System Description & Installation Manual

iEBS Basic , Standard , Premium
Intelligent Electronic Braking System
Trailers

Table of contents

I Symbols used in this document

⚠ DANGER

The signal word DANGER indicates a dangerous situation that, if not prevented, will lead to a severe injury or death.

⇨ Information as to how the danger can be prevented.

⚠ WARNING

The signal word WARNING indicates a dangerous situation that, if not prevented, can lead to a severe injury or death.

⇨ Information as to how the danger can be prevented.

⚠ CAUTION

The signal word CAUTION indicates a dangerous situation that, if not prevented, can lead to a slight or moderate injury.

⇨ Information as to how the danger can be prevented.

NOTICE

The signal word NOTICE indicates a situation that, if not prevented, can lead to property damage.

⇨ Information as to how the property damage can be prevented.

This symbol indicates information concerning special workflows, methods, application of aids, etc.

Reference to information on the internet

Descriptive text

– Action step

Action step 1 (in ascending order)

Action step 2 (in ascending order)

⇨ Consequence of an action

- Listing

II Information on the document

Document overview

The specifications listed in these documents must be observed, because they are a prerequisite for fault free operation of the product and for the warranty granted by ZF Friedrichshafen AG. Please get in touch with your contact if you need binding documents.

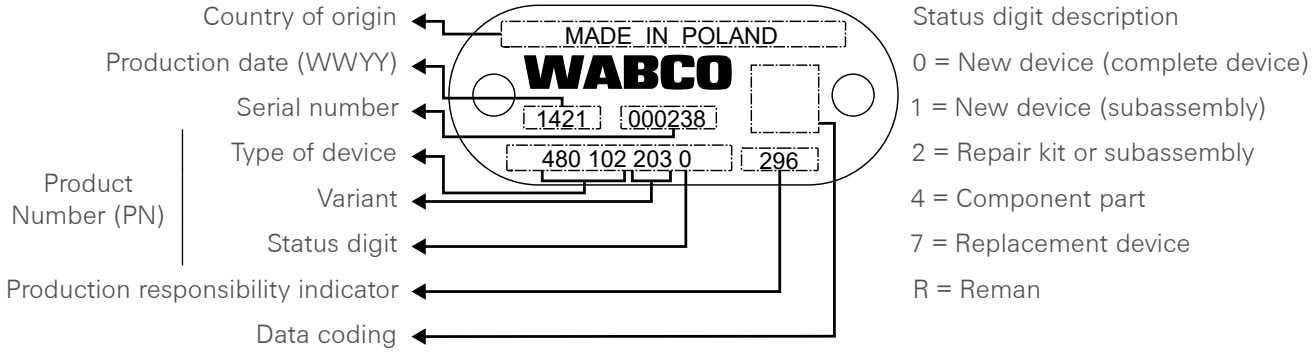
Further to the acquisition of WABCO Group by ZF Group on May 29, 2020, the WABCO brand and trademarks are owned by and proprietary to the ZF Group.

Purpose of this document

This document is intended to be used by trailer manufacturers and workshops.

Structure of the name plate of the device

The name plate contains general information that helps to identify the device and it features. The most relevant information can be obtained from the product number of the device.



Choose genuine ZF parts

Genuine ZF parts (including WABCO branded parts) are made of high-quality materials and are rigorously tested before they leave our factories. You also have the assurance that the quality of every ZF product is supported by a powerful customer service network.

As a leading supplier to the industry, ZF collaborates with the world's leading original equipment manufacturers, and utilizes the experience and capabilities at its disposal to satisfy the most stringent production standards. The quality of every genuine ZF part is supported by:

- Tooling made for serial production
- Regular sub-supplier audits
- Exhaustive end-of-line tests
- Quality standards < 50 PPM

NOTICE

Installing replica parts can cost lives – genuine ZF parts protect your business.

Additional services

The package you will get with a genuine ZF part:

- 24-month product warranty, starting from when the product is manufactured
- Technical support from ZF
- Professional training solutions from the ZF [pro] Academy

– http://proacademy.zf.com/home/

- Access to diagnostics tools and support from the Service Partner network
- Straightforward claims handling

Online product catalogue

– https://www.wabco-customercentre.com/catalog/

The WABCO Customer Centre web page provides you with convenient access to the complete technical documentation. All documents are available in PDF format. Please contact your ZF partner for printed versions. Please note that the publications are not always available in all language versions.

Document title	Document number
CAN Router / CAN Repeater – System Description	815 XX0 176 3
System Diagnostics Software / Hardware – Product Overview and Installation	815 XX0 037 3
Pneumatic Air Brake Equipment for Trailer Vehicles	815 XX0 034 3
OptiTire™ – System Description	815 XX0 229 3
SmartBoard™ – System description	815 XX0 260 3
SmartBoard™ – User Manual	815 XX0 282 3
SCALAR EVO - Trailer Telematics	SCALAR solutions
Couplings Catalogue	815 XX0 080 3

*Language code XX: 01 = English, 02 = German, 03 = French, 04 = Spanish, 05 = Italian, 06 = Dutch, 07 = Swedish, 08 = Russian, 09 = Polish, 10 = Croatian, 11 = Romanian, 12 = Hungarian, 13 = Portuguese (Portugal), 14 = Turkish, 15 = Czech, 16 = Chinese, 17 = Korean, 18 = Japanese, 19 = Hebrew, 20 = Greek, 21 = Arabic, 24 = Danish, 25 = Lithuanian, 26 = Norwegian, 27 = Slovenian, 28 = Finnish, 29 = Estonian, 30 = Latvian, 31 = Bulgarian, 32 = Slovakian, 34 = Portuguese (Brazil), 35 = Macedonian, 36 = Albanian, 97 = German/English 98 = = multilingual, 99 = non-verbal

III Safety information

Observe all required provisions and instructions:

- Read this publication 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 trailer manufacturer's specifications and instructions.
- Observe all accident prevention regulations of the respective company as well as regional and national regulations.

Make provisions for a safe work environment:

- Only trained and qualified technicians are to perform work on the trailer.
- Use personal protective equipment if required (protective goggles, respiratory protection, ear protectors, etc.)
- A sudden relieve of brakes and pedal actuations can lead to severe injuries if persons are in the vicinity of the trailer. Make sure to follow the below instructions.
  - Switch the transmission to "neutral" and apply the park brake.
  - Secure the trailer against rolling by using chocks.
  - Fasten a visible note to the steering wheel indicating that work is being performed on the trailer and that the pedals are not to be actuated.
- The user operating any brake control device installed in the trailer shall be informed that the sudden release of the brakes can lead to a jerky motion of the trailer, and ensure that no persons are in a dangerous distance to the trailer prior to activating the control device.
- The driver is responsible for the checking the state of the vehicle and its components before each drive (e.g., according to 'Unfallverhütungsvorschrift DGUV Vorschrift 70: Fahrzeuge).

Avoid electrostatic charge and uncontrolled discharging (ESD):

Note during construction and building the trailer:

- Prevent potential differences between components (e.g., axles) and the trailer frame (chassis).
  Make sure that the resistance between metallic parts of the components and the trailer frame is less than 10 ohms.
  Establish an electrically conductive connection between moving or insulated trailer parts, such as axles, and the frame.
- Prevent differences in electric potential between the towing vehicle and the trailer.
  Make sure that an electrically conductive connection is made between metal parts in the towing vehicle and the coupled trailer via the coupling (king pin, fifth wheel, claws with pins), even without a cable being connected.
- Use electrically conductive bolted connections when fastening the iEBS modulator to the trailer frame.
- Run the cable inside metallic casing if at all possible (e.g., inside the U-beam) or behind metallic and grounded protective plating, to minimize the influence of electro-magnetic fields.
- Avoid the use of plastic materials if they can cause electrostatic charging.
- For electrostatic painting, connect the ground line of the ISO 7638 plug connection (pin 4) to the paint ground (trailer chassis).

While carrying out repair or welding work on the trailer, observe the following:

- Disconnect the battery (if installed in the trailer).
- Disconnect cable connections to devices and components and protect connectors and ports against contamination.
- When welding, always connect the grounding electrode directly with the metal next to the welding point to prevent magnetic fields and current flow via the cable or components.
- Make sure that current is well conducted by removing paint or rust.
- Prevent heat influences on devices and cabling when welding.

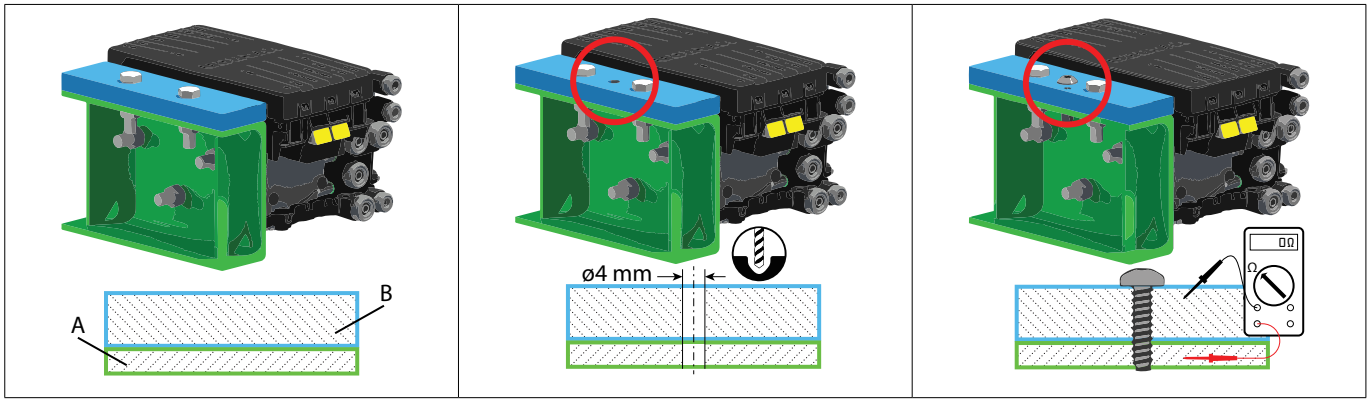
Special note when using prefabricated brackets for installations in the trailer:

Prefabricated brackets (A) are frequently installed in trailers as the result of optimized production processes at the trailer manufacturers. The bracket is then fastened to the trailer frame cross member (B).

The support modules are often painted, so when they are installed in the trailer frames, the electrical conductivity between the frame and support module must be restored.

Ensuring the electrical conductivity between the bracket and the trailer frame:

- Fasten the support module to the trailer frame with electrically conductive screw joints using self-tapping screws with a conducting surface.
- The resistance between the support module and the frame must be < 10 ohms.



The combination of stainless steel and aluminum results in intense corrosion. Direct mounting on stainless steel beams is not permitted

Electromagnetic interference (EMI) and radiofrequency (RF) emissions

The iEBS modulator, available in versions with integrated functions such as OptiTire and without, is fully compliant with FCC regulations.

FCC rules provide a framework for the regulation of unlicensed radio frequency (RF) devices in the United States, aiming to prevent harmful interference with licensed radio services and to ensure operation within established technical standards.

The iEBS has undergone rigorous testing and certification to ensure it does not cause harmful interference and can tolerate any interference received, including that which may cause undesired operation.

According FCC §15.21, changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

IV List of abbreviations

Abbrev.	Meaning
ABS	Anti-Lock Braking System
ADR	(French: Accord européen relatif au transport international des marchandises Dangereuses par Route); European agreement on the transportation of dangerous goods by road
BAT	Battery
BO	(German: Betriebs-Ordnung); Factory regulations; BO force circuit = legally defined turning circuit
BVA	(German: Bremsbelagverschleißanzeige); brake lining wear indicator
CAN	Controller Area Network; asynchronous serial bus system for networking control units in vehicles
EBS	Electronic Braking System, usually including ABS and RSS
ECAS	Electronically Controlled Air Suspension
ECU	Electronic Control Unit
ESD	Electrostatic Discharge
eTASC	Electronic Trailer Air Suspension Control (rotary slide valve with RTR function) and ECAS function
GGVS	(German: Gefahrgut-Verordnung Straße); act governing the road haulage of hazardous goods
GIO	Generic Input/Output
HDSCS	Heavy Duty Sealed Connector Series
iEBS	Intelligent Electronic Braking System
ILS	Integrated Load Switch for lift axle control function
IC	Individual Control of sensed wheels on one side
ISO	International Organization for Standardization
ISS	Integrated Speed Switch
ITP	Intelligent Trailer Program
LACV-IC	Lift Axle Control Valve, Impulse-Controlled
LIN	Local Interconnect Network; specification for a serial communication system, also called LIN bus; sensor interface
LSV	Load Sensing Valve (load regulating function)
MAC	Modified Axle Control; control of two sensed wheels on one axle
MSC	Modified Side Control; control of two sensed wheels on one trailer side
ODR	Operating Data Recorder
OVAS	Overflow Valve Air Suspension
PDM	Pneumatic Distribution Module
PLC	Power Line Communication; data communication via cable for power supply
PN	Part Number
PREV	Park Release Emergency Valve
PRV	Park Release Valve
PUK	Personal Unblocking Key
PWM	Pulse Width Modulation; modulation type where a technical quantity (e.g., electric current) modulates between two values
RSD	Rotary Slide Detection
RSS	Rollover Stability Support

List of abbreviations

Abbrev.	Meaning
RtR	Return-to-Ride (air suspension)
SHV	Select High Valve; valve for governing higher pressure
SLV	Select Low Valve; valve for governing lower pressure
TASC	Trailer Air Suspension Control; rotary slide valve with RtR function
TCV	Trailer Control Valve
TEBS	Trailer EBS, represented by TEBS E and upcoming iEBS
TLI	Trailer Length Indication; actual trailer length
TPMS	Tire Pressure Monitoring System
USB	Universal Serial Bus
UN/ECE	United Nations Economic Commission for Europe
WSS	Wheel Speed Sensor

V Scope of this document

This section provides a brief overview of the structure of this document:

Chapter 1 - Introduction to the iEBS

Description of the iEBS unit, and how it interacts between the Truck-Trailer combination.

Chapter 2 - Typical brake system configurations

In this chapter you can find a list of schemes with the most common trailer configurations per trailer type.

Chapter 3 - Trailer iEBS components

Description of external components that are connected to iEBS and perform independent brake - or suspension control.

Chapter 4 - iEBS modulator features

Description of features and integrated functions related to brake force control functions and other functions that are dedicated for comprehensive data of the trailer status.

Chapter 5 - GIO functions

Generic In/Out (GIO) functions are innovative functions that belong to the Intelligent Trailer Program. Functions such as the control for air suspension and related functions or the dynamic wheelbase control, are explained in this chapter.

Chapter 6 - Installation guide

iEBS modulator installation possibilities on the trailer including cable and piping installation information.

Chapter 7 - Start-up

In addition to trailer commissioning and calibration, this chapter also explains how to configure the parameter setting by using the iEBS diagnostic software.

Chapter 8 - OEM and workshop hints

This chapter contains descriptions on how individual components and cables are to be installed and mounted.

Chapter 9 - ZF contact

Information of regional offices distributed per country.

Chapter 10 - Appendix

The appendix contains diagrams and overviews. A complete summary of all that is needed to know about iEBS.

1 Introduction to the iEBS

1.1 Intelligent Electronic Braking System - iEBS

iEBS is the next generation of electronic braking systems for trailers. It is part of the Intelligent Braking Platform that offers a range of modulators that provide ABS and EBS functionality, along with all the required components. Through standardized cables, this platform simplifies the interchangeability of functions in the production line.

Like former generations, iEBS provides the brake functionality for category O3 and O4 trailers according to the latest UN/ECE regulations.

The system is modular and can be applied to all types of trailers and road trains. The components are designed for harsh environmental requirements and direct assembly to the chassis.

The development was performed according to latest functional safety standards (ISO 26262), implying readiness for future automated driving systems.

The iEBS modulator is available in different variants (i.e., Basic Steel, Basic Air, Standard and Premium) and features:

- Integrated emergency braking and anti-compounding function.
- An integrated overflow valve to supply the air suspension (only applies to air suspension variants)
- A Park Release Valve (PRV) with a single button design that simplifies both the control of the parking brake and the activation of the automatic emergency braking function of an uncoupled trailer.
- A new connector and cable concept with smaller connectors that are easy to install.
- A new diagnostic platform.

The basic brake functionalities of iEBS are:

- Braking via the electronic control line from the towing vehicle (via CAN data bus) resulting in improved response time, shorter braking distance and automatic harmonisation between truck and trailer.
- Load dependent braking by proportionally adjusting the brake pressure according to the trailer load, allowing for best compatibility between truck and trailer.
- Anti-Lock Braking System (ABS) to prevent locking of the wheels and secure trailer stability.
- Rollover Stability Support (RSS) to help prevent rollover of the trailer when driving too fast around corners and to assist the driver in unexpected everyday scenarios.

iEBS is compatible with the Intelligent Trailer Program (ITP). The ITP offers a range of innovative trailer functions that increase operational effectiveness, safety and driver comfort. The Intelligent Trailer Program gives the possibility to add functionalities and customize each trailer to meet specific requirements.

Intelligent Trailer Program

A list of ITP function available for iEBS can be found in chapter "10.7 Intelligent Trailer Program, functions overview", page 222

Additional information	QR code
Intelligent Trailer Program - Landing page Please contact your ZF partner for more information.	
820 010 356 3 - Intelligent Trailer Program - Brochure [EN]	

1.2 iEBS system design

The iEBS system is designed as an electronically controlled braking system with load-dependent braking pressure control, automatic Anti-Lock Braking System (ABS) and Rollover Stability Support (RSS).

iEBS is a Multi-Voltage system that supports input power supply from 8 to 32 V (for further information go to section "Multi-Voltage" on page 112). The peripheral components which are connected to iEBS are 12 V by default.

1.2.1 Scope of application

Vehicles

Category O3 (trailers with a maximum mass exceeding 3,500 kg, but not exceeding 10,000 kg) and O4 (trailers with a maximum mass exceeding 10,000 kg) trailers with one or more axles and that are pursuant to Directive 2007/46/EG, with air suspension, hydraulic suspension, mechanical suspension, disc or drum brakes.

Braking system

Power–assisted braking system with pneumatic or pneumatic-hydraulic transmission system pursuant to regulation UN/ECE R13 or local regulations (EC) No 661/2009.

Single, super single and twin tires

The tire size dimension is essential for the selection of the pole wheel teeth and the accuracy of the wheel speed signal obtained.

Identical tire dimensions must use the same number of pole wheel teeth to ensure a correct wheel speed.

A ratio of tire circumference to number of pole wheel teeth of ≥22 to ≤58 [mm/tooth] is permissible with iEBS.

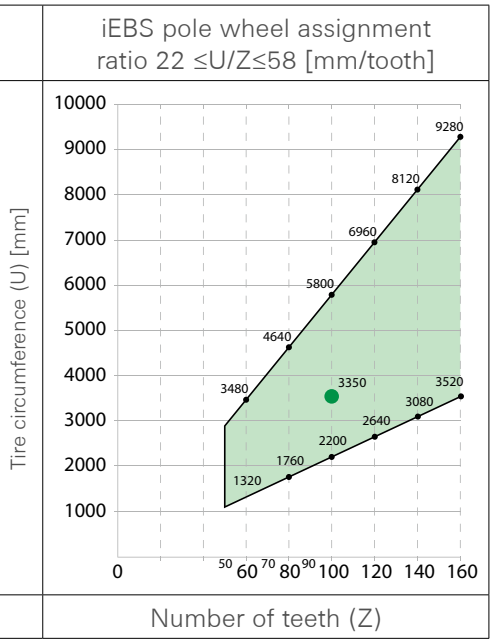
The range for pole wheel teeth is between 50 and 160 teeth.

The dynamic tire circumference corresponds to the distance covered by one full revolution of the wheel.

Example:
The dynamic tire circumference for a 385/65R22.5 tire size is around 3350 mm, therefore a recommended pole wheel with 100 teeth is recommended (green dot in the table).

Increasing the number of teeth in a pole wheel will provide a better accuracy for the wheel speed signal.

For a high tire circumference value, it is recommended to select the highest permissible number for the pole wheel teeth.



1.2.2 Approval reports and standards

Approval reports

Go to www.wabco-customercentre.com/catalog

Search for the iEBS modulator by entering the part number (e.g., 480 102 201 0) in the search box

Select the product from the results to be directed to the details of the device

The approval reports can be found in the documents section

Report (language)	Subject
EB188A	Trailer Anti-Lock Brake System
EB189A	EBS Extension to UN/ECE R13, Series 11, Annex 4 Annex 1, Chapter 3.2.3.1 Electromagnetic Compatibility Annex 2 CAN Repeater / CAN Router
EB190A	Rollover control function pursuant to UN/ECE R13 Series 11

Standards	Subject
ISO/TR 12155 DIN 75031	Commercial vehicles and trailer vehicles – Warning devices for maneuvering – Requirements and tests
DIN EN ISO 228 (Parts 1 - 2)	Pipe threads for connections that are not sealed with the threads
UN/ECE R13	Directive No. 13 of the Economic Commission of the United Nations for Europe – Uniform conditions for the certification of vehicles regarding the installation of the braking system
UN/ECE R 48 (2008)	Directive No. 48 of the Economic Commission of the United Nations for Europe – Uniform conditions for the certification of vehicles regarding the installation of lighting or light signaling equipment
ISO 1185	Road vehicles – Plug-in connections for electrically connecting towing vehicles and trailer vehicles – 7-pin plug-in connection Type 24 N (normal) for vehicles with 24 V nominal voltage
ISO 4141 (Parts 1 - 4)	Road vehicles – Multi-wire connecting lines
ISO 7638 (Parts 1 - 2)	Road vehicles – Plug-in connectors for the electrical connection of towing vehicles and trailer vehicles – Part 1: Plug-in connectors for braking systems and braking equipment of vehicles with 24 V / 12 V nominal voltage
ISO 11898 (Parts 1 - 5)	Road vehicles – CAN
ISO 11992 (Parts 1 - 2)	Road vehicles – Exchange of digital information via electrical connections between towing vehicles and trailer vehicles
ISO 12098	Road vehicles – Plug connections for electrically connecting towing vehicles and trailer vehicles – 15-pin plug connection for vehicles with 24 V nominal voltage
Regulation 141	Tyre pressure monitoring system regulation
Regulation 155	Cyber security and cyber security management system
Regulation 156	Software update and software update management system

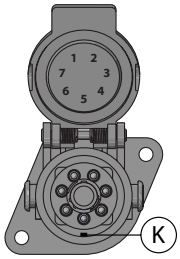
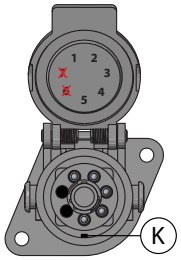
1.3 Truck-trailer interface

1.3.1 Electrical connections

ISO 7638

The ISO 7638 is an electrical interface standard between the truck and the trailer that comes in two different variants, 7 pin ISO 7638 or 5 pin ISO 7638.

To determine if the truck is equipped with the 7 pin ISO 7638 connection, simply look at the connector and verify if all 7 pins are assembled. If pins 6 and 7 are missing, the trailer will operate under pneumatic control mode only (reduced brake performance compared to electrical control mode).

7 pin ISO 7638		5 pin ISO 7638	
Dedicated power supply interface that incorporates the CAN communication protocol (pin 6 & 7) for EBS function (according to ISO 11992).		This cable connector does NOT support CAN communication (according to ISO 11992).	

Both versions are available in 12 V and 24 V, different key way at the connectors will prevent mismatching between the 12 V connector (key indicator "K" between pin 3 and 4) and the 24 V connector (key indicator "K" under pin 5).

ISO 12098

The ISO 12098 is an electrical interface standard between the truck and the trailer used to power supply the trailer's light system. It replaces the elder standards ISO 1185 (24N) and ISO 3731 (24S).

The connection to the integral stop light supply can be used as backup to power the iEBS. For further information refer to chapter "1.3.3.1 Stop light power supply function", page 22

NOTICE

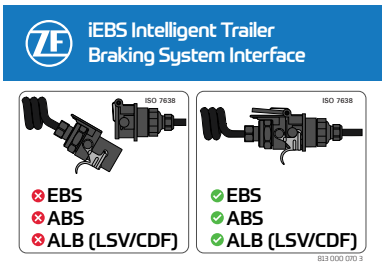
All pneumatic lines and electrical cables must be securely connected before moving a truck and trailer combination.

Importance of connecting the electric lines

A defective or uncoupled ISO 7638 connector will affect the braking operation of the trailer iEBS (modulator will only work pneumatically to control the service brake).

Safety functions such as the Anti-Lock Brake System (ABS), load regulating function (LSV), Rollover Stability Support (RSS) and CAN communication between the truck and trailer will not be available.

Sticker part number 813 000 070 3



Signals that help to identify whether the ISO 7638 connector is correctly powered

The ABS warning lamp illuminates upon starting the engine (key ON). Internal iEBS solenoids activation in intervals ON and OFF (click-click sound). Audible air exhaust sound after the service brakes are applied.

Troubleshooting: Make sure that the cable is not defective and provides power supply.

For cables with an integrated fuse (i.e. 449 174 . . . 0), verify that the fuse has not blown, otherwise replace the fuse if applicable. Further information in section "iEBS cable list" on page 218.

1.3.2 Pneumatic supply and control lines

The pneumatic Truck/Trailer interface consists of two pneumatic lines for supply and control according to ISO 1728.

- The supply line (red coupling) delivers the system pressure from the truck to the trailer and keeps permanently charging the trailer to the maximum pressure system level (standstill or driving).
- The control line (yellow coupling) delivers service brake pressure to the trailer in accordance with the truck's brake control demand pressure.

Connecting/disconnecting pneumatic lines sequence

The pneumatic lines must be connected in the following sequence

Coupling the trailer:

- First couple the control line (yellow coupling)
- Thereafter couple the supply line (red coupling)

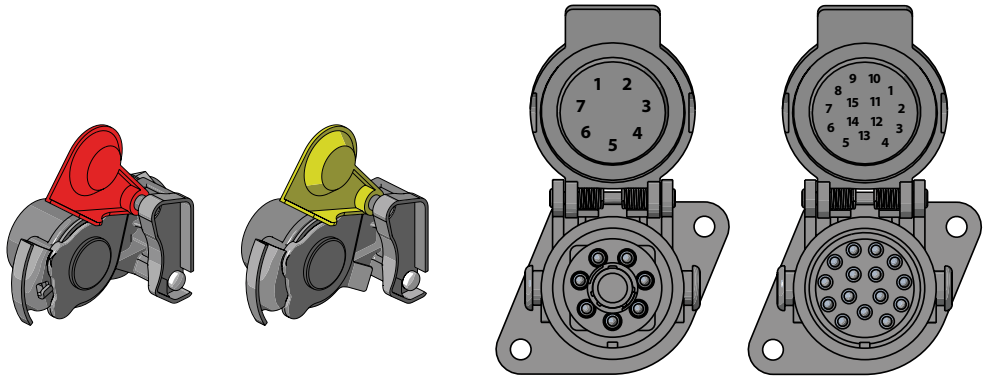
Uncoupling the trailer:

- First disconnect the supply line (red coupling)
- Thereafter disconnect the control line (yellow coupling)

⚠ WARNING

Coupling or uncoupling in a wrong sequence might result in a rolling trailer and fatal accidents.

Standard pneumatic lines and electrical connections



Item	Designation
1	Supply coupling / line
2	Control coupling / line
3	Power supply via ISO 7638 for braking systems – ABS/EBS
4	Power supply via ISO 12098 for trailer light system

Trailer automatically brakes if the supply line is disconnected

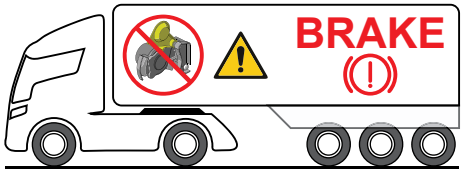
The dual line brake circuit is designed in such way, that in the event the supply line (red coupling) encounters a strong leakage - or disconnect, the trailer spring brake will be automatically applied before the supply line will drops below 2 bar. The emergency brake function is done via spring brake actuation and not via the service brake as with previous TEBS generations. This emergency function is induced in the iEBS via the Pneumatic Distribution Module (PDM). In stationary condition, the spring brake (emergency brake) will remain active.

Whilst the trailer is in driving condition, the emergency brake is controlled by the Emergency Mode Regulation (EMR). The patented EMR will keep the trailer spring brakes activated till the locking of the wheels is sensed by iEBS, subsequently, the EMR will switch from spring brakes to a full service brake application, triggering the Anti-Lock Brake System (ABS) control. At speeds below 15km/h, the ABS control will stop working and the EMR will exhaust the service and the spring brake simultaneously, producing a full spring brake application that will eventually stop the trailer. The emergency brake can only be released if the supply line (red coupling) pressure is above 4 bar.

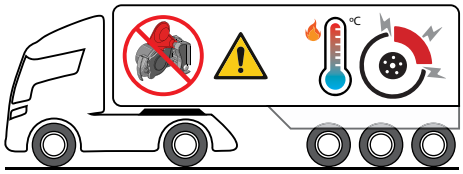
Truck brakes the trailer by monitoring leakages in the control line

In an event where the control line (yellow coupling) encounters a strong leakage - or disconnects; during a service brake application (truck's brake control demand), the Trailer Control Valve (TCV) in the truck will automatically induce a full service brake application on the trailer. This is achieved by reducing the air flow to the leakage in the control line, and simultaneously venting the supply line (red coupling) via the TCV. The trailer emergency brake function will then brake the trailer during the applied service brake.

Importance of connecting the control pressure line

By not connecting the control line (yellow coupling) between the truck and trailer, the trailer will brake solely via the CAN line (ISO 11992 connected), but the pneumatic redundancy function will not be available. The trailer iEBS modulator will recognize the missing control pressure input and will turn on the warning light. Pneumatic connections should be checked and properly coupled, any leakage should be repaired / faulty parts to be replaced.	

Importance of connecting the supply pressure

By not connecting the supply line (red coupling) between the truck and trailer, the trailer brakes will continuously be engaged. Any attempt to start driving will cause severe damage to the tires as the brakes are locked.	

Releasing the spring brakes

Trailer stationary and disconnected from the truck: If there is sufficient air pressure level in the trailer air brake reservoir, then the trailer spring brakes can be released by pushing the red knob of the PRV inwards (black indicator pin standing out).

Trailer coupled to the truck: the trailer spring brakes can be released by pushing the red knob inwards (black indicator alignined with the red knob).

For further information regarding parking and releasing the spring brakes go to section "Park Release Valve (PRV)" on page 49 or to the section "Park Release Emergency Valve (PREV)" on page 51

⚠ CAUTION

Always safely secure the trailer before releasing any brake system.

1.3.3 Additional power supply

1.3.3.1 Stop light power supply function

The iEBS can be optionally supplied with power from the stop light through the IN/OUT port as a back-up power function. According to UN/ECE R13, having power supply solely from stop light is not allowed.

⚠ CAUTION

Stop light function will supply the iEBS modulator with electrical power by means of ISO 12098 during the time the brakes in the truck are applied.

RSS is a self-initiated function that requires permanent power, therefore RSS is not available when the iEBS modulator is powered via stop light.

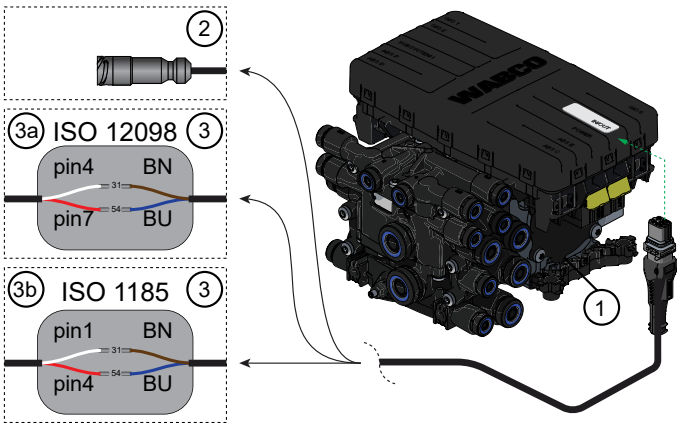
Limited functions available when supplied with only stop light power:

- Limited ABS functionality, delayed control characteristics
- Limited Load Depending Brake Performance, delayed control characteristics
- Limited ISS functionality for actuating a rotary slide valve with RtR function (TASC), this may only work during braking, potential damage to suspension and trailer is possible during the time the brakes are not applied.
- Limited OptiLevel function: When driving, the chasis height is adjusted automatically to the driving level with each brake application. Several braking applications may be required to attain that height.

