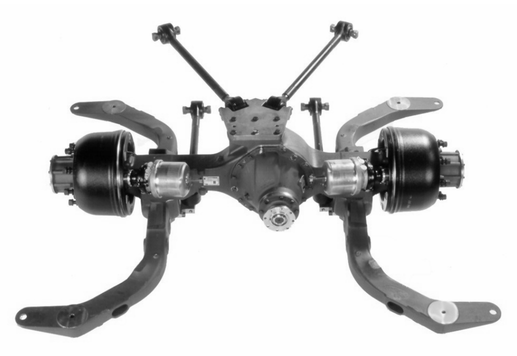
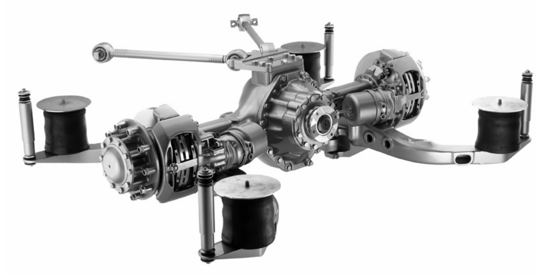
4472 700 026 Version 4.0	# Installation Instructions for Bus Axles	Off-Road Driveline Technology and Axle Systems Division

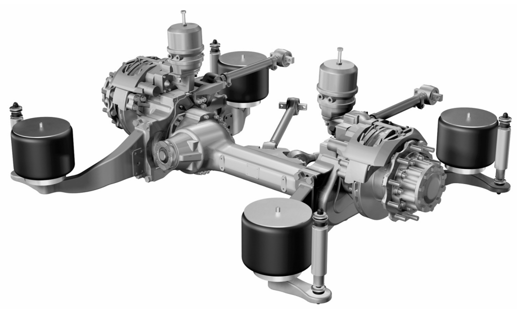




SERIES

A 80

A 131



A 132

AV 132

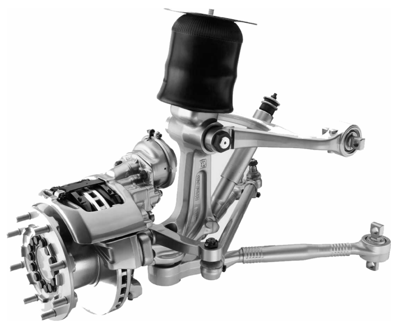
AVN 132

RL 85 A/E

RL 75 A/E

RL75EC

RL 55 E



By:
ZF-Passau GmbH
Dept. AVE
March 2006

Installation Instructions
for
Bus Axles

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4. Auflage / 4th Edition
2006

Contents

PREFACE

The correct installation of ZF units is a prerequisite for:

- ► proper function
- ► precalculated service life

thus providing full customer satisfaction.

The present installation instructions shall ensure that the vehicle manufacturer is familiar with the full extent of requirements made by ZF.

To support the customer on new or initial applications, ZF offers axle commissioning by authorized personnel against payment. During this commissioning, ZF will check axle-specific installation features and inform the vehicle manufacturer about any defects found.

IMPORTANT NOTE

We wish to point out that the present recommendations do not include any guarantee of characteristics.
All data given in these instructions are reference values being based on technical-physical processes and ZF experience.

Furthermore, any claims for indemnification of any damage which has not occurred on the contractual product itself shall be excluded.

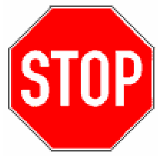
ZF points out and emphasizes that the vehicle manufacturer shall be fully responsible for the correct installation of the unit.

ZF, in its position as manufacturer of the unit, shall not assume any warranty for any defects nor any liability for any damage arising from incorrect or improper installation or from non-compliance with these installation instructions.
ZF reserves the right to refuse any warranty claims in case of incorrect installation.

1 GENERAL INFORMATION ON AXLE INSTALLATION

Most of the supporting elements of the ZF axles are made of high-yield casting materials or quenched and tempered steel.

- ► **Therefore, welding is not permitted.**
- ► **Drilling of holes into oil chambers is not allowed.**
- ► **Supporting parts of the axles must not be weakened by additionally drilled holes.**
- ► **The vehicle manufacturer is not allowed to fix any brackets, clamps etc. to supporting or torque-transmitting bolted connections.**



Unpainted surfaces on the axles are protected either with anti-corrosive oil or with grease. These surfaces have to be cleaned before installing the axles into the vehicle. Packaging parts such as protective caps etc. (for example on breather or brake) have to be removed before starting operation. If necessary, the breather has to be fitted.

The vehicle manufacturer is responsible for correct bolt connections on the chassis, in particular for the definition of tightening torques and length of thread engagement.

The position of the axle fixing points on the chassis must be in accordance with the ZF installation drawing specifications. These fixing points on the chassis must be designed to exclude any deformations by dynamic forces during operation. Any deviations from these instructions are to be coordinated with ZF.

Adjustable axle rods are delivered with bushing housings being fully screwed into the tube. These are to be adjusted to nominal dimension by the vehicle manufacturer during assembly. After correct adjustment of the rods it is mandatory to tighten the clamps with the specified tightening torque.

The vehicle manufacturer must ensure that there is sufficient clearance between axle components and tires towards the chassis in all areas. In this context, special care must be taken with regard to the combination of max. steering angles and wheel travels.
The use of wheel and tire sizes not being specified in the installation drawing must be checked in coordination with ZF.

ZF supplies the axles in primer-painted condition. The vehicle manufacturer is responsible for the later corrosion protection, such as undersealing.
The use of a central lubrication system is subject to prior coordination with ZF. (For maintenance intervals see Chapter 11).

1.1 Installation of Rear Axles

1.1.1 Bus direct-drive axles A 80 / A 131 / A 132

In addition to the frictional contact, the axles are fixed to the subframe or to the spring carrier by means of central bolts.

Do not use any unhardened shims or slotted spring washers below bolt heads or nuts!

Installation position:
Rear axles can be turned up to 9° max. inclination of pinion/input flange from horizontal plane. For any larger installation angles please consult ZF.

1.1.2 Bus portal axles AV-132

► **Spring carrier bolted connection**

When a complete system is supplied, the spring carriers are usually already fixed to the portal housing by ZF.
For those assemblies where the spring carriers are fitted by the customer, the carriers are to be bolted according to the instructions given in the installation drawings.
The bolts M 20 x 1.5 are to be tightened with a torque of MA = 620 Nm.
Recommended bolt quality: 10.9 bolts with finish-rolled thread.
Do not use any unhardened shims or slotted spring washers below the bolt head!

► **Installation position**

Portal axles delivered by ZF with horizontal spring carrier position can be offered with a pinion or flange orientation of up to 9° max. inclination from horizontal plane.

The portal housings must be installed horizontally in any case. The connecting surfaces of the spring carriers at the portal housing must be in an exactly vertical position.

1.1.3 Oil supply of rear axles

Before starting up the vehicle, check the oil filling and the oil level.

The axles are designed for a permanent oil sump temperature of 90° C. 120°C are permitted for a short period.

With regard to coaches please take care that the air stream can at least partly meet the axle.

Even under extreme conditions, the specified oil temperature of 90° shall not be exceeded to a larger extent in order to avoid a reduction of the service life of some axle components and a premature oil change due to the decrease of typical oil characteristics (additives).
In case of extreme applications, e.g. in deserts, a special oil can be used or the oil change interval must be shortened. Extreme cases may require a cooling system for which the vehicle manufacturer shall be responsible.
Please contact ZF if you need any support for the layout of such a system.

For the current list of lubricants including the oils released by ZF please refer to the following internet site (choose English language):

www.zf.com
→ Technical Info → ZF List of Lubrications → Lists of Lubricants (English) → TE-ML 12

1.2 Installation of front axles (general)

The axle is to be fixed to the chassis/frame at the points specified in the installation drawing. Recommended bolt quality: 10.9.

Do not use any unhardened shims or slotted spring washers below bolt heads or nuts!

When using snow chains it may be necessary to reduce the steering angle, depending on the tire size. Detailed coordination with ZF is required in these cases.

2 PROP SHAFTS

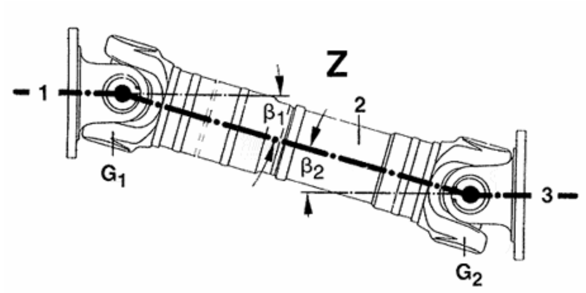
2.1 Prop shaft connection

The vehicle manufacturer is responsible for specifying the prop shaft arrangement.

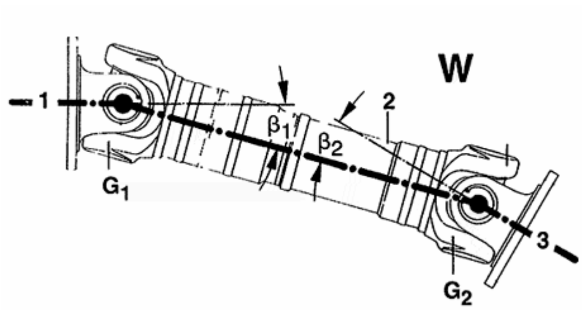
The deflection angles β of both joints have to be identical for Z- and W-arrangement.

Specification: $ß_1 = ß_2$

Permissible tolerances see Chapter 2.2.



Z - Arrangement



W - Arrangement

A <u>simultaneous</u> Z- and W-arrangement in side and top view of the prop shaft is not permissible without technical action!
In this case, the joints of the prop shaft <u>must be</u> turned to each other in a certain angle (offset angle).
For specifying this offset angle, please contact your prop shaft manufacturer. ZF Passau can provide support upon request.

2.2 Permissible limit values

Excessive prop shaft deflection angles ß and alignment errors $\Delta ß$ ($ß_1$-$ß_2$) cause rotation angle errors $\Delta \alpha$ which may lead to detrimental prop shaft oscillations.
These prop shaft oscillations may create:

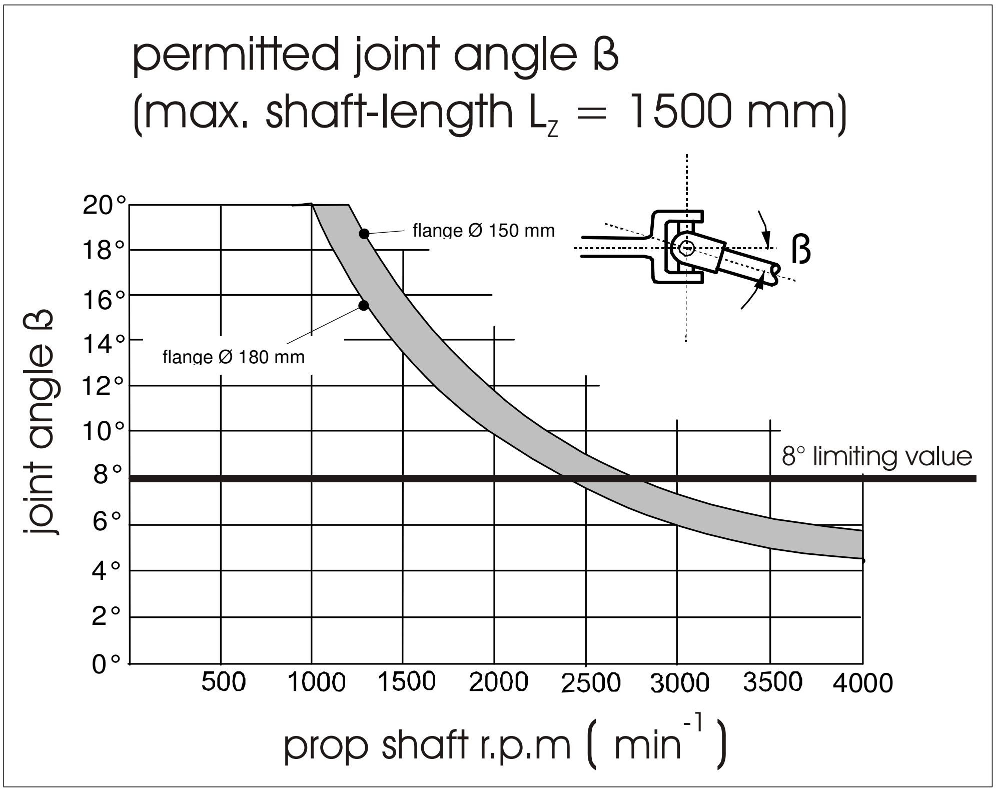
- acoustical problems
- lifetime problems

on transmission, prop shaft and axle components.
In order to avoid such oscillations, please observe the following limit values:

2.2.1 Perm. limit value - revolutions x deflection angle

The permissible deflection angle ß per joint depends on type, size and speed of the prop shaft.

$n \times ß < 22\,000\ min^{-1}$
(see also diagram)



These values have to be observed with regard to low-noise operation and in particular in view of service life and wear. With best-conditioned spring-mass systems these limits may be exceeded in exceptional cases. In these cases the prop shaft manufacturer and ZF have to be consulted.

The maximum prop shaft length without intermediate bearing (midship) must not be over L_Z = 1500 mm.

2.2.2 Perm. deflection angle per joint

Due to acoustical reasons, the following additional requirement is applicable (independent of speed) :

$ß \leq 8°$

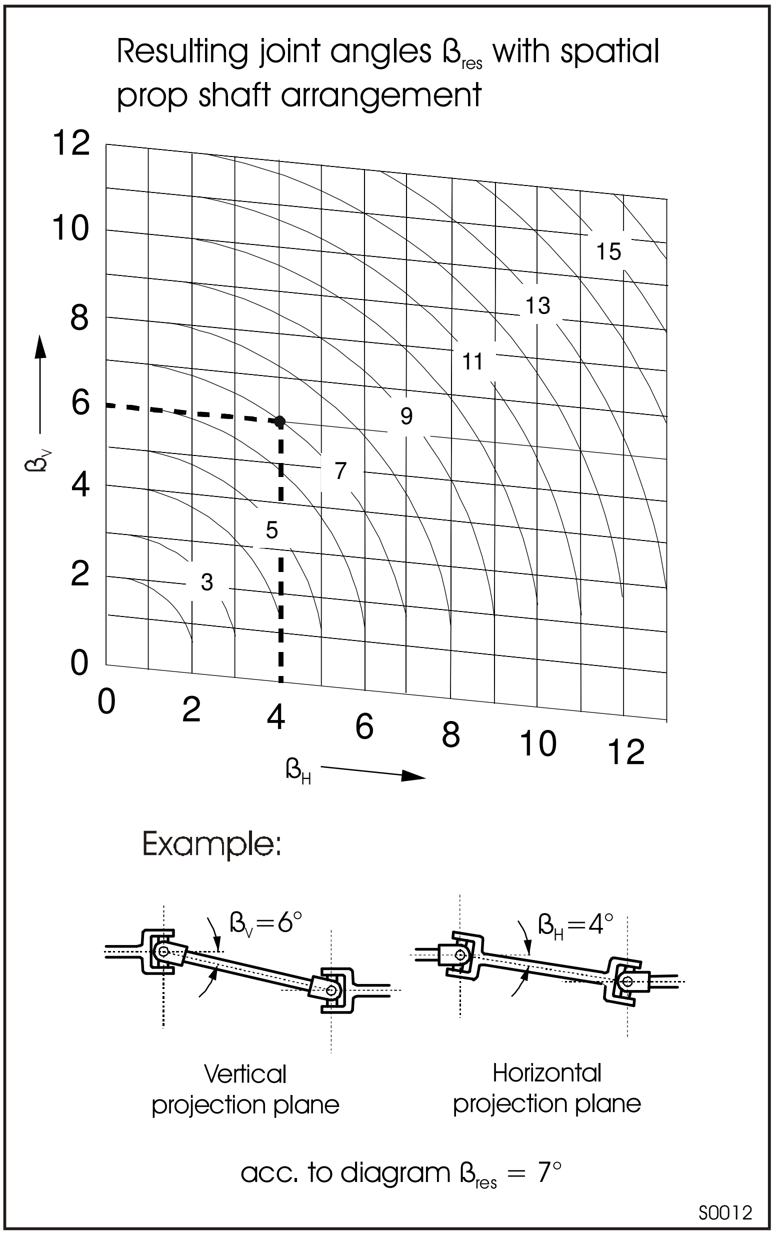
This value applies to the normal vehicle position. It may be exceeded when the axle is in full rebound or bump position.

2.2.3 Resultant three-dimensional deflection angle

For spatial arrangement, the resultant three-dimensional deflection angle has to be calculated and serves as the basis for design!

$$\beta_{res} = arc\tan\sqrt{\tan^2 \beta_V + \tan^2 \beta_H} \leq 8°$$

It is also possible to get β_{res} from the following diagram.



2.2.4 Max. perm. resulting deflection angle on shafts with more than one joint

The resulting deflection angle $ß_E$, the respective deflection angle ß, the input speeds available within the bus and the resultant oscillation amplitudes are in direct connection with each other.

The following limit values apply to the perm. resulting deflection angle $ß_E$ of all joints :

- **Deflection angle ß = 0.0° up to 3.0° → resulting deflection angle $ß_E$ ≤ 3.0°**
- **Deflection angle ß ~ 3.0° up to 6.0° → resulting deflection angle $ß_E$ ≤ 2.0°**
- **Deflection angle ß ~ 6.0° up to 8.0° → resulting deflection angle $ß_E$ ≤ 1.0°**

Note: The a.m. values do not necessarily correspond with the values indicated by the prop shaft manufacturers since those only apply to "general mechanical engineering".
In vehicle engineering, the application criteria frequently are more specific and definition of limits is different. The a.m. indications are values fixed by ZF on the basis of long-term experience as well as vehicle and bench tests. These values must be observed to ensure an optimum operation of the drive components.
The influence of the deflection angle size on the resulting deflection angle is represented in the diagram on the next page.

The resulting deflection angle is calculated from the angles of the single joints with the following formula:

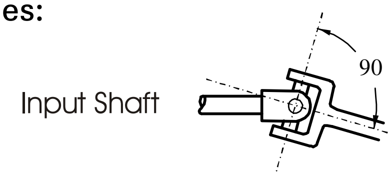
$$ß_E = \sqrt{|\pm ß_1^2 \pm ß_2^2 \pm ß_3^2 \pm \ldots|}$$

In case of spatial prop shaft arrangement, the "resultant" three-dimensional deflection angle $ß_{res}$ is subject to the a.m. conditions. $ß_{res}$ can be defined from the formula or the diagram.

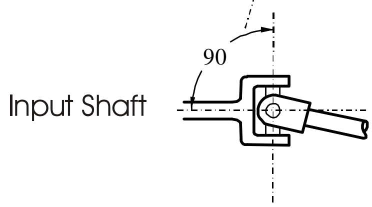
Application examples for the formula are shown in the illustrations on the next page and in Chapter 2.4 Multiple Arrangement.

