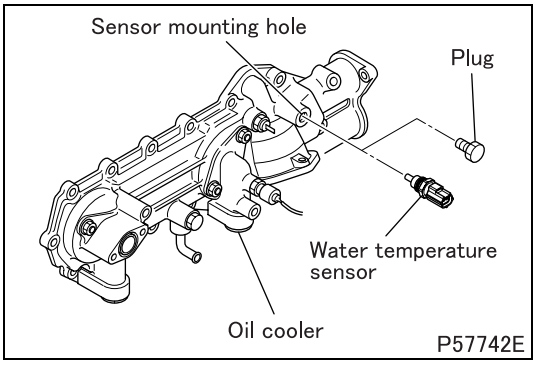
1. Preparation for inspection

Service standards

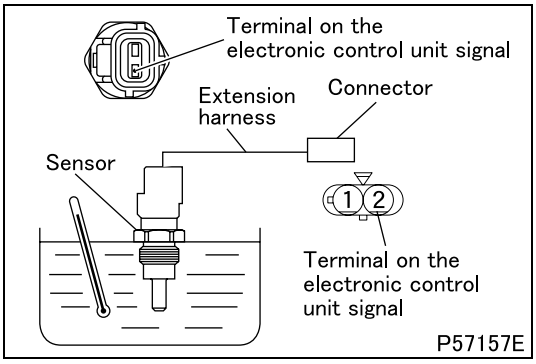
Location	Maintenance item			Standard value	Limit	Remedy
–	Coolant temperature	Pre-glow time	60°C {140°F} or higher	No pre-glow operation	–	Inspect
			0 to 60°C {32 to 140°F}	About 12 seconds	–	
			0°C {32°F} or below	About 12 seconds	–	
		After-glow time	60°C {140°F} or higher	No after-glow operation	–	
			0 to 60°C {32 to 140°F}	No after-glow operation	–	
			0°C {32°F} or below	About 20 seconds	–	
		Indicator lamp ON time	60°C {140°F} or higher	No illumination	–	
			0 to 60°C {32 to 140°F}	No illumination	–	
			0°C {32°F} or below	About 8 seconds	–	



- Turn the starter switch to OFF.
- Connect a check lamp to the glow plug.



- Remove the water temperature sensor from the engine, and close the sensor mounting hole with the plug (M16 × 1.5 mm).



- Connect the extension harness between the water temperature sensor and connector.
- Place the water temperature sensor in a container of water.
- Conduct the following test while changing the temperature of water in the container. If anything abnormal is found, check relevant components.

(1) Pre-glow time and indicator lamp ON time checking

- Turn the starter switch to ON (without starting the engine), and confirm that the pre-glow time and indicator lamp ON time at each water temperature conform with standard values.
- Measure the illuminating time of the check lamp to measure the pre-glow time.
- Measure the meter cluster glow lamp illuminating time to measure the indicator lamp ON time.

(2) After-glow time checking

- Start the engine, and measure how long the illumination of check lamp lasts after the glow lamp on the meter cluster goes out to ensure that the after-glow time conforms with the standard value.

2. Inspection Based on Diagnosis Codes

2.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P0380	Relay for Glow Relay	26
P0381	Glow Lamp	89

2.2 Diagnosis code generation conditions and inspection items

P0380 : Relay for Glow Relay (Warning lamp flashes : 26)

Generation conditions		Glow drive relay short or open circuit, or overload
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Suspend glow control
Inspection	Service data	8D : Glow Relay
	Actuator test	AF : Relay for Glow Relay
	Electronic control unit connector	01 : Glow drive relay
	Electrical equipment	#201 : Glow drive relay #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 220)

P0381 : Glow Lamp (Warning lamp flashes : 89)

Generation conditions		Glow indicator lamp short or open circuit, or overload
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8E : Glow Relay Indicator Lamp
	Actuator test	B0 : Glow Indicator Lamp
	Electronic control unit connector	02 : Glow indicator lamp
	Electrical equipment	Meter cluster #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 220)

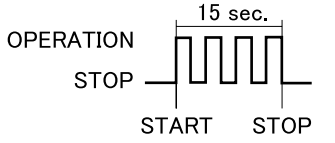
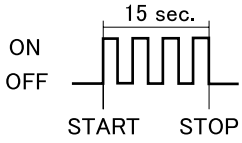
3. Multi-Use Tester Service Data

CAUTION ⚠

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
8D	Glow Relay	ON/OFF	With engine coolant temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect immediately after turning ON starter switch.	ON
			With engine coolant temperature at or above 60°C {140 °F} or water temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect 40 seconds after turning starter switch ON.	OFF
			[Actuator test] AF: Relay for glow relay	
8E	Glow Relay Indicator Lamp	ON/OFF	With engine coolant temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect immediately after turning ON starter switch.	ON
			With engine coolant temperature at or above 60°C {140 °F} or water temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect 40 seconds after turning starter switch ON.	OFF
			[Actuator test] B0: Glow indicator lamp	

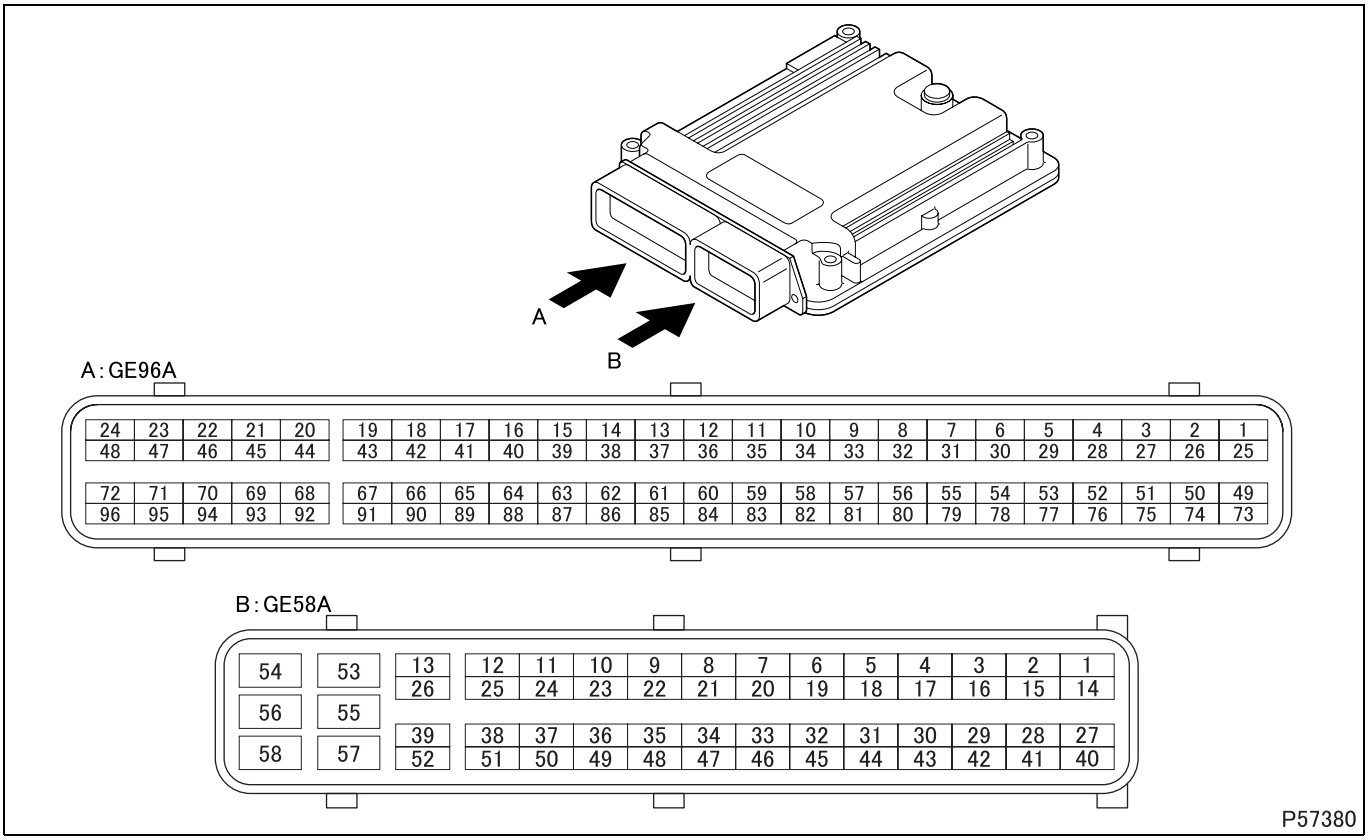
4. Actuator Tests Pertormed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
AF	Relay for Glow Relay	Glow drive relay drive signal  P57740E	Actuation noise should be heard. [Service data] 8D: Glow relay
B0	Glow Indicator Lamp	Glow indicator lamp illumination signal  P57725E	Actuation noise should be heard. [Service data] 8E: Glow indicator lamp

5. Inspection Performed at Electronic Control Unit Connectors

- The following inspection should assist troubleshooting by enabling you to verify whether or not electronic control unit signals are correctly transmitted via the vehicle harnesses and connectors.
  The numbers in the table ⓫, ⓬, etc. cross-refers you to the corresponding numbers in the table in "**2. Inspection Based on Diagnosis Codes**".

5.1 Electronic control unit connector terminal layout



5.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal other than those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
⓫ Glow drive relay voltage	[Conditions] • Keep the vehicle harnesses connected to the electronic control unit connector halves. (Inspection is made at the back of the vehicle connectors.) • Carry out the actuator test "AF - Relay for Glow Relay" using Multi-Use Tester. [Normal status] Terminals (+) - (–) : A73 - A7 • Battery voltage
⓬ Glow indicator lamp illumination	[Conditions] • Keep the vehicle harnesses connected to the electronic control unit connector halves. (Inspection is made at the back of the vehicle connectors.) • Carry out the actuator test "B0 - Glow Indicator Lamp" using Multi-Use Tester. [Normal status] Short the terminal A51 to ground. • The glow indicator lamp should illuminate.

1. Inspection Based on Diagnosis Codes

1.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P0615	Starter Safety Relay	48
P0616		
P0617		

1.2 Diagnosis code generation conditions and inspection items

P0615 : Starter Safety Relay (Warning lamp flashes : 48)

Generation conditions		Safety relay overload
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8F : Starter safety relay
	Actuator test	B1 : Starter safety relay
	Electronic control unit connector	01 : Safety relay
	Electrical equipment	#201 : Safety relay #350 : Engine electronic control unit
	Electronic circuit diagram	Safety relay system (See 210)

P0616 : Starter Safety Relay (Warning lamp flashes : 48)

Generation conditions		Safety relay ground short or open circuit
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8F : Starter safety relay
	Actuator test	B1 : Starter safety relay
	Electronic control unit connector	01 : Safety relay
	Electrical equipment	#201 : Safety relay #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 210)

P0617 : Starter Safety Relay (Warning lamp flashes : 48)

Generation conditions		Safety relay Battery short or open circuit
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8F : Starter safety relay
	Actuator test	B1 : Starter safety relay
	Electronic control unit connector	01 : Safety relay
	Electrical equipment	#201 : Safety relay #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 210)

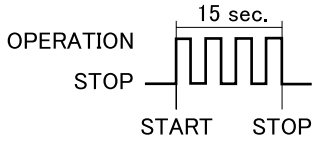
2. Multi-Use Tester Service Data

CAUTION ⚠

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
8F	Starter Safety Relay	ON/OFF	Carry out the actuator test “B1 - Starter safety relay” using Multi-Use Tester. The relay should be ON.	ON
			When not testing	OFF
			[Actuator test] B1: Starter safety relay	

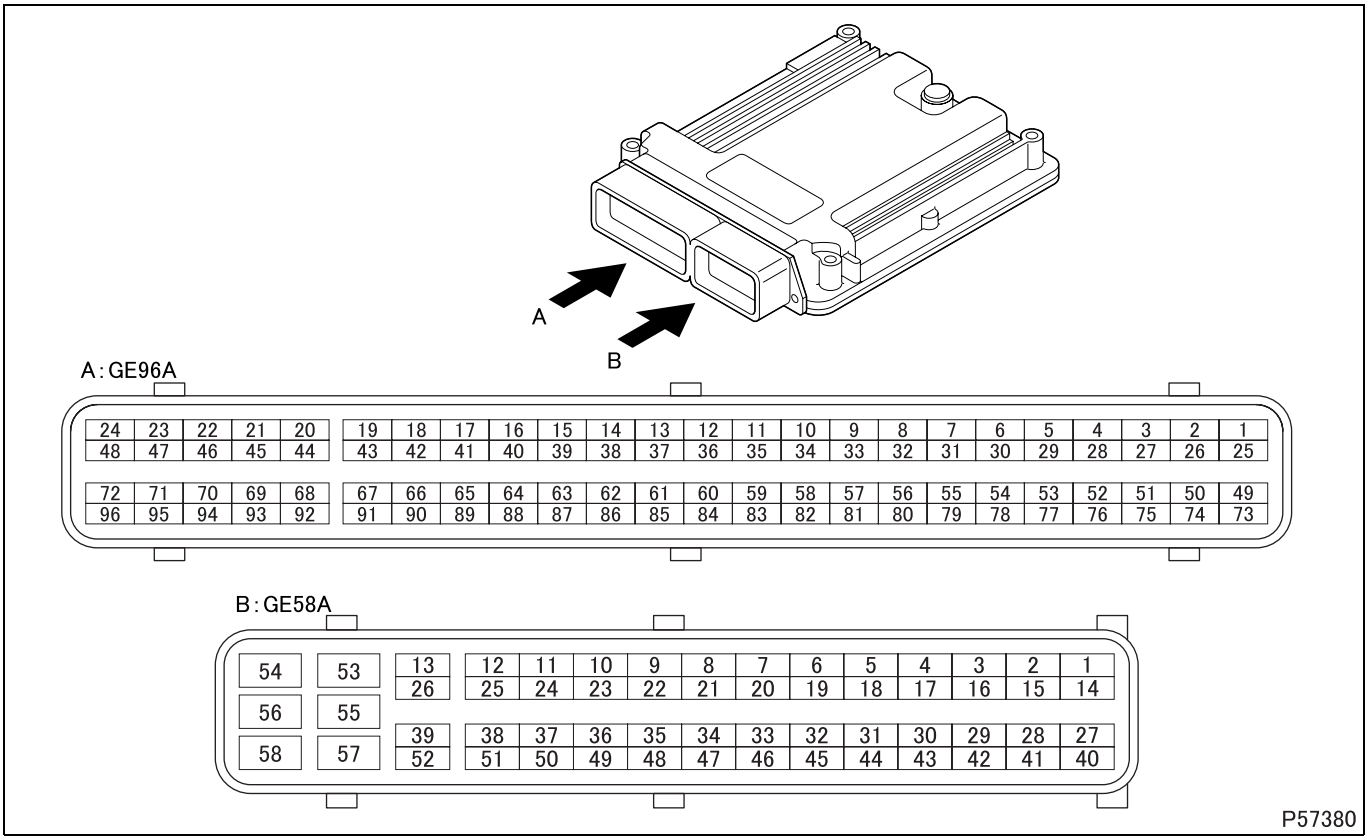
3. Actuator Tests Performed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
B1	Starter Safety Relay	Starter safety relay drive signal  P57740E	Actuation noise should be heard. [Service data] 8F: Starter safety relay

4. Inspection Performed at Electronic Control Unit Connectors

- The following inspection should assist troubleshooting by enabling you to verify whether or not electronic control unit signals are correctly transmitted via the vehicle harnesses and connectors.
  The numbers in the table **01**, **02**, etc. cross-refers you to the corresponding numbers in the table in "**1. Inspection Based on Diagnosis Codes**".

4.1 Electronic control unit connector terminal layout



4.2 Inspection instructions

CAUTION ⚠

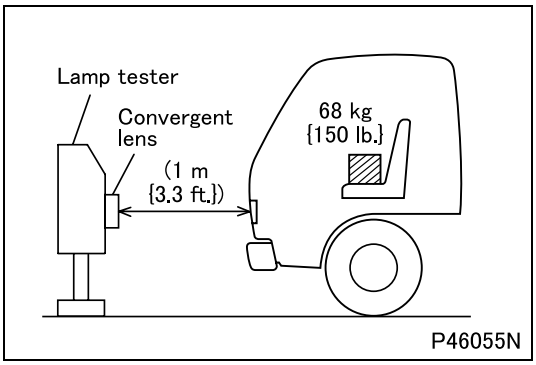
- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal other than those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Inspection item	Procedures
01 Safety relay voltage	[Conditions] • Keep the vehicle harnesses connected to the electronic control unit connector halves. (Inspection is made at the back of the vehicle connectors.) [Normal status] Terminals (+) - (–) : A81 - A49 • Relay ON: 12 V • Relay OFF: 0 V

M E M O

#960 HEADLAMP AIMING

1. Preparation before Adjustment

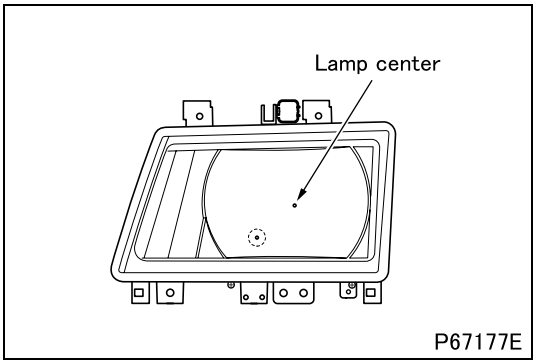


- Park the vehicle on a level place.

WARNING ⚠

- **Be sure to put tire chocks securely in place.**

- Unload the vehicle and make sure no one is in it.
- Inflate the tires to the specified pressure. (See Gr31.)
- Seat one person of an equivalent mass (68 kg {150 lb.}) in the vehicle.
- Start the engine and check that the battery is being charged.
- Place convergent lamp tester and the vehicle facing each other as shown in the drawing.
- Align the center of headlamp bulb and the center of convergent lens of convergent lamp tester. (The drawing shows the left-hand headlamp.)

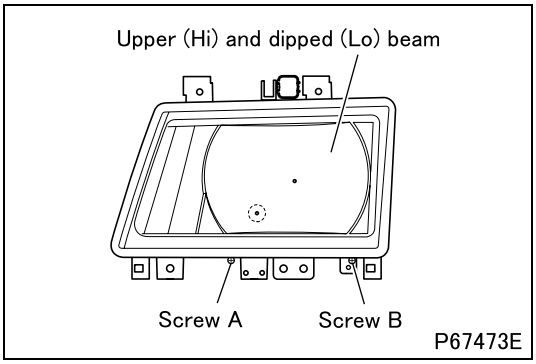


2. Adjustment

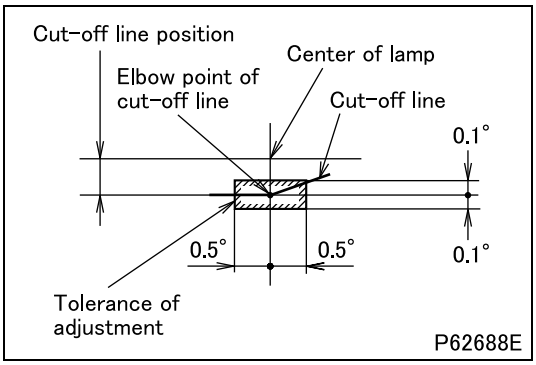
WARNING ⚠

- **Do not mask a lit headlamp for more than 10 minutes or the heat generated might cause a fire.**

2.1 Adjustment of Dipped Beam



- Turn on dipped beam.
- Make adjustment by the following procedure so that the elbow point of dipped beam cut-off line is in the illustrated position.
- Vertical adjustment: Adjust by turning screws A and B in this order by the same amount.



- Horizontal adjustment: Turn screw B. Adjust the optical axes of both the right- and left-hand dipped beams to the illustrated position.
  Cut-off line position: 0.7°

Adjusting direction for optical axis

<Left-hand headlamp>

	Upward	Downward	Leftward	Rightward
Screw A	Counter-clockwise	Clockwise	–	–
Screw B	–	–	Clockwise	Counter-clockwise

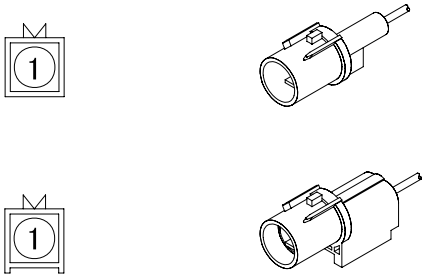
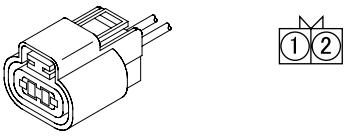
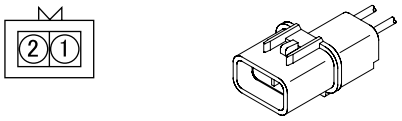
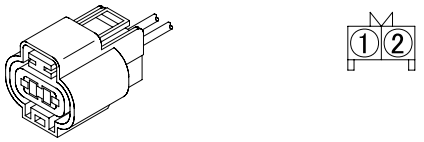
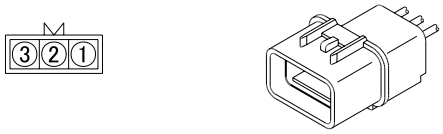
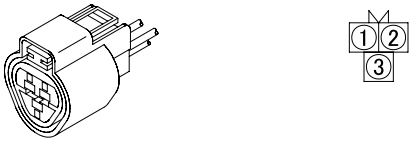
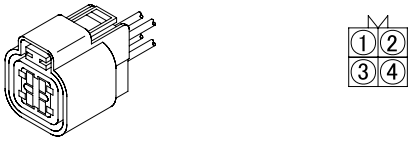
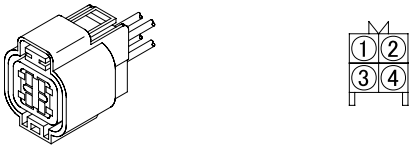
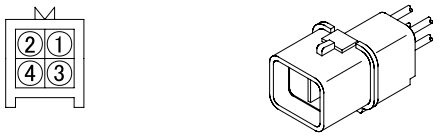
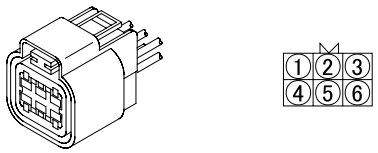
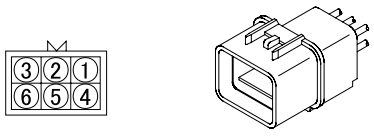
<Right-hand headlamp>

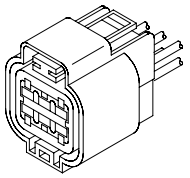
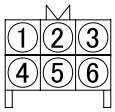
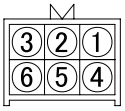
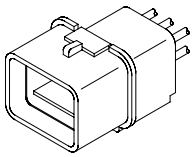
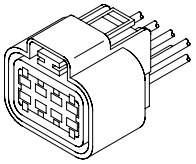
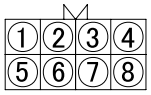
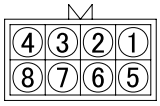
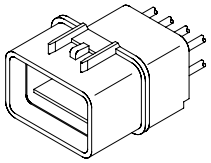
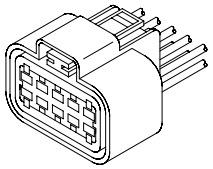
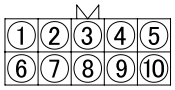
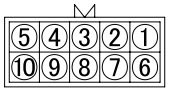
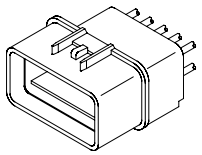
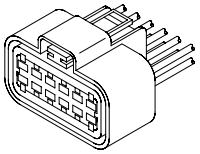
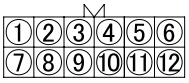
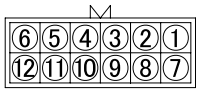
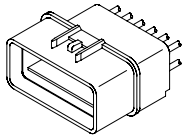
	Upward	Downward	Leftward	Rightward
Screw A	Counter-clockwise	Clockwise	–	–
Screw B	–	–	Counter-clockwise	Clockwise

GROUP 54-14 CONNECTOR CONFIGURATION CHART

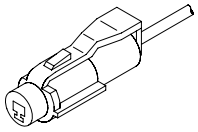
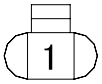
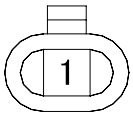
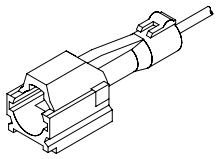
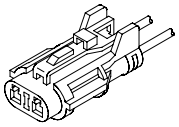
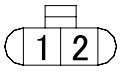
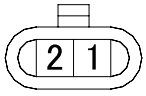
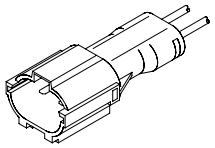
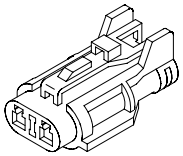
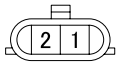
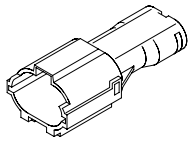
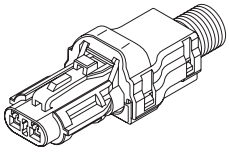
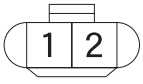
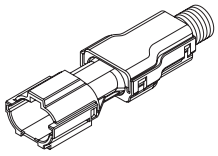
CONNECTOR CONFIGURATION CHART

AA type

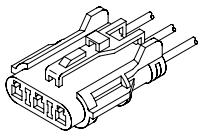
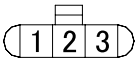
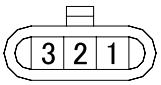
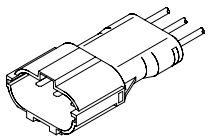
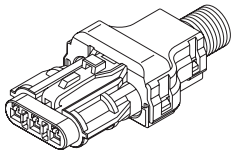
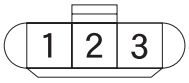
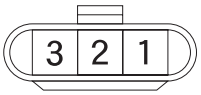
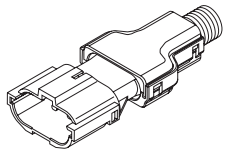
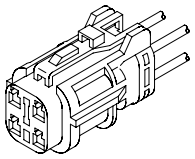
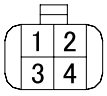
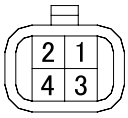
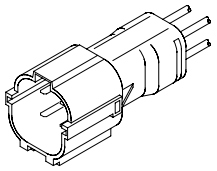
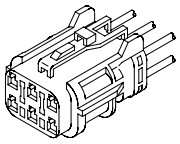
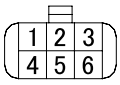
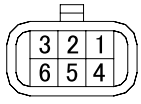
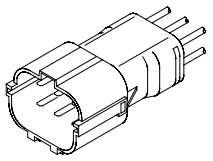
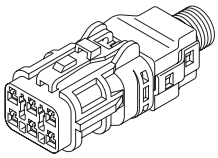
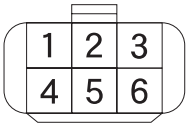
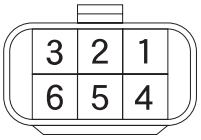
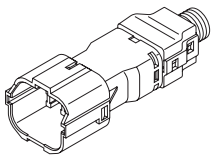
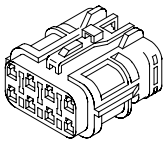
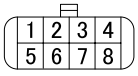
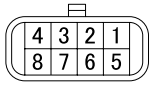
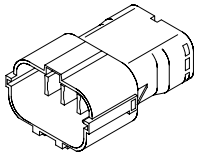
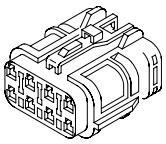
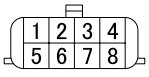
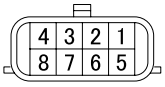
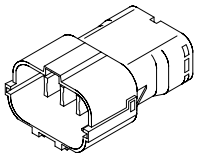
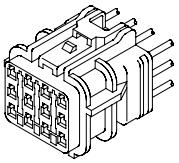
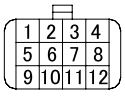
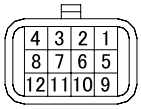
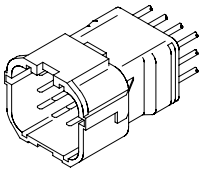
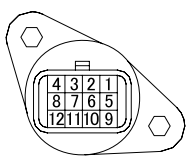
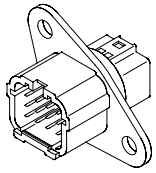
Number shows number of pins	Female connector	Male connector
AA1A		
AA2A		
AA2B		
AA3A		
AA3B		
AA4A		
AA4B		
AA6A		

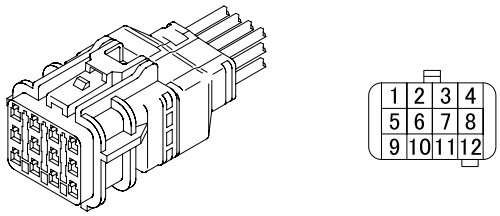
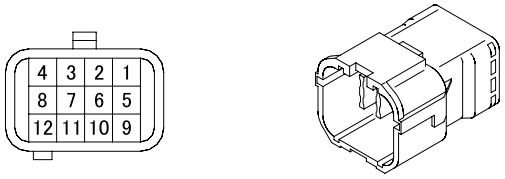
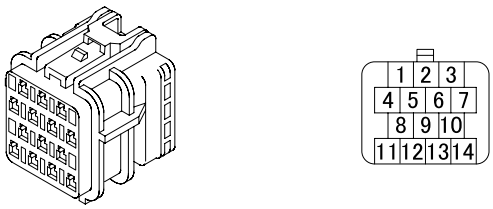
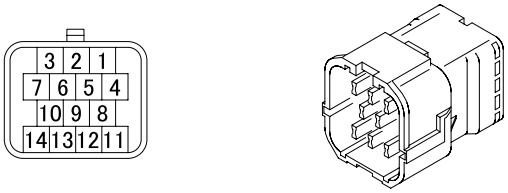
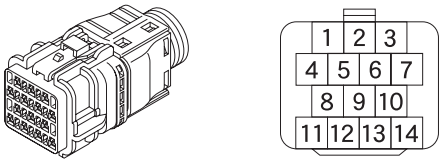
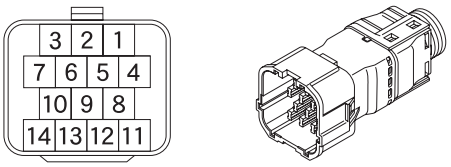
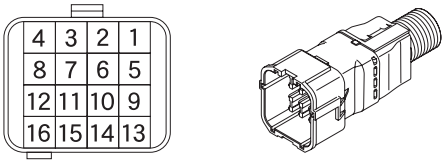
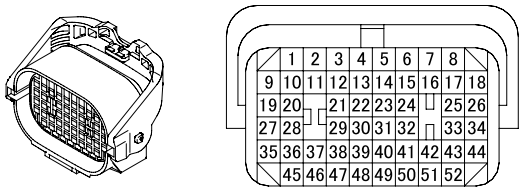
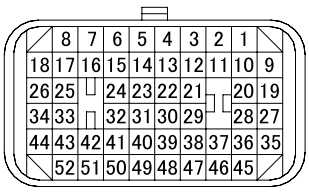
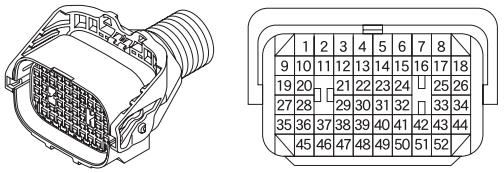
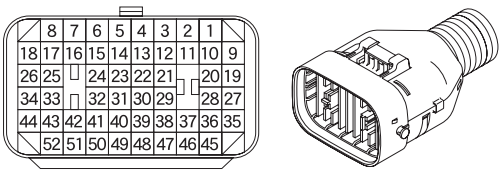
Number shows number of pins	Female connector	Male connector
AA6B	 	 
AA8A	 	 
AA10A	 	 
AA12A	 	 

AB type

Number shows number of pins	Female connector	Male connector
AB1A	 	 
AB2A	 	 
AB2B		 
AB2C	 	

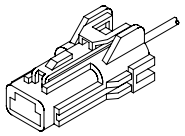
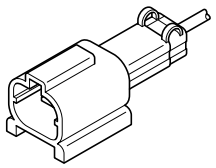
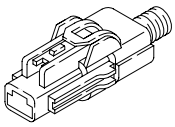
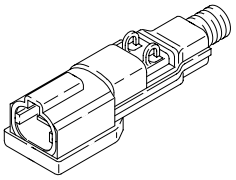
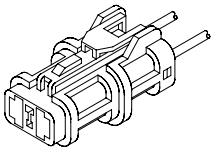
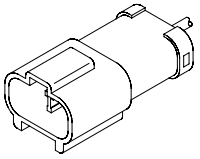
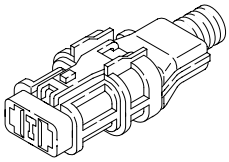
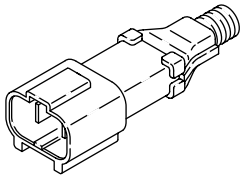
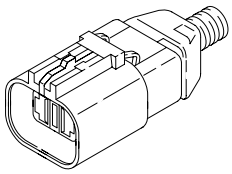
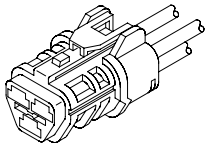
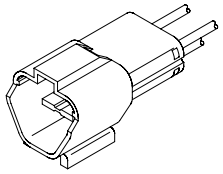
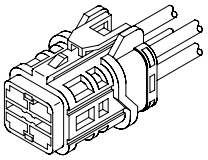
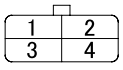
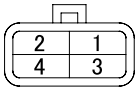
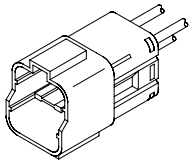
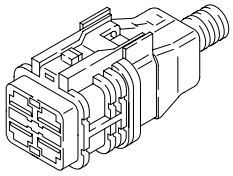
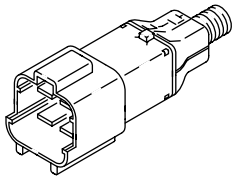
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AB3A	 	 
AB3B	 	 
AB4A	 	 
AB6A	 	 
AB6B	 	 
AB8A	 	 
AB8B	 	 
AB12A	 	   

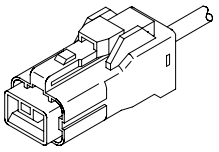
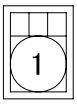
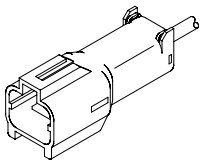
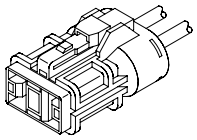
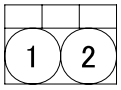
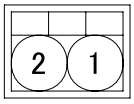
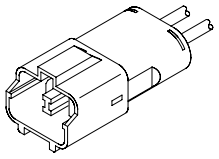
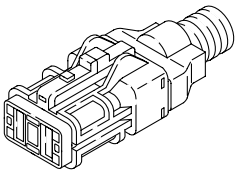
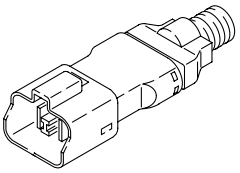
Number shows number of pins	Female connector	Male connector
AB12B		
AB14A		
AB14B		
AB16A		
AB16B		
AB52A		
AB52B		

