

OPTITIRE™

TIRE PRESSURE MONITORING FOR COMMERCIAL VEHICLES

SYSTEM DESCRIPTION



WABCO

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1 List of abbreviations

ABBREVIATION	MEANING
ADR	(French: Accord européen relatif au transport international des marchandises Dangereuses par Route); European agreement concerning the international carriage of dangerous goods by road
CAN	Controller Area Network; asynchronous serial bus system for networking control units in vehicles
ECAS	Electronically Controlled Air Suspension
ECU	Electronic Control Unit
GND	Ground; earth
ID	Identifier
RE	Range Extender
SMS	Strap Mounted Sensor; internal (wheel) sensor or module
TEBS	Electronic Braking System for Trailers
TPMS	Tire Pressure Monitoring System
UDS	Unified Diagnostic Services
VIN	Vehicle Identification Number
VCS	Vario Compact System; compactly structured ABS for trailers
WIS	Wheel Internal Sensor; internal (wheel) sensor or module
WM2	Wheel Module 2; external (wheel) sensor or module

2 Symbols used

Symbols used

DANGER

The signal word denotes a hazard with a high degree of risk which, if not avoided, will result in death or serious injury.

WARNING

The signal word denotes a hazard with a medium degree of risk which, if not avoided, can result in death or serious injury.

CAUTION

The signal word denotes a hazard with a low degree of risk which, if not avoided, may result in minor or moderate injury.

NOTICE

The signal word denotes a hazard which, if not avoided, can result in material damage.



Important information, notes and/or tips



Reference to information on the internet

Descriptive text

– Action step

1. Action step 1 (in ascending order)

2. Action step 2 (in ascending order)

⇒ Consequence of an action

■ Listing

• Listing



Note on the use of a tool

3 Safety information

Observe all necessary regulations and instructions

- Read this document carefully.
Adhere to all instructions, information and safety information to prevent injury to persons and damage to property.
ZF will only guarantee the safety, reliability and performance of their products and systems if all the information in this publication is adhered to.
- Always abide by the vehicle manufacturer's specifications and instructions.
- Observe all accident regulations of the respective company as well as regional and national regulations.

Make provisions for a safe work environment

- Only trained and qualified technicians may carry out work on the vehicle.
- Use personal protective equipment if required (safety goggles, respiratory protection, ear protectors, etc.).
- Ensure that the workplace is dry and provided with sufficient lighting.
- Pedal actuations can lead to severe injuries if persons are in the vicinity of the vehicle. Make sure that pedals cannot be actuated as follows:
 - Switch the transmission to "neutral" and actuate the park brake.
 - Secure the vehicle against rolling by using chocks.
 - Fasten a note clearly visible to the steering wheel indicating that work is being performed on the vehicle and that the pedals are not to be actuated.

4 Introduction

This document describes the function and installation of the OptiTire tire pressure monitoring system.

ZF OptiTire is the next generation of tire pressure monitoring for commercial vehicles and replaces the predecessor system IVTM.

OptiTire was specially developed to reduce the running costs for fleets and increase safety.

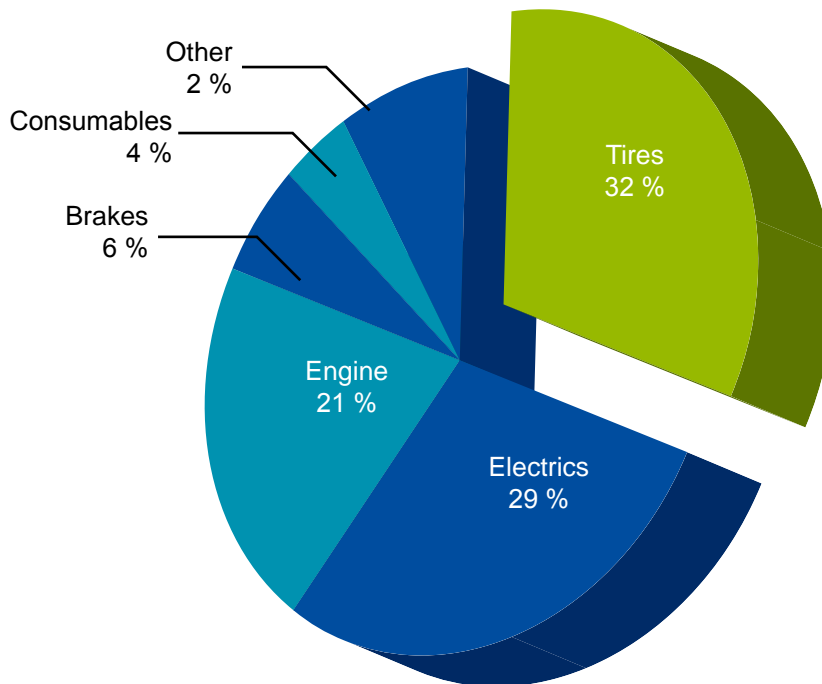
Reduce downtimes and extend tire life

The need to maintain the correct tire pressure seems self-evident, but in reality the tire pressure is checked far too infrequently. Lack of time, inattention and complacency are some of the reasons for this. An official study has found that more than 30 % of all truck breakdowns are caused by tire issues. Further studies have shown that over or under inflation of 15 % can reduce the life of a tire by more than 10 %.

With under-inflated tires there is an increased risk of sustained overheating. This can cause terminal damage to the casing. ZF OptiTire helps to maintain the correct tire pressure and to detect slow punctures early.

Downtimes

Tire damage is the most frequent reason for commercial vehicle vehicles to be out of service.



Cut fuel costs and minimise CO₂ emissions

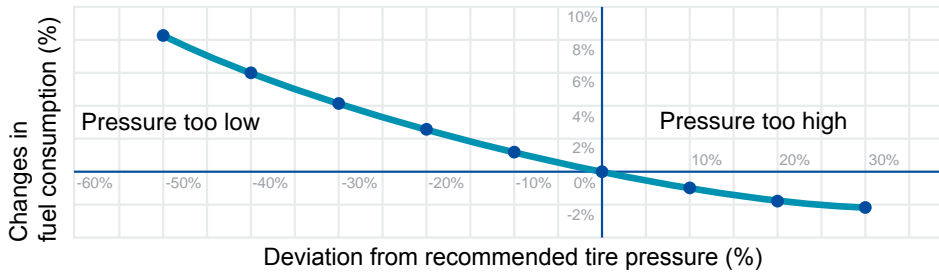
Fuel is the largest variable cost for fleet operators. With diesel prices more frequently going up than down, fuel economy is of paramount importance.

Studies by the tire industry have confirmed that the increased rolling resistance of under-inflated tires has a negative impact on fuel consumption and increases CO₂ emissions. Tires that maintain the correct air pressure, on the other hand, can reduce fuel consumption by up to 2 % and reduce CO₂ emissions.

Introduction

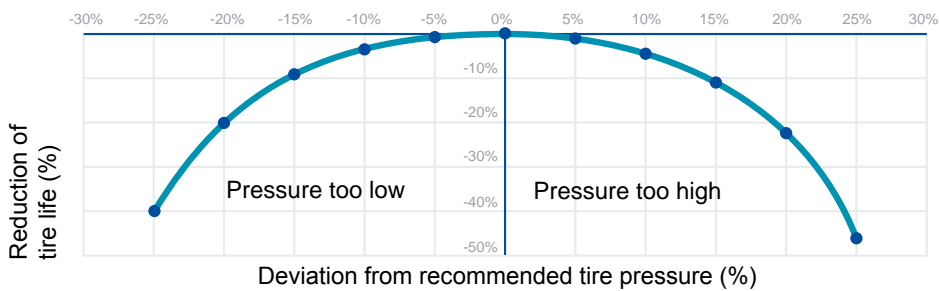
Fuel efficiency

A constantly 17 % under-inflated tire leads up to 1,400 litres increase in fuel consumption (200,000 km annual mileage for long haul applications).



Life of the tires

A deviation of 15 % from the recommended tire pressure reduces the life of a tire by more than 10 %.



Reduce risk and improve safety

Incorrect tire pressure is dangerous and may entail the following risks:

- a tire failure
- a deterioration in vehicle handling
- an extended braking distance

ZF OptiTire helps maintain tire pressure at the recommended level, preventing tire damage and enhancing fleet safety.



OptiTire cannot announce sudden, extreme tire damage caused by external effects.

5 New regulation ECE R141

With the GSR (General Safety Regulation), from 6 July 2024 (6 July 2022 for new vehicles), the monitoring of tire pressures will become mandatory in EU countries for vehicles in the M1, M2, M3, N1, N2, O3 and O4 vehicle categories. The ZF OptiTire system will be adjusted accordingly from January 2023 to meet the necessary test criteria. As the defined tests also refer to the detection of pressure losses in tires with wheels warmed up by driving, the external wheel module WM2 cannot fulfil this standard in the absence of measuring the wheel temperature. But the familiar internal wheel modules WIS, SMS Blue and SMS Grey fulfil them.

ECE R141 includes the following requirements:

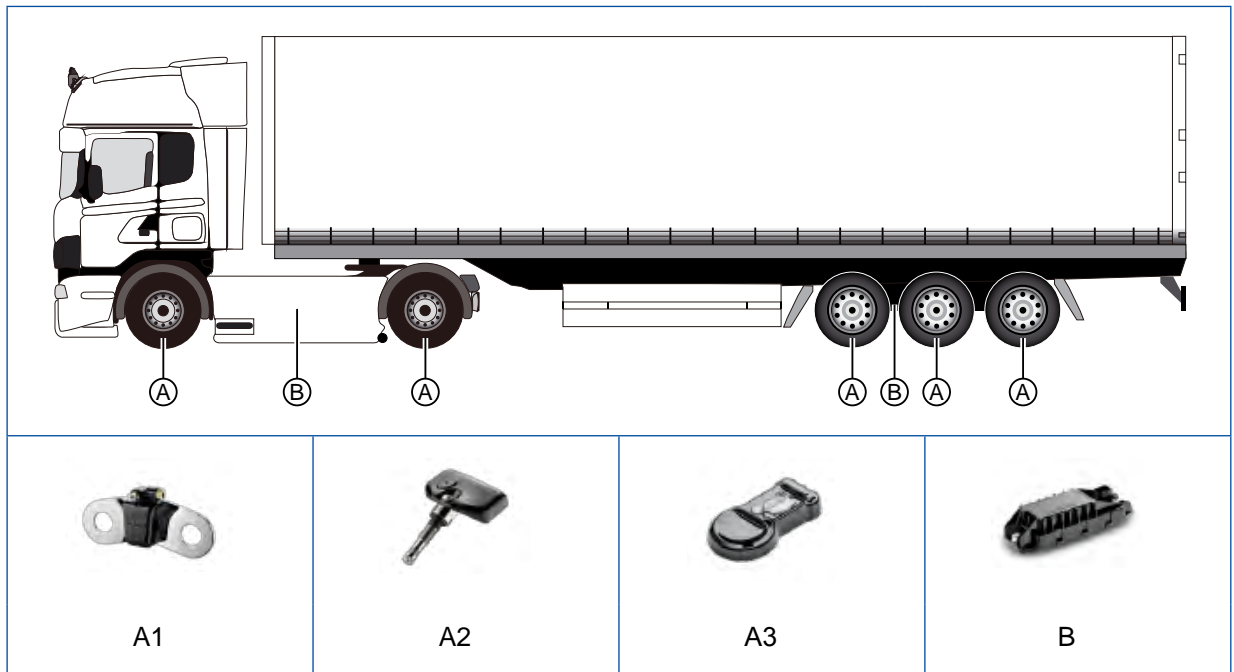
- Detection of tire underpressure of -20 % in relation to the current warm pressure
- Detection of diffusion losses of -20 % in relation to the current warm pressure
- Detection of device faults such as failed system components within 10 min

A homologation of the required function must be carried out by the vehicle manufacturer. For use on trailer vehicles of classes O3 and O4, a set of documents can be provided for OptiTire which enables simplified homologation in accordance with Annex 7 and Annex 8 of ECE R141.

6 System description

This chapter describes the configuration and how the OptiTire system operates. Furthermore, you will also obtain information concerning expert's reports for installing and retrofitting.

6.1 Basic OptiTire function



KEY	
A	Sensors: external sensor WM2 (A1) or internal sensor WIS (A2) or internal sensor SMS (A3)
B	Electronic Control Unit (ECU)

Measuring

The tire pressure is measured by sensors. The values obtained are repeatedly transmitted to the electronic control unit via a radio signal.

The actual tire pressure of each wheel is transmitted to a central ECU. The signals of all wheels are evaluated there and the information is conveyed to a display in the driver's cab.

In order to increase the radio range of the ECU, additional OptiTire ECUs can be installed in the vehicle from 2023. These work as range extenders (RE) and only receive the sensor signals, which are transmitted via CAN to the main ECU for evaluation.

Evaluating

In the ECU, the measured values are compared to one another and to standard values stored as a parameter set in the ECU.

A single OptiTire ECU can monitor up to 20 wheels + 2 spare wheels. Twin wheels are sensed separately.

A warning signal is activated in the event of a critical deviation.

Normal pressure fluctuations due to driving style, outside temperature changes or load are filtered.

The OptiTire system tolerates these typical pressure fluctuations even on poor road sections or with uneven load.

Displaying

Warnings and wheel pressures are usually displayed on the vehicle's dashboard display.

Alternatively, data can also be transmitted to a SmartBoard, OptiLink or TX-TRAILERGUARD™ (telematics). Detailed description of the SmartBoard functionality in chapter "11 Display via SmartBoard", page 69.

6.2 Configuration for bus and towing vehicle

Selection of OptiTire components depends on vehicle type, type and number of wheels and type of systems connected to OptiTire but not on the vehicle system voltage.

ECU

Trucks, buses or articulated buses are equipped with the ECU (ZF part number: 446 220 100 0). The trailer ECU 446 220 110 0 should be used as a range extender.

Sensors

Select sensors, corresponding connection hoses and counterweights according to their axle configuration.

The table contains components for three vehicle type as examples. You will find more information in chapter "7 Components", page 22.



OptiTire configurator

ZF offers an online configurator for the configuration of OptiTire for various vehicles (towing vehicles, buses, semitrailers).

– Open the following homepage on the internet:

<https://www.wabco-customercentre.com/catalog/en/services-and-support/product-and-system-configurators>

System description

Example: Parts list for bus/towing vehicle (with external sensors WM2)

ZF PART NUMBER	COMPONENT	COMMENT	4X2	6X2	ARTICULATED BUS 6X2
446 220 100 0	ECU	Communication with display in the vehicle/warning lights	1	1	1
446 220 000 4	Mount	Support for mounting the ECU	1	1	1
894 607 390 0 + adapter 894 600 001 2	Wiring harness	Cable set 7-pin optional 894 607 295 0 (5-pin, no trailer operation)	1	1	1
960 731 051 0	External sensor, L-shape	For front axle, rim 22.5", 10 holes	2	4	2
960 731 031 0	External sensor	For rear axle, rim 22.5", 10 holes	4	4	8
960 905 822 4	Weight plate	Counterweights for front axle sensor	2	4	2
960 731 802 0	PA tube	For front axle sensor, L-shape	2	4	2
960 731 822 2	PA tube	For rear axle sensor, outside	2	2	4
960 731 804 0	PA tube	For rear axle sensor, inside	2	2	4
960 731 801 0	PA tube	Super Single	2	2	4

Example: Parts list for bus/towing vehicle (with internal sensor WIS)

ZF PART NUMBER	COMPONENT	COMMENT	4X2	6X2	ARTICULATED BUS 6X2
446 220 100 0	ECU	Communication with display in the vehicle/warning lights	1	1	1
446 220 000 4	Mount	Support for mounting the ECU	1	1	1
894 607 390 0 + adapter 894 600 001 2	Wiring harness	Cable set 7-pin optional 894 607 295 0 (5-pin, no trailer operation)	1	1	1
960 732 000 0	Internal sensor	Internal sensor WIS to be attached to a special valve set	6	8	10
960 732 100 0	Valve set	Exact design of the valve depends on the rim	6	8	10

Example: Parts list for trailer (with internal sensor SMS)

ZF PART NUMBER	COMPONENT	COMMENT	SEMITRAILER (3-AXLE) SINGLE TIRES	SEMITRAILER (3-AXLE) TWIN TIRES
446 220 110 0	ECU	Communication with TEBS/warning lamps	1	1
446 220 000 4	Mount	Support for mounting the ECU	1	1
449 913 050 0 + adapter 894 600 001 2	Wiring harness	Wiring harness 7-pin for connection to TEBS E	1	1
960 733 001 0	Internal sensor	Internal sensor SMS Grey to be attached with a strap	6	12
960 733 122 0	Fastening strap 22.5"	Fastening strap for 22.5" rims	6	12



Circuit diagrams

- Go to the web shop on the internet:
<https://www.wabco-customercentre.com/catalog>
- Search the desired circuit diagram by entering the 10-digit number:
 - 841 801 970 0 (solobus)
 - 841 801 971 0 (articulated bus)
 - 841 801 972 0 (tractor/truck)

6.3 Configuration for trailers

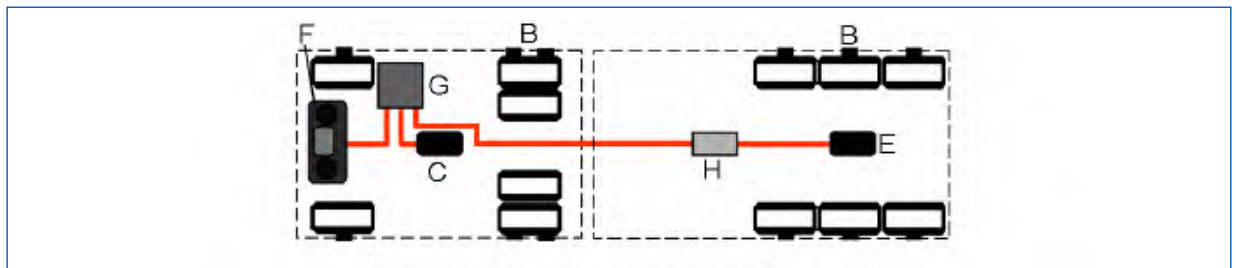
Transmission types

To display the OptiTire data of the trailer in the driver's cabin, both the trailer and towing vehicle must be equipped with OptiTire in combination with the external sensor WM2 if communication is implemented via radio link.