The following sign rule for the different angles ß applies:

+ if the journal cross is vertical to the **output** shaft



– if the journal cross is vertical to the **input** shaft



Examples for the influence of the joint angle ß1 and ß2 on the theoretical joint angle ßE

Z - arrangement W - arrangement

Figure 1 (exact Z - or W - arrangement)

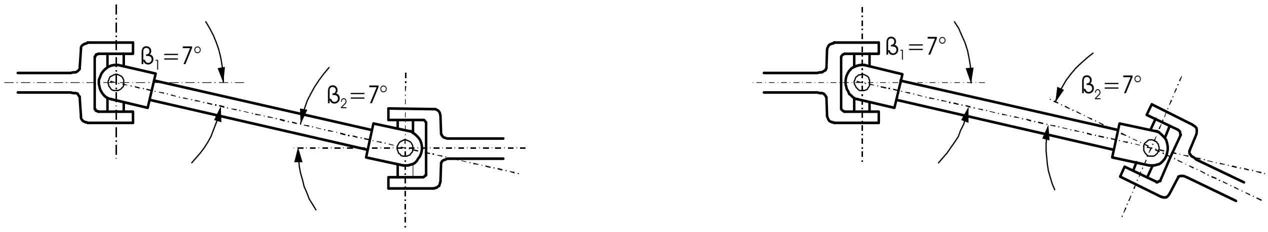


Figure 2 (small joint angles with angle error)

Figure 3 (big joint angle with angle error)

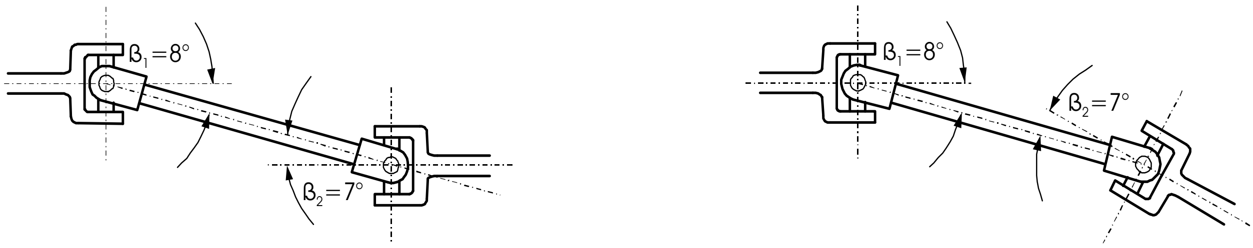


Figure	Angle Error $\Delta\beta = \beta_1 - \beta_2$	Theoretical Joint Angle $\beta_E = \sqrt{\lvert -\beta_1^2 + \beta_2^2 \rvert}$
1	0°	0°
2	1°	1,7°
3	1°	3,9°

Figure 3 illustrates that with big joint angles an angle error
of only 1° already results in an inadmissibly high theoretical joint.

S0011

2.2.5 Bending-critical speed

When an inclined prop shaft transmits a torque there is an alternating bending stress on the prop shaft center part, due to dynamic additional forces. If the stimulating frequency is equal to the natural frequency of the prop shaft, extreme stresses are produced. Therefore, special care must be taken that the prop shaft revolutions are clearly lower than the bending-critical revolutions (equals prop shaft natural frequency). As a reference value, the max. perm. operating speed of the prop shaft should not exceed 65 % of the bending-critical speed.

max. perm. operating speed [min^{-1}]

$n_{perm.\,max} = 0{,}65 \times n_{crit}$

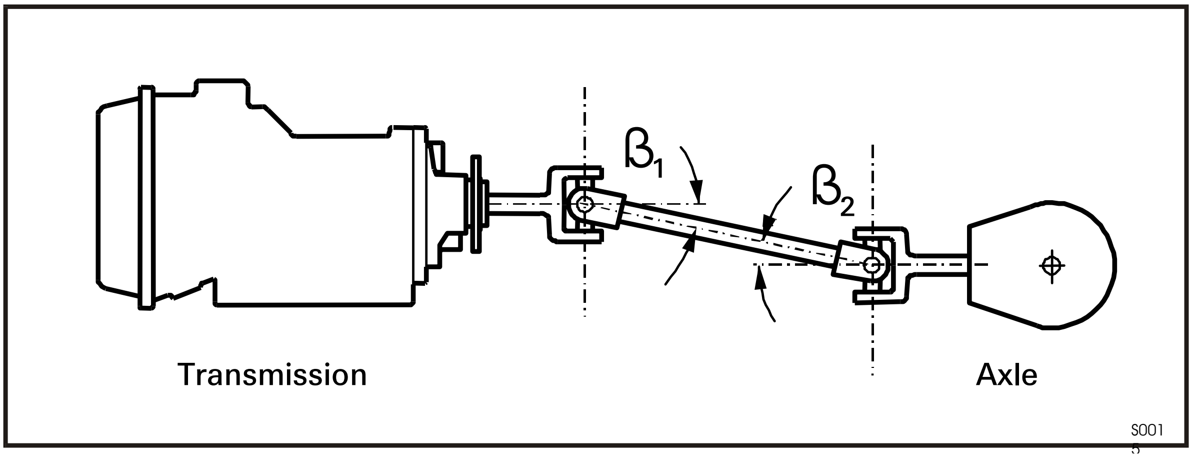
The **bending-critical speed** is calculated as follows:

$$n_{crit} = 1{,}21 \times 10^{8} \times \frac{\sqrt{D^2 + d^2}}{L^2} \qquad (\text{min}^{-1})$$

D	=	tube outer diameter	(mm)
d	=	tube inner diameter	(mm)
L	=	length of prop shaft center part	(mm)

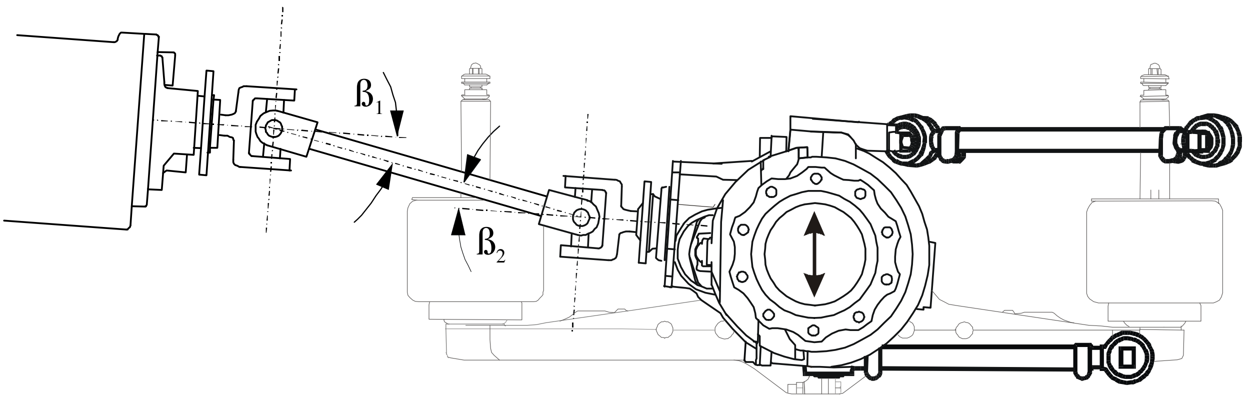
2.3 Single arrangement

Try to obtain an exact Z-arrangement of the prop shaft ($ß_1 = ß_2$) for all vehicle load conditions by means of an appropriate axle suspension.
Since this cannot always be implemented in the vehicle, observe the limit values mentioned in 2.2.



2.3.1 Influence of the axle suspension on the prop shaft deflection angles

Fixing by **longitudinal and V-rods** results in favorable Z-arrangement by parallel axle movement.
Condition $ß_1 = ß_2$ remains more or less unchanged, even at max. spring travel.



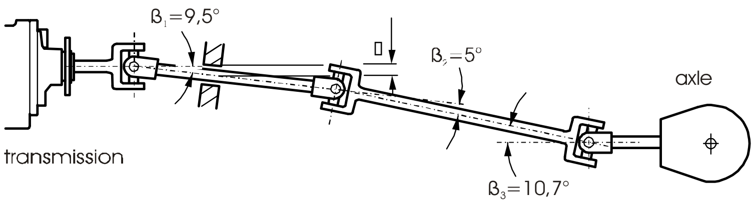
2.4 Multiple arrangement

A prop shaft with multi-arrangement can be optimized by an appropriate choice of the journal cross position and variation of the height h of the intermediate bearing (ß-angle distribution), so that the limit values given in section 2.2 can be met.

Optimization of the prop shaft by modifying the journal cross position.

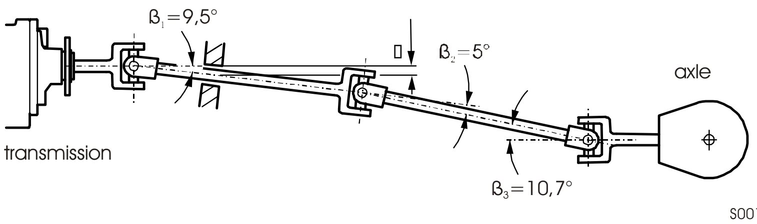
Unfavorable arrangement

$$ß_E = \sqrt{|-ß_1^2 + ß_2^2 - ß_3^2|} = 13{,}4°$$



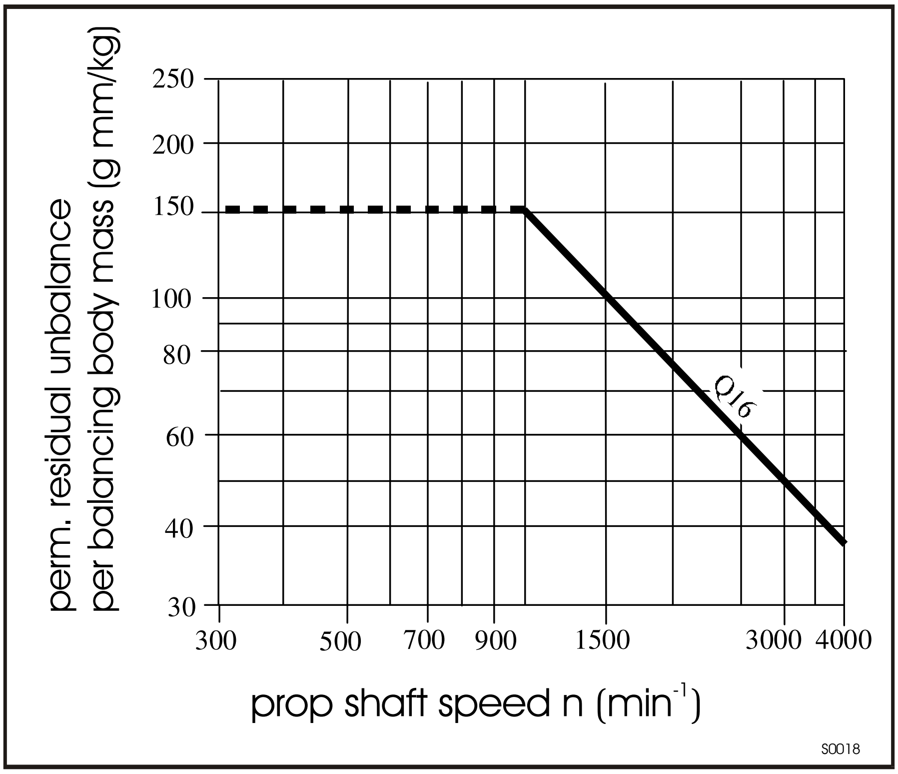
Optimized arrangement
(by modifying the position of the journal cross)

$$ß_E = \sqrt{|-ß_1^2 - ß_2^2 + ß_3^2|} = 0{,}87°$$



2.5 Balancing acc. to VDI 2060

The diagram shows the max. permitted unbalance:



2.6 Lubrication of prop shaft

► <u>Old version of prop shafts, uncoated</u>

Joint bearing and slip spline must be lubricated not only when being assembled, but have to be regularly serviced and relubricated.
When relubricating, fresh grease must come out of the seals!
Relubricate at least every 5000 km or 3 months!

We wish to point out that the pinion bearing may be damaged due to increased axial forces if the prop shaft is not relubricated on a regular basis.
For that reason, this version should not be used any more.

► <u>Prop shafts with plastic-coated length compensation</u>

The **journal cross bearings** have to be lubricated during assembly and for maintenance, provided they have a possibility for relubrication.

ZF recommends a lubrication interval of six months or every 30,000 km.

Relubricate until fresh grease comes out of the seals.

The **plastic-coated** splines are to be lubricated with grease according to the specifications of the prop shaft manufacturer. No further lubrication is required.

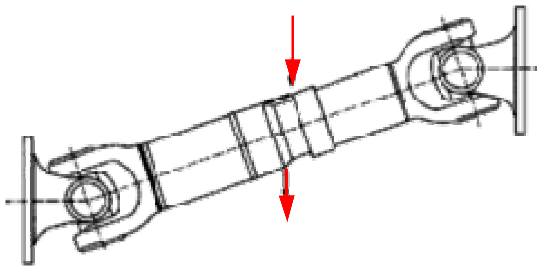
► <u>Grease quality</u>

Use lithium-saponified lubricating grease acc. to DIN 51825-KP2K-30 without MoS_2 additives or follow the recommendations given by the prop shaft manufacturer.

2.7 Miscellaneous

Installation position

Arrange the prop shafts in such a way that the spline is protected against dirt and humidity to the largest possible extent. Generally, the installation should be done according to the below sketch, with the spline seal showing downwards, to ensure that no splash water drops can enter the spline.



Shock factors

Depending on the kind of driveline and the vehicle application, a prop shaft is exposed to shock loads. When dimensioning the prop shaft and the prop shaft bearings, the respective shock factors have to be taken into account. Reference values are given by the prop shaft manufacturers.

3 BRAKE SYSTEM

3.1 General remarks on lifetime of brake disk and brake linings

The service life of brake disk and linings is determined to a very large extent by the operating conditions on which ZF has no influence in its position as axle manufacturer. These operating parameters include topography, frequency and intensity of brake operations, use of a zero-wear continuous service brake, accurately controlled brake force distribution and air circulation in the wheel house, required to dissipate the heat generated by braking, since high temperatures have an extremely negative impact on the lifetime of linings.
The brake system has to be designed according to the following criteria:

a) **Compliance with the legal requirements, e.g. the max. deceleration with permissible gross vehicle weight, wheel lock-up behavior and auxiliary brake effect.**
The vehicle manufacturer is responsible for the appropriate verification and release.

b) **Equal stress level at all wheel brakes in normal operation.**
This is important for wear and service life of the brakes and also applies to vehicles with retarder.

c) **Theoretical brake layout for empty and loaded vehicle condition:**
If buses are fully equipped with ZF axles, ZF is able to perform the brake calculation, based on the technical data provided in the questionnaire.
If buses are not entirely equipped with ZF axles, the vehicle manufacturer must provide details of the theoretical configuration which are to be agreed with ZF.

d) **Temperature measurements over extended periods of service:**
If buses are fully equipped with the same size of disk brakes, the same temperature level should be found on all brake disks during operation.

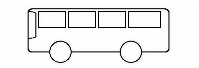
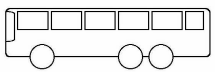
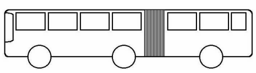
e) **Measurement of brake force distribution at different brake chamber pressures**

The difference of brake force distribution of brake circuit 1 and brake circuit 2 must not be bigger than 0.1 bar for buses with disc brakes.
The brake pressure is measured directly at the brake chamber.

Recommendation:
Before final volume production release, the vehicle manufacturer should conduct endurance tests on the brake system.

3.2 Brake force distribution

In the past, the following brake force distributions provided the best results regarding lifetime:

	1st axle	2nd axle	3rd axle	Brake force distribution
	disk	disk		1 : 1-1.1
	disk	drum		1 : 1.3
	drum	drum		1 : 1.3
	disk	disk	disk	1 : 1.0-1.1 : 0.7-0.8
	disk	drum	disk	1 : 1.3 : 0.7-0.8
	**disk**	**disk**	**disk**	**1 : 1 : 1.1 ***

These values apply up to a brake pressure of 2 bar. At higher brake pressures, the brake force distribution can be adjusted according to the dynamic axle load ratio by means of a pressure control via valves.

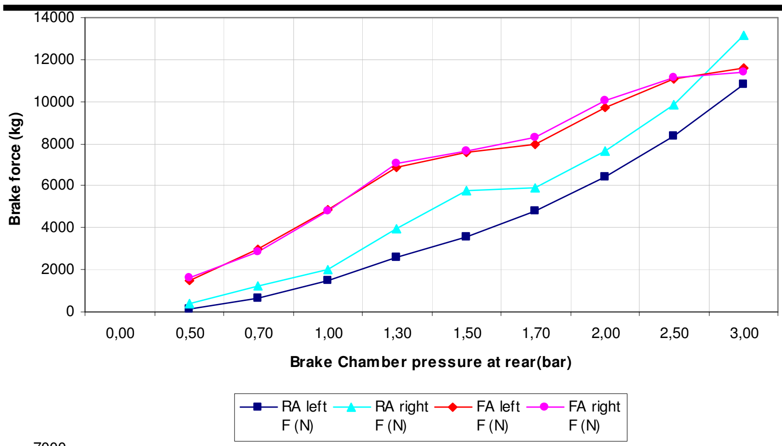
* This only applies to articulated buses with rear-mounted engine

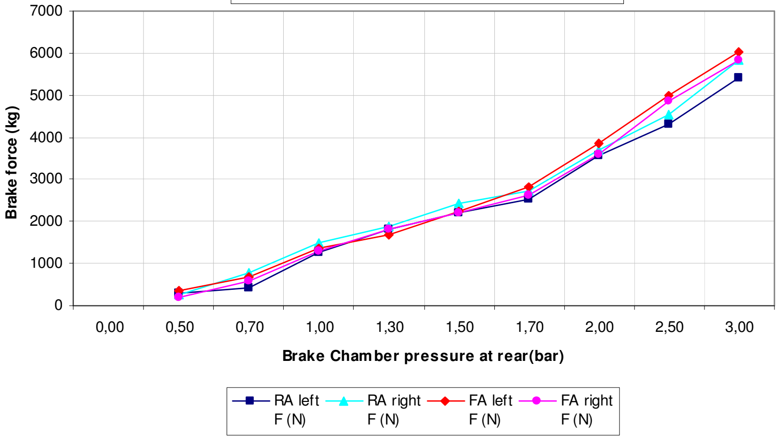
Combinations which are not listed in the table must be coordinated with ZF regarding brake force distribution.

We recommend to coordinate the layout of the brake and compressed-air system with ZF during the project planning stage already to avoid later "upgradings".

The vehicle manufacturer is responsible for reaching the required brake force distribution by means of an appropriate layout of the brake system.
This applies in particular when using electronic brake systems (EBS) in which the correct programming of the EBS equipment must ensure that the required, correct brake force distribution is reached. The EBS program and the brake components must match with each other.

In general, the simultaneous actuation of service brake and parking brake on the rear axle is not permitted.
An overload protection valve has to be provided.





Examples Brake Force Distribution

Example 1:

- amiss brake force distribution
- excessive brake force at the front axle
- negative consequense: high wearout of the brake pads at the front axle

Example 2:

- Balanced brake force distribution between front and rear axle
- Constant and well-balanced wearout of the brake pads at the front and rear axle

3.3 Retarder

If the retarder is actuated with the brake pedal, as usual for city buses, the retarder **must be** fully activated at least when there is 0.4 bar brake pressure at the drive axle. ZF recommends the retarder to be designed in a non-switch-off version. However, if a switch-off retarder version is required, a warning lamp should light up on the dashboard for this non-available brake function.
An existing retarder which is incorporated into the brake management increases the service life of the mechanical wheel brake components, thus extending the service intervals.

3.4 ABS sensors

The axles are prepared for the connection of ABS sensors. Upon request, the sensor can be part of the delivery scope.
This sensor is compatible with Bosch and Wabco ABS systems.
Use an oil-tight sensor for the AV-132 axle.

The number of teeth of the impulse rings is as follows:

Axle type	Rim size	Number of teeth
A-131, A-132, AV-132, AVN-132 RL 75, RL 85	**22.5”**	**100**
A 80, RL 55 E	**19.5”**	**80**

3.5 Brake chambers

Before putting into operation a vehicle incorporating axles with horizontally mounted brake chambers and respective chamber versions, the lower rubber plug of the condensation water drain hole must be removed.