NOTICE

Driving without connection via ISO 7638 is monitored as a fault and is stored in the iEBS modulator's ODR

Connecting the components



Item	Part number	Description	Comment
1	480 102 . . . 0	iEBS modulator (Basic)	
2	449 361 . . . 0	IN/OUT cable bayonet	Cable required for stop light function with bayonet connector Cable lengths in chapter "10.6 Cable overview", page 217
3	449 321 . . . 0	IN/OUT cable open end	Cable required for stop light function [BN = Brown / BU = Blue] Cable lengths in chapter "10.6 Cable overview", page 217
3a	Not supplied	ISO 12098 cable box	Ground (pin 4) and stop light (pin 7) are connected to IN/OUT Cable.
3b	Not supplied	ISO 1185 cable box	Ground (pin 1) and stop light (pin 4) are connected to IN/OUT Cable.

The stop light function can be activated/deactivated in the system diagnostics under the following path: Parameter Module > (6) Common functions tab > Stop Light function (check/uncheck)

1.3.4 System monitoring

1.3.4.1 Warnings and system messages

If the yellow or the red warning signal on the instrument panel lights up or is flashing, a warning / system message will be indicated.

- Yellow warning signal: Controlled by pin 5 of the ISO 7638 connector also via the CAN bus
- Red warning signal: Controlled via the CAN bus of the ISO 7638 connector.

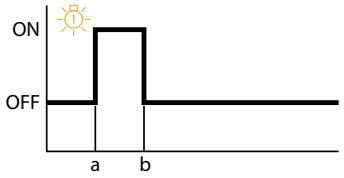
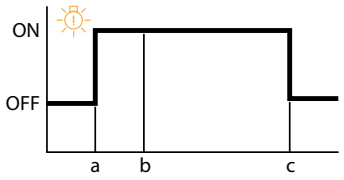
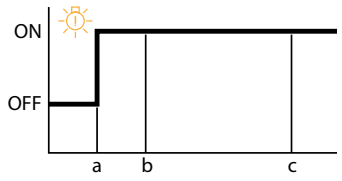
Any events that occur during operation are stored in the iEBS ECU and can be displayed by using the genuine iEBS diagnostic software.

⚠ CAUTION

The warning signal must be monitored by the driver. If the warning lamps are illuminated, a visit to the workshop is necessary. The instructions on the display must be observed if applicable.

Light signal messages

Pursuant to UN/ECE R13, two reactions are permitted when switching ON the ignition and can be configured using the iEBS diagnostic software.

No fault detected situation - Option 1 The ABS warning lamp in the towing vehicle lights up after the ignition is switched on. If no faults are detected at that moment, the warning lamp turns OFF after approx. 2 seconds. Trailer iEBS is operational.	
No fault detected situation - Option 2 If a wheel speed sensor fault was detected during the last drive, the warning lamp turns OFF at speeds v > 7 km/h, (assuming the sensor signal is available).	
Error detected situation If a fault is detected, e.g., such as a sensor error, the warning lamp stays ON.	
If the warning lamp does not turn OFF, even after start driving, the vehicle is unsafe and not fit for going into operation, the driver must seek technical support at the nearest dealership or workshop.	

Legend					
a	Ignition ON	b	2 seconds after ignition ON	c	Trailer speed above 7 km/h

Warning signal sequences for power supply via ISO 12098

ISO 12098 does not support any warning light related to the status of the iEBS. If the ISO 7638 interface connection is lost, a warning cannot be sent.

Warning signal with ignition key ON & without motion detection

The iEBS will switch ON the warning lamp 30 minutes after the ignition key has been turned ON if no wheel speed signals are detected (the time threshold can be configured by the system diagnostics).

Warning signal sequences in the event of unspecified faults pursuant to UN/ECE R 13

Following the switching ON procedure and the warning lamp test, the warning light will flash in the event of non-specified faults pursuant to UN/ECE regulations.

The warning lamp no longer lights up when the vehicle speed exceeds 10 km/h.

The following conditions can cause the warning lamp to flash:

- Immobilizer activated
- Electronic parking brake activated
- Service interval reached (e.g., Brake Line Wear Indicator close to life end)
- Brake lining worn
- Current class 3 faults (e.g., ECAS faults)
- Tire pressure loss (OptiTire/TPMS)

1.3.4.2 Function test when switching ignition ON or coupling

Two seconds after the truck's ignition key is switched is ON, the 7 or 5 pin ISO 7638 connection is established between the truck and the trailer. The iEBS modulator is powered and an automated system check is performed that will briefly activate internal solenoids in intervals (click-click sound).

When service brakes are applied simultaneously, brief exhaust intervals are audible.

⚠ CAUTION

The solenoids activation check MUST be audible after every ignition key ON, otherwise there might be a problem in the power supply between the towing vehicle and the iEBS system or in the iEBS modulator itself.

Consequence: The iEBS modulator is not power supplied. The ABS warning lamp may not illuminate in the truck's dashboard.

⇨ Remedy: Drive with the utmost care to the nearest workshop. Under these conditions the system is only supplied with the pneumatic back up (ABS, RSS and load sensing are not available)

⇨ Troubleshooting: Make sure that the cable is not defective and provides power supply. Verify that the fuse is not blown, otherwise replace the fuse.

1.4 Braking operation modes

Trailers fitted with the iEBS brake system are compatible with both, a conventional ABS or EBS-equipped towing vehicle. Three braking operation modes are available:

- Electrical control: Operation behind towing vehicles with EBS
- Pneumatic control: Operation behind towing vehicles with ABS
- Redundancy control: Back-up operation

1.4.1 Electrical control

For EBS towing vehicles with a 7-pin ISO 7638 interface. All EBS functions are available.

Upon receiving the electrical brake control signal from the truck, iEBS will generate the required braking pressure to the trailer service brake actuators according to the load condition.

The electrical control signal always has priority over the pneumatic control line pressure value. This is to cater for a fast brake response time in the trailer. During electrical braking operation the Truck/Trailer harmonisation is performed automatically.

NOTICE

During the brake application, the behavior between truck & trailer may feel like 'pulling' or 'pushing' tendency towards the truck. This phenomenon might be an indication that leads to lost power supply between the truck and trailer.

Remember to check the warning lamp and if necessary, drive with the utmost care to the nearest workshop.

1.4.2 Pneumatic control

For ABS towing vehicles with a 5-pin ISO 7638, the EBS functionality in the trailer is guaranteed but comes with delayed response time due to the missing electrical control line (missing lines 6 and 7 from ISO 11992).

In this case, the Truck/Trailer harmonisation is not automatic and must be set either manually on the trailer control valve from the truck or via the parameter setting on the trailer EBS (PIN authorization required in the diagnostic software).

The driver's request is provided by the yellow control line (p_m). The brake pressure reference value is obtained from the integrated iEBS pressure sensor (port 4). An external pressure sensor, installed close to the yellow coupling (p_m), will improve the braking response time. This is recommended for exceptionally long trailers to eliminate the response time delay caused by long lines.

Compared to the electrical control mode, iEBS will generate the required brake performance with a certain delay due to the fact of slower air travel speed to the pressure sensor. Only thereafter the pressure signal will be converted into an electrical signal that will trigger the full EBS control with all related functionality for ABS, LSV, RSS.

1.4.3 Redundancy

Back-up function in the event the iEBS is not electrically powered. EBS functions are not available.

If the electrical power supply via ISO 7638 fails, the service braking is solely pneumatically controlled, and the load dependent brake force control, ABS and RSS are not available.

It is recommended to install a complementary stop light power supply. In this case ABS and the load-dependent brake force control are active with reduced performance.

⚠ CAUTION

Driving a trailer with only redundancy brake control operational could be hazardous. Redundancy systems are designed as an emergency backup, and not for regular operation.

Always refer to local regulations and the manufacturer's guidelines to ensure compliance and safety.

Braking modes summary

Braking modes	Interface	Functions
Electrical control	ISO 7638; ISO 11992 (7 pin)	All EBS functions
Pneumatic control	ISO 7638 (5 pin)	Limited EBS functions
Redundancy	Electrical interface lost	NO EBS functions
Stop light operation (optional)	ISO 12098	Delayed ABS function

2 Typical brake system configurations

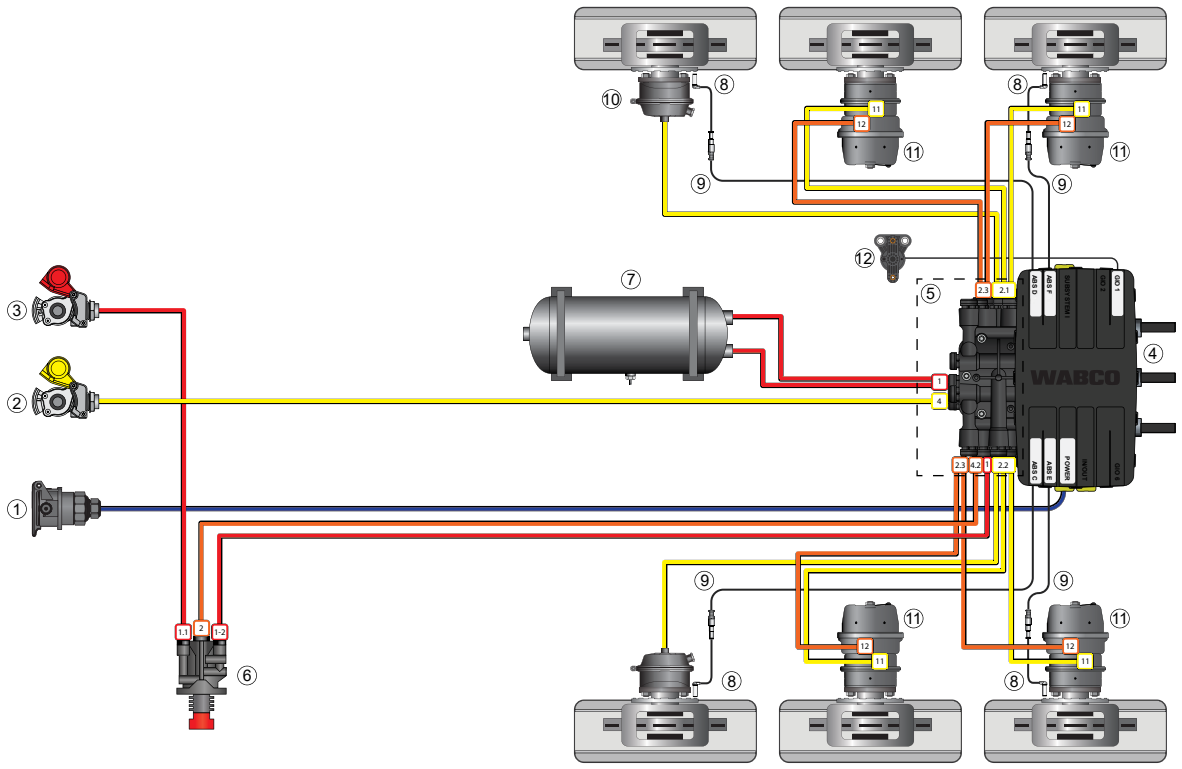
This chapter provides an overview of pneumatic brake & suspension diagrams per trailer type, including the reference bill of material.

System configuration overview

2.1 System configuration per trailer type

2.1.1 3 axle semitrailer with iEBS Basic Steel

Semitrailer with ABS 4S/2M configuration



Item	Designation	Item	Designation
1	Power supply via ISO 7638	7	Service brake system reservoir
2	Control line	8	Wheel speed sensor ABS
3	Supply line	9	Wheel speed sensor extension cable
4	iEBS modulator	10	Service brake cylinder
5	Pneumatic Distribution Module (PDM)	11	Spring brake actuators (e.g. TriStop D)
6	Park Release valve (PRV)	12	Height sensor
The lines represent the cabling and piping to the components.			

Legend

Supply		Control / Service brake		Electric signals	
Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)	

Basic ITP functions for semitrailers

ABS	Anti-Lock Braking Function (ABS)		Rollover Stability Support (RSS)		Operating Data Recorder (ODR)	10 000	ServiceMind

Braking system

The trailer is coupled to the towing vehicle via

- Yellow hose coupling for pneumatic control pressure (2)
- Red hose coupling for pneumatic supply pressure (3)
- 7 Pin connector ISO 7638 for electrical power supply and the transmission for the electrical control line via CAN as per ISO 11992 (1)
- 15 Pin (ISO 12098) connector for trailer light control (not shown in the scheme)

The Park Release Valve (PRV, 6) will conduct the supply pressure to the iEBS modulator (4). The PRV is designed with a red actuating button that can actuate the parking brake or release the emergency brake - that is automatically actuated in case the trailer is uncoupled (supply line disconnected).

The compressed air flows from the coupling supply through the integrated check valve of the PRV to the Pneumatic Distribution Module (PDM, 5) of the iEBS modulator.

The PDM includes the following functions:

- An emergency function to provide the automatic braking
- An anti-compounding valve to protect the wheel brakes from overloading forces – for cases where the service and parking brakes are simultaneously actuated
- A charging valve to protect the air braking system from the air suspension (not applicable for iEBS Steel variants)
- Pressure manifold with integrated fittings

The iEBS modulator controls the service brake and the spring brake. The minimum required number of wheel speed sensors (8) shall be 2 sensors per axle (main axle sensors C and D), however, for steel suspended trailers it is recommended to use 4 wheel speed sensors. This will provide better ABS control performance that will extend tire life.

An optional height sensor can be mounted for load sensing function, depending on the needs of the vehicle combination (for trucks with load sensing function).

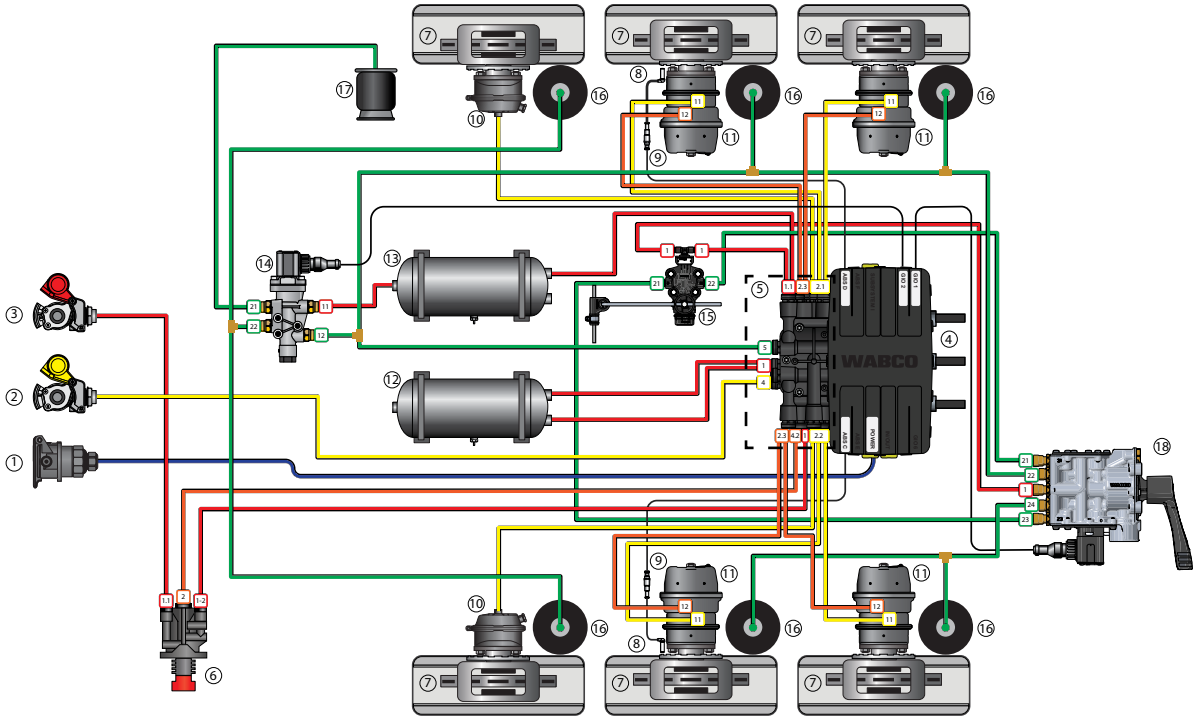
A test connector for the brake pressure is also provided at the PDM. Via the PDM the service brake system reservoir (7) will be charged with the supply pressure from the PRV. The same line is used to supply the iEBS modulator with supply pressure from the reservoir.

Further information regarding the Park Release Valve can be found in the chapter "3.1.1.1 Park Release Valve (PRV)", page 49

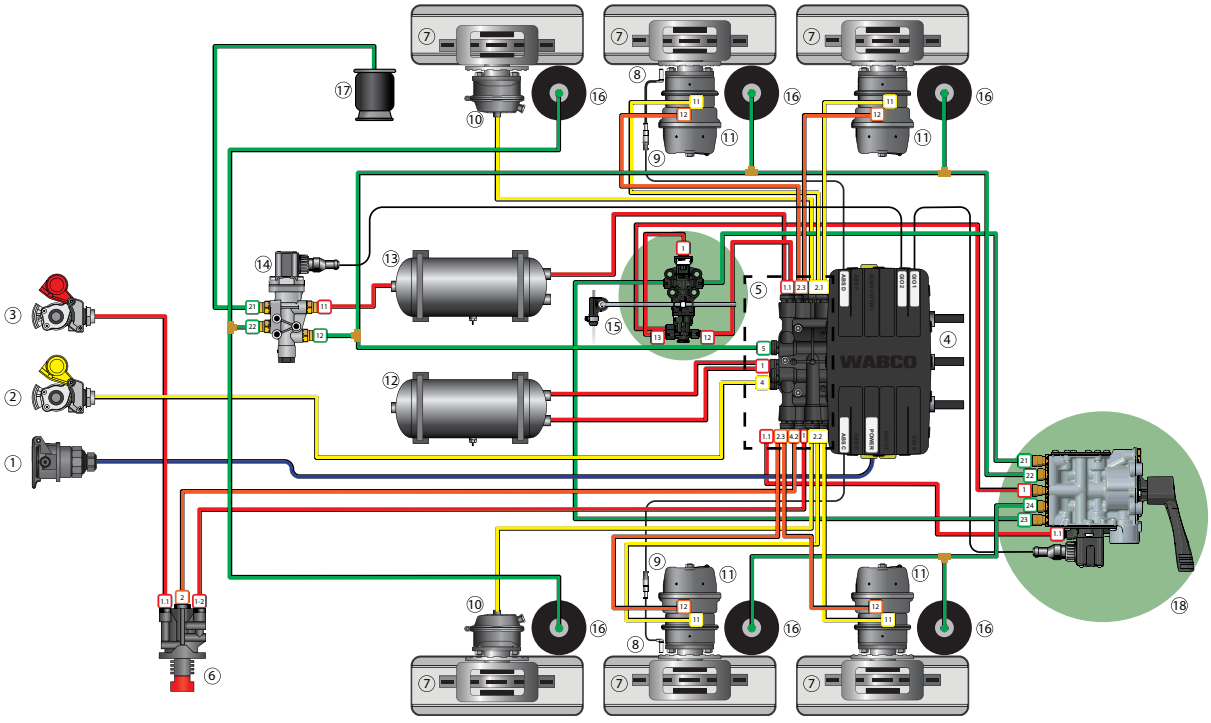
2.1.2 Braking system with conventional air suspension

With the introduction of the new iEBS braking system, the piping and cabling for the trailer braking and air suspension system have been considerably simplified.

Semitrailer braking system with conventional air suspension



Semitrailer braking system with conventional air suspension and height limitation



Legend					
Supply		Control / Service brake		Electric signals	
Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)	

Item	Designation	Item	Designation
1	Power supply via ISO 7638	10	Service brake cylinder
2	Control line	11	Spring brake actuators (e.g. TriStop D)
3	Supply line	12	Service brake system reservoir
4	iEBS modulator	13	Reservoir for the air suspension
5	Pneumatic Distribution Module (PDM)	14	Lifting axle valve (LACV)
6	Park Release Valve (PRV)	15	Levelling valve
7	Wheel end brakes (disc brakes or drum brakes)	16	Axle load bellow
8	Wheel speed sensor (ABS)	17	Lifting axle bellow
9	Wheel speed sensor extension cable	18	Trailer Air Suspension Control (e.g., TASC)
The lines represent the cabling and piping to the components.			

Basic ITP functions for semitrailers							
	Anti-Lock Braking Function (ABS)		Rollover Stability Support (RSS)		Return-to-Ride (RtR)		Traction Help
	Operating Data Recorder (ODR)		ServiceMind		Lift Axle Control		

Braking system

The braking system for a trailer equipped with conventional air suspension works the same as for a mechanical suspension. For further information about braking system operation please refer to section "Braking system" on page 29

Conventional air suspension system

The air suspension system is independent from the braking system.

The reservoir for the air suspension system (13) is charged via the integrated charging valve (OVAS) located in the PDM. The Overflow Protection Valve ensures functional brake performance during a potential pressure drop in the air suspension system. The air suspension system will be charged at pressure level > 6 bar. The primary pressure is maintained in the ‘Brake’ reservoir.

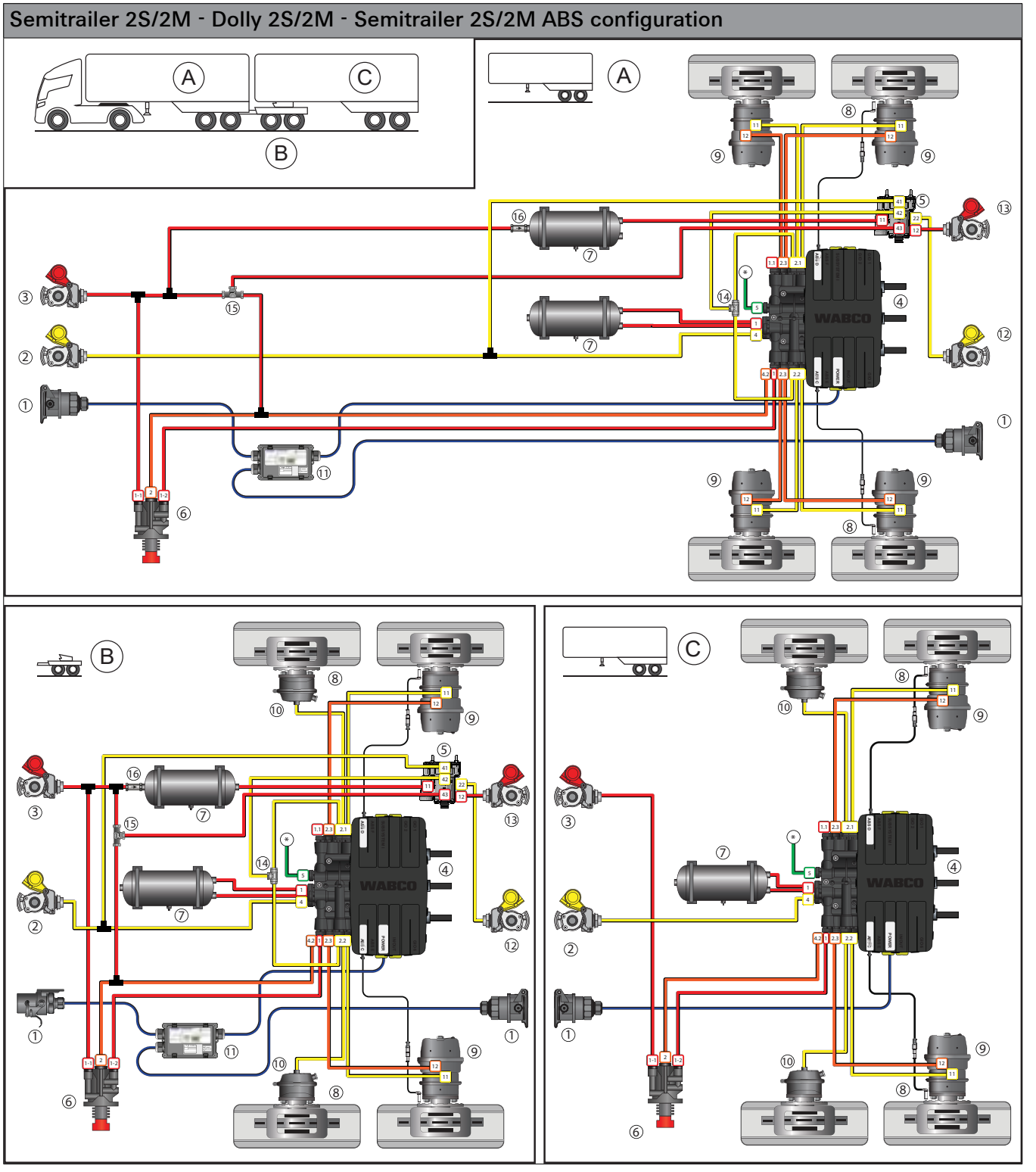
The main control devices of the air suspension are the levelling valve (15) and the raise lower valve TASC (18). Both valves are connected to the air suspension reservoir and to the pressure supply of the PDM (OVAS). The levelling valve will adjust the ride height (driving level) of the trailer chassis by correcting the air volume in the load bellows (16). During stationary conditions, the TASC can be operated by turning the lever in order to change the height of the trailer chassis, useful to adjust the chassis height at the loading dock. In order to prevents potential damage to the air spring bellows when manually raising the trailer chassis beyond the top limit, the height limitation feature for the air control system is available (only for TASC and levelling valves that comes with this option).

In addition, an optional lift axle control valve (14), which is load dependent, can be controlled by iEBS. The LACV will exhaust pressure from the load bellows and will inflate the lift bellows during times of lifting, and vice versa during times when the axle is lowered.

The lifting axle valve is likewise supplied with supply from the suspension reservoir and will independently supply & exhaust (control) the lifting axle bellows (17).

2.1.3 Road train

Semitrailer 2S/2M - Dolly 2S/2M - Semitrailer 2S/2M ABS configuration



Basic ITP functions for road trains

ABS	Anti-Lock Braking Function (ABS)		Rollover Stability Support (RSS)		Operating Data Recorder (ODR)	10 000	ServiceMind
	Router Function						

Item	Designation	Lead semitrailer (A)	Dolly (B)	Semitrailer (C)
1	Power supply via ISO 7638	✓	✓	✓
2	Control line	✓	✓	✓
3	Supply line	✓	✓	✓
4	iEBS modulator	✓	✓	✓
5	Trailer Control Valve (TCV)	✓	✓	-
6	Park Release Valve (PRV)	✓	✓	✓
7	Service brake system reservoir	✓	✓	✓
8	Wheel speed sensor ABS	✓	✓	✓
9	Spring brake actuators (e.g. TriStop D)	✓	✓	✓
10	Service brake cylinder	-	✓	✓
11	Router; with optional demand pressure sensor	✓	✓	-
12	Automatic control coupling	✓	✓	-
13	Automatic supply coupling	✓	✓	-
14	Select high valve	✓	✓	-
15	Double cut-off valve	✓	✓	-
16	Check valve	✓	✓	-
*	Connection to air suspension (i.e, load bellows), bellow pressure not shown in the diagrams.			
The lines represent the cabling and piping to the components.				

Legend					
	Supply		Control / Service brake		Electric signals
	Parking brakes		Air suspension lines		Power supply (ISO 7638)+CAN lines (ISO 11992)

Road train braking system

The best performance for a road train combination is achieved from a truck with EBS and CAN communication to the trailer interface (ISO 7638 with 7 pin). This will ensure all trailers run with RSS functionality and quick brake reaction response. The lead trailers are equipped with a router to share the incoming brake commands from the truck individually with the trailer's iEBS, and further to the following trailer(s).

The moment when the driver hits the brake pedal, a CAN signal is shared with all trailers, demanding a deceleration according to the driver's force on the pedal. iEBS is immediately performing this command this way, ensuring minimal time delay between the application of the truck brakes and the trailer brakes. This enormously reduces the stopping distance whilst increasing the vehicle stability when compared with a conventional road train.

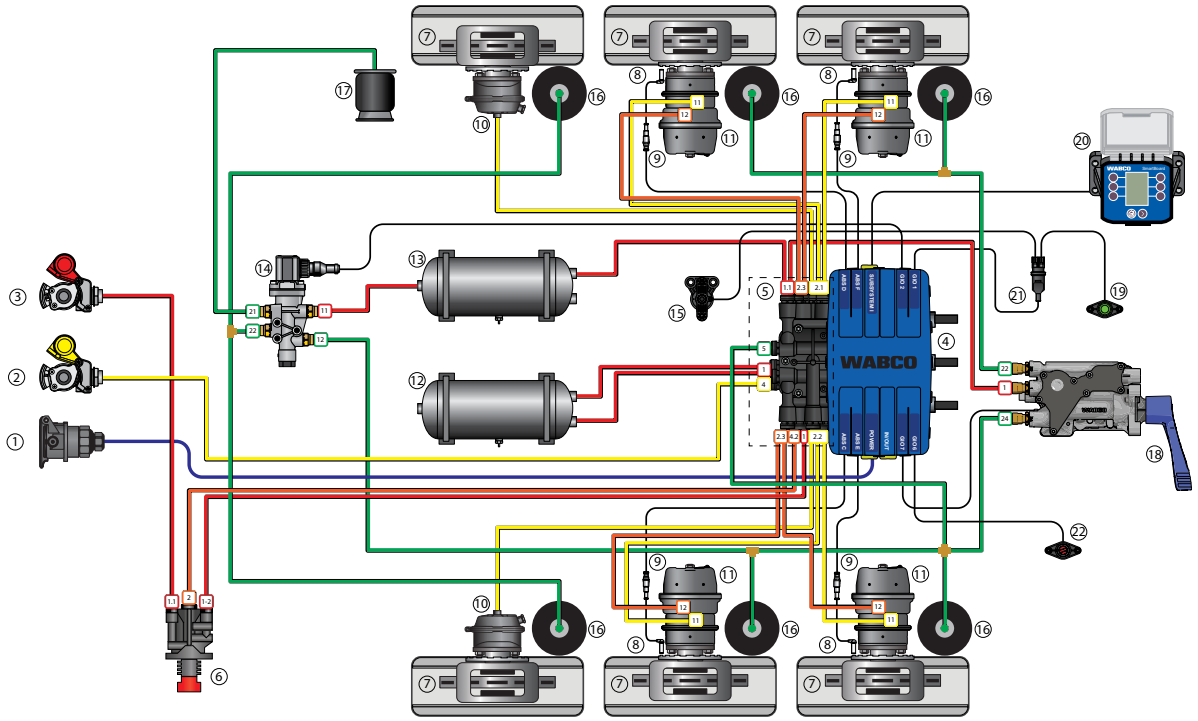
Conventional trailers - with or without - ABS are only controlled by pneumatic pressure at the yellow coupling head. This pneumatic brake control is then forwarded like in a chain reaction from one trailer to the next trailer, each trailer is delaying the brake control through the hysteresis of the pneumatic operating principle.

Every lead trailer (A-trailer) or dolly (B trailer) shall be equipped with a Trailer Control Valve (TCV) to satisfy the requirements as outlined in UN/ECE R13. During a service brake application, the TCV will individually control the next connected trailer allowing the air to flow from lead trailer to the towed trailer.

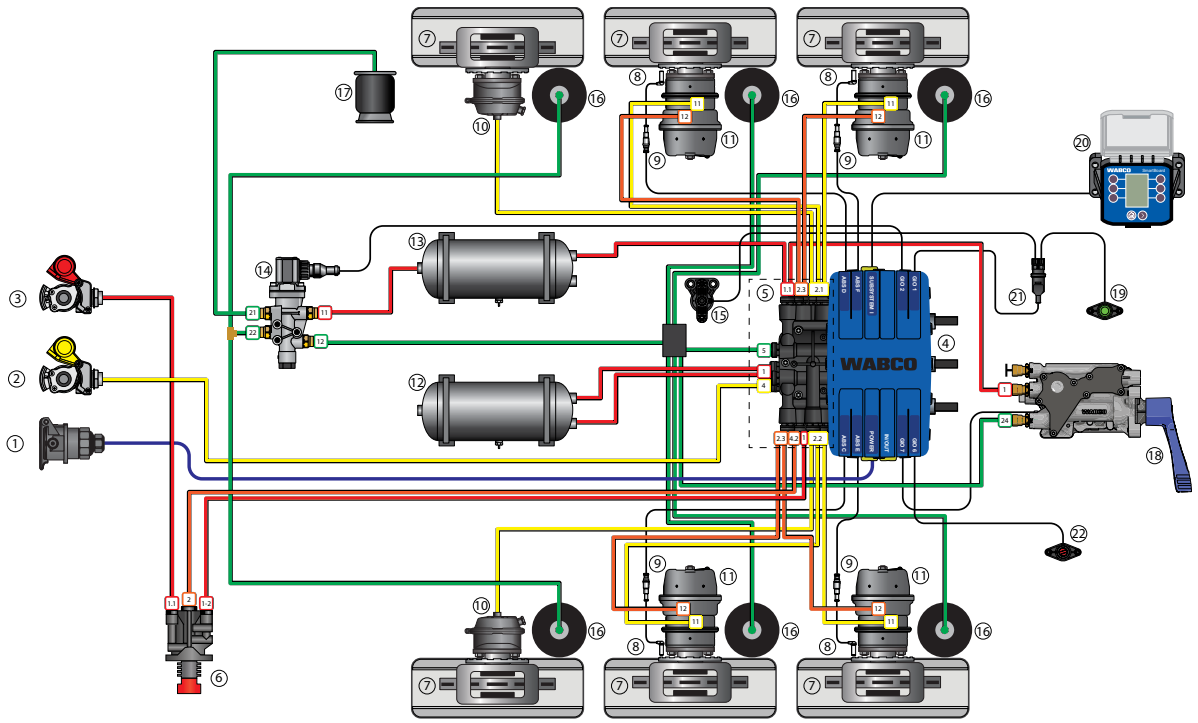
Further information regarding functional operation of the TCV can be found in chapter "3.1.1.5 Trailer Control Valve (TCV)", page 54

2.1.4 Trailer with electronic air suspension

Semitrailer braking system with eTASC dual circuit with LACV



Semitrailer braking system with eTASC single circuit and LACV



Legend					
	Supply		Control / Service brake		Electric signals
	Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)

Item	Designation	Item	Designation
1	Power supply via ISO 7638	12	Service brake system reservoir
2	Control line	13	Reservoir for the air suspension
3	Supply line	14	Lifting axle valve (LACV)
4	iEBS modulator	15	Height sensor
5	Pneumatic Distribution Module (PDM)	16	Axle load bellow
6	Park Release Valve (PRV)	17	Lifting axle bellow
7	Wheel end brakes (disc brakes or drum brakes)	18	OptiLevel device (e.g., eTASC)
8	Wheel speed sensor (ABS)	19	Push button (e.g.: to activate other GIO functions)
9	Wheel speed sensor extension cable	20	SmartBoard
10	Service brake cylinder	21	Port duplicator
11	Spring brake actuators (e.g. TriStop D)	22	Switch
The lines represent the cabling and piping to the components.			