CONNECTOR CONFIGURATION CHART

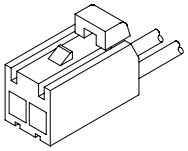
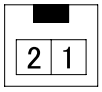
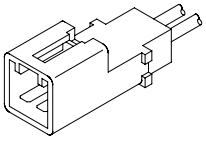
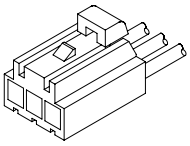
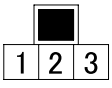
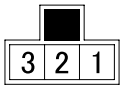
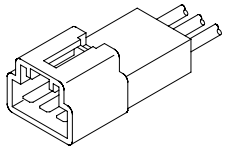
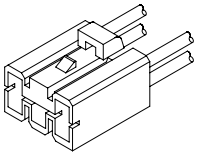
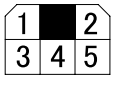
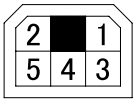
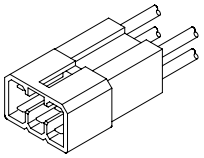
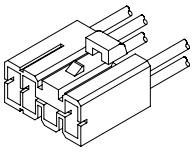
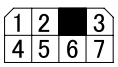
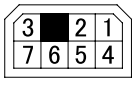
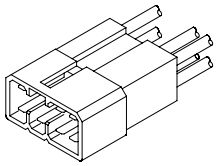
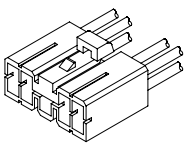
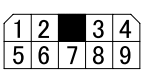
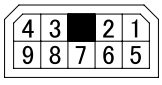
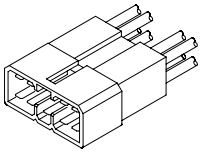
AC type

Number shows number of pins	Female connector	Male connector
AC1A		
AC1B		
AC2A		
AC2B		
AC2C		
AC3A		
AC4A	 	 
AC4B		

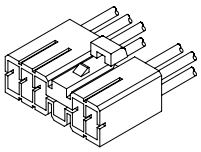
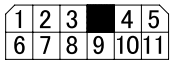
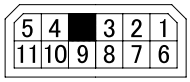
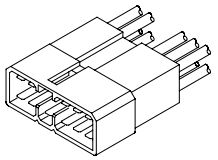
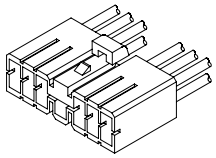
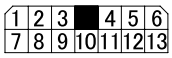
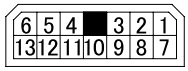
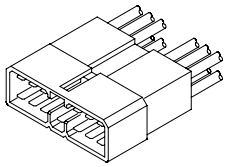
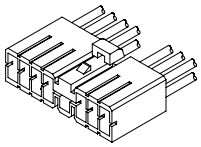
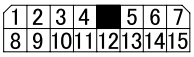
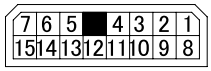
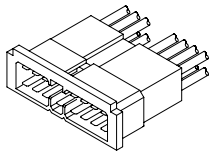
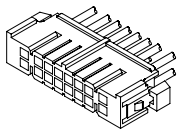
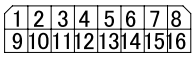
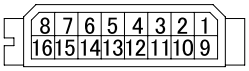
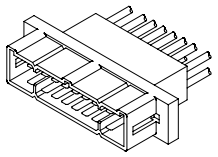
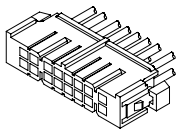
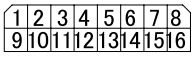
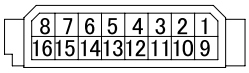
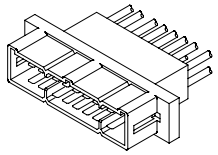
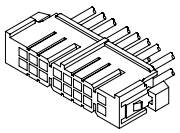
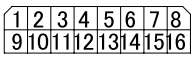
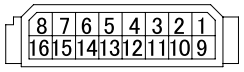
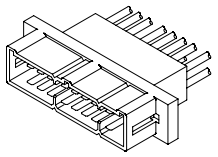
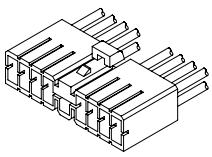
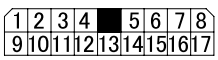
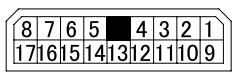
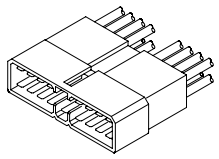
AD type

Number shows number of pins	Female connector	Male connector
AD1A		 
AD2A	 	 
AD2B		

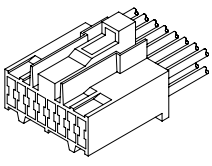
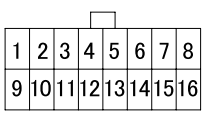
AE type

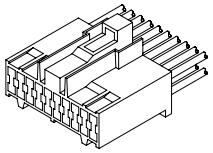
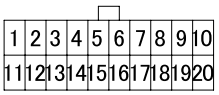
Number shows number of pins	Female connector	Male connector
AE2A		 
AE3A	 	 
AE5A	 	 
AE7A	 	 
AE9A	 	 

CONNECTOR CONFIGURATION CHART

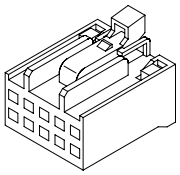
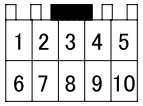
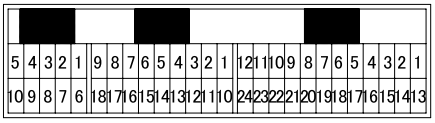
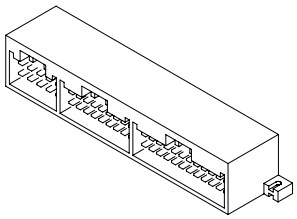
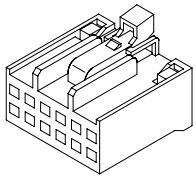
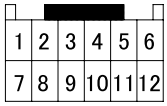
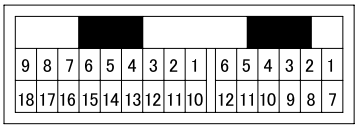
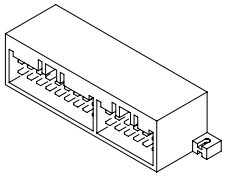
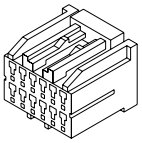
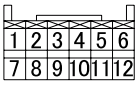
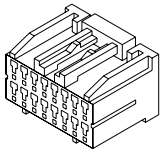
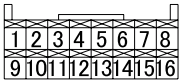
Number shows number of pins	Female connector	Male connector
AE11A	 	 
AE13A	 	 
AE15A	 	 
AE16A	 	 
AE16B	 	 
AE16C	 	 
AE17A	 	 

AG type

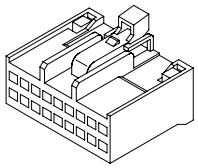
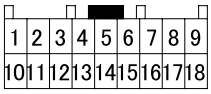
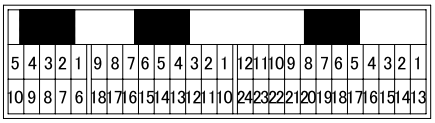
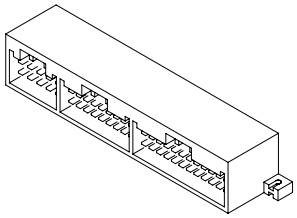
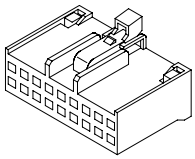
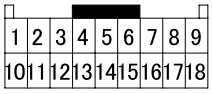
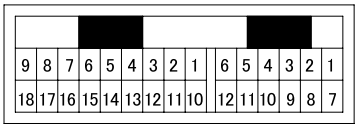
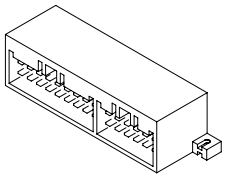
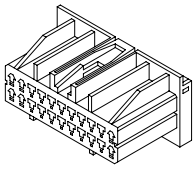
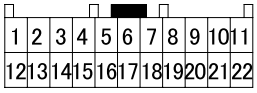
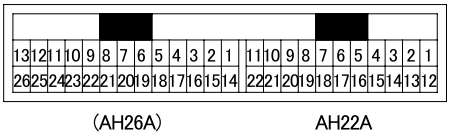
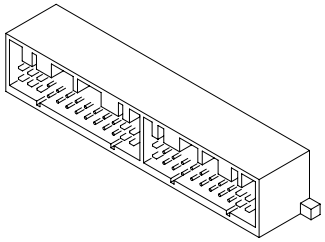
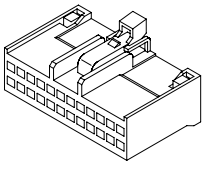
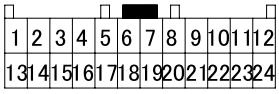
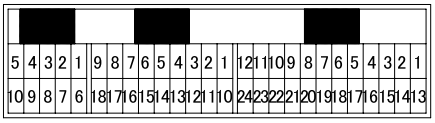
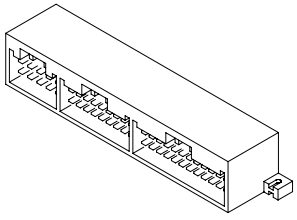
Number shows number of pins	Female connector	Male connector
AG16A	 	

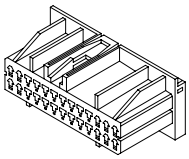
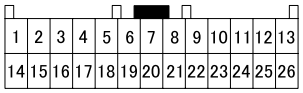
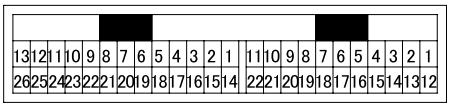
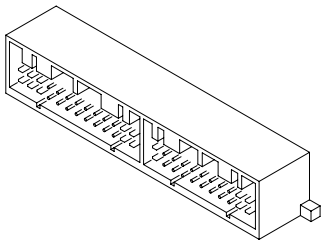
Number shows number of pins	Female connector	Male connector
AG20A	 	

AH type

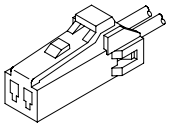
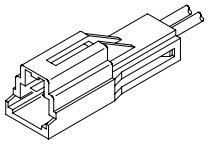
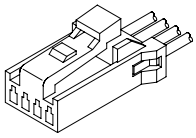
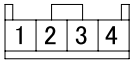
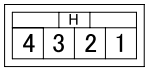
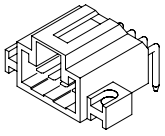
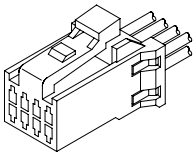
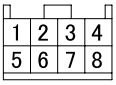
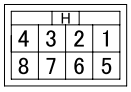
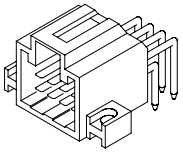
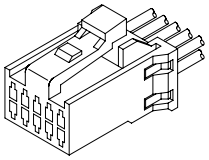
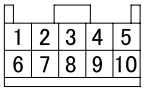
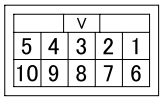
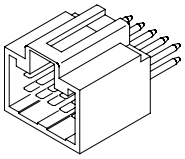
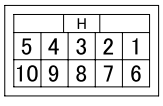
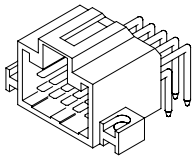
Number shows number of pins	Female connector	Male connector
AH10A	 	 AH10A （AH18A） （AH24A） 
AH12A	 	 （AH18B） AH12A 
AH12B	 	
AH16A	 	

CONNECTOR CONFIGURATION CHART

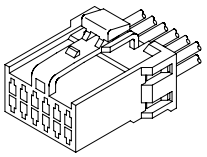
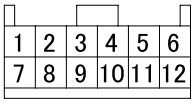
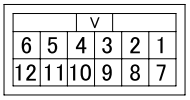
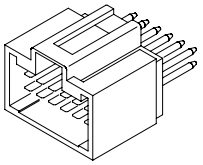
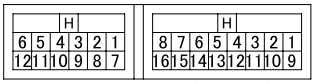
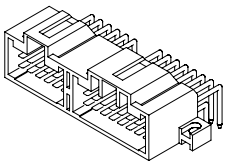
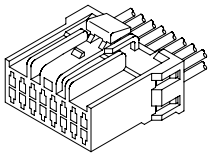
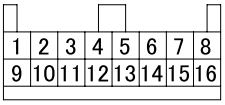
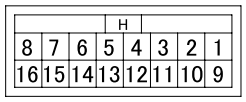
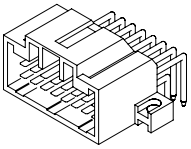
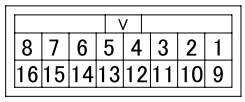
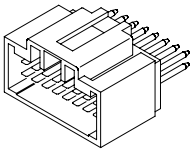
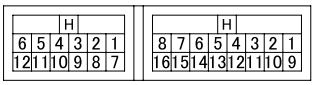
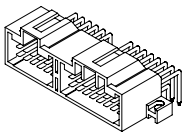
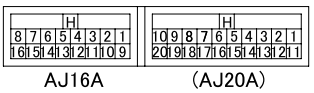
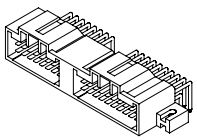
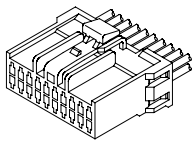
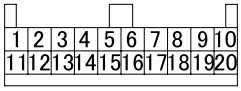
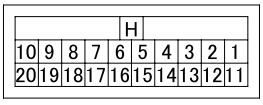
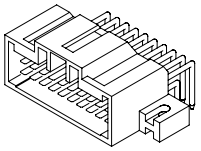
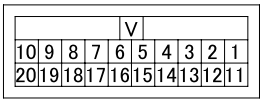
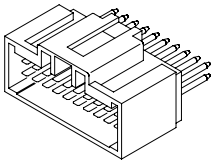
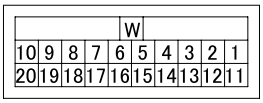
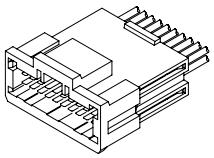
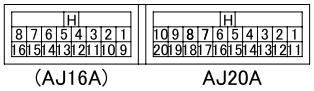
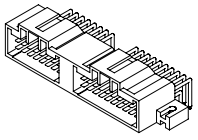
Number shows number of pins	Female connector	Male connector
AH18A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	 5 4 3 2 1 9 8 7 6 5 4 3 2 1 12 11 10 9 8 7 6 5 4 3 2 1 10 9 8 7 6 18 17 16 15 14 13 12 11 10 24 23 22 21 20 19 18 17 16 15 14 13 (AH10A) AH18A (AH24A) 
AH18B	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	 9 8 7 6 5 4 3 2 1 6 5 4 3 2 1 18 17 16 15 14 13 12 11 10 12 11 10 9 8 7 AH18B (AH12A) 
AH22A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	 13 12 11 10 9 8 7 6 5 4 3 2 1 11 10 9 8 7 6 5 4 3 2 1 26 25 24 23 22 21 20 19 18 17 16 15 14 22 21 20 19 18 17 16 15 14 13 12 (AH26A) AH22A 
AH24A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	 5 4 3 2 1 9 8 7 6 5 4 3 2 1 12 11 10 9 8 7 6 5 4 3 2 1 10 9 8 7 6 18 17 16 15 14 13 12 11 10 24 23 22 21 20 19 18 17 16 15 14 13 (AH10A) (AH18A) AH24A 

Number shows number of pins	Female connector	Male connector
AH26A	 	 AH26A (AH22A) 

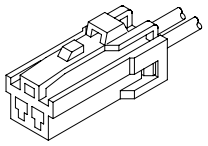
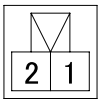
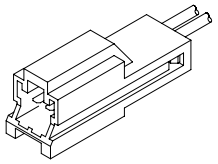
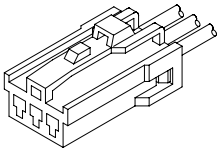
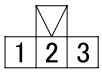
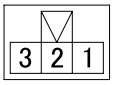
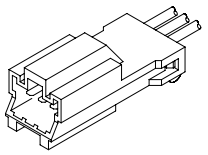
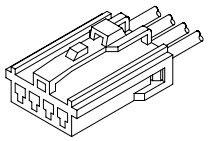
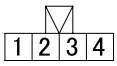
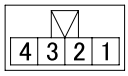
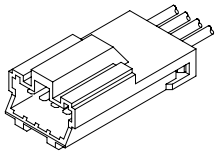
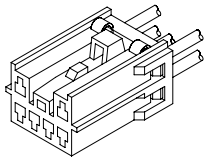
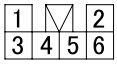
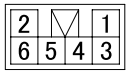
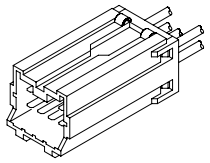
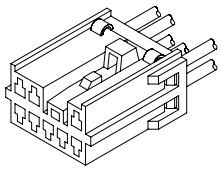
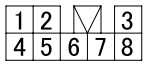
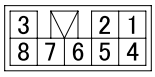
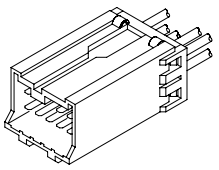
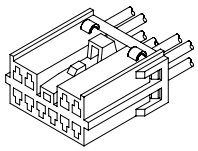
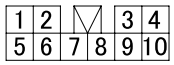
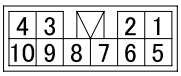
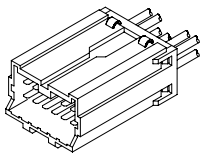
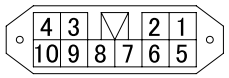
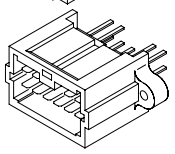
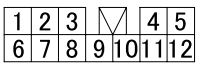
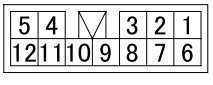
AJ type

Number shows number of pins	Female connector	Male connector
AJ2A		
AJ4A	 	 
AJ8A	 	 
AJ10A	 	   

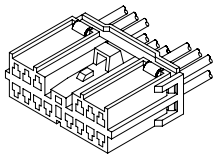
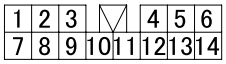
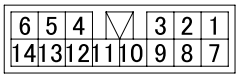
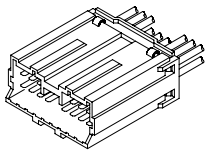
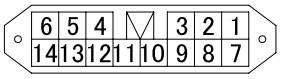
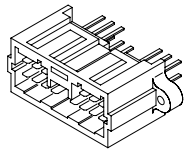
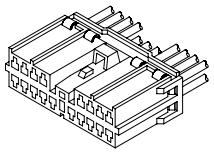
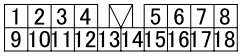
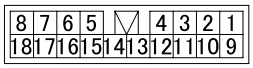
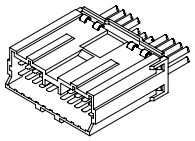
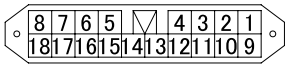
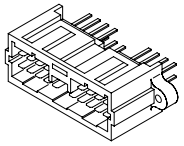
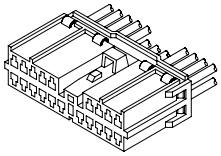
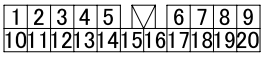
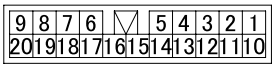
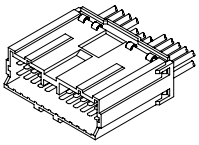
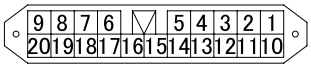
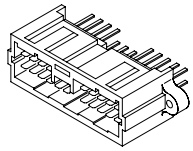
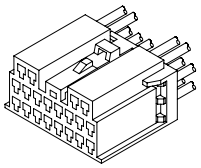
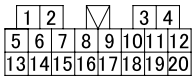
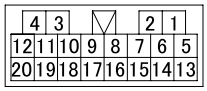
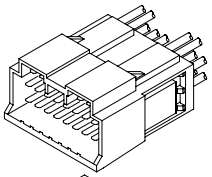
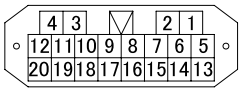
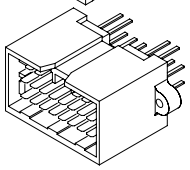
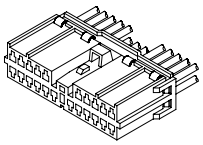
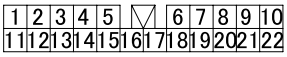
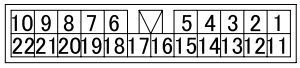
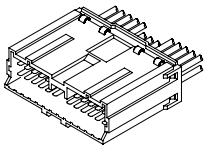
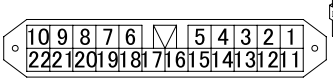
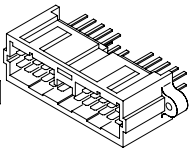
CONNECTOR CONFIGURATION CHART

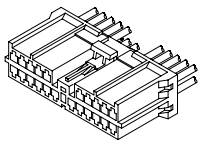
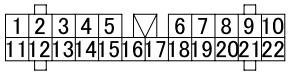
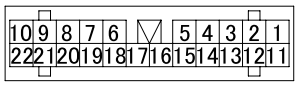
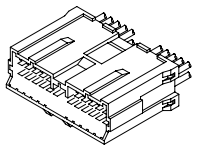
Number shows number of pins	Female connector	Male connector
AJ12A	  1 2 3 4 5 6 7 8 9 10 11 12	 V 6 5 4 3 2 1 12 11 10 9 8 7   H 6 5 4 3 2 1 12 11 10 9 8 7 AJ12A H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 (AJ16A) 
AJ16A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	 H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9   V 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9   H 6 5 4 3 2 1 12 11 10 9 8 7 (AJ12A) H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 AJ16A   H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 AJ16A H 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11 (AJ20A) 
AJ20A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	 H 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11   V 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11   W 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11   H 6 5 4 3 2 1 12 11 10 9 8 7 (AJ16A) H 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11 AJ20A 

AK type

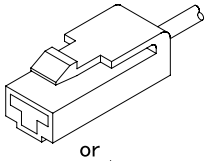
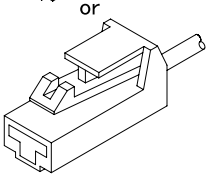
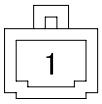
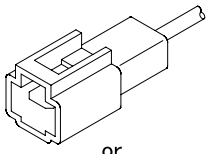
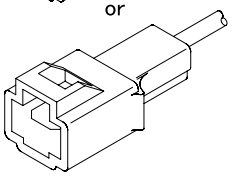
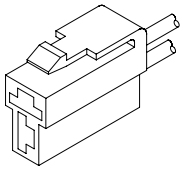
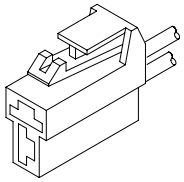
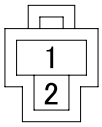
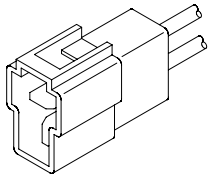
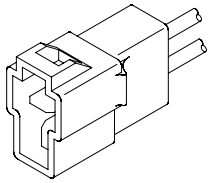
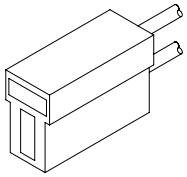
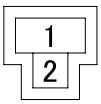
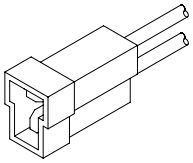
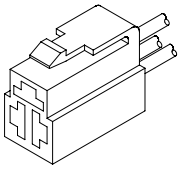
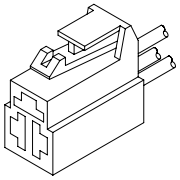
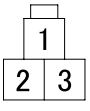
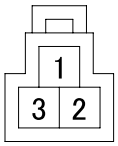
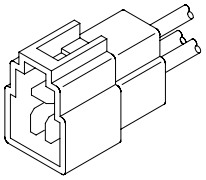
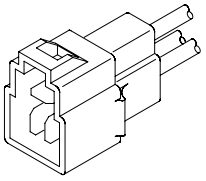
Number shows number of pins	Female connector	Male connector
AK2A		 
AK3A	 	 
AK4A	 	 
AK6A	 	 
AK8A	 	 
AK10A	 	   
AK12A		

CONNECTOR CONFIGURATION CHART

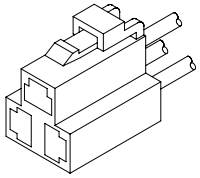
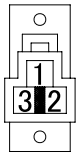
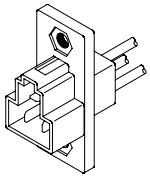
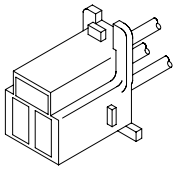
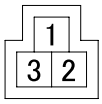
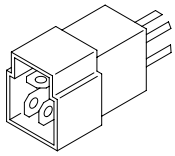
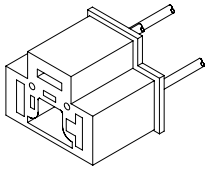
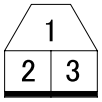
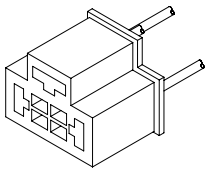
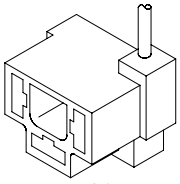
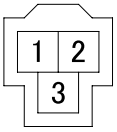
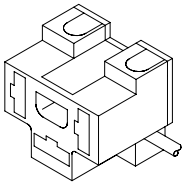
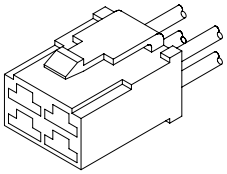
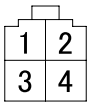
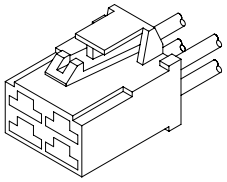
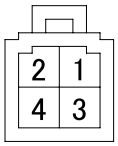
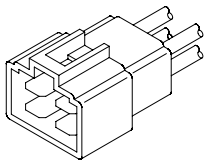
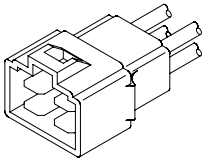
Number shows number of pins	Female connector	Male connector
AK14A	 	   
AK18A	 	   
AK20A	 	   
AK20B	 	   
AK22A	 	   

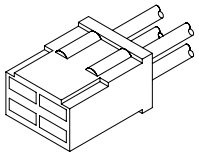
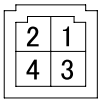
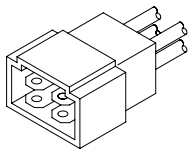
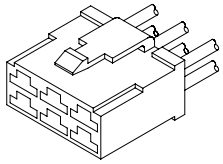
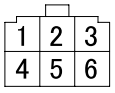
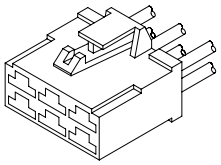
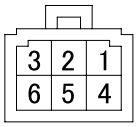
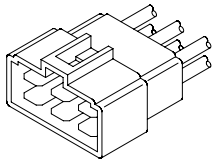
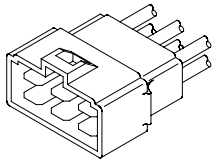
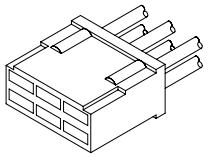
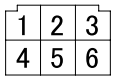
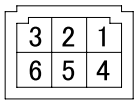
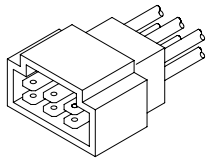
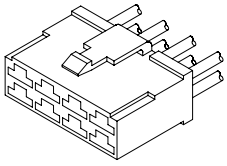
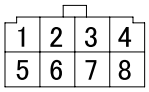
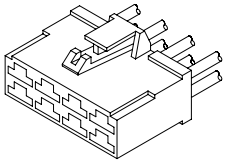
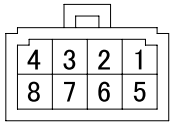
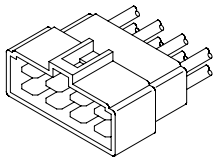
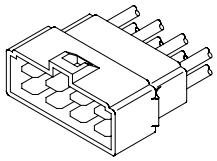
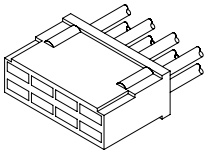
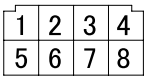
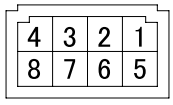
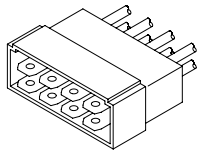
Number shows number of pins	Female connector	Male connector
AK22B	 	 

AL type

Number shows number of pins	Female connector	Male connector
AL1A	 or 	  or 
AL2A	 or 	  or 
AL2B		 
AL3A	 or  	  or 

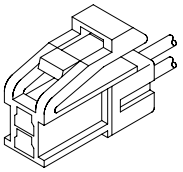
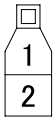
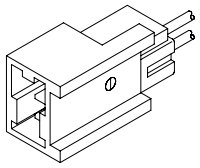
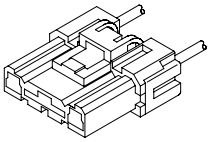
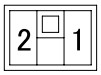
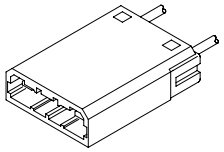
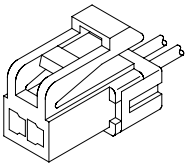
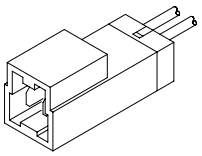
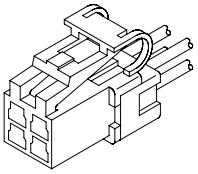
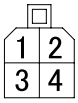
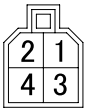
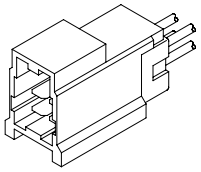
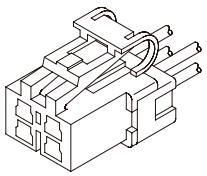
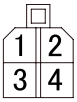
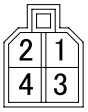
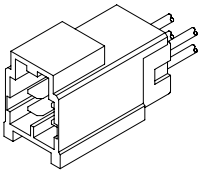
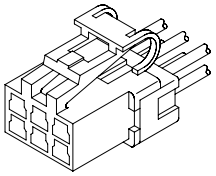
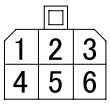
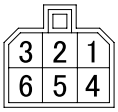
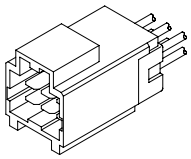
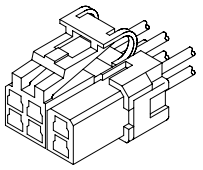
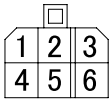
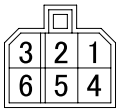
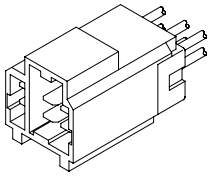
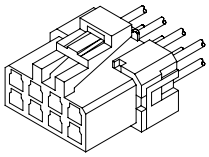
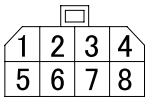
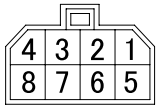
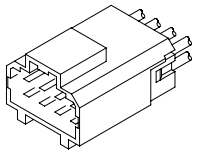
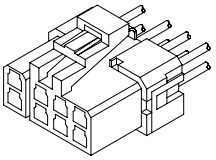
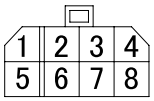
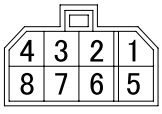
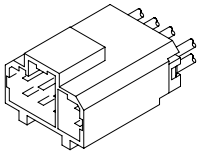
CONNECTOR CONFIGURATION CHART

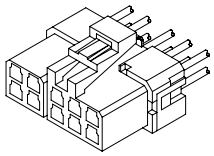
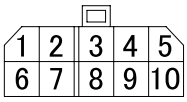
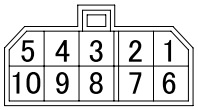
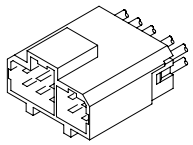
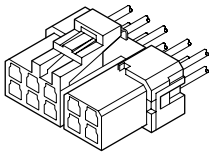
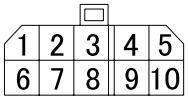
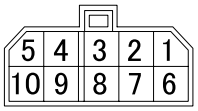
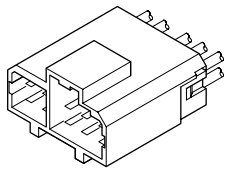
Number shows number of pins	Female connector	Male connector
AL3B		 
AL3C		 
AL3D	  or 	
AL3E	  or 	
AL4A	  or 	  or 

Number shows number of pins	Female connector	Male connector
AL4B		 
AL6A	  or 	  or 
AL6B	 	 
AL8A	  or 	  or 
AL8B	 	 

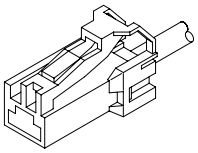
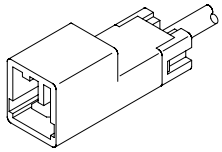
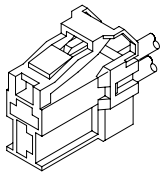
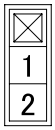
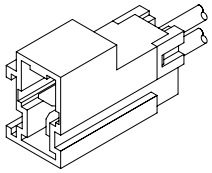
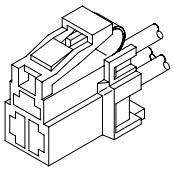
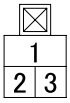
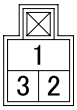
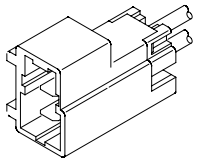
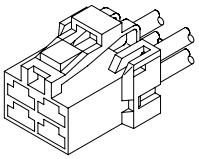
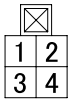
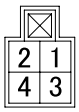
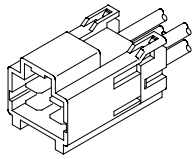
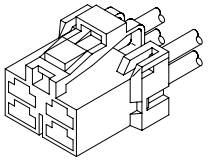
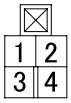
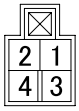
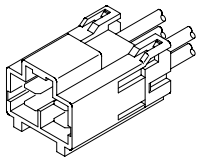
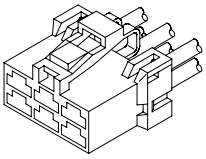
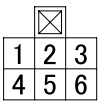
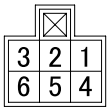
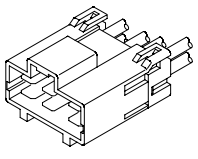
CONNECTOR CONFIGURATION CHART

AM type

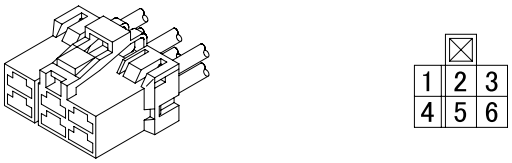
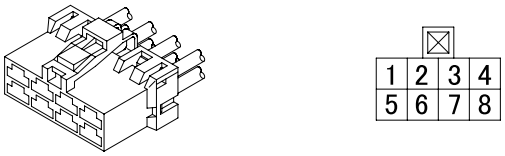
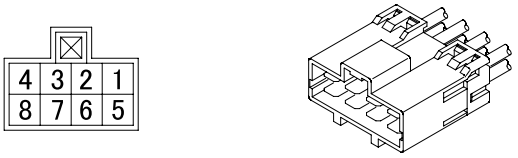
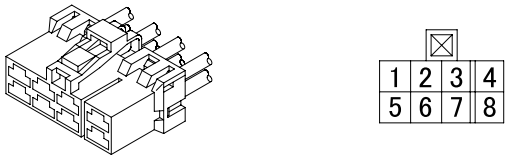
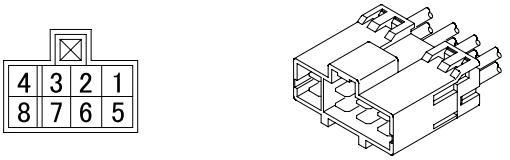
Number shows number of pins	Female connector	Male connector
AM2A	 	
AM2B		 
AM2C		
AM4A	 	 
AM4B	 	 
AM6A	 	 
AM6B	 	 
AM8A	 	 
AM8B	 	 