► **Routing of lines**

When routing compressed air lines and sensor lines, the vehicle manufacturer must ensure that these lines do **not** subject the brake caliper to compressive or tensile forces under any operating conditions, and that they do not restrict the movement of the brake caliper. Care must be taken to ensure that the lines are properly secured and do not hang loose. The lines must also not be subjected to any tensile forces due to axle movements and must not scuff against components or edges.

The vehicle manufacturer is responsible for the correct routing of lines!

► **Brake release clearance**

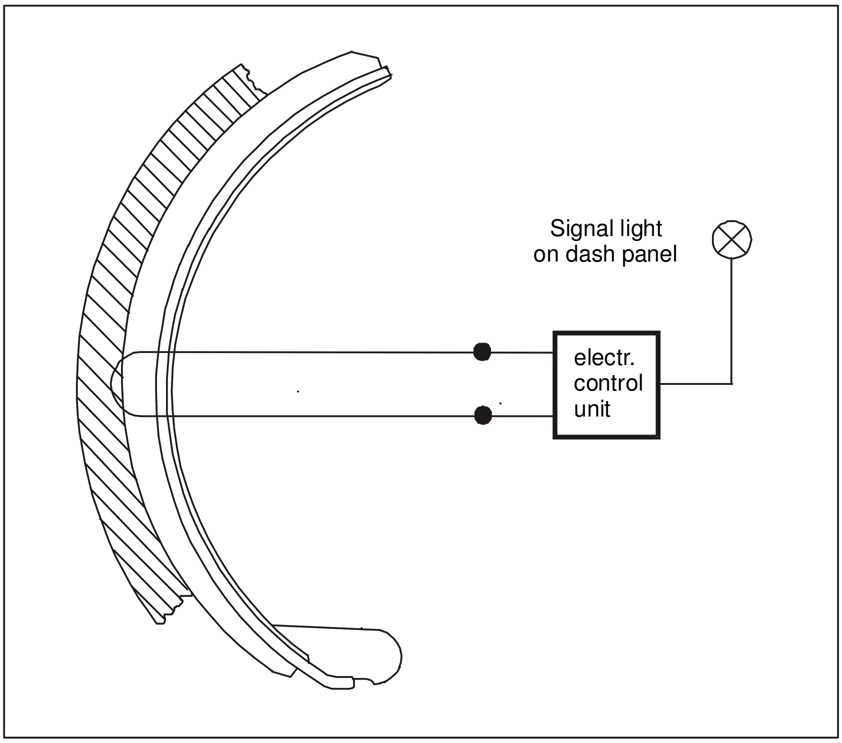
Ensure that the brake release clearance is correctly set to 0.6 - 0.8 mm.
This must be checked prior to putting the vehicle into operation (see for example Knorr Bremse repair manual).

3.6 Brake lining wear sensor

General:

- All plug connections must be according to IP67 protection grade.
- The vehicle manufacturer is responsible for the correct installation of wiring and for the correct fusing of live lines.
- An electrical wear sensor system does not dispense from a regular visual lining wear verification.

Drum brake, loop sensor system



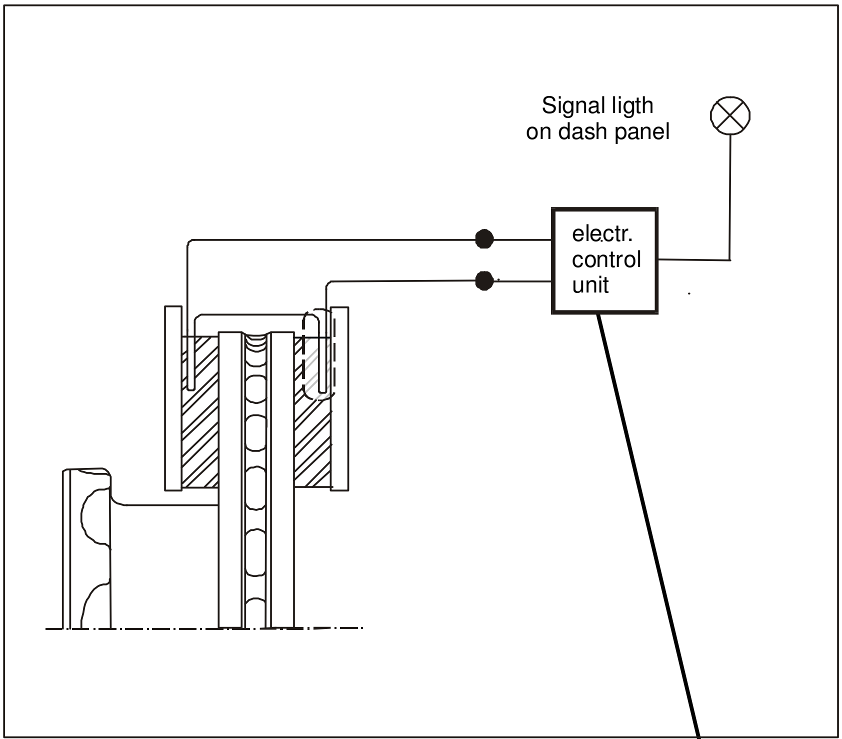
The cable routed in a loop through the lining is disconnected in case of wear. The vehicle manufacturer has to provide electrical system circuitry which enables the control lamp to light up as soon as the electrical circuit is interrupted.

Disk brake, continuous wear sensor system

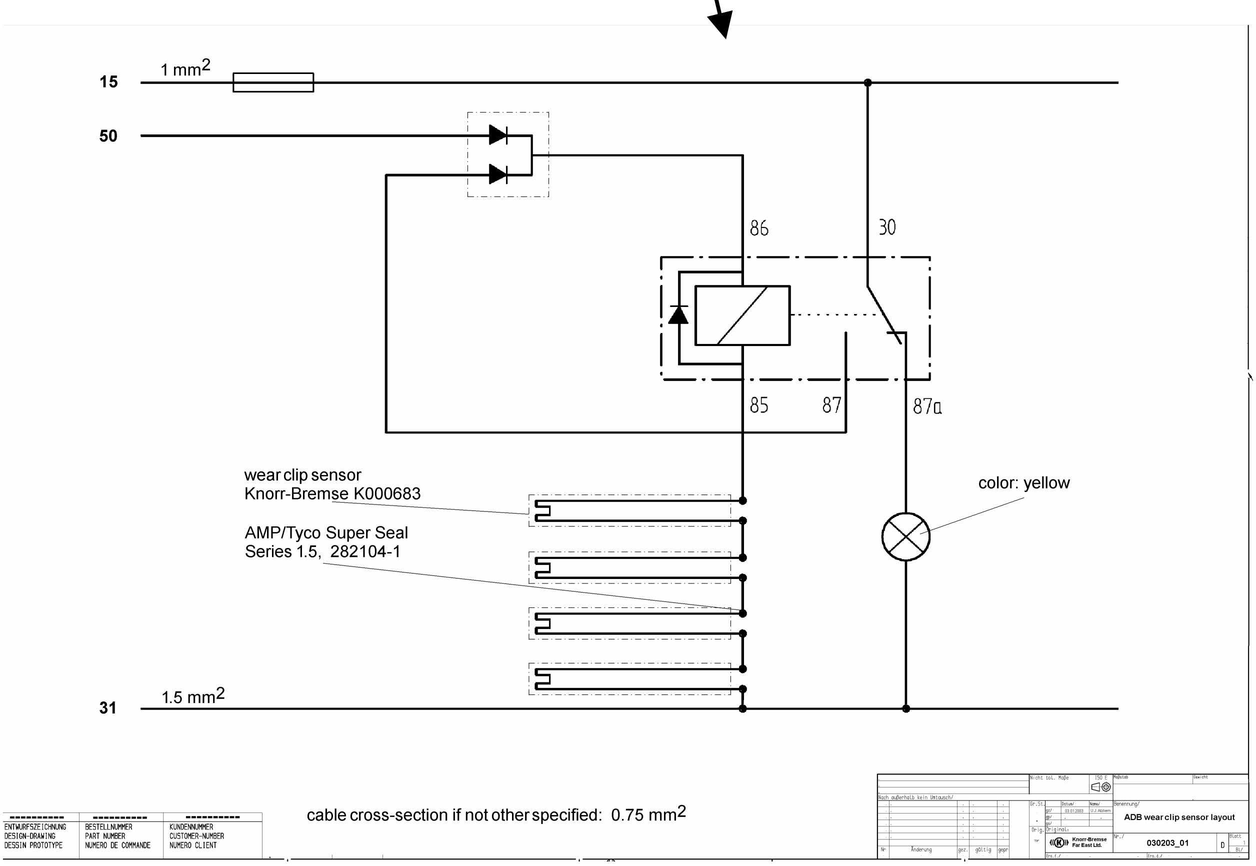
The continuous wear sensor system operates by means of a rotary potentiometer integrated in the brake which is activated by the slack adjusting mechanism. The correct power supply must be ensured. In general, this is five volts (5 V).
If necessary, the exact potentiometer specification is to be requested from ZF.

It is mandatory that the plug connection at the brake caliper is according to IP67 protection grade. Any unused plug connection needs to be sealed accordingly. Suitable plugs can be obtained from ZF Passau.

Disk brake, loop sensor system



The cable routed in a loop through the lining is disconnected in case of wear. The vehicle manufacturer has to provide electrical system circuitry which enables the control lamp to light up as soon as the electrical circuit is interrupted.



This diagram serves as an example.

The vehicle manufacturer is responsible for the correct layout, system circuitry etc.

4 AXLE GEOMETRY AND STEERING SYSTEM RL 55 E, RL 75 A, RL 75 E, RL 85 A, RL 85 E

The design of the steering linkage together with a correctly adjusted axle geometry decisively influences the lifetime of the tires as well as the driving behavior and vehicle handling.

The following items have to be considered:

4.1 Steering geometry

The installation drawings show proposals for the arrangement of the steering linkage, which are tuned to ZF steerings and proven by test runs.
This steering linkage arrangement ensures the correct relation between curve-inner and curve-outer steering angle ("Ackermann geometry"), based on bus-typical wheelbase levels of approx. 5,500 mm to 6,500 mm.
In case of other wheelbase dimensions we recommend to recalculate the steering geometry and to match it to the respective vehicle conditions, if necessary.
Non-compliance involves the risk of increased tire wear.
The layout of the steering gear position and Pitman arm length shown on the installation drawing provides a largest possible and symmetrical "steering gear utilization" with regard to ZF steering systems (angular travel of Pitman arm approx. +/- 45° min.).

4.2 Toe-in change during bump and rebound

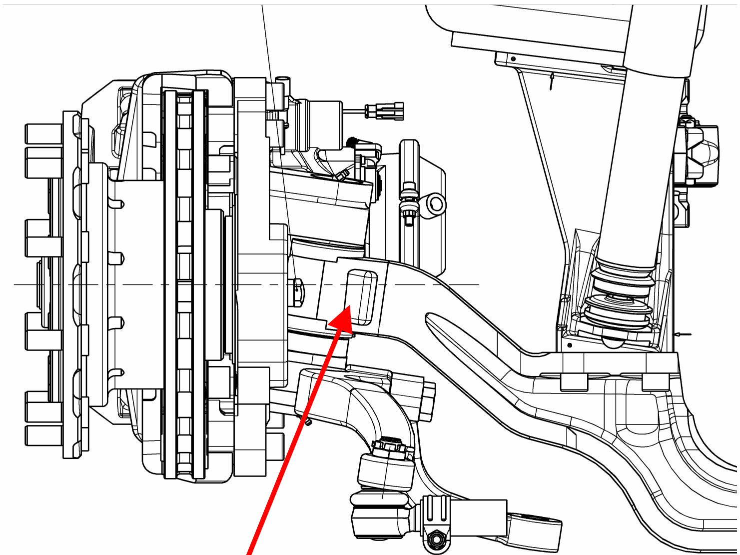
It is recommended to arrange the tie rods and the drag link in accordance with the instructions given in the installation drawing. This arrangement is proven by theoretical investigations and test runs.
On the RL 85A rigid axle, an incorrectly positioned drag link may lead to an unacceptable self-steer effect during bump and rebound or heavy braking operations.
On independent front suspensions, incorrectly positioned tie rods lead to excessive toe-in change during bump and rebound, resulting in increased tire wear.
The reference value for the basic toe-in setting shall be 0 up to max. +2 mm total track (with 22.5″ rim).
ZF recommends to match the basic toe-in setting additionally with the tire manufacturers.

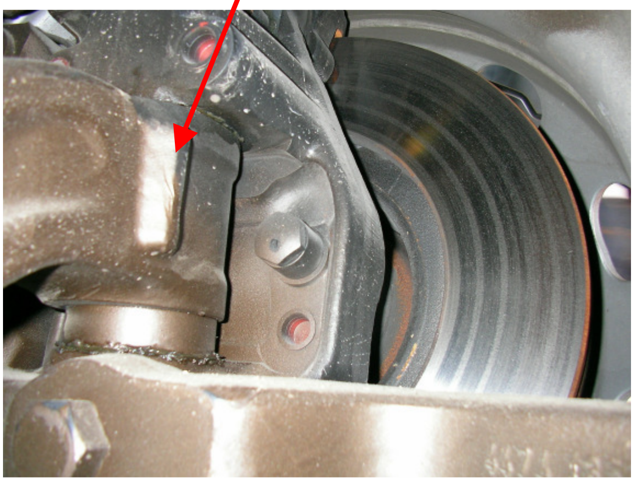
4.3 Steering linkage, steering column components

Special attention shall be paid to designing especially the transmission parts between steering wheel and steering gear at **lowest friction level** since excessive friction has a highly negative impact on steering returnability and precise directional stability.
A maximum of stiffness and a minimum of clearance shall be considered for the design of the whole steering linkage arrangement to ensure a direct transmission of the steering commands.

4.4 Steering stop, steering gear setting

The steering stops at the axle are adjusted to the dimension shown in the installation drawing. A subsequent modification is possible within certain limits and is to be agreed with ZF.
The steering pressure limitation valve of the steering gear must be effective before the steering stop at the axle is contacted to avoid the steering linkage getting pressed against the stop with the full hydraulic steering assistance.





Example: Steering stop RL85A

4.5 Axle geometry setting

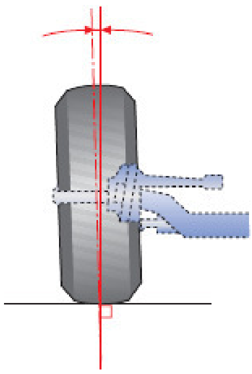
An incorrectly adjusted axle geometry can lead to excessive tire wear, imprecise directional stability and poor steering centering. Therefore, it is imperative to correctly adjust the geometry in compliance with the specifications given in Chapter 4.3.

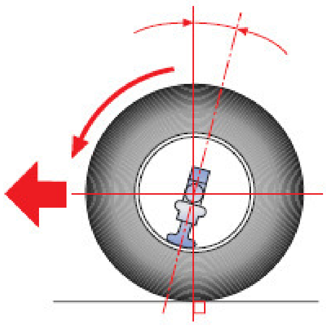
The **rigid front axles** are to be adjusted to the caster angle according to the installation drawing by means of the axle rods.
The toe-in is adjusted via the tie rod. In any case, the setting must be checked before putting the vehicle into service. Due to the technical configuration, an adjustment of the camber is not possible and not required.

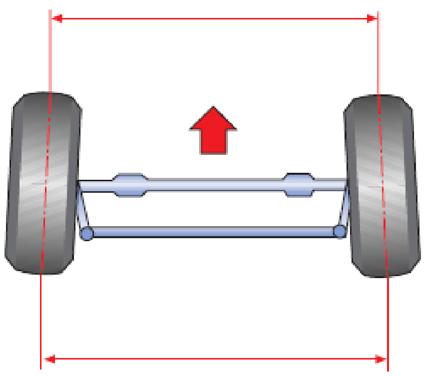
On **independent front suspensions** type RL 55/75/85E, the correct camber is to be adjusted by means of spacers on the control arm bolt connection at the chassis. A caster angle setting is not possible. The toe-in is adjusted via the tie rods as on rigid axles.

The **rear axles** shall be installed with a maximum of 2 mm/m or ± 0.15° deviation at right angles towards the longitudinal vehicle axis. Setting is implemented via the axle rods. Excessive rear axle inclined position has a negative impact on the directional stability behavior of the vehicle.

ZF recommends to check and adjust the axle geometry by means of laser-optical measuring equipment prior to putting the vehicle into service. (References of manufacturers in Europe are for example JOSAM or KOCH).


Camber


Caster

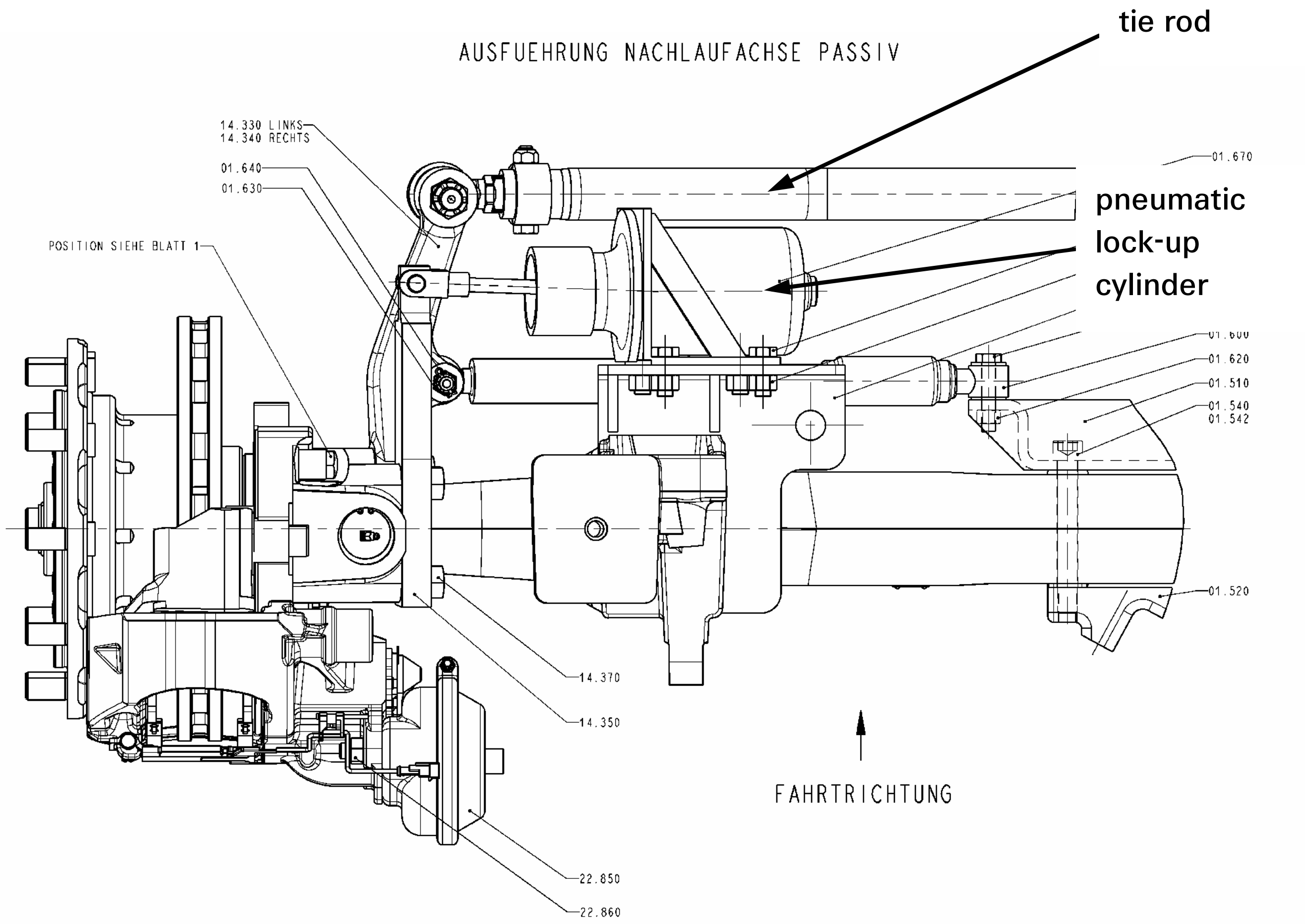

Toe-in

4.6 Setting of tag axles RL 75/85A, active and passive

Special care must be taken that in straight-line driving, i.e. in locked-up condition, both tag axle versions are correctly aligned towards the rear axle. The toe angle deviation between tag axle wheels and rear axle toe must not exceed **2 mm/m max.** Excessive deviation involves the **risk of increased** tire wear on the tag axle.