Electronically controlled air suspension system

The ECU of the electronically controlled air suspension is integrated to iEBS. The air suspension works independent from the brake system, and its air supply is through an overflow valve (OVAS) that is an integrated part of the PDM.

The main control devices of the air suspension are the height sensor (15) and the OptiLevel devices for raise & lower (i.e: eTASC or ECAS devices) (18).

The OptiLevel valves are connected to the air suspension reservoir, and to the air suspension supply ports of the PDM (OVAS). The height sensor monitors the chassis height, and when needed, the iEBS will electrify an OptiLevel device that will change the volume in the load bellows and correct height deviations.

OptiLevel height sensors (15) offer more economical control of the trailer height, compared to conventional air suspension applications.

In addition, an optional lift axle control valve (13), which operates according to the trailer's load and the parameterized settings, can be controlled by iEBS. The LACV will exhaust pressure from the load bellows and will inflate the lift bellows during times of lifting, and vice versa during times when the axle is lowered.

The lifting axle valve is likewise supplied with supply from the suspension reservoir and will independently supply & exhaust (control) the lifting axle bellows (16).

Advantage of trailers with electronically controlled air suspension

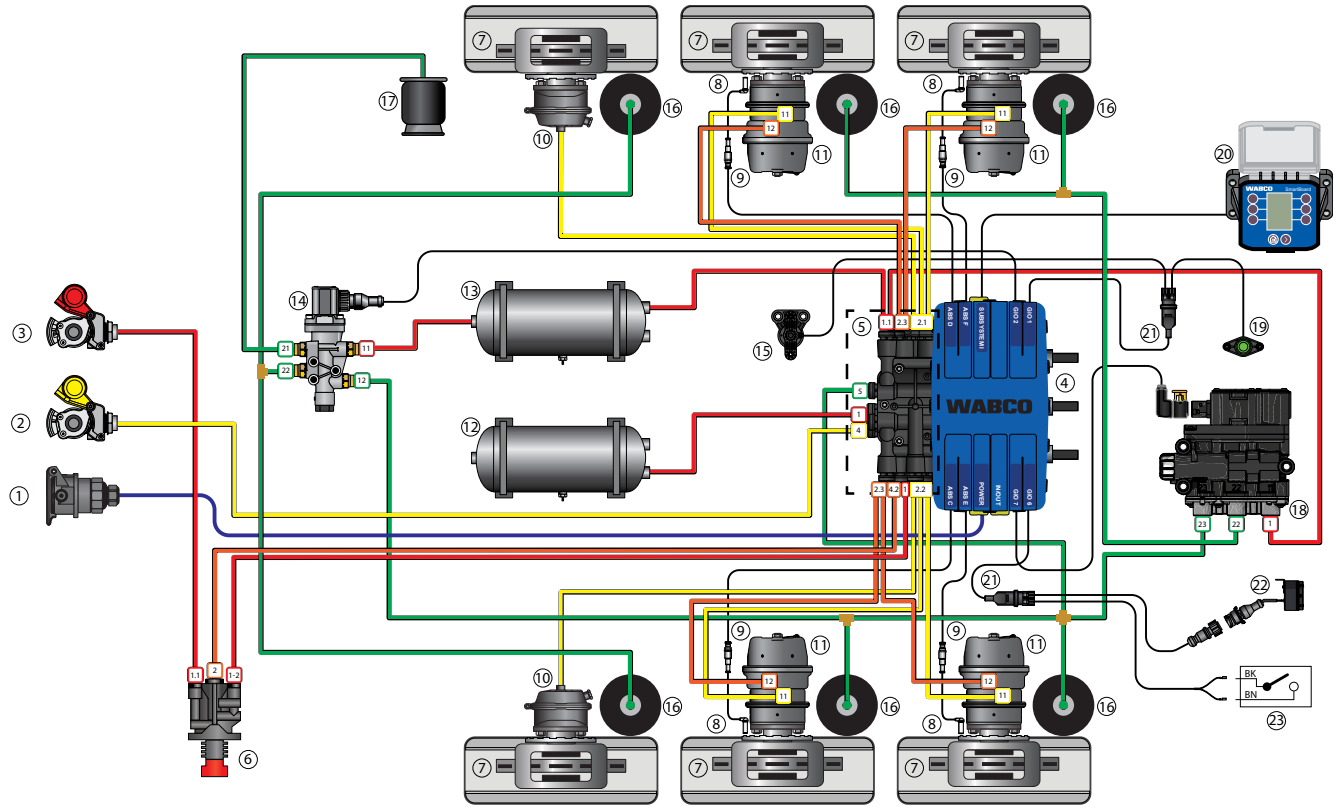
The electronic air suspension control provides a faster, smoother, loading and unloading procedure. The trailer can be lifted and lowered faster than using conventional lift-and-lower valves.

Once docked, it keeps the trailer at the required height regardless of loading and unloading operations.

Typical ITP functions for trailers with electronically controlled air suspension			
	OptiLevel	Intelligent trailer height control that reduces trailer drag and air consumption when compared to conventional air suspension.	See chapter "OptiLevel - Electronic Air Suspension Control" on page 152
	Traction Help	Traction Help lifts the trailer lift axle to increase the traction on the truck's driving axle, improving safety and operating efficiency on slippery surfaces and slopes.	See chapter "Traction Help" on page 137
	Lift Axle Control	Automatically lift axles when depending on load condition	See chapter "Lifting axle control" on page 132

2.1.5 Tipper and tank trailer schemes

Semitrailer braking system with electronically controlled air suspension



Item	Designation	Item	Designation
1	Power supply via ISO 7638	13	Reservoir for the air suspension
2	Control line	14	Lifting axle valve (LACV)
3	Supply line	15	Height sensor
4	iEBS modulator	16	Axle load bellow
5	Pneumatic Distribution Module (PDM)	17	Lifting axle bellow
6	Park Release Valve (PRV)	18	OptiLevel device (e.g., ECAS 1-point)
7	Wheel end brakes (disc brakes or drum brakes)	19	Push button (e.g., to activate other GIO functions)
8	Wheel speed sensor (ABS)	20	SmartBoard
9	Wheel speed sensor extension cable	21	(2x) Port duplicator
10	Service brake cylinder	22	Buzzer
11	Spring brake actuators (e.g. TriStop D)	23	Switch (e.g.: to activate other GIO functions)
12	Service brake system reservoir		
The lines represent the cabling and piping to the components.			

Legend					
	Supply		Control / Service brake		Electric signals
	Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)

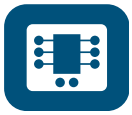
Tipper and tank trailer functions

Tipper and tank trailers are usually equipped with switches or sensors to detect if an unloading process is in progress (e.g., to detect if the tipper body is raised or a discharge door is open).When the Standard or Premium iEBS modulator is equipped on those trailer types, additional functions are made available.

Tipper trailers

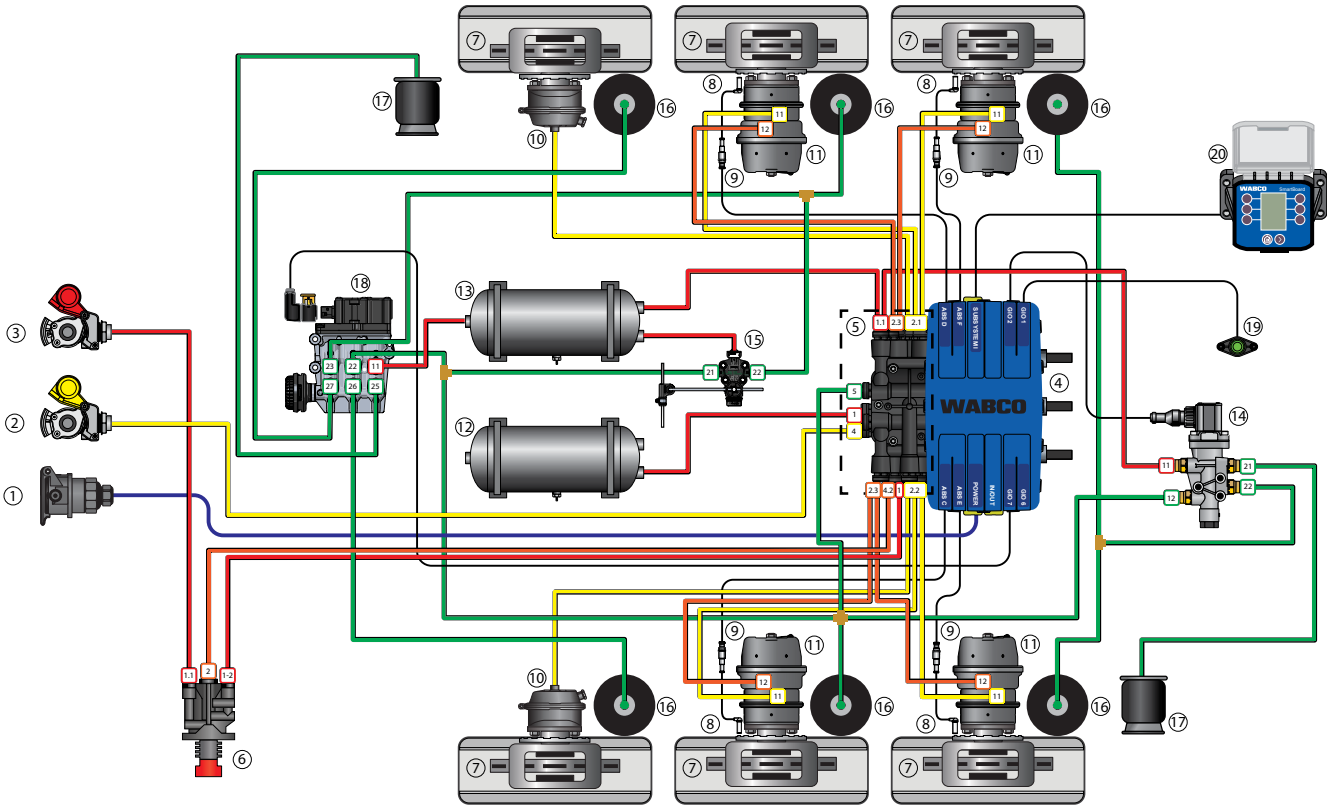
ITP functions for tipper trailers			
	OptiLevel	Intelligent trailer height control that reduces trailer drag and air consumption when compared to conventional air suspension.	See chapter "OptiLevel - Electronic Air Suspension Control" on page 152
	TiltAlert	When the tipper reaches a critical tilting angle, TiltAlert warns the driver to prevent the tipper from tilting over. Increasing the safety procedure when unloading.	See chapter "Tilt Alert" on page 170
	SafeStart	SafeStart keeps a trailer stationary (e.g., during loading process) or brakes the moving trailer to prevent critical situations (e.g., when a driver ignores a lifted tub on a tipper).	See chapter "SafeStart" on page 171
	Finisher Brake	Finisher Brake controls the trailer brakes to synchronize it to an asphalt finisher vehicle during unloading. Prevents asphalt spilling on uneven surfaces.	See chapter "Road finisher brake function" on page 173
	Overload Indicator	Continuously measuring load pressure of the air suspension, will automatically send a warning upon overloading, compared to the programmed data.	See chapter "Overload detection" on page 178

Tanker trailers

ITP functions for tipper trailers			
	OptiLevel	Intelligent trailer height control that reduces trailer drag and air consumption when compared to conventional air suspension.	See chapter "OptiLevel - Electronic Air Suspension Control" on page 152
	SafeStart	SafeStart keeps a trailer stationary (e.g., during loading process) or brakes the moving trailer to prevent critical situations (e.g., when a driver ignores a lifted tub on a tipper).	See chapter "SafeStart" on page 171
	Immobilizer	Secures the trailer with a unique PIN code locking system.	Function not covered in this document
	SmartBoard	An easy-to-use control pad that provides the driver with access to key trailer information and also allows operation of many air suspension functions.	See chapter "SmartBoard™" on page 76

2.1.6 Two lift axles trailer scheme configuration

Semitrailer braking system with conventional air suspension and 2 lift axles



Item	Designation	Item	Designation
1	Power supply via ISO 7638	11	Spring brake actuators (e.g. TriStop D)
2	Control line	12	Service brake system reservoir
3	Supply line	13	Reservoir for the air suspension
4	iEBS modulator	14	Lifting axle valve (LACV)
5	Pneumatic Distribution Module (PDM)	15	Levelling valve
6	Park Release Valve (PRV)	16	Axle load bellow
7	Wheel end brakes (disc brakes or drum brakes)	17	Lifting axle bellow
8	Wheel speed sensor (ABS)	18	Lifting axle valve (LACV-IC)
9	Wheel speed sensor extension cable	19	Push button (e.g.: to activate other GIO functions)
10	Service brake cylinder	20	SmartBoard
The lines represent the cabling and piping to the components.			

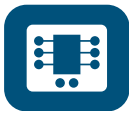
Legend					
	Supply		Control / Service brake		Electric signals
	Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)

Trailers with two lift axles

This trailer configuration allows to have a lift axle installed in front and behind the main trailer axle(s). The lift axles use load bellows to carry weight and lift bellows to raise and lower the axle. The lifting and lowering can be controlled via lift axle valves, electric switches or SUBSYSTEMS devices.

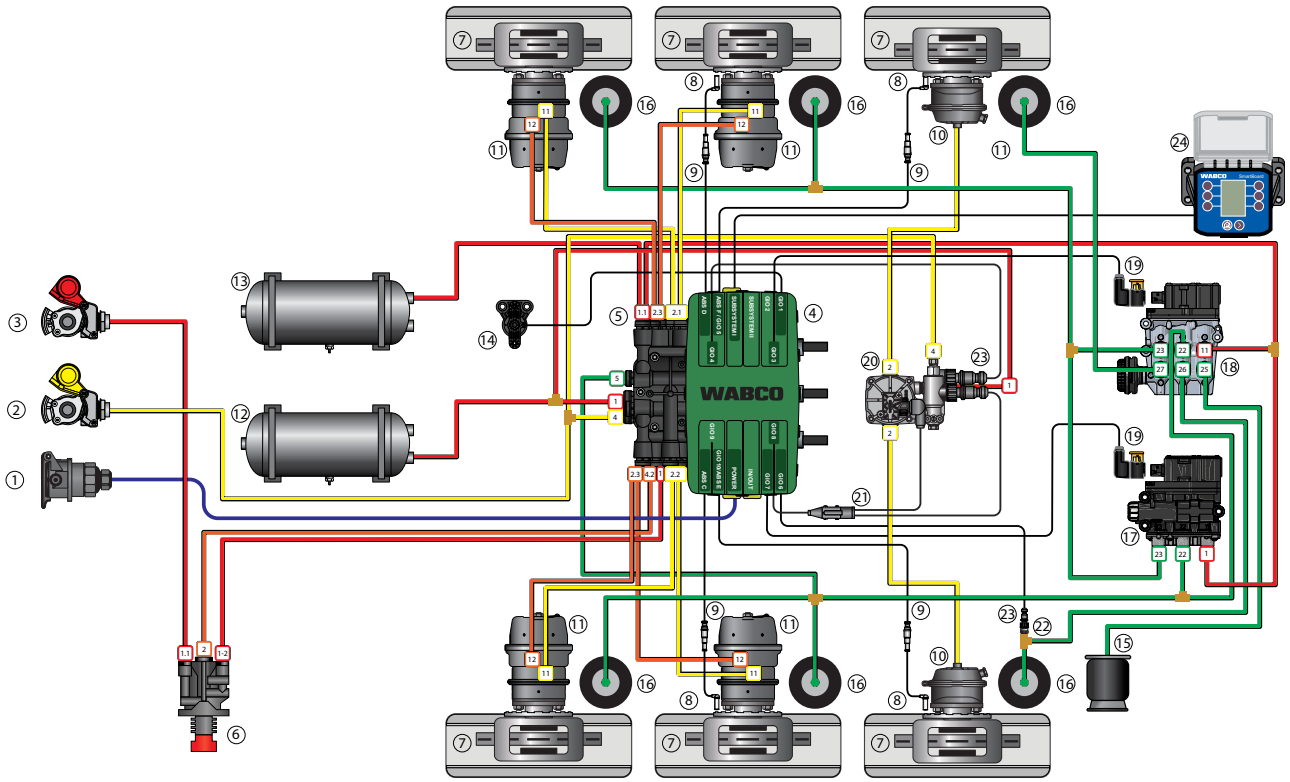
Typical trailer applications are flatbeds, dump and concrete mixer trailers.

Air suspension regulation via TASC valve and user interfaces as SmartBoard are optional.

ITP functions for trailers with two lift axles			
	Traction Help	Traction Help lifts the trailer lift axle to increase the traction on the truck's driving axle, improving safety and operating efficiency on slippery surfaces and slopes.	See chapter "Traction Help" on page 137
	Lift Axle Control	Automatically lift axles depending on load condition	See chapter "Lifting axle control" on page 132
	SmartBoard	An easy-to-use control pad that provides the driver with access to key trailer information and also allows operation of many air suspension functions.	See chapter "SmartBoard™" on page 76

2.1.7 3 axle semitrailer with iEBS Premium and 3rd modulator

Semitrailer braking system with 3rd modulator and ECAS valves



Item	Designation	Item	Designation
1	Power supply via ISO 7638	13	Reservoir for the air suspension
2	Control line	14	Height sensor
3	Supply line	15	Lifting axle bellow
4	iEBS modulator	16	Axle load bellow
5	Pneumatic Distribution Module (PDM)	17	ECAS single block valve (1-point control)
6	Park Release Valve (PRV)	18	Lifting axle valve (LACV-IC)
7	Wheel end brakes (disc brakes or drum brakes)	19	GIO cable for ECAS or LACV-IC
8	Wheel speed sensor (ABS)	20	3rd modulator (EBS relay valve)
9	Wheel speed sensor extension cable	21	"Y" cable for 3rd modulator
10	Service brake cylinder	22	Pressure sensor
11	Spring brake actuators (e.g. TriStop D)	23	Pressure sensor cable
12	Service brake system reservoir	24	SmartBoard
The lines represent the cabling and piping to the components.			

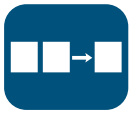
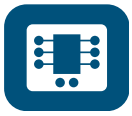
Legend					
	Supply		Control / Service brake		Electric signals
	Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)

Semitrailers equipped with iEBS Premium modulator

iEBS premium modulators support 4S/2M, or 4S/3M ABS configuration if equipped with a EBS relay valve as a 3rd modulator. The trailer configuration shown is equipped with a 3rd modulator (20), changing the 4S/2M ABS configuration into a 4S/3M ABS configuration. Further details about ABS configuration differences can be found in section "ABS configurations" on page 91.

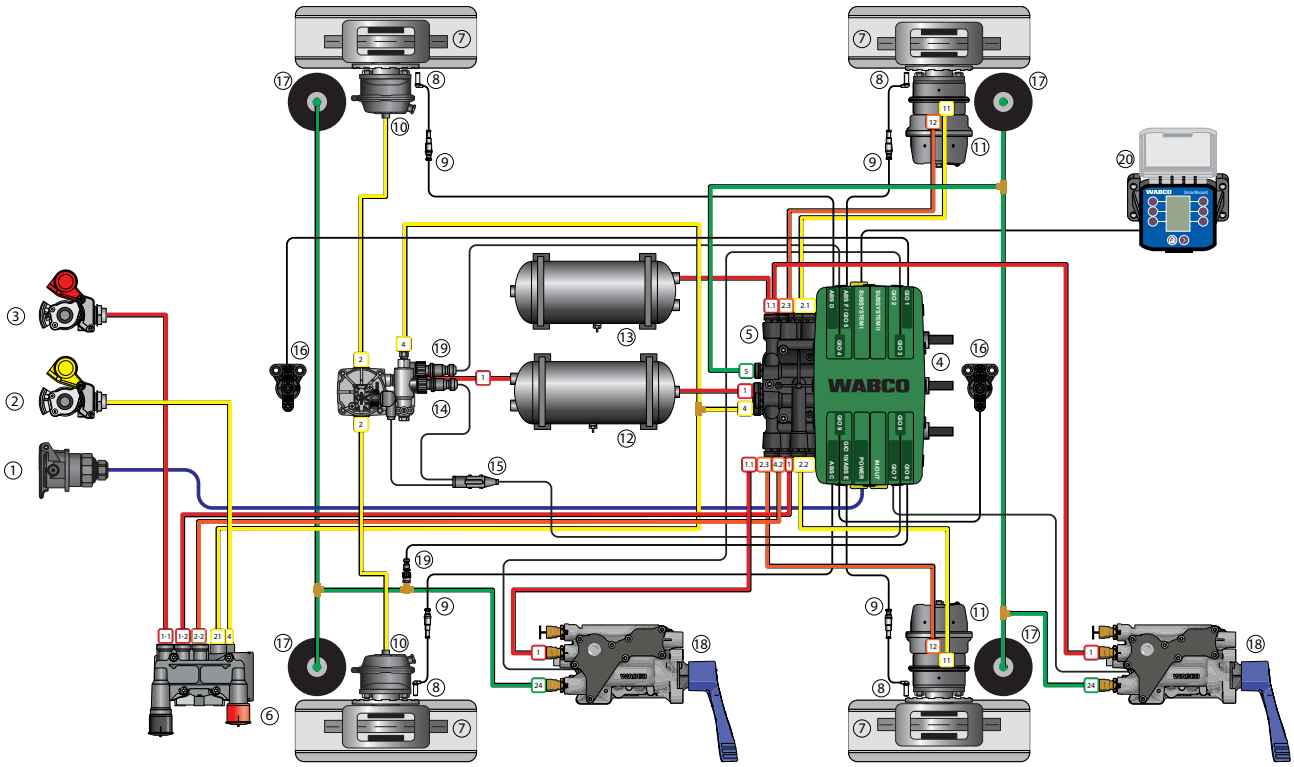
Additionally, the semitrailer is as well equipped with electronically controlled air suspension (17) and LACV-IC (18) on the rear axle. All three devices equipped on the semitrailer allow to have functions like OptiLoad or OptiTurn.

The iEBS Premium modulator is capable of an increased implementation of the ITP functions by having up to 10 GIO connections and integrated functions. Further information can be found on chapter "5.1.5 Integrated functions", page 130

ITP functions for trailers with 3rd modulator			
	Lift Axle Control	Automatically lift axles when depending on load condition.	See chapter "Lifting axle control" on page 132.
	OptiLoad	Automated load control to avoid overload on the fifth wheel Reducing risk of overload penalties and overload damage to your truck's rear axle.	See chapter "OptiLoad" on page 142.
	OptiTurn	OptiTurn improves trailer maneuverability on roundabouts and through sharp corners.	See chapter "OptiTurn" on page 140.
	SmartBoard	An easy-to-use control pad that provides the driver with access to key trailer information and also allows operation of many air suspension functions.	See chapter "SmartBoard™" on page 76
	Telematics	ZF Trailer telematics solution boosts safety, security and efficiency through monitoring, reporting and analysis of all critical trailer data.	See chapter "ZF Telematics" on page 80.
	OptiTire	Tire pressure monitoring system warns of over and under-inflation enhancing fuel economy and safety.	See chapter "OptiTire™" on page 78.
	Immobilizer	Secures the trailer with a unique PIN code locking system.	Function not covered in this document

2.1.8 Drawbar trailer with iEBS Premium and 3rd modulator

Drawbar trailer braking system with PREV control and electronically controlled air suspension



Item	Designation	Item	Designation
1	Power supply via ISO 7638	11	Spring brake actuators (e.g. TriStop D)
2	Control line	12	Service brake system reservoir
3	Supply line	13	Reservoir for the air suspension
4	iEBS modulator	14	3rd modulator (EBS relay valve)
5	Pneumatic Distribution Module (PDM)	15	"Y" cable for 3rd modulator
6	Park Release Emergency Valve (PREV)	16	Height sensor
7	Wheel end brakes (disc brakes or drum brakes)	17	Axle load bellow
8	Wheel speed sensor (ABS)	18	eTASC
9	Wheel speed sensor extension cable	19	Pressure sensor
10	Service brake cylinder	20	SmartBoard
The lines represent the cabling and piping to the components.			

Legend					
	Supply		Control / Service brake		Electric signals
	Parking brake		Air suspension		Power supply (ISO 7638)+CAN lines (ISO 11992)

Drawbar trailer with 2-point control regulation

A 2-point control configuration on a drawbar requires the installation of 2 height sensors (one for each control point) and 2 eTASC devices. The automatic regulation bring the front and rear side of the trailer to the reference level, while the manual regulation by the lever allow to control each reference point independently (1st device is connected to the front axle, while the 2nd device is connected to the rear axle).

2.2 Function overview

The table below shows the main ITP functions and features for the iEBS variants.

Functions	Basic Steel	Basic Air	Standard	Premium
Basic functions and supported components				
ABS Configuration	4S/2M	2S/2M	4S/2M	4S/3M
Number of GIO ports	2	3	4	10
CAN 5 V (SUBSYSTEMS) ports	1	1	2	2
Axle Load Monitoring	✓*(with height sensor)	✓	✓	✓
Load depending brake performance	✓*(with height sensor)	✓	✓	✓
24 V CAN	✓			
Stop light power	✓			
Power supply for external devices	✓(via SUBSYSTEMS ports)			
Advanced Multi-Voltage	✓			
Trailer ABS warning Lamp	✓			
Brake Release	-	-	✓	✓
Free Configurable Functions (FCF)	-	-	✓	✓
GIO Power service (1 & 2)	-	-	✓	✓
SUBSYSTEMS devices				
SmartBoard	✓			
ZF Telematics	✓			
OptiLink	-			
OptiTire	✓ (external ECU)		✓(external ECU or integrated**)	
Advanced Safety				
Anti-Lock Braking System (ABS)	✓	✓	✓	✓
Rollover Stability Support (RSS)	✓	✓	✓	✓
Router & Repeater	✓	✓	✓	✓
Emergency Brake Alert	-	-	✓	✓
Tilt Alert	-	-	✓	✓
SafeStart (via service brake)	-	-	✓	✓
SafeStart (via parking brake)	-	-	-	✓
Bounce control	-	-	-	✓
TailGUARD	-			✓(integrated**)

Functions	Basic Steel	Basic Air	Standard	Premium
Driver Comfort & Effectiveness				
Integrated Speed Switch ISS1 / RtR	✓	✓	✓	✓
Integrated Speed Switch ISS2	-	-	✓	✓
Traction Help	-	✓	✓	✓
Steering Axle Control	-	-	✓	✓
Finisher Brake	-	-	✓	✓
Trailer Length Indication	-	-	-	✓
Operational Efficiency				
ServiceMind	✓	✓	✓	✓
Operating Data Recorder (ODR)	✓	✓	✓	✓
Brake Lining Wear Indicator	✓	✓	✓	✓
Notebook Memory	-	-	✓	✓
Trailer Extending Control	-	-	✓	✓
OptiLevel (Electronic lifting/lowering)	-	-	✓	✓
Return-to-Ride (OptiLevel)	-	-	✓	✓
Return-to-Load (OptiLevel)	-	-	✓	✓
Memory Level (OptiLevel)	-	-	✓	✓
Immobilizer	-	-	✓(integrated**)	✓(integrated**)
Battery Control	-	-	-	✓
OptiTurn	-	-	-	✓
OptiLock	-	-	-	✓
Fuel & CO_2 Reduction				
OptiFlow Tail	✓	✓	✓	✓
OptiFlow AutoTail	✓	✓	✓	✓
Lift Axle Control	-	✓	✓	✓
# of separate lift axle control	-	1	2	3
Fuel Saving Suspension (OptiLevel)	-	-	✓	✓
Load Optimization				
Overload Detection	-	-	✓	✓
OptiLoad	-	-	-	✓
Tag Axle Control (Air Bellows Protector)	-	-	-	✓
Forklift Control	-	-	-	✓
OptiLevel 2-Point Control	-	-	-	✓

*Function available only with calibrated height sensor connected. Axle load monitoring works under determined conditions.

** Function integrated in dedicated variants. Further details on chapter "5.1.5 Integrated functions", page 130.

3 Trailer iEBS components

Section	Component	Reference
Brake control valves	Park Release Valve (PRV)	See page 49
	Park Release Emergency Valve (PREV)	See page 51
	Relay valve	See page 52
	EBS Relay valve	See page 53
	Trailer Control Valve (TCV)	See page 54
Air suspension control valves	Lift Axle Control Valve (LACV)	See page 55
	Impulse Controlled Lift Axle Valve (LACV-IC)	See page 57
	Tag axle valve	See page 59
	Trailer Air Suspension Control (TASC) with Return-to-Ride (RtR)	See page 60
	Levelling valve	See page 62
	eTASC	See page 63
	Electronically Controlled Air Suspension valve (ECAS)	See page 65
Other valves	Non-return valve (check valve)	See page 68
	Directional control valve 3/2	See page 68
	Select High Valve (Double Check Valve - DCV)	See page 68
	Select Low Valve (Double Cut-Off Valve - DCOV)	See page 69
Sensors	Wheel Speed Sensor (WSS - ABS Sensor)	See page 70
	Height sensor	See page 71
	Pneumatic pressure sensor	See page 73
	Hydraulic pressure sensor	See page 73
Switches	Push button	See page 74
	Rotary switch	See page 74
	Pressure switch	See page 75
	Proximity switch	See page 75
SUBSYSTEMS	SmartBoard™	See page 76
	OptiTire™	See page 78
	ZF Telematics	See page 80
Others	Router / Repeater	See page 83
	Buzzer	See page 85
	External green warning lamp	See page 86

Additional information

Description	QR code
Further information can be found in the following catalogue. Pneumatic Brake Equipment for Trailer Vehicles Product Catalogue	

3rd party devices

The iEBS system is designed for use with proper defined external components (wheel speed sensors, external pressure sensors, lift axle control valve, etc.) provided by ZF.

In case of the replacement of these external components by other that are not part of the ZF product portfolio, the same electrical, magnetic and pneumatical characteristics have to be considered.

⚠ WARNING

Use of components outside of the ZF portfolio may result in functional issues and diagnostic fault entries.

ISO 26262 compliance

The iEBS system has been developed according to the functional safety standard (ISO 26262). Therefore, it is necessary that any electrical component connected to the system will ensure a certain safety level known as Automotive Safety Integrity Levels (ASIL). The ASIL provides the minimum safety level requirements that have to be achieved for a component.

The probability for safety related hardware faults of the iEBS system depends on the system configuration (e.g., Basic Air with external bellow pressure sensors including 24V CAN and lift axle). Safety calculations have been performed for typical system configurations and for each safety goal.

The following list indicates the minimum requirements related to the fault detection mechanisms that an external device must fulfil in context with iEBS according to its purpose to comply with the ISO 26262 standard.