Number shows number of pins	Female connector	Male connector
AM10A	 	 
AM10B	 	 

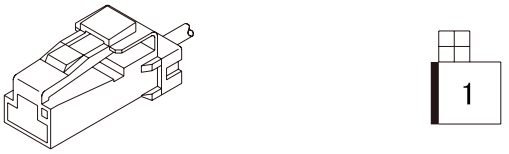
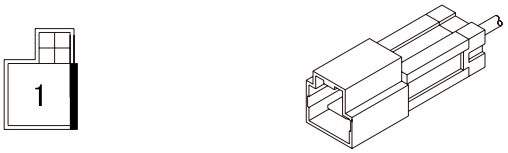
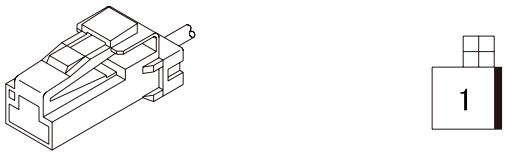
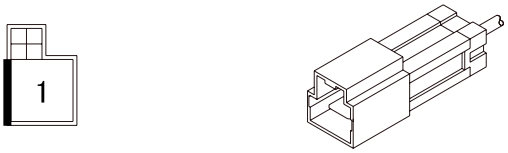
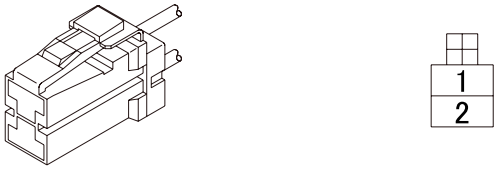
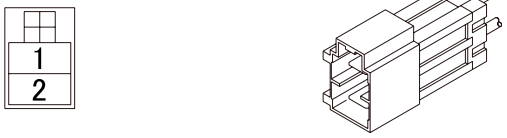
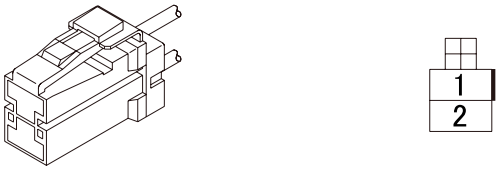
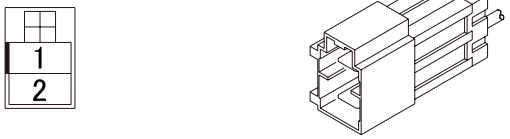
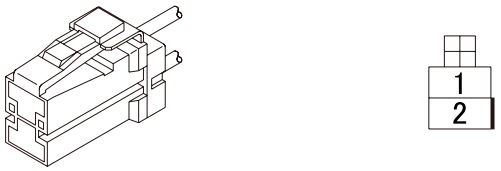
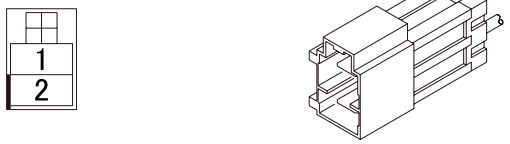
AN type

Number shows number of pins	Female connector	Male connector
AN1A		
AN2A		 
AN3A	 	 
AN4A	 	 
AN4B	 	 
AN6A	 	 

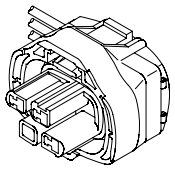
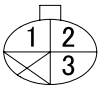
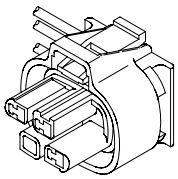
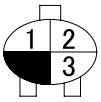
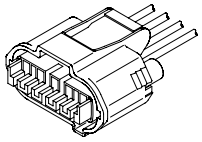
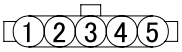
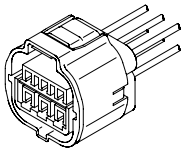
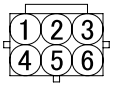
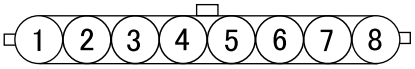
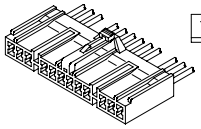
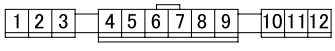
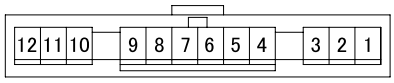
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AN6B		
AN8A		
AN8B		

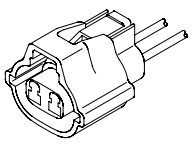
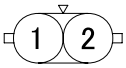
AP type

Number shows number of pins	Female connector	Male connector
AP1A		
AP1B		
AP2A		
AP2B		
AP2C		

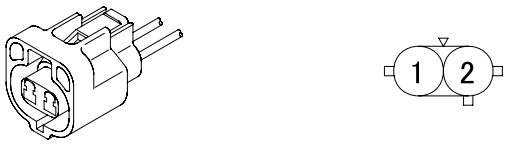
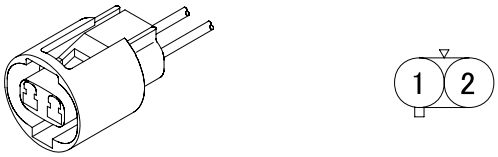
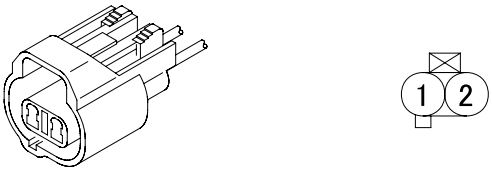
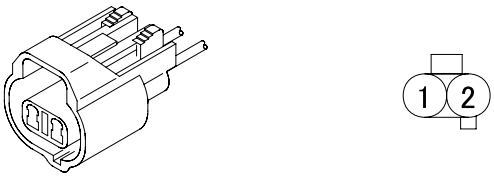
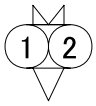
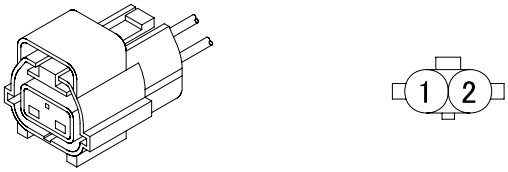
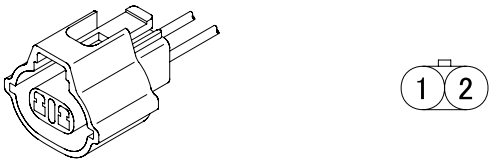
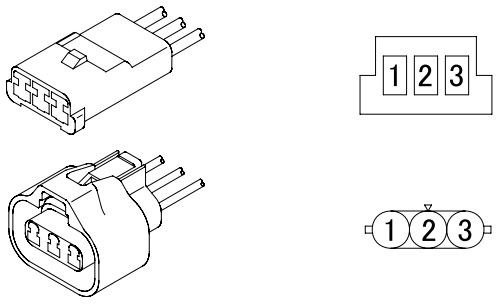
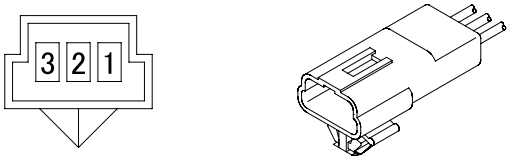
AQ type

Number shows number of pins	Female connector	Male connector
AQ1A		
AQ3A	 	
AQ3B	 	
AQ5A	 	
AQ6A	 	
AQ8A		
AQ12A	 	

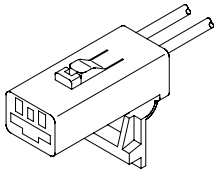
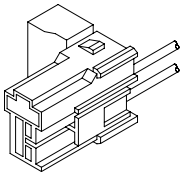
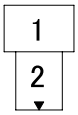
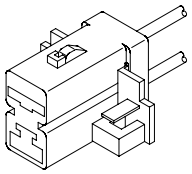
AR type

Number shows number of pins	Female connector	Male connector
AR2A	 	

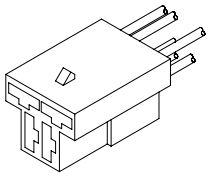
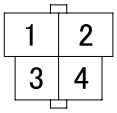
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AR2B		
AR2C		
AR2D		
AR2E		
AR2F		
AR2G		
AR2H		
AR3A		

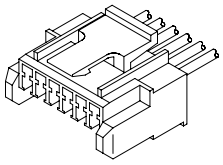
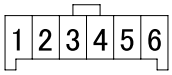
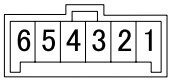
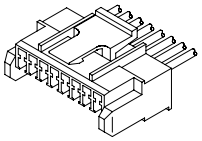
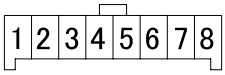
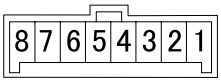
AS type

Number shows number of pins	Female connector	Male connector
AS1A		
AS2A	 	
AS2B		

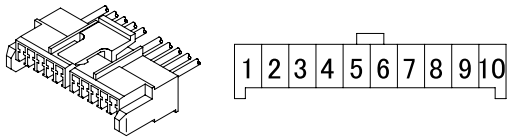
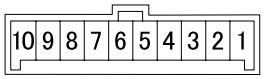
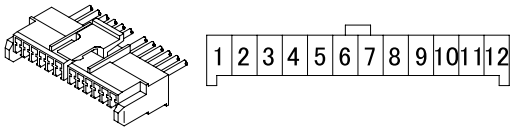
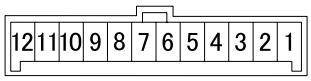
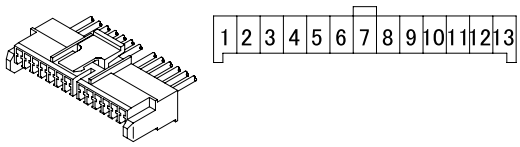
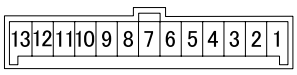
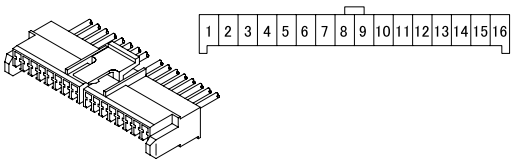
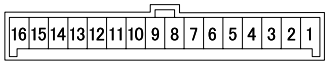
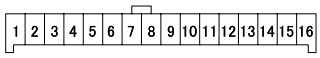
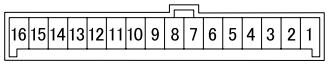
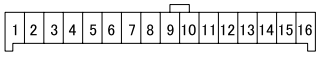
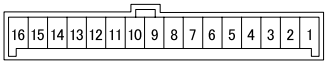
AT type

Number shows number of pins	Female connector	Male connector
AT4A	 	

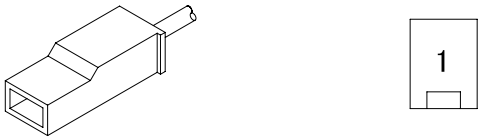
AU type

Number shows number of pins	Female connector	Male connector
AU2A		
AU6A	 	
AU8A	 	

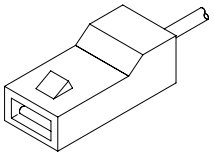
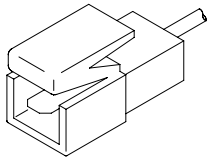
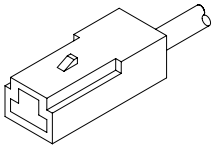
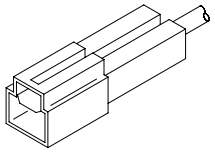
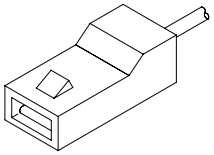
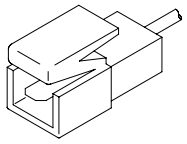
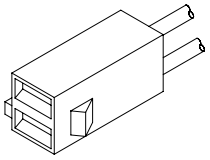
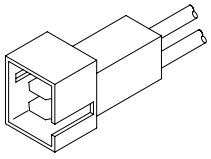
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AU10A		
AU12A		
AU13A		
AU16A		
AU16B		
AU16C		

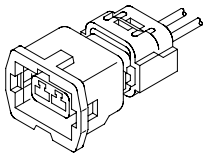
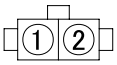
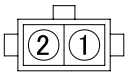
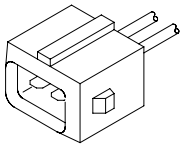
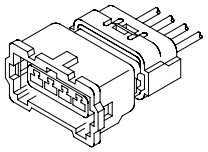
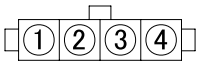
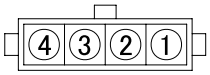
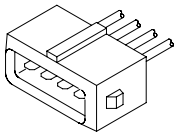
AV type

Number shows number of pins	Female connector	Male connector
AV1A		
AV2A		

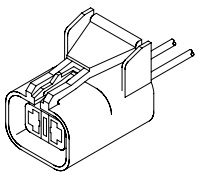
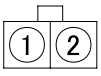
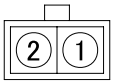
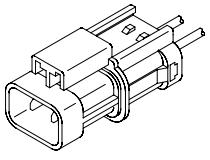
AW type

Number shows number of pins	Female connector	Male connector
AW1A		
AW1B		
AW1C		
AW2A		

AX type

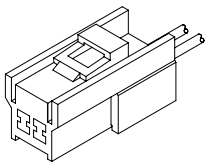
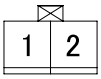
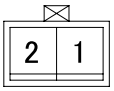
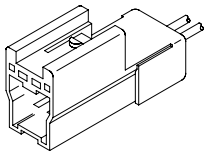
Number shows number of pins	Female connector	Male connector
AX2A	 	 
AX4A	 	 

AY type

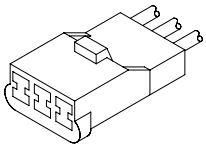
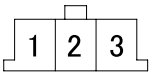
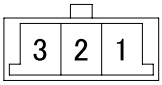
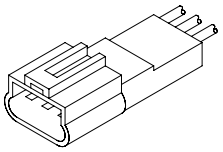
Number shows number of pins	Female connector	Male connector
AY2A	 	 

CONNECTOR CONFIGURATION CHART

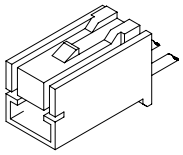
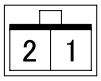
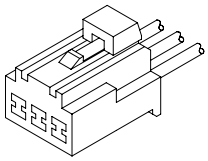
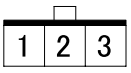
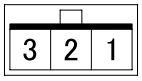
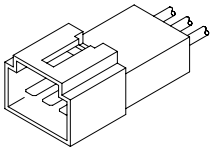
AZ type

Number shows number of pins	Female connector	Male connector
AZ2A	 	 

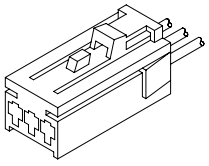
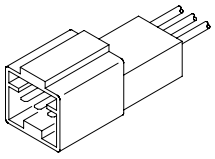
BA type

Number shows number of pins	Female connector	Male connector
BA3A	 	 

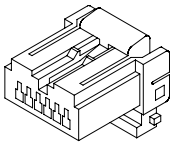
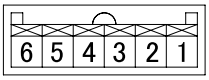
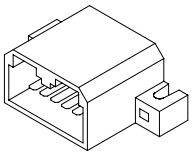
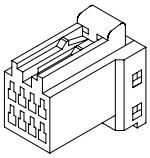
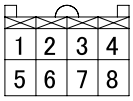
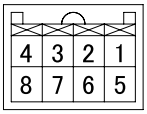
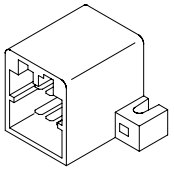
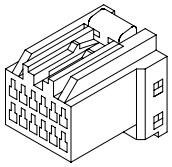
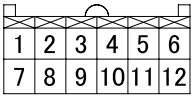
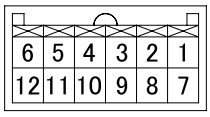
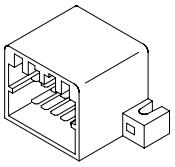
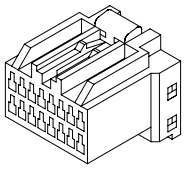
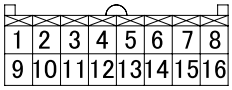
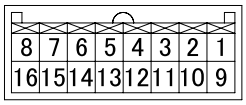
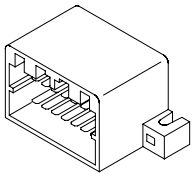
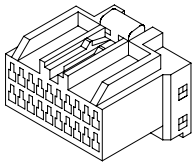
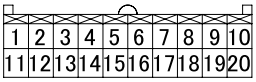
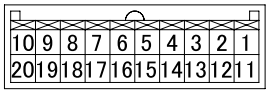
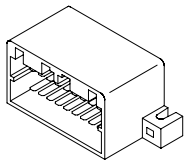
BB type

Number shows number of pins	Female connector	Male connector
BB2A		
BB3A	 	 

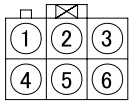
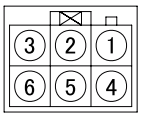
BC type

Number shows number of pins	Female connector	Male connector
BC3A		

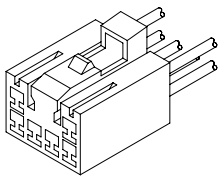
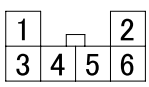
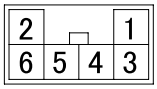
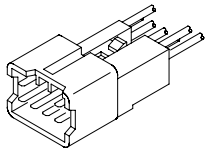
BD type

Number shows number of pins	Female connector	Male connector
BD6A		 
BD8A	 	 
BD12A	 	 
BD16A	 	 
BD20A	 	 

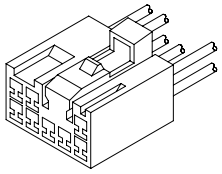
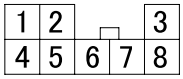
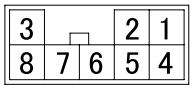
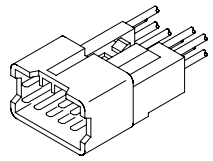
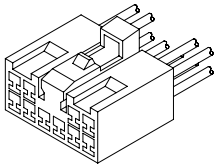
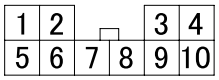
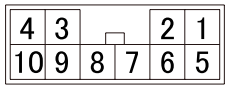
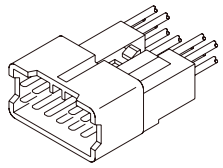
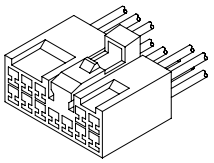
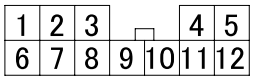
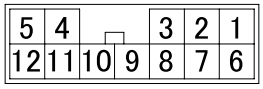
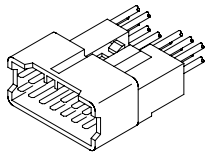
BE type

Number shows number of pins	Female connector	Male connector
BE6A		

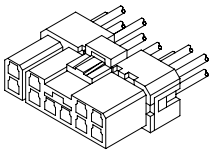
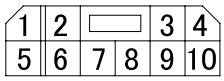
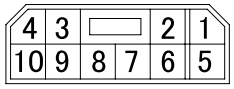
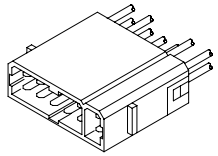
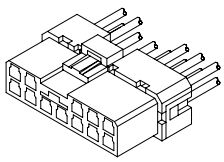
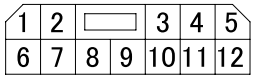
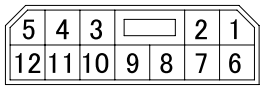
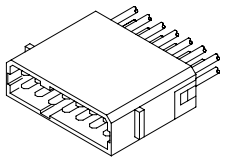
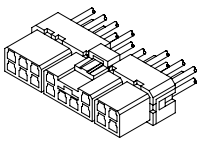
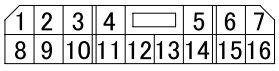
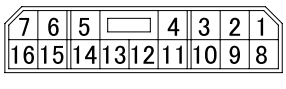
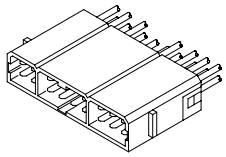
BF type

Number shows number of pins	Female connector	Male connector
BF6A	 	 

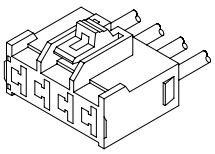
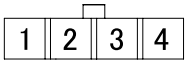
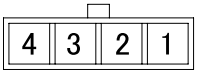
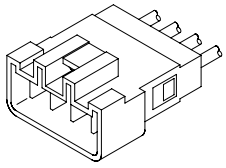
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BF8A	 	 
BF10A	 	 
BF12A	 	 

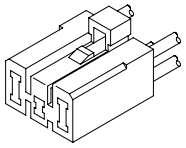
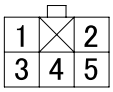
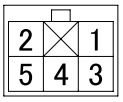
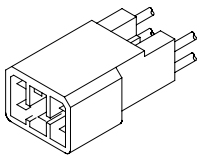
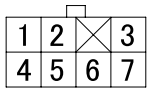
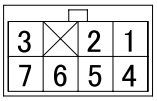
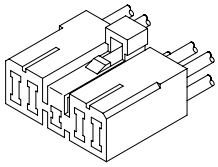
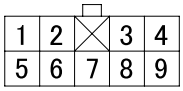
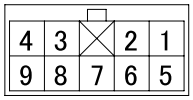
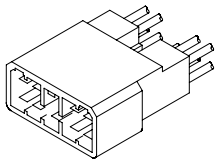
BG type

Number shows number of pins	Female connector	Male connector
BG10A	 	 
BG12A	 	 
BG16A	 	 

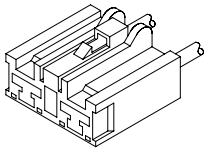
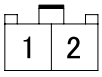
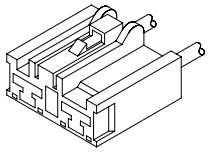
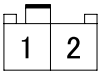
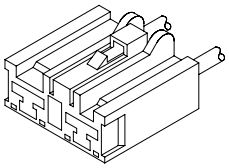
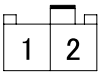
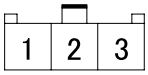
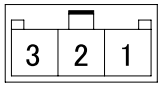
BH type

Number shows number of pins	Female connector	Male connector
BH4A	 	 

BJ type

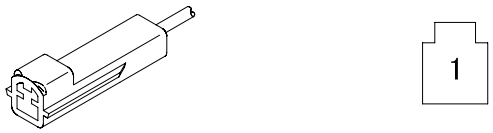
Number shows number of pins	Female connector	Male connector
BJ5A	 	 
BJ7A		
BJ9A	 	 

BM type

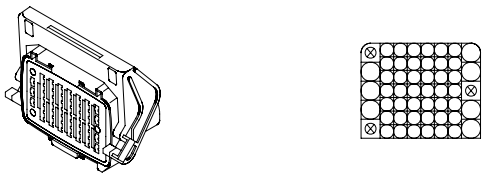
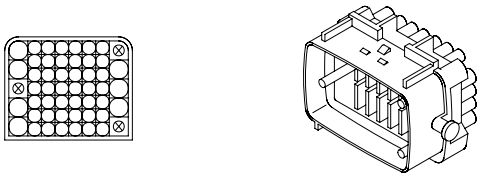
Number shows number of pins	Female connector	Male connector
BM2A	 	
BM2B	 	
BM2C	 	
BM3A		

CONNECTOR CONFIGURATION CHART

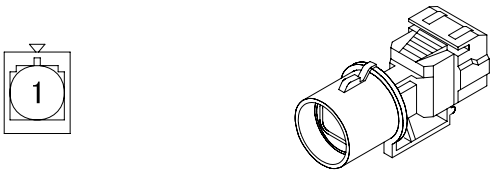
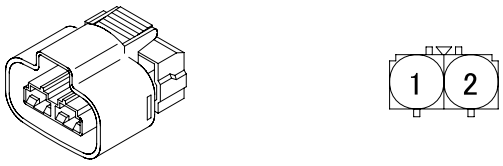
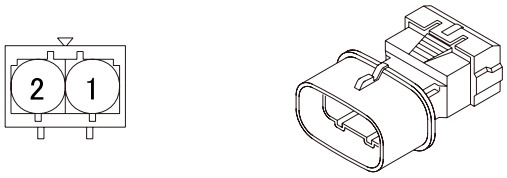
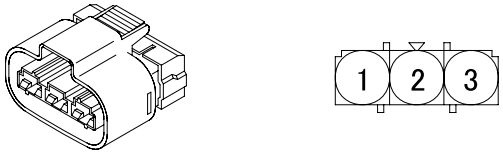
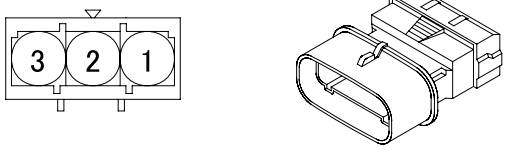
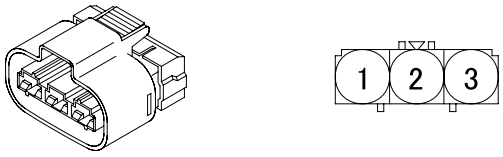
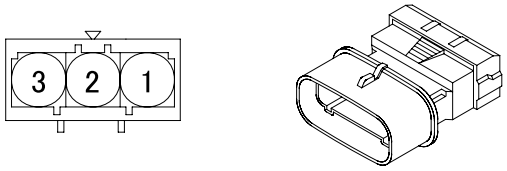
BN type

Number shows number of pins	Female connector	Male connector
BN1A		

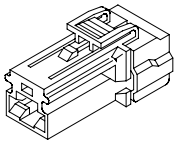
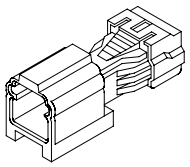
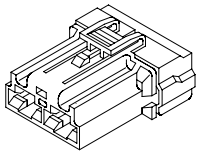
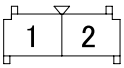
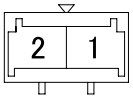
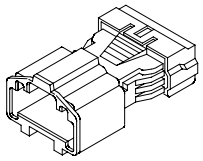
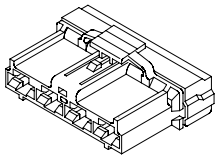
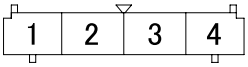
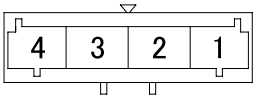
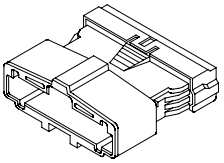
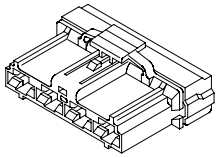
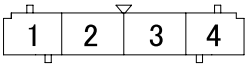
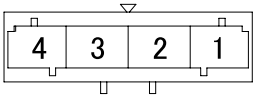
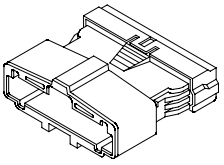
BP type

Number shows number of pins	Female connector	Male connector
BP49A		

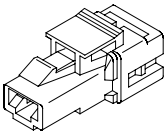
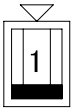
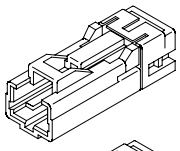
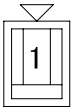
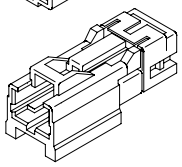
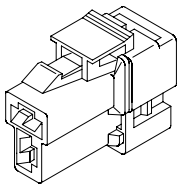
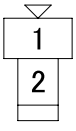
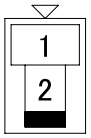
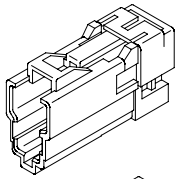
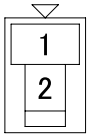
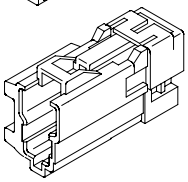
BQ type

Number shows number of pins	Female connector	Male connector
BQ1A		
BQ2A		
BQ3A		
BQ3B		

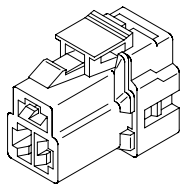
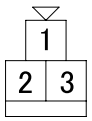
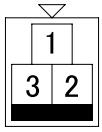
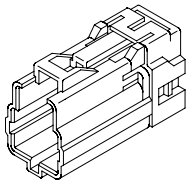
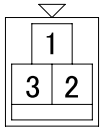
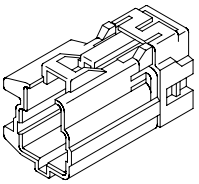
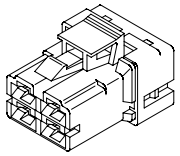
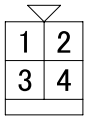
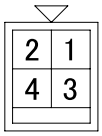
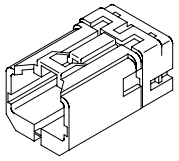
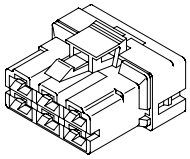
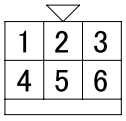
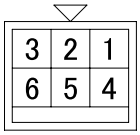
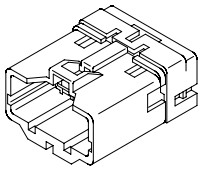
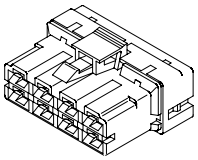
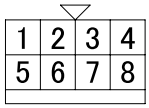
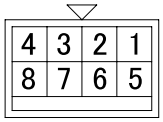
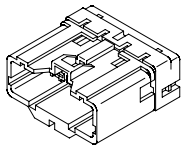
BR type

Number shows number of pins	Female connector	Male connector
BR1A		
BR2A	 	 
BR4A	 	 
BR4B	 	 

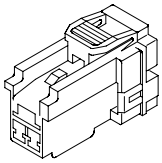
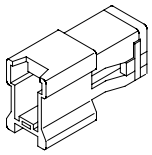
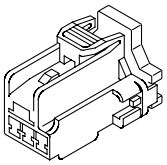
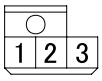
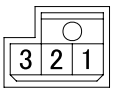
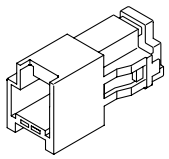
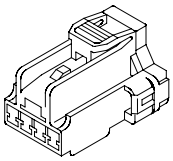
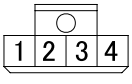
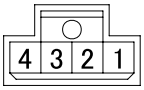
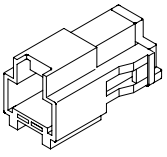
BS type

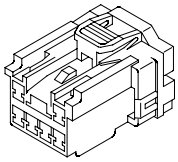
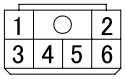
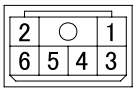
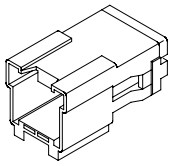
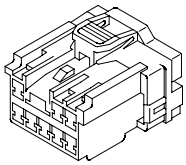
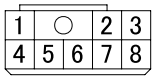
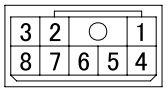
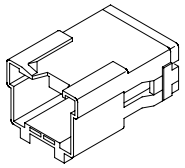
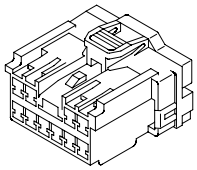
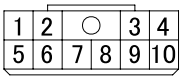
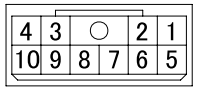
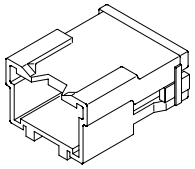
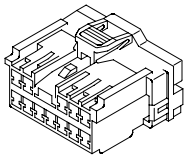
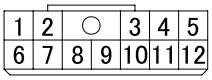
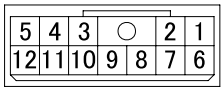
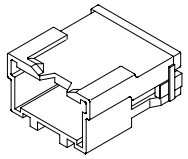
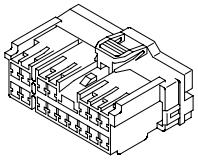
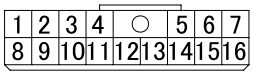
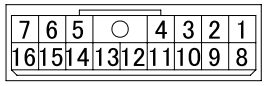
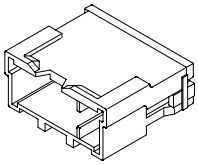
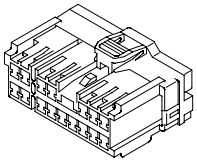
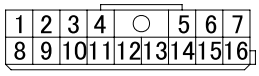
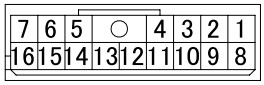
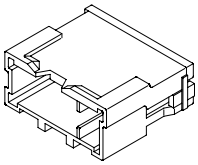
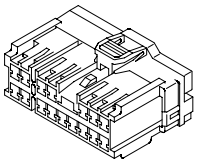
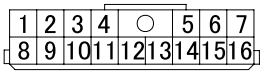
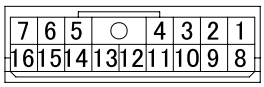
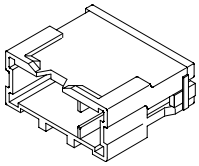
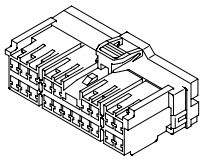
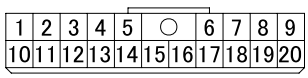
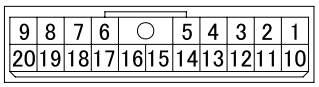
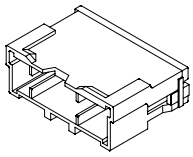
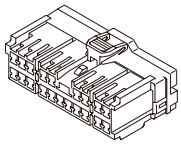
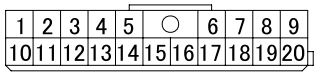
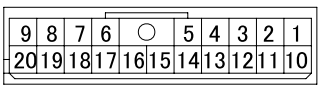
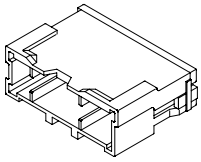
Number shows number of pins	Female connector	Male connector
BS1A		   
BS2A	 	   

CONNECTOR CONFIGURATION CHART

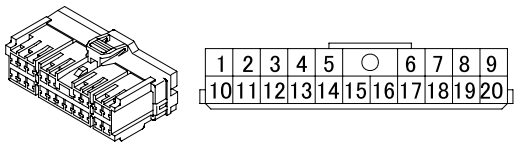
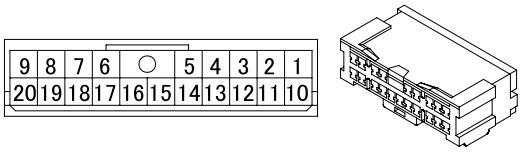
Number shows number of pins	Female connector	Male connector
BS3A	 	   
BS4A	 	 
BS6A	 	 
BS8A	 	 

BT type

Number shows number of pins	Female connector	Male connector
BT2A		
BT3A	 	 
BT4A	 	 

Number shows number of pins	Female connector	Male connector
BT6A	 	 
BT8A	 	 
BT10A	 	 
BT12A	 	 
BT16A	 	 
BT16B	 	 
BT16C	 	 
BT20A	 	 
BT20B	 	 