On the passively steered version, the correct lock-up position is to be implemented via the adjustable pneumatic lock-up cylinders. On the actively steered version, the tag axles are adjusted via the hydraulic steering cylinder.

Before setting the precise lock-up position, the correct toe-in is to be adjusted via the tie rod.



5 LONGITUDINAL RODS AND TRANSVERSE CONTROL ARMS

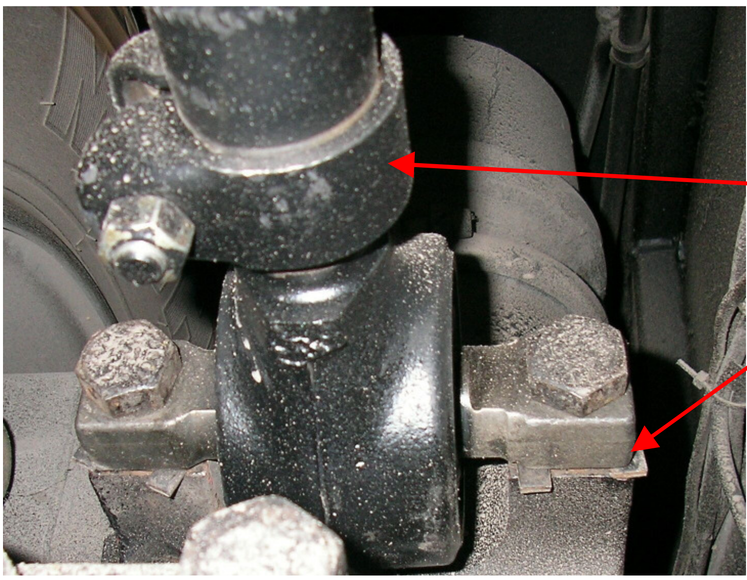
The rods and control arms are designed for guiding the axle in longitudinal and transverse direction. They have to transmit to the chassis all forces acting on the axle, such as drive, brake and cornering forces, by avoiding elastic deformation wherever possible. For that reason they have to be configured and dimensioned accordingly.

If you purchase the control arms from ZF, these components have been designed and proof-tested accordingly.

5.1 Bolted connection of axle rods and control arms on the chassis

The exact position of the axles towards the chassis must be adjusted by means of the length of control arms and axle/chassis. Provide for adjustment possibilities!
In general, welded vehicle frames are subject to certain manufacturing tolerances. For that reason it is necessary to compensate tolerances at the chassis fixing points of **non-adjustable** axle rods and control arms by means of spacing washers in order to be able to precisely align the axle geometry to the values shown in the installation drawing.
It is the vehicle manufacturer's responsibility to ensure sufficient diameter and strength of the spacers.

ZF recommends to use closed shims, since the so-called horseshoe shims may get loose and fall out.
The vehicle manufacturer is responsible for a correct and durable bolted connection incl. adjusting shims.



Negative Example (AV132)**:**

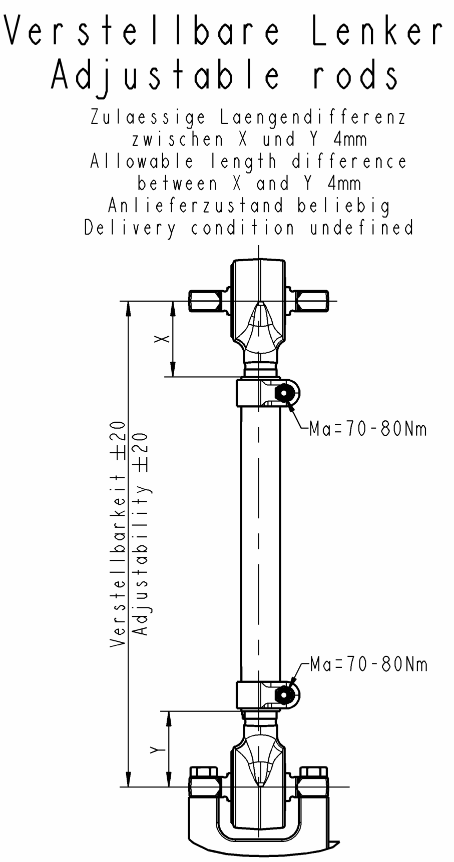
Additionally to an **adjustable** rod several horseshoe shims were put underneath the bracket.

In case of **adjustable** control arms you have to observe the tolerances. When using adjustable axle rods, please pay attention that the max. permissible adjustment range is not exceeded - see attached drawing.

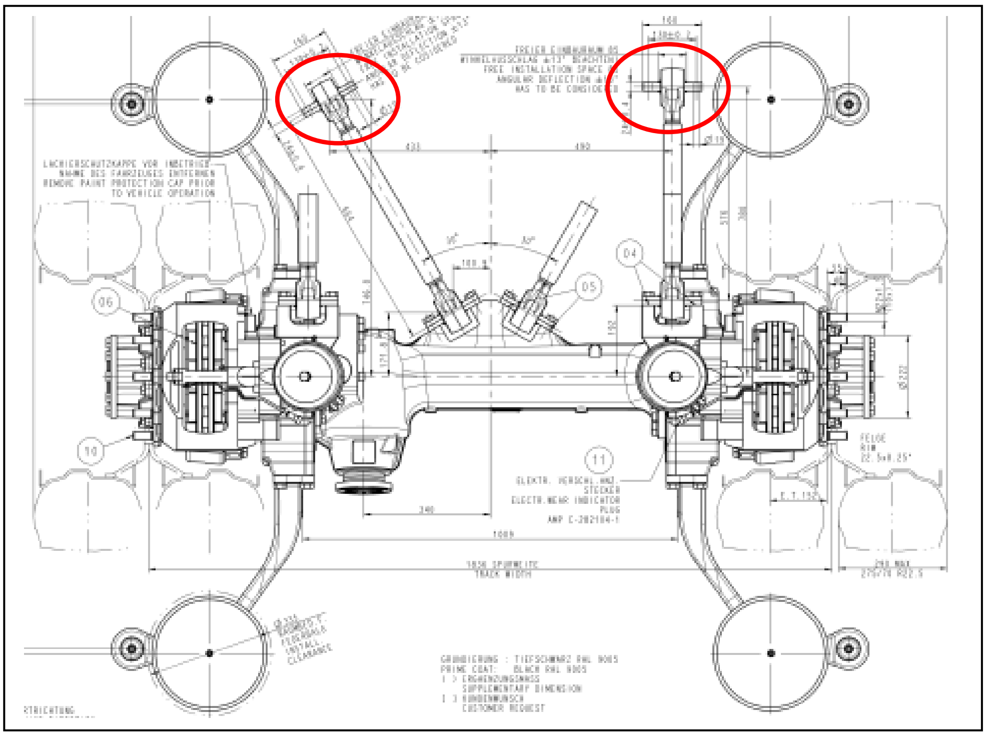
The respective control arm is to be adjusted symmetrically, with each - and not just one - of the joint housings to be turned out or in !

In order to protect the threads, adjustable control arms are delivered with bushing housings being fully screwed into the tube.
Pay attention to the permissible length difference!

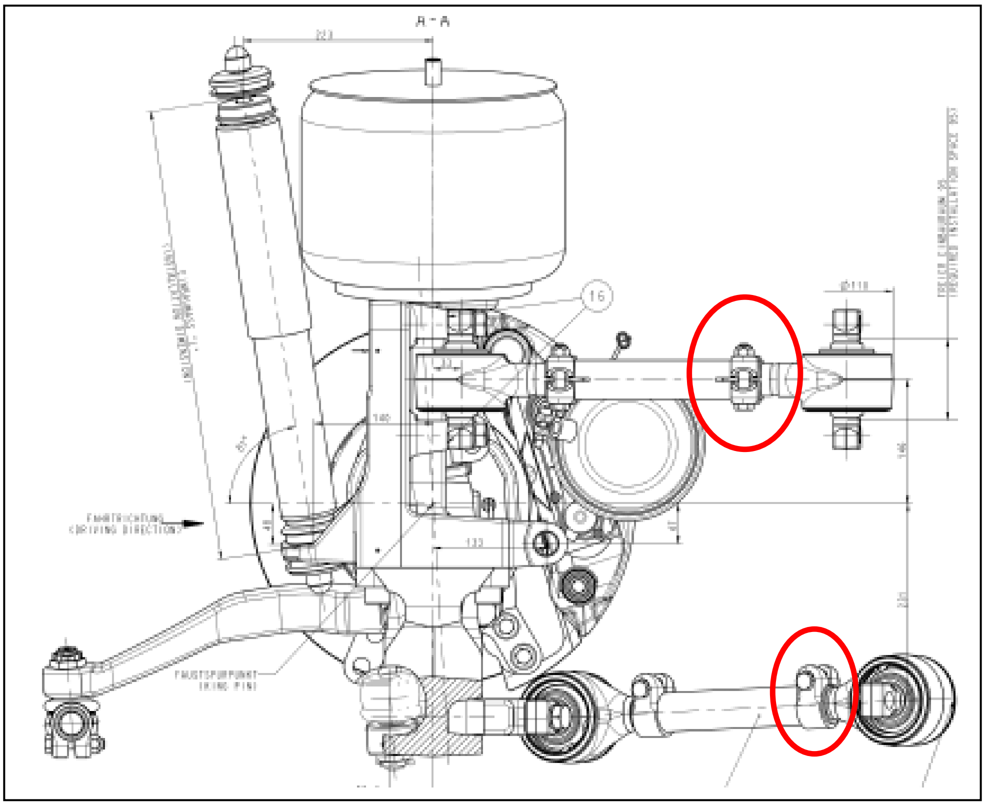
Attention:
Adjustable axle rods are delivered with bushing housings being fully screwed into the tube. Setting to the correct length is to be done by the vehicle manufacturer.
The bolt-on surfaces of the axle rods at the chassis must be within the following evenness and dimensional tolerance.
Non-observance involves the risk of joint breakage!



Example:
Adjustable control arm



Example:
<u>Non-adjustable</u> control arms:
Installation of spacers to obtain the required, correct installation position of the axle.



Example:
Use of adjustable control arms to obtain the correct installation position of the axle and the correct caster angle.

<u>**Note:**</u> These figures are to be considered as an example.
For binding information please contact ZF Passau for installation drawings.

5.2 Joints of control arms

The design configuration of the control arm joints must ensure that

- the axle can carry out the rated spring travel.
- there is no inadmissible deformation at max. forces and
  the axle does not develop any undesired self-steer effect.
- noise transmission is prevented to the largest possible extent.

6 STABILIZER

It is possible to fit stabilizers to the front and rear axle upon the vehicle manufacturer's request.
In general, the stabilizer is designed by the vehicle manufacturer.
The attachment points at the axle can be taken from the ZF installation drawing.
The support bearings of the stabilizer must be maintenance-free.
The bearings must be designed in such a way that the stabilizer is located in the vehicle transverse axis.
The bearings at the chassis are to be arranged outwards to the largest possible extent, directly besides the radius of the stabilizer. Care must be taken to not preload the stabilizer during assembly.
The stabilizer linkage must allow the full bump and rebound travel of the axle without blocking.

7 WHEELS

The axles are designed for hub (pilot) centered wheels. Use wheel nuts with press plate. Wheel bolt quality of the axles: 10.9.
Tightening torques of nuts (quality 10) for steel wheels and thread size M 22 x 1.5: 600 Nm. When using light-alloy wheels, please refer to the manufacturer's instructions, but not more than 600 Nm.

In case of bolt centering, please take care that appropriate wheels are used. Tightening torque for this version: 400 to 450 Nm or according to the manufacturer's instructions, but not more than 600 Nm.
These tightening torques are to be tolerated ±15 % according to bolt connection class 5 and require a friction coefficient of μ=0.12 to μ=0.18. The friction coefficient itself depends on several factors.

To obtain uniform bolt connection results, it is imperative to comply with the specified tolerance range:

► At an identical tightening torque, an insufficient friction value leads to a higher preload in the bolt connection. If this load is higher than the max. admissible load, this will lead to plastic deformations (elongation of bolt, deformation of thread etc.).

Friction-reducing thread lubrications are not permitted
(in particular lubricants with Cu, MoS2 additives or GL5 oil).

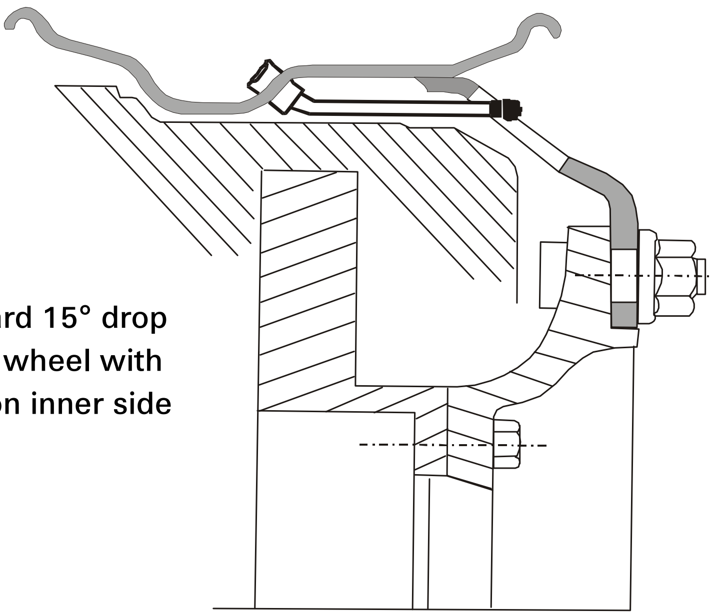
The wheel nuts are to be tightened crosswise, the torque is to be applied manually, not by means of an electric or pneumatic impact wrench, in 3 steps with approx. 300/500/600 Nm (150 - 300 - 400).
The vehicle manufacturer has to specify the relevant instructions for a regular check of the wheel nut tightening torque.

ZF recommends to balance the wheels dynamically. The max. residual imbalance shall not exceed 50 g/wheel for rim size 22.5".

Attention:
The so-called „finish-balancing", i.e. balancing at the vehicle, does not always lead to the requested result, since generally this balancing procedure does not allow to identify whether the balancing weight has to be positioned at the inner or outer rim flange.
Therefore, ZF recommends to balance the wheels by means of balancing machines.
The max. radial tire runout should not exceed 2 mm.

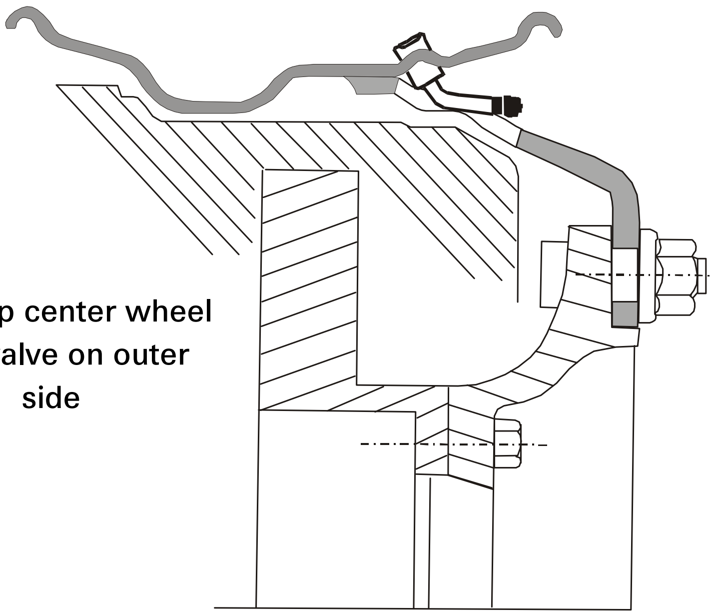
Ensure that there is sufficient clearance between wheel and brake.
The brake envelope is shown in the installation drawing.

For disk brakes we recommend to use only wheels with the valve being positioned on the outer side.



Standard 15° drop center wheel with valve on inner side

On this version, foreign parts may wedge between the valve and the stationary brake caliper.
This may result in the valve being damaged or torn off.



15° drop center wheel with valve on outer side

The 15° drop center wheel with external valve differs from conventional wheels because the valve is no longer inserted through a ventilation hole in the wheel disk, but is fitted outside the wheel disk at a safe distance from the brake caliper. These wheels can also be used on vehicles with drum brakes.

8 SHOCK ABSORBERS

8.1 Installation of ZF-Sachs shock absorbers

Numerous problems may arise during the design phase of the shock absorber arrangement for different application scenarios.
It is therefore essential that the shock absorbers are integrated into the overall concept during the design phase already so that favorable conditions can be created for optimum damping characteristics.

On a general basis, the following items should be observed when fitting ZF-Sachs shock absorbers:

- Wherever possible, the **shock absorber travel** should not be less than the extent of travel of the system being dampened. Attempts should be made to achieve a ratio between wheel travel and shock absorber travel of 1 : 1.
  Under these conditions, the damping force can be directly effective and the shock absorber is subject to minimum levels of mechanical and thermal loading.

- For thermal and functional reasons, the **shock absorber length** selected should be as large as possible.

- The **installation position** must ensure cooling of the shock absorber by the airstream.

- There should be sufficient **distance** between the shock absorber and the exhaust system or any other **heat-emitting components**.

- Experience has shown that the available **installation space** often plays a decisive role. The space available should be designed in such a way that large shock absorbers may also be fitted for special applications (e.g. version used for badly surfaced roads) if necessary.

- **When supporting the vehicle spring** via the shock absorber, the transverse forces exerted on it should be kept as low as possible.

- Attempts should be made to achieve **as small an installation angle as possible relative to the vertical axis** because, as the angle increases, damping forces also have to rise to provide an equivalent level of effectiveness. The max. permissible installation angle (variance from perpendicular axis) is 45° for all double-tube shock absorbers. Angular movements must not exceed the permissible values to ensure that reset torques from the flexible shock absorber mountings do not generate excessive transverse forces which would in turn lead to high levels of wear.
  A vertical installation is most suitable for obtaining these favorable prerequisites and a high level of effectiveness of the shock absorbers. Usually, such a configuration also ensures a low level of angular movements. In practical application, however, it is not always possible to materialize the vertical arrangement of shock absorbers.

- The top and bottom shock absorber mounting points must be properly aligned with each other in terms of the vehicle's design configuration and **are to be installed according to the design configuration of the axle**. This is the only way of avoiding torsional stress and premature wear to the shock absorbers in their installed position.

The shock absorbers being available at ZF are tuned to the respective axle systems. Consequently, they can be applied according to the release given for the axle.

Front axles RL 75 A/E and RL 85 A/E can be delivered with shock absorbers upon customer's request. In this case, the shock absorbers are not mounted to the axle or the wheel suspension, but they are supplied separately, packed as loose parts. The shock absorber mounting position on the chassis can be taken from the installation drawing. It is absolutely necessary to observe this position. Any deviations are to be agreed with ZF.