Application example	3rd party device type	ASIL	Fault detection mechanism
Indication of axle load	Pneumatic sensor	ASIL B	• Short to ground, • Short to supply, • Stuck-at failure detection using a plausibility check during braking while driving, • Blown out detection.
	Height sensor (level sensor for spring leaf suspension)	ASIL B	• Short to ground, • Short to supply, • Open line at the sensor signal line, • Shorted sensor wires between supply and signal line, • Supervision of the frequency and the duty cycle of the sensor signal, • Stuck-at failure detection using a plausibility check during braking while driving
Brake signal improvement for long trailer	Repeater	ASIL B(D)	• Short to ground, • Short to supply, • Demand pressure below normal, • Stuck-at an offset failure (detection at the signal line using various plausibility checks).
Brake signal distribution for multiple iEBS modulators (CAN demand pressure)	Router	ASIL B(D)	• Timeout monitoring, • CRC, • CAN breakdown, • One-wire operation detection, • Plausibility check with the demand pressure sensor

Application example	3rd party device type	ASIL	Fault detection mechanism
Trailer speed measurement used for braking function (e.g., ABS and RSS functions)	Wheel speed sensor	ASIL B(D)	• Shorted sensor wires, • Short to ground, • Short to supply, • Open line, • Speed signal jump, • Rattle, • Plausibility check between two sensors and each sensor and the vehicle speed, • Mechanical or installation related defects (outside ISO 26262): eccentricity, run out, loss of teeth at the pole wheel, wrong pole wheel.
Locking of a self-steering axle	Solenoid valves	QM	Not safety relevant
Warning signal related to a brake event (e.g., ABS active or RSS active function)	LED or light bulb	QM	Not safety relevant
Warning status of the brake pad	Brake pad wear sensing	QM	Not safety relevant
Trailer chassis height regulation	Air suspension valves	ASIL B	• Shorted solenoids, • Short to ground, • Short to supply, • Open lines, • Internal PCB faults • Plausibility check of the ECAS control path
	Height sensor	ASIL B	• Short to ground, • Short to supply, • Open line at the sensor signal line, • Shorted sensor wires between supply and signal line, • Supervision of the frequency and the duty cycle of the sensor signal, • Plausibility check of the ECAS control path
Raise and lowering of lift axles	Lift axle valves	ASIL A	• Short to ground, • Short to supply, • Open lines
Reversing system with active braking	Reversing system device (ultrasonic sensors)	QM	Ultrasonic sensors are not safety relevant

External devices that are used for auxiliary functions (non-brake related) need to be analyzed independently.

3.1 Valves

3.1.1 Brake control valves

3.1.1.1 Park Release Valve (PRV)

Application

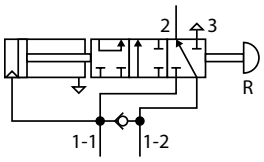
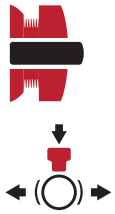
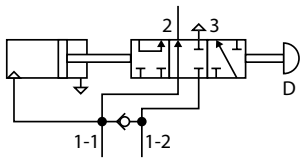
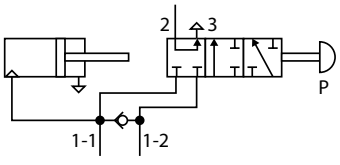
The Park Release Valve (PRV) provides a manual interface for the trailer operator to apply or release the parking brake of semitrailers, central axle trailers and dollys equipped with iEBS.

PRV comes without any emergency braking function, resulting in a smaller valve design. The trailer emergency brake function is integrated within the iEBS modulator.

Function

The PRV fulfils the following functions:

- Filling and protection of the reservoir pressure: The PRV fills and in case of supply line rupture protects the air reservoir pressure by means of a check valve.
- Automatic switching to driving: When the red coupling is coupled and the minimum required air pressure is reached (1 ± 0.5 bar), the PRV will automatically switch from release position to driving position without any manual intervention.
- Protection from unintended engagement of release function: When the trailer is coupled, a pneumatic engagement mechanism within the device prevents the unintended actuation of the release function.
- Automatic braking of the trailer when the supply line ruptures/ heavily leaks: During the rupture of the supply line / accidental uncoupling of trailer during driving condition, this device exhausts the delivery pressure leading to an emergency brake application (operated by iEBS).

PRV button position description	PRV symbol	PRV position
Released (R): Black indicator protrudes from the red knob. Release of the trailer parking brake in uncoupled condition. Shunt function: When there is a necessity to tow the trailer in an uncoupled condition, the red knob needs to be pushed in into the release position. The reservoir (port 1-2) connects to delivery (port 2) leading to release of the parking brake. The trailer can be towed without any external air supply.		
Driving (D): Black indicator & red knob are alligned. Truck and trailer have to be in coupled condition. Parking brake release: When the red knob is pushed to the "driving" position, the supply pressure from red hose coupling (port 1-1) connects to delivery (port 2) leading to the release of the parking brake		
Parking (P):Black indicator is inside the red knob. Parking brake can either be applied in both trailer conditions,coupled and uncoupled. Parking brake application: When the red knob is pulled to the "parking" position of the PRV, the delivery (port 2) of the valve connects with the valve's internal exhaust (port 3), leading to the application of the parking brake.		

NOTICE

Dismantling of the device is possible only according to the repair instructions and by using genuine repair kits. Further dismantling, or repair of the device, or its fittings is not permitted.

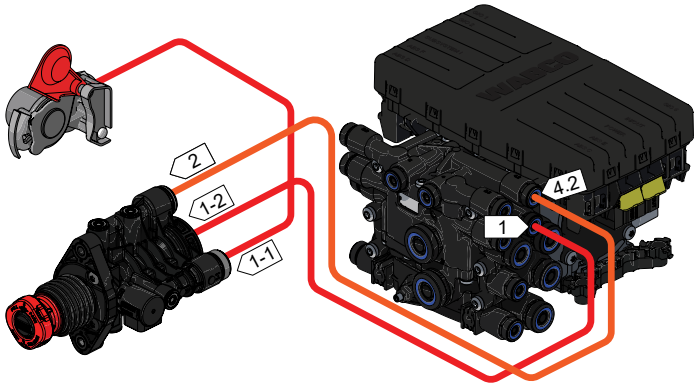
Variants

Part number	Operation sticker (899 202 608 4)	Fittings for ø tube size		
		Supply port (1-1)	Delivery port (2)	Reservoir port (1-2)
971 003 001 0	yes	ø 8x1	ø 8x1	ø 8x1
971 003 003 0	yes	ø 10x1	ø 8x1	ø 8x1
971 003 029 0	yes	ø 8x1	ø 8x1	ø 8x1 + pressure test connection (M16x1.5)

PRV Installation

The pneumatic connection for the PRV shall be installed as follows:

- The pipe from the supply coupling head goes to the port 1-1 of the PRV
- The pipe from port 1-2 of the PRV connects to the port 1 of the PDM. The brake reservoir is charged through the PDM port 1.
- The pipe from port 2 of the PRV connects to the port 4.2 of the PDM.



⚠ WARNING

The PRV shall be installed as per installation instruction. In case port 1-2 and port 2 of the PRV will be mismatched, the automatic brake function (emergency brake) of the brake system shall not work correctly.

To check if the function is working, a leakage simulation can be performed by disconnecting the supply coupling head. To ensure the correct operation of the valve, the device shall be pneumatically tested after installation and any After Market repair activities.

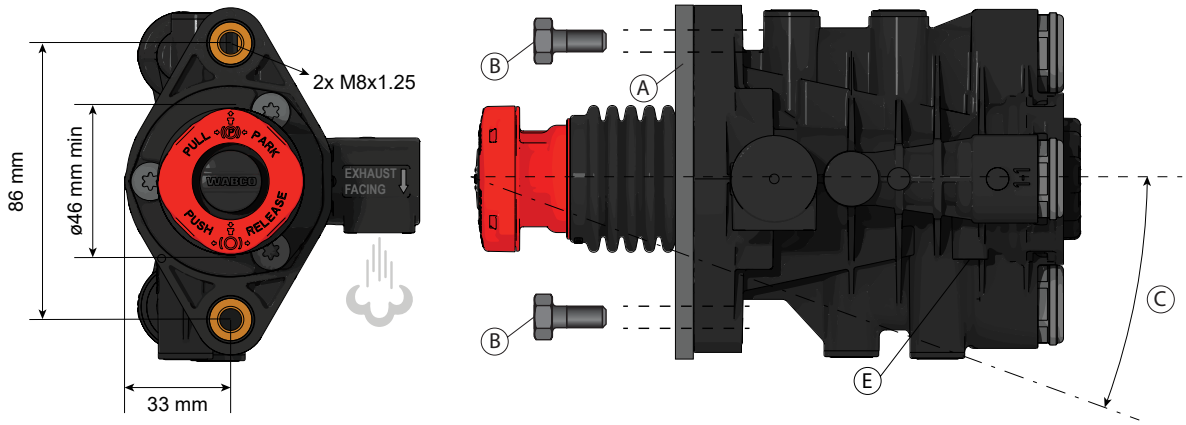
The PRV needs to be installed in the horizontal position. A 20° inclination respecting the horizontal is allowed (C). A device mounting hole with a circular area of 46 mm is required to mount the PRV valve. The exhaust port must face downwards. The breather of the PRV (E) shall be free from blockage.

To mount the valve, 2 bolts (B) M8x1.25, grade 8.8 with washers are required.

Permissible bolt length (B) must be selected according to frame thickness (A):

- 20 mm for frame thickness 3 to 6 mm
- 25 mm for frame thickness 7 to 11 mm
- 30 mm for frame thickness 12 to 16 mm

The bolts must be tightened with a torque of 22.5 ± 2.5 Nm



3.1.1.2 Park Release Emergency Valve (PREV)

Application

The Park Release Emergency Valve (PREV) is used on drawbar trailers equipped with iEBS. The double release valve allows you to release the turntable of the drawbar without the trailer rolling.

The PREV includes the trailer emergency braking function, applying the brakes of the trailer during supply pressure loss or evacuated supply line.

Function

The PREV fulfils the following functions:

- Automatic braking: Automatically applies the emergency brake during supply pressure loss, or a ruptured supply line, once the pressure value drops below 2.5 bar. Automatic braking of the trailer is achieved by increasing the control line pressure via the internal connection of the iEBS to the trailer brake reservoir.
- Filling and protection of the trailer reservoir pressure: It fills and at the same time protects the air reservoir pressure, in the case of a supply line rupture, by means of a check valve.
- Protection of the supply pressure in the spring brake unit: When the supply pressure in the trailer drops, the pressure in the spring brake unit is protected until the supply pressure drops to 2.5 bar. This ensures the usual functionality with released spring brakes as long as the service brake has enough pressure to hold the trailer.
- Actuation of parking brake: The PREV provides the spring brake actuators with compressed air up to the available supply pressure (port 1-1 to port 22). The parking brake can be operated manually by pulling the square shape red knob as it releases the air pressure from the spring brake actuators. Once the parking brake has been engaged, it must be manually released before start driving.
- Release of the trailer service brake (during uncoupled condition): Whilst the trailer emergency brake is applied, the service brakes can be manually released via the black button (pushed in).
  Attention: Please apply measures to secure the trailer from rolling away as the trailer's brakes will not be engaged at this time.
- Automatic application of the parking brake (during uncoupled condition): The PREV will automatically exhaust the trailer spring brakes when a supply pressure in the reservoir drops to 2.5 bar. This will result in secure and automatically engaged parking brake.

Technical data

Air working pressure (supply)	8.5 bar (nominal) / 12 bar (maximum)
Weight	~ 1.8 kg

Variants

Part number	Function plate (971 002 103 4)	Fittings for ø tube size				
		Supply port (1-1)	Air reservoir (1-2)	Modulator (21)	Spring brake cylinder (22)	Service line (4)
971 002 912 0	yes	ø8x1	ø8x1 * & test connector	ø8x1	ø8x1	ø8x1

Other variants available in Customer Centre under the family part number 971 002 9 .. 0

3.1.1.3 Relay valve

Application

The relay valve rapidly increases or decreases the pressure of compressed air equipment such as brake actuators, to shorten the response and pressure build-up times.

In trailers, the relay valve is commonly used to improve the response time of large brake cylinders.

Slave axle applications via relay valve: A relay valve can be used to rapidly replicate the brake signal sent by the iEBS modulator to the other axles (i.e. those axles that are not equipped with wheel speed sensors).

- RV + SLV: Together with a select-low valve, the relay valve can be used to control a self-steering axle to improve the stability.
- RV + SHV: In case the relay valve is used together with a select-high valve, the relay valve will deliver the highest pressure measured from the brake modulators.

Function

The relay valve has its own supply (port 1) that is connected to the brake system reservoir. The delivery pressure (port 2) is equal to the control pressure (port 4) allowing for fast response of the connected component. The delivery pressure of the relay valve is sidewise equally distributed.

Technical data

Air working pressure (supply)	9 bar (nominal) / 10 bar (maximum)
Weight	~ 0.6 kg
Mounting bolts	M8

Variants

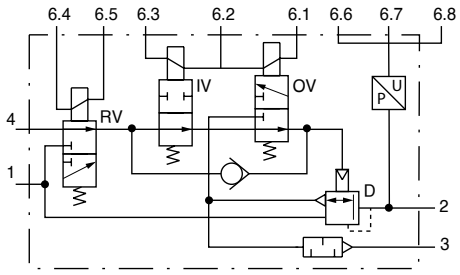
Part number	Thread size for fittings			
	Air supply (1)	Delivery port (2)	Air exhaust (3)	Control line port (4)
973 011 000 0	M22x1.5	(X2) M22x1.5	✓	M16x1.5

3.1.1.4 EBS Relay valve

Application

The EBS relay valve is an electrically controlled valve with integrated pressure sensor and redundancy valve (secondary safety circuit). When the service brake will be applied, the EBS relay valve will independently control the service brake pressure. The ABS modulation control when installed in 4S/3M systems will also be controlled independently. The EBS relay valve can be used in drawbar trailers (front or rear axle control), as well as in semitrailers (usually on self-steering axles, and/or lift/tag axles).

Function

Brake operation with the EBS relay valve	Symbol
The EBS relay valve is mounted to the brake system with direct lines to the brake actuators (delivery port 2). It is electrically actuated by iEBS, providing accurate and fast brake applications. The valve count with a relay valve (D) (for fast braking response), inlet (IV) and outlet (OV) solenoids (responsible for the ABS control), and a redundancy valve (RV) (as a safety circuit in case of EBS failures).	

The EBS relay valve is added to the iEBS Premium modulator to upgrade the 4S/2M ABS configuration to a 4S/3M configuration. This 3rd modulator (EBS relay valve) is capable of 3 different types of braking behaviors:

- iEBS modulator is powered via ISO 7638 and no faults are present: The EBS relay valve will be electrically controlled via the iEBS modulator during any service brake demand that is delivered via the electrical control line of the ISO 7638 interface. The redundancy valve will switch ON to deliver direct supply pressure, and via electric pulse control cycles, the inlet valve (IV) will precisely pulse control the delivery pressure to the service brake actuators, in line with the brake demand pressure value. In the event of potential wheel locking, the iEBS modulator will electrically control the EBS relay valve that will perform a series of braking pressure modulations (by venting, holding, and increasing the service brake pressure to the brake actuators), until the wheel slip will no longer show locking tendency.
- If potential faults are detected by iEBS (e.g., defective EBS relay valve pressure sensor), the EBS functionality (e-control) will be deactivated. This also applies when the ISO 7638 interface is defective, and only the stop light power supply via ISO 12098 is present. In this condition, the ABS control will be working via the redundancy circuit when needed.
- When the ISO 7638 power supply is no longer present, or interrupted, iEBS can no longer electrically control the EBS relay valve. In this case, the EBS relay valve operates like a standard pneumatic relay valve (D), which means that the same value of the control line pressure demand (pm) will be delivered to the service brake actuators by the EBS relay valve function.

Technical data

Air working pressure (supply)	10 bar (nominal)
Weight	~ 1.8 kg
Mounting bolts	M8

Variants

Part number	Thread size for fittings			
	Air supply (1)	Delivery port (2)	Air exhaust (3)	Control line port (4)
480 207 202 0	M22x1.5	(X2) M22x1.5	✓	M22x1.5

3.1.1.5 Trailer Control Valve (TCV)

Application

Used on lead trailer in case of multiple trailer configurations.

Function

The TCV forwards the pneumatic control from the truck to the next trailer while protecting the trailer's own brake system from pressure loss caused by coupled trailers.

The TCV will individually control the next connected trailer in different modes.

- Normal service brake: The TCV in the lead trailer will pneumatically relay the service brake signal via the primary circuit (41) directly from the trailer service control coupling further to the next connected trailer service control coupling via port (22). All connected trailers will brake pneumatically as per trucks brake demand.
- Primary circuit control fail: In the event of a failure in the primary circuit (41), the secondary circuit (42) will control the TCV via the iEBS modulator delivery (using select-high valve) in the same way as described in the primary circuit.
- Disconnecting the trailer: Upon disconnecting the lead trailer from the truck, port 43 of the TCV will be exhausted. In proportion to the pressure drop at port 43, the TCV will pressurize the trailer service control coupling (22). In this way the following trailer is braked by fully applied service brakes. The same function applies when the parking brake of the lead trailer will be applied.
- Breakaway function: In the event that the control line (yellow coupling) to the following trailer encounters a heavy leakage during a service brake application, the integrated 3/2 way valve of the TCV will automatically reduce the air flow to the leakage, and simultaneously vent the trailer supply line (red coupling), causing the following trailer's emergency brake to automatically apply.

Variants

Part number	Description
973 009 006 0	Trailer Control Valve

Additional information

Further information about road train applications can be found in chapter "2.1.3 Road train", page 32.

3.1.2 Air Suspension Control Valves

3.1.2.1 Lift Axle Control Valve (LACV)

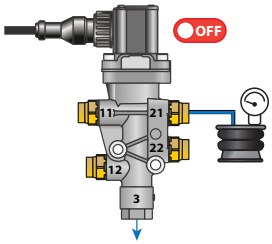
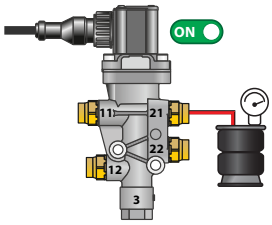
Application

LACV valves are used in all trailer types with one multiple lift axles. In iEBS we promote the usage of 12 V components due to the Multi-Voltage functionality. However, there are also 24 V LACV variants available.

Function

The lift axle control valve is part of the air suspension control system and will be electrically controlled by iEBS.

The LACV design principle is to keep the lift axle on ground when the solenoid is not electrified. This protects the axles against overload when the trailer is not power supplied.

LACV operation	Lift axle position
Solenoid not powered When the LACV is not receiving electrical power from iEBS: • The lifting bellow port (21) is exhausted via the exhaust port (3) • The load bellows port (22) is connected via port (12) with the rigid axle load bellows • The axle is lowered with wheels on the ground	
Solenoid powered Upon receiving electrical power from iEBS, the LACV will perform an automatic pneumatic switch function: • The lifting bellow port (21) is connected and pressurized via supply port (11) • The load bellows port (22) is internally connected to exhaust port (3) • The axle is lifted	

The LACV can be controlled automatically or manually.

Automatic control: The LACV Valve is subject to parameter setting (iEBS modulator) to operate in different control modes. Further information regarding modes and compatibility with the various iEBS variants can be found on chapter "5.2 Lifting axle control", page 132

Manual control: Manual activation of an electric switch connected to a GIO port in iEBS is used to control the power supply to the LACV solenoid. For a personalized behavior of the switch, please refer to chapter "5.7 Switch control", page 149

For safety reasons the lift axle will always be lowered to the ground in the following cases

- The trailer is not powered supplied
- The ignition is OFF
- Forced lowering command used by the operator
- The axle weight on the main axle exceeds the maximum weight
- The cable between the LACV and the iEBS modulator is defective

Technical data

Air working pressure (supply)	5 ... 13 bar
Weight	~ 0.7 kg
Voltage / nominal current consumption	12 V ± 3 V / 0.22 A

Pneumatic connections

Port	Function
11	Air Supply
12	Delivery (Levelling Valve) + Load bellow (Rear Axle)
21	Delivery (Lift bellow)
22	Delivery load bellow (Lift Axle)

Variants

Part number	Description	Comments
463 084 060 0	LACV spring returned	12 V variant without fittings.
463 084 061 0	LACV spring returned	12 V variant with fittings (all ports ø8x1)
463 084 031 0	LACV spring returned	24 V variant without fitting
463 084 041 0	LACV spring returned	24 V variant with fittings (all ports ø8x1)
463 084 042 0	LACV spring returned	24 V variant with fittings (supply port ø12x1,5 / delivery ports ø8)
463 084 043 0	LACV spring returned	24 V variant with fittings (quick coupling fitting on port 11 / delivery ports ø8)

3.1.2.2 Impulse Controlled Lift Axle Valve (LACV-IC)

Application

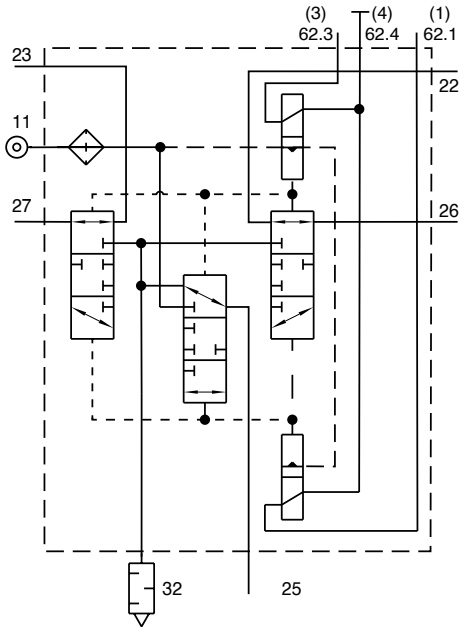
LACV-IC valves are used in all trailer types with one or multiple lift axles. In addition, the LACV-IC is used for tag axle applications, also featuring the ITP functions OptiTurn and OptiLoad.

In iEBS we promote the usage of 12 V components due to the Multi-Voltage functionality.
The 24 V LACV-IC variants available are only used for TEBS E applications.

Function

The LACV-IC is a dual pneumatic circuit valve that is used for inflating, exhausting and holding pressure from the lift/tag axle load bellows and lift bellows.

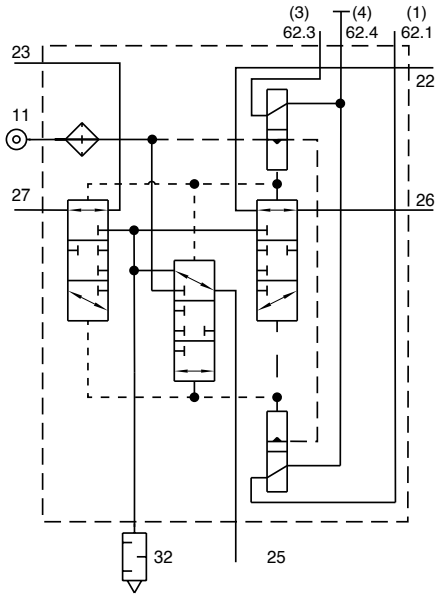
The LACV-IC is part of the air suspension control system and will be electrically controlled by iEBS. Powered solenoids will trigger a pneumatic control switch function. When the solenoids will no longer be powered, the valve will maintain the last activated position.

Lift axle operation with LACV-IC	Sequence	Symbol
Lifting: The lift bellow of the lift axle will be supplied with air. Simultaneously, the load bellows of the lift axle will be exhausted through the valve.	• The solenoid (pin 62.1) is electrically impulse controlled by iEBS • The lifting bellow port (25) is pressurized via the supply port (1), inflating lift bellows • The lift axle's load bellows ports (26 & 27) are deflating through the internal exhaust port (32)	
Lowering: The pressurized lift bellow will be exhausted. Simultaneously, the load bellows will be pressurized via the main suspension air source through the valve.	• The solenoid (pin 62.3) is electrically impulse controlled by iEBS • The lifting bellow port (25) is connected to the internal exhaust port (32), deflating the lift bellows • The main axle load bellow ports (22 & 23) are connected to the lift axle's load bellow ports (26 & 27), and the axle load is balanced.	
Hold: Both solenoids will be energized simultaneously. Therefore, all ports of the valve are cut off and holding its pressure.	• The solenoids (pin 62.1 + 62.3) are electrically impulse controlled by iEBS • The lifting bellow port (25) is closed and the pressure is on hold • The lift axle's load bellow ports (26 & 27) are closed and the pressure is on hold. The lift axle position remains fixed	

The hold position represents a special case and causes to isolate (hold) the pressure in all bellows. This will occur, for instance, when the pressure in the load bellows for the lift/tag axle vary while Traction Help or OptiTurn is active. This means, the pressure in the load bellows of the main axle is at its maximum and the pressure in the load bellows of the lift/tag axle is at a lower value.

Tag axle operation

For a tag axle configuration, the port 25 of the LACV-IC shall be plugged.

Tag axle operation with LACV-IC	Sequence	Symbol
Inflating: The load bellow of tag axle will be pressurized by main axle load bellow.	• The solenoid (pin 62.3) is powered by iEBS • The load bellow ports of the main axle (22 & 23) are connected to the tag axle's load bellow ports (26 & 27) • The axle load is balanced	
Deflation: Air inside the load bellow of tag axle will be exhausted through to ambient.	• The solenoid (pin 62.1) is powered by iEBS • The load bellow ports of the main axle (22 & 23) are cut off from the tag axle's load bellow ports (26 & 27) • The load bellow ports (26 & 27) deflate through the exhaust port (32)	
Hold: The load bellow of tag axle is cut off from main axle load bellow and from ambient.	• The solenoids (pin 62.1 + 62.3) are powered by iEBS • The tag axle's load bellow ports (26 & 27) and the main axle ports (22 & 23) are closed and the pressure is on hold	

At all times the tag axle wheels will be rolling on the ground. The deflation and hold situations will only be reducing the axle load on the tag axle. Therefore, the tires will undergo less friction and rubbing when cornering, thus reducing tire wear.

Technical data

Air working pressure (supply)	5 ... 12 bar
Weight	~ 2.1 kg
Voltage / nominal current consumption	12 V ± 3V / 0.625 A per solenoid

Pneumatic connections

Port	Function
11	Air Supply
22	From the load bellows of the non-lifting axle(s) circuit 1
23	From the load bellows of the non-lifting axle(s) circuit 2
26	To the load bellows of the lift/tag axle circuit 1
27	To the load bellows of the lift/tag axle circuit 2
25	To the lifting bellows (for tag axles this port is plugged)
31, 32	Exhaust

Variants

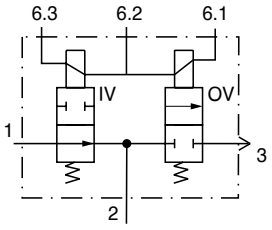
Part number	Description	Comments
463 084 102 0	LACV-IC	Variant with fittings (all ports ø8x1)
463 084 103 0	LACV-IC	Variant with fittings (all ports ø12x1,5)
463 084 104 0	LACV-IC	Variant with fittings (air supply port ø8x1 / delivery ports ø12x1,5)

3.1.2.3 Tag axle valve

Application

The tag axle valve is used is used for trailer suspension applications on trailers equipped with tag axles.

Function

Tag axle valve operation	Symbol
The valve is actuated by the iEBS modulator and it serves the purpose of holding the pressure or venting the bellow pressure of the tag axle. The solenoid modulator used by the tag axle valve consists of two 2/2 valves (one inlet valve (IV), and one outlet valve (OV)) that are actuated by solenoids and pilot valves.	

Function brake pressure	IV	OV	Operational description
Increasing	OFF	OFF	Pressure in the bellow pressure is increasing
Decreasing	ON	ON	Pressure in the bellow pressure is decreasing
Holding	ON	OFF	Pressure in the bellow pressure is held on a constant level

Technical data

Air working pressure (supply)	10 bar (nominal)
Weight	~ 0.7 kg

Variants

Part number	Thread size for fittings		
	Air supply (1)	Delivery port (2)	Air exhaust (3)
472 195 600 0	M22x1.5	M22x1.5	yes

3.1.2.4 Pneumatic push button

Application

Mechanically operated valve that is suitable (among others) for trailer air suspension applications. Used to manually adjust the chassis height (raise/lower), i.e., height corrections when the trailer is at the loading dock.

The design is based on a 3/2-way directional control valve that is operated mechanically via an integrated push button. It can be positioned & mounted to the inner side walls of the trailer's loading area. This is very helpful during loading or unloading, as the manual adjustment can comfortably be performed from the side of a trailer.

Variants

Part number	Description	Inlet (1)	Outlet (2)	Exhaust (3)
463 036 024 0	Push Button Directional Control Valve 3/2	M16 x 1.5	M16 x 1.5	M10 x 1

3.1.2.5 Trailer Air Suspension Control (TASC) with Return-to-Ride (RtR)

Application

Fitted to the air suspension on trailers that require a lifting & lowering function of the trailer chassis by a handle combined with a Return-to-Ride (RtR) function which is triggered by iEBS.

This valve is available in:

- Single-circuit suspension: The valve counts with one port for the air suspension bellows connection.
- Dual-circuit suspension: The valve counts with more ports for the air suspension bellows connection.

Function

TASC can be used to manually lift and lower the trailer chassis with an intuitive single-hand operation. The lifting/lowering process is started by simply turning the handle clockwise or counterclockwise. Upon releasing the handle from either turning the handle clockwise or counterclockwise, the handle is moved back into the stop position.

TASC can be operated with either levelling valves that feature the height limitation functions or not.

Depending on the variant, TASC will perform as per the following principles.

- Locking in lowering position: The lever can be locked in the lowering position. This will result in complete evacuation (exhausting) of the air suspension load bellows for all axles connected to TASC. The advantage is that the trailer chassis will automatically be lowered without holding the handle, as long as the handle remains in the locking position.
- Deadman control: The lever must be held in the lifting or lowering position. Upon releasing the hand, the lever automatically returns to the stop position.

Return-to-Ride: Is an integrated function that allows iEBS to set the lever position to drive (ride), for cases where the driver may not have manually reset the lever back to the driving level.

Height Limitation: Prevents potential damage to the air load bellows when manually raising the trailer chassis beyond the top limit. The air supply to port 1 of the TASC will be cut-off, only by the levelling valve with height limitation, stopping the inflation of the load bellows that will prevent the trailer chassis from raising any further. To support the RtR function, the height limitation supply port 1.1 of TASC variants with height limitation must be permanently pressure supplied.

Technical data

Air working pressure supply	10 bar (maximum)
Weight	~ 1.7 kg
Voltage / nominal current consumption	12 V ± 3 V / 0.62 A

Pneumatic connections

Port	Function
1	Air Supply
1.1	Height limitation supply port for RtR
21 - 23	Levelling Valve
22 - 24	Air Suspension Bellows

Variants

12 V variant part number	Circuit type	Handle mechanism	Height limitation supply port	Test connector	Fittings for ø tube size	
					Ports 1, 21 & 23	Ports 22 & 24
463 090 320 0	Single	Locking in lowering	✓	×	ø8x1	ø12x1.5
463 090 321 0	Single	Locking in lowering	×	×	ø8x1	ø12x1.5
463 090 322 0	Single	Locking in lowering	✓	✓	-	-
463 090 323 0	Single	Locking in lowering	×	✓	-	-
463 090 300 0	Dual	Locking in lowering	×	✓	ø8x1	ø12x1.5
463 090 301 0	Dual	Locking in lowering	×	×	ø8x1	ø8x1
463 090 302 0	Dual	Locking in lowering	✓	×	ø8x1	ø8x1
463 090 303 0	Dual	Locking in lowering	✓	✓	-	-
463 090 304 0	Dual	Locking in lowering	×	✓	-	-
463 090 305 0	Dual	Deadman	✓	×	-	-
463 090 306 0	Dual	Deadman	×	×	-	-

24 V variants part number	Circuit type	Handle mechanism	Height limitation supply port	Test connector	Fittings for ø tube size	
					Ports 1, 21 & 23	Ports 22 & 24
463 090 330 0	Single	Locking in lowering	✓	×	ø8x1	ø12x1.5
463 090 331 0	Single	Locking in lowering	✓	✓	-	-
463 090 332 0	Single	Locking in lowering	×	✓	-	-
463 090 310 0	Dual	Locking in lowering	×	✓	ø8x1	ø12x1.5
463 090 311 0	Dual	Locking in lowering	✓	×	ø8x1	ø8x1
463 090 312 0	Dual	Locking in lowering	✓	✓	-	-
463 090 313 0	Dual	Locking in lowering	×	✓	-	-
463 090 314 0	Dual	Deadman	✓	×	-	-
463 090 315 0	Dual	Locking in lowering	×	✓	ø8x1	ø8x1
463 090 316 0	Dual	Locking in lowering	✓	✓	ø8x1	ø12x1.5

3.1.2.6 Levelling valve

Application

Used in conventional air suspension systems to maintain the driving level of the trailer irrespective of the trailer load.

Function

This valve is fixed to the trailer chassis and actuated by a lever that is linked to the main axle. When the trailer is loaded, this valve will supply air into the suspension air bellows, resulting in lifting the trailer chassis towards driving level. When trailer is unloaded, this valve will exhaust air out of the suspension air bellows resulting in lowering the trailer chassis towards driving level.