Alternatively, the trailer data can be displayed in the towing vehicle if it is equipped with an integrated display. When the trailer is also equipped with ZF Trailer EBS, the data can be transferred to the towing vehicle's central computer via CAN.

The following illustrations compare both transmission types, wireless connection and CAN bus, with each other.

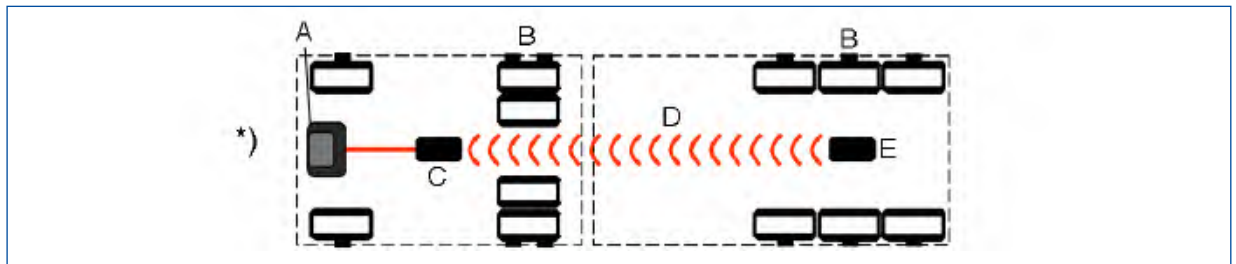
Data transmission via a CAN bus



Data transmission via radio link



The data can only be transmitted via a radio link if both the towing vehicle and the trailer are equipped with external sensors.



KEY

A	Display
B	Sensors
C	ECU
D	Wireless connection
E	Trailer ECU
F	Integrated display
G	Central computer
H	TEBS modulator
*)	In combination with external sensor in towing vehicle and trailer

Display of trailer data in the towing vehicle

If the trailer data is to be displayed in the towing vehicle, which is required by ECE R141, for example, the towing vehicle must be able to transmit and display this data. This is usually done via the standardised ISO 7638 connection. To do this, the TEBS in the trailer must transmit the trailer's tire pressure data in a suitable manner. ZF TEBS of generations E and F (iEBS) are certified to carry this out in a suitable manner. This includes monitoring of the connected OptiTire ECU.

Stand-alone trailer towing operation

If the trailer should be independently equipped with OptiTire, the pressure release can be carried out via telemetry or the vehicles own display. When using the OptiTire display, it requires a special box for splash protection or another protected installation position. The ZF SmartBoard can be installed as an alternative.

OptiTire with several trailers

It is possible to equip tractor/trailer combinations with more than one trailer. Trains with two trailers can even be implemented with radio links, for road trains a CAN bus connection with special ECUs is required.

Please contact your ZF partner for more information.

OptiTire with TEBS D, TEBS E or iEBS

Installation in a vehicle with TEBS D, TEBS E or iEBS is simple, as only pre-assembled cables need to be plugged in. Other systems would require open wiring that needs to be enclosed by protective housing.

System description

Wiring diagrams for trailers



Circuit diagrams

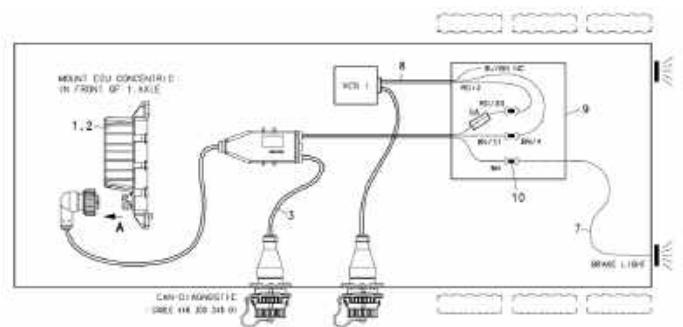
- Go to the web shop on the internet:
<https://www.wabco-customercentre.com/catalog>
- Search the desired circuit diagram by entering the 10-digit number.



If the OptiTire system is installed instead of the IVTM system, additionally use the adapter cable with the ZF part number: 894 600 001 2 required.

Circuit diagram 841 801 943 0 "Trailer ABS VCS"

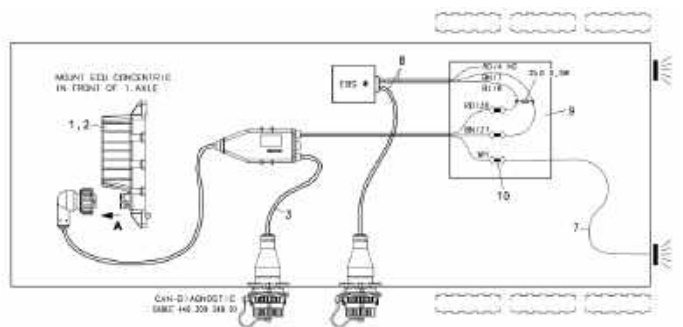
Cable position 8 (ZF part number: 449 314 XXX 0) is opened and connected to cable position 3 (ZF part number: 449 674 273 0) and a line to the stop light.



Circuit diagram 841 801 941 0 "Trailer EBS without CAN connection"

Cable position 8 (ZF part number: 449 614 XXX 0) is opened and connected to cable position 3 (ZF part number: 449 674 273 0) and a line to the stop light.

The ISS output must not be used and needs to be set to 0 km/h.

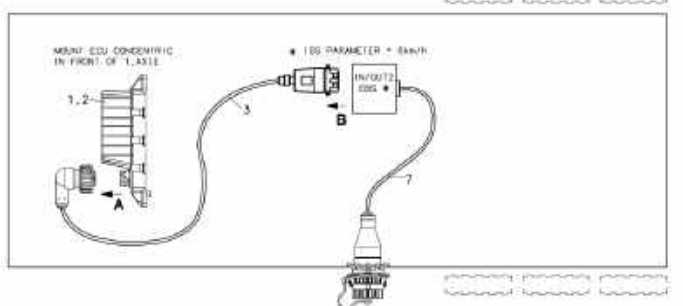


Circuit diagram 841 801 945 0 "Trailer EBS D with CAN"

Connection is implemented using cable position 3 (ZF part number: 449 377 XXX 0/449 378 XXX 0).

The ISS output must not be used and needs to be set to 0 km/h.

The OptiTire diagnosis is carried out using diagnostic cable 446 300 329 2 via the Trailer EBS diagnostic port.



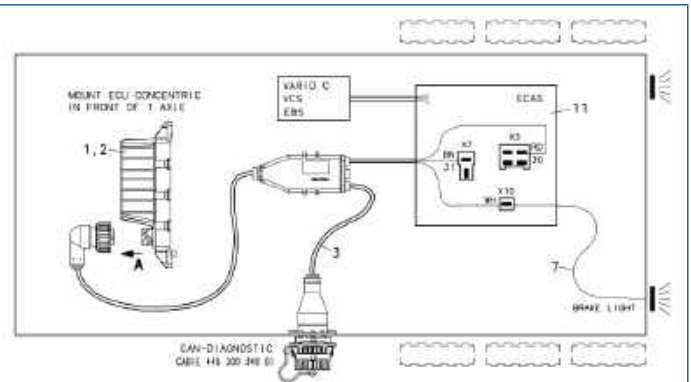
System description

Circuit diagram 841 801 940 0 "Trailer ECAS"

The cable position 3 (ZF part number: 449 674 273 0) is fed into bottom box of the ECAS ECU and connected there.

One cable to stop light (position 7) is installed additionally.

You need screwed cable glands (PG 11: 894 130 312 2) for two cables.



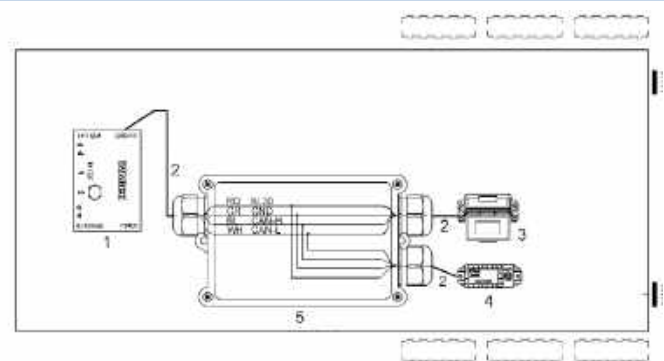
Circuit diagram 841 801 913 0 "Trailer EBS D with CAN and SmartBoard"

(from year of manufacture 2004)

The SmartBoard and OptiTire are connected to the Trailer EBS D modulator on port IN/OUT2.

CAN2 must be activated via the Diagnostic Software.

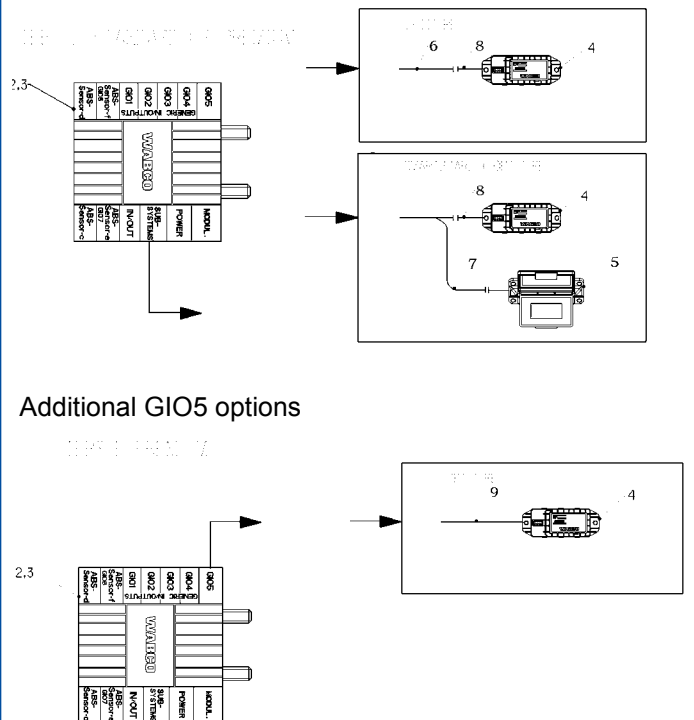
1. Trailer EBS D modulator (ZF part number: 480 102 014 0)
2. Cable family (ZF part number: 449 377 XXX 0)
3. SmartBoard (ZF part number: 446 192 110 0)
4. OptiTire ECU
5. Distribution box



Circuit diagram 841 802 066 0 "Trailer EBS E"

The circuit diagram shows different connection options with Trailer EBS E.

1. Standard TEBS E (ZF part number: 480 102 03X 0)
2. Premium TEBS E (ZF part number: 480 102 06X 0)
3. Multi-Voltage TEBS E (ZF part number: 480 102 08X 0)
4. OptiTire ECU (ZF part number: 446 220 110 0)
5. SmartBoard (ZF part number: 446 192 11X 0)
6. Cable (ZF part number: 449 913 XXX 0)
7. Cable (ZF part number: 449 916 XXX 0)
8. Adapter cable (ZF part number: 894 600 001 2)
9. Cable (ZF part number: 449 627 XXX 0)



6.3.1 OptiTire in trailer operation

Operating mode

The OptiTire system in the trailer operates self-sufficiently if supplied with power.

Tire pressures can be displayed with the SmartBoard or transmitted via OptiLink or TX-Trailerpulse. In addition, the tire pressure information is transmitted to the towing vehicle via the ISO 7638 CAN connection.



Not all towing vehicles display the tire pressures transmitted via CAN in the dashboard. Please contact the manufacturer of the towing vehicle if you have any questions on this subject.

Alternatively, the tire pressures of the trailer can be transmitted by a radio signal to an OptiTire system in the towing vehicle.

This wireless transmission can only occur if the external sensors are configured on both vehicles.

Apart from the display of trailer tire data in the towing vehicle, this data can also be transmitted directly to the haulage company by means of telematics. The combination of OptiTire with TX-TRAILERGUARD™ is of particular interest if the trailer is transported by subcontractors or rented to third parties.

Automatic recognition of the trailer vehicle for wireless truck-trailer communication

The towing vehicle's ECU automatically detects the combination with a trailer ECU: The stop light is enabled on the towing vehicle and trailer when actuating the brake. The trailer ECU sends a radio signal with the voltage pulse that is expected by the towing vehicle's ECU that instant. The towing vehicle's ECU thus clearly detects that the trailer belongs to the tractor/trailer combination and subsequently transmits trailer ECU messages to the display.

As trailers are usually not permanently powered, it is possible that due to the frequency of sensor transmission the tire pressure data for all the wheels of the trailer is not available in the display for up to 21 minutes after starting the drive – depending on the sensor used.

6.4 Approval reports/certificates



RF certificates:

- Go to the web shop on the internet:
<https://www.wabco-customercentre.com/catalog>
- Use the product name OptiTire or IVTM to search the desired certificates.
- If you have any questions, please contact your local partner.

Approval reports/certificates for mounting and additional mounting of OptiTire are available, which significantly facilitate approval of vehicle registration papers. Customers must also include the relevant details in the operating instructions.

6.4.1 ECE R141

For tire pressure monitoring (TPMS) according to ECE R141, a set of documents according to Annex 7 (alternative procedure for trailers) is available.

6.4.2 ATEX

As the WM2 has its own battery and is attached to the outside of the wheel, it falls under the ATEX directive to be used as explosion-proof equipment for potentially explosive gas atmospheres up to zone 1. It fulfils the relevant requirements.



Approval report/certificate

- WM2: Associated EU type test certificate
TÜV 04 ATEX 2418 X
- Application area ADR (G: potentially explosive gas atmospheres):
 Ex II 2G Ex ib IIC T4



The device is rated as being a small piece of electrical equipment, and therefore the marking does not contain the complete information in accordance with directives or standards. The manufacturer of the sensor is ZF CV Distribution GmbH & Co. KG, Am Lindener Hafen 21, 30453 Hanover.

6.4.3 Radio approvals

The OptiTire components contain a radio transmitter for the 433 MHz ISM waveband. The output power is less than 1 mW. The following approvals are available:



Approval report/certificate

- CE: 2014/53/EU (RED)
- FCC: Part 15
- IC: RSS-210 Issue 8, RSS-GEN Issue 4, RSS-102 Issue 5

6.4.4 OptiTire RF declaration of conformity

"This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation"

"This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device."

"Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- 1) l'appareil ne doit pas produire de brouillage;
- 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."



CAUTION TO USERS: "Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment."

7 Components

This component description details the properties of basic components.



Outline drawings

- Go to the web shop on the internet:
<https://www.wabco-customercentre.com/catalog>
- Search for the desired outline drawing by entering the product number of the component.