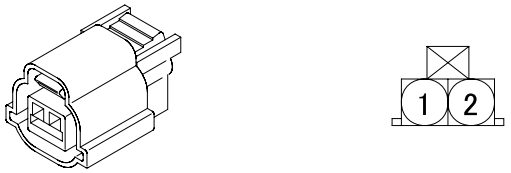
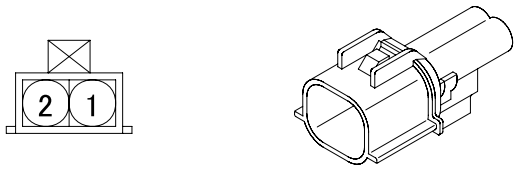
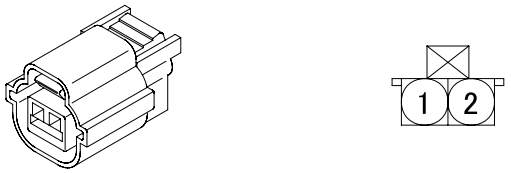
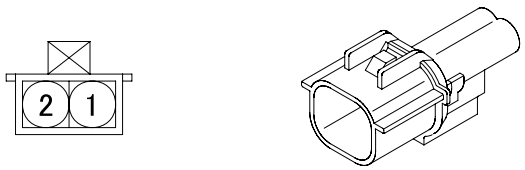
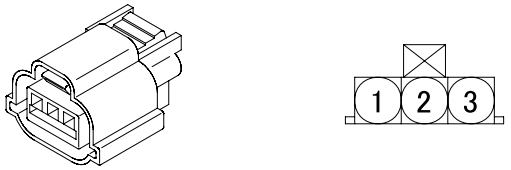
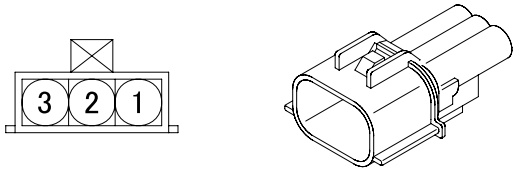
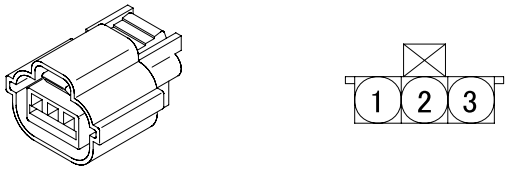
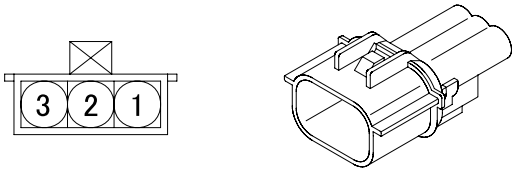
CONNECTOR CONFIGURATION CHART

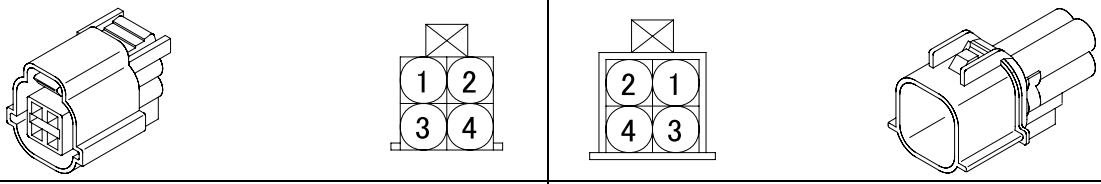
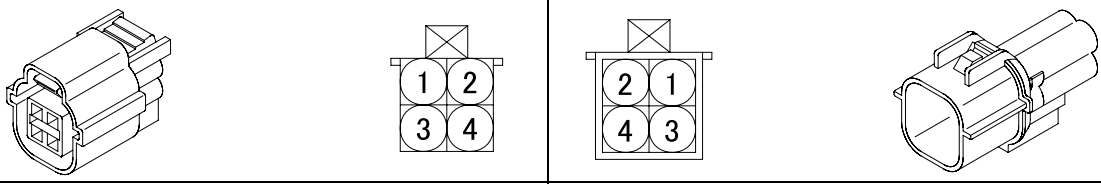
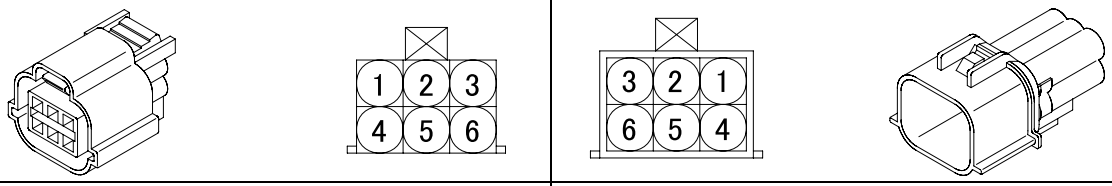
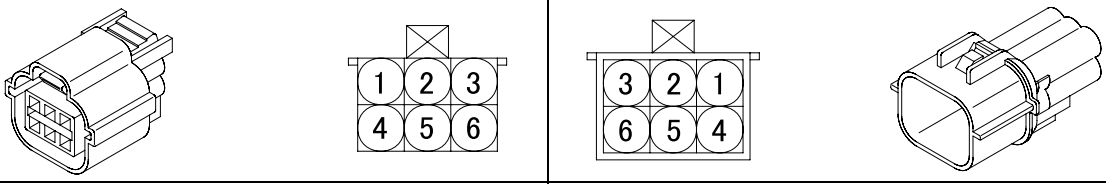
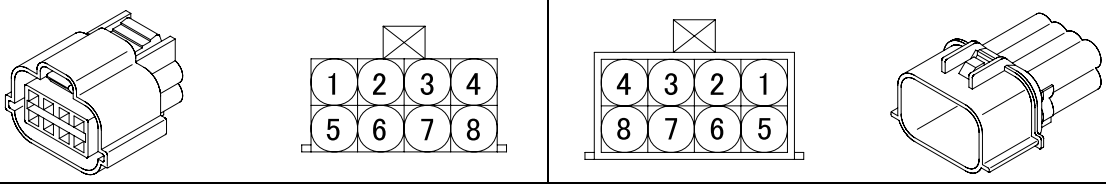
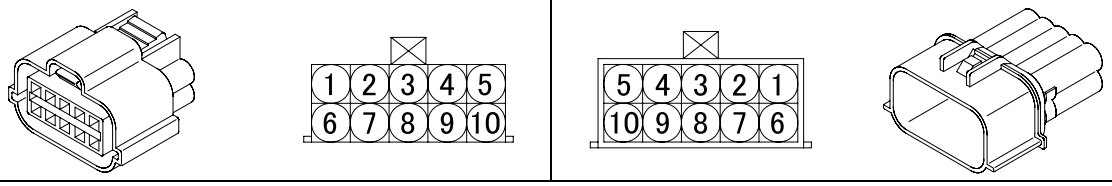
Number shows number of pins	Female connector	Male connector
BT20C		

BU type

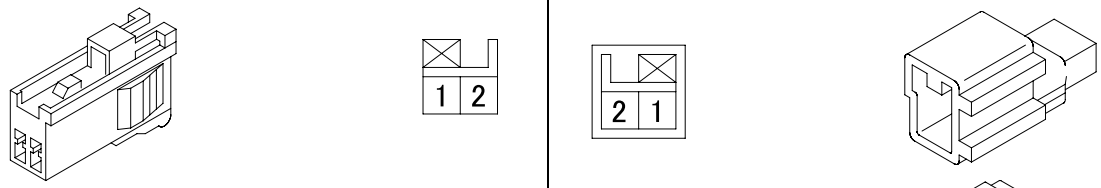
Number shows number of pins	Female connector	Male connector
BU4A		
BU6A		

BW type

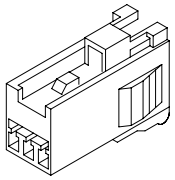
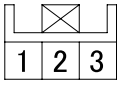
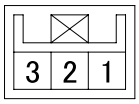
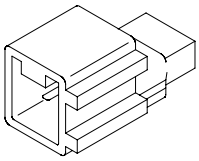
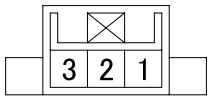
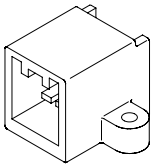
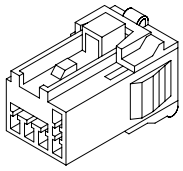
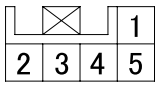
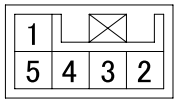
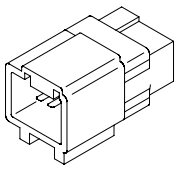
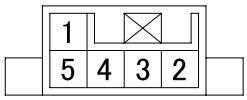
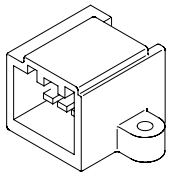
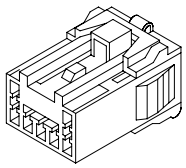
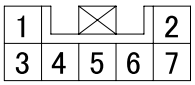
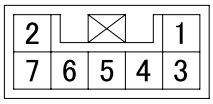
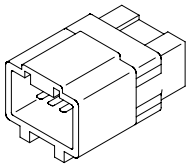
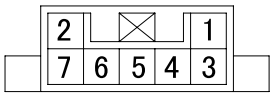
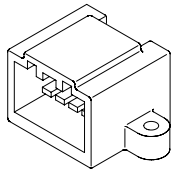
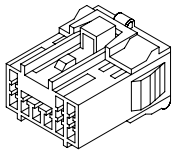
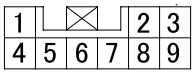
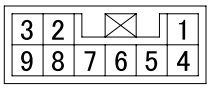
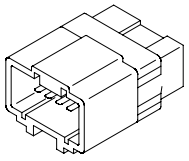
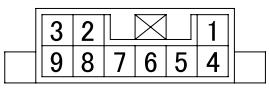
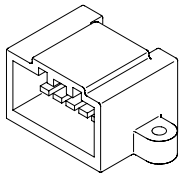
Number shows number of pins	Female connector	Male connector
BW2A		
BW2B		
BW3A		
BW3B		

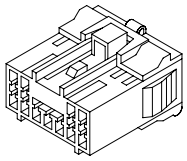
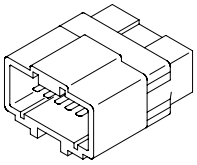
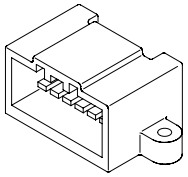
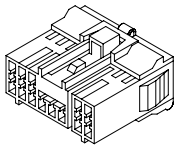
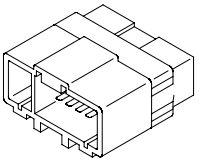
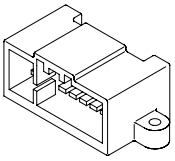
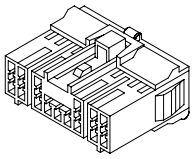
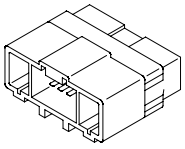
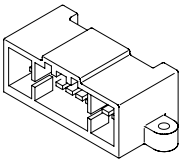
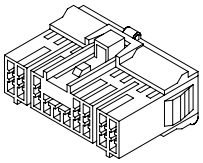
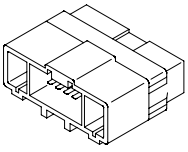
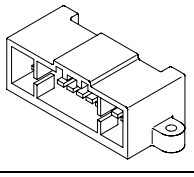
Number shows number of pins	Female connector	Male connector
BW4A		
BW4B		
BW6A		
BW6B		
BW8A		
BW10A		

BX type

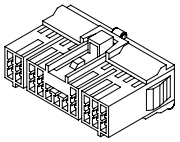
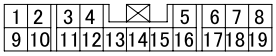
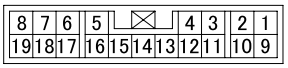
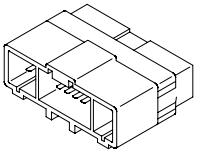
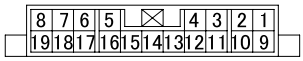
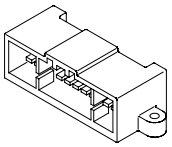
Number shows number of pins	Female connector	Male connector
BX2A		

CONNECTOR CONFIGURATION CHART

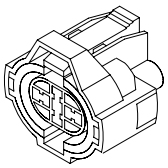
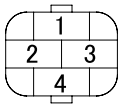
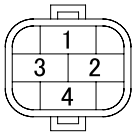
Number shows number of pins	Female connector	Male connector
BX3A	 	   
BX5A	 	   
BX7A	 	   
BX9A	 	   

Number shows number of pins	Female connector	Male connector
BX11A	 1 2 3 4 5 6 7 8 9 10 11	4 3 2 1 11 10 9 8 7 6 5  4 3 2 1 11 10 9 8 7 6 5 
BX13A	 1 2 3 4 5 6 7 8 9 10 11 12 13	5 4 3 2 1 13 12 11 10 9 8 7 6  5 4 3 2 1 13 12 11 10 9 8 7 6 
BX15A	 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	6 5 4 3 2 1 15 14 13 12 11 10 9 8 7  6 5 4 3 2 1 15 14 13 12 11 10 9 8 7 
BX17A	 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	7 6 5 4 3 2 1 17 16 15 14 13 12 11 10 9 8  7 6 5 4 3 2 1 17 16 15 14 13 12 11 10 9 8 

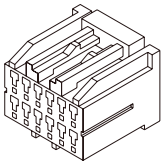
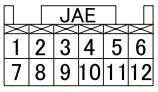
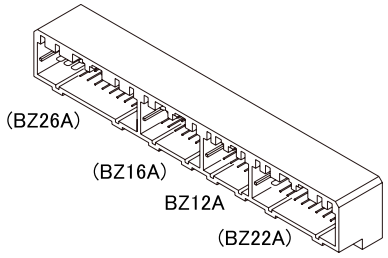
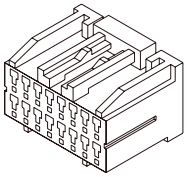
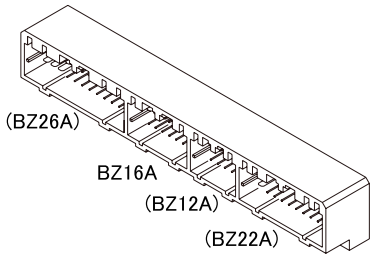
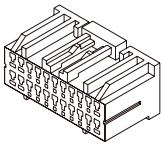
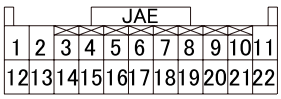
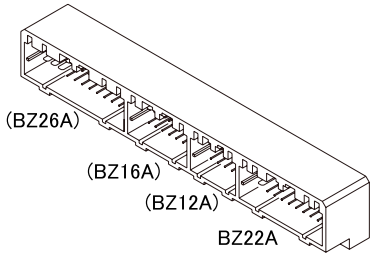
CONNECTOR CONFIGURATION CHART

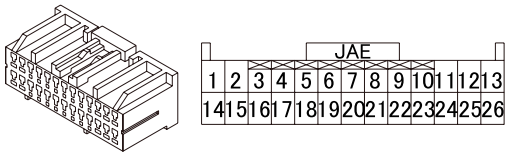
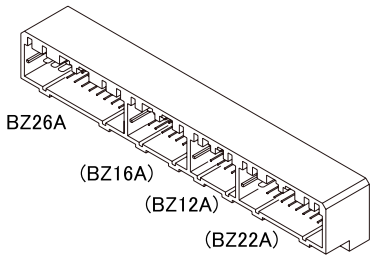
Number shows number of pins	Female connector	Male connector
BX19A	 	   

BY type

Number shows number of pins	Female connector	Male connector
BY4A	 	

BZ type

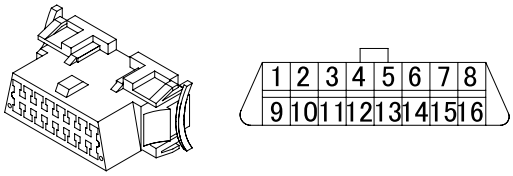
Number shows number of pins	Female connector	Male connector
BZ12A	 	
BZ16A		
BZ22A	 	

Number shows number of pins	Female connector	Male connector
BZ26A		

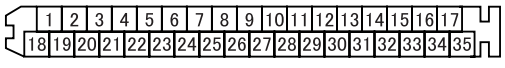
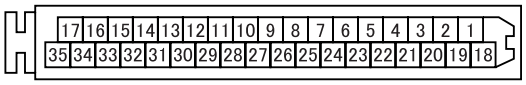
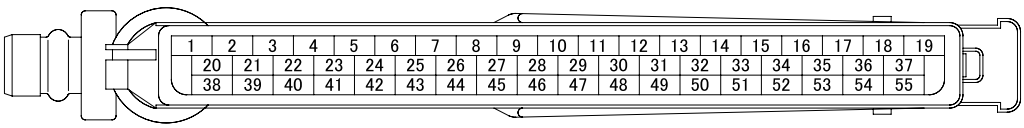
CA type

Number shows number of pins	Female connector	Male connector
CA2A		

CB type

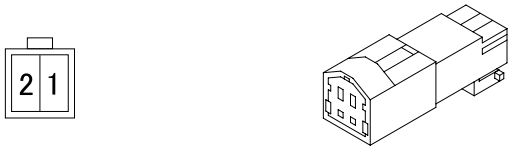
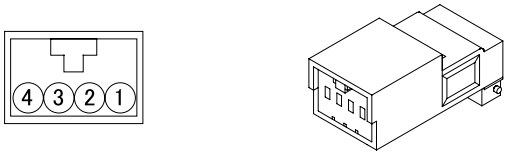
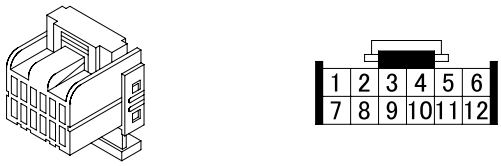
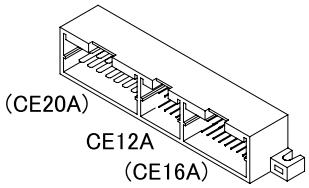
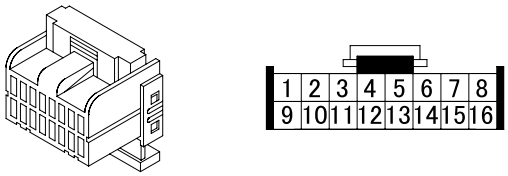
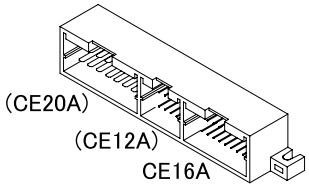
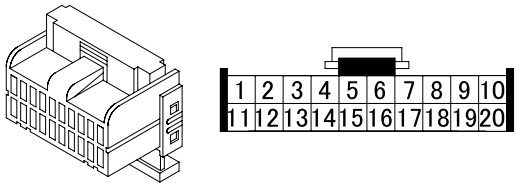
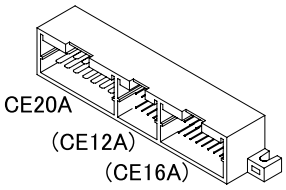
Number shows number of pins	Female connector	Male connector
CB16A		

CD type

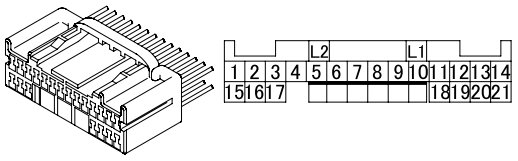
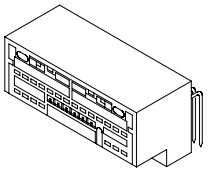
Number shows number of pins	Female connector	Male connector
CD35A		
CD55A		

CONNECTOR CONFIGURATION CHART

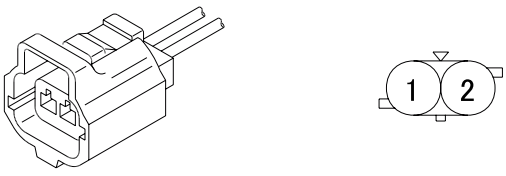
CE type

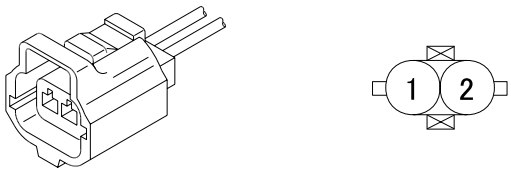
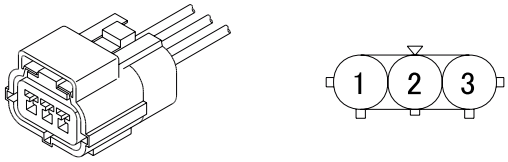
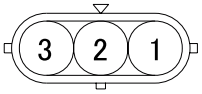
Number shows number of pins	Female connector	Male connector
CE2A		
CE4A		
CE12A		
CE16A		
CE20A		

CF type

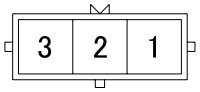
Number shows number of pins	Female connector	Male connector
CF21A		

CH type

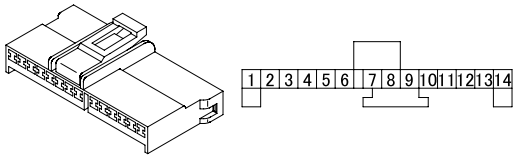
Number shows number of pins	Female connector	Male connector
CH2A		

Number shows number of pins	Female connector	Male connector
CH2B		
CH3A		

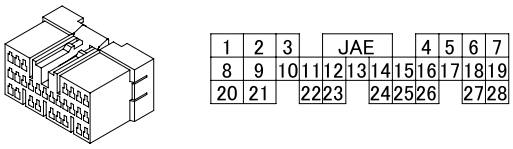
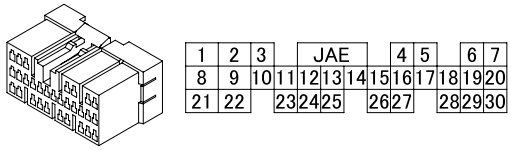
CK type

Number shows number of pins	Female connector	Male connector
CK3A		

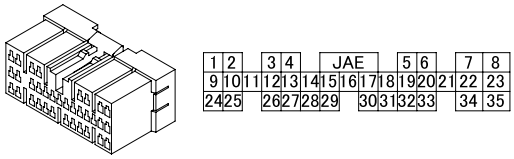
CL type

Number shows number of pins	Female connector	Male connector
CL14A		

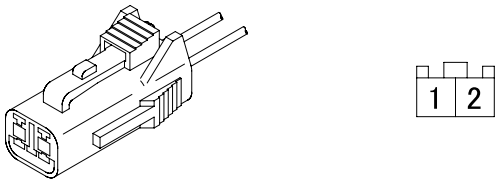
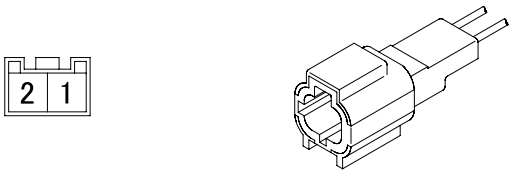
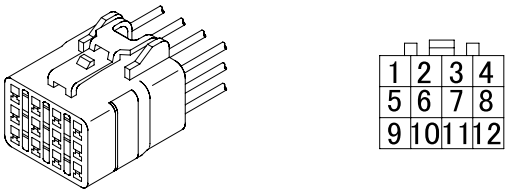
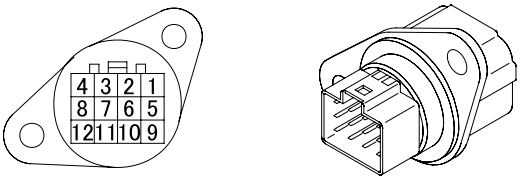
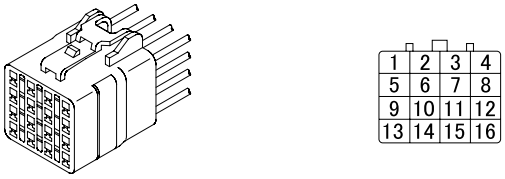
CM type

Number shows number of pins	Female connector	Male connector
CM28A		
CM30A		

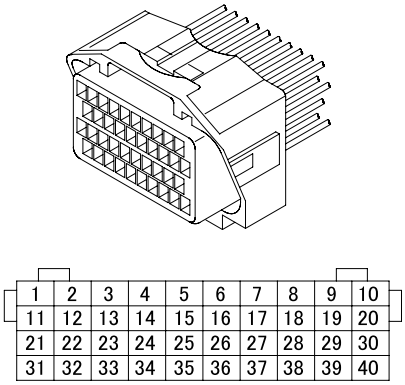
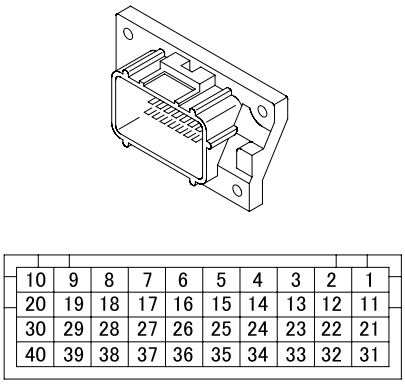
CONNECTOR CONFIGURATION CHART

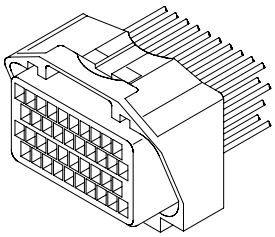
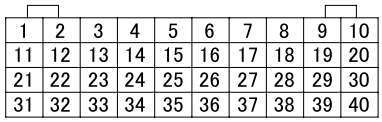
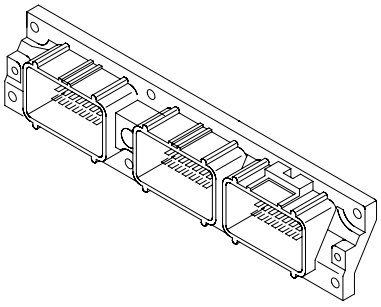
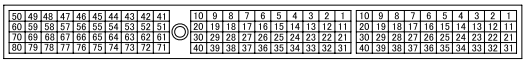
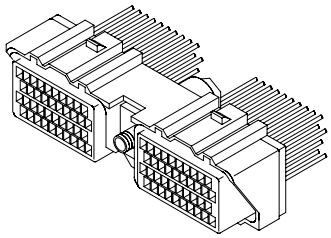
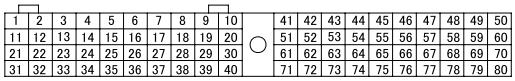
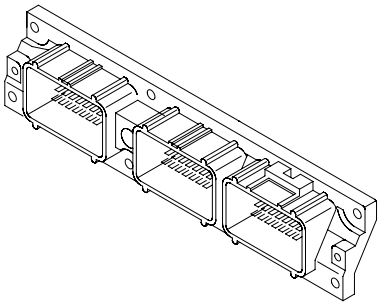
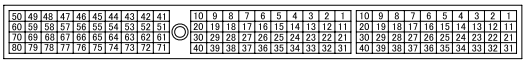
Number shows number of pins	Female connector	Male connector
CM35A		

CN type

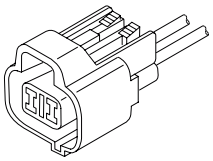
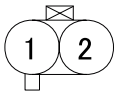
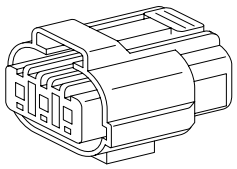
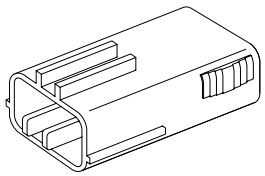
Number shows number of pins	Female connector	Male connector
CN2A		
CN12A		
CN16A		

CP type

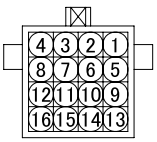
Number shows number of pins	Female connector	Male connector
CP40A		

Number shows number of pins	Female connector	Male connector
CP40B	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	  (CP80A) CP40B
CP80A	  1 2 3 4 5 6 7 8 9 10 / 41 42 43 44 45 46 47 48 49 50 11 12 13 14 15 16 17 18 19 20 / 51 52 53 54 55 56 57 58 59 60 21 22 23 24 25 26 27 28 29 30 / 61 62 63 64 65 66 67 68 69 70 31 32 33 34 35 36 37 38 39 40 / 71 72 73 74 75 76 77 78 79 80	  CP80A (CP40B)

CQ type

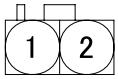
Number shows number of pins	Female connector	Male connector
CQ2B	  1 2	
CQ3A		

CR type

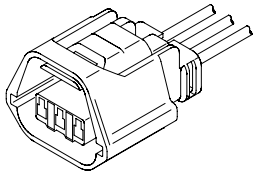
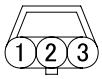
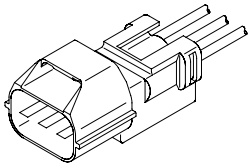
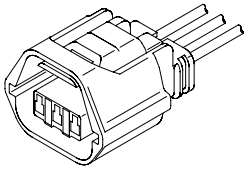
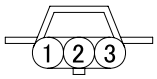
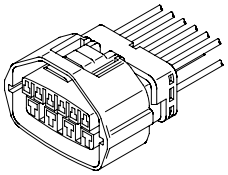
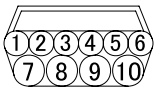
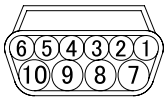
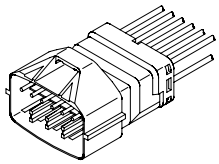
Number shows number of pins	Female connector	Male connector
CR16A		 4 3 2 1 8 7 6 5 12 11 10 9 16 15 14 13

CONNECTOR CONFIGURATION CHART

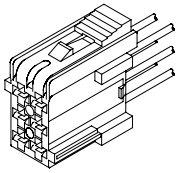
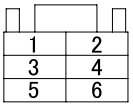
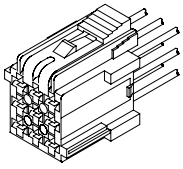
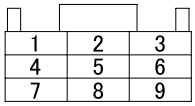
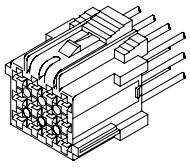
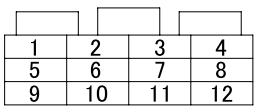
CS type

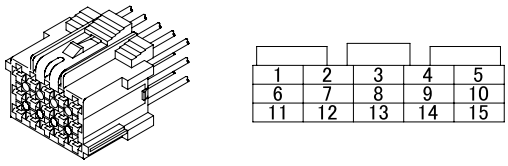
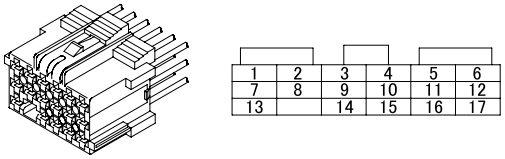
Number shows number of pins	Female connector	Male connector
CS2A		

CT type

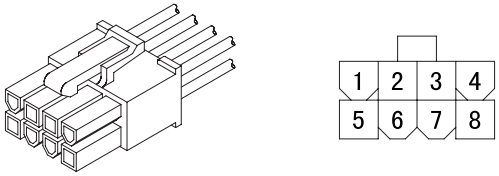
Number shows number of pins	Female connector	Male connector
CT3A	 	
CT3B	 	
CT10A	 	 

CU type

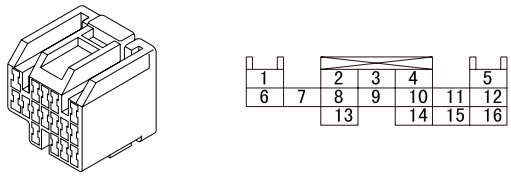
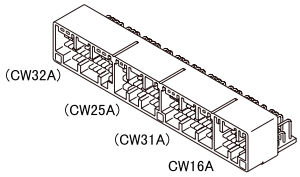
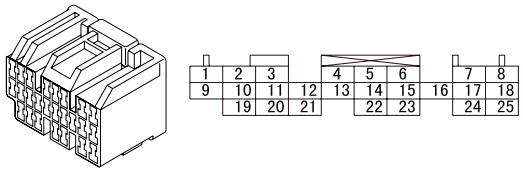
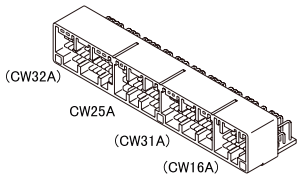
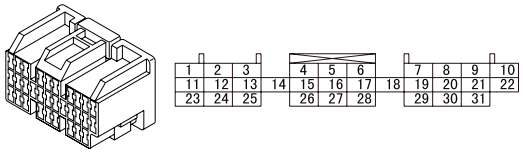
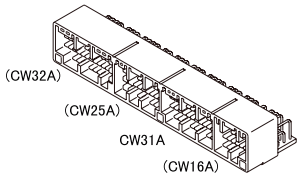
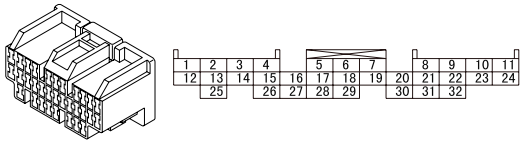
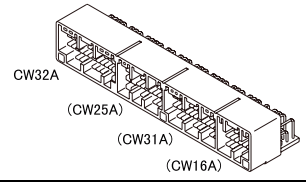
Number shows number of pins	Female connector	Male connector
CU6A	 	
CU9A	 	
CU12A	 	

Number shows number of pins	Female connector	Male connector
CU15A		
CU17A		

CV type

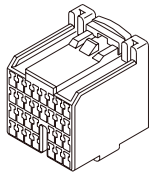
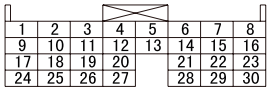
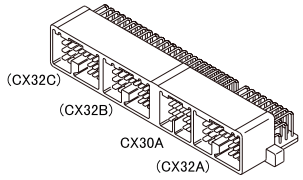
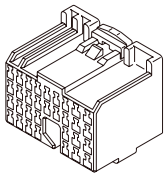
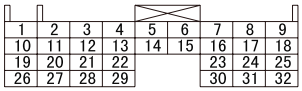
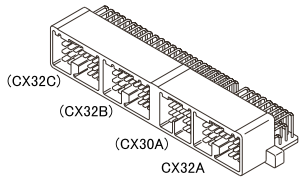
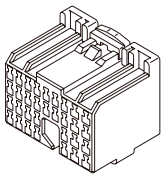
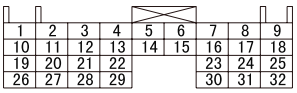
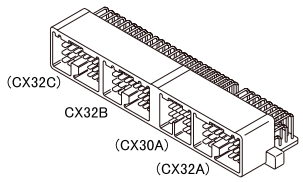
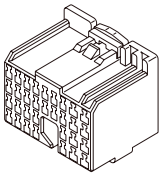
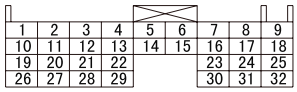
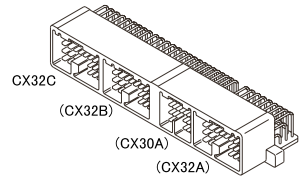
Number shows number of pins	Female connector	Male connector
CV8A		