During dynamic operational conditions and depending on the road conditions, the lever is exposed to vertical dynamic frequencies and travels within a range of marginal deflections. This levelling valve comes with a stroke dependent - 2 step - air flow characteristics that will minimize the air consumption.

The valve protects the load bellow pressure, if the supply pressure falls below the load bellow pressure level.

Height limitation function: With an add-on 3/2-directional control valve integrated to the levelling valve main body, the height limitation function is achieved (i.e., preventing raising of the trailer chassis beyond the permissible level).

At a predefined adjustable lever angle, this add-on valve will close. Any further lever deflection towards raising the chassis will result in exhausting its delivery supply.

Variants

Part number	Circuit variant	Supply port(s)	Delivery port(s)	Exhaust
464 006 540 0	Single	1	22	3
464 006 500 0	Dual	1	21 & 22	3
464 006 520 0	Dual with height limitation	1, 12 & 13	21, 22 & 23	3
464 006 580 0	Dual with inverted lever	1	21 & 22	3

Technical data

Air working pressure	13 bar (maximum)
Weight	~ 0.4 kg
Tightening torque for mounting bolts	maximum 25 Nm

3.1.2.7 eTASC

Application

The eTASC valve is an ECAS valve with a hand lever that is used to pressurize or exhaust the load bellows. The trailer chassis height can be adjusted by means of:

- Manual control: Turning the lever with hand (stationary condition, with or without electrical power)
- Automatic or remote control: Electric signal from iEBS (stationary or driving condition)

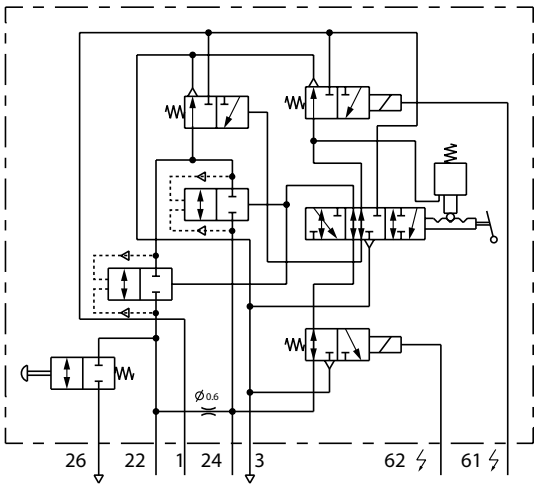
The eTASC valves operating voltage is 12 V and can control up to three axles when combined in one aggregate.

Function

The eTASC valve has two integrated solenoids that are used to control the chasis height. The device features the automatic Return-to-Ride function (RtR), which ensures the driving level is restored and maintained once a certain driving speed is reached.

The eTASC valve is a 1-point control valve, allowing to lift or lower the height of the chassis in accordance with one reference point which is the linkage of the height sensor

A 2-point control functionality is possible for drawbar trailers by connecting 2 eTASC devices to the same trailer. This allows for raising or lowering of the front axle and rear axle in accordance with the reference points. These can be controlled independently (1st device is connected to the front axle, while the 2nd device is connected to the rear axle).

Load bellow behavior via eTASC	Electrical sequence for single eTASC device (1-point control)	Symbol
Pressurizing: The load bellow(s) will be pressurized via the main suspension air source.	• The solenoid (61) is powered by iEBS • The load bellows of the main axle (connected to ports 22 & 24) will be pressurized	
Exhausting: Air inside the load bellow(s) will be exhausted through to ambient via the valve internal exhaust port.	• The solenoid (62) is powered by iEBS • The load bellows of the main axle (connected to ports 22 & 24) are deflated through the valve internal exhaust port (3)	

Technical data

Air working pressure (supply)	10 bar
Weight	~ 2.4 kg
Voltage / nominal current consumption	12 V ± 3 V / 0.625 A per solenoid

Pneumatic connections

Port	Function
11	Air Supply
22	From the load bellows of the non-lifting axle(s) circuit 1
24	From the load bellows of the non-lifting axle(s) circuit 2
26	Test connector
3	Exhaust

Variants

Part number	Description	Comments			
		Fittings	Test connector	Locking on lowering	Locking on lifting
463 090 500 0	eTASC	ø12x1,5 (3x)	✓	✓	-
463 090 501 0	eTASC	ø8x1 (3x)	✓	✓	-
463 090 502 0	eTASC	-	-	✓	-
463 090 503 0	eTASC	-	✓	✓	✓
463 090 504 0	eTASC	ø12x1,5 (2x) / ø8x1 (1x)	✓	✓	-
463 090 510 0	eTASC	-	✓	✓	-

3.1.2.8 Electronically Controlled Air Suspension valve (ECAS)

Application

The ECAS solenoid valves are used to pressurize or exhaust the air suspension bellows of trailers that are equipped with air suspension.

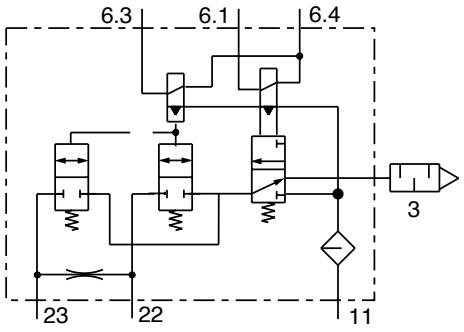
The ECAS valve allows remote height trailer control by electric signal from iEBS in stationary or driving condition when power is supplied to iEBS modulator from the truck or from an external battery.

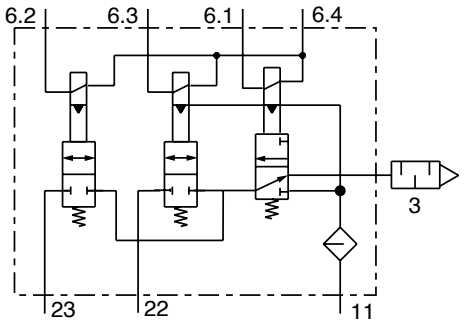
The ECAS valves operating voltage is 12 V.

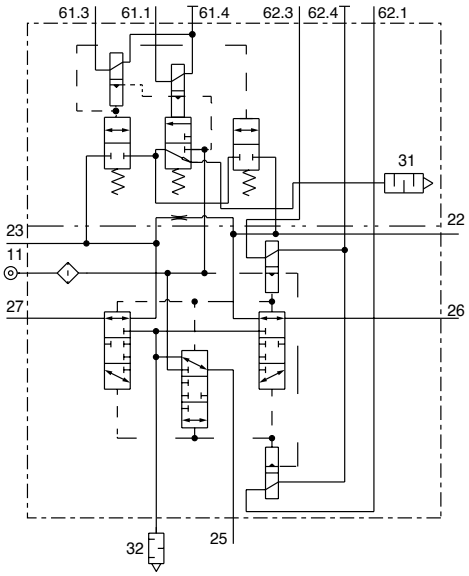
Function

The ECAS valve can be classified into 3 different types:

- ECAS single block valve (1-point control): Allows the lifting and lowering control function according to 1 reference point. The reference point can be either front or rear axle. This valve does not allow for independent left/right control
- ECAS dual block valve (1-point control): Allows the same lifting/lowering functionality as the ECAS single block (1-point control). In addition, the lift axle functionality is included (suitable as well for tag axles). The lift axle functionality of the ECAS dual block (1-point control) works in the same way as an LACV-IC and is used for inflating, exhausting and holding pressure from the lift/tag axle load and lift bellows.
- ECAS single block valve (2-point control): lifting/lowering function according to 2 reference points that can be controlled independently
  2-point control on drawbar trailers: Allows for independent lifting or lowering between the front and rear axles.
  2-point control on other trailer types: Allows independent lifting or lowering between the left and right side of the trailer axle.

Load bellow behavior via ECAS	Electrical sequence for control 1-point control ECAS valve	Symbol
Pressurizing: The load bellow(s) will be pressurized via the main suspension air source.	• The solenoids (6.1 + 6.3) are powered by iEBS • The load bellows of the main axle are pressurized via the valve ports 22 & 23	
Exhausting: Air inside the load bellow(s) will be exhausted through to ambient via the valve internal exhaust port.	• The solenoid (6.3) is powered by iEBS • The load bellows of the main axle (connected to ports 22 & 23) are deflated through the valve internal exhaust port (3)	
Hold: The load bellow is cut off from the the main suspension air source and from the ambient.	• No solenoids are powered by iEBS • The load bellows of the main axle (connected to ports 22 & 23) are closed and the pressure is on hold	

Load bellow behavior via ECAS	Electrical sequence for 2-point control ECAS valve	Symbol
Pressurizing: The load bellow(s) will be pressurized via the main suspension air source.	• When iEBS powers the ECAS valve solenoids (pin 6.1 + 6.3), the load bellows of the primarily controlled axle (connected to port 22) will be pressurized (i.e. rear axle for drawbars, or left side for semitrailers) • When iEBS power the ECAS valve's solenoids (pin 6.1 + 6.2), the load bellows of the secondary controlled axle (connected to port 23) will be pressurized (i.e. front axle for drawbars, or right side for semitrailers)	
Exhausting: Air inside the load bellow(s) will be exhausted through to ambient via the valve internal exhaust port.	• When iEBS powers the ECAS valve solenoid (pin 6.3), the load bellow of the main axle (connected to port 22) will be deflated via the exhaust port (3) • When iEBS powers the ECAS valve solenoid (pin 6.2), the load bellow of the main axle (connected to port 23) will be deflated via the exhaust port (3)	
Hold: The load bellow is cut off from the main suspension air source and from the ambient.	• No solenoids are powered by iEBS • The load bellows of the main axles (connected to ports 22 & 23) are closed and the pressures are on hold	

ECAS dual block valve: Lift axle operation	Sequence	Symbol
Lifting: The lift bellow of the lift axle will be air supplied, simultaneously, the load bellows of the lift axle will be exhausted through the valve internal exhaust port.	• The solenoid (pin 62.1) is electrically impulse controlled by iEBS • The lifting bellow(s) port (25) is pressurized via the supply port (1), inflating lift bellow(s) • The Lift axle's load bellow ports (26 & 27) are deflating through the internal exhaust port (32)	
Lowering: The pressurized lift bellow will be exhausted, simultaneously, the load bellows will be pressurized via the main suspension air source through the valve.	• The solenoid (pin 62.3) is electrically impulse controlled by iEBS • The lifting bellow(s) port (25) is connected to the internal exhaust port (3), deflating the lift bellow(s) • The main axle load bellows port (22 & 23) are connected to the lift axle's load bellow ports (26 & 27), and the axle load is balanced.	
Hold: Both solenoids 62.1 & 62.3 will be energized simultaneously, therefore all ports of the valve are cut off and holding its pressure.	• The solenoids (pin 62.1 + 62.3) are electrically impulse controlled by iEBS • The lifting bellow(s) port (25) is closed and the pressure is on hold • The load bellow ports of the lift axle (26 & 27) are closed and the pressure is on hold. The lift axle position remains fixed	

The hold position represents a special case and causes to isolate (hold) the pressure in all bellows. This will occur, for instance, when the pressure in the load bellows for the lift/tag axle vary while e.g., Traction Help or OptiTurn is active. This means, the pressure in the load bellows of the main axle is at its maximum and the pressure in the load bellows of the lift/tag axle is at a lower value.

Technical data

Air working pressure (supply)	5 ... 12 bar
Weight	~ 3.9 kg
Voltage / nominal current consumption	12 V ± 3 V / 0.625 A per solenoid

Pneumatic connections

Port	Function
11	Air Supply
22	From the load bellows of the non-lifting axle(s) circuit 1
23	From the load bellows of the non-lifting axle(s) circuit 2
26	To the load bellows of the lift/tag axle circuit 1
27	To the load bellows of the lift/tag axle circuit 2
25	To the lifting bellows (for tag axles this port is plugged)
31, 32	Exhaust

Variants

Part number	Description	Comments
472 890 076 0	ECAS single block valve (1-point control)	Lifting/lowering
472 890 114 0	ECAS dual block valve (1-point control)	Lifting/lowering; including lift axle functionality (No fittings)
472 890 115 0	ECAS dual block valve (1-point control)	Lifting/lowering; including lift axle functionality (ø8x1)
472 890 116 0	ECAS dual block valve (1-point control)	Lifting/lowering; including lift axle functionality (ø12x1.5)
472 890 117 0	ECAS dual block valve (1-point control)	Lifting/lowering; including lift axle functionality (ø8x1; ø12x1.5)
472 890 070 0	ECAS single block valve (2-point control)	Lifting/lowering; front and rear axle valve (drawbar trailers) or left and right valve (other trailer types)
472 890 022 0	ECAS single block valve (2-point control)	Lifting/lowering; front and rear axle valve (drawbar trailers) or left and right valve (other trailer types) 24 volts variant

3.1.3 Others

3.1.3.1 Non-return valve (check valve)

Application

This valve is used for multiple applications in compressed air systems. The function of a non-return valve is to limit the air flow in one direction. By design it will protect and secure the pressure level in one direction as the return is blocked by the check valve.

Typical applications where a protection upon pressure drop is required are self-contained circuits, reservoirs, spring brakes etc.

Variants

Part number	Description	Comments
434 014 000 0	Non-return check valve	Single check, 20 bar max. air working pressure. Thread M22x1,5

3.1.3.2 Directional control valve 3/2

Application

This valve is suitable for trailer air suspension applications to pneumatically control e.g., lift axles, chassis height (raise/lower), or circuits that are based on switching functions. The 3/2 way valve can be positioned & mounted directly into the air suspension circuit.

The pneumatic control will open or close the 3/2 way valve in order to internally connect port 1 with port 2 (pneumatic switch function), or port 2 with port 3 (exhaust function). The maximum working pressure is 10 bar.

Variants

Part number	Description	Inlet (1)	Outlet (2)	Exhaust (3)
571 040 000 0	Directional Control Valve 3/2	M14 x 1.5	M14 x 1.5	M14 x 1.5

3.1.3.3 Select High Valve (Double Check Valve - DCV)

Application

This valve is suitable for various applications that require the high-pressure control switch through, in cases of different pressure control input values being present, i.e., brake pressure values that are different between left and right, only the higher-pressure value will be switched through.

Simultaneously applying control pressure to both sides of the SH-DCV at port 11 and port 12, an internal piston will allow for the higher control pressure to switch through to port 2, while the lower control pressure will be blocked.

Variants

Part number	Description	Comments
434 208 028 0	Double check valve	M16x1.5, working pressure 8 bar (max. 10 bar)
434 208 029 0	Double check valve	M22x1.5, working pressure 8 bar (max. 10 bar)
434 208 055 0	Double check valve	M16x1.5 with spring, working pressure 8 bar (max. 10 bar)

3.1.3.4 Select Low Valve (Double Cut-Off Valve - DCOV)

Application

This valve is suitable for various applications that require the lower pressure control to switch through, in cases of different pressure control input values being present. Typical applications linked to 2S/2M configurations, e.g., the trailer self-steering axle.

During ABS control the lower pressure value between the left and right sides will be switched through, whilst braking on different road friction surfaces (split μ).

Function

Simultaneously applying control pressure to both sides of the SL-DCV at port 11 and port 12, an internal piston will allow for the lower control pressure to switch through to port 2, while the higher control pressure will be blocked.

Variants

Part number	Description	Comments
434 500 003 0	Double cut-off valve	M22x1.5, working pressure 8 bar (max. 10 bar)

3.2 Sensors

3.2.1 Wheel Speed Sensor (WSS - ABS Sensor)

Application

The wheel speed sensor (WSS) is used to detect the rotational speed of wheels in all kind of trailer applications

Function

The WSS will be triggered by the rotating pole wheel that is connected to the wheel hub. Depending on the rotational speed, an AC voltage is inducted and transmitted to the iEBS modulator where the AC frequency is calculated into a velocity.

Variants

Part number	Description	Comments
441 032 808 0	ABS wheel speed sensor	ABS sensor type S+ with 0.4 m connection cable
441 032 809 0	ABS wheel speed sensor	ABS sensor type S+ with 1.0 m connection cable
441 032 921 2	ABS repair kit	Repair kit (0.4 m sensor + bush + grease)
441 032 922 2	ABS repair kit	Repair kit (1.0 m sensor + bush + grease)
899 760 510 4	Sensor bush	

3.2.2 Height sensor

Application

The height sensor is used for permanent detection of height variation between axle and chassis of a trailer equipped with air suspension. For trailers equipped with mechanical suspension, the height sensor can be used to measure the axle load status by means of the leaf spring deflection.

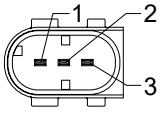
Variants

Part number	Description	Comments
441 050 202 0	Height sensor	
441 050 203 0	Height sensor	HDSCS connector turned 90°

Complementary elements for installation

Part number	Description	Comment
441 050 024 4	T shape lever	
441 050 641 2	Straight lever	Mounting conditions differ from the "T" shape lever
441 050 711 2	Linkage	Linkage length 209 ± 1 mm
441 050 712 2	Linkage	Linkage length 289 ± 1 mm
441 050 713 2	Linkage	Linkage length 299 ± 1 mm
441 050 714 2	Linkage	Linkage length 323 ± 1 mm
441 901 712 2	Linkage	Linkage length 235 ± 1 mm
441 905 711 2	Linkage	Linkage length 248 ± 1 mm
441 905 713 2	Linkage	Linkage length 262 ± 1 mm
441 906 710 2	Linkage	Linkage length 289 ± 1 mm
449 829 . . . 0	Height sensor's cable	Cable variant lengths: chapter "10.6 Cable overview", page 217

Connections

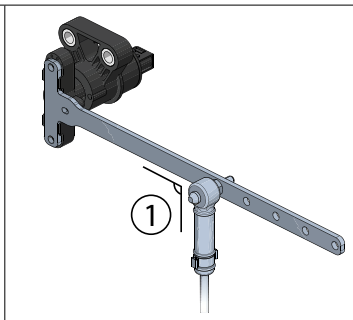
Pin	Electric data description	Image
1	Supply voltage	
2	Ground (GND)	
3	PWM out	

Technical data

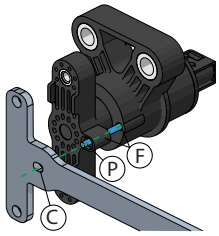
Resolution	0.2 °

Height sensor installation instructions

- The Height Sensor 441 050 202 0 is mounted to the cross member above the axle. If needed, a steel bracket may be fabricated and then welded to the cross member, in order to bring the height sensor to the appropriate mounting height.
- The height sensor shall be mounted vertically (hanging), both mounting holes on top.
- The height sensor linkage (441 050 71. 0) must be attached perpendicular to a fabricated bracket that is welded to the axle and vertically linked to the sensor lever (1). For an alternative connection use the linkage (433 401 003 0).

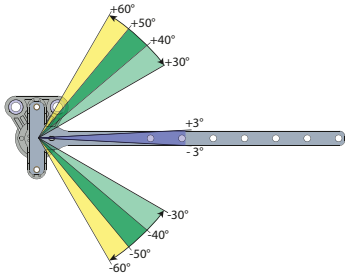


- The sensor lever should be installed by aligning the calibration hole of the T-shaped lever (C) with the fixation hole of the height sensor (F). A fixation pin (P) with a diameter of 4 mm can be temporarily installed to ensure that the height sensor arm is horizontaly positioned. The sensor lever must be horizontally aligned for accurate calibration during system diagnostics.
- ⚠ After installation, remove the fixation pin (P). It must be taken out prior to the calibration at the End of Line test.



- When installing the height sensor, the height sensor arm must be kept in horizontal position (tolerance ± 3°).
- The lever length shall be defined so that the entire suspension travel between the frame and axle will utilize a deflection of at least ±30° but shall not exceed ± 60°. The recommended lever travel range is between ± 40° and ± 50°.

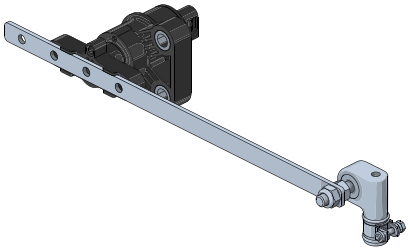
  ⚠ Please consider that additional holes can be drilled in the lever to adjust the recommended lever length. Recommended pivot distance for the linkage in mechanical suspension is between 50 and 100 mm.
- It is important that the height sensor always moves freely across its operating range, and that the lever can only move in the way intended.



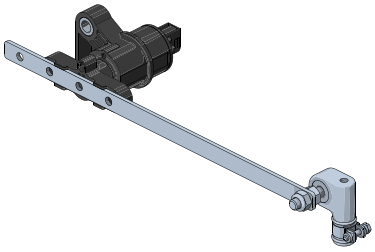
NOTICE

The conventional lever (e.g., PN 441 050 641 2) can be used as an option. In that case the height sensor shall be mounted 90° from the hanging position and the hole for the fixation pin must point upwards.

Clockwise



Counter-clockwise



3.2.3 Pressure sensors

3.2.3.1 Pneumatic pressure sensor

Application

Pneumatic pressure sensors are used to measure and monitor air pressure values of any kind. Typically used for brake or suspension applications in trailers.

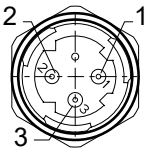
Function

The pneumatic pressure sensors permanently measure air pressure values by transmitting electrical voltage values to the iEBS modulator. Deviations or change of air pressure values will be transmitted by way of voltage value changes.

Technical data

Measuring range / admissible overpressure	0 ... 10 bar / 16 bar (maximum)
Resolution	400 mV / bar
Thread	M16x1.5

Connections

Pin	Electric connection description - 4-pole, DIN 72585-A1-3.1-Sn/K2	Image
1	Voltage (8 ... 32 V)	
2	Ground (GND)	
3	Signal out	
4	-	

Variants

Part number	Description	Comments
441 044 101 0	Pressure sensor for flat sealing	Pressure sensor cable: 449 826 . . . 0 Cable lengths in chapter "10.6 Cable overview", page 217
441 044 102 0	Pressure sensor with O-ring	

3.2.3.2 Hydraulic pressure sensor

Application

Hydraulic pressure sensors are used to measure and monitor pressure values in an hydraulic circuit. It is typically used for measuring the load status in trailers with hydraulic suspension.

Function

The hydraulic pressure sensors permanently measure the hydraulic suspension pressure values by transmitting electrical voltage values to the iEBS modulator. Any change of the pressure values will be directly transmitted by way of changing voltage values. The pressure sensor shall be selected based on the pressure values that are specified for the suspension type. The signal output must be linear between 0.5 and 4.5 V. (e.g., Hydraulic pressure sensor: 0 to 250 bar => 0.5 to 4.5 V)

The hydraulic pressure value is converted to a pneumatic reference pressure value when using the iEBS diagnostic software. This simplifies the setting of parameters.

Variants

Hydraulic pressure sensors are not part of ZF supply portfolio.

3.3 Switches

3.3.1 Electrical switches and push buttons

Application

Electric switches are used to provide an electrical control signal (low current) to iEBS that triggers a function.

In this manual we define the terminology as follows:

Push button: Momentarily changing electric condition as long as it is pressed

Switch: Permanently changing electrical condition until it is pressed again.

3.3.1.1 Push button

Common type of electrical connection for push buttons are:

- Push button (momentary - normally open): It will connect the circuit only while pressed, turning ON the device connected to it. This type of push buttons are also known as "push to make".
- Push button (momentary - normally closed) It will break the circuit once pressed, turning OFF the device connected to it. This type of push buttons are also known as "push to breake".

Variants

Part number	Description	Mounting	Circuit type	Cable
441 006 029 0	Push button (green)	Central thread	Momentary actuation (Normally open)	Switch cable 449 448 060 0
441 006 030 0	Push button (green)	Housing socket	Momentary actuation (Normally open)	

3.3.1.2 Rotary switch

Application

Switches are electrical devices that are used for switching electric functions. For iEBS, a switch is manually operated by the user and will keep the electric function ON - OFF

Common type of electrical devices are:

- Rotary switch (mantained): Switch operated by rotation and remains the electrical function either OFF or ON.
- Rotary switch (momentary): Switch operated by rotation and is actuated only when someone is operating the switch.

Part number	Description	Mounting	Circuit type	Cable
441 006 031 0	Rotary switch (yellow)	Central thread	Mantained actuation (Normally open)	Switch cable 449 448 060 0
441 006 032 0	Rotary switch (blue)	Central thread	Momentary actuation (Normally open)	

3.3.1.3 Pressure switch

Application

The electrical contact is activated (ON or OFF) upon reaching a specified air pressure value. Once the pressure threshold is reached, the electrical circuit will be closed (Normally open - NO) or open (Normally Closed - NC).

Technical data

Degree of protection	IP5K4K, IP6K7, IP6K9K
Nominal voltage	12 / 24 V DC
Air working pressure	≤12 bar
Maximum switch frequency	30 operations per minute

Variants

Part number	Description	Comments
441 014 602 0	Pressure switch	Normally open contact (NO), switch pressure 0.4 ± 0.15 bar

3.3.1.4 Proximity switch

Application

The proximity switch is an electrical switch that operates by detecting the presence of an objects. When the object is detected, the proximity switch will automatically open or close the electrical circuit without touching or mechanically switching contacts.

Proximity switches are commonly used to activate safety GIO functions on trailers (e.g., SafeStart or road finisher brake functions)

Common type of electrical connection for proximity switches are normally open or normally closed, which represent the state of the switch before it is activated by the target object:

- Normally open: Indicates that the internal electronic switch closes when the proximity sensor detects an object (if the object is within the active zone → output switched).
- Normally closed: Indicates that the internal electronic switch opens when the proximity sensor detects an object (if the object is within the active zone → output blocked).

Variants

Proximity switches are not part of ZF supply portfolio.

The following list shows some minimum requirements that makes a proximity switch compatible with iEBS

Characteristics	Recommendation
Operating voltage	8 to 32 V
Connection type	3-wire technology (positive or negative switching)
Nominal sensing range	From 20 to 40 mm depending on the type of application
Minimum degree of protection	IP 6K7; IP 6K9K
Standard sensed objects	Metallic (steel, stainless steel, brass, aluminium, copper)

3.4 SUBSYSTEMS

3.4.1 SmartBoard™

Application

SmartBoard is an interactive display unit that is used to electronically monitor and display information from a trailer equipped with iEBS. SmartBoard can actively control several of the trailer's suspension and braking functionalities.

Function

Enables specific trailer functions and displays trailer information by way of a simple, user-friendly, eight button control pad. It comes with an intuitive menu structure and an icon-oriented display. The power for the SmartBoard will normally be supplied by iEBS.

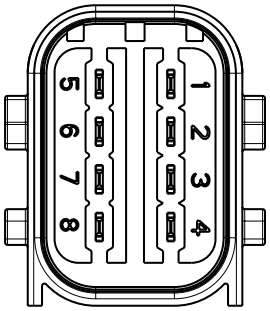
- Wake-Up Mode: SmartBoard will start operating by pressing any button. When not connected to the power cable, the power is supplied by internal battery. In this case, SmartBoard might not start up when the remaining battery power is low in order to prevent deep discharging.
  When the battery capacity drops under 30 %, a warning information is displayed.

Technical data

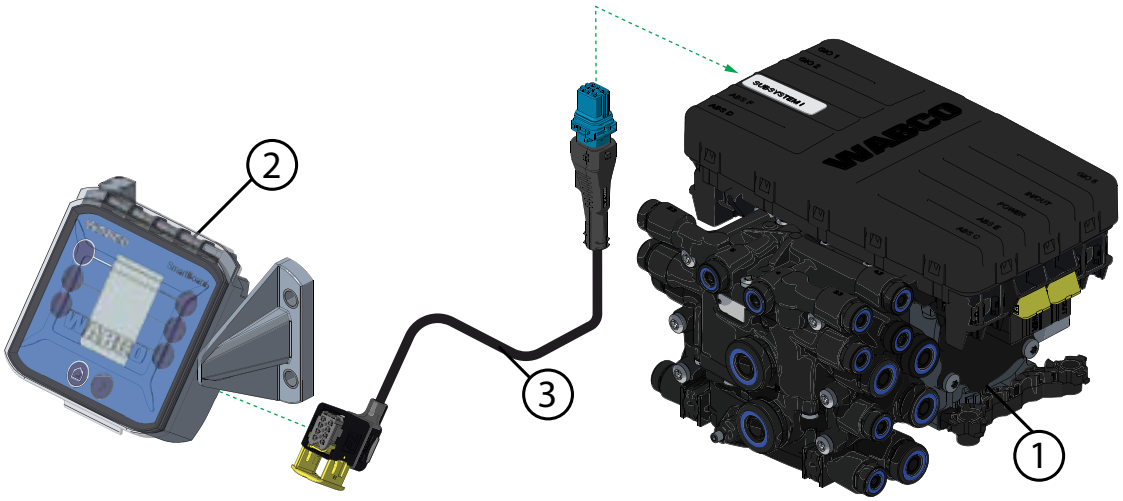
Voltage range operation	8 V to 32 V
Degree of protection	IP 6K9K ISO 20653
Torque for mounting screw	15 Nm ± 15 %

Connections

The SmartBoard is connected using an HDSCS connector for power supply and CAN communication via the iEBS SUBSYSTEMS port.

Pin	HDSCS pining description	Image
1	CAN Low	
2	CAN High	
3	-	
4	-	
5	-	
6	-	
7	Supply	
8	Ground (GND)	

Connecting the components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		
2	446 192 210 0	SmartBoard	449 929 . . . 0	Battery included (lifetime approx. 6 years)
	446 192 211 0	SmartBoard for ADR trailers	449 929 . . . 0	Without battery
3	449 929 . . . 0	HDSCS cable for SmartBoard		Cable lengths in chapter "10.6 Cable overview", page 217

Additional information

Description	QR code
SmartBoard - System Description	

3.4.2 OptiTire™

Application

OptiTire is a Tire Pressure Monitoring System (TPMS) for trailers, trucks and buses. It provides continuous monitoring of pressures and temperatures of the vehicle's tires.

OptiTire can be set up as an independent system using the OptiTire ECU connected to any iEBS modulator variant (e.g., for trailers with up to 5 axles). For trailers with more than 5 axles or trailer applications that require an extended range of radio receiving, up to 3 additional OptiTire ECUs might be added as Range Extender

OptiTire can be set up as well as an integrated function in iEBS Standard and iEBS Premium. The iEBS with integrated OptiTire can also use up to 3 external OptiTire ECUs as range extenders, to improve the receiving performance on complex applications. Further information can be found on chapter "5.1.5 Integrated functions", page 130

Function

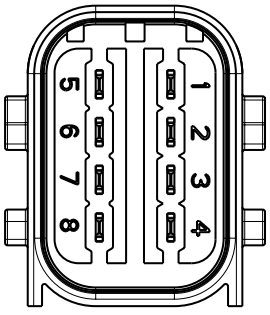
Tire pressures are measured by individual sensors. The measured values obtained by the sensors are repetitively transmitted to the OptiTire ECU via radio signal.

Four different sensor types are available:

- External Wheel Sensor (WM2): Outside mounting to the existing wheel bolts. External sensors are not supported on devices with integrated OptiTire functionality (e.g., iEBS Standard, iEBS Premium and SCALAR EVO Pulse).
- Internal Wheel Sensor (WIS): Inside mounting fixed to the rim by means of valve neck. It has a transmission baud rate of 19200 baud.
- Blue Strap Mounted Sensor (Blue SMS): Inside mounting to the rim circumference by means of a hook-and-loop fasteners strap band. It has a transmission baud rate of 19200 baud.
- Grey Strap Mounted Sensor (Grey SMS): Inside mounting to the rim circumference by means of a hook-and-loop fasteners strap band. It has a transmission baud rate of 9600 baud.

The connection to the iEBS SUBSYSTEMS provides power and data forwarding to iEBS and CAN bus members like SmartBoard or the telematic units.

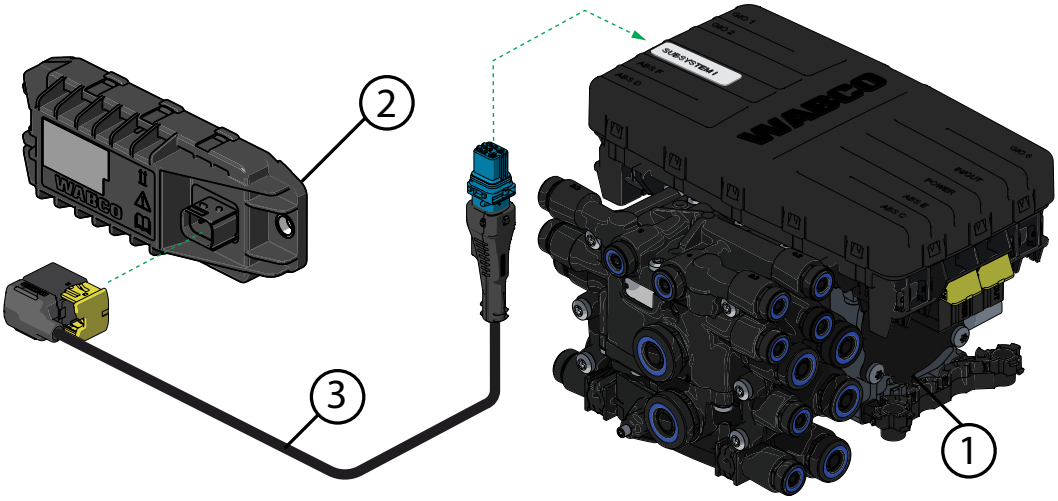
With iEBS as the gateway to the ISO 7638, all tire data according to the UN/ECE R13 can be forwarded to the driver’s dashboard.