OptiTire can be interrupted in its function if other devices or systems in the vicinity are also transmitting in the area of 433 MHz. These can be radio sets, radio remote controls (e.g. for door actuation, cranes, forklift), insufficiently shielded electrical drives with high power or other radio transmitters. When the OptiTire system is removed from the area of interference, the function is guaranteed again.

7.1 Sensors

General information and technical data

SENSORS (APPLIES TO INTERNAL AND EXTERNAL SENSORS)	
Material	Plastic (moulded and self-contained)
Integrated components	<ul style="list-style-type: none"> ■ Pressure sensor ■ Circuit for evaluation ■ Radio transmitter and battery
Radio transmission	433 MHz signal
Transmission intervals	<ul style="list-style-type: none"> ■ Depends on the sensor type ■ The transmission frequency is increased when there are pressure changes
Repairs	Not possible
Warning messages	With position on the vehicle
Battery	<ul style="list-style-type: none"> ■ Lithium ■ Service life: up to 9 years ■ Around 6 months before the end of its service life the sensor transmits a warning signal that the battery is exhausted

Sensor ID

An ID makes each sensor unique and ensures that the sensors are clearly assigned to particular wheels. The sensor will "report" to ECU using this code. This will exclude pressure signals from other vehicles to be assigned to own system. The ID is defined when the sensor is manufactured and cannot be changed.

This ID is imprinted on the sensor for start-up.

The ID can also be read out wirelessly using the ZF TPMS Manager (ZF part number 300 200 001 0).



Assignment between wheel and sensor must be absolutely maintained during tire change procedure. If a tire and sensor is incorrectly matched, the OptiTire system will not send the required warning when a wheel with low pressure is wrongly assigned to an axle on which this pressure is actually permissible.

The assignment of an ID to a wheel is determined during initial start-up of the diagnostic software on start-up (see chapter "10 Start-up", page 61).

7.1.1 The external sensor (WM2)

⚠ CAUTION

Risk due to incorrect handling

Any changes or manipulation to the sensor of any type, especially attempts made to change the battery will destroy the device and may lead to injuries.

- Do not unscrew or remove the sensor from the bracket.

Information and technical data

EXTERNAL SENSOR (WM2)



ZF part numbers	See chapter ""External sensors WM2" variants", page 24. Depending on rim crank, use of the normal external sensor or the so-called L-shape or T-shape version is recommended
Pressure range	2 to 14 bar correspond to the nominal values of pressures from 3 to 10 bar
Temperature range	-40 °C to +90 °C, 24 h to 120 °C
Transmission interval	<ul style="list-style-type: none"> ■ Depends on the part number and availability of an acceleration sensor ■ With constant pressure: 9 minutes
Counterweight	<ul style="list-style-type: none"> ■ Required, see chapter "Counterweight", page 26 ■ With Twin tires: two external sensors and no counterweight
Installation	<ul style="list-style-type: none"> ■ Fastening by means of standard wheel nuts on the outside of the rim ■ Connected via a PA tube to the valve
Start-up	With magnet or ZF TPMS Manager (chapter "10 Start-up", page 61)
Retrofit	Tires do not need to be removed from the rim.

Function

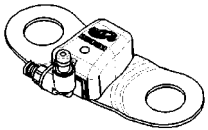
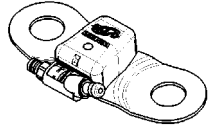
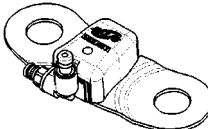
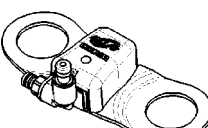
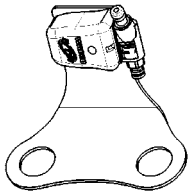
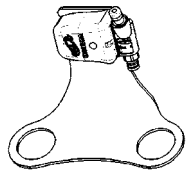
The external sensor, which is fastened to the existing wheel bolts, enables a wheel change without the need to reconfigure the system. The external sensor is also predestined for retrofitting due to the way it is installed. Please note that special external sensor and PA tube variants must be used for different rims and installation locations.



With Twin and Super Single rims, problems may occur with the radio transmission due to the immersion depth. To ensure a good quality of reception, T-shaped external sensors should be used (ZF part numbers: 960 731 031 0 or 960 731 041 0).

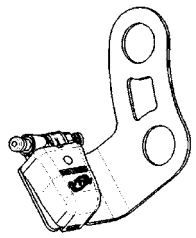



"External sensors WM2" variants

The various types of external sensors are illustrated in the table:

APPLICATION	ZF PART NUMBER	HOLE, WHEEL BOLT	BOLT HOLE Ø	ANGLE	FIGURE
Trailer: Independent wheel (no Super Single)	960 731 011 0	26 mm	335 mm	0°	
Trailer: Independent wheel (no Super Single), 20° for special purposes (e.g. Iveco)	960 731 013 0	23 mm	335 mm	0°	
Trailer: Independent wheel (no Super Single), 23 mm pitch circle diameter	960 731 017 0	23 mm	335 mm	0°	
Trailer: Independent wheel (no Super Single)	960 731 021 0	32 mm	335 mm	0°	
Twin tires, Super Single	960 731 031 0	26 mm	335 mm	70°	
Twin tires, Super Single	960 731 041 0	32 mm	335 mm	70°	

Components

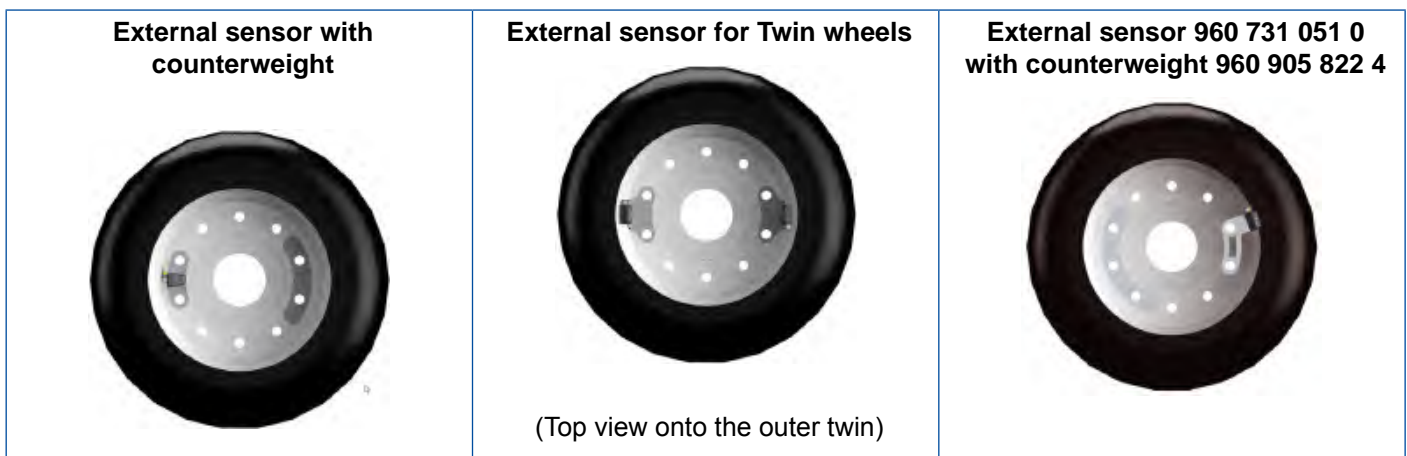
APPLICATION	ZF PART NUMBER	HOLE, WHEEL BOLT	BOLT HOLE Ø	ANGLE	FIGURE
Towing vehicle: Front axle, load axle	960 731 051 0	26 mm	335 mm	60°	
Towing vehicle: Front axle, load axle	960 731 053 0	32 mm	335 mm	0°	
Towing vehicle: Front axle, load axle	960 731 055 0	26 mm	335 mm	60°	
Towing vehicle: Front axle, load axle	960 731 061 0	32 mm	335 mm	33°	
Twin tires, Super Single	960 731 073 0	26 mm	285.75 mm	70°	
Towing vehicle: Front axle, load axle	960 731 075 0	26 mm	285.75 mm	33°	

APPLICATION	ZF PART NUMBER	HOLE, WHEEL BOLT	BOLT HOLE Ø	ANGLE	FIGURE
Twin tires, Super Single	960 731 081 0	26 mm	225 mm	70°	
Counterweight for L-shape sensor	960 905 822 4 960 905 823 4	26 mm 32 mm	335 mm	0°	
Counterweight independent wheels	960 905 820 4 960 905 821 4	26 mm 32 mm	335 mm	0°	
Counterweight independent wheels (North America)	960 905 824 4	26 mm	285.75 mm	0°	

Counterweight

To prevent the external sensor causing an imbalance on the wheel, a counterweight is mounted on the opposite side.

Axles with Twin tires do not need a counterweight. In this case, the external sensor of one wheel serves as counterweight for the external sensor of the other wheel. The external sensors are opposite each other.



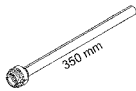
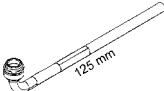
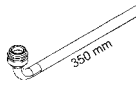
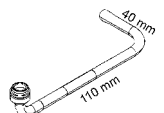


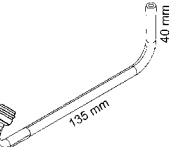
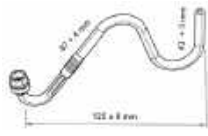
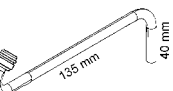

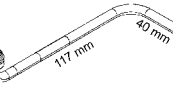

Connecting tube

The external sensors must be permanently connected to the tires for sensing tire pressures. Use ZF pre-assembled PA tubes for this purpose. The connection does not have to be disconnected for inflating the tires as valves for inflating the tire are located on the external sensors.

Depending on the wear condition, a replacement of the PA tube is recommended after 1,000,000 km.

Various types of PA tubes are illustrated in the chart:

"PA tube" variants

ZF PART NUMBER	FIGURE	ORDER NUMBER	FIGURE
960 731 800 0		960 731 810 0	
960 731 801 0		960 731 816 0	
960 731 802 0		960 731 821 0	
960 731 803 0		960 731 822 0	
960 731 804 0		960 731 825 0	
960 731 808 0		960 731 827 0	



Check PA tubes frequently for damages and replace them if necessary.

Replace defective hose connections with PA tubes. Fit a new external sensor at the same time (see chapter 12.2.2 "Replacing 1st generation external sensor with a 2nd generation sensor", page 70).

7.1.2 The internal sensor (WIS)

NOTICE

Risk due to incorrect handling

Any changes of manipulation to the sensor of any type, especially attempts made to change the battery will destroy the device and may damage the tire.

- Adhere to the maximum torques and use screws with locking paint.
- Do not use balancing powder.

NOTICE

Functional limitations due to incorrect installation

Vehicles that are equipped with external sensors (WM2) may not function when the receiving ECU is in the same position when the external sensors are replaced with internal sensors (WIS).

- Install the receiving ECU max. 3 m away from all wheel hubs.
- Install the spare wheel so that the sensor points in the direction of the receiving ECU.
- Run a system test when you have replaced the external sensors with internal sensors.

Information and technical data

INTERNAL SENSOR (WIS)



ZF part numbers	960 732 000 0
Pressure range	0 to 13 bar correspond to the nominal values of pressures from 3 to 10 bar
Transmission intervals	Every minute
Counterweight	Not required
Installation	<ul style="list-style-type: none"> ■ Installation on the rim by means of valve neck. ■ Fastened to a special tire inflation valve with a 6 mm hollow screw coated with locking varnish. ■ The tire valve must match the installation conditions of the original valve. ■ In the interior the mounting surface for the valve must be aligned so that the internal sensor rests flat and level on mounting surface. This prevents large forces acting on the internal sensor and tearing it off during tire assembly/disassembly.
Start-up	Using the ZF TPMS Manager (ZF part number 300 200 001 0)

Purpose and function

In addition to monitoring the tire pressure, the internal sensor also enables an indication of the tire temperature.



Make sure you use suitable tire inflation valves during installation of the internal sensor (WIS).

Valve sets

The following valve sets (consisting of valve, nut and locking screw) are available:

APPLICATION	ZF PART NUMBER	SURFACE	OUTER CONTOUR
Standard steel rims 17 to 22.5"	960 732 100 0	Brass	ETRTO V0.07.3
Standard steel rims 17 to 22.5", tighter rim crank	960 732 101 0	Nickel	ETRTO V3.22.1
Standard steel rims 17 to 22.5", additional 5° inclined section	960 732 102 0	Nickel	ETRTO V3.22.1

Rim overview

Valve sets are available for the following rims. This overview is for example only.



RIM SIZE	MATERIAL	SUPPLIER	RIM NO.	VALVE SET
22.50 x 15.00	Aluminium	Alcoa	85051 EU	960 732 133 0
22.50 x 15.00	Aluminium	Alcoa	85052 EU	960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	819510 Brushed	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	819511 Polished	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	819510DB Dura Bright®	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	819511DB Dura Bright®	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	819510DB Dura Flange®	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	819511DB Dura Flange®	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	81951 EU	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	81952 EU	960 732 104 0/ 960 732 133 0
22.50 x 11.75	Aluminium	Alcoa	81251 EU	960 732 105 0
22.50 x 11.75	Aluminium	Alcoa	81252 EU	960 732 105 0
22.50 x 11.75	Steel	Europart	8600292399	960 732 101 0
22.50 x 11.75	Steel	Gianetti	15815	960 732 102 0
22.50 x 11.75	Steel	Gianetti	15645	960 732 102 0
22.50 x 11.75	Steel	Gianetti	16103	960 732 102 0
22.50 x 09.00	Steel	Gianetti	15939	960 732 100 0/ 960 732 101 0

Components

RIM SIZE	MATERIAL	SUPPLIER	RIM NO.	VALVE SET
22.50 x 09.00	Steel	Gianetti	15941	960 732 100 0/ 960 732 101 0
22.50 x 09.00	Steel	Gianetti	16088	960 732 100 0/ 960 732 101 0
22.50 x 08.25	Steel	Gianetti	16094	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Hayes Lemmerz	2920751 073 85	960 732 102 0
22.50 x 07.50	Steel	Hayes Lemmerz	2920499	960 732 100 0/ 960 732 101 0
22.50 x 07.50	Steel	Hayes Lemmerz	2920699	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Kronprinz	15084	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Kronprinz	15083	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Kronprinz	15095	960 732 100 0/ 960 732 101 0
22.50 x 09.00	Steel	Kronprinz	852XA	960 732 102 0
22.50 x 08.25	Steel	Kronprinz	15098	960 732 100 0/ 960 732 101 0
22.50 x 08.25	Steel	Kronprinz	850 RA	960 732 100 0/ 960 732 101 0
17.50 x 06.00	Steel	Kronprinz	35038	960 732 100 0/ 960 732 101 0
17.50 x 06.00	Steel	Kronprinz	803 WA	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Mefro	15083	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Mefro	15095	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Mefro	15084	960 732 100 0/ 960 732 101 0
22.50 x 09.00	Steel	Mefro	KPB15099OE	960 732 100 0/ 960 732 101 0
22.50 x 09.00	Steel	Mefro	CU-852XAF	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Südrad	15084	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Südrad	15083	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Südrad	15095	960 732 100 0/ 960 732 101 0
22.50 x 11.75	Steel	Südrad	857 BB	960 732 100 0/ 960 732 101 0
17.50 x 06.75	Steel	Südrad	805 YA	960 732 101 0

7.1.3 The internal sensor (SMS)

Information and technical data

INTERNAL SENSOR (SMS)		
		
ZF part number	960 733 000 0 (SMS Blue)	960 733 001 0 (SMS Grey)
Pressure range	0 to 13 bar correspond to the nominal values of pressures from 3 to 10 bar	
Transmission intervals	60 seconds	40 seconds
Counterweight	Not required	
Installation	Installation on the rim by means of fastening strap.	
Start-up	Using the ZF TPMS Manager (ZF part number 300 200 001 0)	

Purpose and function

In addition to monitoring the tire pressure, the internal sensor also enables an indication of the tire temperature.