CW type

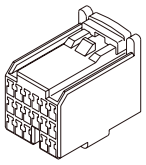
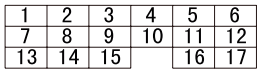
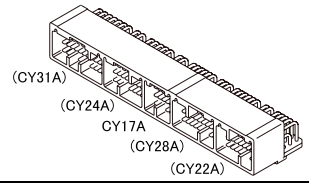
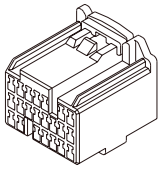
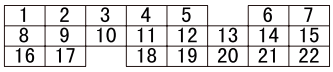
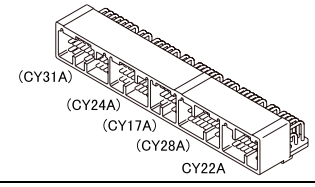
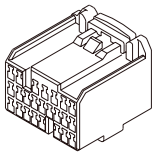
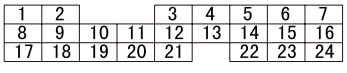
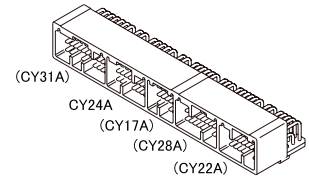
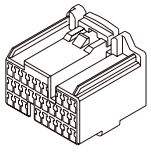
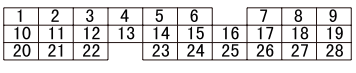
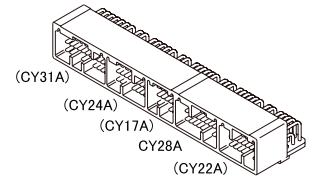
Number shows number of pins	Female connector	Male connector
CW16A		
CW25A		
CW31A		
CW32A		

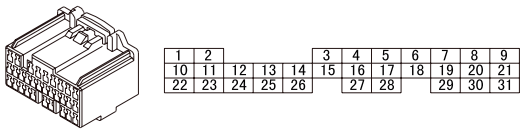
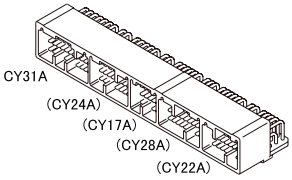
CONNECTOR CONFIGURATION CHART

CX type

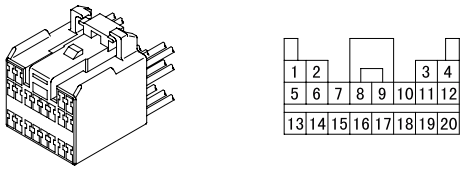
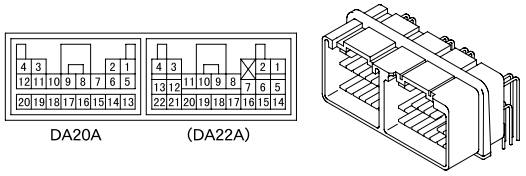
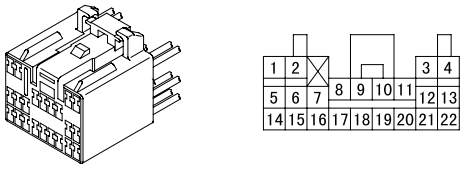
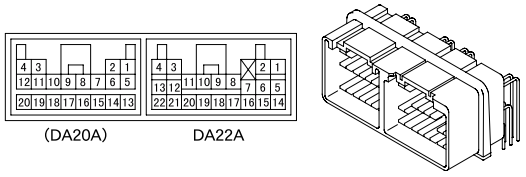
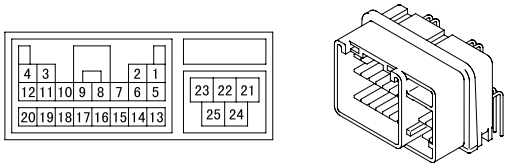
Number shows number of pins	Female connector	Male connector
CX30A	 	
CX32A	 	
CX32B	 	
CX32C	 	

CY type

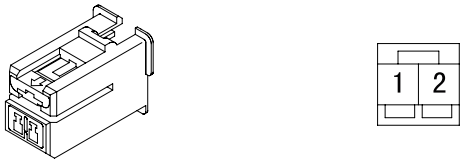
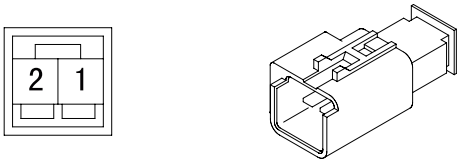
Number shows number of pins	Female connector	Male connector
CY17A	 	
CY22A	 	
CY24A	 	
CY28A	 	

Number shows number of pins	Female connector	Male connector
CY31A		

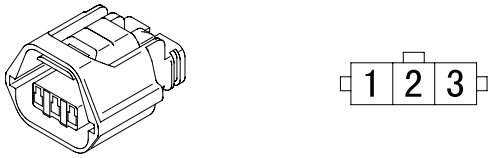
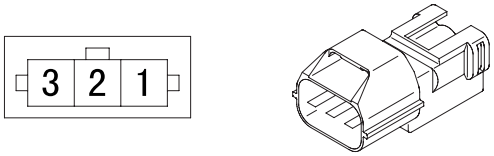
DA type

Number shows number of pins	Female connector	Male connector
DA20A		
DA22A		
DA25A		

DB type

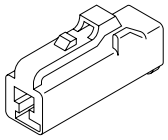
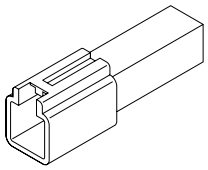
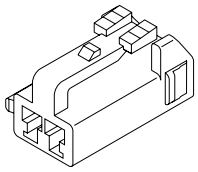
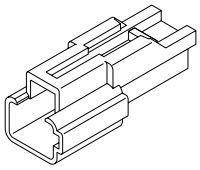
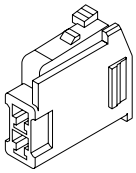
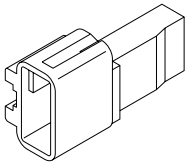
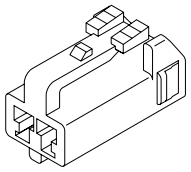
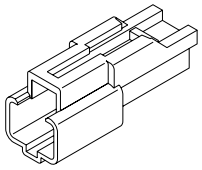
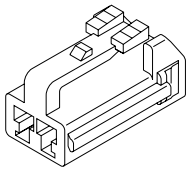
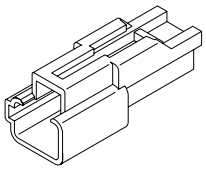
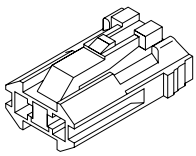
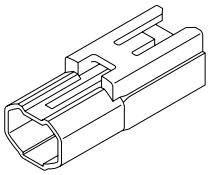
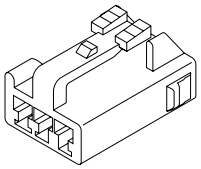
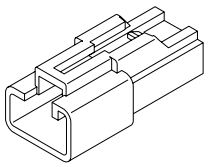
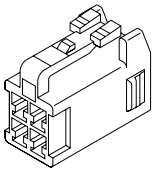
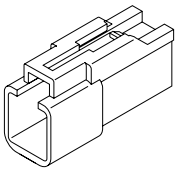
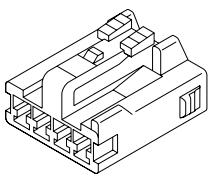
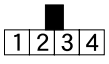
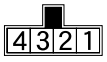
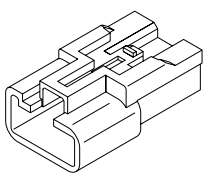
Number shows number of pins	Female connector	Male connector
DB2A		

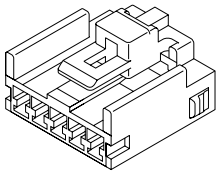
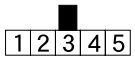
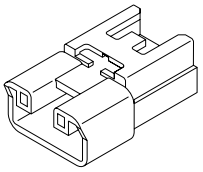
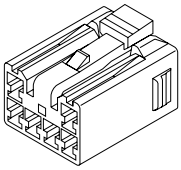
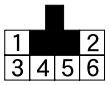
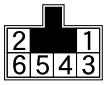
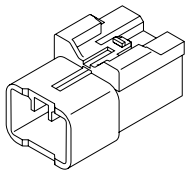
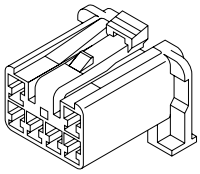
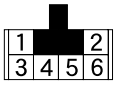
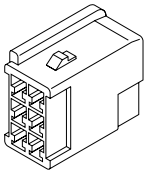
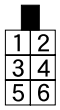
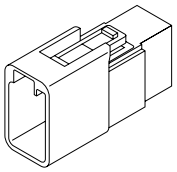
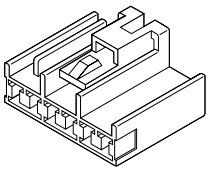
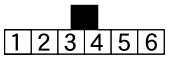
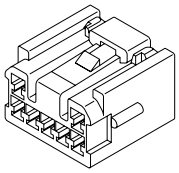
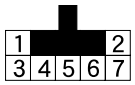
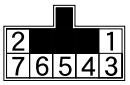
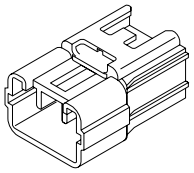
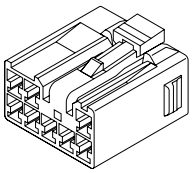
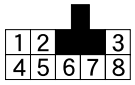
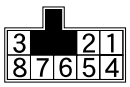
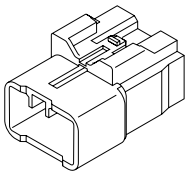
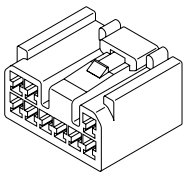
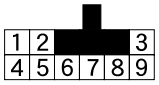
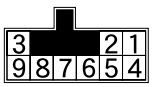
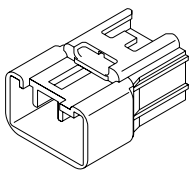
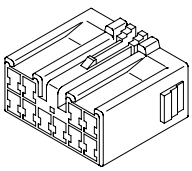
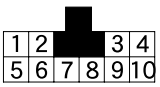
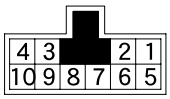
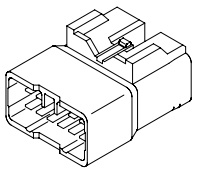
DC type

Number shows number of pins	Female connector	Male connector
DC3A		

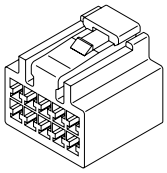
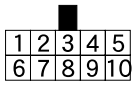
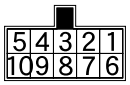
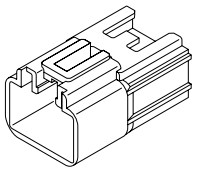
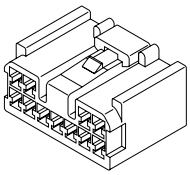
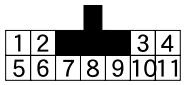
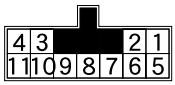
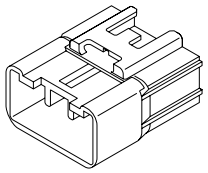
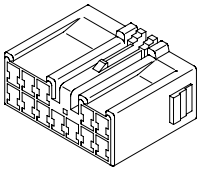
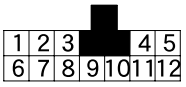
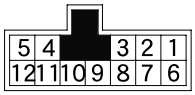
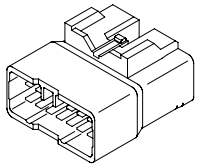
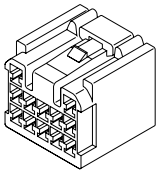
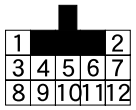
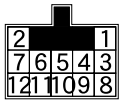
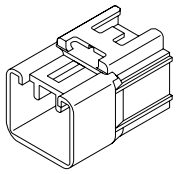
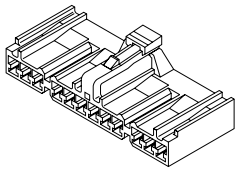
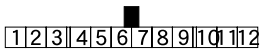
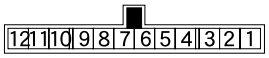
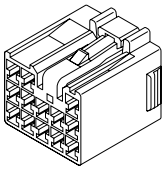
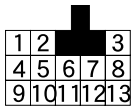
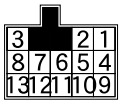
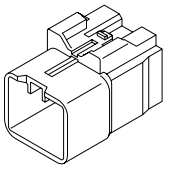
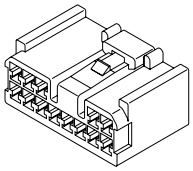
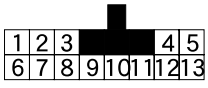
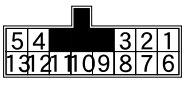
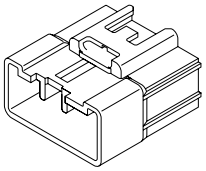
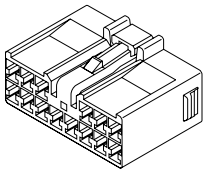
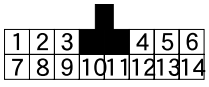
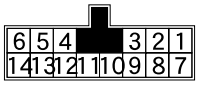
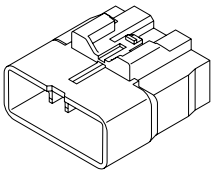
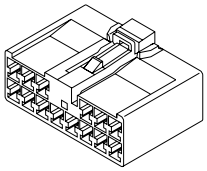
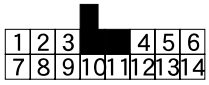
CONNECTOR CONFIGURATION CHART

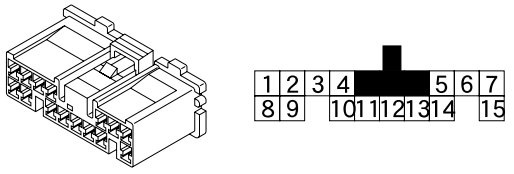
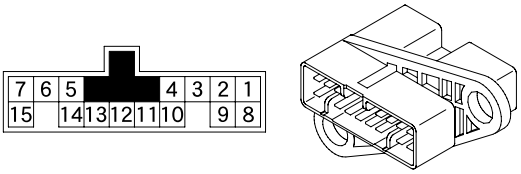
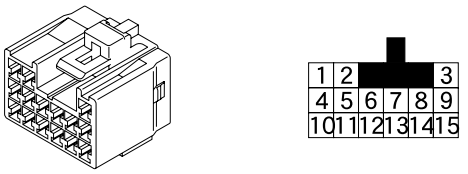
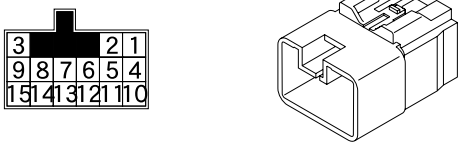
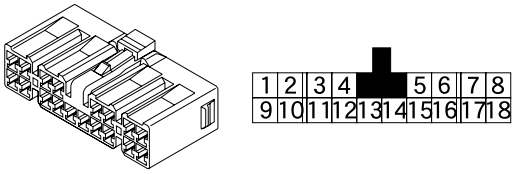
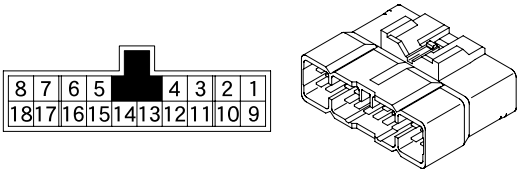
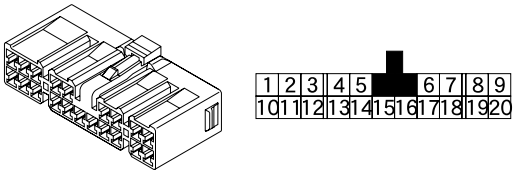
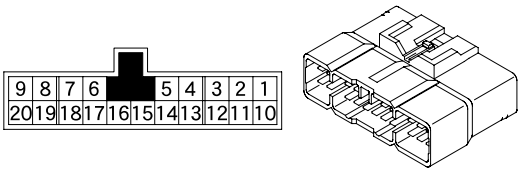
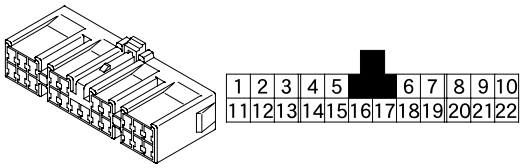
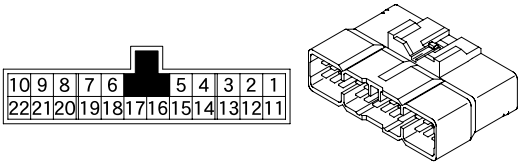
DD type

Number shows number of pins	Female connector	Male connector
DD1A		
DD2A		
DD2B		
DD2C		
DD2E		
DD2F		
DD3A		
DD4A		
DD4C	 	 

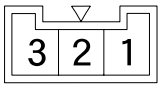
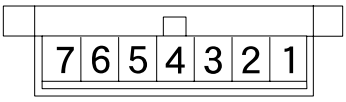
Number shows number of pins	Female connector	Male connector
DD5A	 	
DD6A	 	 
DD6B	 	
DD6C	 	
DD6E	 	
DD7A	 	 
DD8A	 	 
DD9A	 	 
DD10A	 	 

CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DD10B	 	 
DD11A	 	 
DD12A	 	 
DD12B	 	 
DD12C	 	
DD13A	 	 
DD13B	 	 
DD14A	 	 
DD14B	 	

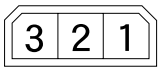
Number shows number of pins	Female connector	Male connector
DD15A		
DD15B		
DD18A		
DD20A		
DD22A		

DE type

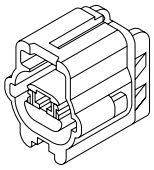
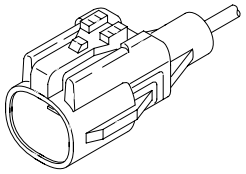
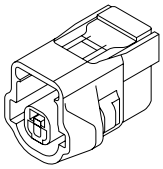
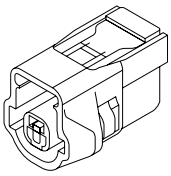
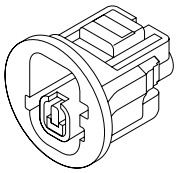
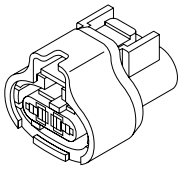
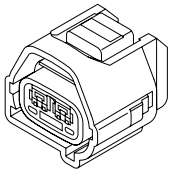
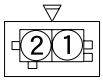
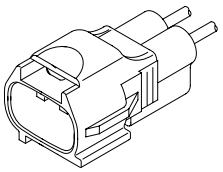
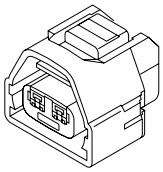
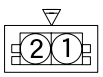
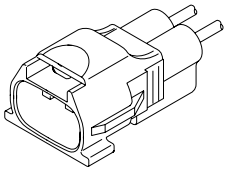
Number shows number of pins	Female connector	Male connector
DE3A		
DE7A		

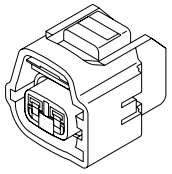
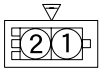
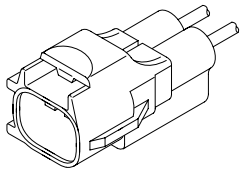
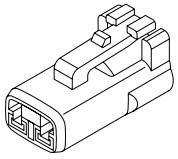
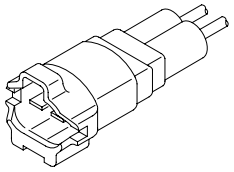
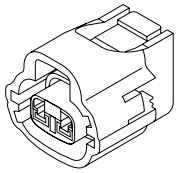
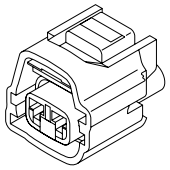
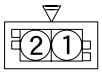
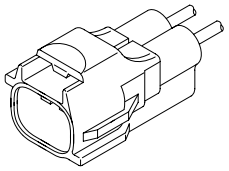
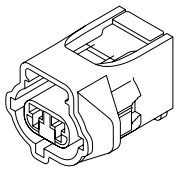
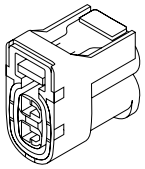
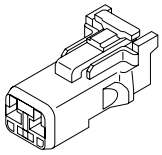
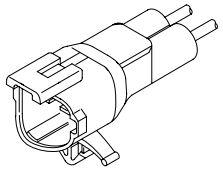
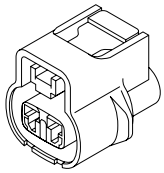
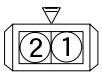
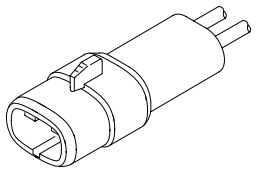
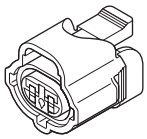
CONNECTOR CONFIGURATION CHART

DF type

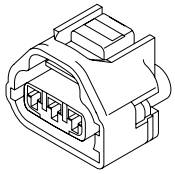
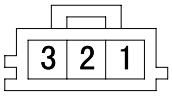
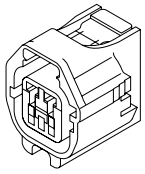
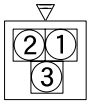
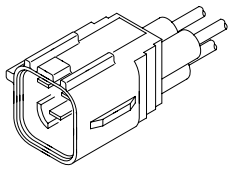
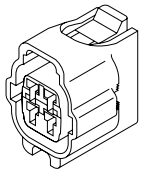
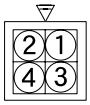
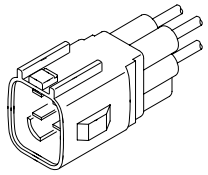
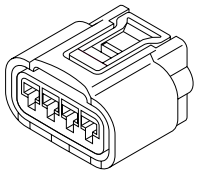
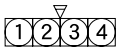
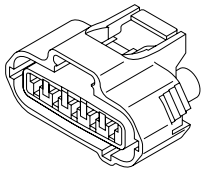
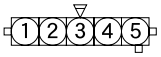
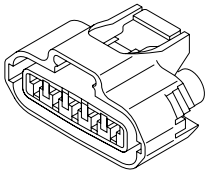
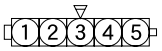
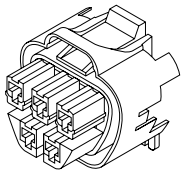
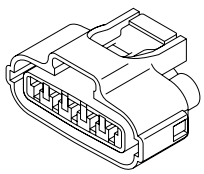
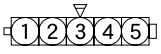
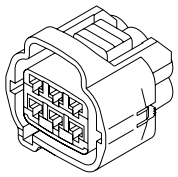
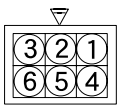
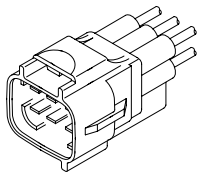
Number shows number of pins	Female connector	Male connector
DF3A		

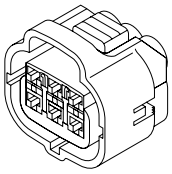
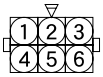
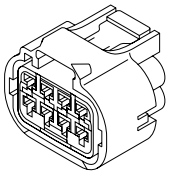
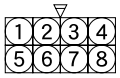
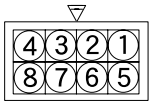
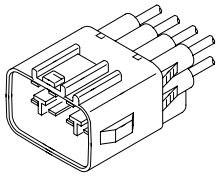
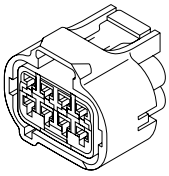
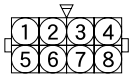
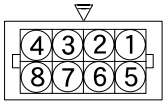
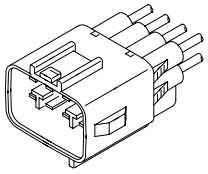
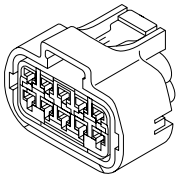
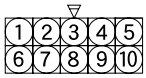
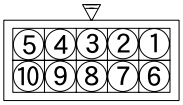
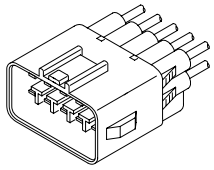
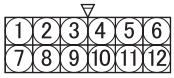
DG type

Number shows number of pins	Female connector	Male connector
DG1A		
DG1B		
DG1C		
DG1D		
DG2A		
DG2B		 
DG2C		 

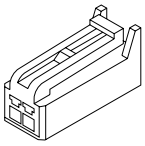
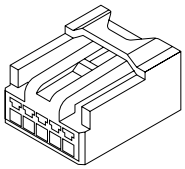
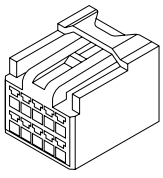
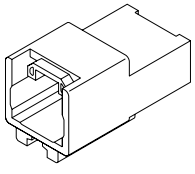
Number shows number of pins	Female connector	Male connector
DG2D		 
DG2E		
DG2F		
DG2G		 
DG2H		
DG2J		
DG2K		
DG2L		 
DG2M		

CONNECTOR CONFIGURATION CHART

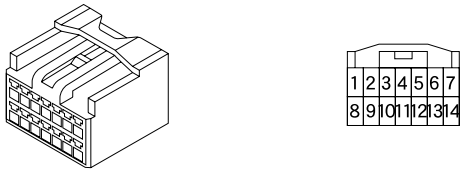
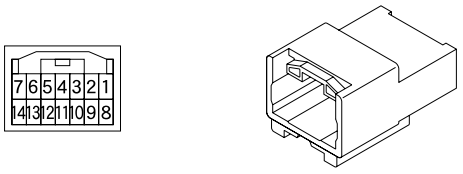
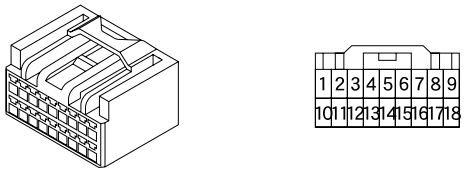
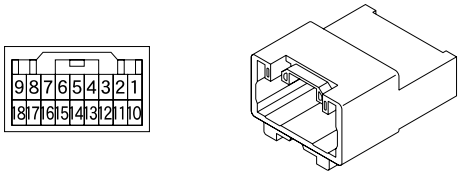
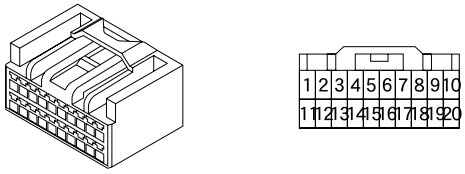
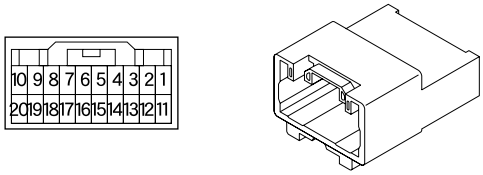
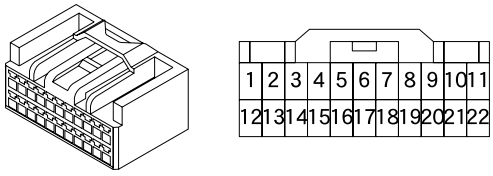
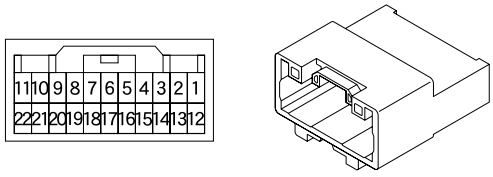
Number shows number of pins	Female connector	Male connector
DG3A		
DG3B		 
DG4A		 
DG4B	 	
DG5A	 	
DG5B	 	
DG5C		
DG5D	 	
DG6A		 

Number shows number of pins	Female connector	Male connector
DG6B	 	
DG8A	 	 
DG8B	 	 
DG10A	 	 
DG12A		

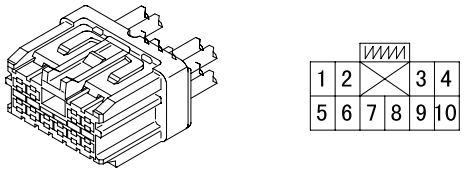
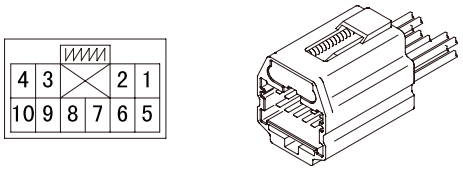
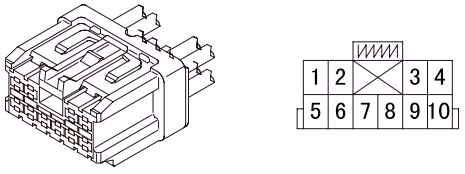
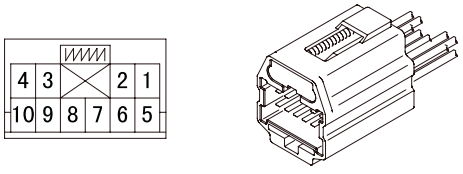
DH type

Number shows number of pins	Female connector	Male connector
DH2A		
DH5A		
DH10A		

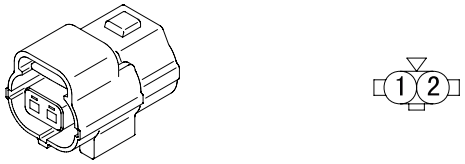
CONNECTOR CONFIGURATION CHART

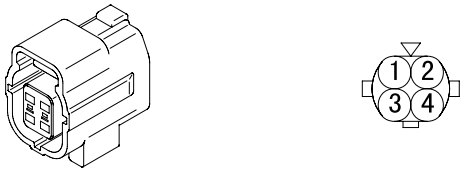
Number shows number of pins	Female connector	Male connector
DH14A		
DH18A		
DH20A		
DH22A		

DJ type

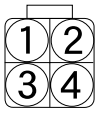
Number shows number of pins	Female connector	Male connector
DJ10A		
DJ10B		

DK type

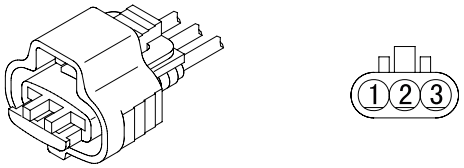
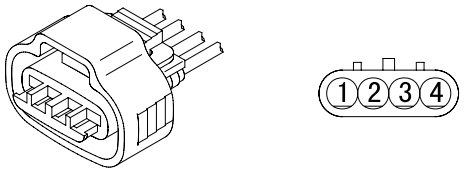
Number shows number of pins	Female connector	Male connector
DK2A		

Number shows number of pins	Female connector	Male connector
DK4A		

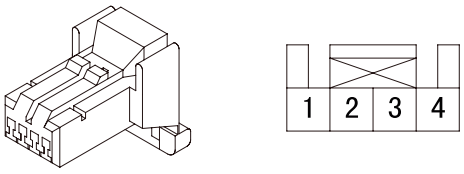
DL type

Number shows number of pins	Female connector	Male connector
DL4A		

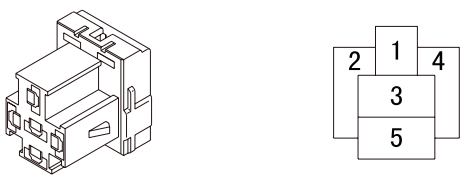
DM type

Number shows number of pins	Female connector	Male connector
DM3A		
DM4A		

DN type

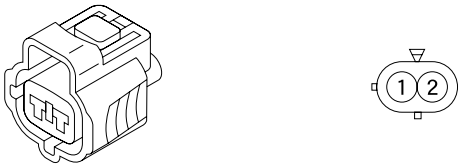
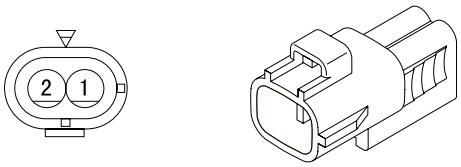
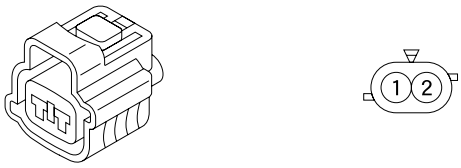
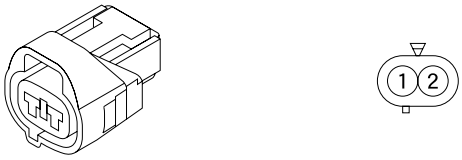
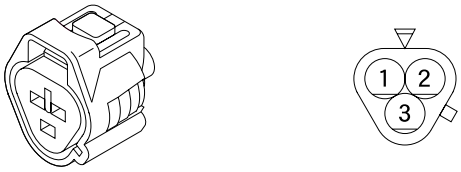
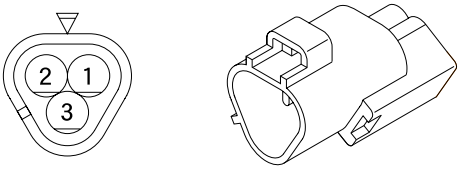
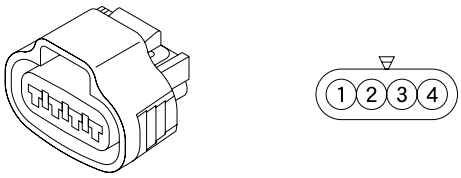
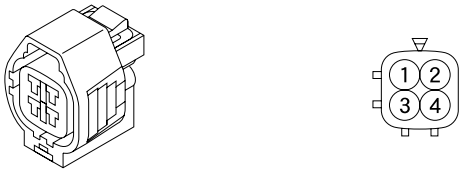
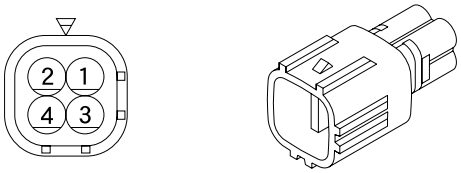
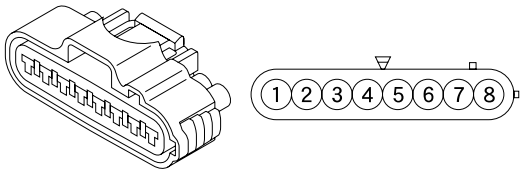
Number shows number of pins	Female connector	Male connector
DN4A		

DP type

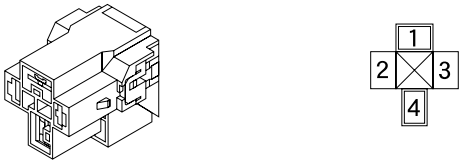
Number shows number of pins	Female connector	Male connector
DP5A		

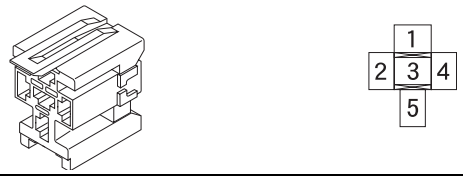
CONNECTOR CONFIGURATION CHART

DQ type

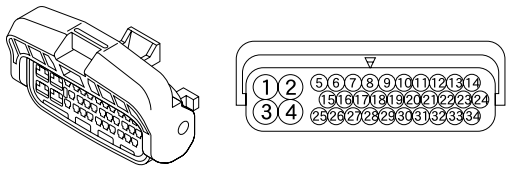
Number shows number of pins	Female connector	Male connector
DQ2A		
DQ2B		
DQ2C		
DQ3A		
DQ4A		
DQ4B		
DQ8A		

EN type

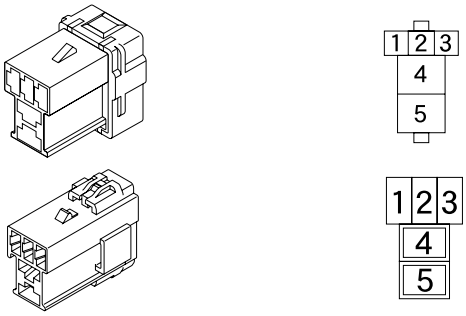
Number shows number of pins	Female connector	Male connector
EN4A		