Pin	HDSCS Pining description	Image
1	CAN Low in/out	
2	CAN High in/out	
3	-	
4	-	
5	-	
6	-	
7	Operating voltage (input, typ. +24 V, terminal 30)	
8	Ground (GND)	

Technical data

Voltage	8 V to 32 V
Radio frequency	433 MHz
Maximum number of wheels modules	• 20 distributed on up to 5 axles (maximum 4 wheel modules per axle) • 2 spare wheels

Connecting the components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator (Basic)		
2	446 220 110 0	OptiTire	449 928 . . . 0	
3	449 928 . . . 0	HDSCS cable		Cable lengths in chapter "10.6 Cable overview", page 217
-	446 220 100 0	OptiTire (Trucks)		OptiTire device dedicated for truck and buses.

Additional information

Description	QR code
OptiTire™ - System Description	
OptiTire™ - Overview of components in the trailer	

3.4.3 ZF Telematics

Application

Telematics devices provide truck and trailer information that are used for different business applications. Telematics will assist in managing a fleet, increase the driver's safety, and improves the trailer maintenance.

A Trailer telematics offers several benefits such as:

- Trailer geographic position, actual condition (stationary or moving)
- When a telematic is connected to the iEBS SUBSYSTEMS port, further information can be retrieved like the iEBS fault codes in case of malfunction
- Basis for the connection of 3rd party telematic device is the Trailer CAN standard.

Function

ZF Telematics devices allow the access to the TrailerFit portal which provides a detailed view into the trailer's health. Events in the iEBS ODR can be presented with the GPS position and all trip information. As an example, an ABS intervention can be shown with the position on a map, with mileage, with axle load and further trip information.

The following telematic devices are supporting the TrailerFit portal

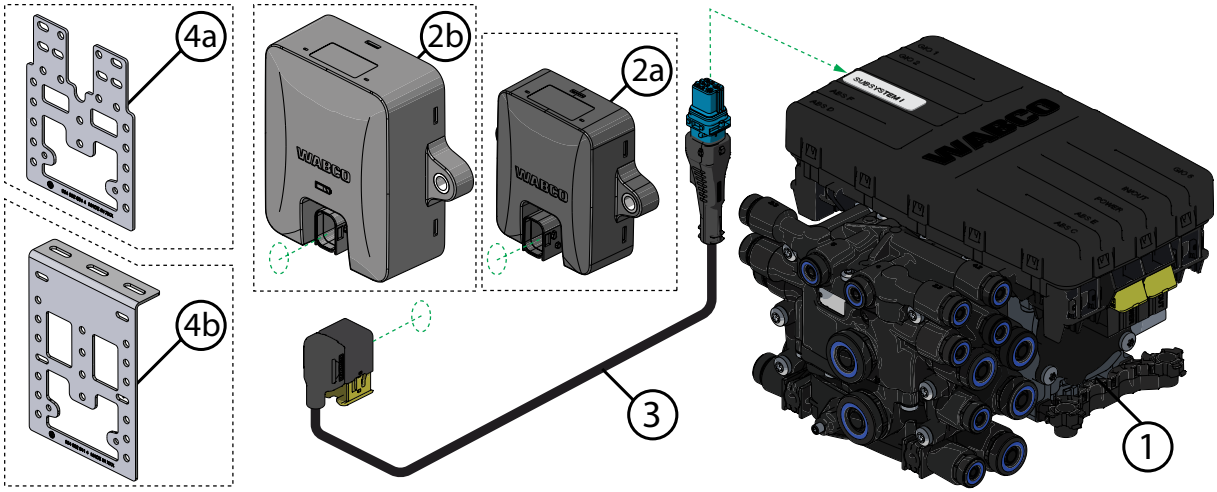
- TX-Trailer Pulse: Low cost telematic device that fulfils standard requirements and complies to ADR regulations for the carriage of dangerous goods.
- SCALAR EVO Pulse: Telematic device with battery. It complies with ADR regulations. Additionally, an integrated OptiTire receiver compatible with SMS sensors is monitoring the TPMS information. With the integrated battery, the position of a trailer can be monitored up to 160 days, even when uncoupled.
- SCALAR EVO Guard: Premium telematic device that allows to monitor and control setting of external sensors (e.g., reefer communication, temperature sensors and door sensors). With the integrated battery, the position of a trailer can be monitored up to 160 days, even when uncoupled.

Technical data

	TX-TRAILERPULSE	SCALAR EVO Pulse	SCALAR EVO Guard
Dimensions (including fixing points)	125 x 103 x 44 mm	154 x 132 x 50 mm	218 x 152 x 63 mm
Dimensions (excluding fixing points)	82 x 103 x 44 mm	105 x 132 x 50 mm	175 x 152 x 63 mm
Weight	~ 0.25 kg	~ 0.48 kg	~ 0.9 kg
Ingress protection (IP)	IP6K6K / IP6K9K ISO 20653		
Input voltage range	10 to 32 V		9 to 32 V

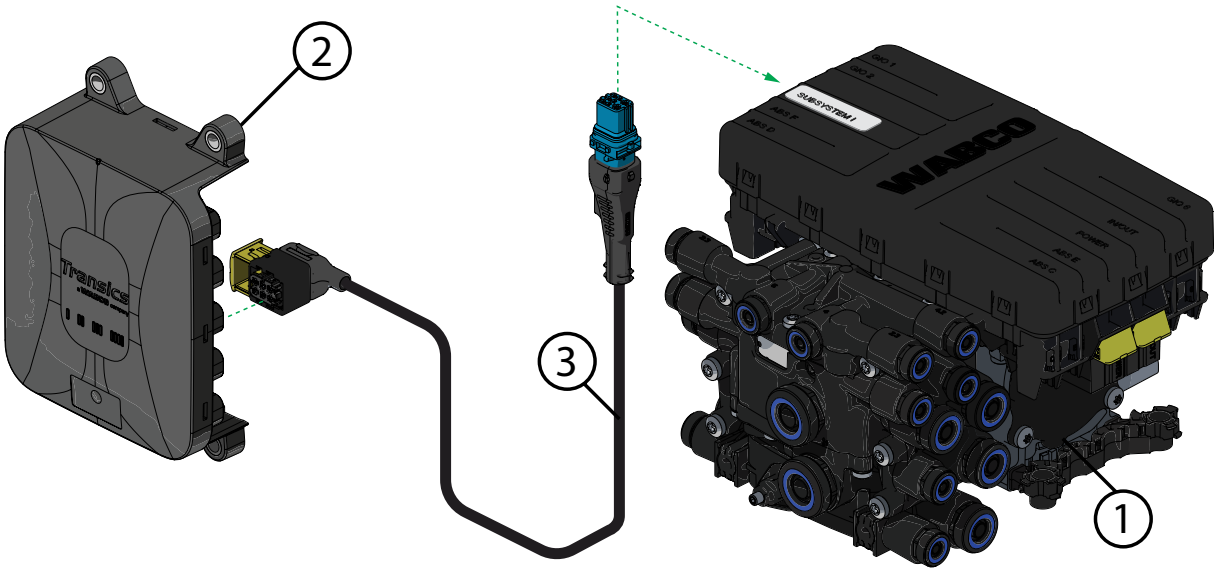
Connecting the components

TX-TRAILERPULSE and SCALAR EVO Pulse



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		
2a	346 291 000 0	TX-TRAILERPULSE	449 928 . . . 0	
2b	346 292 000 0	SCALAR EVO Pulse	449 928 . . . 0	Includes battery and integrated OptiTire functionality
2b	346 292 001 0	SCALAR EVO Pulse	449 928 . . . 0	Includes battery and integrated OptiTire functionality. With surge protection
3	449 928 . . . 0	HDSCS cable		Cable lengths in chapter "10.6 Cable overview", page 217
4a	554 052 051 4	Advanced I - Bracket		Bracket for TX-TRAILERPULSE and SCALAR EVO Pulse. The Advanced I is the default bracket. The L bracket is an alternative
4b	554 052 041 4	L - Bracket		

SCALAR EVO Guard



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		
2	346 290 000 0	SCALAR EVO Guard	449 936 050 0	
3	449 936 050 0	HDSCS cable (6 pin)		Cable lengths in chapter "10.6 Cable overview", page 217

Additional information

Description	QR code
Detailed information about SCALAR EVO solutions can be found at: https://www.zf.com/products/en/cv/fleet/fms_for_cargo/fms_for_cargo_transics	

3.5 Others

3.5.1 Router / Repeater

Application

Used in road train applications or extendable trailers. The device supports bi-directional communication between the towing vehicle and the trailer iEBS and further trailers.

- Router: ISO 11992 CAN communication to a second trailer (road trains)
- Repeater: Support of extra-long trailers (more than 18 m CAN-line inside the trailer respectively 80 m in total).

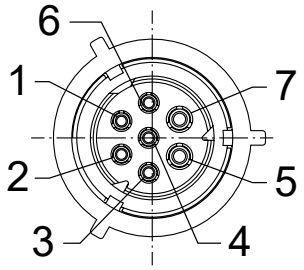
Function

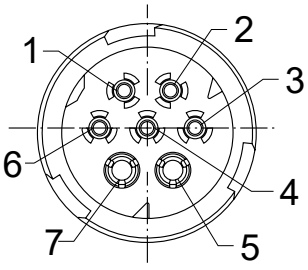
The CAN router receives the CAN brake signal of the towing vehicle and distributes the signal to up to five iEBS modulators.

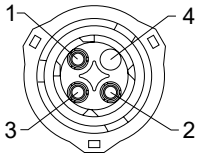
Some router and repeater variants are equipped with a port for a pressure sensor. The pressure sensor shall be connected to the control line (close to the yellow coupling) to speed up the pneumatic brake signal to the iEBS modulator. This will improve the response time in case the CAN signal via ISO 7638 is missing. Compatible pressure sensor can be found in chapter "3.2.3 Pressure sensors", page 73.

The Router/Repeater is fully compliant with ISO 11992. Road trains may be composed with trailers using different brake systems if they all comply to the UN/ECE R13.

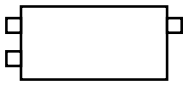
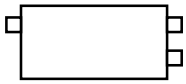
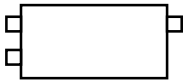
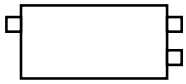
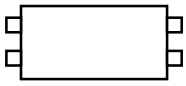
Connections

Pin	Power IN	Image
1	Data line CAN-L	
2	Data line CAN-H	
3	Warning lamp	
4	Ground (Terminal 15)	
5	Ground (GND)	
6	Terminal 15	
7	Terminal 30	

Pin	Power OUT 1 / OUT 2	Image
1	Data line CAN-L	
2	Data line CAN-H	
3	Warning lamp	
4	Ground (Terminal 15)	
5	Ground (GND)	
6	Terminal 15	
7	Terminal 30	

Pin	Pressure sensor	Image
1	Sensor supply	
2	Ground (GND)	
3	Sensor in	
4	-	

Variants

Part number	Housing	Plug			
		Power IN	Power OUT 1	Power OUT 2	Pressure sensor port
Router 446 122 050 0		Female	Male	Male	-
Repeater 446 122 051 0		Female	Male	-	Female
Router 446 122 052 0		Male	Male	Male	-
Repeater 446 122 053 0		Male	Male	-	Female
Router 446 122 054 0		Male	Male	Male	Female
Router 446 122 056 0		Female	Male	Male	Female

Limitations

Router/Repeater is subject to ISO 7638, it is not possible to configure via 24N.

Additional information

Description	QR code
Router & Repeater - System Description for TEBS E	

3.5.2 Buzzer

Application

The buzzer is an external acoustic device for all type of trailers that require an additional warning to the user of systems such as TailGUARD or GIO functions (e.g., immobilizer or tilt alert).

The buzzer is only an “add on” and has no influence on the actual systems or functions.

Technical data

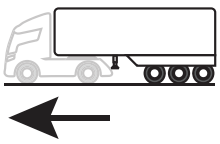
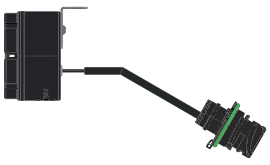
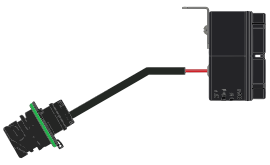
Degree of protection	IP67
Nominal voltage	12 / 24 V DC
Current consumption	300 mA
Sound pressure level (resonant frequency)	91 dB ± 3 dB (1.5 kHz ± 300 Hz)
Mounting screws / Tightening torque	2x M6 / 6 ±1 Nm

Variants

Part number	Description	Comments
894 450 000 0	Buzzer	Cable required 449 408 . . . 0. Cable lengths in chapter "10.6 Cable overview", page 217

Installation

The Buzzer will be mounted to the tail of the trailer (vehicle frame, body or support). The buzzer shall be mounted on an area protected from splashing water and dirt ingress.

Driving direction	Permitted mounting positions		
	Facing front	Facing rear	Facing sides
			

3.5.3 External green warning lamp

Application

Frequent applications for the green warning lamp are:

- For active signals, either ABS or RSS
- Overload signal: indicates that the maximum weight has been exceeded
- Trailer's chassis height: ECAS height outside a certain level (e.g., the driving level)
- Lift axle status: indicates if the lift axle is raised/lowered

Function

The green warning lamp provides a visual signal to the driver about the functional status of the system the green lamp is connected to. The warning lamp shall be installed according to the corresponding legal requirements.

The green lamp is a multi-voltage LED lamp that operates at optimum performance with 12 V and 24 V systems.

The LED type of the green warning lamp requires correct polarity.

Technical data

Electrical connector	Female Tyco AMP superseal connector (part no 282080-1)
Mounting screws / Tightening torque	(2x) Flange head M4 screws / 1 ± 0.1 Nm

Variants

Part number	Description	Comments
446 105 523 2	External green warning lamp	Cable for green warning lamp: 449 940 . . . 0 Cable lengths in chapter "10.6 Cable overview", page 217

4 iEBS modulator features

4.1 Technical features

Technical data

iEBS modulators are equipped with:

- Two ABS solenoid modulator valves for controlling the brake cylinders
- 2 or 4 input channels for wheel speed sensors (depending on the variant)
- CAN interface according to ISO 11992, for the truck-trailer communication
- 1 lateral acceleration sensor for monitoring the driving stability (used for RSS)
- 1 internal pressure sensor to measure the brake control pressure (yellow coupling head)
- 2 internal pressure sensors for measuring the output pressures for the brake cylinders
- 1 internal pressure sensor for monitoring the supply pressure (brake reservoir)
- 1 internal pressure sensor to measure the axle load (variants for air suspended trailers)
- A Pneumatic Distribution Module (PDM) equipped with the emergency brake function and all pneumatic connections
- A redundancy valve to ensure basic brake function in case there is no electrical power

Connections

Electric connections: An overview of the electrical connectors per iEBS variant can be found in the chapter "10.4.1 Electric connections", page 212

Pneumatic connections: An overview of pneumatic ports designation and fitting configurations per iEBS variant can be found in the chapter "10.4.2 Pneumatic connections for iEBS", page 213

Variants

A full variant overview can be found in the chapter "10.1 iEBS variants", page 210

Installation

A full description of the installation process and technical data based on the part number can be found in the chapter "6 Installation guide", page 188

Additional information

Go to www.wabco-customercentre.com/catalog
Search for the iEBS modulator by entering the part number (e.g., 480 102 201 0) in the search box
Select the product from the results to be directed to the details of the device

4.2 Braking functions

Braking functions overview

Braking functions	Description	Reference
Anti-Lock Braking function (ABS)	Anti-Lock Braking function (ABS) optimizes trailer control during emergency braking by preventing wheels from locking tendency.	Chapter 4.2.1 - see page 89
Rollover Stability Support (RSS)	Rollover Stability Support (RSS) automatically brakes the trailer when it threatens to rollover during cornering. It helps to stabilize the trailer within the physical limits, significantly reducing the risk of rollover.	Chapter 4.2.2 - see page 98
Load sensing function	Primary function used to improve the braking compatibility in a truck-trailer combination by automatically adapting the brake force in proportion to the axle load.	Chapter 4.2.3 - see page 102
Standstill function	Function that switches from electric brake control to redundancy braking during standstill situation to avoid unnecessary power consumption by the iEBS modulator.	Chapter 4.2.4 - see page 109
Emergency braking	This function simulates a laden characteristic by applying 6.5 bar to ensure the maximum deceleration is achieved if an emergency brake situation is detected.	Chapter 4.2.5 - see page 109
Anti-compounding protection	Function that prevents the application of both, the spring and service brakes simultaneously.	Chapter 4.2.6 - see page 109
Overflow Valve Air Suspension (OVAS)	Integrated charging valve that protects the brake system air pressure level in the event of a pressure drop in the air suspension system. This ensures a minimum pressure level of 5 bar inside the brake circuit.	Chapter 4.2.7 - see page 109
Reservoir pressure monitoring	A safety function that is constantly monitoring the reservoir supply pressure. Pressure levels below 4.5 bar will be alerted via a warning light.	Chapter 4.2.8 - see page 110
Brake pressure control	The internal brake pressure control of the iEBS will adjust the delivery pressure (output to actuator) in proportion to the control pressure (p_m input) in accordance with the trailer's load.	Chapter 4.2.9 - see page 110
External demand pressure sensor	For truck trailer combinations where the truck does not provide the brake demand via CAN. To improve the brake application time, an optional external demand pressure sensor can be installed. This converts the pneumatic control pressure into an electrical signal that will be transmitted to iEBS.	Chapter 4.2.10 - see page 111

4.2.1 Anti-Lock Braking function (ABS)

Application

Anti-Lock Brake Systems (ABS) are designed to prevent the trailer wheels from locking as a result of the service brake being applied. This ensures trailer stability during braking.

Applicable to all trailers subject to category O3 and O4.

Regulation

As per UN/ECE R13, since October 1991, ABS is mandatory for trailers of category O4 when certifying a new vehicle for the first time. ZF ABS meets the performance requirements that has significantly contributed to enhance road safety. Today the ABS function is integrated into iEBS and continuously regulated by UN/ECE R13.

Function

The integrated ABS function requires wheel speed sensors (WSS) that are installed to the wheel ends of the trailer. The sensors are constantly providing wheel speed signals to the iEBS when the trailer is in motion.

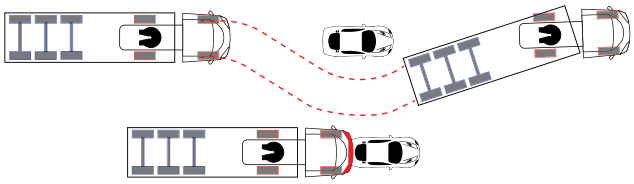
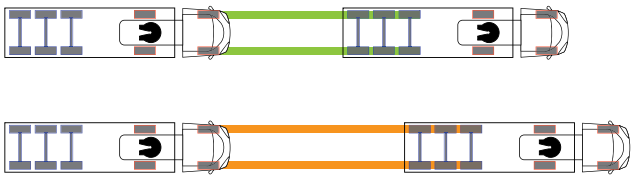
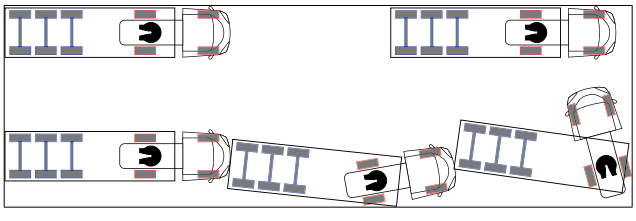
During a potential wheel lock event, the ABS control logic, using information provided by the wheel speed sensors, sends signals to the appropriate ABS solenoid modulator valve(s) to hold, apply or release the brakes as needed. The ABS function works automatically, and the driver does not have to select this feature.

The aim is to maintain cornering forces on braked wheels, to ensure that the vehicle - or vehicle combination retains its driving stability and maneuverability within the possible physical limits.

ABS control will maximize the utilization of adhesion or friction between the tires and the road surface without locking the tires. This will lead to minimizing the braking/stopping distance whilst maximizing the trailer deceleration.

iEBS is constantly monitoring the rotational speed of the sensed wheels. During an imminent occurring wheel locking event, the iEBS modulator will intervene (the braking pressure will be reduced until the wheels will rotate again, before starting the same brake process over again).

ABS benefits

Securing steerability Effectively supports the driver during braking maneuvers to help maintain the trailer stability and steerability		ABS NO ABS
Shortening braking distances Greater deceleration rate during hard brake applications.		ABS NO ABS
Security braking safety ABS control ensures braking stability of the truck-trailer combination helping to avoid jack-knifing situations (trailer & truck becoming unstable leading to a folding pocket knife effect, potentially causing the trailer to hit the truck cabin).		ABS NO ABS

Installation

The signals from ABS wheel speed sensors C-D and E-F are evaluated for the ABS control logic.

For all ABS configurations (chapter "4.2.1.1 ABS configurations", page 91) additional brake cylinders for other axles can be connected to the existing modulators along with the brake cylinders of the wheels with sensors. These indirectly controlled wheels do not send any information to the iEBS modulator. Therefore, it cannot be guaranteed that indirectly controlled wheels (non-sensed wheels) will not lock.

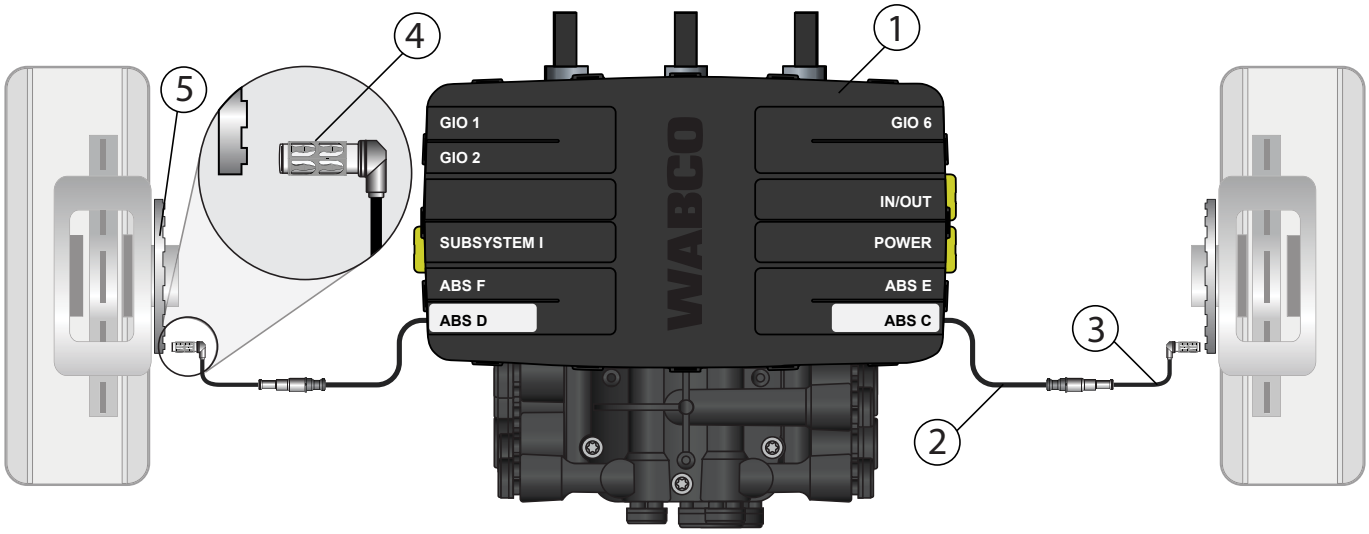
Tire size parameter setting

To allow for an optimized ABS control function, it is required to enter the correct parameter setting of the tire dimensions (main axle definition, number of teeth on the pole wheel and tire circumference).

A deviation of ±20% of the defined tire sizes from the installed pole wheel is allowed, as long as this affects all wheels with sensors in the same way. A single wheel can have a maximum deviation of 6.5% from the tire size parameter value. For further information go to section "Single, super single and twin tires" on page 17

The tires can be configured in the iEBS diagnostic software in tab System > Parameters > (1) Vehicle > Axle definition

Connecting components



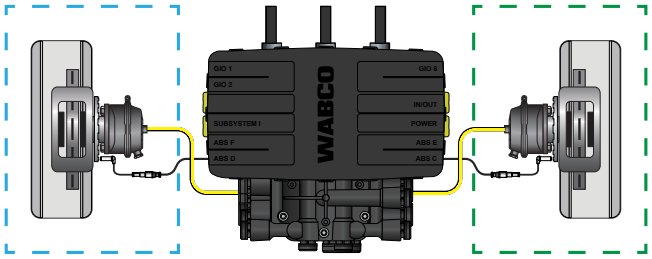
Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		
2	449 733 . . . 0	Cable for wheel speed sensor		Connect into ABS's ports Cable lengths in chapter "10.6 Cable overview", page 217
3	441 032 808 0	ABS wheel speed sensor	449 733 . . . 0	ABS sensor type S+ with 0.4 m of cable
	441 032 809 0	ABS wheel speed sensor	449 733 . . . 0	ABS sensor type S+ with 1.0 m of cable
4	899 759 815 4	Sensor bush		
5	Not supplied	Tooth wheel		

4.2.1.1 ABS configurations

The ABS configuration should be carefully chosen based on the trailer's wheel locking behavior. Axle load in air suspensions is usually dynamically balanced, where mechanical suspensions may or may not be balanced. In order to have the best performing ABS control, while achieving the least wheel locking for mechanical suspensions, a 4S configuration (with 4 sensors) is suggested.

From the speed behavior of the wheels, the control logic determines whether one or several wheels show a locking tendency and decides whether the respective braking pressure must be lowered, held or increased.

The below overview shows the various configurations and explains the differences between them.

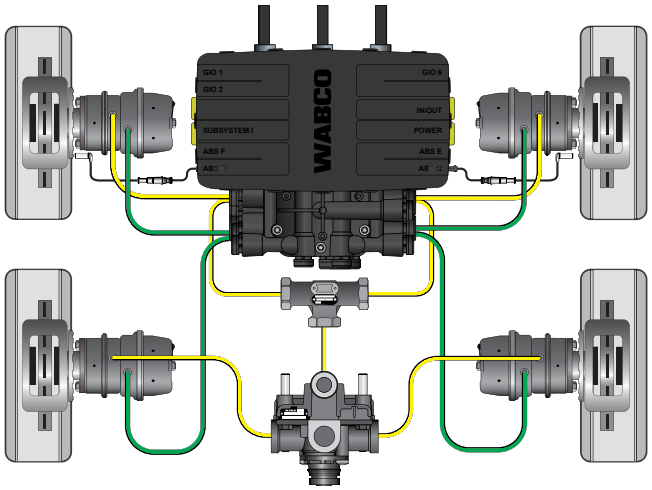
2S/2M	Components	Vehicle type
	1x iEBS modulator 2x ABS speed sensor	1 to 3-axle semitrailer / central axle trailer
	Trailer suspension	
	Air suspension, hydraulic or mechanical suspension	

Description

ABS control principle IC: At each side, one ABS wheel speed sensor and one ABS solenoid valve, will form an individual side-by-side control channel (IC), this means the brake control principle (IC) is operating independently side-by-side.

The 2S/SM ABS configuration will show the best ABS control performance during full braking. During ABS brake control, the brake pressure is individually maximized on each side. That will allow for the best possible and shortest stopping distance.

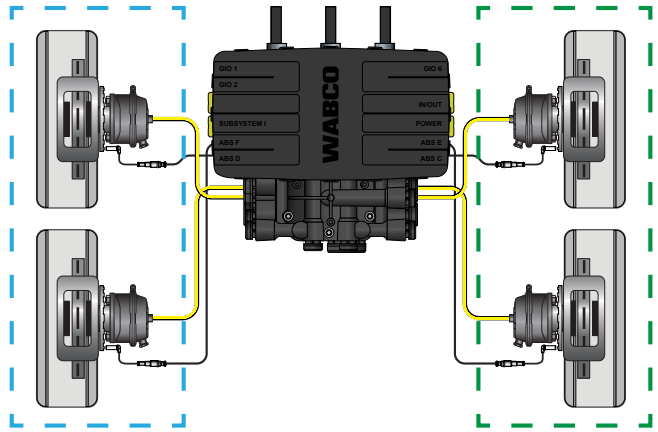
Brake actuators of additional wheels that are not equipped with wheel speed sensors can be pneumatically connected side-by-side to the (IC) sensed wheels, however those non-sensed wheels may show locking tendency as they will only be indirectly controlled (IDC).

2S/2M+SLV	Components	Vehicle type
	1x iEBS modulator 2x ABS speed sensor 1x Select low valve (SLV) 1x Relay valve	1- to 3-axle semitrailer / central axle trailer
	Trailer suspension	**Dedicated to**
	Air suspension, hydraulic or mechanical suspension.	Trailers with one self-steering axle

Description

ABS Control principle IC + IDC: This configuration is dedicated to trailers equipped with a self-steering axle to improve the stability of the self-steering axle during ABS brake control on road surfaces with different friction coefficients between each side of the trailer (left & right).

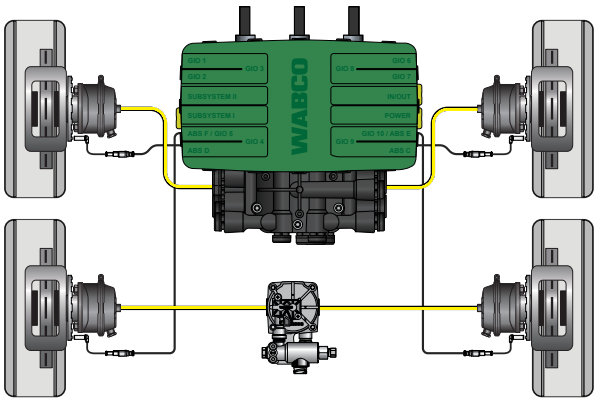
Via a Select Low Valve (SLV), it will allow for the lower pressure value from the side-by-side pressure control channels (ABS solenoid valves) to feed the Relay Valve (RV) that will distribute equal brake pressure to the brake actuators of each side of the self-steering axle (IDC).

4S/2M	Components	Vehicle type
	1x iEBS modulator 4x ABS speed sensor	2 to 3-axle semitrailer / central axle trailer
	Trailer suspension	
	Air suspension, hydraulic or mechanical suspension	

Description

ABS control principle MSC (Modified Side Control): Two ABS wheel speed sensors are positioned on each side of the trailer axles. The left and the right sides of the trailer axles are controlled separately.

During ABS brake control, the sensed wheel that is running into locking tendency will dominate the ABS brake control for that whole side (MSC), including the brake pressure of indirectly controlled wheel.

4S/3M	Components	Vehicle type
	1x iEBS modulator Premium 4x ABS speed sensor 1x 3rd EBS modulator (EBS relay valve) 1x Pressure sensor + cable	2 to 3-axle semitrailer / central axle trailer / drawbar trailer
	Trailer suspension	
	Air suspension, hydraulic or mechanical suspension	

Description

ABS control principle IC for the main axle and MAC (Modified Axle Control) for the axle equipped with the 3rd EBS modulator (EBS relay valve).

One ABS wheel speed sensor is positioned on each side of the trailer's main axles. The other 2 sensors are positioned on each side of the axle equipped with the EBS relay valve as a 3rd modulator.

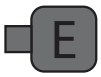
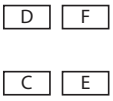
In order to determine the axle load, and adjusting the braking force, a pressure sensor must be installed to the air suspension of the axle where the 3rd modulator is positioned.