Fastening straps overview

ZF PART NUMBER	RIM DIAMETER	COLOUR OF SEAM	ADJUSTABLE CIRCUMFERENCE [MM]	WEIGHT [G]
960 733 117 0	17.5"	red	1200-1350	50
960 733 119 0	19.5"	blue	1300-1450	52
960 733 122 0	22.5"	yellow	1535-1685	56
960 733 124 0	24.5"	green	1725-1875	60

7.2 ECU – The electronic control unit

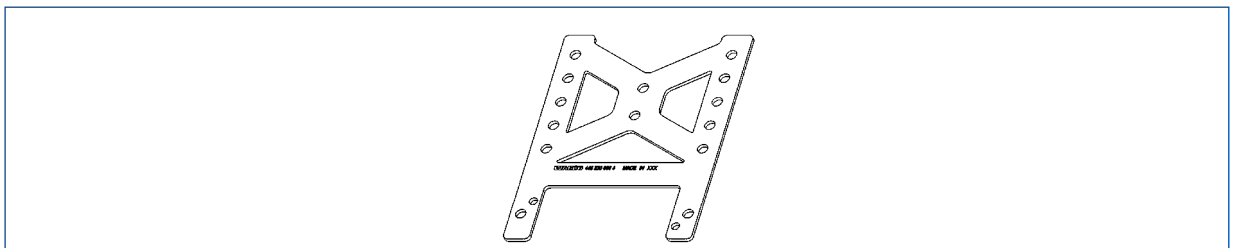
Purpose and function

The ECU receives the sensor signals and immediately recognises all changes from programmed nominal tire pressure values by combined comparison with threshold pressure values and pressure changes.

Faults occurring during operation are stored in the ECU for diagnostic purposes.

The ECU is mounted in a central position on the vehicle chassis so that perfect radio communication with all sensors and between trailer ECU and towing vehicle ECU is ensured. You should use special brackets for good radio contact.

Fixing bracket (ZF part number: 446 220 000 4)



Radio contact is provided by antenna integrated in the ECU housing that guarantees interference-free pressure signal reception from all sensors.

Information and technical data

ECU – THE ELECTRONIC CONTROL UNIT



ZF part numbers	<p>446 220 100 0: Towing vehicle and bus</p> <p>446 220 110 0: Trailer and trailer train (can be cascaded up to 5 times with 22 sensors respectively, must be parameterised by diagnosis)</p> <p>ECUs essentially differ by radio communication signal structure and CAN bus (ID) connection. External distinguishing mark by type label only.</p> <p>Further ECU types are tailored to specific customer requests and have other pin assignments.</p>
Supply voltage	12 or 24 volts
Assembly	Central position on the vehicle chassis

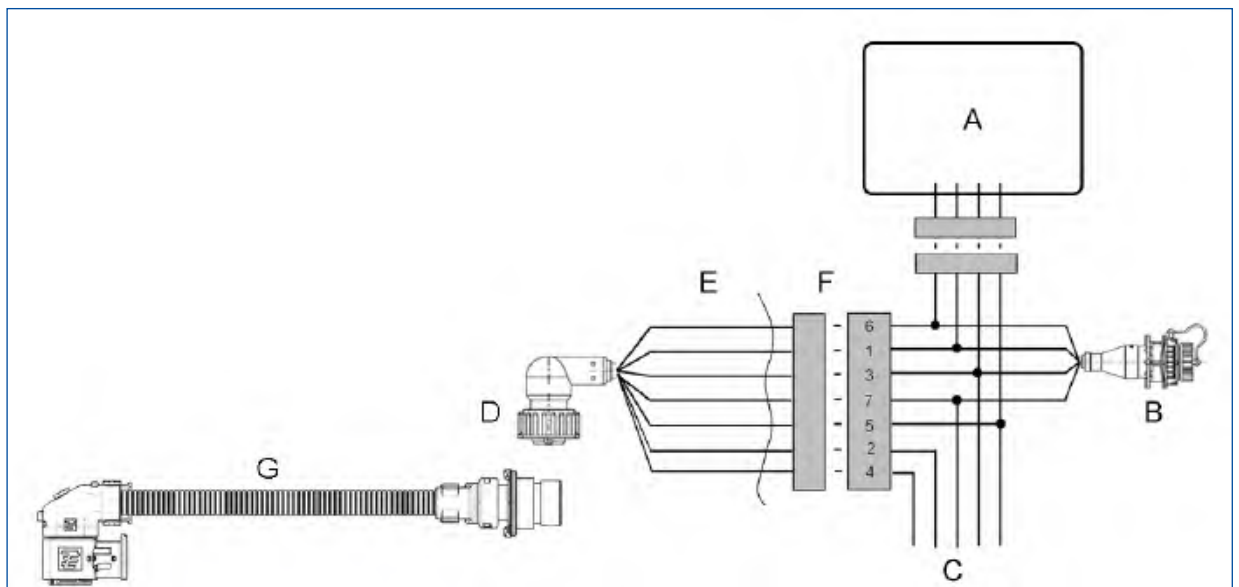
7.3 Connecting cables

OptiTire is connected to the vehicle cabling in two sections on the towing vehicle/bus:

- The first section comprises the connection of the ECU to the distribution element in the vicinity of the driver's workplace. This section is splash-proof allowing external installation on vehicle. The OptiTire cables are connected via the adapter cable (ZF part number: 894 600 001 2).
- The second section is a cable set designed exclusively for the interior. Here there is a split connection from the connection of the first cable to the display, to the diagnostic port, and a connection to the vehicle wiring terminals using free cable ends.

Basic wiring principle for towing vehicle/bus is displayed in the following illustration:

Wiring of towing vehicle



KEY	
A	Display
B	Diagnosis
C	Vehicle electrical system
D	ECU
E	External
F	Internal
G	Adapter cable with ZF part number: 894 600 001 2

Cable set assignment

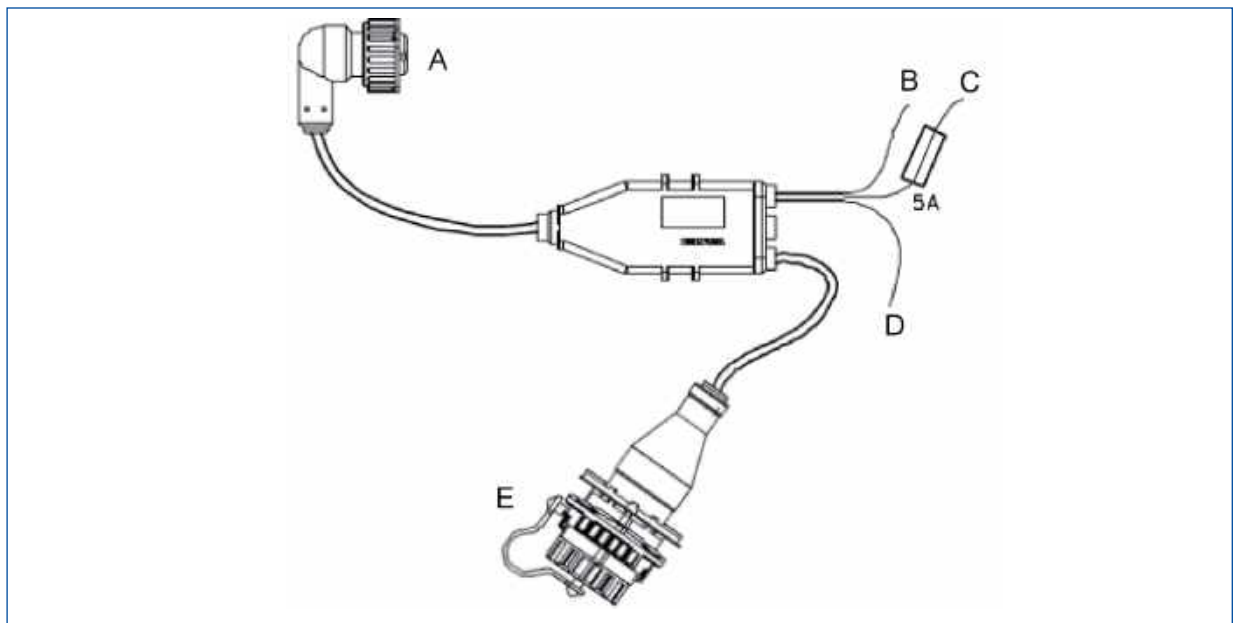
PIN NO.	CONNECTOR PLUG ALLOCATION	CABLE COLOUR 5-PIN	CABLE COLOUR 7-PIN
2	CAN high		
1	CAN low		
8	GND	blue	blue
7	+24 V or 12 V	red	red

PIN NO.	CONNECTOR PLUG ALLOCATION	CABLE COLOUR 5-PIN	CABLE COLOUR 7-PIN
6	Ignition	yellow & grey	grey
4	Stop light/warning lamp 2		yellow
3	Warning lamp 1		green



Connection to +12 V/24 V and ignition must be fused with 5 ampere fuses. Since OptiTire has a low current consumption an existing fused circuit can normally be integrated as well.

Trailer wiring

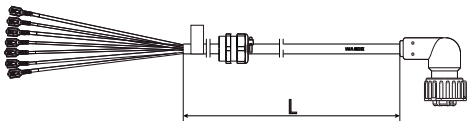


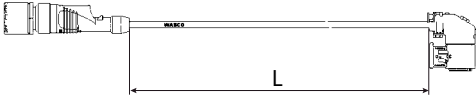
KEY

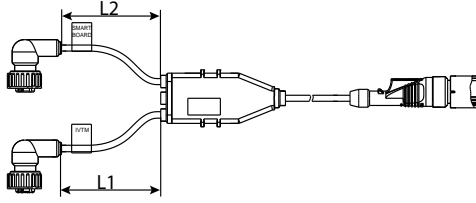
A	ECU (via adapter cable with ZF part number: 894 600 001 2)
B	Brown: Ground
C	Red: +12 V/24 V
D	White: Stop light
E	Diagnosis

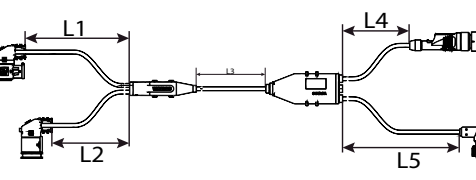
7.4 Cable sets

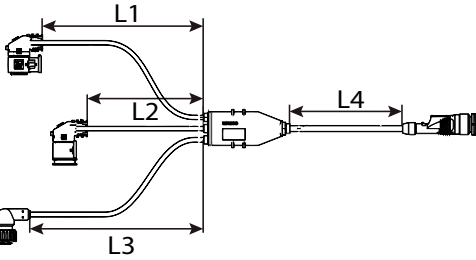
Connecting cables

with open end			
	Part number	L [m]	Cable end type
	449 376 070 0	7	Open 7-wire with push-on contacts and PG screw connection 7x 0.5 mm ² Bayonet socket 7-pin
	449 376 250 0	25	

for TEBS E (direct connection)			
	Part number	L [m]	Cable end type
	449 963 020 0	2	CODE A 4-PIN HDSCS 8-PIN
	449 963 030 0	3	
	449 963 050 0	5	

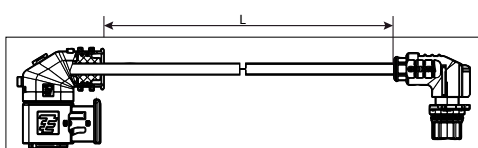
for TEBS E (subsystem) and SmartBoard				
	Part number	L1 [m]	L2 [m]	Cable end type
	449 916 182 0	0.4	4	2x bayonet socket 7-pin Code C 8-pin
	449 916 243 0	1	6	
	449 916 253 0	6	6	

for TEBS E (subsystem), OptiLink™ and SmartBoard							
	Part number	L1 [m]	L2 [m]	L3 [m]	L4 [m]	L5 [m]	Cable end type
	449 934 330 0	12	1	4	0.5	6	2x HDSCS 8-pin Code C 8-pin + bayonet socket 7-pin

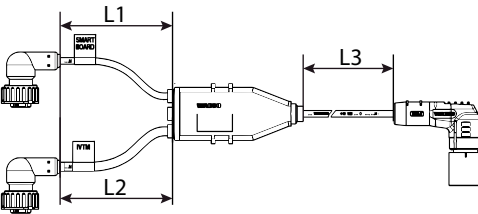
for TEBS E (subsystem), OptiLink™ and control box						
	Part number	L1 [m]	L2 [m]	L3 [m]	L4 [m]	Cable end type
	449 944 217 0	12	4.5	6	0.5	2x HDSCS 8-pin + bayonet socket 7-pin Code C 8-pin

Components

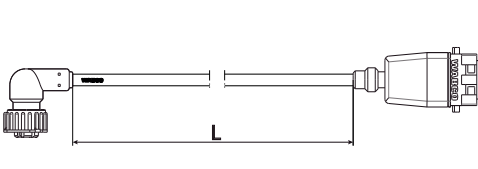
for TEBS E (GIO 5)

	Part number	L [m]	Cable end type	
	449 927 050 0	5	Socket HDSCS 8-pin	Code B 4-pin
	449 927 120 0	12		

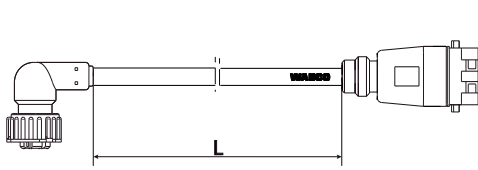
for electronic extension module and SmartBoard

	Part number	L1 [m]	L2 [m]	L3 [m]	Cable end type	
	449 925 253 0	6	6	0.4	2x bayonet socket 7-pin	Code C 8-pin

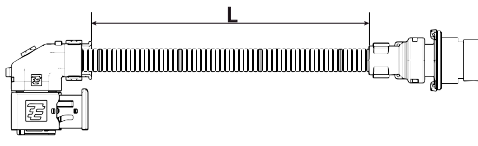
for TEBS D

	Part number	L [m]	Cable end type	
	449 377 030 0	3	Bayonet socket 7-pin	X3 IN/OUT 2 8-pin
	449 377 080 0	8		

for Trailer Central Electronic

	Part number	L [m]	Cable end type	
	449 302 015 0*	1.5	Bayonet socket 7-pin	X32 IVTM + CAN setup 8-pin
	449 302 080 0*	8		

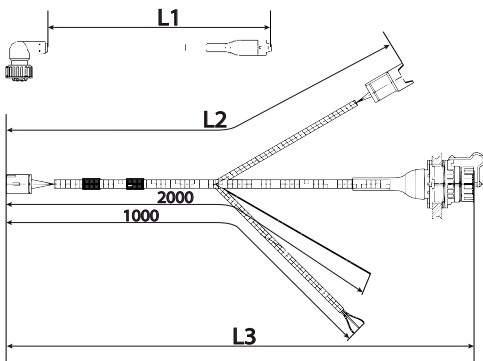
adapter cable

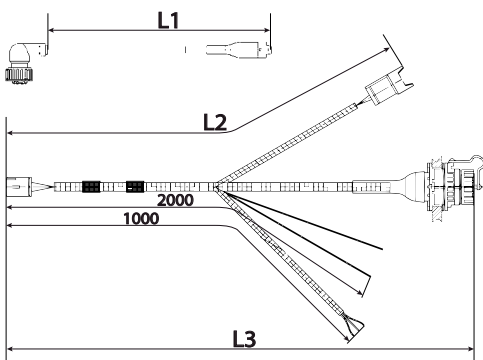
	Part number	L [m]	Cable end type	
	894 600 001 2	0.15	Socket HDSCS 8-pin	Bayonet connector 7-pin

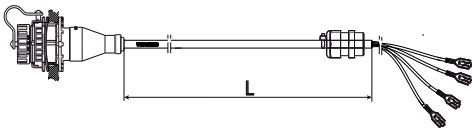
trailer vehicle cable set

	Part number	L1 [m]	L2 [m]	Cable end type	
	449 674 273 0	6	7	Diagnosis socket with blue cap 7-pin	Open 3-wire 3x 0.5 mm ²
	449 674 306 0	2	10	Bayonet socket 7-pin	

Components

bus cable set, 5-pin						
	Part number	L1 [m]	L2 [m]	L3 [m]	Cable end type	
		894 607 295 0	9	2.5	2	Bayonet socket 7-pin

towing vehicle cable set, 7-pin						
	Part number	L1 [m]	L2 [m]	L3 [m]	Cable end type	
		894 607 390 0	9	2.5	2	Bayonet socket 7-pin

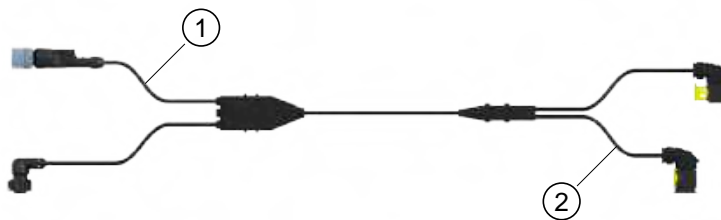
for diagnosis				
	Part number	L [m]	Cable end type	
		449 601 060 0	6	Diagnosis socket with blue cap 7-pin

7.5 Range Extender

To increase the radio range in larger vehicles, up to 3 Range Extenders (RE) can be used on the same CAN bus as the main ECU. The range extenders transmit the received wheel module messages via CAN to the main ECU. Only the latter must carry out the vehicle configuration. The Range Extenders are pre-configured to receive SMS Grey by default. Only this setting must be changed if necessary. The Range Extender is a standard truck or trailer ECU that is configured for operation as an RE as follows:

- With the truck ECU via OptiTire diagnosis
- With the trailer ECU by self-configuration within 6 s after initial switch-on

7.6 CAN termination



A CAN connection should always consist of a path with a maximum of two defined ends. Termination must be provided at each end by a terminating resistor. As a rule, the terminal resistor is located in the connected CAN device.