Rear axles A131, A132, AV132 and AVN132 can be delivered with shock absorber upon customer's request. Depending on the requested scope of delivery, these shock absorbers can be mounted or delivered separately as loose parts.
The shock absorber mounting position on the axle and chassis can be taken from the respective installation drawings. It is absolutely necessary to observe this position. Any deviations are to be agreed with ZF.

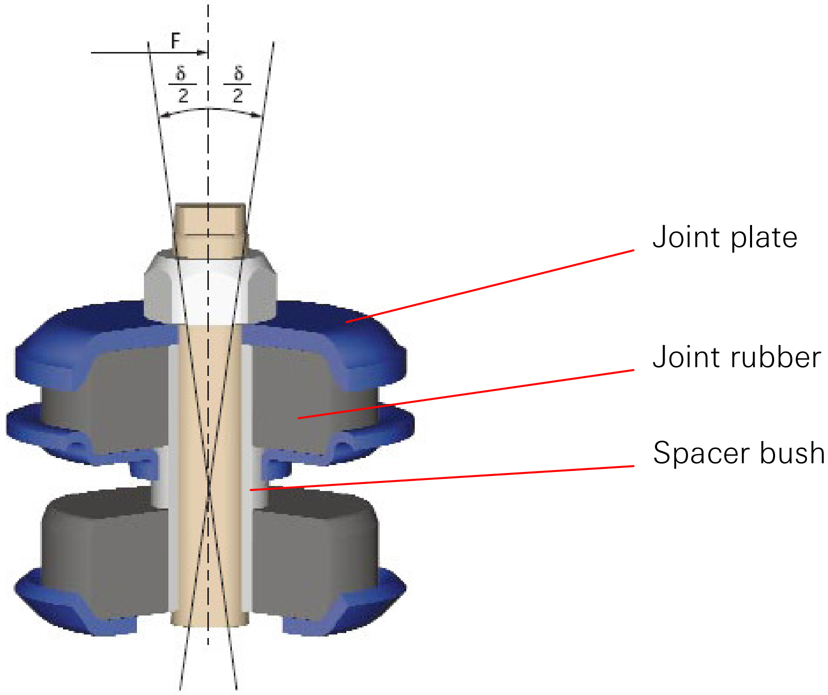
All shock absorbers being presently available at ZF have a hydraulic rebound stop. This hydraulic rebound stop serves to limit the maximum rebound travel of the axles. For that reason additional elements for rebound travel limitation are not necessary.

Please bear in mind that the maximum force acting on the rebound stop must not exceed 30 kN per shock absorber. This means that the max. air spring force in fully rebound condition must not exceed this value of 30 kN each.

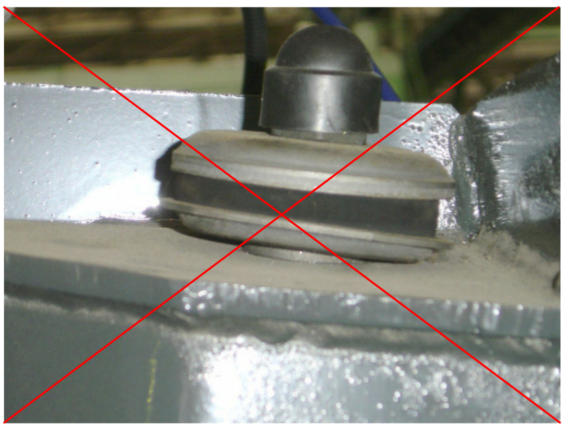
8.2 Shock absorber joints

The shock absorber joints provide the elastic, noise-insulating and (to a certain extent) the articulated connection between wheel suspension and chassis.
In addition to the loads applied by tensile and compressive forces, the joint parts designed for the attachment of the shock absorbers must also absorb angular movements.

The permissible deflection angle is $\delta/2 \approx 5°$



When installing the shock absorbers and their joints, pay special attention to the correct number of joint plates, their installation position and the correctly inserted joint rubber and spacer bush!



Negative example

9 AIR SPRINGS

Air springs are available at ZF upon request. Their dimensions are tuned to the respective axle loads and to the respective axle system.
Data sheets for the different versions are available on request.

The vehicle manufacturer is responsible for an appropriate rebound travel limitation (e.g. correctly designed and installed shock absorbers) that avoids overstretching of the air spring bellow.

The vehicle's air supply system must produce a sufficiently high pressure level and volume of compressed air.

The following items have to be considered:

- ► The spring bellows must not be exposed to high temperatures. This must already be taken into account for the vehicle design, e.g. for the exhaust system.
- ► Air springs must be kept free of solvents, undercoating, paint and similar substances.
- ► When fitting the air spring, it is imperative to comply with the specified tightening torques for the fixing bolts.
  Follow the instructions given in the installation drawing.

Observe the following safety regulations for the installation and operation of air springs:

- ► Operating temperature -40°C to 70°C
- ► Max. static operating pressure: 7 bar
- ► Max. operating pressure during lifting operations 8.5 bar
- ► Do not fill the air spring with compressed air until it has been installed or in case a mechanical height limitation (rebound stop) is provided.
  ! Risk of injury !

The air springs of RL 75 A/E, RL 85 A/E front axles and A 132 and AV-/AVN 132 rear axles are equipped with an internal rubber end stop for bump travel limitation.
A stone shield for the air spring bellow is recommendable.

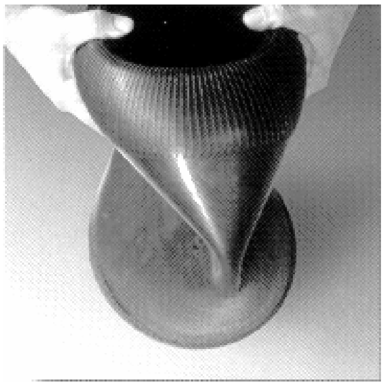
To ensure a good axle load compensation, the connection line of the air spring bellow should not fall below a diameter of 12x1.5 mm.

The fitting of the air spring bellow between piston and plate is described hereafter.

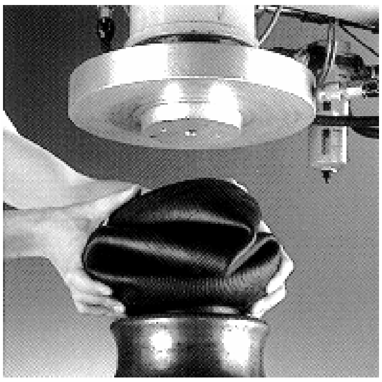
10 FITTING OF A NEW AIR SPRING BELLOW

1. Clean the bead seats on the clamping plate and spring piston. Check that the mounting hardware is free of burr and is not corroded (replace if necessary). Apply a soap solution or an approved fitting lubricant (no grease) to the bead seat of the piston.

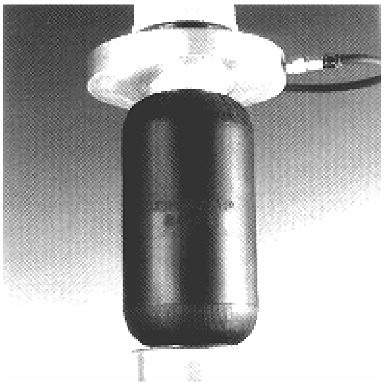
2. Compress the new air spring to a hand's width, while pushing it in below the upper bead.



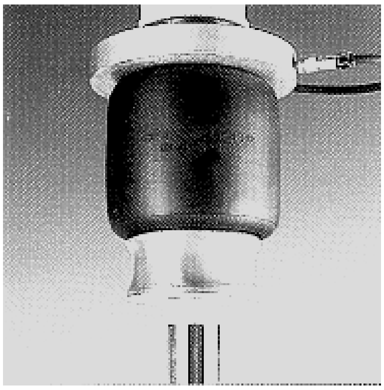
3. Place the folded air spring between the piston and the clamping plate.



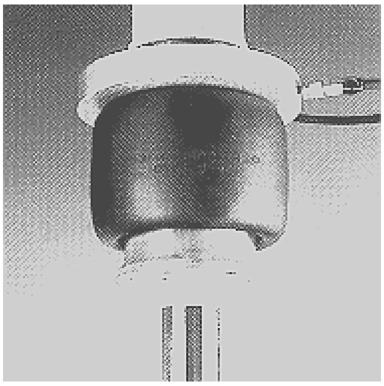
4. Fix the lower bead to its seat on the piston and the upper bead to its seat on the clamping plate.



5. Pressurize the air spring so that its beads fit precisely between plate and piston. The beads should snap into place.



6. Lower the vehicle and the air spring will automatically roll down the piston. The air spring is now fitted.

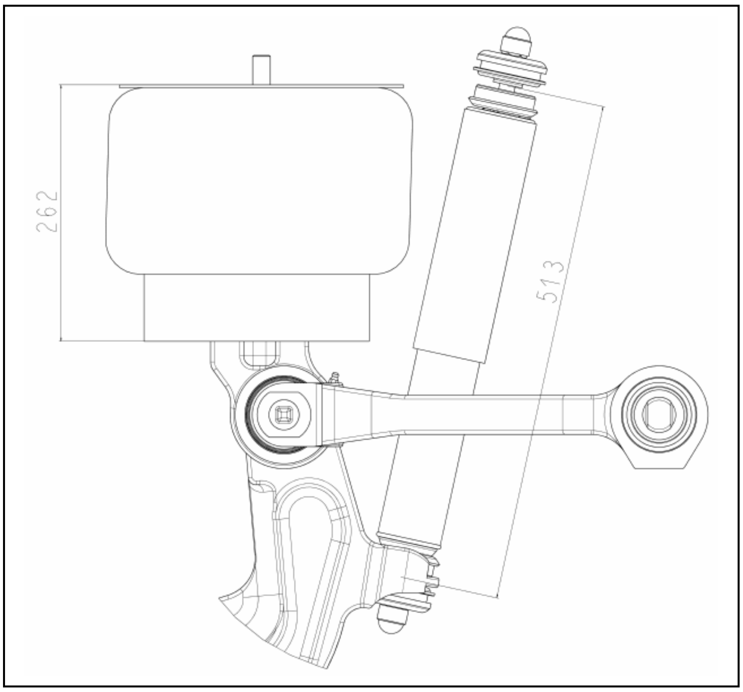


11 SPRING TRAVEL LIMITATION IN AXLE BY MEANS OF ZF AIR SPRINGS AND SHOCK ABSORBERS

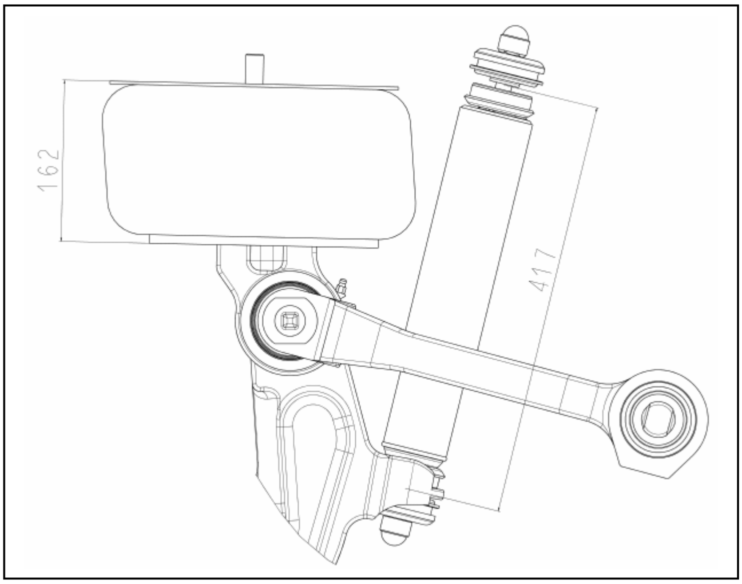
Bump travel is limited by means of a progressively acting rubber buffer, which is integrated in the air spring, and designed to bear the maximum wheel load even with a completely unpressurized air spring.

Rebound travel is limited by means of a hydraulic rebound stop integratged in the shock absorber. When the wheel is in full rebound position and completely unloaded, the axle „hangs“ on the shock absorber. Due to its rating, the shock absorber can transmit a possibly existing residual spring force of max. 30 kN.

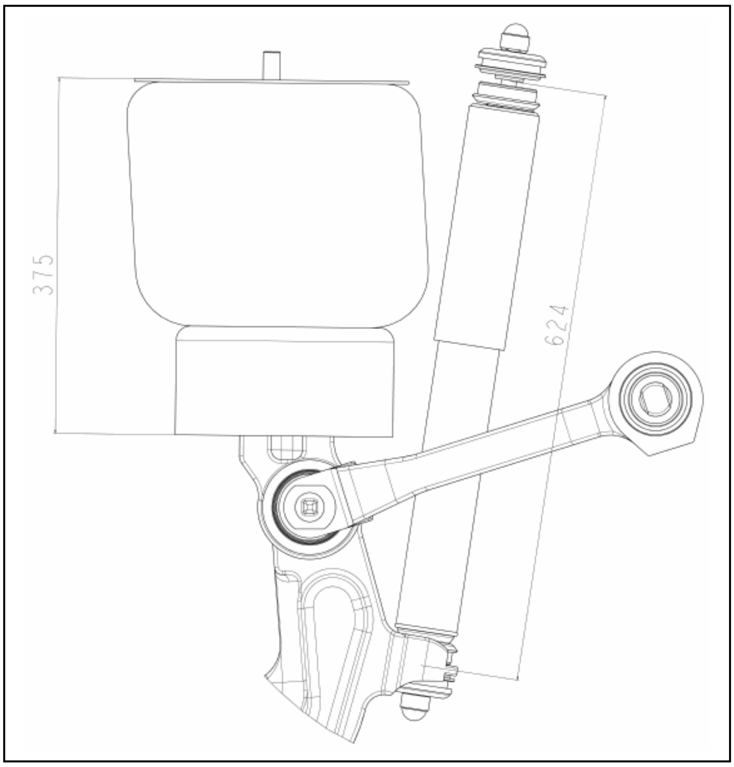
► **Example: spring travel limitation RL 85E**



Design position of air spring and shock absorber, arrangement according to installation drawing



In full bump position:
The correctly positioned air spring limits the max. bump travel, with air spring and rubber buffer being fully compressed.



In full rebound position:
The correctly positioned shock absorber limits the max. rebound travel. The axle „hangs“ in the rebound stop of the shock absorber.

The installation positions of air spring and shock absorber indicated in the installation drawing must strictly be observed.
This alone ensures that the specified spring travels are achieved.
Non-observance could result in a damage to air spring, shock absorber and axle components

12 FITTING INSTRUCTIONS FOR BREATHER

The pressure compensation of the axle oil sump requires breathing and bleeding. For this purpose, ZF recommends to install a breather hose.
It is important to run this hose within a hollow space protected from dirt and splash water.
It is imperative that you follow these fitting instructions.

12.1 Cutting-to-length of the polyamide tube

The polyamide tube must be cut at right angles.
Do not use a saw because the unavoidable formation of burrs endangers the sealing function of the connection.
ZF recommends to use the VOSS plastic tube cutting pliers (Art. No.: 5994 55 00 00) to ensure a clean and square cut of the tube. In this way, no rework of the cut surface, such as deburring, is required.

12.2 Fitting of the polyamide tube

Fully insert the polyamide tube into the plug connection; the resistance of the O-ring seals (items 1 and 2) and the serrated ring (item 5) has to be overcome.
The insertion depth of 19.5 mm should be marked on the tube before inserting it since otherwise no visual check is possible.
After the insertion, pull the tube slightly back so that the all-round holding edges inside the serrated ring (item 5) engage with the outer jacket of the tube.
When laying the tube, make sure that the tube attachment prevents the polyamide tubes from turning.

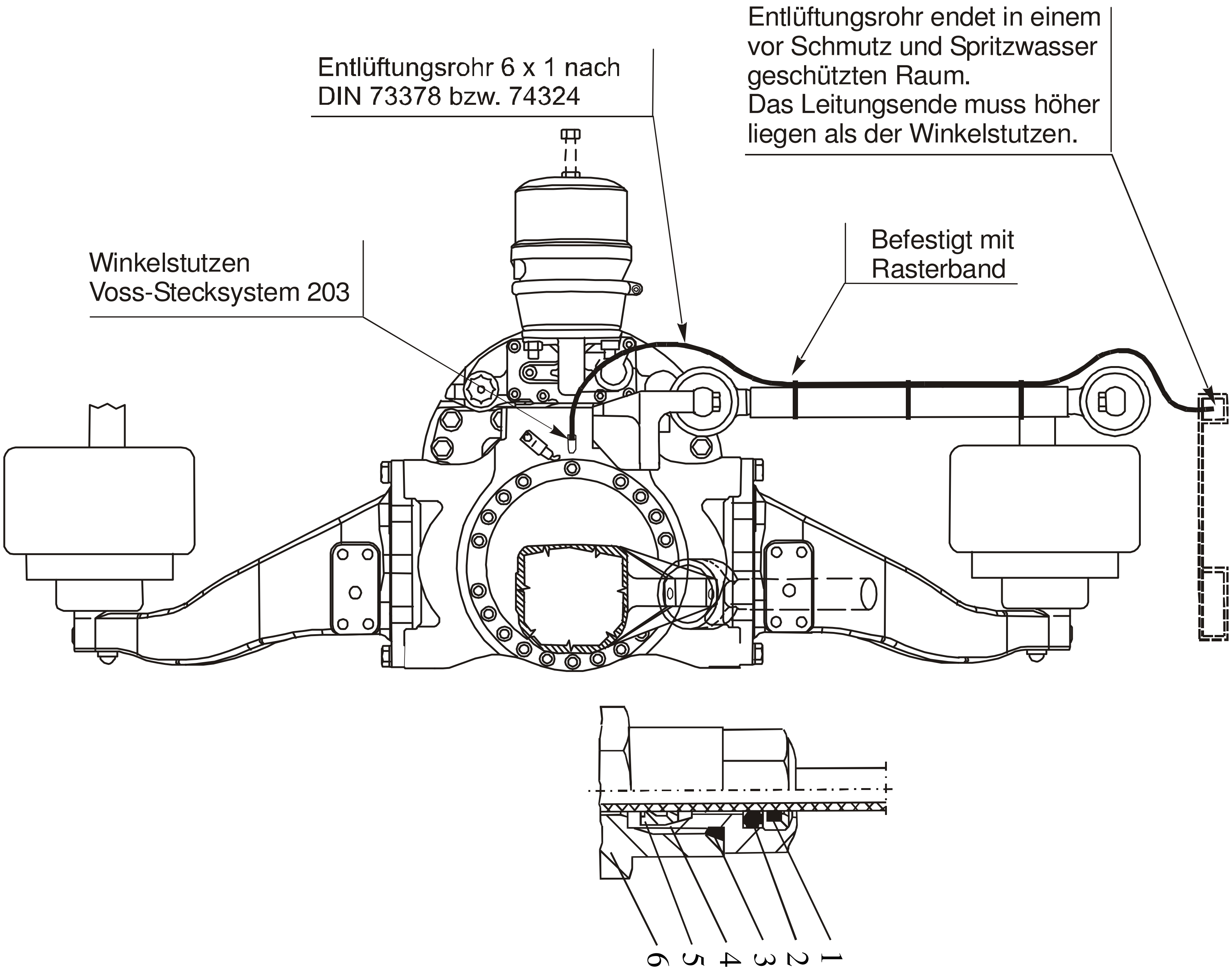
12.3 Removal and refitting of the polyamide tube

Turn the cap screw out of the axle or the neck.
The serrated ring (item 5) and the cap screw (item 4) remain on the polyamide tube.
When refitting, turn the cap screw into the neck (item 6) or the axle again and tighten it with 5 Nm (+ max. 1 Nm).