Brake actuators of additional wheels that are not equipped with wheel speed sensors can be pneumatically connected side-by-side to the (IC) sensed wheels of the main axle. However, those non-sensed wheels may show locking tendency as they will only be indirectly controlled (IDC)

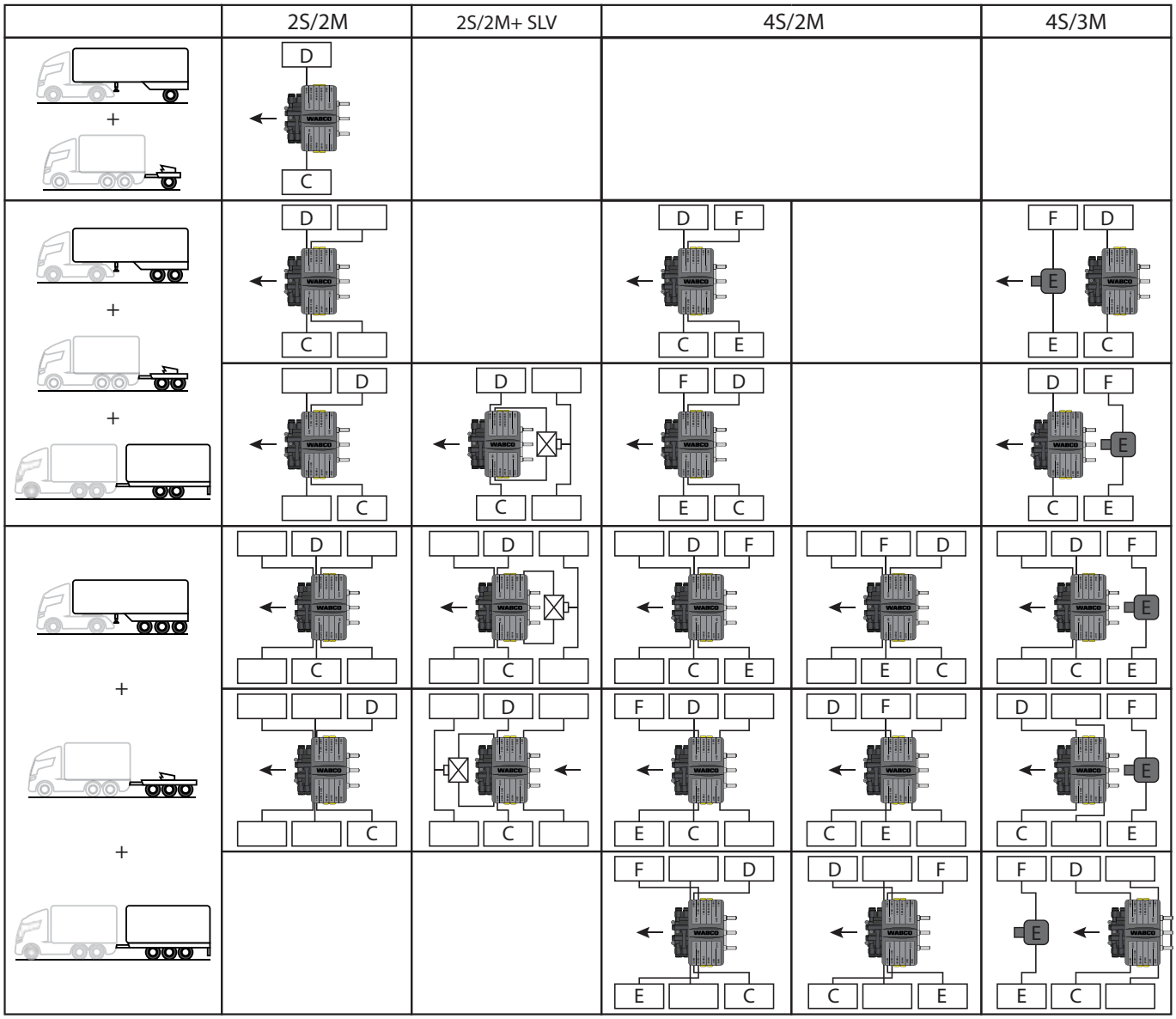
During ABS brake control, the main axle, and the indirectly controlled axles, will be controlled by individual side-by-side control, while the axle with the 3rd modulator will distribute equal brake pressure to the sensed brake actuators of that axle.

4.2.1.2 ABS arrangement of the sensors / modulators

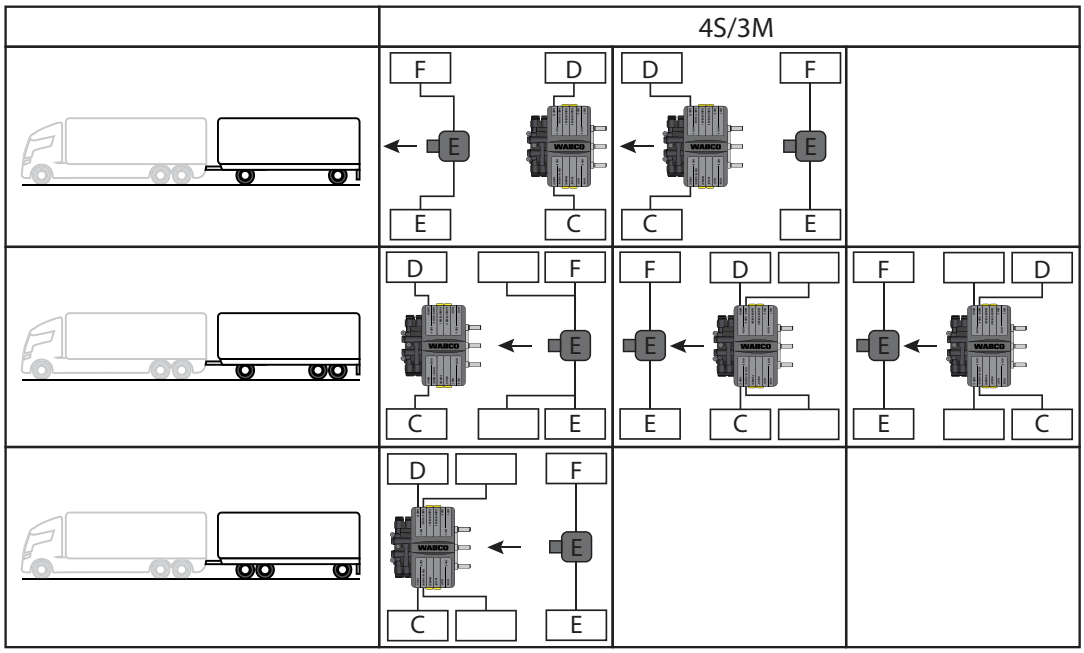
Modulator	ABS rotational speed sensors	System axle	Control type
iEBS Basic Air	C - D	Main axle (non-lifting)	Individual Control (IC)
iEBS Basic Steel iEBS Standard iEBS Premium	C - D	Main axle (non-lifting)	Modified Side Control (MSC)
	E - F	Additional axle (lift axle is permitted)	

Legend						
Driving direction	iEBS modulator	EBS relay valve	Select Low Valve (SLV)	Relay valve	Non-sensed wheel indirectly controlled	Sensed wheel (directly controlled)
						

Standard semitrailers, dolly and central axle trailers ABS configuration

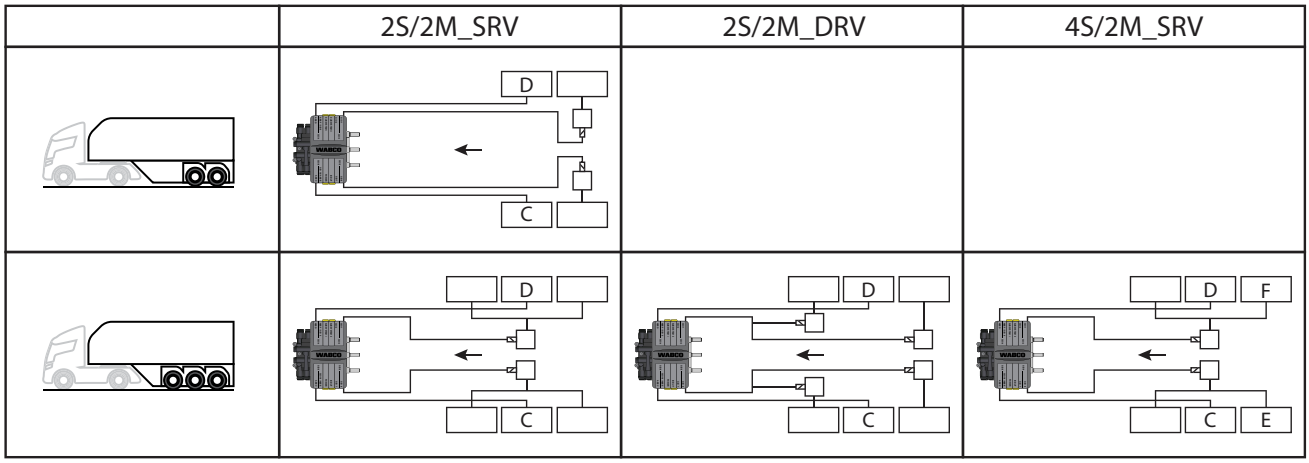


Drawbar trailers ABS configuration



Inloader trailers ABS configuration

Inloaders are trailers used for special transport (e.g., big glass or concrete panels). The trailers have a U-frame with no mechanical connection from left to right vehicle side in the area of the bogie. The trailer modulator can only be installed in the front of the trailer near the king pin. Due to the long piping required to connect the modulator and brake chambers, relay valves are used to improve the brake response time.



Alternative modulator arrangement can be found in chapter "6.2 Installation on the trailer", page 188.

4.2.1.3 ABS configuration based on axle types

Main axle

Semitrailers, central axle trailers:

The axle where C and D ABS wheel speed sensors are installed is the main axle. This axle cannot be lifted as it is dedicated to remaining on the ground, constantly providing wheel speed values for the ABS function.

Non-sensed axles are considered indirectly controlled and might be configured for special functions, e.g., lifting or self-steering axle.

Lift axles and tag axles

A lift axle is designed to improve the efficiency of the trailer by automatically lifting or grounding the tires from the road's surface. A lift axle is commonly installed in front of the main axle to adjust the load distribution of the trailer, and behind the main axle to control the wheelbase of the trailer and its maneuverability.

A special form of lift axles are tag axles. Tag axles reduce the axle load by venting the pressure of the load bellows while remaining on the ground. The trailer maneuverability is improved in a similar way as a lift axle.

Some benefits for lifting or lowering the lift axle:

- Trailer load optimization, the maximum load will be distributed to those axles remaining on the ground.
- Maneuvering, improvement by shortening the wheelbase of the trailer. The tag axle load will be reduced with the wheels remaining on the road surface, however friction and rolling resistance have been significantly reduced.
- Extending the tire life and reducing the rolling resistance when the axle is lifted in the unladen condition, this will result in fuel savings.

Limitations

The main sensed axle cannot be used as a lift axle. Any 2S/2M configuration can only use the non-sensed axle wheels for a lift axle.

For trailers with more than 1 lift axle, iEBS Standard or Premium is required. Axles with non-sensed wheels are the preferable option for a lift axle.

An axle installed with sensors E and F may be used as lift axle, in that case the ABS configuration will shift from 4S to 2S until the lift axle is lowered.

Steering axles

Steering axles assist in directing the trailer towards the desired turning direction whilst reducing tire wear because of dragging while turning.

Forced-steering axles - or self-steering axles can be directly controlled by ABS (axle equipped with wheel speed sensors) - or indirectly controlled (axle without wheel speed sensors and controlled via the main sensed axle).

The ABS 2S/2M+SLV configuration is recommended for trailers equipped with self-steering axle(s) to prevent the trailer from breaking away in a bend when RSS is activated.

	Additional stability for a self-steering axle during ABS operation In case of vibrations or deviations during ABS control, the steering axle should be switched to rigid using the speed switch (ISS).

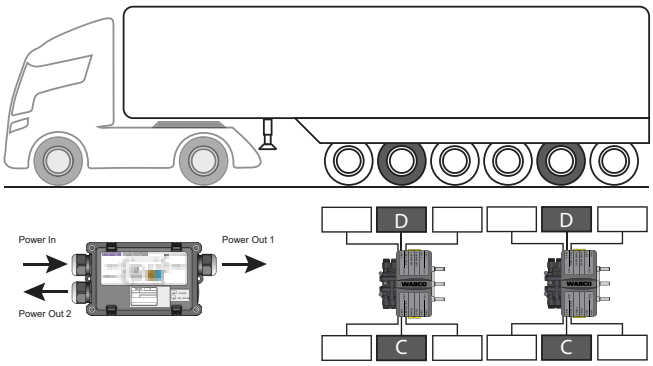
Multi-axle configurations

While a standard configuration for a semitrailer consist of a trailer equipped with one, two or three axles sharing the load capacity as a one axle group, a multi-axle configuration consist of a trailer with 4 or more axles that shares the load capacity into two or more axle groups.

Multi-axle trailers must have at least one axle fitted with wheel speed sensors per each axle group. The wheel speed sensors should be fitted to those axles of the axle group that have the greatest tendency to lock. Non-sensed axles or wheels are controlled in the same way as the directly controlled axles (MAR) or wheels(IC).

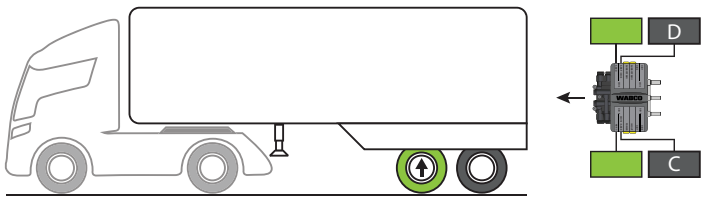
An equal utilization of the axles during braking is assumed for axle groups with dynamic load allocation (e.g., equipped with air suspension for axle load distribution). Axle groups having only static axle load compensation (e.g., equipped with mechanical suspension) should be equipped in such way that the wheels of all axles reach their locking limit at the same time. Additionally, a directly control sensed wheel shall not control more than two other non-sensed wheels per axle group (in case of central axle trailer the directly control sensed wheel shall not control more than one wheel or axle per axle group). The admissible differentials on brake input torque for all anti-lock braking configurations must be within a range of 20 %.

Multiple iEBS Basic modulators

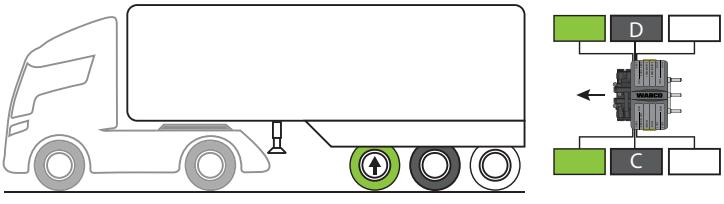
Multi-axle trailer with multiple iEBS modulators	
2 iEBS modulator systems can be installed using the CAN router on trailers with more than 3 axles and up to 6 axles. For example, a 6 axles semitrailer, the first 2S/2M configuration will control 3 axles, and a second 2S/2M configuration will control the rest of axles.	

Common ABS configurations

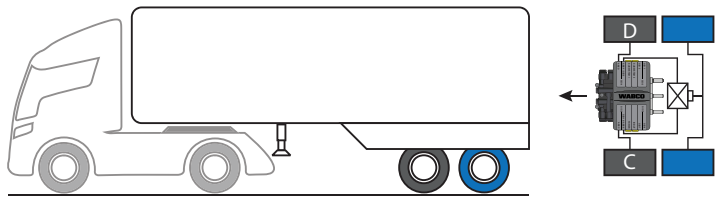
Lift axle configuration	
Number of axles	2 axles
ABS control	2S/2M - IC
Modulator	iEBS Basic Air
First axle	Lift axle
Second axle	Main axle



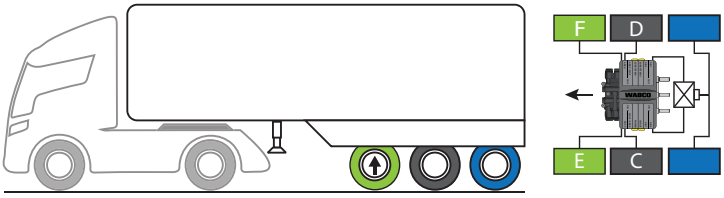
Lift axle configuration	
Number of axles	3 axles
ABS control	2S/2M - IC
Modulator	iEBS Basic Air
First axle	Lift axle
Second axle	Main axle
Third axle	Indirectly controlled axle



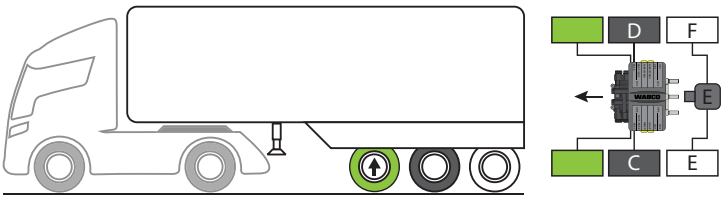
Self-steering axle configuration	
Number of axles	2 axles
ABS control	2S/2M + SLV
Modulator	iEBS Standard
First axle	Main axle
Second axle	Self-steering axle



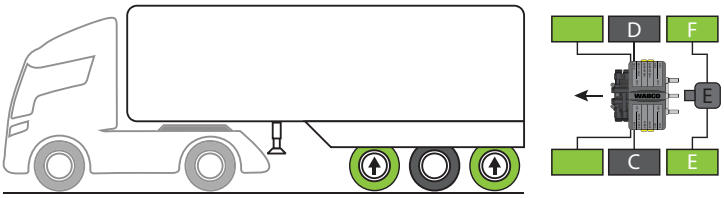
Lift axle & Self-steering axle configuration	
Number of axles	3 axles
ABS control	4S/2M - MSC
Modulator	iEBS Standard
First axle	Lift axle
Second axle	Main axle
Third axle	Self-steering axle



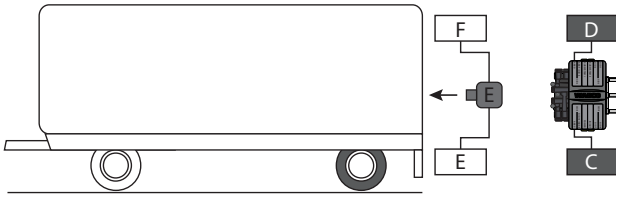
Lift axle & 3rd modulator configuration	
Number of axles	3 axles
ABS control	4S/3M
Modulator	iEBS Premium
First axle	Lift axle
Second axle	Main axle
Third axle	3rd modulator (MAC)



Double Lift axle & 3rd modulator configuration	
Number of axles	3 axles
ABS control	4S/3M
Modulator	iEBS Premium
First axle	Lift axle
Second axle	Main axle
Third axle	Lift axle equipped with 3rd modulator (MAC)



Double Lift axle & 3rd modulator configuration	
Number of axles	1 front and 1 rear axle
ABS control	4S/3M
Modulator	iEBS Premium
Front axle	Equipped with 3rd modulator
Rear axle	Main axle



Legend							
	Lift axle		Main axle		Steering axle		Other axle(s)

4.2.2 Rollover Stability Support (RSS)

4.2.2.1 RSS function with load information

Application

Rollover Stability Support (RSS) is an advanced rollover mitigation function integrated into iEBS that provides rollover protection. The function provides an automatic brake application as a preventive measure when there is a danger of tipping, improving the stability of the truck-trailer combination.

The RSS function is compatible with all trailer types and is independent of the stability control system of the towing vehicle.

Regulation

UN/ECE R13 requirements stipulate that Class O3 and O4 trailers with up to 3 axles with air suspension must be equipped with a stabilization function as from July 2010. ZF RSS complies with all legal requirements concerning safety and traffic.

Function

The RSS function performs an active test braking if the iEBS senses a potential rollover situation (e.g., during harsh cornering).

The system automatically accounts for the load status and measures lateral acceleration while driving. In case a potential rollover is detected, a stronger brake application is performed, thereby reducing the likelihood of a rollover.

In the event an RSS intervention is triggered, but the driver is taking over the brake maneuver with a higher brake demand than the brake application performed by the RSS, then the active RSS function is interrupted.

RSS function variants according to suspension type

Parameters	Air suspension	Steel suspension	Steel suspension (No-load information)
Input values for RSS calculation	• Lateral acceleration • Axle load (measured from air suspension) • Trailer speed	• Lateral acceleration • Axle load (measured from steel suspension) • Trailer speed	• Lateral acceleration • Trailer speed
Axle load measuring system	Air pressure sensor	Height sensor (spring deflection measuring)	Not available

Further information about trailers with steel suspension and no-load information, go to section "RSS function without load information" on page 100

Standard configurations for trailers with iEBS and RSS

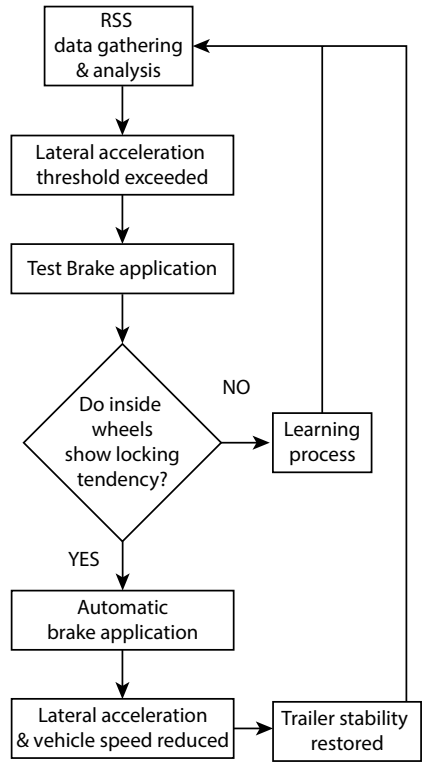
Basic Steel	Basic Air	Standard	Premium		Number of axles	Semitrailers			Central-axle trailers			Drawbar trailers	
				ABS System ↓	→	1	2	3	1	2	3	2	3
✓	✓	✓	✓	2S/2M		✓	✓	✓	✓	✓	✓		
✓	✓	✓	✓	2S/2M+SLV			✓	✓		✓	✓		
✓		✓	✓	4S/2M			✓	✓		✓	✓		
			✓	4S/3M			✓	✓		✓	✓	✓	✓

Multi-axle configurations for trailers with iEBS and RSS

The following configurations are showing examples for multi-axle trailers. Reference can be found in the EB190A report.

Basic Steel	Basic Air	Standard	Premium	ABS system ↓	Number of axles →	Semitrailers 4	5	6	7	8	9	10	Drawbar trailers 4	5	6
			✓	4S/3M		✓	✓	✓					✓	✓	✓
✓	✓	✓	✓	2S/2M + 2S/2M				✓							
✓	✓	✓	✓	2S/2M + 4S/3M				✓	✓	✓					
			✓	4S/3M + 4S/3M					✓	✓	✓	✓			

RSS Logic control



The RSS function uses the input values of iEBS, such as wheel speeds, loading information, lateral acceleration and target deceleration for calculation.

When the integrated lateral acceleration sensor detects a rapid increase of the lateral acceleration that exceeds the parameterized threshold (critical situation due to imminent trailer tilting), test brake activations are triggered.

The test brake activations will be performed for restricted periods at low pressure. The duration and magnitude of the test brake pressure (service brake application) depend on the lateral acceleration sequence.

The reaction of the wheels braked during a test determines if the risk of tilting is detected.

If a danger of tilting is detected, a full brake application is initiated on the wheels of the trailer from outside the curve (at least on the individually controlled (IC) wheels). This reduce the trailer speed, lateral acceleration, and therefore the danger of tilting, preventing a possible rollover event.

The braking pressure for the wheels on the inside of the curve is largely unchanged. As soon as the trailer stability is restored and there is no danger of tipping, the RSS brake application is ended.

4.2.2.2 RSS function without load information

Application

Trailers with mechanical suspension which are homologated with RSS but without load sensing function.

Function

The stability function works without load information and can be parameterized via the iEBS diagnostic software.

A test brake application with small deceleration starts when a threshold for lateral acceleration is reached. In the beginning, only the brakes on the inner side of the curve will be applied.

Depending on the reaction of the inner wheels, the outer wheels are also braked, and their reaction will be evaluated to assess the rollover tendency. When the result is uncritical, the threshold will be adapted to prevent unnecessary braking. Otherwise, the brake will be applied with high pressure to prevent overturning. When the rollover is averted, the intervention is ended. The adaption of the threshold will be discarded during standstill or ignition reset.

Downsides of RSS without load information

Due to the working principle of the logic control, the sensitivity and number of brake interventions might affect the driving comfort.

In order to enhance driver comfort, it is recommended to switch to the RSS function with axle load measuring information by adding an axle load sensor.

4.2.2.3 RSS - General installation restrictions

The Rollover Stability Support (RSS) function depends on the accuracy of the parameter setting for the tire circumferences, number of pole wheel teeth and other relevant trailer information used for the brake calculation.

The input values are used to calculate the lateral acceleration which represents a risk of tipping.

⚠ CAUTION

Never fit tires that are different from the ones specified in the brake calculation, otherwise gathering of information becomes inaccurate and the function will not work properly.

Please refer to the brake calculation if you want to install different tires or to get information about the permitted tire circumference range.

RSS position calibration

The RSS feature requires that the iEBS modulator is centrally positioned in the trailer.

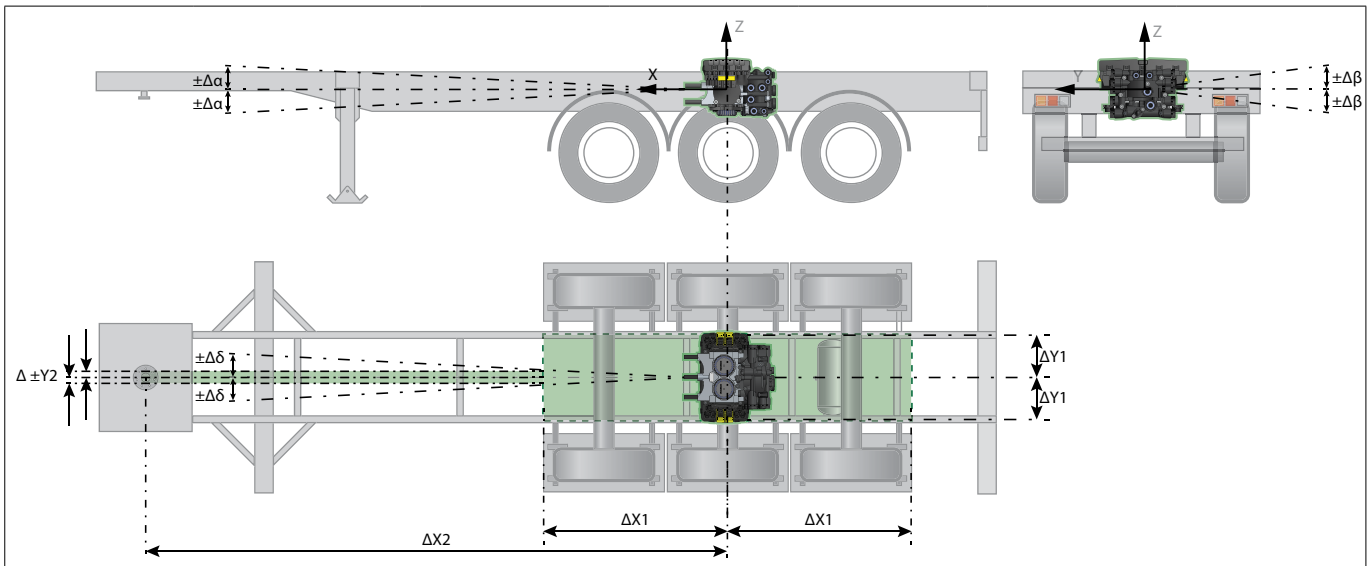
Setting the sensitivity of the RSS function for trailers where tilting is critical, can be set in the iEBS diagnostic software.

Multiple iEBS modulators fitted in a special trailer or road train that communicate with one another via CAN routers to coordinate their RSS actuations. This increases the stability of the road train.

Calibrate the inclination of the modulator (Δβ) using the iEBS diagnostic software.

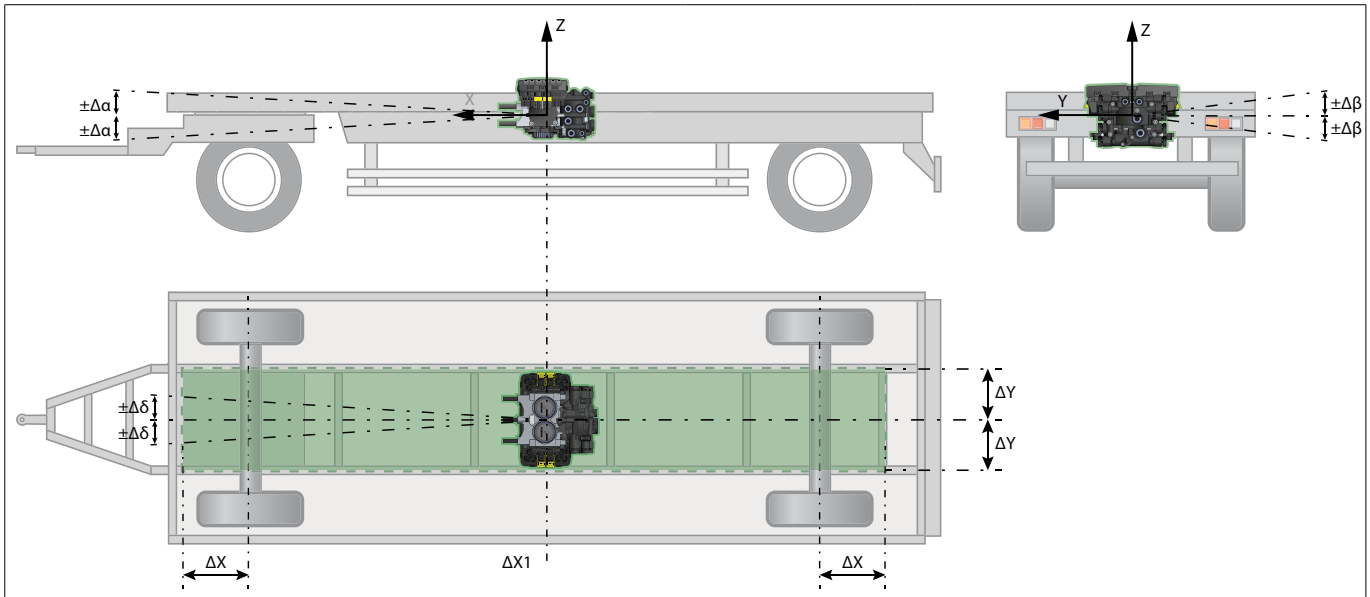
- Requirement: Ensure the trailer is parked on a flat and level surface. (deviation from horizontal < 1°).
- If the calibration is not carried out, the modulator inclination will calibrate itself when driving.

iEBS Positioning - Semitrailer/central axle trailer



Δ X1 [mm]	Δ Y1 [mm]	Δ X2 [mm]	Δ Y2 [mm]	Δα	Δβ	Δδ
2000	1000	9000	50	± 15°	± 3°	± 3°

iEBS Positioning - Drawbar trailer



Δ X [mm]	Δ Y [mm]	Δα	Δβ	Δδ
600	500	± 15°	± 3°	± 3°

4.2.3 Load sensing function

Application

The load sensing function in iEBS supports different suspension types by sensing the load information:

- Pneumatic air suspension: Pneumatic pressure sensor(s) connected to the bellow pressure
- Hydraulic suspension: Hydraulic pressure sensor connected to the hydraulic suspension
- Mechanical suspension: Measuring the deflection travel on the mechanical suspension via height sensor(s)

Function

The iEBS modulator features an integrated load sensing function that is part of the pneumatic braking system. It is a function developed to improve the braking compatibility in a truck-trailer combination by automatically adapting the brake force in proportion to the axle load, whilst reducing the ABS control interventions and optimizing the brake lining-pad wear.

The geometric and the load characteristics of the trailer are used to define the load sensing function to fulfil the legal requirements.

An *.xml file from the brake calculation program can be read by the iEBS diagnostic software to simplify setting of the parameters.

Semitrailers and drawbar trailers are controlled differently.

NOTICE

Trailers that can have different lateral bellow pressure during driving, require special measures to ensure adequate braking.

The best solution is to read the bellow pressure from one trailer side with the internal sensor at port 5. The other side is measured by an external pressure sensor that is connected by cable to the iEBS modulator.

A second solution is using only one pressure sensor to read the higher pressure of the two sides; this can be done by means of a select-high valve.

Parameter setting

The parameter file from the brake calculation program can be loaded via the iEBS diagnostic software in tab System > Parameters > (1) Vehicle > Read from file

Brake parameters can be manually customized by means of the iEBS diagnostic software. Any modification to the brake parameters must comply with the UN/ECE R13 compatibility braking bands. The manual adjustment of the load sensing function can be done in tab System > Parameters > (2) Brake > Braking pressures.

The brake parameters are only a partial step of the full parameterization of the trailer brake control. To perform a full parameterization, refer to the chapter "7.1.2 Brake parameters", page 195

4.2.3.1 Characteristic curves

The characteristic curves represent the braking behavior of the trailer for laden or unladen situations.

The brake force distribution is done according to the trailer's load and is determined by the brake calculation.