A CAN network with more than two end resistors does not allow reliable communication. For this reason it is necessary that additional devices are only operated with the resistor switched off. Resistanceless devices must be connected to the short end of a path (max. 1 m). On the picture shown an EBS modulator and an OptiTire ECU are connected to the connectors ① and ②. TEBS automatically switches off its termination due to the parameterisation.

For OptiTire it is necessary to switch off the termination via the Expert Mode in the diagnosis.

However, this is only necessary if four devices are connected. When using only three devices, the termination remains in OptiTire and the free cable end is sealed with the supplied cap.

When using 449 944 XXX X (ECAS control box), termination does not have to be taken into account, as the ECAS control box is not a CAN device.

7.7 ZF TPMS Manager

WARNING

Danger from electromagnetic radiation

Electromagnetic and electronically generated waves can interfere with the operation of pacemakers.
 – If you have a pacemaker, do not use this product.

Information and technical data

ZF TPMS MANAGER



ZF part number	300 200 001 0
Battery life	Approx. 400 operations per full charge
Dimensions (H x W x D)	16.5 cm x 9.5 cm x 3.8 cm
Housing material	High-impact ABS
Response frequency	Main frequencies: 315 MHz and 433.92 MHz (support of most specific frequencies)
Low battery indication	LCD bar display
Weight	Approx. 1 kg
Temperatures	Operation: -20 °C to +55 °C Storage: -40 °C to +60 °C
Working height	Up to 2000 m

Purpose and function

The ZF TPMS Manager can be used to stimulate and read all types of ZF tire pressure sensors (WM2, WIS and SMS). Data such as temperature, pressure, lifetime of internal batteries, IDs, etc. can be read out.

The ZF TPMS Manager can be configured in different languages via its menu.

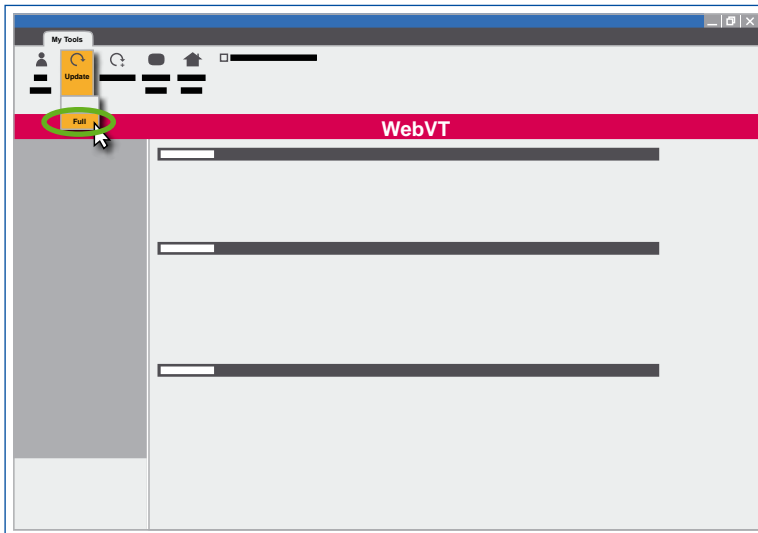
Supported units:

UNIT	BAR	KILOPASCAL	POUND PER QUARTER INCH
Celsius	bar/°C	kPa/°C	PSI/°C
Fahrenheit	bar/°F	kPa/°F	PSI/°F

To control the internal sensor SMS, you may need to update the software version on the ZF TPMS Manager.

ZF TPMS Manager software update

1. Start the WebVT software.
2. Connect the ZF TPMS Manager to your PC using the supplied USB cable.
3. Click on the *My Tools* tab.
4. Click on *Update* and select *Full*.
5. Wait until the update is complete.



8 Installation

In this chapter you will learn how to install the OptiTire system in the vehicle.

Observe all safety instructions when carrying out assembly work on the vehicle.



OptiTire configurator

ZF offers an online configurator for the configuration of OptiTire for various vehicles (towing vehicles, buses, semitrailers).

- Open the following homepage on the internet:

<https://www.wabco-customercentre.com/catalog/en/services-and-support/product-and-system-configurators>

8.1 Safety information

- Observe the occupational health and safety regulations of the respective country, the workshop as well as the vehicle manufacturer's instructions.

WARNING

Risk of accident due to loose wheel nuts

Loose wheel nuts may lead to accidents when driving on roads.

- Wheel nuts must be tightened with torque specified by vehicle manufacturer.
- Check the tightness of the wheel nuts after 500 km.

WARNING

Risk of accident due to unsecured vehicle

Vehicles not secured may roll away during the assembly. This might lead to severe injuries or even death.

- Secure the vehicle against rolling away before carrying out work on the vehicle.

CAUTION

Danger to health due to dust

Dusts that are dangerous to health are generated when the rim is cleaned using compressed air.

- Do not clean the rims using compressed air.

8.2 Assembly of the external sensors WM2

WARNING

Risk of accidents due to loosening the fastening screws of the external sensor

The safe fixing of the wheel module is only possible when the external sensor housing has a tight fit to the bracket.

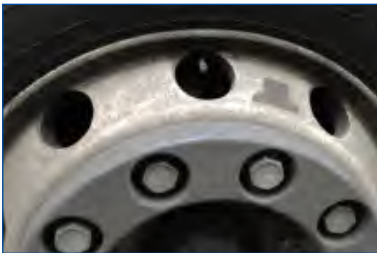
- Never loosen the fastening screws fixing the sensor housing on the bracket.



The vehicle does not need to be jacked up when only four wheel nuts are removed.

Preparing the installation

- Read chapter "7.1.1 The external sensor (WM2)", page 23.
- If necessary, also remove the rim protecting ring.



Installation of the external sensor

1. Loosen and remove two wheel nuts positioned next to each other near to the valve.
2. Check if the position of the external sensor is suitable for connecting to the PA tube and the valve.
 - ⇒ The PA tube should be able to be guided to the tire valve without stretching, twisting or deforming.
3. Position the external sensor on the wheel bolts.
4. Screw the wheel nuts back on.
5. Remove the white protective cap from the pressure connection.

Assembly of the counterweight

1. Loosen the wheel nuts that are exactly opposite of the external sensor (trailer). If the counterweight has 3 holes, loosen another nut clockwise to the left (front axle, load axle see chapter "Counterweight", page 26).
2. Position the counterweight on the wheel bolts.
3. Screw the wheel nuts back on.

Assembly of the PA tube

Tube cutting tool

NOTICE

Increased wear due to incorrect installation

With tubes that rest on the edge of enclosures, there is an increased chance of wear due to vibrations. This might lead to leakages.

- PA tubes need to be installed such that they neither exercise tensile or compressive stress on connections nor rest on the rim.
- Avoid excess lengths to prevent undesired vibrations.
- Avoid moisture in the PA tube or at the pressure port of the external sensor.

1. Hold the PA tube with the connection to the tire valve.
2. Hold the other end of the PA tube to the external sensor.
3. Mark the position on the tube where the PA tube sits flush with the edge of the external sensor (e.g. using adhesive tape).
4. Cut the PA tube to length (ZF part numbers: 960 731 800 0 bis 960 731 802 0) to the required length if necessary.
Make sure that the PA tube is 20 mm inside the connection. For this purpose, the PA tube should be cut 20 mm behind the marking.
Use a cutting tool suitable for right-angled shortening, such as that used for shortening plastic brake lines.
5. Mount the connecting tube to the external sensor by inserting the end of the PA tube into the external sensor opening.
⇒ After pressing with force, the PA tube is locked in position and can then only be removed again after unscrewing the brass screw connection (ZF part number: 893 770 005 2).

Tube cutting tool for $\varnothing 4$ to $\varnothing 12$



Tube cutting tool for $\varnothing 4$ to $\varnothing 22$



- Using the marking, check if the PA tube has been pushed in until the stop.
- Pull on the PA tube to check if the PA tube has been inserted with a tight connection (approx. 20 N).
- Connect the PA tube to the tire valve.
- Tighten union nuts on the tire valve hand-tight.
- Check that the connection is tight using a leakage indicating spray.



Getting external sensor ready for operation

1. Tighten the wheel nuts crosswise again according to the vehicle manufacturer's specifications.
2. Re-tighten the rim protective ring if necessary.



Correct assignment of external sensor ID vs. connected wheel is essential for later commissioning.

- Make a note of the position of the external sensors installed.
- Affix stickers with external sensor ID next to the respective wheel module.
- Adjust tires to correct operating pressure according to the vehicle manufacturer's instructions.
- Note down the corresponding nominal pressures of the axles for later parameterisation by means of diagnosis.



Avoid standing water or moisture in the filling tool or in the tire inflating device.

Valve extension

NOTICE

Do not use plastic valve extensions. These will not remain tight under permanently existing pressure.

Twin wheels (outer wheel)



Twin wheels (inner wheel)



8.3 Assembly of the internal sensor WIS

Safety information

- Always observe the applicable hazard warnings and correct procedures on the assembly machine. This information has priority over these instructions.
- Replace the internal sensor if the pressure opening is blocked with foreign bodies.
- Make sure that the screw can retain the internal sensor permanently with 4 Nm.
- In the case of screws with locking varnish, always use new screws with every assembly.
- Never re-tighten self-locking screws and union nuts.
- Use self-locking fastening screws only once.
- Use the valve that matches the rim. Select the correct valve using an assignment table see chapter 7.1.2 "The internal sensor (WIS)", page 28.
- Do not apply compressed air, assembly paste, detergents or other cleaners to the internal sensor.
- Never clean the rim with high pressure when the tires are removed and the internal sensor still installed.
- Remove contaminations only with a clean, lint-free cloth.
- Renew the internal sensor if you have identified the following:
 - The housing is visibly damaged.
 - Foreign bodies can be seen in the pressure opening.
 - The battery of the internal sensor has reached the end of its life.

Preparing the installation

1. Read chapter "7.1.2 The internal sensor (WIS)", page 28.
2. Jack up the vehicle at the corresponding wheel positions.
3. Remove the wheel.
4. Use a suitable assembly device to remove the tire.
It is sufficient to pull the tire over the rim on one side; free access to the drop-centre and valve is all that is required.
5. Remove the original tire inflation valve.

Installation of the internal sensor

1. Fit the suitable tire inflation valve (Figure 1).
Observe the tightening torque specified for the rim and correct alignment of the valve.

Figure 1



2. After fitting the valve, place the internal sensor on the inside of the rim on the valve head (Figure 2) and secure with the screw (Figure 3). Note the following:
 - The internal sensor must be aligned parallel to the rim (Figures 4 & 5).
 - The sensor must make contact over the entire contact area of the valve; in addition it must be supported at two other points on the rim (3-point assembly) (Figures 6 & 7).
 - The tightening torque is 4 ± 0.5 Nm (Figures 8 & 9). Always use a torque wrench for the exact torque!
3. Fit the tire according to chapter "8.5 Assembly of the tire", page 51.
⇒ The installation of the internal sensor WIS is completed.

Figure 2

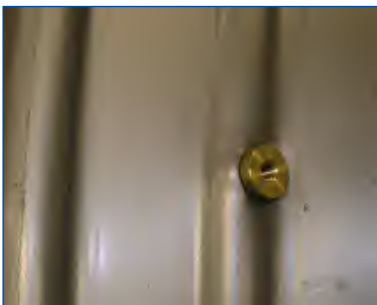


Figure 3



Figure 4



Figure 5



Figure 6

In the case of steel rims the internal sensor sits flat on the rim.

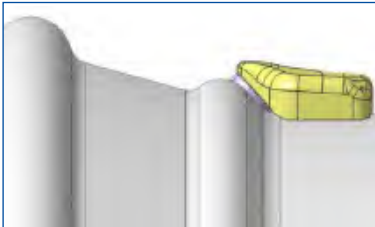


Figure 7

In the case of aluminium rims only the rear section of the wheel electronics sits on the rim.

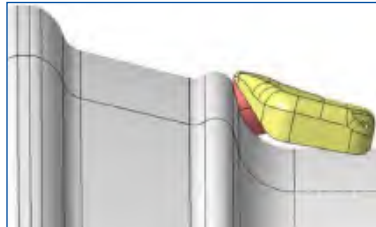


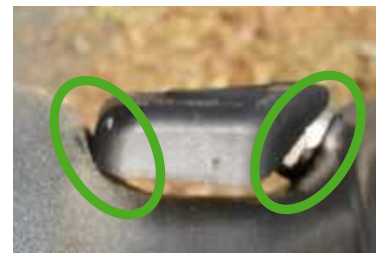
Figure 8



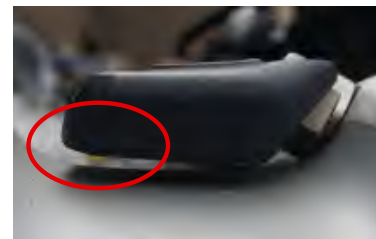
Figure 9



Correct fit of the internal sensor



Incorrect fit of the internal sensor



8.4 Assembly of the internal sensor SMS

Safety information

NOTICE

Risk due to incorrect handling

Any changes of manipulation to the sensor of any type, especially attempts made to change the battery will destroy the device and may damage the tire.

- Never attempt to open the sensor.
- Do not use balancing powder.

NOTICE

Functional limitations due to incorrect installation

If external sensors (WM2) are replaced with internal sensors (SMS) with the same positioning of the receiving ECU, the tire pressure monitoring may no longer function.

- Install the spare wheel so that the sensor points in the direction of the receiving ECU.
- Run a system test when you have replaced the external sensors with internal sensors.
- Always observe the applicable hazard warnings and correct procedures on the assembly machine. This information has priority over these instructions.
- Replace the internal sensor if the pressure opening is blocked with foreign bodies.
- Use fastening straps that are approved for the corresponding rim size (see chapter "7.1.3 The internal sensor (SMS)", page 31).
- Observe the maximum distance of the wheel hubs to the receiving ECU (see chapter "8.6 Fitting the ECU in the trailer", page 53).
- Do not apply compressed air, assembly paste, detergents or other cleaners to the internal sensor.
- Never clean the rim with high pressure when the tires are removed and the internal sensor still installed.
- Remove contaminations only with a clean, lint-free cloth.
- Renew the internal sensor if you have identified the following:
 - The housing is visibly damaged.
 - Foreign bodies can be seen in the pressure opening.
 - The battery of the internal sensor has reached the end of its life.

Preparing the installation

1. Read chapter "7.1.3 The internal sensor (SMS)", page 31.
2. Jack up the vehicle at the corresponding wheel positions.
3. Remove the wheel.
4. Use a suitable assembly device to remove the tire.
It is sufficient to pull the tire over the rime on one side; free access to the drop-centre and valve is all that is required.

Installation

Installation of the internal sensor

1. Slide the sensor on the inside of the fastening strap (unmarked side) with the rounded side first into the pocket provided (Figures 1 & 2).

Figure 1



Figure 2



Inside (unmarked)

Outside (marked)

2. Guide the fastening strap through the centre of the drop centre and once around the rim (Figure 3).
3. Pass the Velcro through the ladder buckle (Figure 4).
4. Tighten the fastening strap with a tensile force of ~100 N and close the Velcro fastener (Figure 5).
Note the following:
 - The sensor must lie flat on the drop-centre with the concave underside (Figure 6).
 - The Velcro fastener must be pressed firmly over its entire length.
 - The two layers of the Velcro fastener must lie flush on top of each other over the entire length (the Velcro fastener must not be pressed laterally offset).