12.4 Removal and refitting in case of a defective polyamide tube

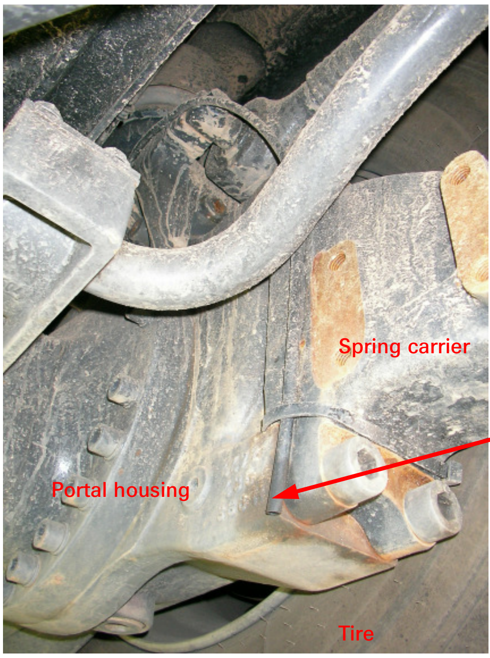
Turn the cap screw out of the axle or the neck.
Cut off the defective polyamide tube above the serrated ring. Insert a new serrated ring into the formed hole of the neck or the axle. Take care that the tapered side of the serrated ring is facing upwards, i.e. towards the cap nut.
When refitting, turn the cap screw into the neck (item 6) or the axle again and tighten it with 5 Nm (+ max. 1 Nm). Then insert the tube into the connection as described above.

12.5 Sketch of breather hose routing

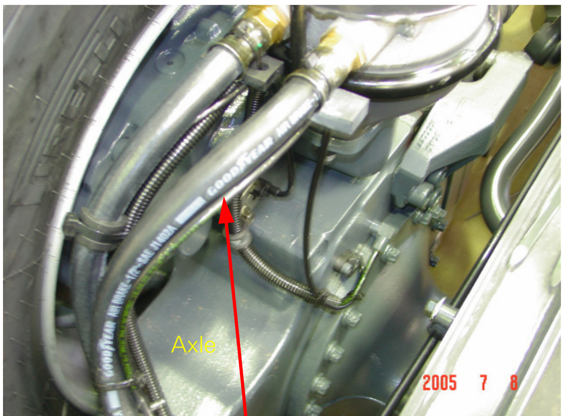


12.6 Incorrect fitting of breather hose

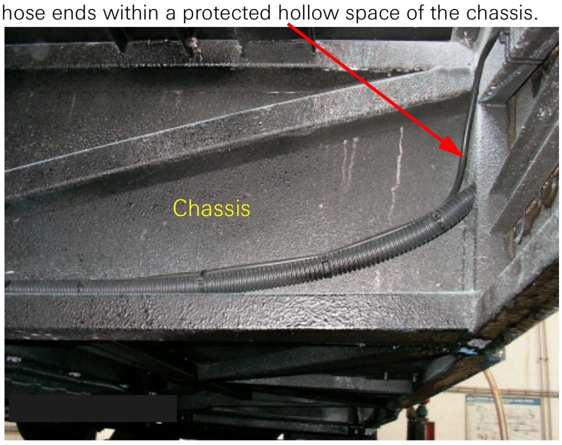
This breather hose has been incorrectly routed.
It is imperative to correct the routing!
ZF shall not assume any warranty for any damage arising from an incorrect routing of the breather hose.



The breather hose ends directly above the road. Water, dust and dirt can enter the axle inner space and get into the oil, thus impairing the oil quality and the interior axle components. The axle lifetime is significantly reduced. Furthermore, oil may leak from the axle and get directly onto the road (environment!).



Breather hose: large bend facing upwards;
hose ends within a protected hollow space of the chassis.



Correct routing: Large bend of the hose to face upwards. Hose end to be installed within a protected hollow space of the chassis.

The end of the line must be in a higher position than the angular fitting.

13 MAINTENANCE AND ACCESSIBILITY, REPAIR INSTRUCTIONS

The following areas of the axles must be easily accessible after installation:

- oil filler hole
- oil drain hole
- window in the cover plate of the brake to check the lining
- grease nipples
- identification plate

ZF provides repair manuals for the individual axle types, which also contain information regarding operation and maintenance.

For repairs on the brakes, observe the repair instructions of the brake manufacturers! These are also available at ZF.

For safety reasons, only authorized workshops are allowed to carry out repairs on vehicle brakes.

For the current list of lubricants TE-ML 12 including the lubricants released by ZF please refer to the following internet site (choose English language):

www.zf.com
→ Technical Info → ZF List of Lubrications → Lists of Lubricants (English) → TE-ML 12

Upon request, the list of lubricants can also be obtained directly from ZF.

If a vehicle shall also be cleaned from below, it is imperative to observe the following instructions:

Do not use any aggressive chemical cleaning agents.
When using high-pressure cleaners, the jet of water must in no case be directed straight onto the seals or similar parts, since this involves the risk of damage and allows water and dirt to enter the axle or its components.
Such operations will reduce the lifetime of your axle!

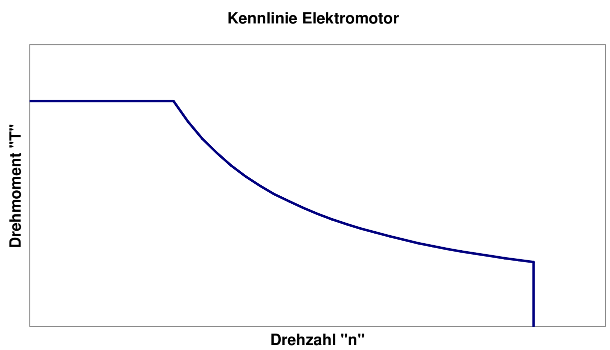
14 AXLE RELEASE PROCEDURE FOR ELECTRIC-DRIVE BUSES

e.g. portal axle AV 132 in trolley buses

14.1 Required data

The bus manufacturer shall provide ZF with the following data:

1. Completed bus axle questionnaire indicating the max. possible gross vehicle weight (GWV) and the max. vehicle speed.
2. Complete characteristics of the electric engine for drive and coast (braking) operation presented as follows:



3. Topographic profile of the specific bus application (city) indicating the stops per kilometer or mile, max. grades and their specific portions (i.e. % length with the respective grade).
4. Installation drawing of the prop shaft with vertical and horizontal view.

14.2 Verification

After having received the data made available by the bus manufacturer, ZF verifies the suitability of the axle and informs the customer in writing about release, limited release or non-release.

14.3 Guarantee of characteristics for the control unit

The bus manufacturer guarantees that the control unit fulfills the following characteristics:

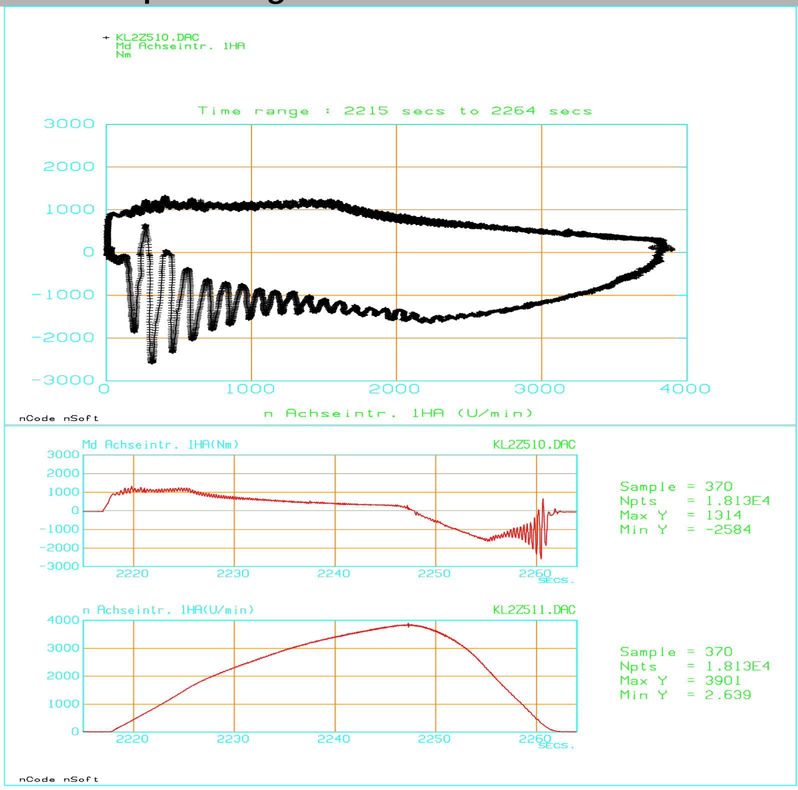
1. The max. permissible axle input torque of $\frac{50{,}000Nm}{axle\ ratio}$ is not exceeded by peak loads caused by for example short circuit or electric power breakdown.

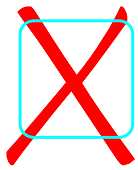
2. When accelerating and braking, torque peak values may exceed the nominal torque indicated in the engine performance characteristics and confirmed by ZF by a maximum of 200 Nm.

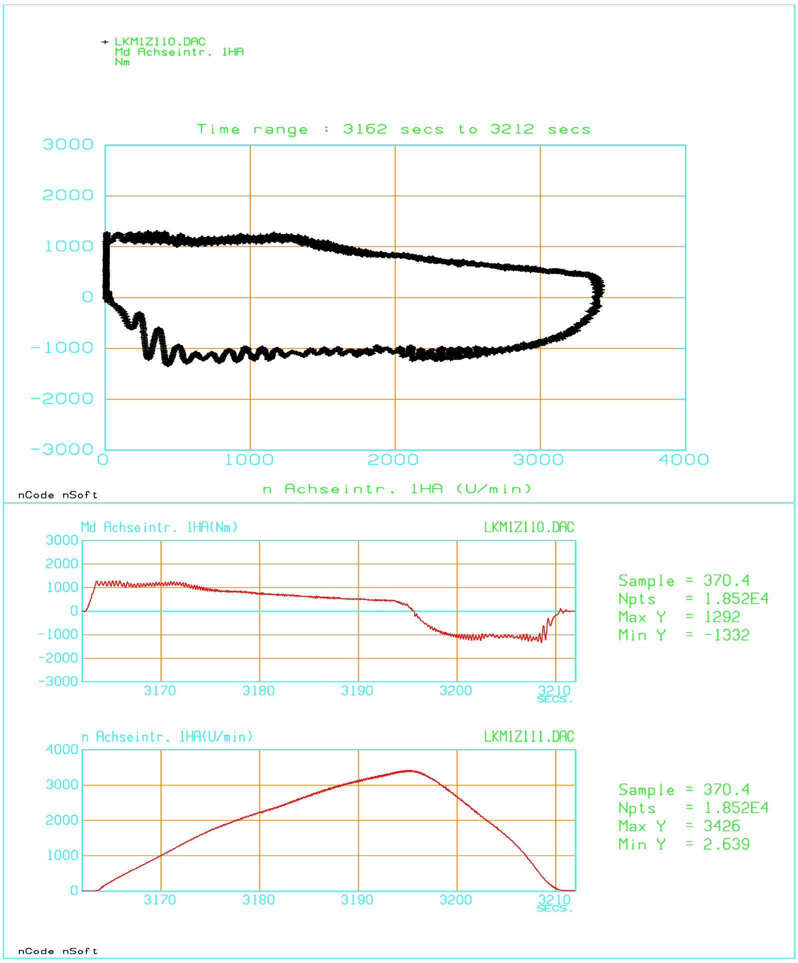
3. Vibrations (also damped ones) must not occur in any case. In particular, vibrations in torque-less condition are not permitted (i.e. change between drive and coast gear tooth flank).

Example: see next page

14.4 Examples of guarantee of characteristics for the control unit



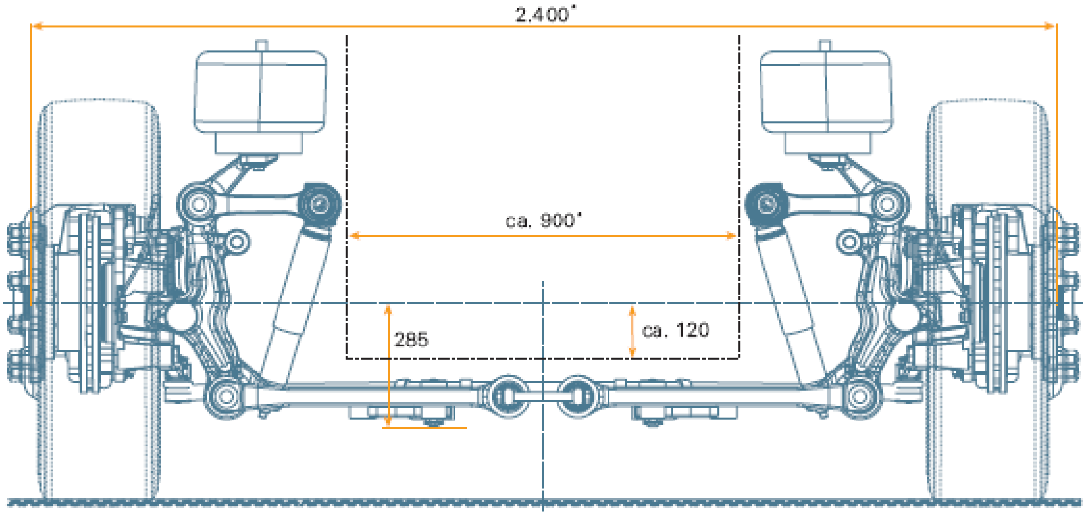




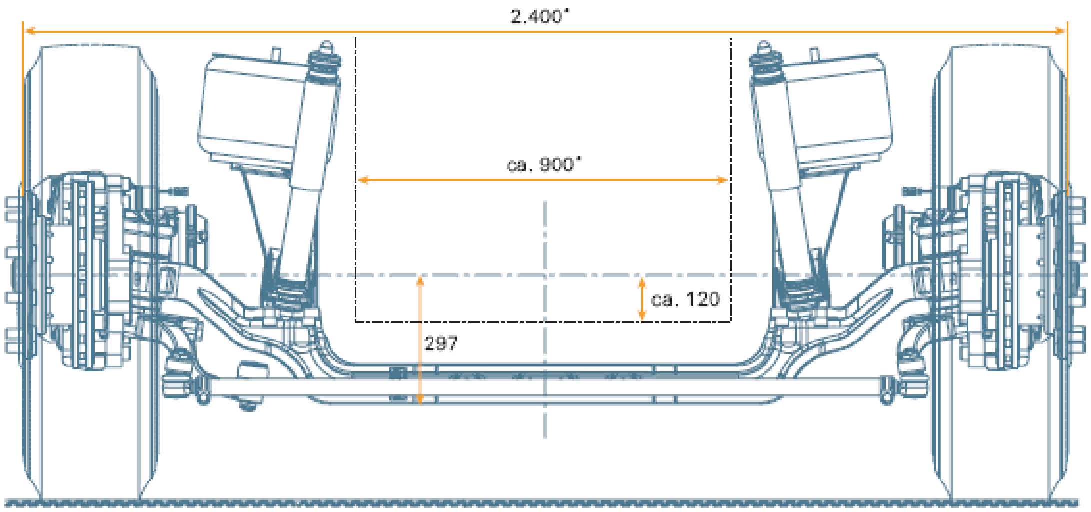
15 TYPICAL DIMENSIONS OF SOME AXLE VERSIONS

These figures are to be considered as an example. For binding information please contact ZF Passau for installation drawings.

RL 75 EC



RL 85 A

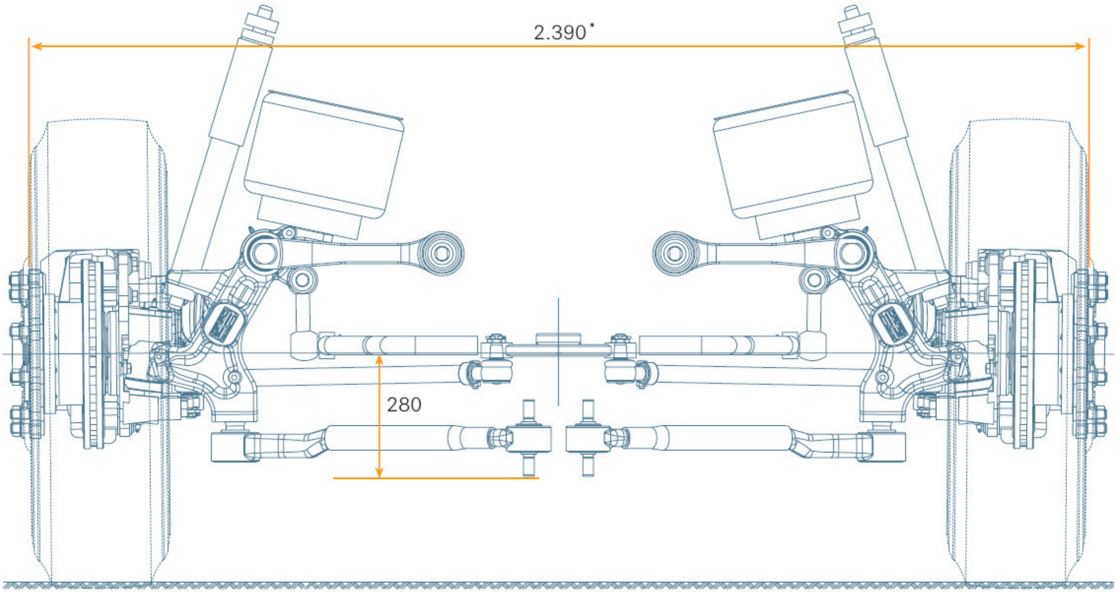


* andere Maße auf Anfrage

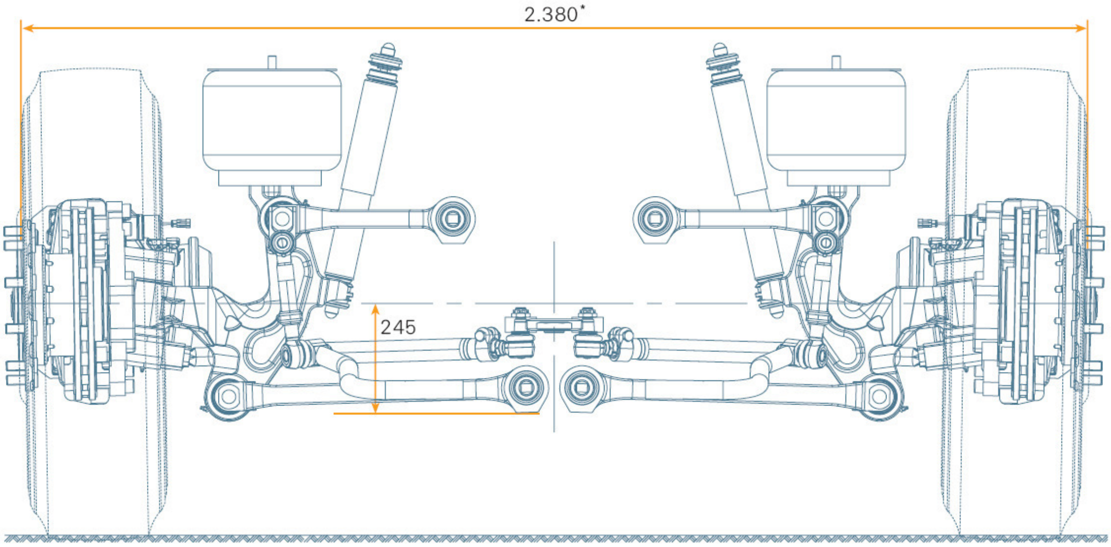
	RL 75 EC Low Floor Independent Front Suspension	RL 85 A Low Floor Front Beam Axle
Vehicle width mm	2,500-2,600	2,300-2,600
Axle load max. kg	7,500	8,500
Wheel travel mm	+ 90 / - 100	± 85
Wheel cut (back-lock/front-lock)	max. 56° / 46°	max. 55° / 40°
Tire size (standard)	275/70R22.5	275/70R22.5
Wheel size (standard)	22.5" x 7.5"	22.5" x 8.25"
Brakes	disc	disc
Axle system weight kg	529**	625***