Number shows number of pins	Female connector	Male connector
EN5A		

EP type

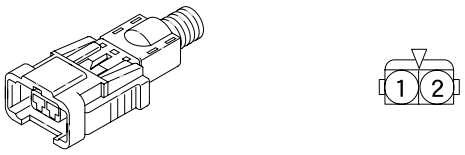
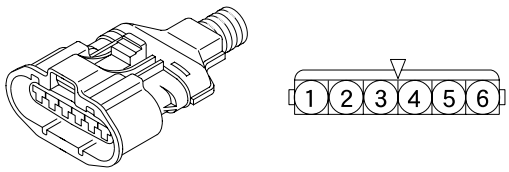
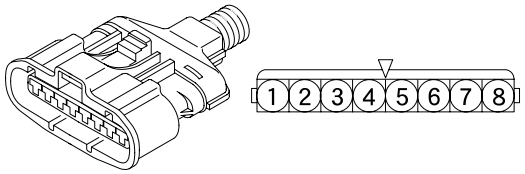
Number shows number of pins	Female connector	Male connector
EP34A		

EQ type

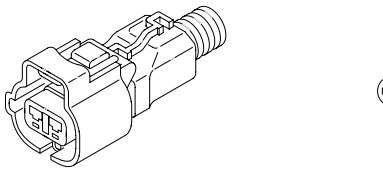
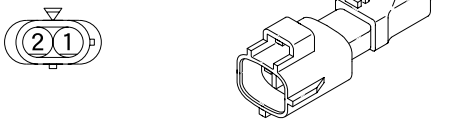
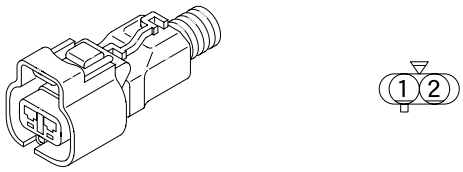
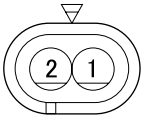
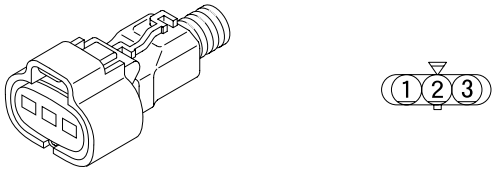
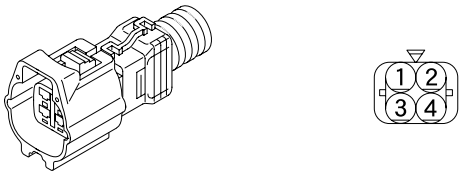
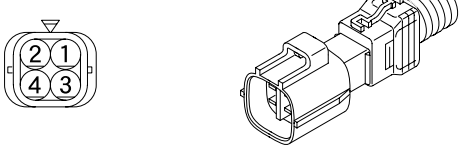
Number shows number of pins	Female connector	Male connector
EQ4A		
EQ4B		
EQ5A		
EQ5B		

CONNECTOR CONFIGURATION CHART

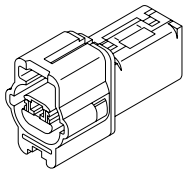
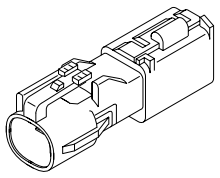
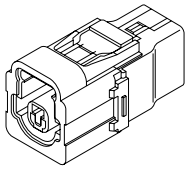
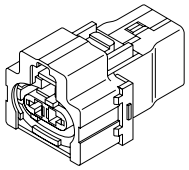
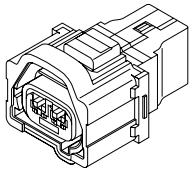
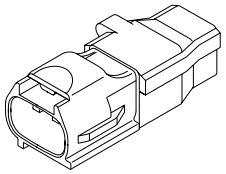
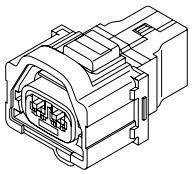
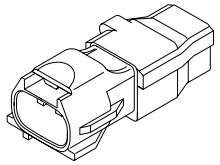
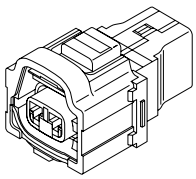
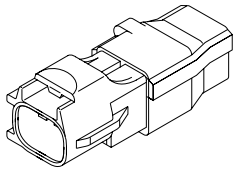
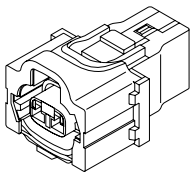
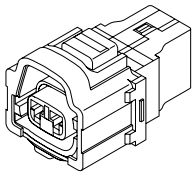
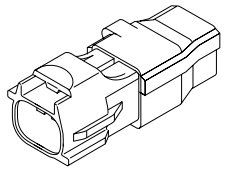
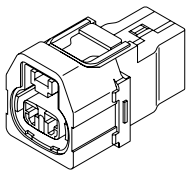
ER type

Number shows number of pins	Female connector	Male connector
ER2A		
ER6A		
ER8A		

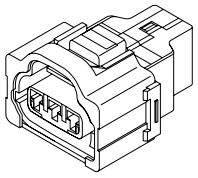
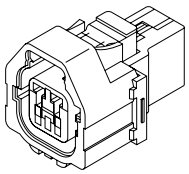
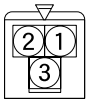
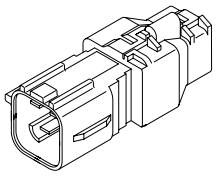
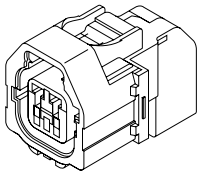
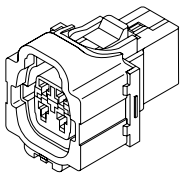
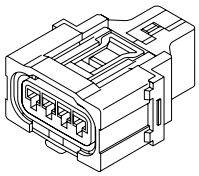
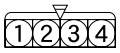
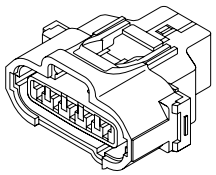
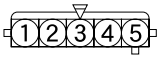
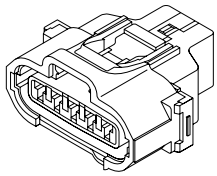
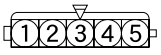
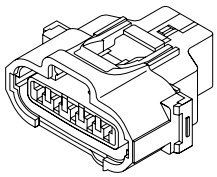
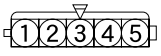
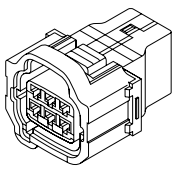
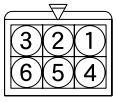
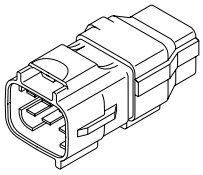
ES type

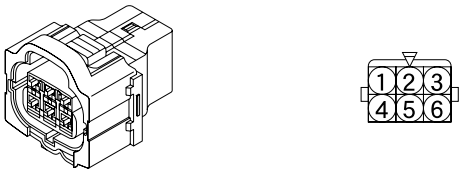
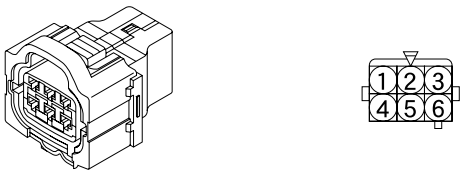
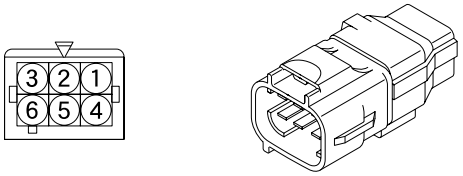
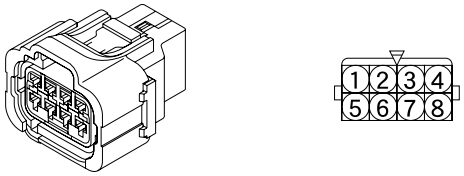
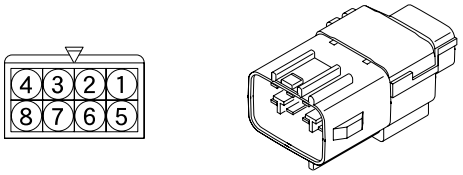
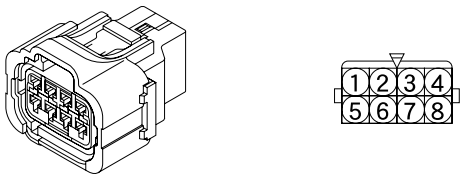
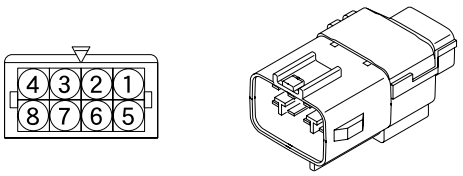
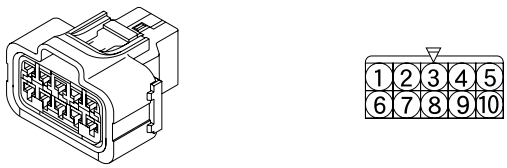
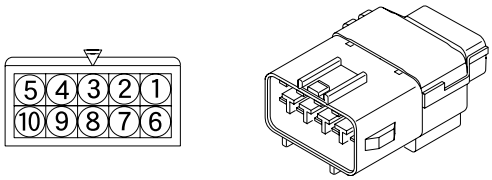
Number shows number of pins	Female connector	Male connector
ES2A		
ES2B		
ES2C		
ES3A		
ES4A		

ET type

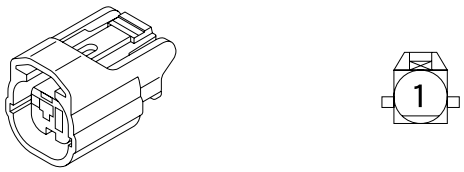
Number shows number of pins	Female connector	Male connector
ET1A		
ET1B		
ET2A		
ET2B		
ET2C		
ET2D		
ET2F		
ET2G		
ET2L		

CONNECTOR CONFIGURATION CHART

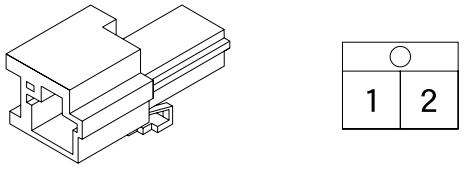
Number shows number of pins	Female connector	Male connector
ET3A		
ET3B		 
ET3C		
ET4A		
ET4B	 	
ET5A	 	
ET5B	 	
ET5D	 	
ET6A		 

Number shows number of pins	Female connector	Male connector
ET6B		
ET6C		
ET8A		
ET8B		
ET10A		

EU type

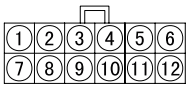
Number shows number of pins	Female connector	Male connector
EU1A		

EV type

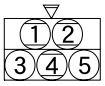
Number shows number of pins	Female connector	Male connector
EV2A		

CONNECTOR CONFIGURATION CHART

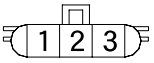
EW type

Number shows number of pins	Female connector	Male connector
EW12A		

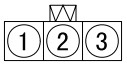
EX type

Number shows number of pins	Female connector	Male connector
EX5A		

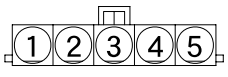
EY type

Number shows number of pins	Female connector	Male connector
EY3A		

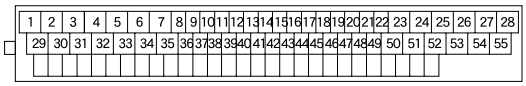
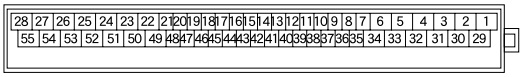
EZ type

Number shows number of pins	Female connector	Male connector
EZ3A		

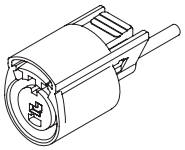
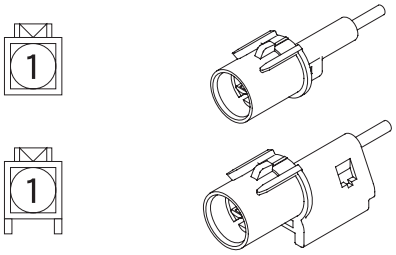
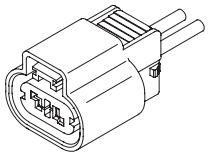
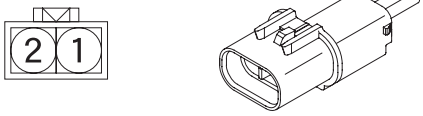
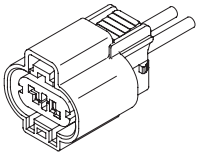
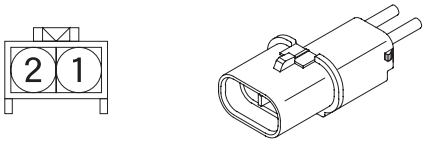
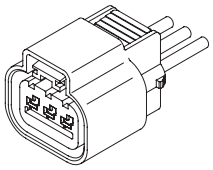
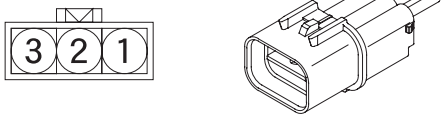
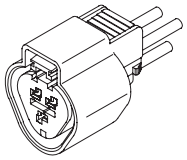
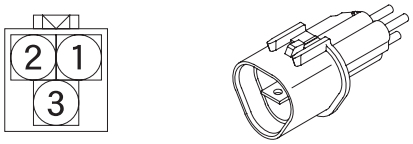
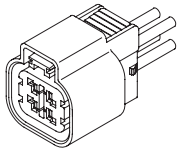
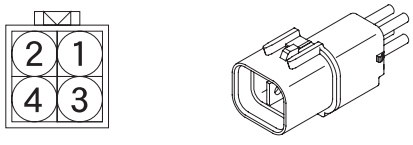
FA type

Number shows number of pins	Female connector	Male connector
FA5A		

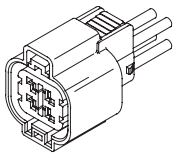
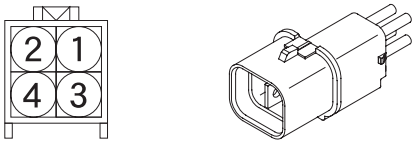
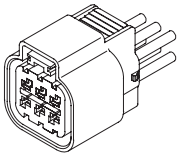
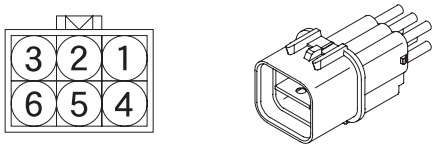
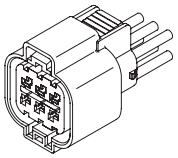
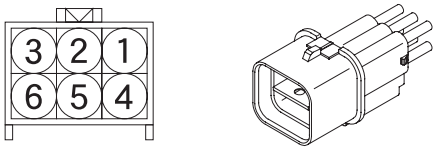
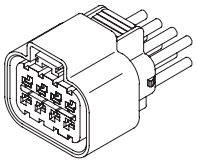
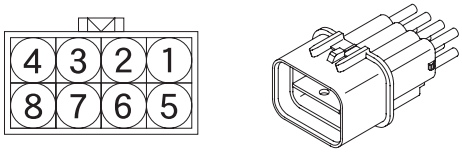
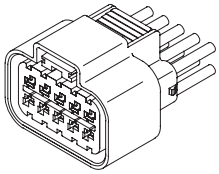
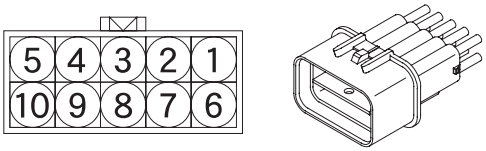
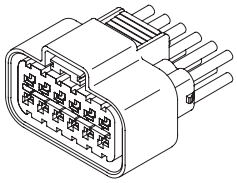
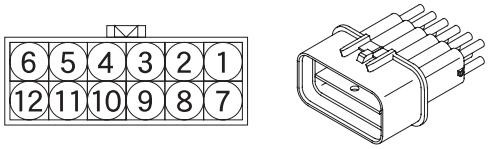
FB type

Number shows number of pins	Female connector	Male connector
FB55A		

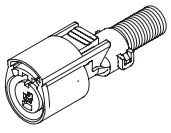
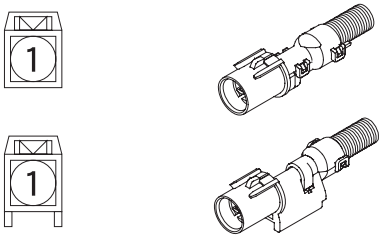
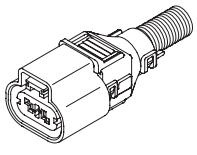
GA type

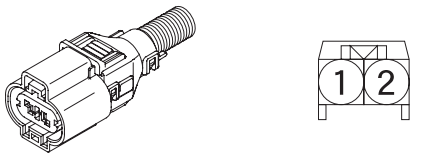
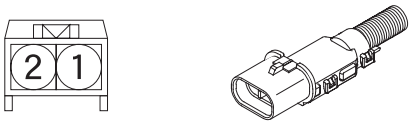
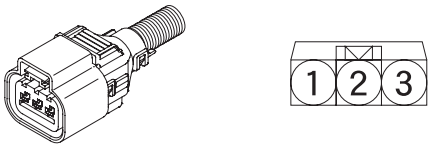
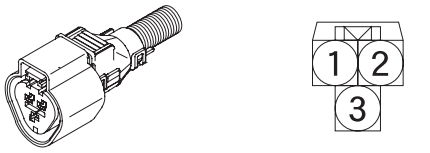
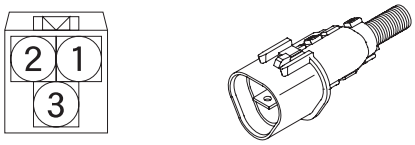
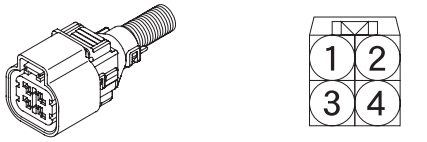
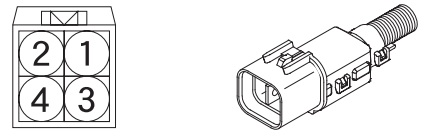
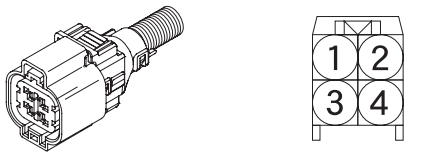
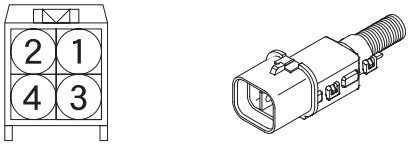
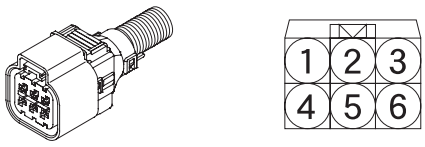
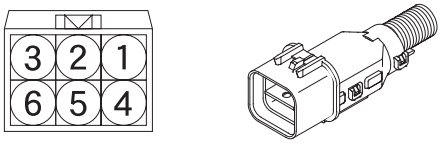
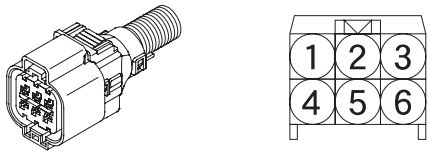
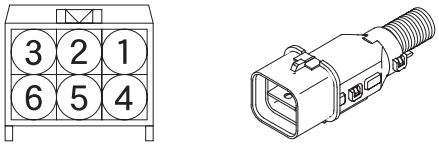
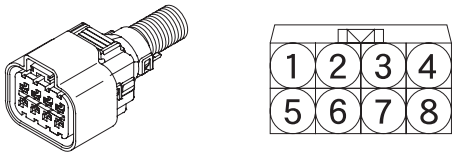
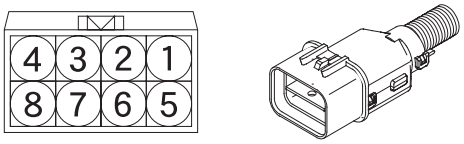
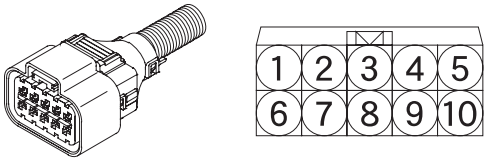
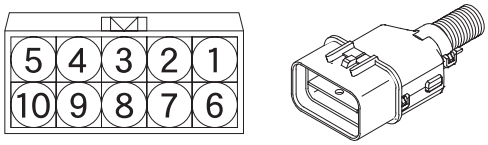
Number shows number of pins	Female connector	Male connector
GA1A		
GA2A		
GA2B		
GA3A		
GA3B		
GA4A		

CONNECTOR CONFIGURATION CHART

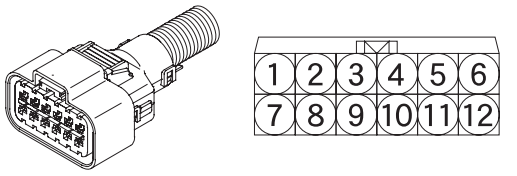
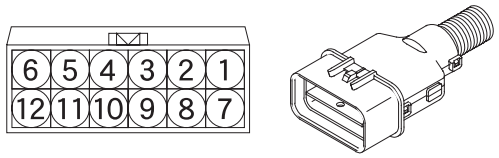
Number shows number of pins	Female connector	Male connector
GA4B		
GA6A		
GA6B		
GA8A		
GA10A		
GA12A		

GB type

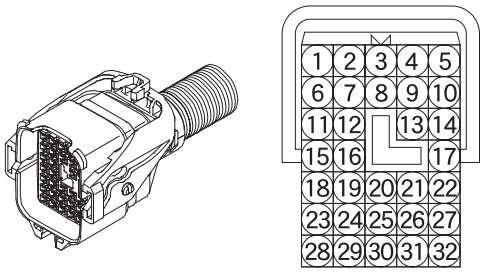
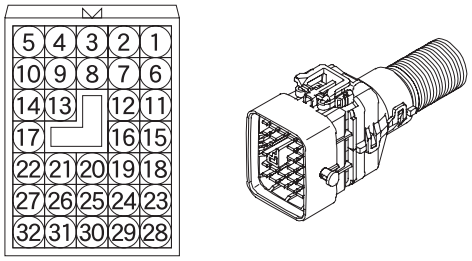
Number shows number of pins	Female connector	Male connector
GB1A		
GB2A		

Number shows number of pins	Female connector	Male connector
GB2B		
GB3A		
GB3B		
GB4A		
GB4B		
GB6A		
GB6B		
GB8A		
GB10A		

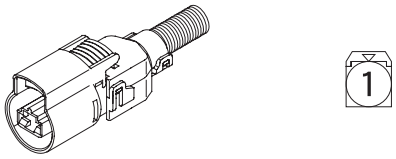
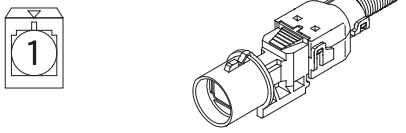
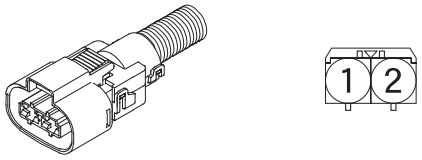
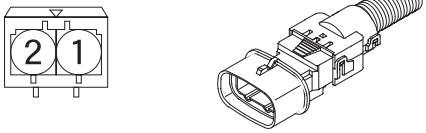
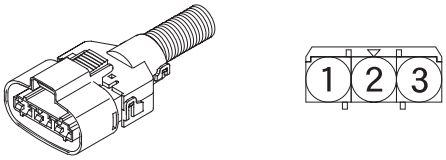
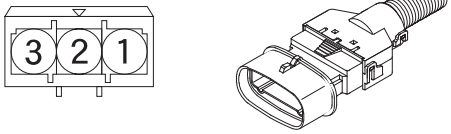
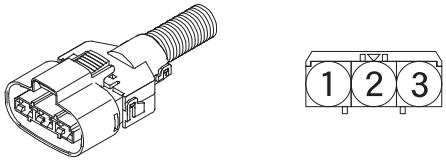
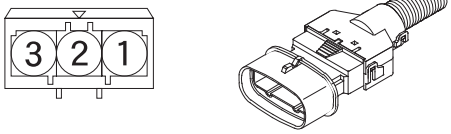
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
GB12A		

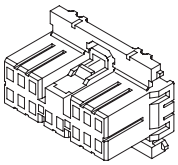
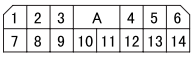
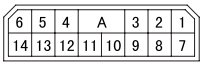
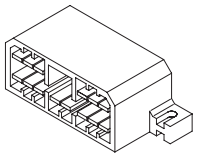
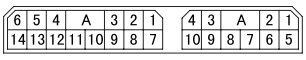
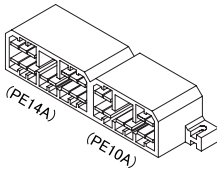
GC type

Number shows number of pins	Female connector	Male connector
GC32A		

GD type

Number shows number of pins	Female connector	Male connector
GD1A		
GD2A		
GD3A		
GD3B		

PE type

Number shows number of pins	Female connector	Male connector
PE14A	 	   

GROUP 55 INDEX

SPECIFICATIONS 55-2

STRUCTURE AND OPERATION
1. **Heater 55-4**
2. **Air Conditioner..... 55-5**
3. **Air Duct 55-6**
4. **Heater Control 55-7**

TROUBLESHOOTING 55-10

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Recovery of Refrigerant 55-12**
2. **Recharging the System with Refrigerant 55-13**
3. **Checking Refrigerant Charge Level 55-15**
4. **Adding Refrigerant 55-16**

CONNECTING AIR CONDITIONER PIPING 55-17

COMPRESSOR 55-18

CONDENSER, RECEIVER..... 55-20

HEATER CONTROL 55-22

AIR DUCT 55-26

HEATER AND COOLING UNIT, BLOWER 55-28

SPECIFICATIONS

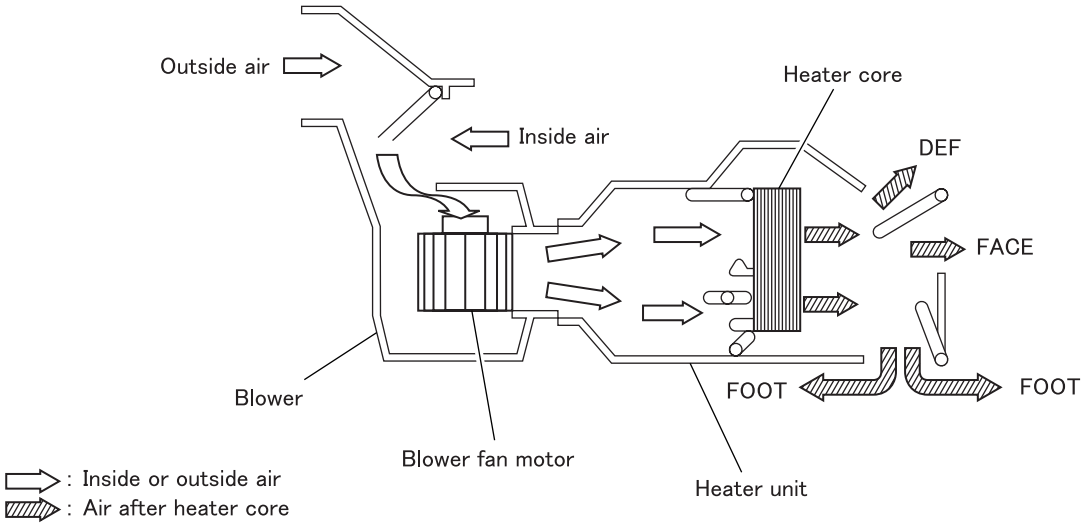
<Without Air Conditioner>

Item			Specifications
System	Damper change-over system	Mode selection	Manual cable type
		Air mixing	Manual cable type
		Fresh/recirculation changeover	Servomotor
	Servomotor rated voltage V		12
Heater unit	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Heating capacity W {kcal/h}		4370 ± 437 {3758 ± 376}
	Temperature control system		Air mixing type
Blower	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Blower motor voltage V		12

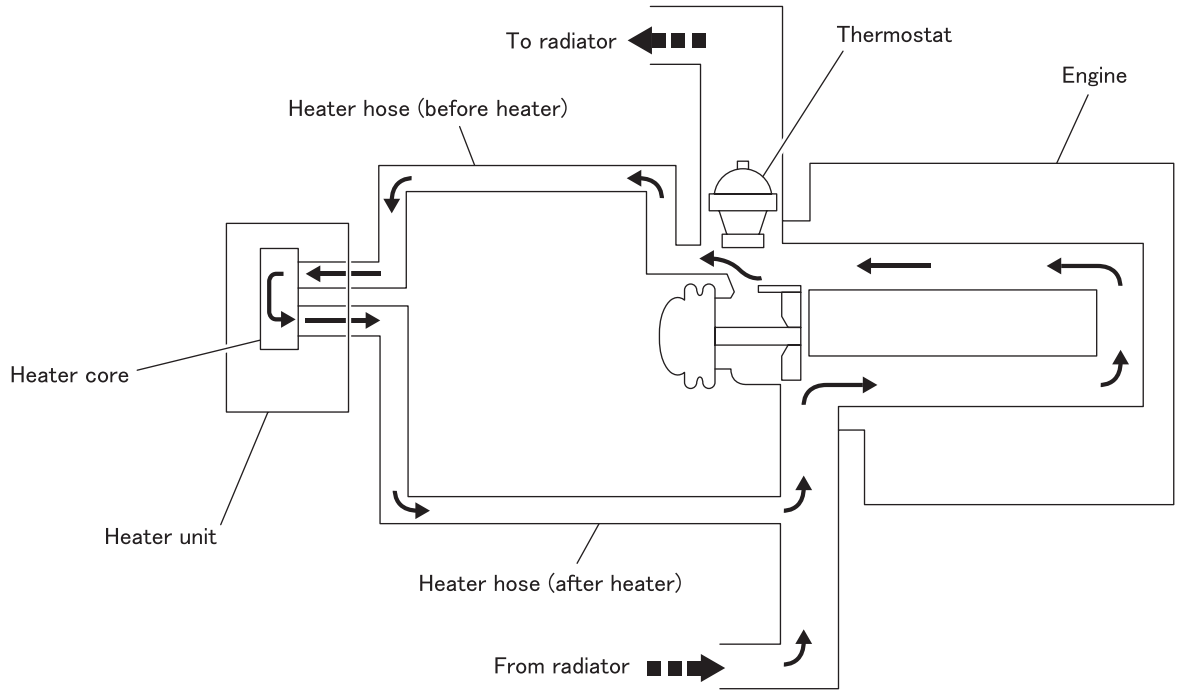
<Air Conditioner>

Item			Specifications
System	Type		Manual air conditioner
	Refrigerant	Type	HFC134a
		Charged quantity g {oz}	650 {22.9}
	Damper change-over system	Mode selection	Manual cable
		Air mixing	Manual cable
		Fresh/recirculation changeover	Servomotor
	Servomotor rated voltage V		12
Heater and cooling unit	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Heating capacity W {kcal/h}		4370 ± 437 {3758 ± 376}
	Cooling capacity W {kcal/h}		4340 ± 434 {3732 ± 373}
	Temperature control system		Air mixing type
Blower	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Blower motor voltage V		12
Compressor	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Model		MSC90TA
	Discharge cm^3 {mL}/1 rotation		90 {90}
	Lubricant	Type	SUN PAG56
		Quantity cm^3 {in^3}	$140\ ^{+20}_{0}$ {$8.54\ ^{+1.22}_{0}$}
Condenser	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Rated current A	Wide cab	$7\ ^{+1.0}_{-1.5}$
		Standard wide cab	$9.5\ ^{+1.8}_{-2.0}$
Receiver	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Capacity cm^3 {in^3}		350 {21.4}

1. Heater



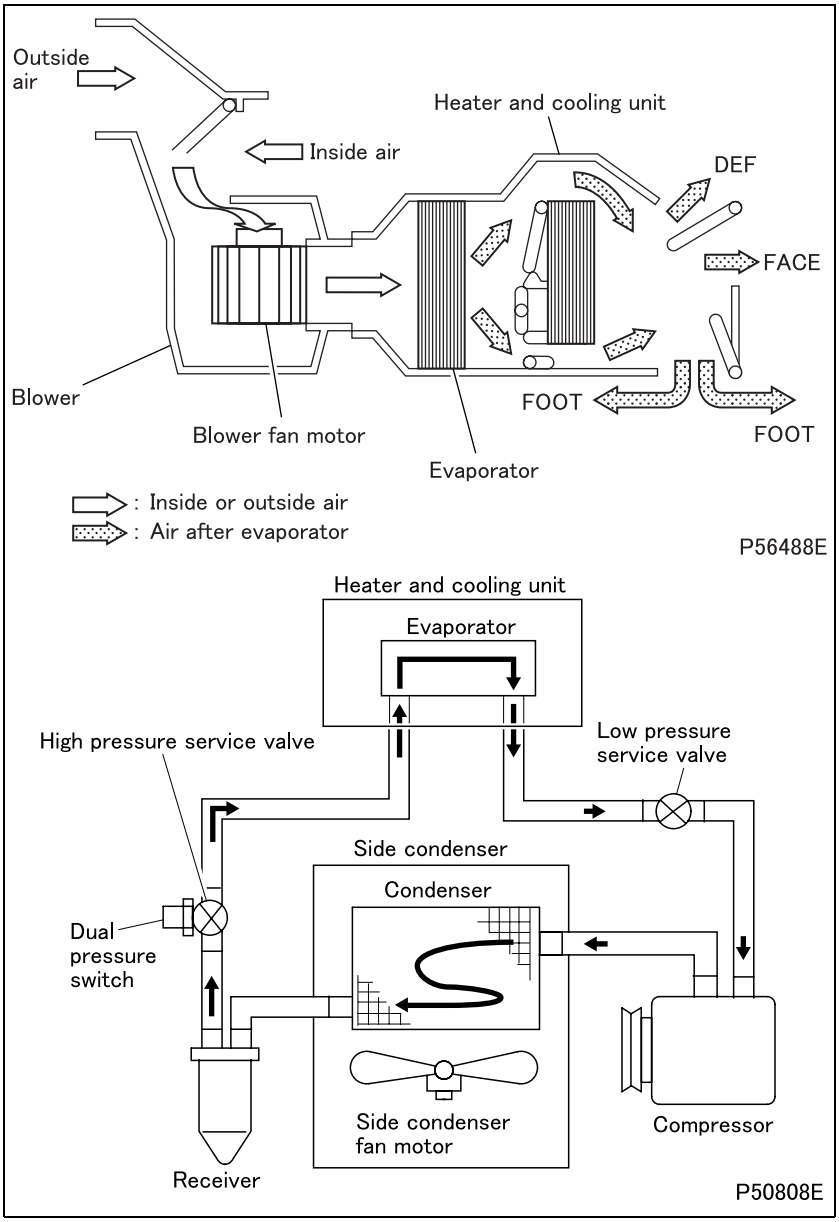
P56487E



P11955E

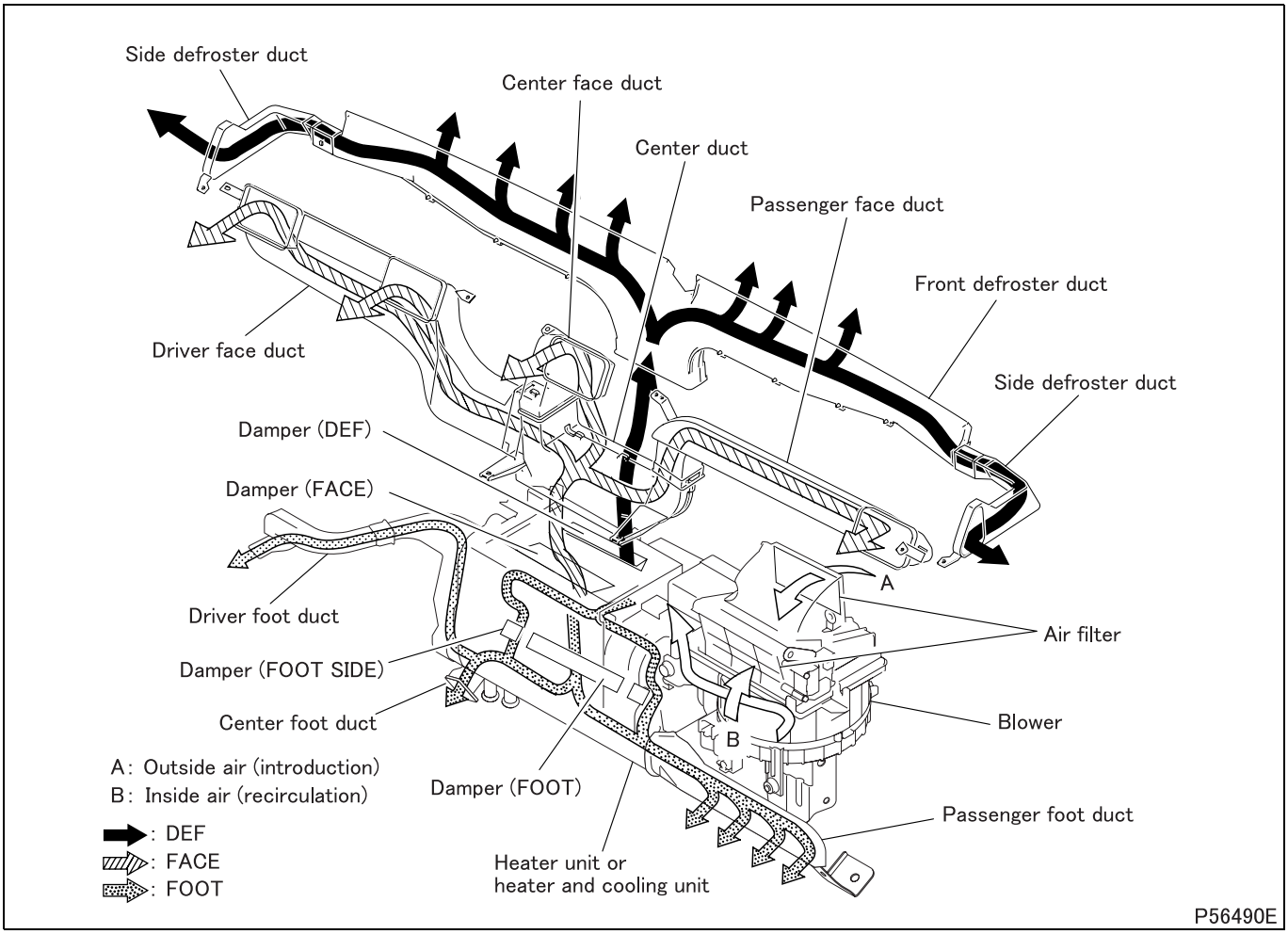
- The blower sends air to the heater unit, where the air is heated by the heater core (heat exchanger). The warm air is then sent through the ducts into the cab.
- Coolant warmed by the heat of the engine circulates continuously through the heater core, whether the thermostat is open or closed.