Figure 3

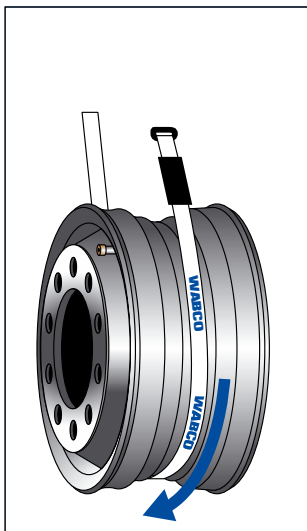


Figure 4

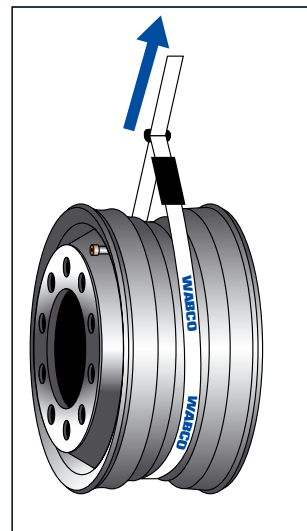


Figure 5

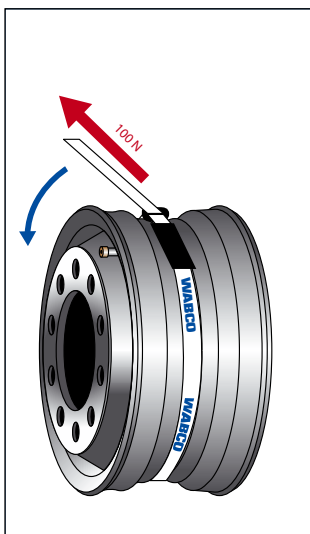
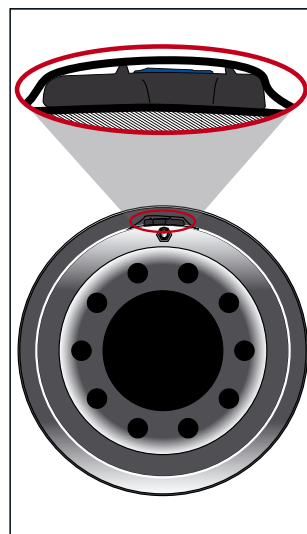
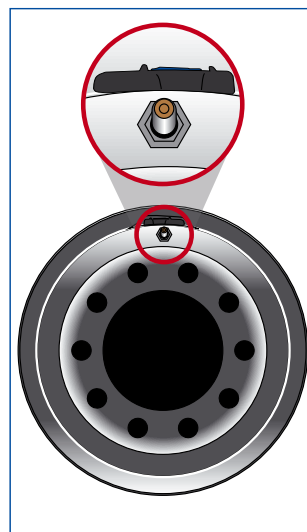


Figure 6



To better locate the sensor when mounted, secure the sensor at the height of the valve (Figure 7).

Figure 7



5. Secure the Velcro fastener by pulling the plastic strap loop centrally onto the sewn end of the fastening strap (Figure 8).

Figure 8



Outside (marked)

6. Fit the tire according to chapter "8.5 Assembly of the tire", page 51.
⇒ The installation of the internal sensor SMS is completed.

8.5 Assembly of the tire

NOTICE

Damage of the internal sensor by fluids

The internal sensor can be damaged by the penetration of fluids.

- Make sure that the internal sensor does not come into contact with fluids (e.g. assembly fluid).
- Do not fill the tires with water.

1. Fit the wheel onto the assembly machine that the assembly head is on the opposite side of the valve, i.e. offset by 180° (Figure 9).

Figure 9



2. Apply assembly fluid to the tire bead and rim flange.

NOTICE

Damage to the internal sensor due to tensile or compressive forces

During assembly the tire bead must not be pressed against the wheel electronics. Otherwise there is a risk that the internal sensor will be destroyed by the contact.

- Make sure that a tire bead is not pressed onto or pulled over the sensor.

3. Push the bead to be fitted onto the rim over the rim flange.
4. Pull the second tire bead onto the rim.

During assembly the assembly head must have a minimum distance of 20 cm to the internal sensor (Figure 10). The remaining part of the bead can be pressed over the rim flange in the normal way (Figure 11).

Figure 10

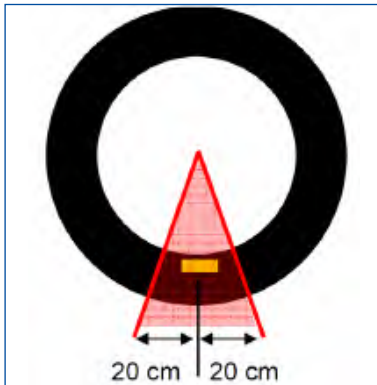


Figure 11



5. Then remove the complete wheel from the assembly machine.
6. Inflate the tire as usual.



If a filling bell is used, the tire must not exert any pressure on the internal sensor housing or get stuck on the housing.

Assembly of the wheel

- Fit the complete wheel to the vehicle. When doing this, apply the tightening torques specified by the vehicle manufacturer.

8.6 Fitting the ECU in the trailer

- Maintaining good radio contact the ECU must not be shielded off by metal walls in its direct vicinity. Keep a distance of at least 35 cm.
 - If possible, there should be a line of sight to the wheels with the built-in sensors. For this purpose, the ECU should be mounted underneath the vehicle's beams if possible.
 - If possible, keep a large distance from other electronic control units; they could interfere with the reception of the wheel modules by emitting interference frequencies.
 - The distance to the wheel modules should be as small as possible.
- Observe the following distances when installing the ECU. If these distances are exceeded, you may need to use one or more Range Extenders.

SENSOR	ZF PART NUMBER	MAX. DISTANCE SINGLE TIRES	MAX. DISTANCE TWIN TIRES
WIS	960 732 000 0	2.5 m	2.2 m
SMS Blue	960 733 000 0	1.6 m	–
SMS Grey	960 733 001 0	2.5 m	2.2 m



Exceeding the specified distances or use in unfavourable installation situations is permissible if sufficient availability is proven with the aid of the signal availability measurement in the OptiTire Diagnostic Software.

8.7 Mounting the ECU in bus/towing vehicle

ECU position on vehicle

NOTICE

Damage to the vehicle frame due to welding

Welding work for mounting the bracket (ZF part number 446 220 000 4) may affect the strength of the vehicle frame.

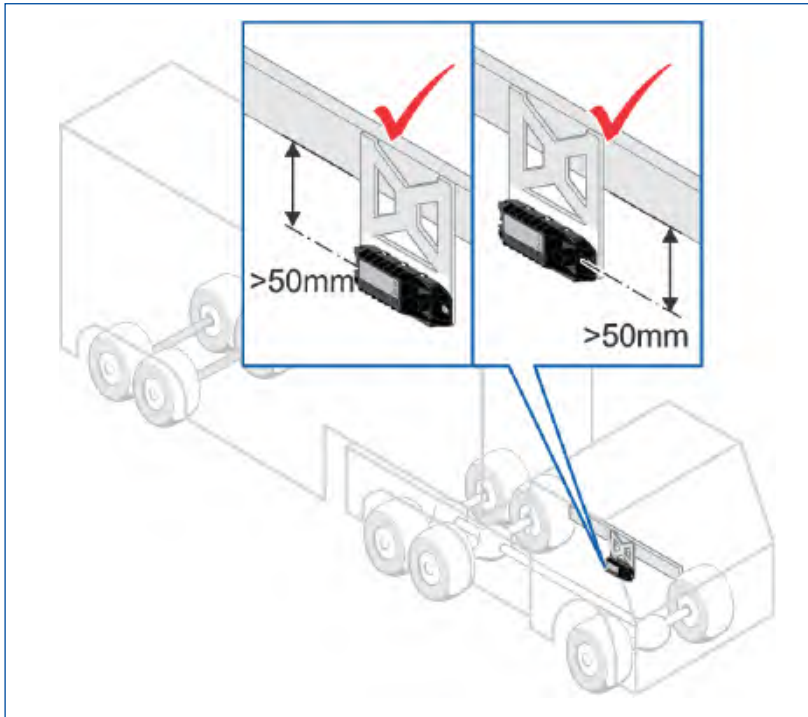
- Screw the bracket to the vehicle.

Towing vehicle

The ECU connector must point to right or left only and not up, to the rear or down. With external sensors (WM2) it is recommended to mount the ECU in front of the first axle with Twin tires or Super Single tires.

- Choose the fitting position in accordance with the figure "Assembly on the longitudinal beam".
- If the vehicle is equipped with a low lying coupling for central axle trailer, install the ECU on the right side of the vehicle, so that the wireless connection to the trailer is not shielded off by the coupling.

Assembly on the longitudinal beam



Bus

- Use threaded rods for hanging assembly at the roof frame in the cabin.
- For solo bus: Position the ECU at the centre of the vehicle.
- For articulated bus: Position the ECU in front of the articulation in driving direction.

Further possible installation positions are:

- in the roof cove opposite the entrances (if the cover is made of plastic)
- in the roof lining
- with articulated buses, in the rear area of the front section (in the geometric centre of all axles)
- with coaches, also on the luggage compartment (if the luggage compartment components are at least in part of wood or plastic)

Mounting the ECU

- Read chapter "7.2 ECU – The electronic control unit", page 32.
- Mount ECU so that the distance to the sensors is as equal as possible.
Select distance to truck driver's cab such that length of ECU cable (8 m) is sufficient to reach driver's cab.
In the towing vehicle there is an ideal installation position between the front and rear axles underneath the frame.
For a good radio connection, the ECU must not be shielded by metal walls in the immediate vicinity, e.g. by a U-beam.
- For the towing vehicle use the bracket (ZF part number 446 220 000 4). Screw the bracket to the vehicle.
- Tighten ECU to bracket using torque of 15 ± 1.5 Nm.

8.8 Wiring in towing vehicle/bus

Proceed as follows to install the wires of the OptiTire system into the bus or the towing vehicle:

- Read chapter "7.3 Connecting cables", page 33.
- Select the suitable circuit diagram (see chapter "6.2 Configuration for bus and towing vehicle", page 12).
- Attach display to support supplied at a suitable attachment location. The display must not necessarily be located inside driver's direct field of vision.
- Fit the diagnostic socket to a suitable attachment location and label it with "Diagnosis OptiTire". Locations where diagnostic ports are already located would be specially suitable as the attachment location.
- Install cables according to the wiring diagram using cable ties in parallel with already existing wiring harnesses.
- Do not lay the cable directly in front of or behind the ECU.
- Form large loops from ample lengths.
- Turn off the ignition.
- In the fuse box, search for appropriate fused circuits or connect 5 A "flying" fuses to terminal 15 (ignition) and 30 (U Batt).
- Label the flying fuses with "OptiTire".
- Connect the cable set with the fuses.
- Connect the ground line to the ground contact.
- Connect display and ECU.

8.9 Mounting the ECU in the trailer

NOTICE

Damage to the ECU by fluids

The ECU can be damaged by the penetration of fluids. The gap between the bottom of the housing and the cover must not point upwards or in the direction of travel.

- Mount the ECU so that the top of the ECU (the side with the socket) is facing in the direction of travel.
- Read chapter "7.2 ECU – The electronic control unit", page 32.
- Determine the best possible installation position, depending on the type of the trailer:
 - Drawbar trailer:
Mount the ECU at the centre of the trailer.
 - Semitrailers and central axle trailers:
Mount the ECU in the front area on the cross member near the middle axle or in the middle between all axles.
 - ECU longitudinal axis must be in parallel with the vehicle axis.

NOTICE

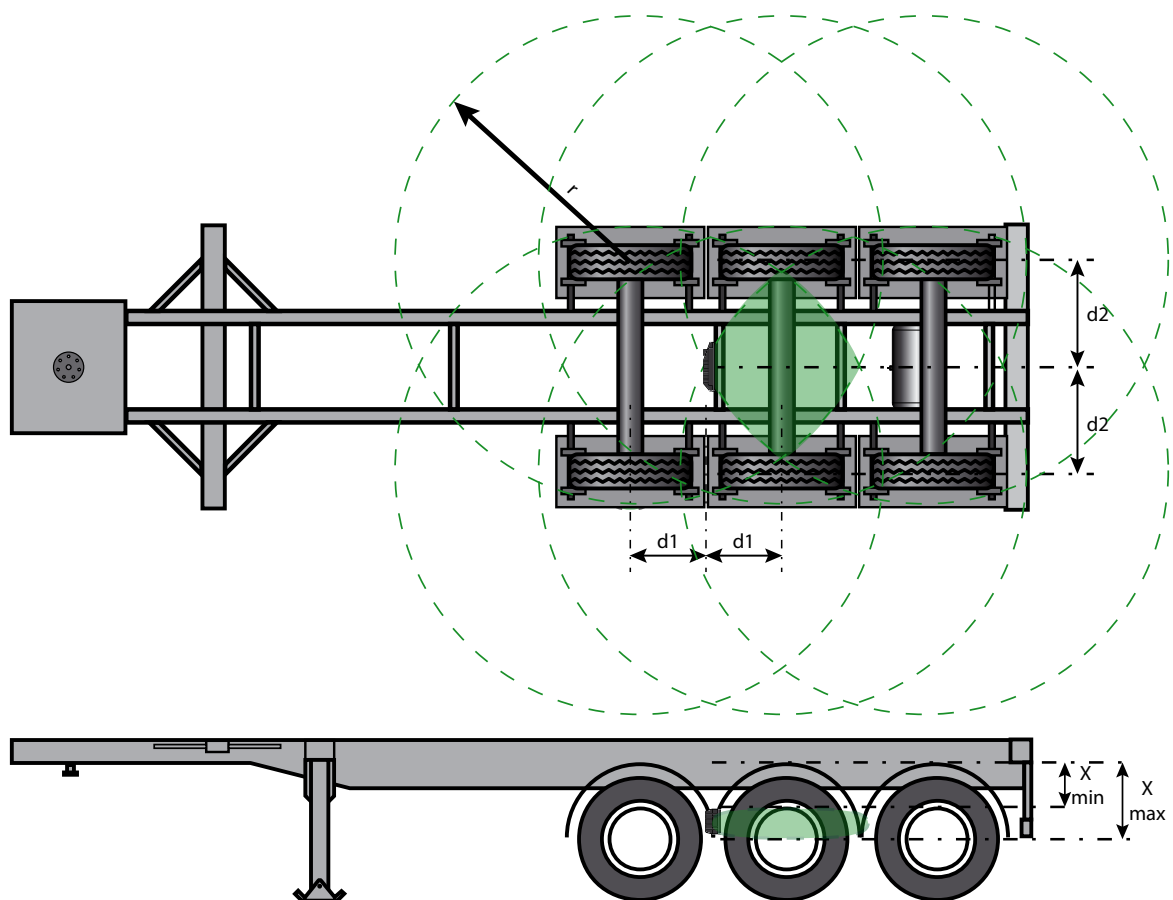
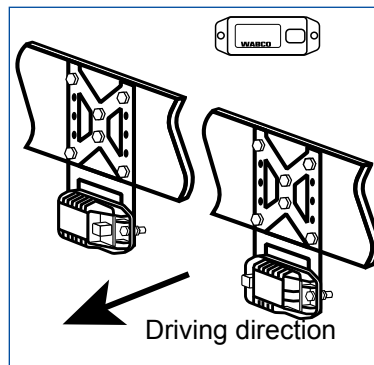
Damage to the vehicle frame due to welding

Welding work for mounting the bracket (ZF part number 446 220 000 4) may affect the strength of the vehicle frame.

- Screw the bracket to the vehicle.
- Attach the ECU below on the frame.
- Tighten ECU to bracket using torque of 15 ± 1.5 Nm.

Installation

Semitrailer: Assembly at cross member



KEY	
d1	Half distance between two axles
d2	Half distance between two sensors
r	Signal radius of a sensor
x	Distance from the centre of the cross member to the centre of the axle
---	Signal range of a sensor
■	Optimum mounting position of the ECU

8.10 Wiring in trailer

Proceed as follows to install the wires of the OptiTire into the trailer:

- Read chapter "7.3 Connecting cables", page 33.
- Select the suitable circuit diagram (see chapter "Wiring diagrams for trailers", page 17).
- Fit the diagnostic socket to a suitable attachment location and label it with "Diagnosis OptiTire". Locations where diagnostic ports are already located would be specially suitable as the attachment location.
- De-energise the trailer.
- Install cables according to the wiring diagram using cable ties in parallel with already existing wiring harnesses. Form large loops from ample lengths.
- Connect OptiTire wiring to existing wiring.
- Connect the ECU.