** Total axle system weight including tie-rods, air springs and shock absorbers
*** Total axle system weight including spring supports, all rods, air springs and shock absorbers

RL 75 E



RL 85 E

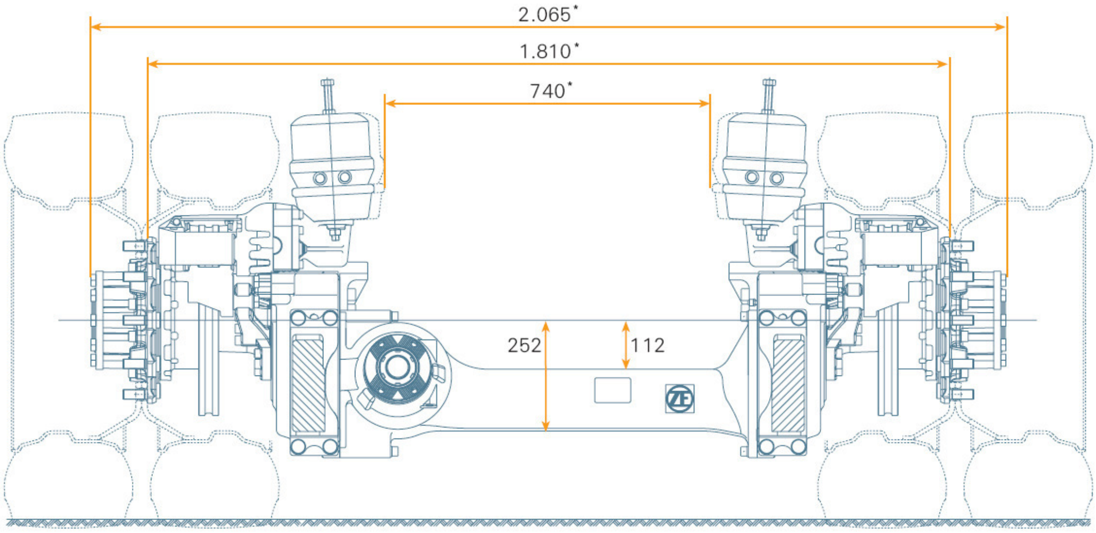


*andere Maße auf Anfrage

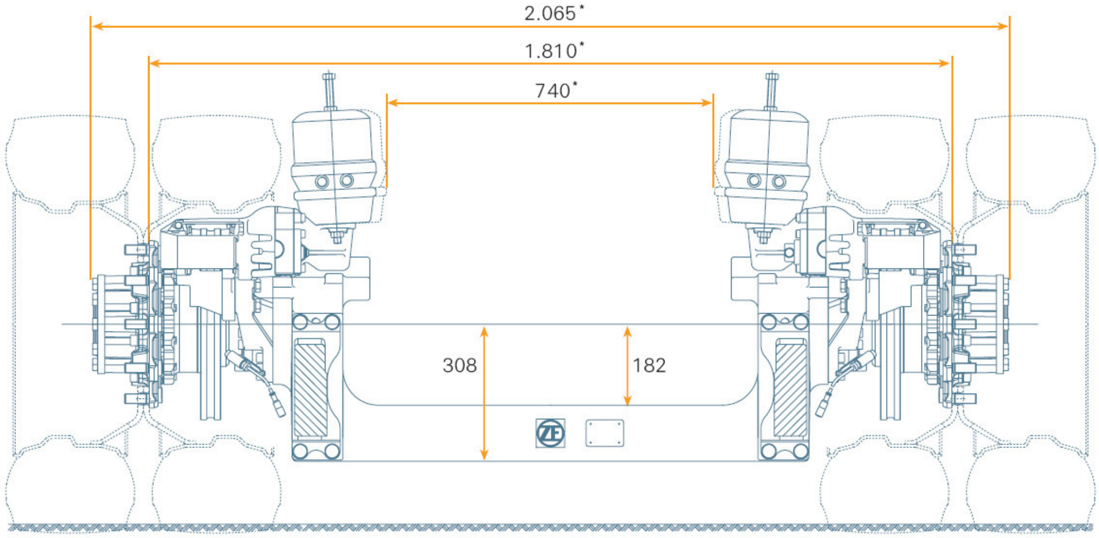
	RL 75 E Independent Front Suspension	RL 85 E Independent Front Suspension
Vehicle width mm	2,500-2,600	2,500-2,600
Axle load max. kg	7,500	8,500
Wheel travel mm	± 100	± 100
Wheel cut (back-lock/front-lock)	max. 60° / 46°	max. 53° / 47°
Tire size (standard)	295/80R22.5	295/80R22.5
Wheel size (standard)	22.5″ x 8.25″	22.5″ x 8.25″
Brakes	disc	disc
Axle system weight kg	547 **	551 **

** Total axle system weight including tie-rods, air springs and shock absorbers

AV 132

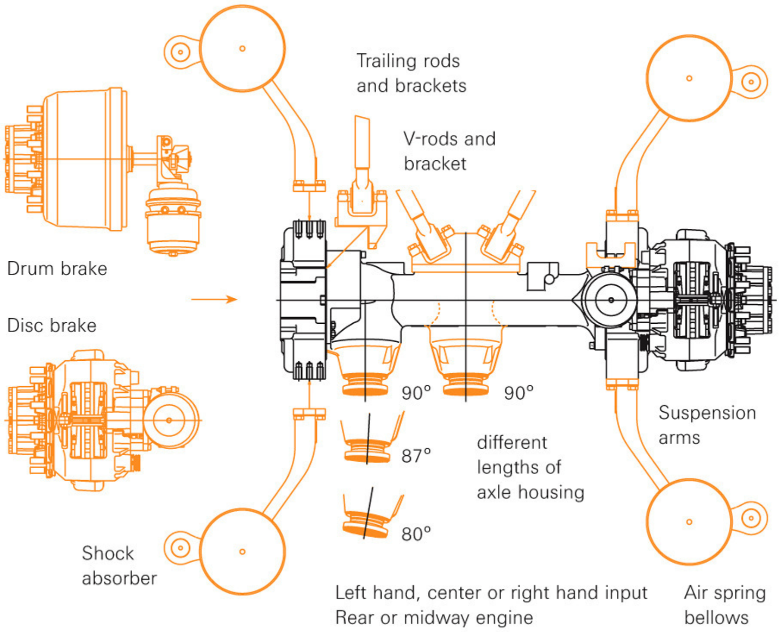


AVN 132



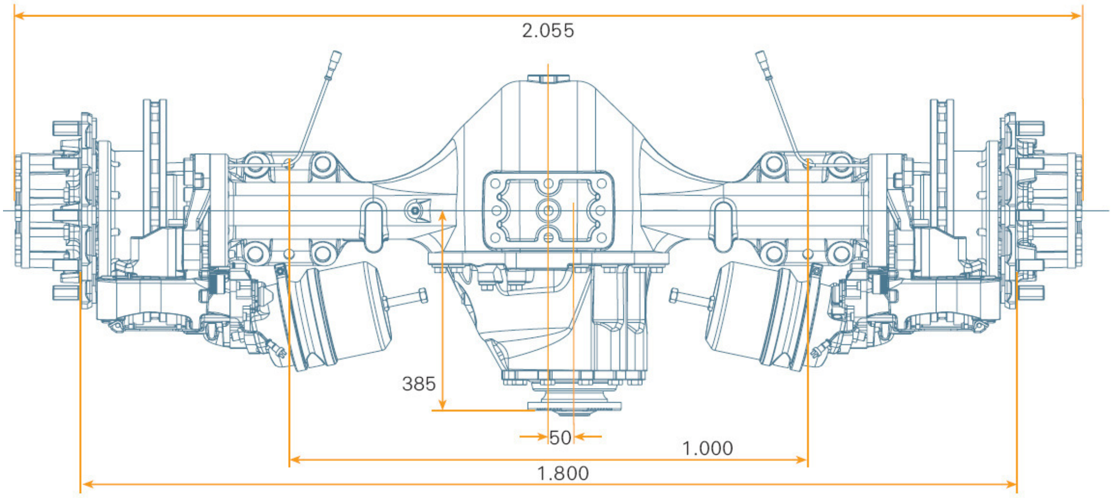
	AV 132 / 80° Portalachse, angetrieben	AV 132 / 87° Portalachse, angetrieben	AV 132 / 90° Portalachse, angetrieben	AVN 132 Portalachse, nicht angetrieben
Fahrzeugbreite mm	2.300-2.600	2.300-2.550	2.300-2.550	2.500-2.600
Achslast max. kg	11.500-13.000	11.500-13.000	11.500-13.000	11.500
Abtriebsmoment max. Nm	50.000	50.000	50.000	–
Motorleistung max. kW	260	260	260	–
Übersetzungen	4,07/4,54/5,13/ 5,74/6,20/7,38/9,82	3,93/4,37/4,72/ 5,27/5,77/6,21/7,38	3,85/4,18/4,54/5,13/ 5,74/6,20/7,38/9,82	–
Reifengröße (Standard)	275/70R22,5 Zwilling	275/70R22,5 Zwilling	275/70R22,5 Zwilling	275/70R22,5 Zwilling
Felgengröße (Standard)	22,5" x 8,25"	22,5" x 8,25"	22,5" x 8,25"	22,5" x 8,25"
Bremse	Scheibe/Trommel	Scheibe/Trommel	Scheibe/Trommel	Scheibe/Trommel
Achsgewicht (mit Ölfüllung)	792**	792**	792**	589**
Achssystemgewicht kg	1.002***	1.002***	1.002***	799***

** mit Scheibenbremse
*** Gewicht der Achse mit Scheibenbremse, inkl. Federträgern, Längs- und Dreiecklenkern, Luftfedern und Dämpfern



Scope of system

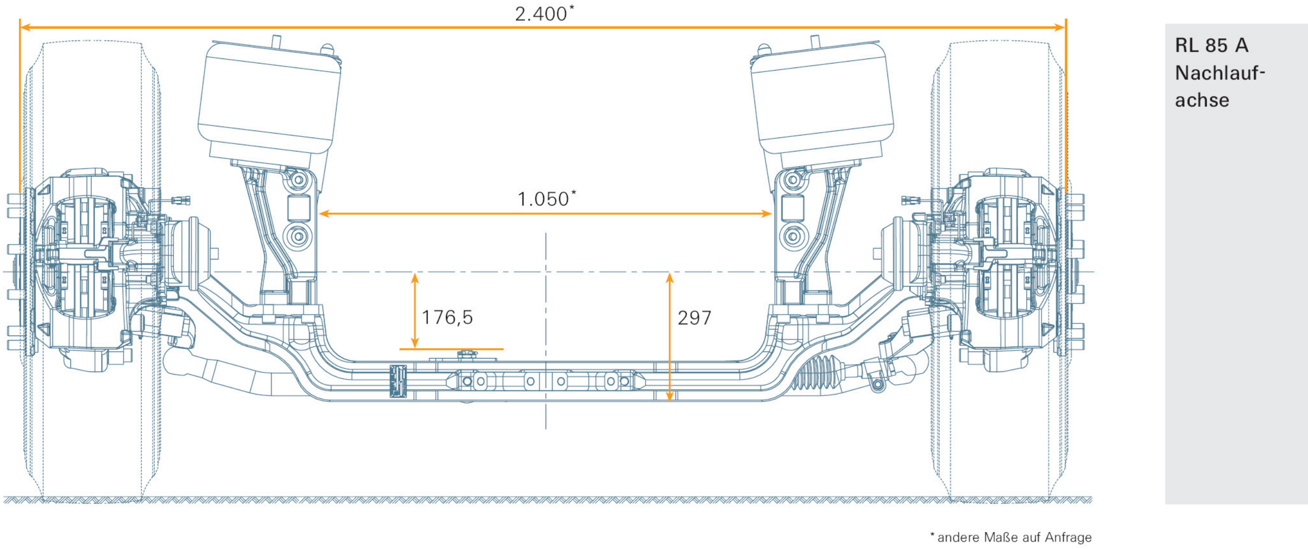
The figure shows the max. delivery scope which is possible for both axles as a complete system:
spring carriers, air springs, shock absorbers, as well as longitudinal and V-rods including brackets.



A 132

	A 132 Hypoid Single Reduction Drive Axle
Vehicle width mm	2,500-2,550
Axle load max. kg	12,000
Output torque max. Nm	50,000
Engine performance max. kW	370
Ratio	2.93/3.23/3.54/ 3.82/4.27/4.70
Tire size (standard)	295/80R22.5 twin
Wheel size (standard)	22.5" x 8.25"
Brakes	disc
Axle weight (oil filled) kg	689
Axle system weight kg	998*

* Total axle system weight including suspension arms, all rods, air springs and shock absorbers



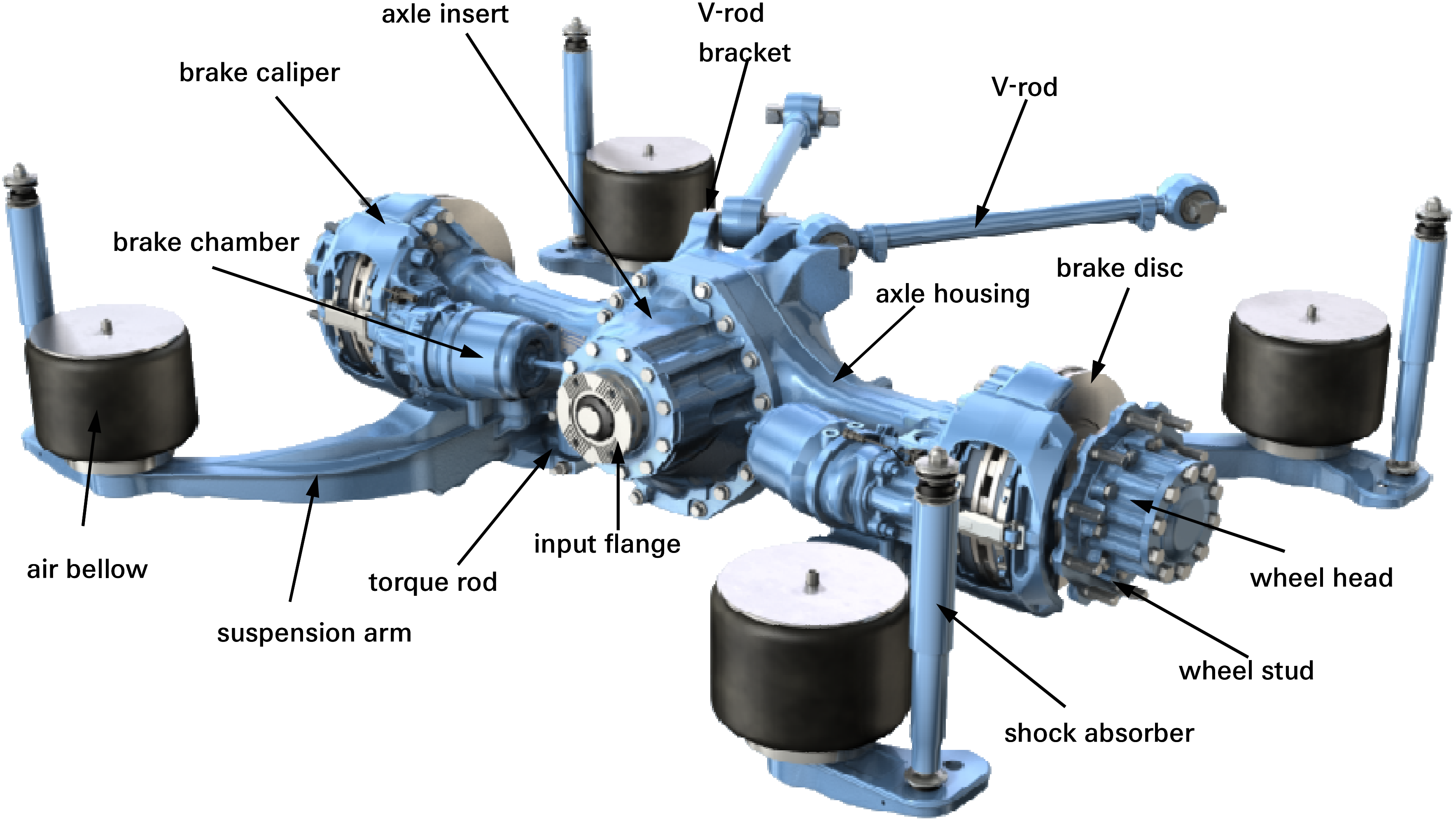
	RL 75 A / RL 85 A Tag Axle
Vehicle width mm	2,500-2,600
Axle load max. kg	7,500-8,500
Wheel travel mm	± 100
Wheel cut	on request
Tire size (standard)	275/70R22.5
	295/80R22.5
Wheel size (standard)	22.5" x 8.25"
Brakes	disc
Axle system weight kg	622**

** Total axle system weight including spring supports, all rods, air springs, shock absorbers and steering cylinder

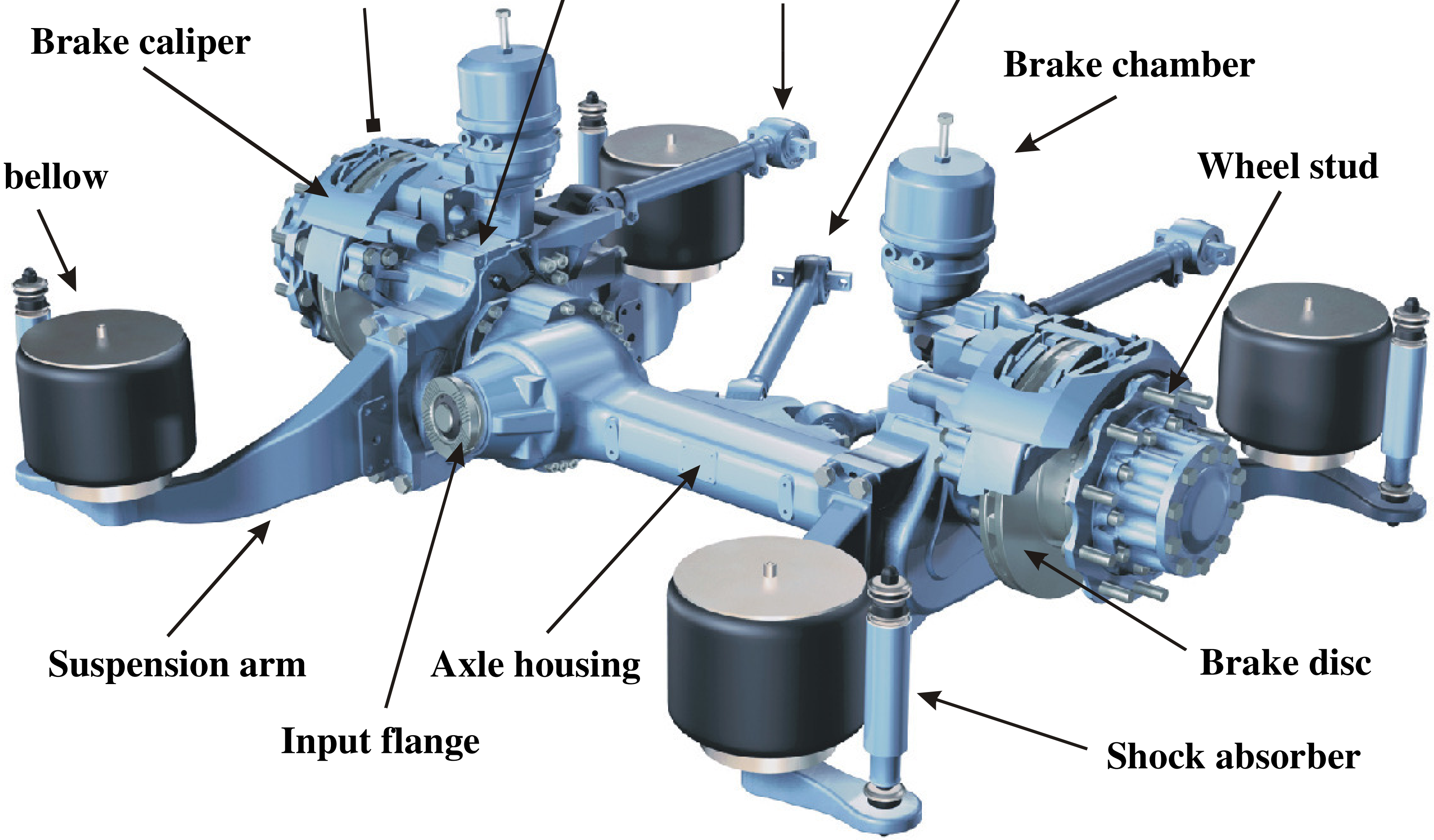
16 PICTURES AND DESCRIPTIONS

The following pages provide a description of the axles A 132, AV 132, RL 85 A, RL 55 E, RL 85 A NLA and their individual components.