2. Front Air Conditioner



- The blower sends air to the heater and cooling unit, where the air is cooled by the evaporator. The cool air is then sent through the ducts into the cab.
- The refrigerant, in gaseous form, is compressed by the compressor. The compressed gas is then sent to the side condenser, where it is cooled by outside air and condenses into liquid form.
- The liquid refrigerant is sprayed into the evaporator, where it quickly evaporates into a gas, while at the same time absorbing heat from the surrounding air.
- The refrigerant in gas form is again sent to the compressor.
- When the refrigerant pressure in the high pressure line reaches the specified limit, the dual pressure switch senses this and turns itself OFF. At the same time, the magnetic clutch is turned OFF.

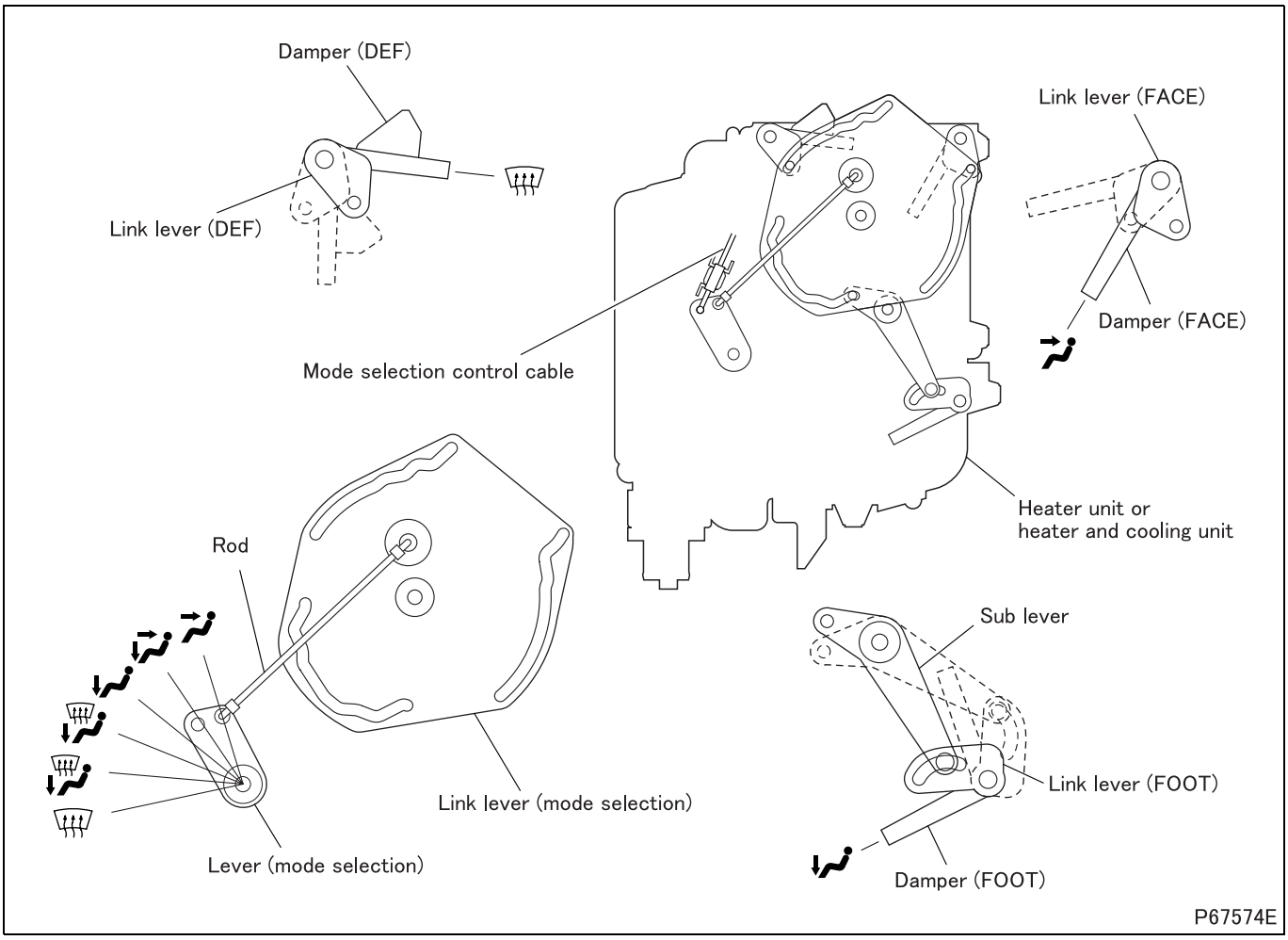
3. Air Ducts



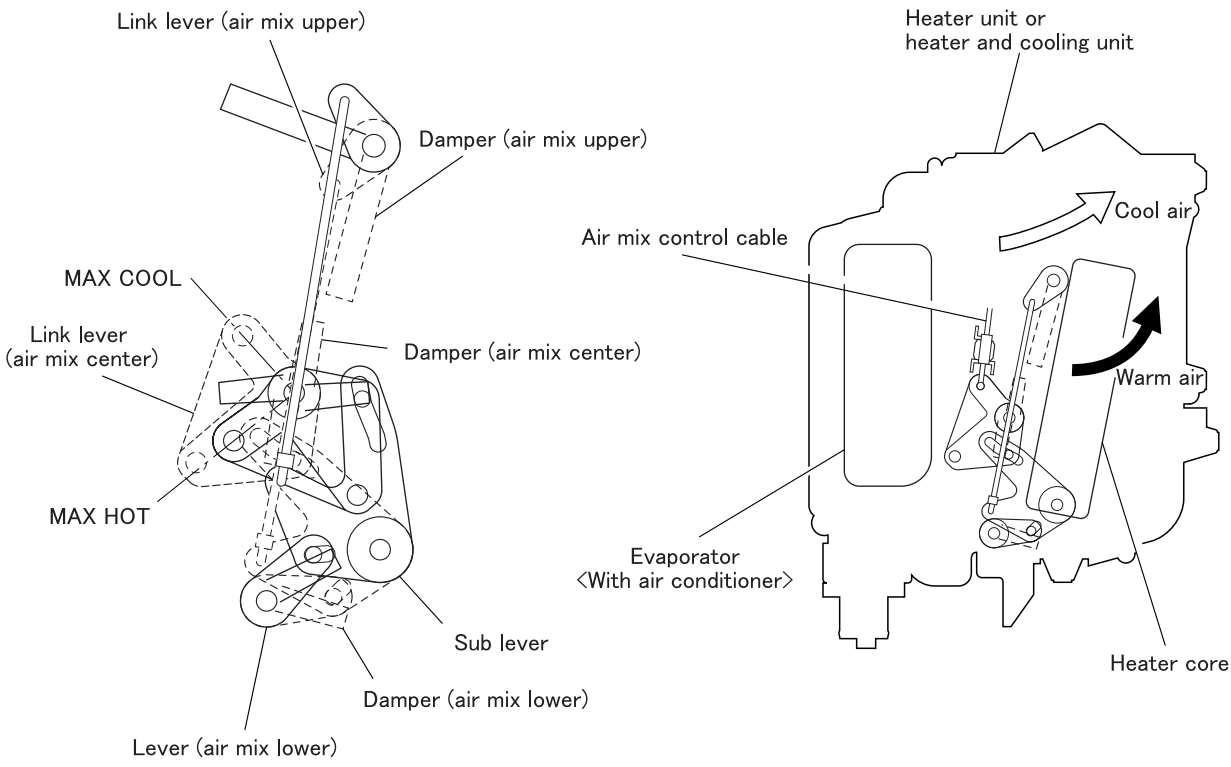
- The blower sends outside air **A** or inside air **B** through the heater unit or heater and cooling unit to the ducts. The flow of air can be directed in various ways by opening and closing the dampers.

4. Heater Control

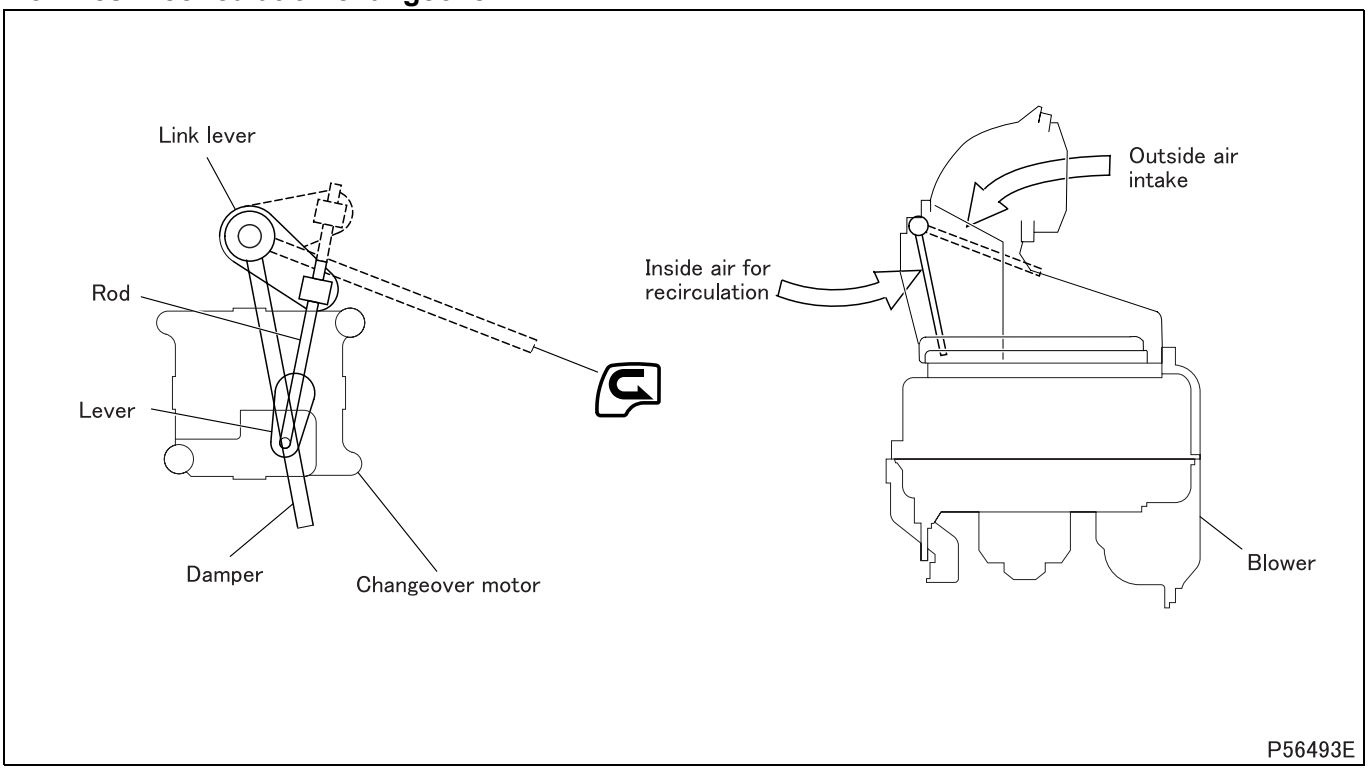
4.1 Mode selection



4.2 Air mix selection <Air conditioner>



4.3 Fresh/recirculation changeover



- The fresh air/recirculation damper is operated by a motor.

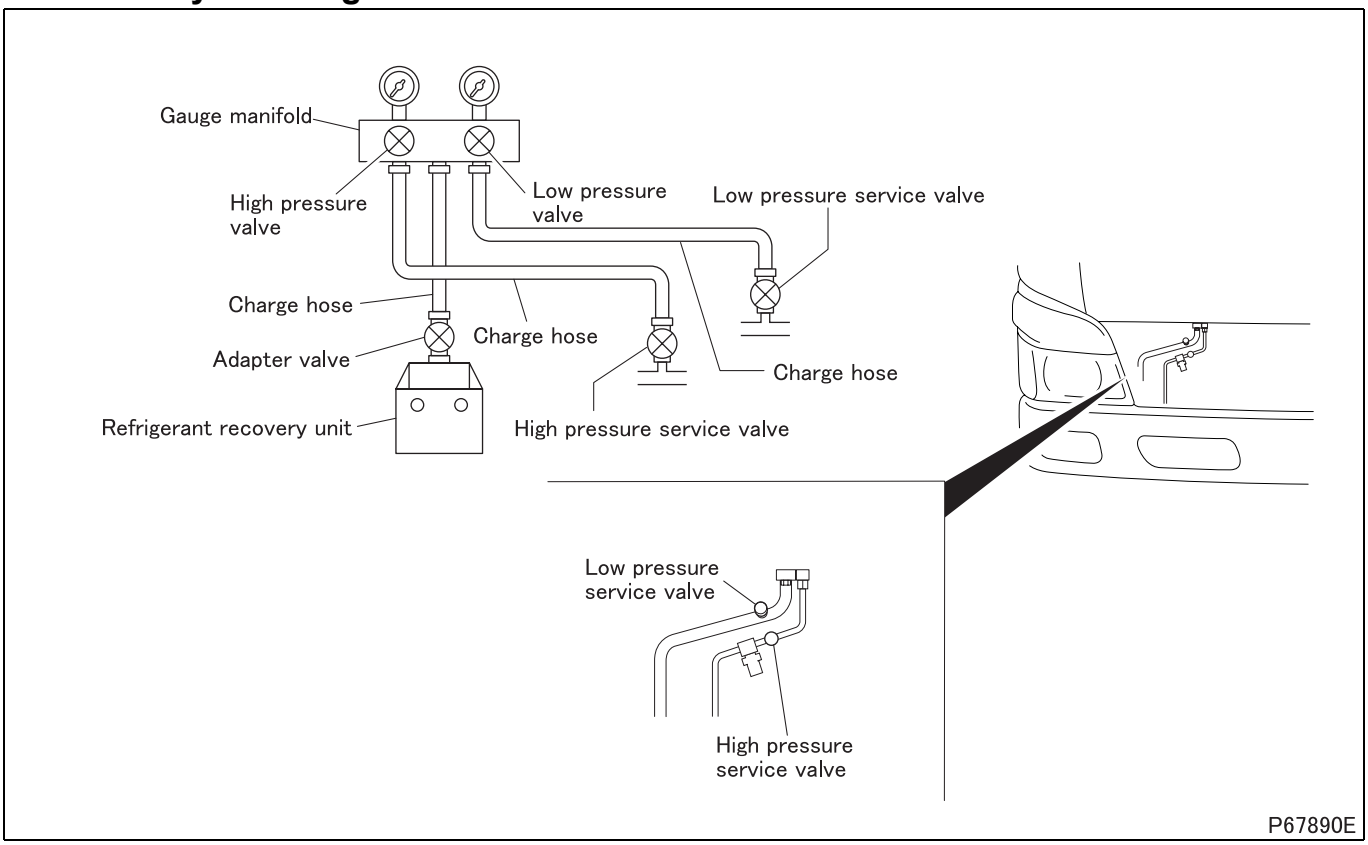
Heater, Front Air Conditioner

Symptoms / Possible causes	No air from vents	Poor cooling	Poor heating	No mode selection	Draft from vents	No temperature setting	No ventilation/recirculation selection	Air volume from vents unstable	Controls require too much effort	Reference Gr
Blower motor coil open, shorted	O									Gr54
Blower motor relay contacts stuck closed, coil open, shorted	O									
Blower resistor malfunction <A/C>								O		
Compressor seized, malfunction <A/C>		O								
Refrigerant charge low <A/C>		O					O			
Air conditioner relay contacts stuck closed, coil open, shorted <A/C>		O								
Mode damper malfunction, not fully closed				O	O				O	
Air mix damper malfunction, not fully closed					O	O			O	
Ventilation/recirculation selection damper malfunction, not fully closed					O		O		O	
Condenser fan motor coil open, shorted <A/C>		O								Gr54
Condenser relay contacts stuck closed, coil open, shorted <A/C>		O								
Dual pressure switch coil open, shorted <A/C>		O								
Heater control malfunction	O	O	O	O	O	O	O			
Thermostat stays open			O							Gr14
Coolant level low			O							
Connector poor contact, harness open, faulty earth	O	O		O	O	O	O			Gr54
Fuse blown	O	O								
Air conditioner piping clogged, loose, incorrectly connected <A/C>		O								
Heater piping clogged, loose, incorrectly connected			O							
Duct incorrectly connected					O					
Heater and cooling unit clogged			O							
Condenser clogged <A/C>		O								
Condenser core restricted, accumulation of foreign matter <A/C>		O								
Receiver clogged, inefficient desiccant <A/C>		O								
Evaporator clogged <A/C>		O								
Control wire jammed, incorrectly installed				O	O		O		O	
Lever bent				O	O		O		O	
Lever sliding section worn, out of grease				O	O		O		O	

<A/C>: Air conditioner

M E M O

1. Recovery of Refrigerant



- Recover refrigerant from the air conditioning system in accordance with the following flow chart.
  - Installation of the refrigerant recovery unit

↓

Close both the low pressure and high pressure valves.

↓

Connect the charge hose to the low pressure service valve.

↓

Connect the charge hose to the high pressure service valve.

↓

Connect the charge hose to the adapter valve.

↓

Open both the low pressure and high pressure valves.

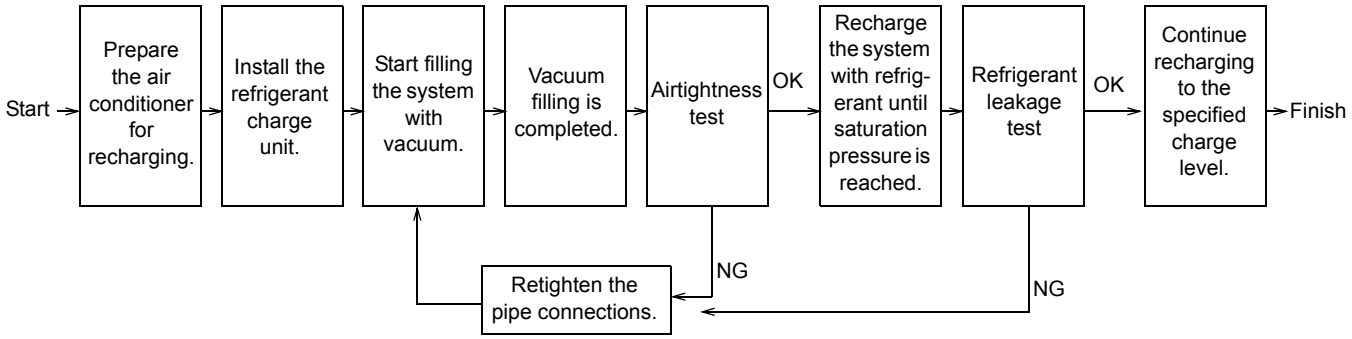
↓

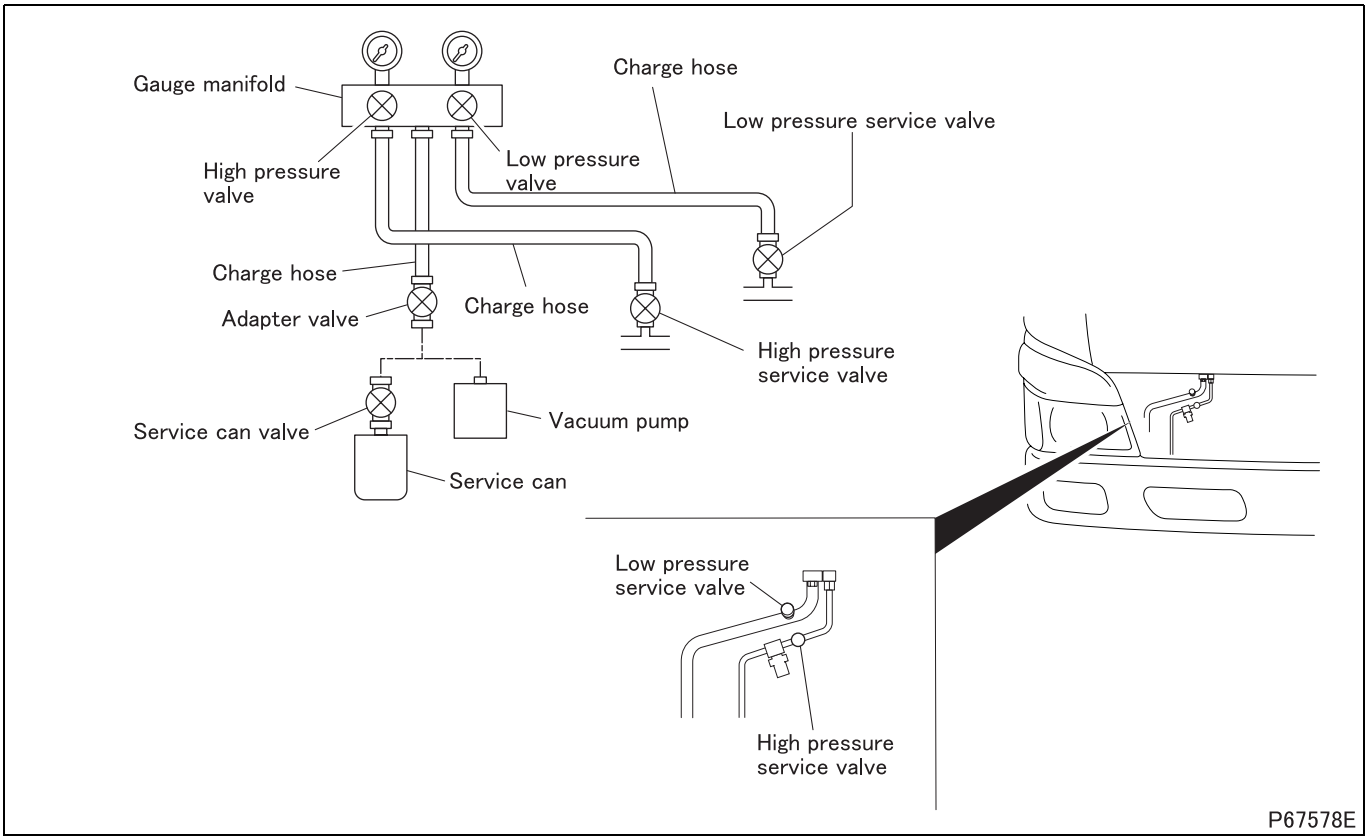
Open the adapter valve.

↓

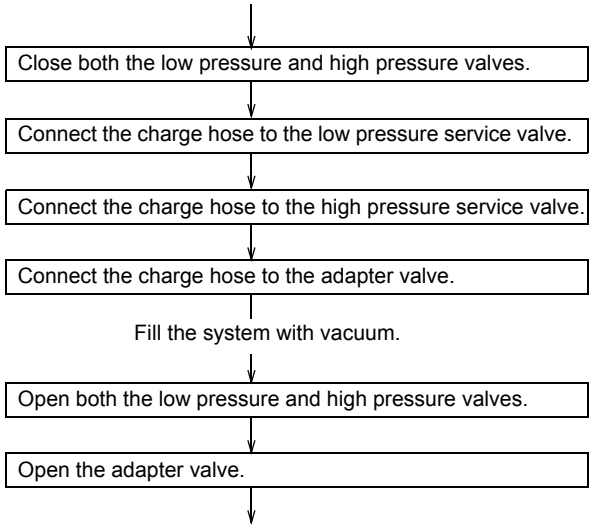
Run the recovery unit to collect the refrigerant.

2. Recharging the System with Refrigerant





- Recharge the system with refrigerant in accordance with the following flow chart.
  - Installation of the refrigerant charge unit



Run the vacuum pump.

Continue to run the pump for a minimum of 10 to 15 minutes. Close the adapter valve.

Stop the vacuum pump.

CAUTION ⚠

- **Make sure that the adapter valve is closed before stopping the vacuum pump.**

Close both the low pressure and high pressure valves.

Wait for 5 minutes. During this interval, the readings on the gauges installed on the gauge manifold should stay where they are and should not move towards zero.

Vacuum filling is now completed.

Recharging the system with refrigerant

With the adapter valve still closed, remove it from the vacuum pump. Connect the valve to the refrigerant container via the container valve.

Open the container valve and then the adapter valve.

Open the low pressure valve to fill refrigerant in gas form.

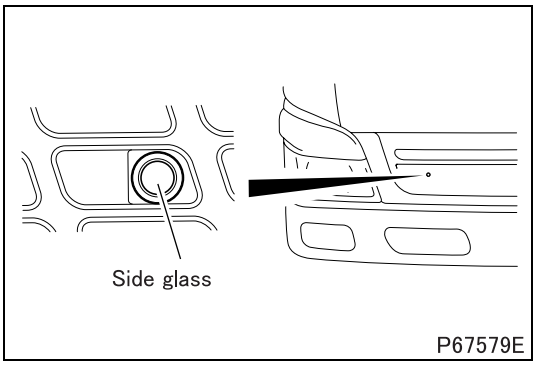
CAUTION ⚠

- **Adding liquid refrigerant to the system may damage the compressor. To prevent this, keep the refrigerant container in the upright position so that the refrigerant stays in gaseous form.**

When the refrigerant container is empty, close the adapter valve and install a new container. Continue filling the system.

When the air conditioning system is saturated, start the engine. Turn on the air conditioner to run the compressor, and continue recharging until the specified charge level is reached.

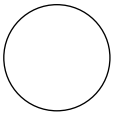
3. Checking Refrigerant Charge Level



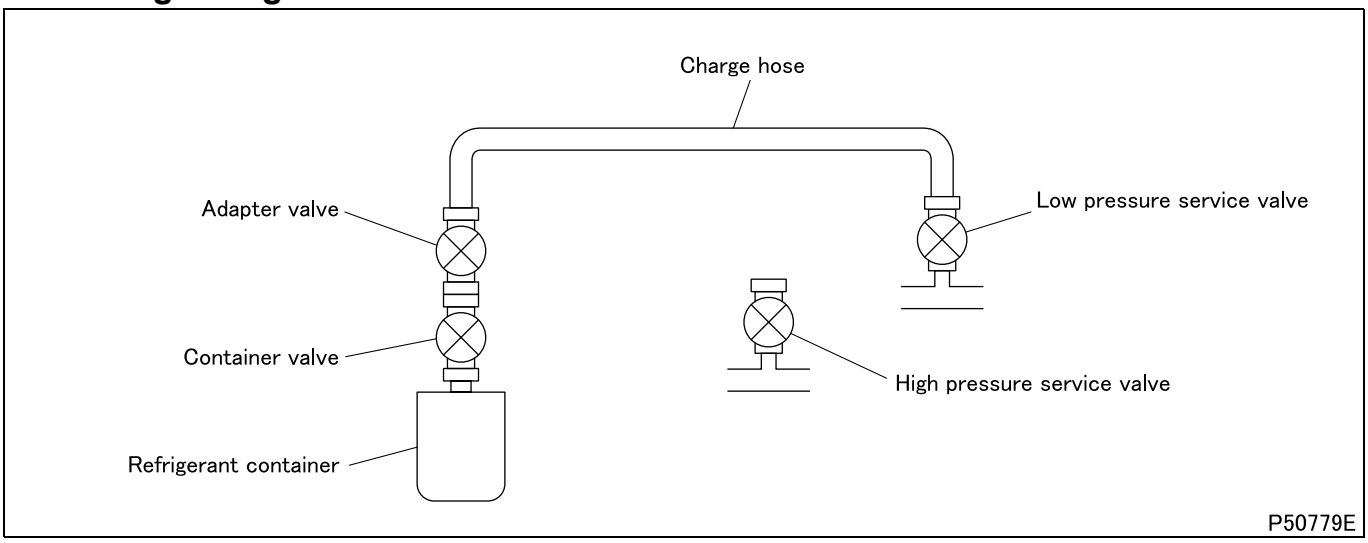
- To check the refrigerant charge level, observe the flow of refrigerant through the sight glass. If the visual inspection indicates a low charge level, add refrigerant.
- The visual check should be performed under the following conditions.
  - Engine speed: 1400 rpm
  - A/C button: ON
  - Fan switch: 4 (MAX)
  - Temperature control switch: MAX COOL
  - Recirculation button: OFF (fresh air)
  - Doors: Fully open

CAUTION ⚠

- **If the visual inspection indicates a low charge level, stop the air conditioner immediately. To run it in this condition for a long period of time would cause the compressor to seize.**

	Normal level	Low level	No refrigerant
Sight glass	P06554 Under careful observation, something like mist can be seen to flow.	P06553 Air bubbles are seen flowing at all times. The refrigerant may be transparent or whitish.	 P06552 The refrigerant is almost transparent. Air bubbles may be seen flowing, but they disappear when the engine is revved up and down.
High/low pressure piping	The high pressure piping is warm; the low pressure piping is cold.	The high pressure piping is warm; the low pressure piping is slightly cold.	There is almost no difference in temperature between the high and low pressure piping.

4. Adding Refrigerant



- Add refrigerant in accordance with the following flow chart.

With the adapter valve closed, connect the charge hose to the low pressure service valve.

CAUTION ⚠

- **If the charge hose is connected to the high pressure service valve, refrigerant may backflow, possibly damaging the refrigerant container and charge hose.**

Open and close the adapter valve to bleed air of the charge hose.
After air bleeding is completed, close the adapter valve.

Take the refrigerant container and valve assembly. With the container valve closed, connect the assembly to the adapter valve.

CAUTION ⚠

- **Adding liquid refrigerant to the system may damage the compressor. To prevent this, keep the refrigerant container in the upright position so that the refrigerant stays in gaseous form.**

Open the container valve and then the adapter valve.

Start the engine.

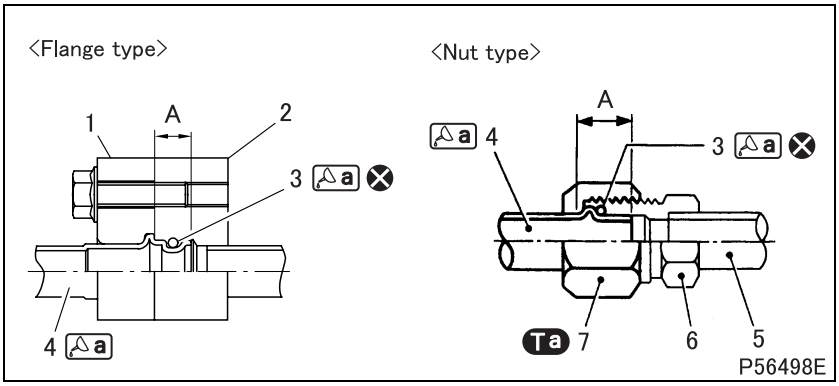
Set the temperature control to MAX COOL. Turn on the air conditioner to run the compressor.

Continue adding refrigerant while observing the sight glass for charge level.

When “normal level” is confirmed through the sight glass, add refrigerant further 50 g {1.76 oz}.

When charging is completed, close the adapter and container valves. Remove the charge hose and the refrigerant container from the low pressure service valve.

If there is still some refrigerant in the container, keep it for the next opportunity. Be sure to keep the container valve closed.