9 Requirements for start-up

9.1 Training

Entering a PIN is required for the parameter settings.

Having participated in a course of E-Learning, you can request a PIN for the Diagnostic Software from us. You can then use this personal identification number to enable enhanced functions in the software that allow you to modify the settings in electronic control units.



More information on ZF [pro]Academy training and E-learning courses can be found on the internet at: <http://www.wabco-academy.com/home>

9.2 Diagnostic Software

With the Diagnostic Software you have the following options:

- Retrieving the diagnostic memory data
- Retrieving current measured values
- Parameter setting
- Displaying measures to remedy faults (if faults are indicated).



The ECU settings can only be changed by trained workshop staff in the protected program area.



Downloading the Diagnostic Software

- Go to the following homepage on the internet:
<https://www.wabco-customercentre.com/catalog/en/services-and-support/diagnostics/diagnostic-software>

Requirements for start-up

9.3 Diagnostic Hardware

Diagnostic components for towing vehicle

The CAN diagnostic cable (ZF part number 446 300 348 0) is used for diagnosing towing vehicles.

Diagnostic components for trailers

When carrying out diagnosis on trailers, please extract the ZF part number of the required diagnostic components from the chart:

SYSTEM IN TRAILER VEHICLES	REQUIREMENTS	DIAGNOSTIC HARDWARE		
VCS ECAS TEBS before 2004	Depends on system	Diagnostic cable 446 300 329 2 		
TEBS since 2004 VCS II	ISO 7638 disconnecting adapter with CAN socket 446 300 360 0 	Diagnostic Interface (DI-2) with USB port (for connection to a PC) 446 301 030 0 	CAN diagnostic cable 446 300 361 0 (5 m) 	Diagnostic Interface (DI-3) with USB port, Bluetooth and Wi-Fi (for connection to a PC)
TEBS E Premium	External diagnostic socket with yellow cap 449 611 XXX 0 	Diagnostic Interface (DI-2) with USB port (for connection to a PC) 446 301 030 0 	CAN diagnostic cable 446 300 348 0 	300 400 103 0 

9.4 Installing the Diagnostic Hardware

Proceed as follows to put the OptiTire into operation with the Diagnostic Software:

- Make sure that the OptiTire system is installed according to the instructions (see chapter "8 Installation", page 41).
- Connect the computer to the vehicle using the diagnostic cable and Diagnostic Interface.

10 Start-up

10.1 Starting the Diagnostic Software

- Start the OptiTire Diagnostic Software.
- Switch on ignition. Ensure power supply of trailer if necessary.
- Choose whether a guided selection should take place or the Diagnostic Software should automatically search for connected ECUs.



Select a "Trailer Train Configuration" only if at least 2 trailers are operated coupled behind each other.

Use a system for simultaneous operation of a tractor and a trailer.


10.2 Parameter setting

10.2.1 Reading in a parameter set

- If you want to enter parameters directly, click on:



10.2.2 Selection/entry of parameter data

- If you want to carry out a complete start-up, click on: 
- ⇒ The *Parameters* window is opened.
- Select whether the *Module reception* should be displayed or an *Assignment test* should be carried out.
- Click on *Start* to start the parameter setting.
- Select an existing parameter file (.ecu) if you want to use previously configured vehicles as a template, or click on *Cancel* to skip this option.

"Vehicle configuration" tab

- Enter the respective vehicle data and *Vehicle type*.
- Select the vehicle configuration to use under *System configuration*.
If the vehicle is not included under the standard system configurations a spare tire is used with the internal sensor, select the free *System configuration*.
- Define the type and position of the axles for this free configuration.
- Select the *Sensor type*: *Internal sensor (WIS – also valid for SMS)* or *external sensor (WM2)*.

"Module configuration" tab

- Enter IDs of the sensors and tire pressure values (according to vehicle manufacturer) in list of axes and wheels.

The following options are available for entering the IDs:

First option: Manual entry of the IDs

- Enter the number code on the barcode directly at the corresponding wheel position.

Second option: Barcode scanner

- If you have stuck the barcode label onto a sheet of paper in accordance with the vehicle configuration, you can scan in the values directly using a barcode scanner.

Third option: Sensor assignment and stimulation

The modules can be assigned by means of a free or sequential assignment. For this purpose a diagnostic message is stimulated for the selected sensors and the corresponding ID is inserted automatically at the selected position:

- Under *Module assignment*, click on the *Execute* button.
- Select *Sequential* (complete installation of a vehicle) or *Free module selection* (replacement of a wheel or sensor).
- Select the *Assign* check box.
- Click on *Start*.
- Stimulate the first sensor within five minutes.
 - ⇒ The background colour changes to green and the sensor ID is placed here.
- Stimulate the next sensor after at least three seconds.
- When all assignments are complete, click on *OK*.

10.2.3 Stimulating the sensors

Stimulating the external sensors

- Select an external sensor (WM 2.2 TRIG or WM 2.4 TRIG from year of manufacture 2017) in the *READ OUT SENSOR* menu of the ZF TPMS Manager (ZF part number: 300 200 001 0).
- Hold the ZF TPMS Manager close to the external sensor.
The adjacent wheel may interfere with the radio signal, in which case the respective wheel must be turned.

Alternative

- For this purpose, touch the housing of each wheel module below the sticker "OptiTire" for 5 seconds using a magnet (2 kg retention force) or using a bar magnet parallel to the OptiTire logo.

External sensor with solenoid for simulating the external sensors



Stimulate the internal sensors (WIS and SMS) with the ZF TPMS Manager (ZF part number: 300 200 001 0)



To use the ZF TPMS Manager to control the internal sensor (SMS), the latest software version must be installed on the ZF TPMS Manager (see chapter "7.7 ZF TPMS Manager", page 39).

- Select an internal sensor (WIS, SMS Blue or SMS Grey) from the *READ OUT SENSOR* menu of the ZF TPMS Manager.
- Hold the ZF TPMS Manager close to the internal sensor, either from the side of the tire sidewall or from the tread.
The adjacent wheel may interfere with the radio signal, in which case the respective wheel must be turned.

ZF TPMS Manager to stimulate internal sensors



10.2.4 Warning lamp configuration

- Configure possible warning lamps.
For a towing vehicle ECU, only one external warning lamp can be configured.
For a trailer ECU, two external warning lamp can be configured.

10.2.5 Change ECU address (Trailer Train) (Trailer ECUs only)

For large vehicles and/or a large number of wheels, it is necessary to enable multiple use of OptiTire via a CAN bus. This option cannot be used in conjunction with TEBS or SmartBoard.

Note the following specifications:

- Since the CAN source address of the affected ECU changes, the diagnostic connection must be rebuilt after a change.
- In order to avoid interference with the CAN bus, each configuration may only be used once per vehicle.
- For all standard truck and trailer applications, the configuration must be left in the ZF delivery state (address CF Hex/207 dec).
- To ensure correct operation of the CAN bus, the first and the last ECU (incl. display) must be equipped with a CAN termination (see chapter "10.2.7 Expert parameters", page 64).

10.2.6 Country-specific adjustments

- In the Diagnostic Software, carry out country-specific adjustments, e.g. indication of bar or PSI, use of USA radio protocol (FCC), resolution of the tire message.

10.2.7 Expert parameters



As the last parameter setting define the parameters in the *Expert parameters* window.

Expert parameters are available for special applications:

- In the window *Parameters* under the tab *module configuration* activate the *Display expert parameters* function for this purpose.
 - ⇒ The *Expert parameters* window appears.

You have the following options:

- **Temperature warning:**
If internal sensors are used, a warning message can be given out when the defined temperature value is exceeded. 100 °C is defined as default here (maximum value: 115 °C).
- **Tire status messages:**
Here the transmission of trailer data in the towing vehicle and the transmission of the vehicle configuration can be deactivated. The latter can be useful for telemetry configurations. With external sensors, the temperature transmission can be deactivated.
- **Tire pressure limit values:**
Here the setpoint pressures that can be set in the module configuration can be restricted when using the driver configuration (only for OE vehicles).
- **Lifting axle positions:**
To prevent the monitoring of non-moving wheels (which, in the worst case, can result in a sensor not being received) with lifting axles, the corresponding axles can be selected here.
- **CAN configuration:**
Here the CAN bus baud rate can be adjusted.



After the data is written to the ECU, diagnosis needs to be re-established.

- **CAN termination:**
For an integration in an existing CAN bus or with a trailer train configuration it may be necessary to deactivate the CAN termination, which is activated by default.
In addition, you can define whether the CAN termination should remain activated in sleep and listen mode.



Increased power consumption with ignition off if the CAN termination is activated with sleep and listen mode.

- **Reset and leakage parameter:**
If activated, another page displays the parameters for resetting the leakage algorithm are displayed.
- **DM1 message:**
These parameters define the conditions for sending DM1 messages and whether they should be empty (no event present) or filled (event present) in a fault-free state.
- **Range Extender:**
Here you can select whether the ECU is configured as Main ECU or Range Extender (RE1, RE2 or RE3), or whether the trailer ECU should learn itself the first time it is switched on (OptiTire factory setting: Reset Autolearn).

10.3 Range Extender (RE)

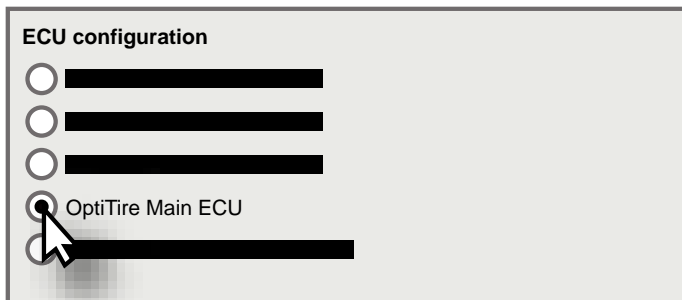
The Range Extender is used to increase the reception range of the wheel modules. For proper operation, it is usually only necessary to configure the main ECU. The Trailer ECU 446 220 110 0 is generally used as a Range Extender.

When the supply voltage is first applied, the ECU automatically detects that more than one trailer ECU is connected and configures itself: The trailer ECU with the lowest serial number automatically remains the main ECU, the up to 3 Range Extenders configure themselves upwards according to their serial number. It is basically irrelevant which ECU is positioned at which location in the vehicle.

The start-up is different on the towing vehicle and trailer:

- In the case of the towing vehicle/bus, up to 3 trailer ECUs (446 220 110 0) are provided as Range Extenders to the main ECU (ZF part number 446 220 100 0) depending on the reception area to be covered. After initial supply, the trailer ECU of the lowest must be converted to the highest Range Extender ECU by a Main ECU (e.g. as RE2 with 2 Range Extenders connected).
- For trailers, the initial configuration can be adopted in this way.

Using the Diagnostic Software, the assignment can be changed at any time in the expert diagnosis:



10.4 Module reception

In this menu item, the signal strengths of the individual sensors are queried and displayed. The display can vary from weak signal strength (one bar) to strong signal strength (three bars).

1. Click on the *Measured values* menu item.
2. Select *Module reception*.
3. If no bar is displayed on an internal sensor, rotate the affected wheel so that the sensor points toward the ECU. If there is still no sensor received, the distance to the ECU is too great and the ECU must be installed elsewhere.

10.5 Assignment test

The configuration is checked to ensure that all entries including the sensor ID have been made correctly during configuration. For this purpose, all sensors must be stimulated (see chapter "10.2.3 Stimulating the sensors", page 62).

1. Click on *Start* to start the assignment test.
2. Stimulate the sensors according to the wheel position highlighted on the screen.
 - ⇒ The assignment test is completed after all sensors have been stimulated.

10.6 Finalising start-up

1. Delete content of diagnostic memory (start window: *Messages* => *Diagnostic memory*).
2. Print the start-up log (*Start-up* window).
3. Print the vehicle label onto self-adhesive aluminium foil (ZF part number: 899 200 922 4) (*Start-up* window).
4. Attach the vehicle label to the vehicle where it is protected and legible.
5. Exit the start-up procedure in the Diagnostic Software.
6. Check operation on display and data exchange with towing vehicle respectively.
 - ⇒ Start-up is complete.

10.7 Signal availability

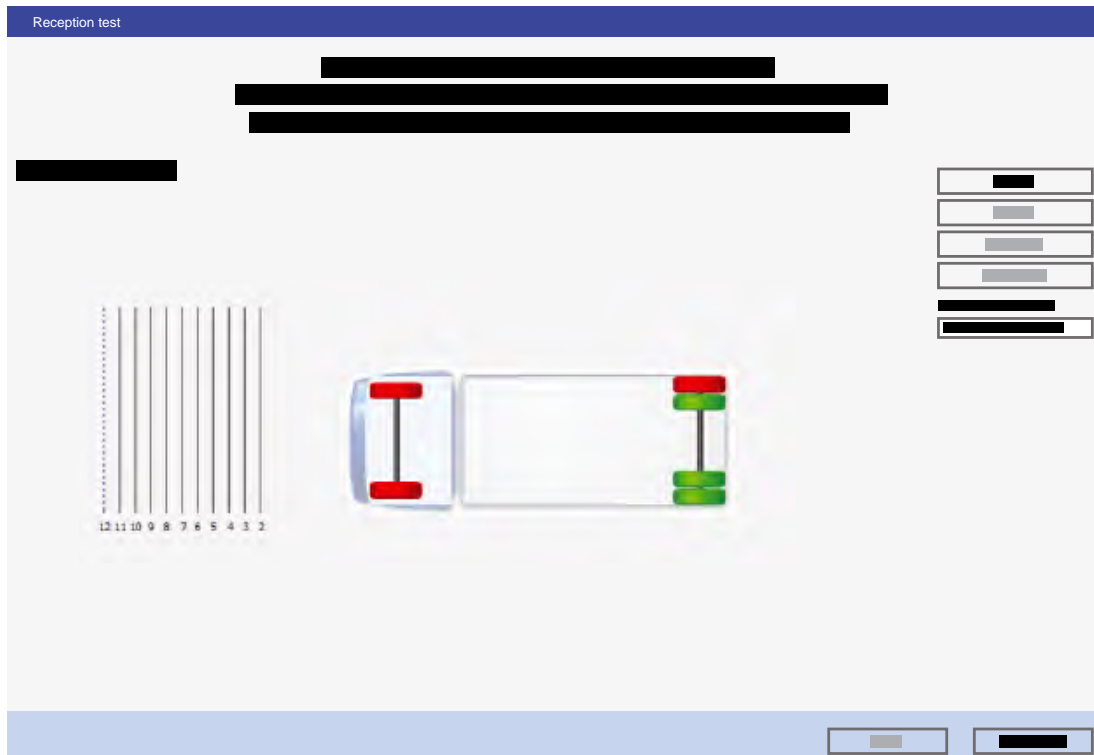
In order to determine a good availability of the received wheel module messages, the signal availability can be checked while the vehicle is stationary (with little movement of the vehicle) as well as while driving. For this, more than 50 % of the possible messages should be available for each wheel position. Below 35 %, a high probability of fault messages due to sensor messages not being received must be expected.