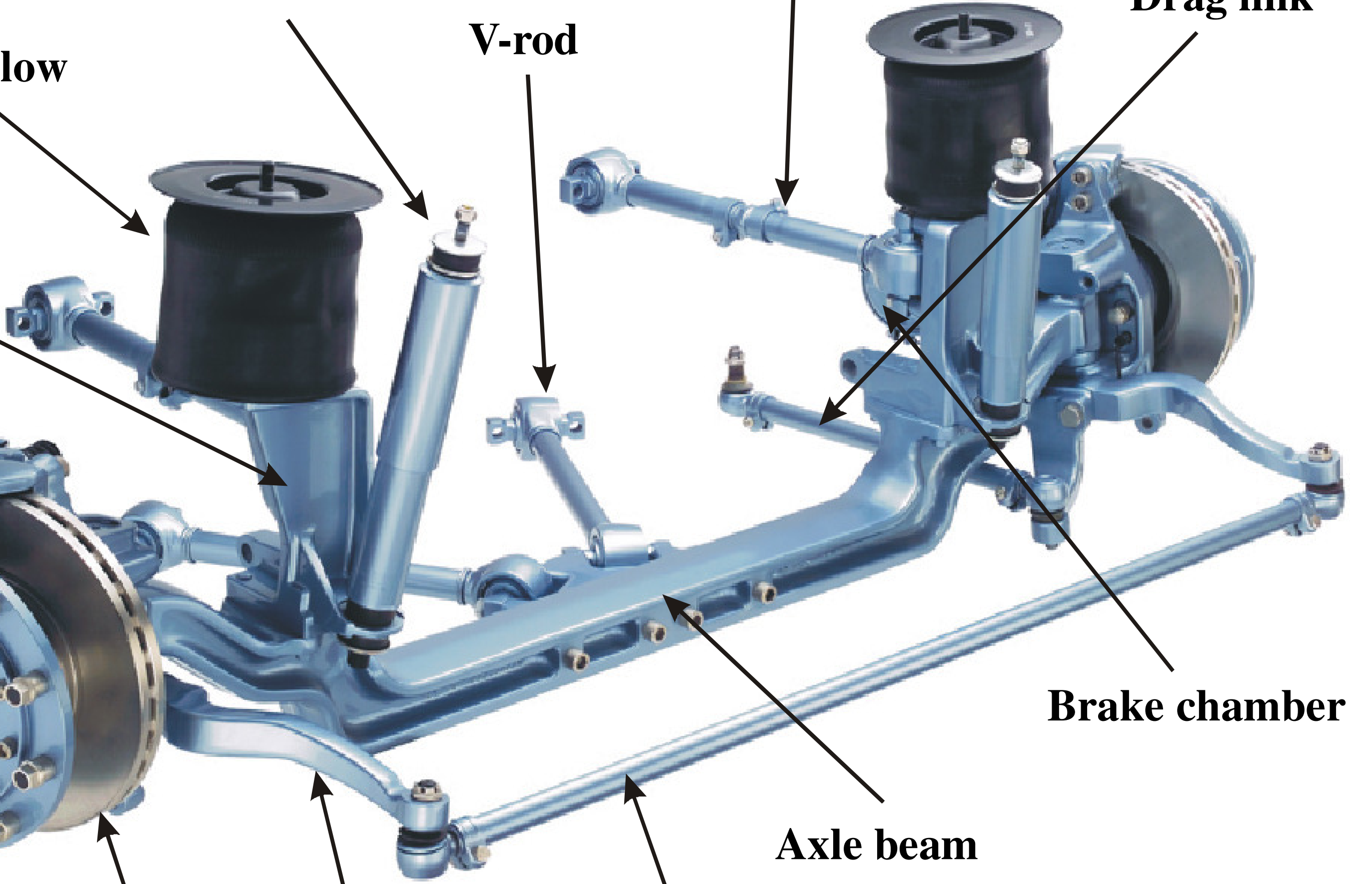
ZF-Direct Drive Axle
Example A132



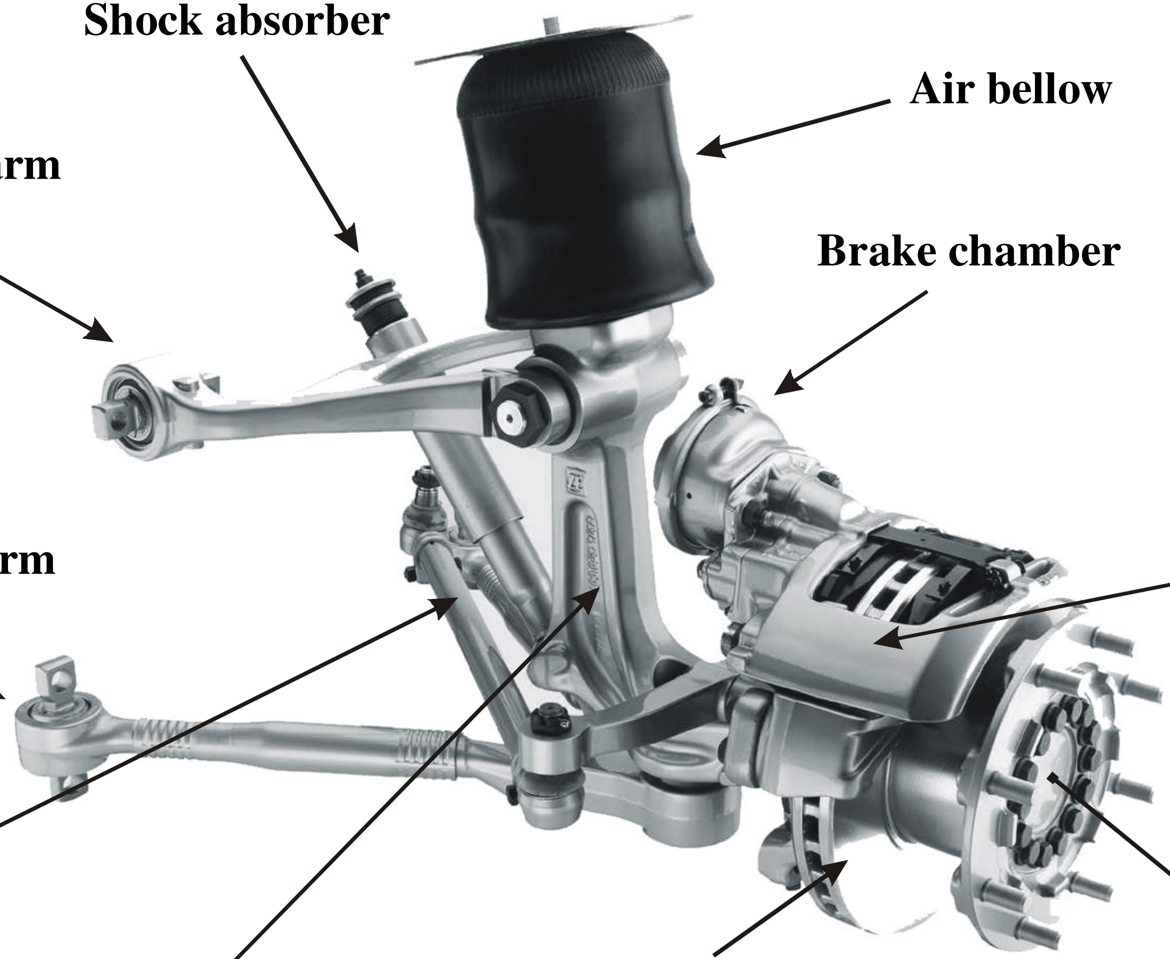
ZF-Drop Centre Axle
Example AV 132



ZF-Front axle
Example RL 85A

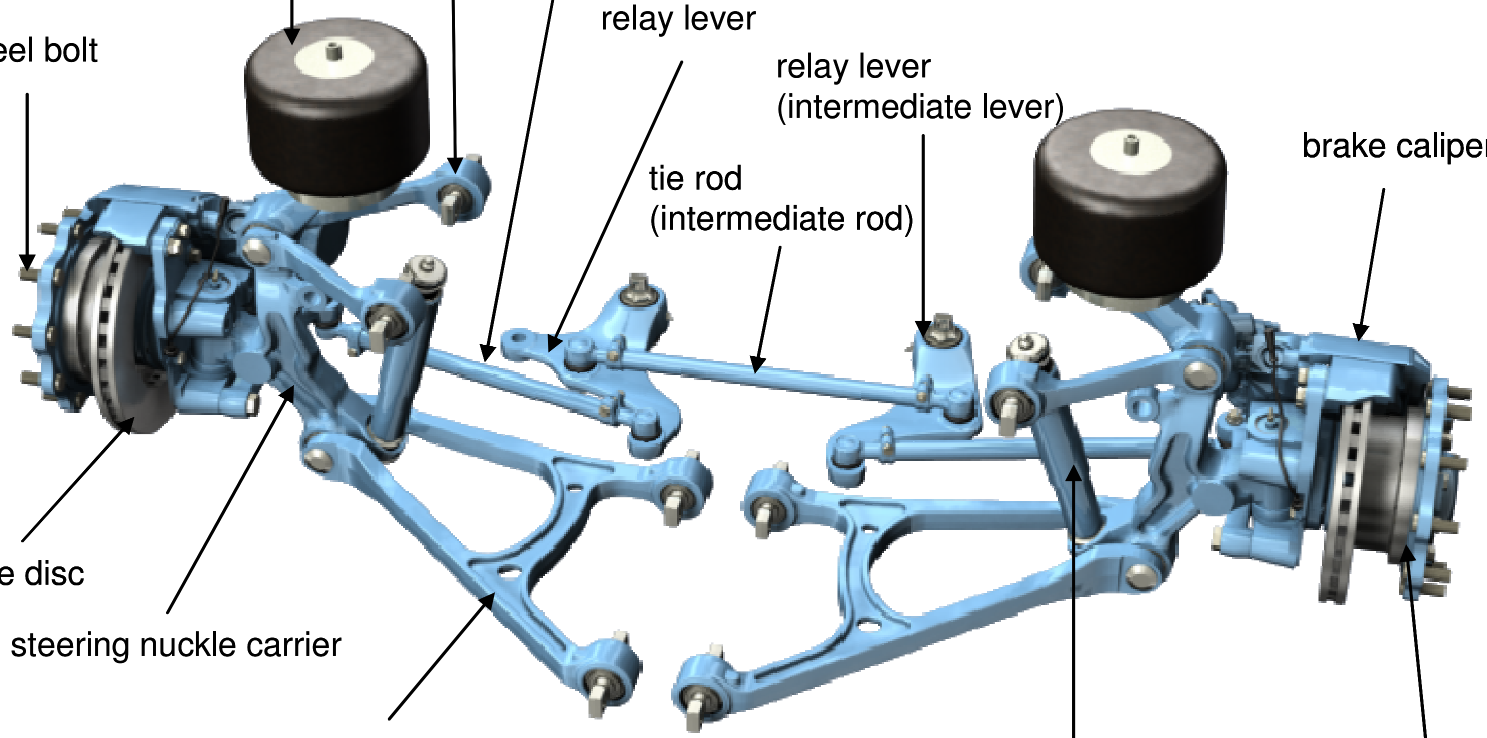


ZF-Independent Front Suspension System
Example RL 55E

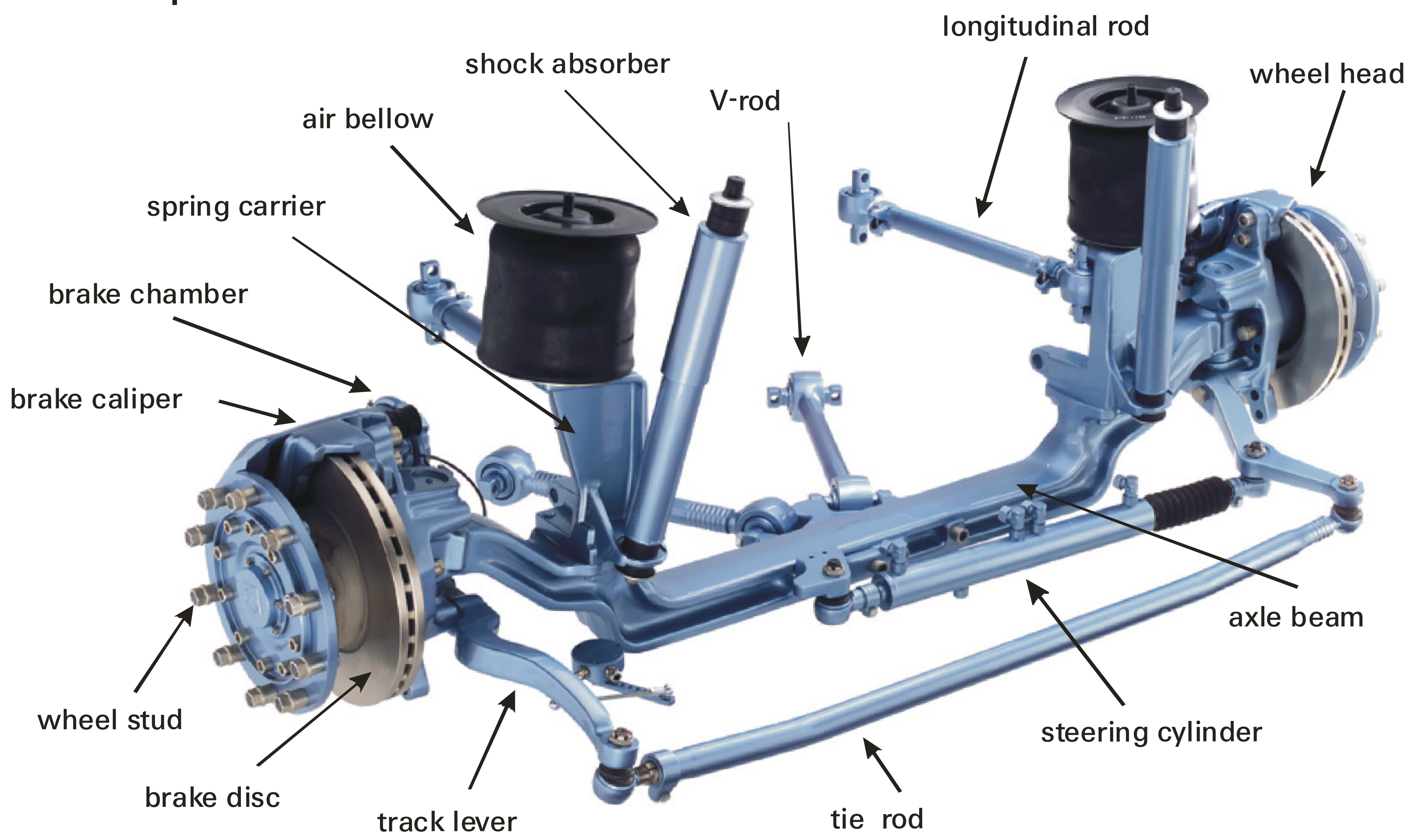


ZF Independent Front Suspension

Example RL 75 EC



ZF Tag Axle
Example RL85A - NLA



Installation Check List for Bus Axles

Business Unit A - Axle Systems for Commercial Vehicles - Passau

Bus manufacturer					
Bus type / model					
ZF axle (type)	1st axle:		2nd axle:		3rd axle:
Parts List / Inst. Draw.					
Production year		Transmission		Engine	

Axle No. 1 / 2 / 3 (Note: Please tick as appropriate, since this list is to be completed individually for each axle.)

		YES	NO
1.	Correct axle installation in horizontal plane?	☐	☐
2.	Correct axle installation in vertical plane?	☐	☐
3.	Correct caster angle of steering axle?	☐	☐
4.	Shock absorber installation o.k. (dimension and position; see installation drawing)?	☐	☐
5.	Air spring installation o.k. (dimension and position; see installation drawing)?	☐	☐
6.	Steering stop of steering axle o.k.?	☐	☐
7.	Steering angle of steering axle L/H / R/H o.k.?	☐	☐
8.	Longitudinal rod lengths o.k.?	☐	☐
9.	V-rod lengths o.k.?	☐	☐
10.	Wear indicator for brake (if applicable) connected?	☐	☐
11.	ABS connected?	☐	☐
12.	Brake force distribution (BFD) acc. to ZF recommendation?	☐	☐
13.	Collisions of axle and related systems or of add-on parts with chassis?	☐	☐
14.	Collision or clearance problems in steering operation and/or bump position?	☐	☐
15.	Use of nuts, bolts and washers of the specified strength category?	☐	☐
16.	Tightening torques correct?	☐	☐
17.	Breather hose correctly routed (see installation instructions)?	☐	☐
18.	Prop shaft arrangement in compliance with the prop shaft manufacturer's and ZF Passau's instructions?	☐	☐
19.	Protection caps removed?	☐	☐
20.	Oil level check implemented?	☐	☐
21.	Cable and line routing o.k.?	☐	☐
22.	Axle protected against corrosion?	☐	☐

General

		YES	NO
1.	Have the individual driveline components been tuned with each other (axle/transmission/engine)?	☐	☐
2.	Has an installation check of the axles been carried out by ZF Passau?	☐	☐
3.	Have add-on parts (e.g. additional linkages or brackets) been mounted onto the axle?	☐	☐
4.	Has welding work been implemented on the axle or axle parts?	☐	☐
5.	Have (additional) holes been drilled into the axle or into axle parts?	☐	☐
6.	Have modifications been carried out on the axle?	☐	☐
7.	Axle installation in accordance with ZFP installation instructions 4472.700.023?	☐	☐

Notes

Date		Person in charge	

Contact persons at ZF Passau

Service	Engineering - Front Axles	Engineering - Rear Axles	Test Engineering / Inst. Check
Maximilian Kalleder	Hans Wimmer	Werner Brysch	Frank Alsdorf
Dept. AVT	Dept. AVES	Dept. AVED	Dept. AVET
Tel.: +49 (0)851-494-2839	Tel.: +49 (0)851-494-5486	Tel.: +49 (0)851-494-5410	Tel.: +49 (0)851-494-5695
Mail: Maximilian.Kalleder@zf.com	Mail: Hans.Wimmer@zf.com	Mail: Werner.Brysch@zf.com	Mail: Frank.Alsdorf@zf.com