1 Flange (pipe end) <Flange type>
2 Flange (mating end) <Flange type>
3 O-ring
4 Pipe
5 Pipe <Nut type>
6 Union <Nut type>
7 Nut <Nut type>

A: Refrigerating machine oil application area
⊗: Non-reusable parts

Torque: N·m {lbf·ft}

Mark	Fastener	Torque value	Remarks
Ta	Nut	12 to 15 {9 to 11}	–

Lubricant and/or sealant

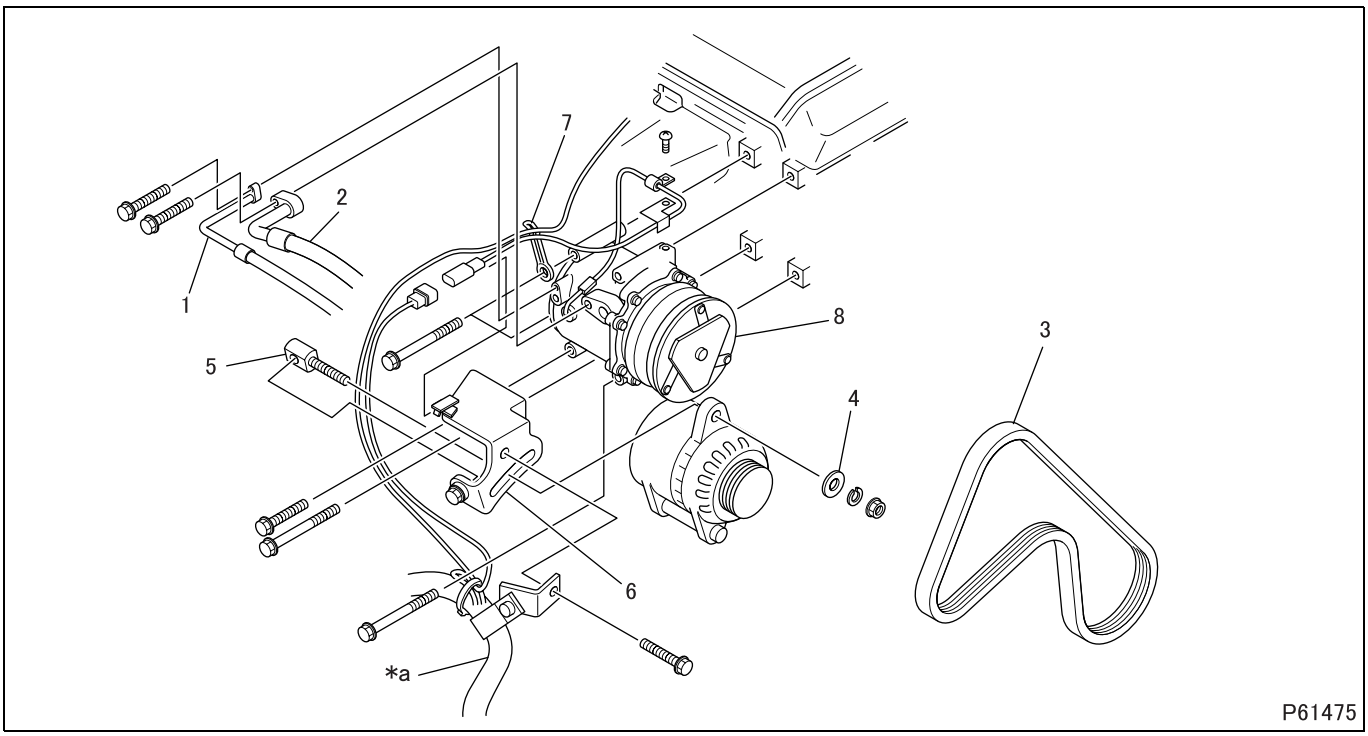
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Refrigerating machine oil SUN PAG56	As required
	Outer periphery of pipe end (area A)		

- There are 2 types of air conditioner pipe/hose connections: flange type and nut type. When connecting/tightening the connections, observe the following precautions.

CAUTION ⚠

- **The connected parts are sealed by the O-ring. Be careful not to damage the O-ring, such as by twisting.**
- **The O-rings are exclusively designed for HFC-134a refrigerant and are not reusable.**
- **Never tighten the nut-type connection by rotating the union. This will deform the piping, allowing refrigerant to leak out. Tighten by rotating the nut while holding the union in position.**

COMPRESSOR



● **Disassembly sequence**

1 Discharge hose (high pressure side) (see CONNECTING AIR CONDITIONER PIPING)
2 Suction hose (low pressure side) (see CONNECTING AIR CONDITIONER PIPING)
3 Drive belt
4 Spacer
5 Shaft
6 Adjusting plate
7 Clamp
8 Compressor

***a**: Vehicle harness

CAUTION ⚠

- **Recover the refrigerant before removing the discharge hose and suction hose.**
- **Plug discharge hose, suction hose, and compressor after removal to keep them free from dust etc.**

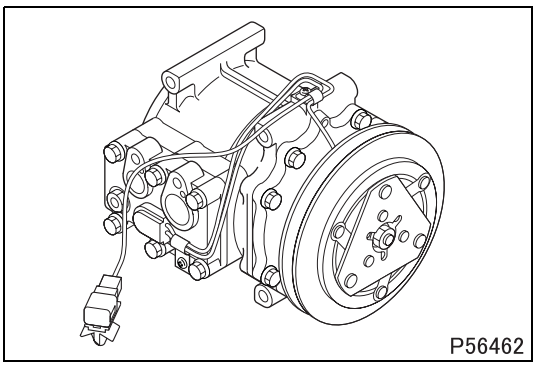
● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After installation, tension the drive belt to specification (see Gr14).**

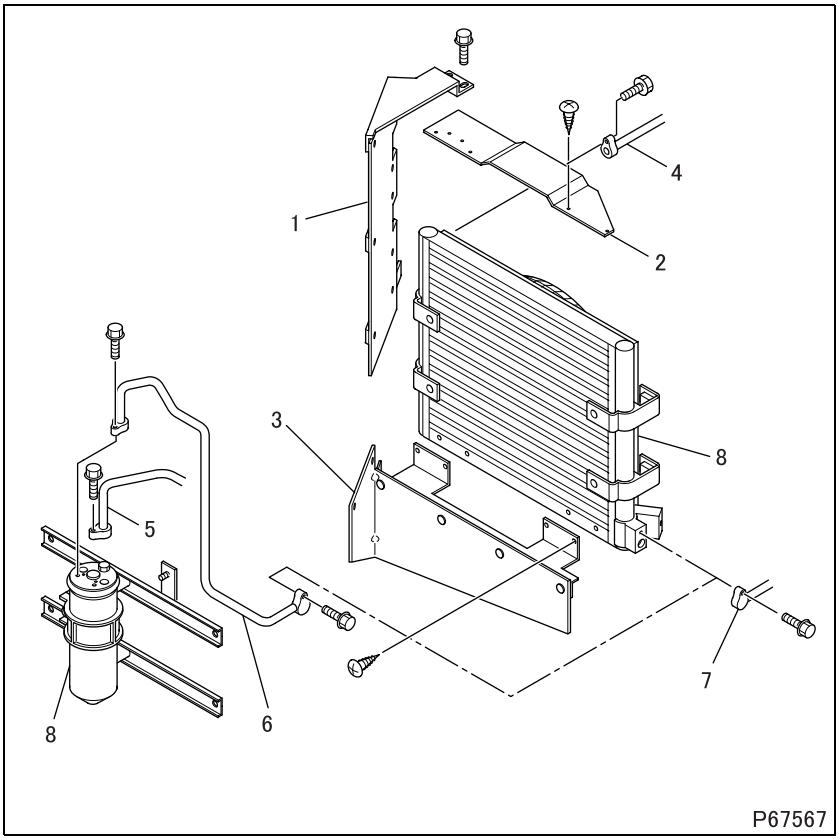
◆Inspection procedure◆



■ **Inspection: Compressor**

- Check the compressor for proper operation and signs of oil leakage.
- If there is anything wrong with the compressor, replace it.

CONDENSER, RECEIVER



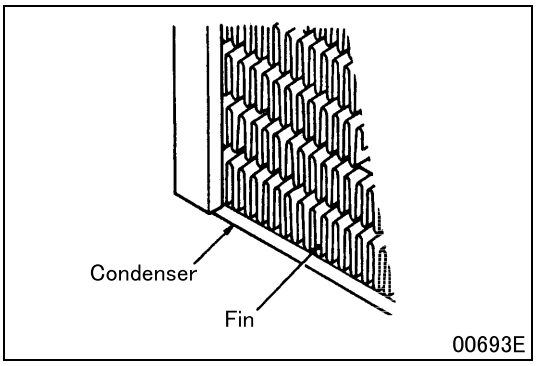
● Removal sequence

1 Baffle plate
2 Baffle plate (upper)
3 EVA plate (lower)
4 Discharge line (compressor end) (see CONNECTING AIR CONDITIONER PIPING)
5 Coolant line (heater and cooling unit end) (see CONNECTING AIR CONDITIONER PIPING) <Without rear air conditioner>
6 Coolant line (see CONNECTING AIR CONDITIONER PIPING) <Without rear air conditioner>
7 Coolant line (condenser end) (see CONNECTING AIR CONDITIONER PIPING) <With rear air conditioner>
8 Receiver <Without rear air conditioner>
9 Condenser

● Installation sequence

Follow the removal sequence in reverse.

◆Inspection procedure◆

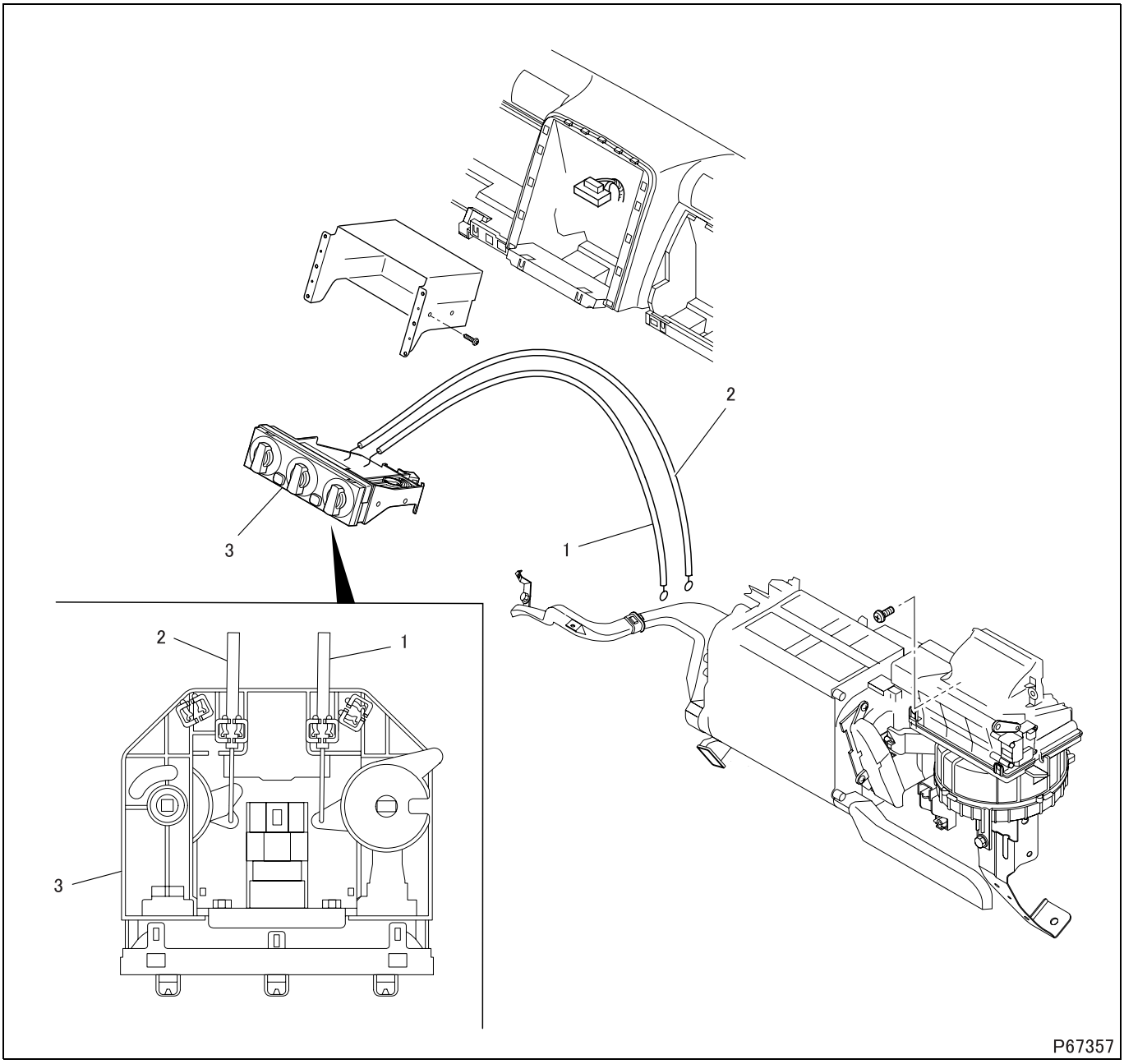


■ Inspection: Condenser

- Remove any dirt, dust, or other foreign matter from the condenser fins. Straighten any bent fins.

M E M O

<Left-hand Drive Vehicle>



● Removal sequence

1 Air mix control cable (BLACK)
2 Mode selection control cable (NATURAL)
3 Heater control unit

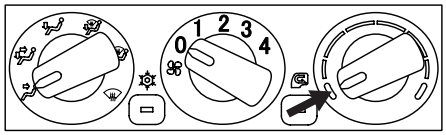
CAUTION ⚠

- **Never remove the cable(s) from the heater control(s) except when the control cable(s) needs to be replaced. Failure to observe this may damage the cable clip.**

● Installation sequence

Follow the removal sequence in reverse.

◆Work before removal◆

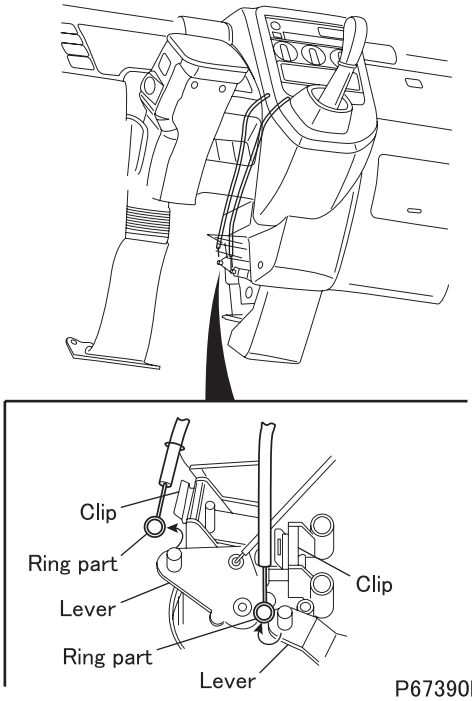


P65915

■ **Adjustment: Temperature control knob**

- Before disconnecting the control cables, turn the temperature control knob of the heater controls to the MAX-COOL position.

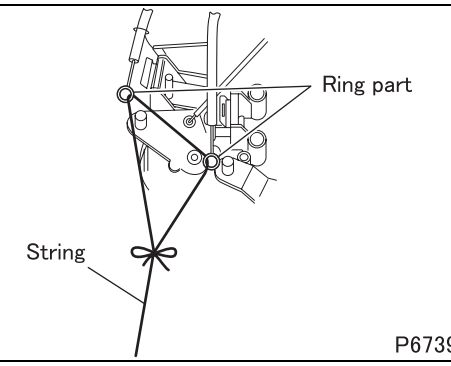
◆Removal procedure◆



P67390E

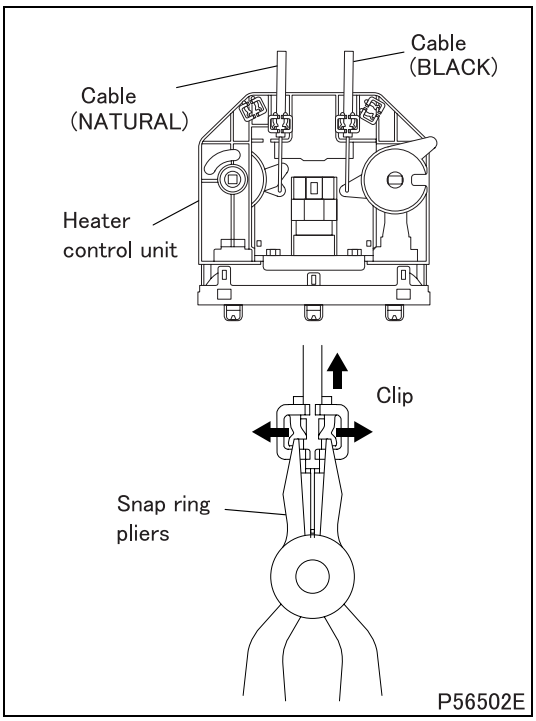
■ **Removal: Control cables**

- Before disconnecting the cables from the levers, mark each cable and lever with a paint pen.
- Disconnect the control cables from the heater unit.



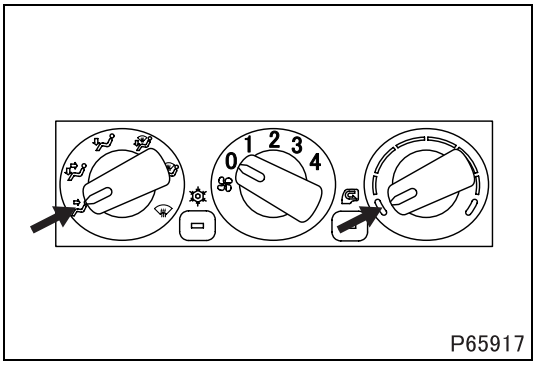
P67391E

- In order that the control cables can be pulled back at the time of installation, attach a string (guide wire) to the cables as shown in the illustration.



- Remove the heater control unit from the instrument panel.
- Use snap ring pliers to disconnect the cable(s) from the heater control(s).

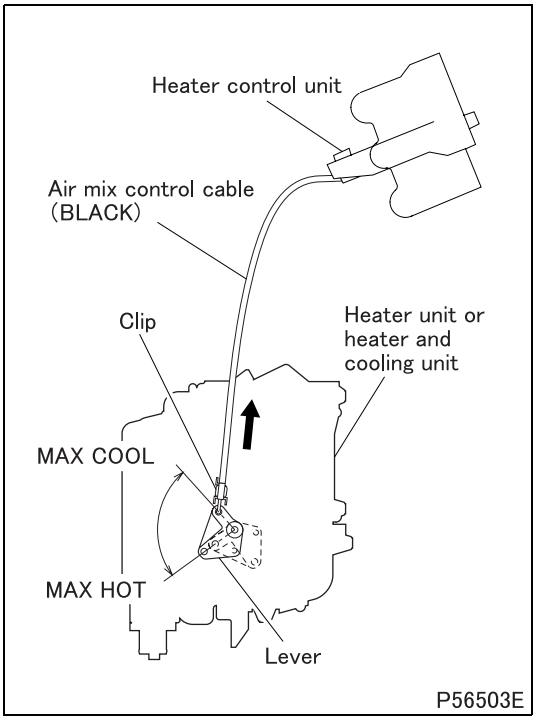
◆Work before installation◆



■Adjustment: Heater control unit knobs

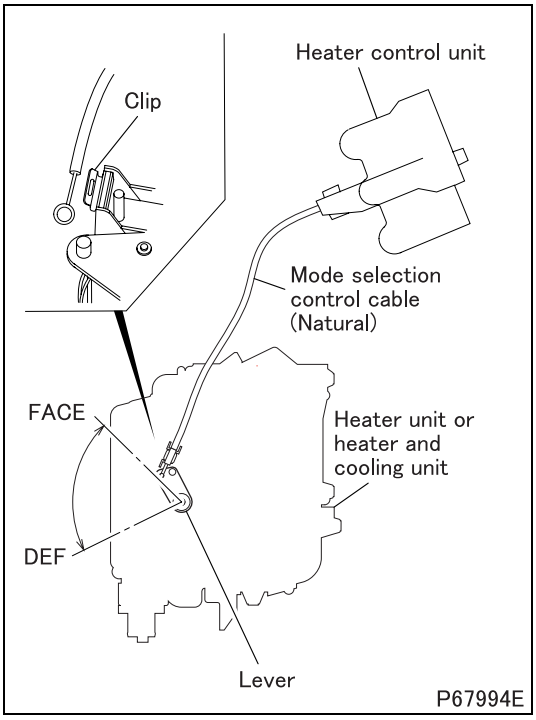
- At the heater controls, turn the temperature control switch all the way to the left (maximum cooling) and turn the air selection switch to the face position before reconnecting the control cables.

◆Installation procedure◆



■ Installation: Air mix control cable

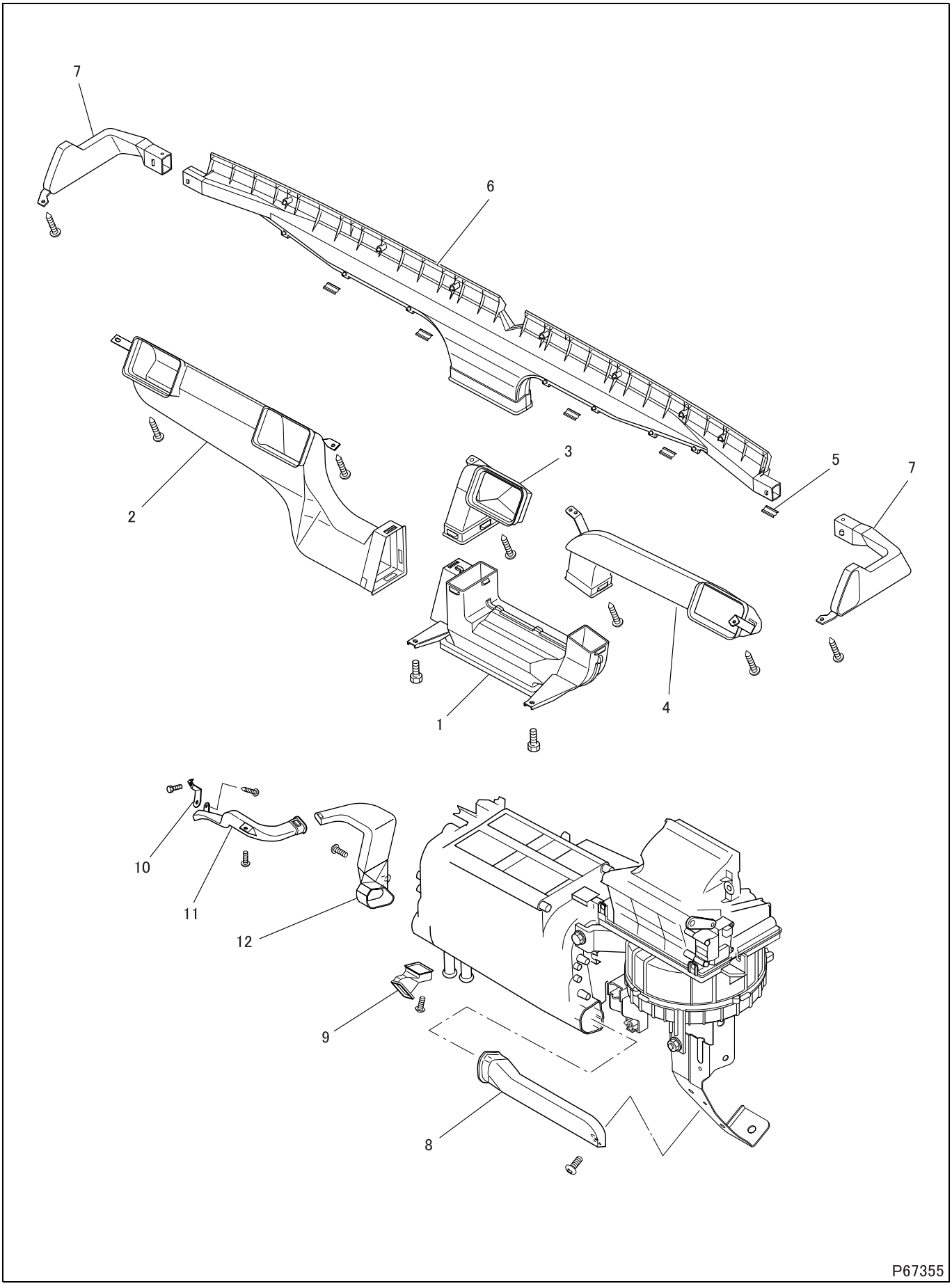
- Install one end of the air mix control cable to the heater control unit.
- Set the temperature control switch on the climate control panel all the way to the left (maximum cooling).
- Pull back the control cable using the string attached at the removal procedure.
- Install the other end of the air mix control cable to the lever on the heater unit (heater and cooling unit).
- With the air mix control cable connected to the lever, pull the cable in the direction of the arrow to move the lever to MAX COOL (upper) position. Clip the cable into the position.
- Move the temperature control switch back and forth from maximum cooling (left) to maximum heating (right). Make sure that the lever moves to the corresponding MAX COOL and MAX HOT positions. If not, repeat the above sequence to correctly install the cable. Make sure that the cable being installed is the correct color.



■ Installation: Mode selection control cable

- Install one end of the mode selection control cable to the heater control unit.
- Set the air selection switch to FACE.
- Pull back the control cable using the string attached at the removal procedure.
- Install the other end of the mode selection control cable to the lever on the heater unit or heater and cooling unit.
- With the mode selection control cable connected to the lever, and push the cable into the clip.
- Move the mode control knob back and forth from face (left) to defrost (right). Make sure that the lever moves to the corresponding FACE and DEF positions. If not, repeat the above sequence to correctly install the cable. Make sure that the cable being installed is the correct color.

AIR DUCT



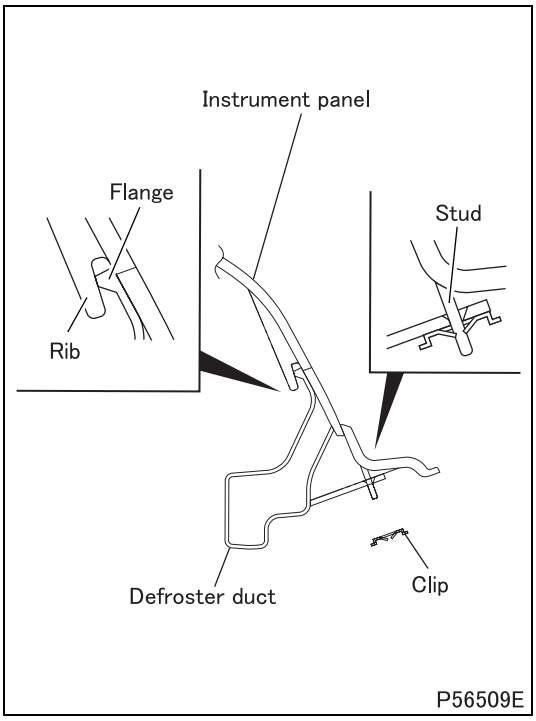
● Removal sequence

1 Center duct
2 Driver face duct
3 Center face duct
4 Passenger face duct
5 Clip (× 7)
6 Front defroster duct
7 Side defroster duct
8 Passenger foot duct
9 Center foot duct
10 Foot duct bracket
11 Driver foot duct B
12 Driver foot duct A

● Installation sequence

Follow the removal sequence in reverse.

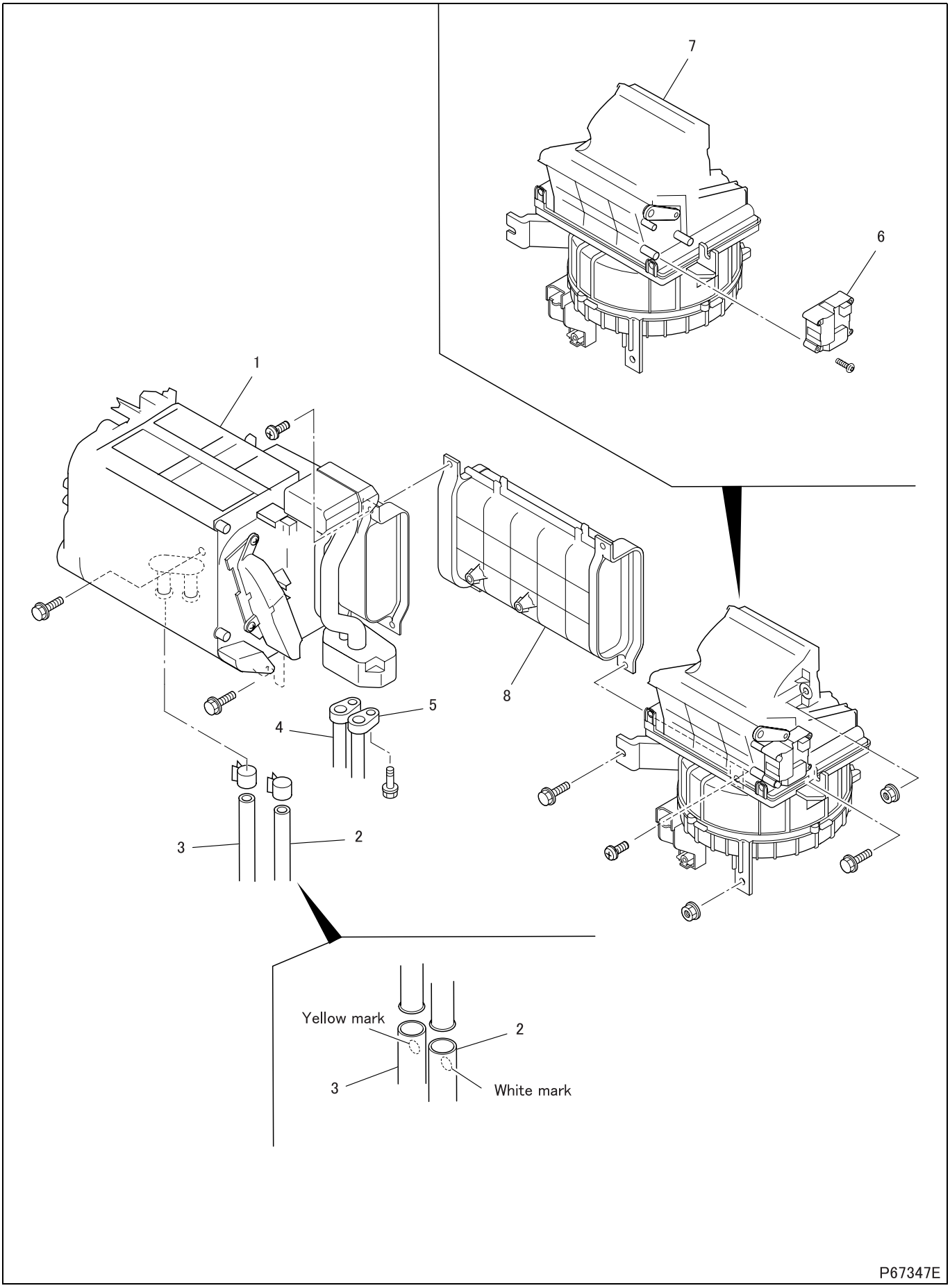
◆Installation procedure◆



■ **Installation: Front defroster duct**

- Insert the front defroster duct flanges into the instrument panel ribs.
- Insert the instrument panel studs into the front defroster duct holes and clip them together.

HEATER AND COOLING UNIT, BLOWER



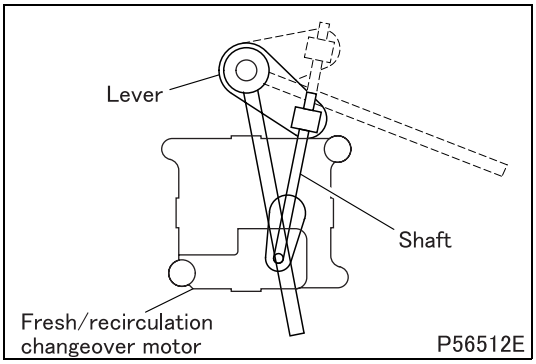
● Removal sequence

1 Heater unit
Heater and cooling unit <With air conditioner>
2 Heater hose (outlet)
3 Heater hose (return)
4 Discharge pipe (high pressure)
(see CONNECTING AIR CONDITIONER PIPING)
5 Suction pipe (low pressure)
(see CONNECTING AIR CONDITIONER PIPING)
6 Fresh air/recirculation motor
7 Blower
8 Joint duct

● Installation sequence

Follow the removal sequence in reverse.

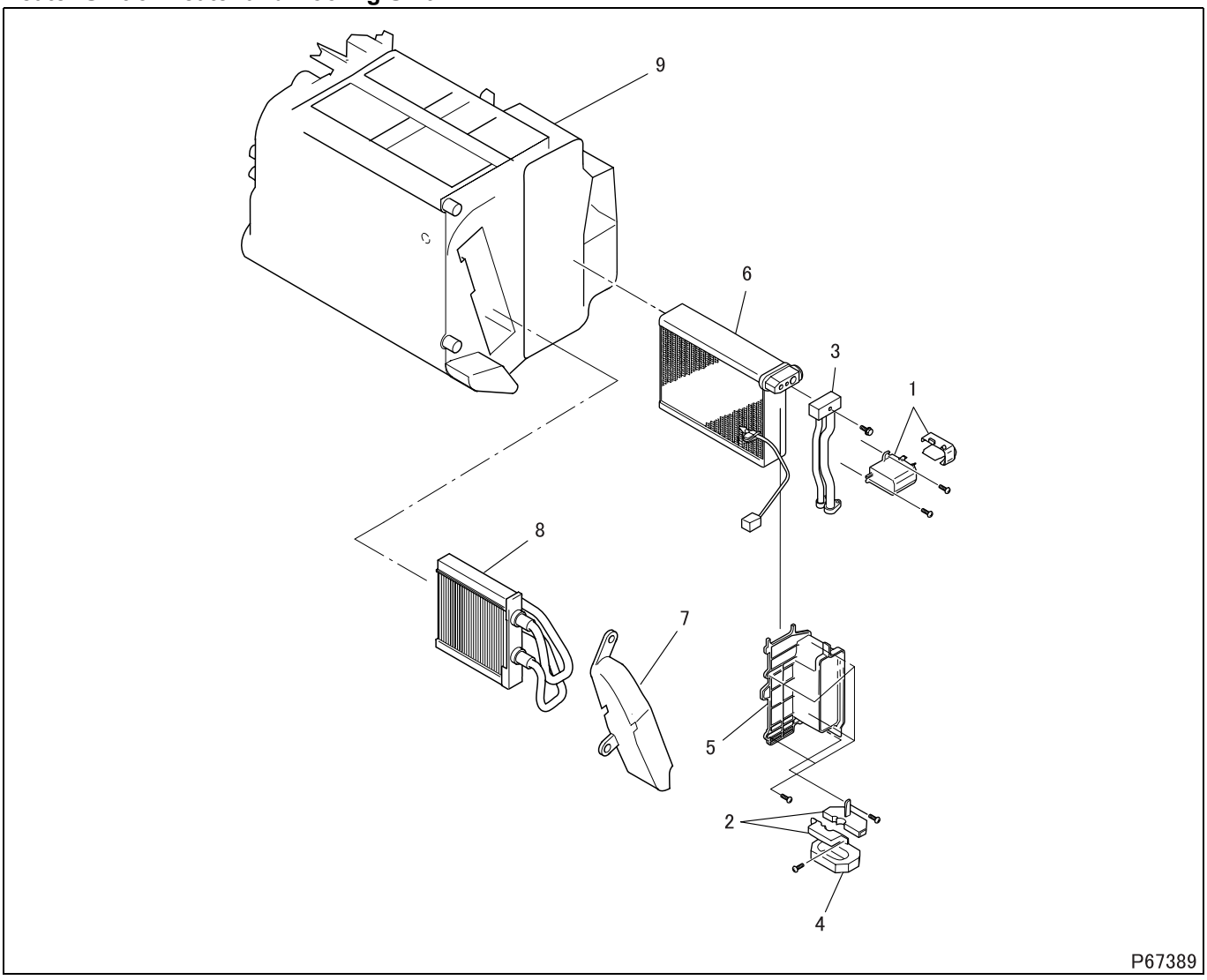
◆Installation procedure◆



■ Installation: Fresh/recirculation changeover motor

- With the lever set to the FRESH position, install the motor shaft through the lever.

Heater Unit or Heater and Cooling Unit



● Disassembly sequence

1 Cover <A/C>
2 Baffle cover <A/C>
3 Pipe assembly <A/C>
4 Rubber insulation <A/C>
5 Case cover
6 Evaporator assembly <A/C>
7 Cover
8 Heater core
9 Heater and cooling unit case

<A/C>: With air conditioner

● Assembly sequence

Follow the disassembly sequence in reverse.