10.7.1 Standstill measurement

When stationary, the vehicle is moved forward in 12 equal parts of the wheel circumference for this purpose. The reception is checked for 3 minutes in each position. Finally, the overall availability is analysed on the basis of this systematic investigation. After starting the reception test, the rim diameter must be specified:

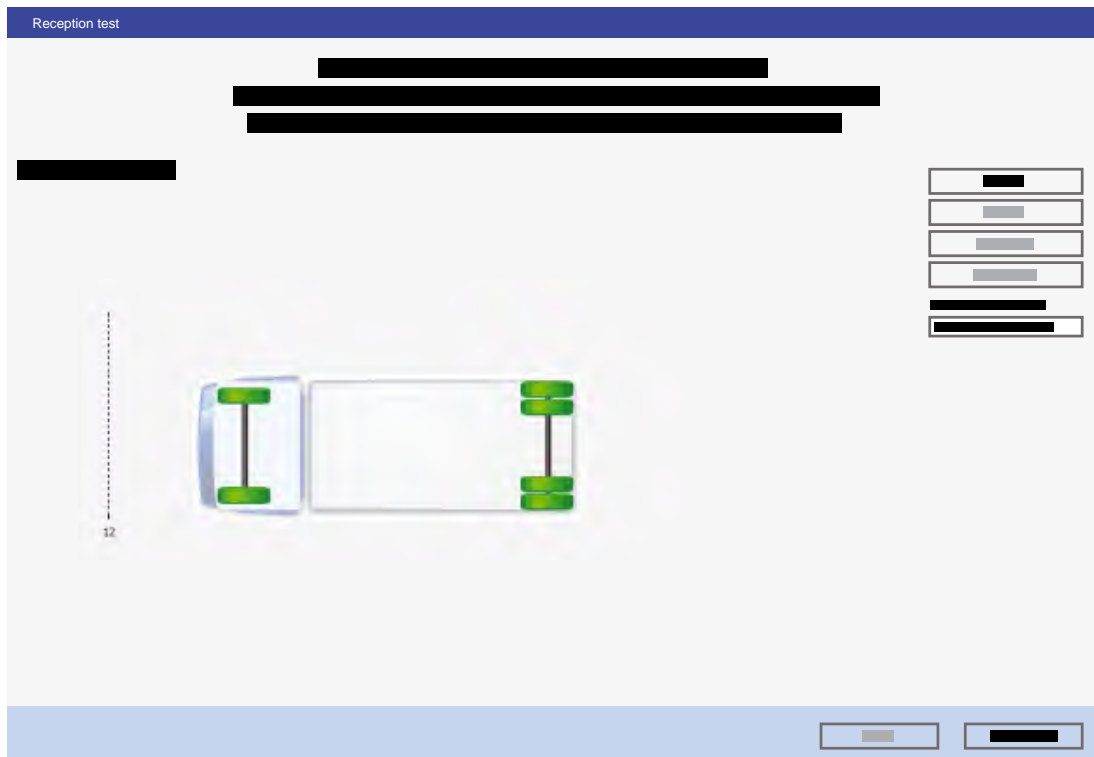


Then the measurement of the first position starts for 3 min:



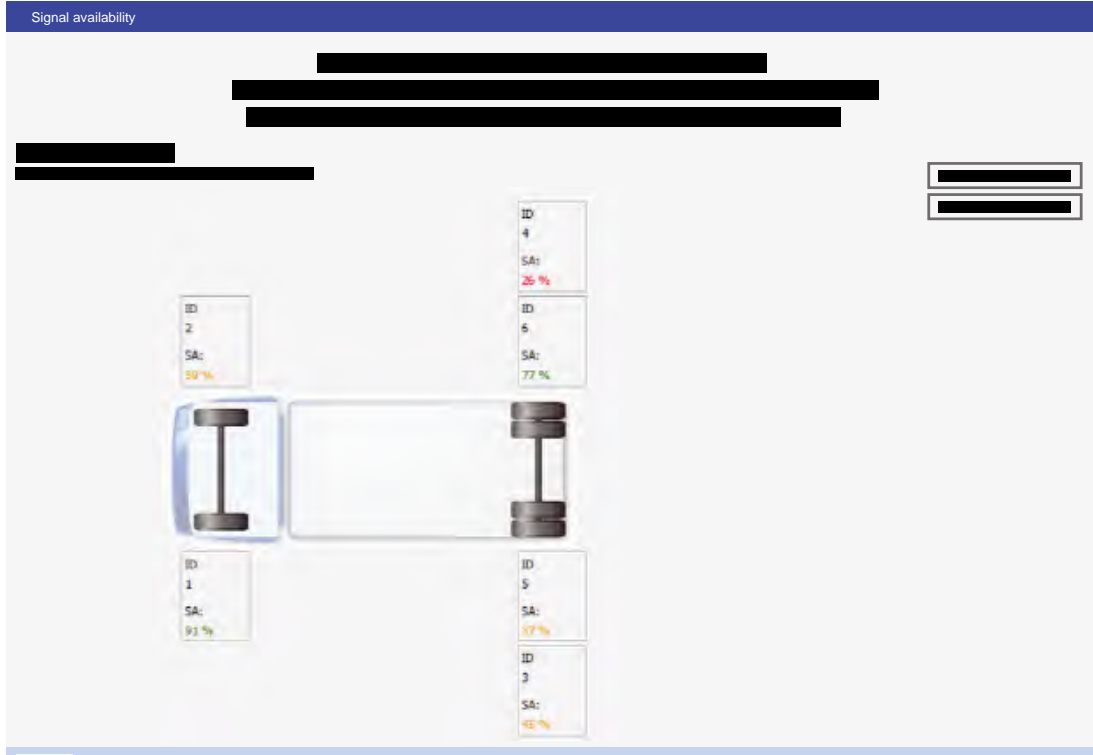
After each measurement phase, the vehicle must be driven on for one twelfth of its wheel circumference. It is advisable to install a bearing aid on the vehicle, e.g. a suspended cord that is oriented to the distance markings made on the ground with chalk.

After the last measurement, the overall result is output and details are displayed in a log.



10.7.2 Driving measurement

The measurement of the moving vehicle takes place automatically for all configured wheel modules. For this purpose, the received messages are made in relation to the operating time. Since the driving condition is not taken into account, it is recommended to reset the data before starting the measurement. A driving test of at least 60 min should then be carried out. Then a good estimate of signal availability can be made for the underlying installation:



- Values above 50 % are very good.
- Values between 33 % and 50 % can occasionally lead to the display of failed wheel modules.
- For values below 33 %, the use of a Range Extender, another sensor or a modified OptiTire ECU position should definitely be considered.

11 Display via SmartBoard



The SmartBoard is a display and operating console that can be used to display the following information relating to the OptiTire system:

- System configuration, such as part number, software version, serial number, production date and vehicle identification number (VIN)*
- Nominal values and actual value pressures
- Tire status (OK/not OK)
- ID of a sensor (if the sensor is activated with a solenoid)**
- ECU data

*VIN is only displayed with 446 192 110 0 and 446 192 111 0.

**The complete VIN is only displayed with 446 192 210 0 and 446 192 211 0.

12 Workshop notes

12.1 Maintenance

OptiTire does not require maintenance.

Only when the display indicates a malfunction, fault finding must be performed with diagnosis

12.2 Replacement and repair

12.2.1 Replacing an IVTM ECU with an OptiTire ECU

In principle, the OptiTire is backwards compatible to the IVTM ECU, but the following differences need to be noted:

- Assembly: If the original IVTM retaining plate and associated 8 mm screws are used, either cap nuts or suitable washers must be used in addition to compensate the 11 mm holes in the OptiTire housing.
- The adapter connector (ZF part number 894 600 001 2) should be used to connect the original IVTM cable.
- A new Diagnostic Software is required because OptiTire is addressed by means of a UDS diagnostic log (IVTM: KWP2000).

12.2.2 Replacing 1st generation external sensor with a 2nd generation sensor

To select the correct 2nd generation external sensors, the rim shape (ET, size) is also important alongside the 1st generation external sensors that are to be replaced. The appropriate 2nd generation external sensor and matching PA tube can then be selected on this basis.

12.2.3 Wheel change



When changing tires, make sure that the sensors are correctly assigned and, if necessary, reset the parameters.

If the fault message cannot be found immediately, each wheel must be checked.

Wheel with external sensor

Due to the external fixation of the sensor on the wheel bolts after wheel change a new sensor is not needed. It is only to be ensured, that after wheel exchange the sensor is fitted exactly to the same position as before.

As long as the external sensor itself is not exchanged, there is no need for new settings of system parameters.



The external sensors are not allowed to be swapped with each other.

Make sure that the external sensor are respectively located in the original position on the vehicle after the wheel change.

Especially with Twin wheels, the accurate relationship to the inner or outer wheel must be observed.

Please perform wheel changes as follows:

1. Remove any dirt from the external sensor and PA tube.
2. Note ID of external sensor (engraved on top of the housing) and its position on the vehicle, e.g. rear axle left, outside.
Alternative: Attach labels with the designation of the mounting location to each external sensor.
3. Loosen the union nut of the PA tube on the tire valve.
4. Pull the PA tube from the valve.
5. First unscrew only those wheel nuts that fasten the external sensor.
6. Remove external sensor completely, together with the PA tube.
Do not turn the PA tube at the external sensor and do not remove the PA tube from external sensor unnecessarily.
Prevent dirt from entering into the PA tube.
7. Check the PA tube for any damage.
8. Replace the PA tube if ageing ruptures or rubbing wear is visible (see chapter 12.2.4 "Replacing PA tubes (external sensor)", page 72).
9. Remove the remaining wheel nuts.
10. Change the wheel or tire.
11. Fit the wheel or wheels again.
12. Fix the wheel or wheels with a few wheel nuts to the wheel bolt to which neither the external sensor nor the weight plate will be mounted.
While assembling the wheel make sure that the tire valve gets its original position.
With Twin tires, the tire valves should be placed in opposite position.
13. Place the respective external sensor to its original position and fix it with wheel nuts.
In the case of single wheels, mount the counterweight plate in the position opposite the external sensor.
14. Screw the union nut of the hose back on to the tire valve.
15. Tighten union nuts manually only.
16. Check that the connection is tight using a leakage indicating spray.
17. Tighten the wheel nuts crosswise according to the vehicle manufacturer's specifications.

Wheel with internal sensor

When changing a wheel with the internal sensor it must be ensured that the new wheel is also equipped with a internal sensor. If this is not the case, the internal sensor must be installed in the new wheel (see chapter "8.3 Assembly of the internal sensor WIS", page 45 or chapter "8.4 Assembly of the internal sensor SMS", page 48).

For start-up, the new ID of this internal sensor must be learned. For this purpose the Diagnostic Software must be opened.

"Module configuration" parameter setting

- Enter the new ID of the respective wheel position directly at the corresponding wheel position or carry out a free assignment under *Module assignment* (see chapter "8.3 Assembly of the internal sensor WIS", page 45 or chapter "8.4 Assembly of the internal sensor SMS", page 48).

12.2.4 Replacing PA tubes (external sensor)

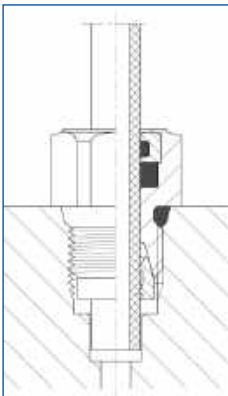


When removing the PA tube from the external sensor, take care that the thread on the external sensor is kept clean.

Proceed as follows when replacing a defective PA tube:

1. Loosen the PA tube from the valve.
2. Unscrew the V203 connection together with the PA tube from the external sensor.
3. Check the thread on the external sensor for damage.
4. With damaged thread, replace the complete external sensor.
5. Screw the new V203 connection into the thread of the external sensor.
A new V203 connection can be obtained using the ZF part number 893 770 005 2.

VOSS SV 203 connection



1. Tighten the V203 connection with a tightening torque of 3 Nm (hand-tight).
2. Remove the protective cap of the V203 connection.
3. Insert the new, cut to length PA tube into the V203 connection.
4. Check if the PA tube has been pushed in until the stop into the V203 connection.
5. Check if the PA tube has a tight connection (approx. 20 N).
6. Connect the PA tube to the valve.
7. Tighten union nuts on the valve hand tight.
8. Check that the connection is tight using a leakage indicating spray.

12.2.5 Creeping pressure loss

If there is evidence of gradual pressure loss:

- First use leak detection spray to check the connection of the indicated wheel between valve and sensor.
- If these connections are tight, check the tire's bearing surface and edges.
So-called indicators at the tire edges point on damages at the carcass, which usually causes creeping pressure loss of the wheel.
- If the casing is damaged, replace the tire.

12.2.6 No signal received from the sensor

Battery life

An internal lithium battery supplies the sensor with power.

For reasons relating to mechanical stress and tightness, the battery is coated within the sensor and cannot be exchanged.

The battery life-time depends on certain factors. Under normal operating conditions the life of the battery will be up to 9 years.

Since significant pressure deviation increases transmission frequency for short-term warning, frequent pressure changes cause a shorter life time.



The replacement required due to a weak battery will be indicated around half a year before the end of its life. A corresponding entry in the diagnostic memory will be seen.

Checklist for sensor

- If the warning "No reception" appears repeatedly, you can use the following checklist to see whether you should replace the sensor.
- Copy in this table line per line the default value to the "Result" column if the description matches.
- Total the standard values in the "Result" column.
You will find more information on your items in the section "Test result" 74.



Ensure while troubleshooting that the vehicle is not in vicinity of high-frequency radiation (chapter "7.1.1 The external sensor (WM2)", page 23).

Checklist

NO.	DESIGNATION	DEFAULT	RESULT
1a	Warning "No reception" is not active but stored in diagnostic memory (fault shown blue in diagnosis).	0	
1b	Warning "No reception" is active (fault shown in red in diagnosis).	2	
2a	Warning "No reception" appears for one sensor.	0	
2b	Warning "No reception" appears for several sensors.	3	
3a	The age of the sensor (according to the engraved production date in format WW/YY) is less than 5 years.	0	
3b	The age of the sensor lies between 5 and 7 years.	4	
3c	The age of the sensor is more than 7 years.	8	
4a	The average outside temperature was around -20 °C while occurrence of the failure	0	
4b	The average outside temperature was around 0 °C while occurrence of the failure	3	
4c	The average outside temperature was around +20 °C while occurrence of the failure	5	

NO.	DESIGNATION	DEFAULT	RESULT
5a	Activation of the external sensor WM2 with bar magnet or the internal sensor WIS or SMS with the ZF TPMS Manager (WIS) is successful.	0	
5b	Activation of the external sensor WM2 with bar magnet or the internal sensors WIS and SMS with the ZF TPMS Manager (WIS) is not successful.	4	
6	In the display the sensor is indicated with a crossed-out battery symbol.	4	
7a	During diagnosis, only one bar is displayed on the sensor in the module reception test, even if the wheel is turned.	10	
7b	During diagnosis, no bar is displayed on the sensor in the module reception test, even if the wheel is turned.	12	
		Total	

Test result

Sum between 0 and 11 points

The battery of the sensor is in order. The loss of the sensor from time to time might be caused by very low temperatures, contamination of sensor/ECU or an unfavourable installation position of the ECU.

Sum between 12 and 15 points

- Monitor the correct reception of the sensor and replace as required.

Sum between 16 and 22 points

Battery of sensor exhausted.

- Replace the sensor with a new one.
- Parameterise ID of the sensor to the ECU via diagnosis.

13 Disposal

- The final and professional decommissioning and disposal of the product must be carried out in accordance with the applicable legal regulations of the user country. In particular, the regulations for the disposal of batteries, equipment and the electrical system must be observed.
- Electrical appliances must be collected separately from household or commercial waste and recycled or disposed of in accordance with regulations.
- If applicable, take the old device to the company's internal disposal department, which will then forward it to specialist companies (specialist disposal companies).
- In principle, it is also possible to return the old device to the manufacturer. For this purpose, contact the manufacturer's customer service. Any special agreements must be observed.
- Electrical and electronic equipment must be collected separately from unsorted municipal waste and recycled or disposed of properly, because harmful substances can cause lasting damage to health and the environment if disposed of improperly.
- Detailed information can be obtained from specialist waste management companies or the responsible authorities.
- The packaging must be disposed of separately. Paper, cardboard and plastics must be recycled.

14 ZF contact

You can find your local ZF contact via the following page:

<https://aftermarket.zf.com/en/aftermarket-portal/services-and-support/partner-finder/>



You can find information on WABCO products here: www.wabco-customercentre.com
For further information please contact your WABCO partner.

ZF Friedrichshafen AG

ZF is a global technology company and supplies systems for passenger cars, commercial vehicles and industrial technology, enabling the next generation of mobility. ZF allows vehicles to see, think and act. In the four technology domains Vehicle Motion Control, Integrated Safety, Automated Driving, and Electric Mobility, ZF offers comprehensive solutions for established vehicle manufacturers and newly emerging transport and mobility service providers. ZF electrifies different kinds of vehicles. With its products, the company contributes to reducing emissions and protecting the climate.

ZF, which acquired WABCO Holdings Inc. on May 29, 2020, now has 162,000 employees worldwide with approximately 260 locations in 41 countries. In 2019, the two then-independent companies achieved sales of €36.5 billion (ZF) and \$3.4 billion (WABCO).

With the integration of WABCO, the leading global supplier of braking control systems and other advanced technologies that improve the safety, efficiency and connectivity of commercial vehicles ZF will create a new level of capability to pioneer the next generation of solutions and services for original equipment manufacturers and fleets globally. WABCO, with almost 12,000 people in 40 locations worldwide, will now operate under the ZF brand as its new Commercial Vehicle Control Systems division.



WABCO