Examples of characteristic curves

The following parameters are used to define the characteristic curves:

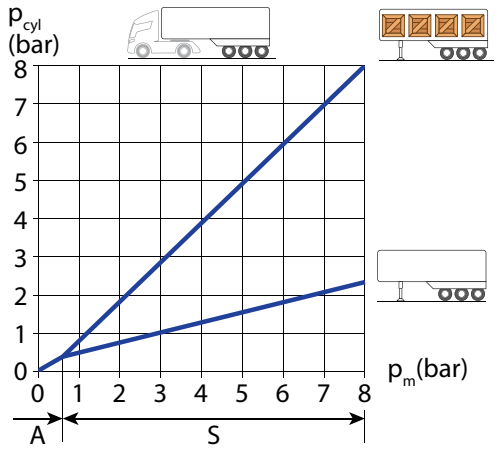
- Coupling head pressure (p_m): It represents the measured pressure signal at the control coupling head generated by the towing vehicle's brake demand
- Service brake pressure (p_{cyl}): It represents the pressure at the brake actuators in proportion to the measured control coupling head pressure(p_m)
- Pressure value application range (A): Defines the application pressure needed in order to apply the brakes. Only when the service brake pressure (p_{cyl}) exceeds the value of the application pressure, the air gap between brake pad and brake disc is closed and the trailer starts decelerating.
- Stability range (S): Defines the effective pressure at the service brake actuator (p_{cyl}) in proportion to the pressure signal from the coupling head pressure (p_m). An increase of the control pressure (p_m) will generate increasing brake force.
- Wear range (W): Defines the partial braking range for drawbar with different brake actuator sizes between front and rear axle. The brake pressure between axles is individually adapted to reduce wear.

Semitrailer example

The characteristic for the laden and unladen condition are different when braking in the stability range (S).

Laden: The characteristic curve is the defined line in the chart that represents the maximum output of the service brake pressure (p_{cyl}) in proportion to the maximum load within the input control pressure range starting from 0.7 bar to 6.5 bar (p_m) ($p_m = p_{cyl}$).

Unladen: The characteristic curve is the defined line in the chart that represents the reduced output for the service brake pressure (p_{cyl}) in proportion to the minimum load within the input control pressure range starting from 0.7 bar to 6.5 bar (p_m) (e.g., a p_m value of 6.5 bar produces a p_{cyl} response of 2 bar)



Drawbar trailer example

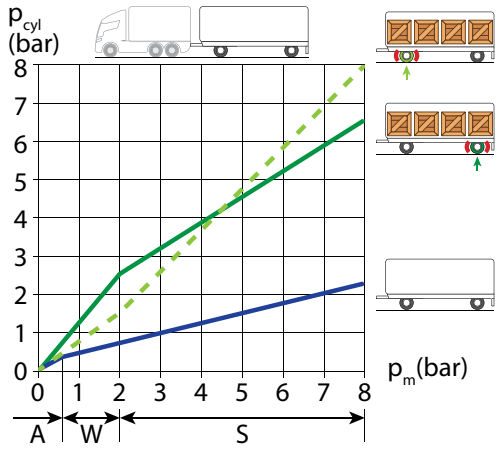
To ensure an even brake force distribution during laden situations between the axles, the brake pressure at the front may slightly differ from the brake pressure at the rear.

This will ensure a better and more evenly utilization of the braking elements.

Example: Drawbar trailer with type 24 actuators on the front axle and type 20 actuators on the rear axle:

The pressure at the front axle is slightly reduced and the one that at the rear axle is slightly increased in accordance with the configuration. This ensures that the load is distributed evenly between all wheel brakes.

Additional characteristic points are used for drawbar trailers to reduce wear.



4.2.3.2 Load sensing function for air suspensions

Application

The load sensing function determines the axle load on trailers with air suspension based on the actual pressure input of the load bellow pressure. The suspension characteristics shall be obtained from the axle or suspension manufacturer. In most cases, the bellow pressure is nearly linear to the axle load.

The load bellows in trailers with multiple axles are connected to each other, sharing the load equally over the axles. In regards of side to side stabilization of the axles, two systems are commonly used:

- A direct connection between the load bellows left and right is possible if the axle features strong inner stabilization.
- Dual-circuit axle load determination is required for trailer axles that are independent left and right (i.e., inloaders). Further information can be found in chapter "4.2.3.4 Dual-circuit axle load determination", page 108.

Function

The axle load is calculated by measuring the pressure of the load bellows via an internal pressure sensor, located at port 5 of the PDM. The internal pressure sensor converts pressures between 0 bar and 12 bar into electrical signals that are transmitted to the iEBS modulator

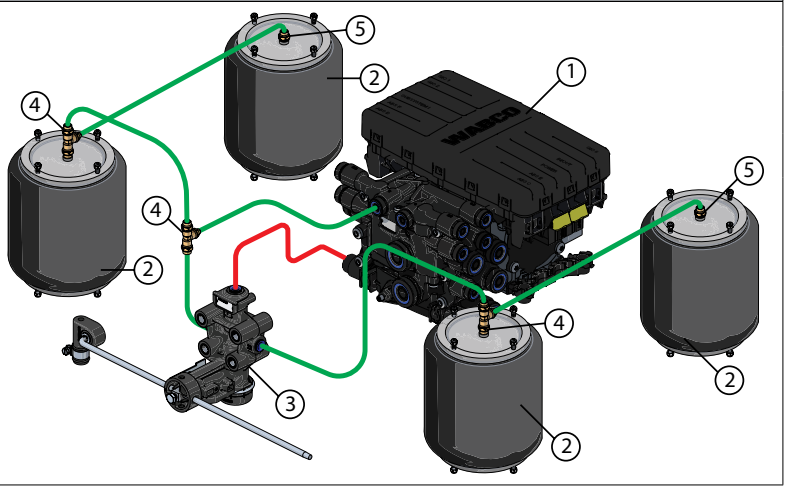
An external pressure sensor (e.g., installed directly in the suspension of the trailer) can be used instead of the internal pressure sensor. The pressure will be converted into an electrical value, that is transmitted to the iEBS modulator. The value signal range depends on the pressure sensor used.

- External pressure sensor: Between 0.5 V (equivalent to 0 bar) and 4.5 V (equivalent to 10 bar).Up to 2 external bellow pressure sensors are possible with iEBS Premium

The external axle load sensor C-D can be enabled in the iEBS diagnostic software in the tab System > Parameter > (1) Vehicle > External sensors > External axle load sensor C-D

An additional external pressure sensor to measure the load on the main axle is recommended on trailers equipped with hydraulic suspension. This option can be enabled in the iEBS diagnostic software in the tab System > Parameter > (1) Vehicle > External sensors > Second external axle load sensor C-D

Connecting the components

Item	Part number	Description	Load sensing via internal pressure sensor
1	480 102 . . . 0	iEBS modulator	
2	Not supplied	Load bellow	
3	464 006 500 0	Levelling valve basic	
4	Not supplied	Tee fittings	
5	Not supplied	Fittings	

NOTICE

For precise bellow pressure readings, it is advised to obtain the pressure value from the main axle, which is equipped with a wheel speed sensor (c-d), and to utilize the most direct connection to read the pressure from the load bellows through the pressure sensor situated at port 5 of the PDM.

4.2.3.3 Load sensing function for steel suspensions

Application

This function determines the axle load on trailers with leaf spring suspension (mechanical suspension) based on the suspension deflection.

Function

The load sensing function in iEBS Basic Steel requires an input of the actual axle load via a height sensor. The height sensor can be installed to measure the axle load status by means of the leaf spring deflection. The installation position shall be to the middle of the axle beam in order to measure the average deflection of both sides of the leaf springs. It is also possible to install the height sensor towards the side of the trailer axles if the axle features strong stabilization.

The suspension deflection will be converted into rotational angle data by the height sensor, transmitted to the iEBS modulator. The lever-link connections used to measure the deflection of the mechanical suspension should produce a rotational angle of the height sensor of at least ±30° for an acceptable load resolution (maximum permissible rotational range for height sensor is ±45°). Recommended lever length is between 50 and 100 mm.

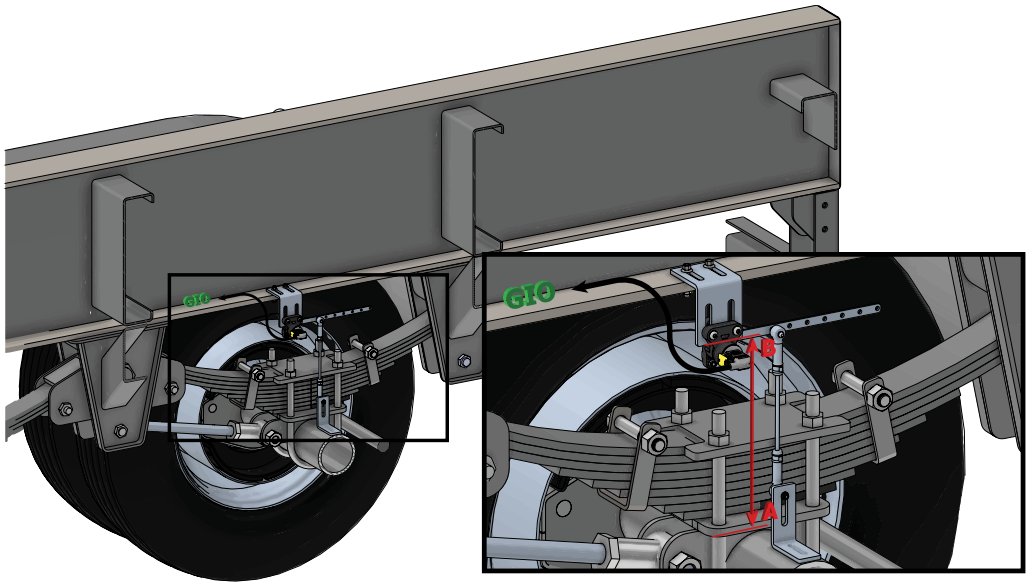
The leaf springs deflection on a mechanical suspension (difference between unladen and laden status) must be obtained from the suspension manufacturer prior to programming the ECU (mechanical suspension deflection vs applicable load data).

NOTICE

Deflection values lower than 20 mm might not be enough to rotate the sensor and to provide a reliable axle load.

Determine spring deflection rate

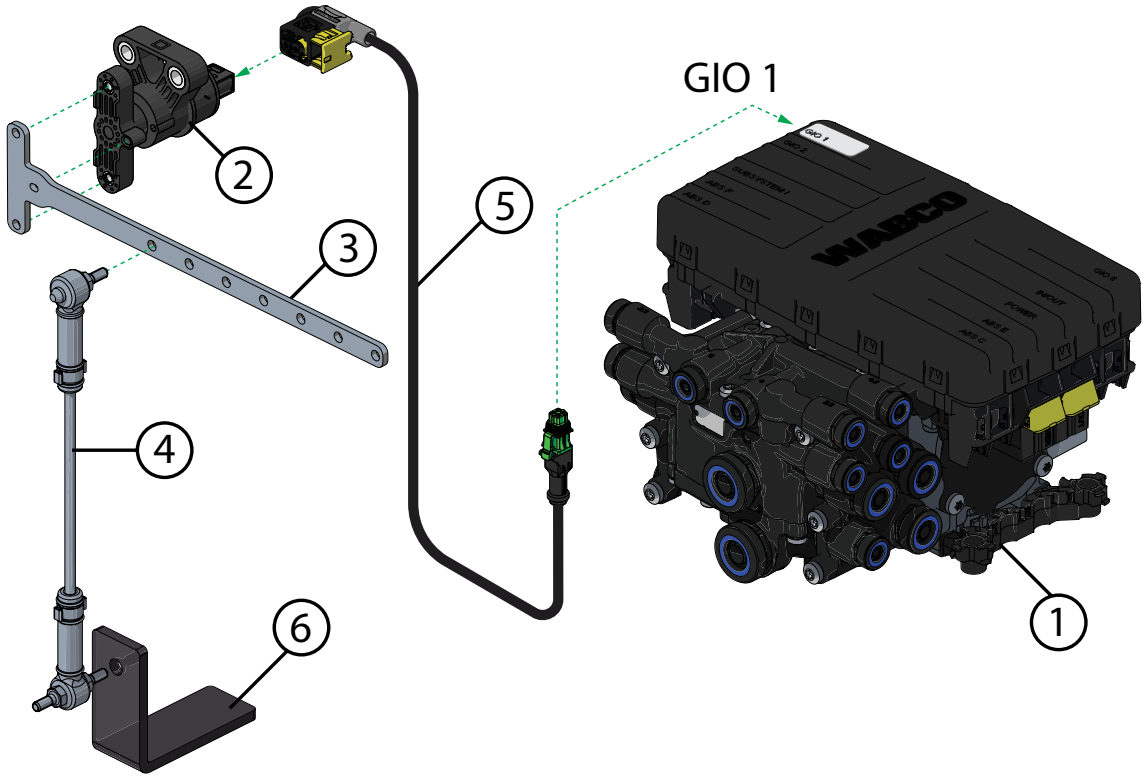
If the value cannot be obtained from the suspension manufacturer, the following procedure can be performed to obtain the value.



- Set the trailer to unladen condition; measure from the top of the axle tube (A) to a fixed point (B) on the underside of the trailer chassis (I-beam). Capture and note down the distance in mm.
- Set the trailer to laden condition; measure from the same points (A and B) that were used for the trailer in unladen condition. Capture and note down the distance in mm.
- Subtract the value trailer laden from trailer unladen, this is the spring deflection value for this trailer suspension.

During the setting from the unladen to laden condition, it is recommended to ensure that the trailer wheels are free to rotate (spring brakes must be released). This will prevent any counter forces and allow for the true deflection travel of the leaf spring (no hindrance). Please remember that it will be necessary to move the trailer a few meters forward to eliminate the high friction force within the leaf springs that could produce "noise" in the deflection value.

Connecting the components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		
2	441 050 202 0	Height sensor	449 829 . . . 0	Height sensor on main axle c-d; To connect plug to GIO 1
	441 050 203 0			
3	441 050 024 4	T shape lever		
4	441 050 711 2	Linkage		Linkage length 209 ± 1 mm
	441 050 712 2	Linkage		Linkage length 289 ± 1 mm
	441 050 713 2	Linkage		Linkage length 299 ± 1 mm
	441 050 714 2	Linkage		Linkage length 323 ± 1 mm
	441 901 712 2	Linkage		Linkage length 235 ± 1 mm
	441 905 711 2	Linkage		Linkage length 248 ± 1 mm
	441 905 713 2	Linkage		Linkage length 262 ± 1 mm
	441 906 710 2	Linkage		Linkage length 289 ± 1 mm
5	449 829 . . . 0	Height sensor's cable		Cable variant lengths: chapter "10.6 Cable overview", page 217
6	Not supplied	Axle bracket		Welded on the measured axle

Height sensor installation instructions

Information about how to install the height sensor can be on found chapter "3.2.2 Height sensor", page 71

NOTICE

To accurately measure the load of the trailer, it is recommended to read the spring deflection from the main axle (equipped with wheels speed sensor c-d) .

Parameterization and calibration of the height sensor

For trailers with mechanical suspension the parameterization of the height sensor according to the installation must be done prior calibration.

The parameter settings of the height sensor can be done in 2 different ways:

- Manual input of mechanical values: Enter the spring deflection value (compression of the leaf springs) and the specified lever lenght (distance between center of the height sensor and anchor point at the linkage). Those values can be entered in the iEBS diagnostic software in tab System > Parameter > (2) Brake > Braking pressures table
- Load parameter file: The trailer data can be set and saved offline directly to a *.ECU parameter file. The *.ECU file can be uploaded by using the "Read from file" button from the section System > Parameter > (1) Vehicle.
  This method is recommended for large series. This method requires that the position of the height sensor, the lever length, as well as the length of the linkage to the axle are identical in all trailers.

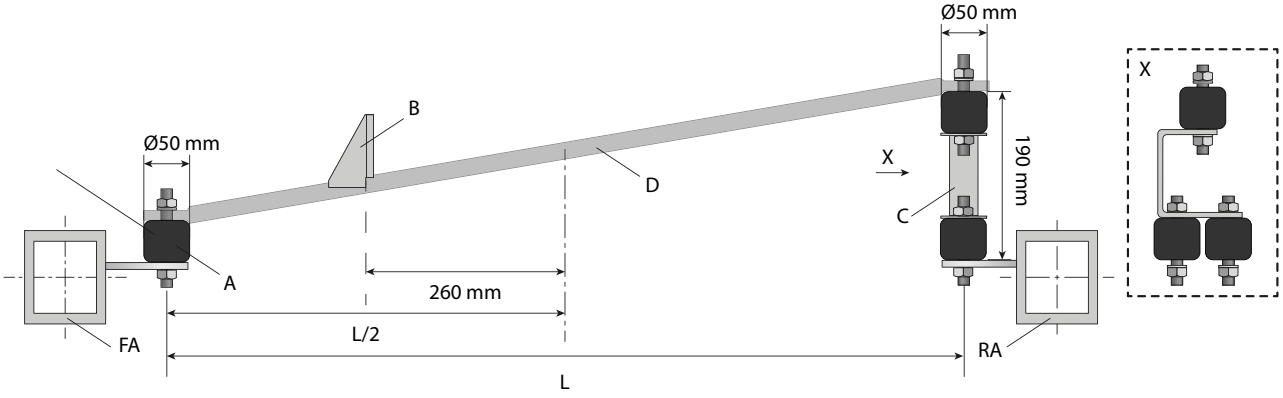
After saving the parameters to the ECU, the calibration process for a load sensing height sensor can be performed in tab System > Calibration > Calibration of the height sensors for axle load.

- Calibration of the height sensor shall only be done when the trailer is in unladen condition. The unladen axle load must be confirmed/entered.
- Set the lever of the height sensor in horizontal position (e.g., 0 degrees ± 3 degrees)
- Initiate the calibration of the height sensor and select the corresponding mounting position to complete the calibration process.

Tandem bogies

For mechanically suspended tandem bogies an elastic connection between the axles is recommended to measure the average deflection value of both axles.

- Install a metal bracket on the front axle (FA) and on the rear axle (RA)
- Mount a single rubber buffer (A) on the front bracket and a triple rubber buffer on the rear bracket (C) as on the image bellow.
- Use a tube ("D", ø 22x2 mm recommended) to link the rubber mountings.
- Mount the angle bracket (B) according to the drawing. This bracket will be used to connect the height sensor.



4.2.3.4 Dual-circuit axle load determination

Application

Two load sensors are used to determine a more accurate brake force distribution.

Available for following trailers:

- Semitrailer with left / right axle load determination
- Drawbar trailer with front / rear axle load determination

Purpose

This function improves the braking behavior of the trailer thanks to its more precise determination of the actual load status (average value of the measured axle load from the sensors). This is a recommended configuration for inloader trailers with independent axles between left and right.

Connecting the components

Air suspension	Mechanical suspension
• Use internal pressure sensor, located at port 5 of the PDM, to measure the axle load of one side of the trailer axle (e.g., left side for a semitrailer, rear side for a drawbar). • Connect the additional pressure sensor (e.g., 441 044 102 0) to the bellow that needs to be measured (e.g., right side for semitrailer, front side for drawbar). • Connect the pressure sensor via cable (e.g., 449 826 . . . 0) to a compatible GIO port (output stage, ground (GND) and analog pins)	• Connect a height sensor to one side of the trailer axle and connect the cable to a GIO port with PWM pin (e.g., GIO 1) • Connect the additional height sensor to the other side of the trailer axle and connect the cable to a GIO port with PWM pin (e.g., GIO 9)

Parameter settings

If an additional axle load sensor is installed to the main axle, the iEBS diagnostic software shall be used to configure this option.

The additional axle load sensor (i.e., additional pressure sensor for air suspension trailers or a second height sensor for mechanical suspension trailers) can be enabled in the iEBS diagnostic software in the tab System > (1) Vehicle > External sensors > Second external axle load sensor C-D.

NOTICE

iEBS is featuring a safety function "Vehicle on bumper": If the bellow pressure is below 0.15 bar and less than 50 % of the defined unladen bellow pressure value (always the lower value) then iEBS will automatically switch the load sensing characteristic curve to "Laden". This is done as the trailer frame is probably resting on the air suspension bumpers of the axles hence no reliable conclusion can be drawn regarding the load status.

4.2.4 Standstill function

Function

In the event the brake demand pressure is constant, for at least three seconds, while the trailer is stationary or at a speed below 1.8 km/h, the electrical brake control is replaced and done only via the redundancy circuit.

This integrated function is used to avoid unnecessary current consumption by the iEBS modulator (e.g., during standstill in front of a traffic light or when parking with the brakes applied and the ignition ON). The function is deactivated and switched back to electrical brake control upon starting to drive at speeds above 2.5 km/h.

The standstill function can be optionally parameterized in such a way that it is only activated at control pressures above 6.5 bar (usually achieved when the truck's hand brake valve is applied). This prevents unintentional activation of the standstill function during maneuvering at very low speeds.

This can be parameterized in the iEBS diagnostic software in tab System > Parameters > (5) Brake functions > Functions for special vehicles.

4.2.5 Emergency braking

Function

In the event of the truck brake demand (electrical and pneumatical) being greater than 90 % of the available supply pressure or > 6.4 bar, i.e., panic braking is evident, a steady increase of braking pressure is automatically applied up to the characteristic curve of the laden trailer and up to the possible intervention of ABS control. The emergency braking function is deactivated again upon a drop of the truck brake demand below 70 % of the available supply pressure.

4.2.6 Anti-compounding protection

Function

This is an integrated function of iEBS that is available for trailers with spring brake actuators (Double Diaphragm Spring Brake - DDSB, or TriStop). It is designed to protect the wheel brake from overloading, through added forces in both brake chambers.

The function reduces the brake forces in the brake actuator when the service brake and the spring brake are applied simultaneously. That usually occurs during the coupling - or uncoupling procedure of a trailer, when the trailer parking brake has been applied, and simultaneously the service brake (foot brake or hand brake valve of the truck) will be applied.

The spring brake chamber is supplied with pressure in the same amount as the service brake has been applied. This will reduce and prevent adding forces up to the full compression of the spring brake (fully released). Once the service brake has been released the spring brake will automatically be engaged again.

4.2.7 Overflow Valve Air Suspension (OVAS)

Application

This is an internal function within iEBS dedicated to air suspension trailers. The overflow valve separates the air braking circuit from the air suspension circuit. This prioritizes the charging of the brake circuit over the air suspension circuit. Once a pressure of approximately 6 bar is reached in the brake circuit, the charging valve opens and allows the charging of the air suspension circuit.

In case of a sudden pressure drop in the air suspension circuit (e.g., by a broken pipe in the air suspension system or the burst of the load bellow), the overflow valve will close and isolate the braking circuit from the suspension circuit once the pressure in the brake circuit drops to 5 bar. It maintains an adequate pressure level in the brake system air reservoir allowing braking of the trailer.

The overflow valve allows for slight adjustments in the closing and opening pressure values.

4.2.8 Reservoir pressure monitoring

Purpose

Integrated function in the iEBS modulator that monitors the appropriate supply pressure for iEBS.

Function

Warning lamp: If the supply pressure drops below 4.5 bar in the trailer air brake reservoir, the driver is warned by the warning lamp (red and yellow) lighting up. If this is the case while in motion, a message is also saved in the diagnostic memory. The fault indicator / warning lamp only turns OFF when the supply pressure will be exceeds 4.5 bar again.

⚠ WARNING

Risk of accidents caused by low supply pressure (< 4.5 bar)

The trailer can no longer be braked adequately by means of the service brake. If the pressure in the trailer air brake reservoir falls below 2.5 bar, the trailer is automatically braked by the spring actuators.

As soon as the warning lamp (red and yellow) lights up, the vehicle must be stopped and parked in a safe place. The supply pressure must be checked – in addition seek consultation with the repair service representative as required.

4.2.9 Brake pressure control

The pressure control circuits follow the nominal pressure specified by the load sensing function and convert those into service brake output pressures.

The iEBS modulator will measure the actual output of the relay valves and compare those with the driver demand pressure. Potential deviations will be compensated by actuating the inlet or exhaust solenoids of the iEBS modulator, or the EBS relay valve that actuates as 3rd modulator.

⚠ CAUTION

In accordance with the EEC Braking Systems Directive 71/320 and UN/ECE R 13 regulations, a maximum of 8.5 bar supply pressure is permitted in the trailer.

If the measured supply pressure is exceeding 10 bar, the red warning signal becomes active and the EBS and RSS functions are deactivated. The brake force distribution according to axle load and ABS control remain available.

Pneumatic advanced response and CAN advanced response

An advanced response (predominance) can be defined for truck-trailer harmonization of the brake pad wear. The values for the pneumatic advanced response and CAN advanced response can vary.

Parameter setting

The advanced response (predominance) is entered in the iEBS diagnostic software in tab 3, Braking Data.

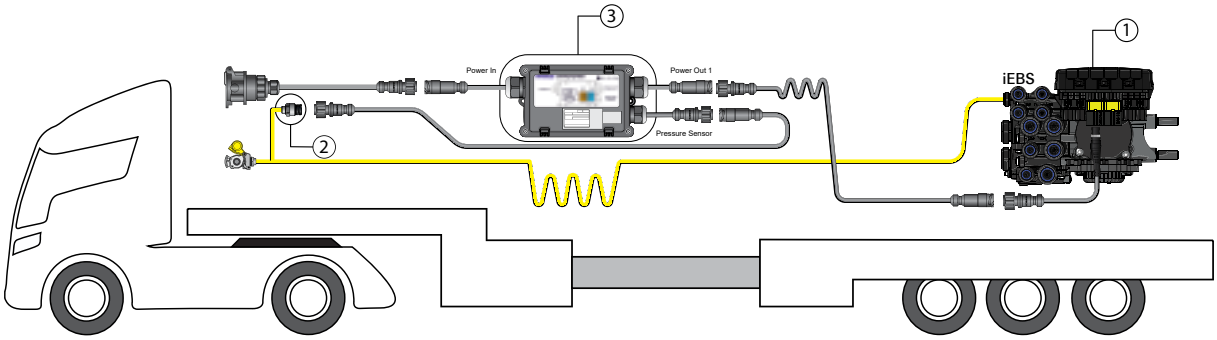
4.2.10 External demand pressure sensor

Application

Optional installation to improve the response times for towing vehicles without EBS (no CAN signal).

- Direct connection to iEBS: The information from the pressure sensor is sent to the iEBS modulator as a pressure signal. The electrical signal of the pressure sensor travels faster than the pressure control signal from the yellow coupling head, improving the brake response time of the trailer.
- Connection via Router/Repeater: Available for all trailers, particularly where there is a long distance between the yellow coupling head and the iEBS modulator. The information from the pressure sensor is transformed into a corresponding CAN signal that is used as a CAN brake demand for iEBS.

Components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator	Extension cable: 894 600 . . . 0 Power cable: 449 309 005 0	See chapter "iEBS variants" on page 210
2	441 044 101 0 441 044 102 0	Pressure sensor:	449 425 . . . 0	Pressure sensor range: 0 to 10 bar
3	446 122 05 . 0	CAN Router/ Repeater	Power cable (semi-trailers): 449 135 . . . 0	See chapter "Router / Repeater" on page 83

Installation

The external demand-pressure sensor (2) is connected directly to the control line at the front of the trailer.

The pressure sensor can be connected to the iEBS modulator in two ways:

- Directly to the iEBS via GIO 1
- Via the CAN Router/Repeater.

⚠ CAUTION

If the service line is equipped with a pressure sensor, it is recommended to connect the ISO7638 power as last one and the reservoirs must be at working pressure.

Parameter setting

The external pressure sensor that is directly connected to the iEBS modulator can be enabled in the iEBS diagnostic software in tab System > Parameters > (1) Vehicle > External sensors > External demand pressure sensor.

A pressure sensor connected to a Router/Repeater can be enabled in the iEBS diagnostic software in tab System > Parameters > (1) Vehicle > External sensors > Demand pressure sensor on R/R

4.3 ECU Functions

Internal functions overview

Internal functions	Description	Reference	iEBS variants			
			Basic Steel	Basic Air	Standard	Premium
Multi-Voltage	Multi-Voltage simplifies truck-trailer operations by allowing the connection to 12 V and 24 V trucks to your trailer without a converter.	Chapter 4.3.1 - see page 112	✓	✓	✓	✓
Operating Data Recorder (ODR)	A trailer “black box” that records all operating data.	Chapter 4.3.2 - see page 113	✓	✓	✓	✓
Odometer	Function that measures the mileage covered by the trailer during a trip and lifetime.	Chapter 4.3.3 - see page 115	✓	✓	✓	✓
Service Interval	Allows for tracking of operating hours, moving components and reminds you of service intervals to minimize maintenance costs. The reminder is based on the mileage covered.	Chapter 4.3.4 - see page 116	✓	✓	✓	✓
Axle load monitoring	Function that measures and displays the real time value of the load per axle via the Electronic SUBSYSTEMS devices	Chapter 4.3.5 - see page 116		✓	✓	✓
ServiceMind	Tracking hours for GIO and your own developed functions. Allows you to set a reminder based on how many hours a function has been active or idle.	Chapter 4.3.6 - see page 118			✓	✓
Notebook Memory function	Store important information in the iEBS modulator memory of the trailer braking system	Chapter 4.3.7 - see page 119			✓	✓
Service documentation	A reference (URL) with essential service information including the trailer configuration can be saved in the iEBS modulator.	Chapter 4.3.8 - see page 119	✓	✓	✓	✓
ECU operation modes	It describes the iEBS modulator behavior based on the way it is supplied with power.	Chapter 4.3.9 - see page 120	✓	✓	✓	✓

4.3.1 Multi-Voltage

The Multi-Voltage functionality allows the iEBS modulator to operate across the entire operating range from 8 to 32 V. This function is intended to provide compatibility whilst coupling trailers with iEBS to towing vehicles with nominal voltage 12 V or 24 V. System functions are available in Multi-Voltage only when all connected components support 12 V operation.

Please consider that it is possible to connect peripheral devices that operate on 24 V. In this case, only towing vehicles that operate on 24 V can be connected to the trailer. This can be done by parameter setting using the diagnostics software. Do not connect a 12 V towing vehicle as the lower nominal voltage input to the iEBS modulator will be insufficient to operate the 24 V connected devices.

⚠ CAUTION

Damage to the iEBS modulator

Multi-Voltage functionality is not intended for connecting valves with mixed voltage rating (12/24 V). Using components that operate on different voltages results in functional issues and diagnostic fault entries.

4.3.2 Operating Data Recorder (ODR)

Purpose

The ODR function will log data whilst the trailer is in service. This will allow for active technical health checks, advise trailer status, analysis of the driver behavior, and helps to predict potential breakdowns as well as assisting you to plan maintenance schedules.

This operating data can be evaluated using the TrailerFit web portal for trailers equipped with telematics or by using the ODR Decoder (https://odr-decoder.eu1.scalar.zf.com)

The information from the ODR can be displayed as single event recorder or as historical data (information as trip accumulator, histograms and others).

The ODR data can be protected from deletion by a user-defined password.

Statistical data

The statistical data is stored in check sums or mean values throughout the trailer's service life or re-starting from the last time the Operating Data Recorder (ODR) was erased.

Trailer data		
ODR data	**Trailer data**	**Brake modulator data**
Odometer reading out date	Vehicle Identification Number	Device number
ODR deleted at odometer reading	Manufacturer	Serial number (ECU)
Kilometers relevant for analysis	Vehicle model	Software version
Operating hours relevant for analysis	Vehicle production date	
Reading-out date	Vehicle identification	
Total number of trips	Group	
Evaluated trips	Vehicle type	

The ODR values that can be analyzed are:

ODR values	
Brake applications	Number of brake applications with service brake
Brake frequency	Number of brake applications per km
Average aggregate load	Average value of the aggregate load
Average aggregate load	Mean value of the aggregate load percentage (relative to the maximum aggregate load)
Average control pressure	Average value of the control pressure p_m at the yellow coupling head
Trips with overload	Number of trips with more than 10 % overload (with reference to the defined axle load parameter)
Brake actuations without ABS connector	Braking with stop light supply during failure of the power supply via ISO 7638
Brake applications with anti-jack-knifing brake	Number of brake actuations with anti-jackknifing brake, sole pneumatic braking of the trailer
Brake actuations without CAN specifications	Number of brake actuations behind towing vehicle without CAN communication
RSS interventions, stage 1	Number of RSS test brake actuations
RSS interventions, stage 2	Number of RSS deceleration brake applications

Trip Information

A trip has a distance of at least 5 kilometers and a minimum speed of 30 km/h. The trip accumulator stores data from the last 1000 trips and can be shown by graphic or by table.

The following data is recorded per trip:

Trip Information		
Graphics	**Table data**	
ABS & RSS interventions	Odometer reading	Aggregate load at beginning of trip
Average control pressure	Distance	Min. and max. aggregate load
Braking frequency	Date/time	ABS brake applications
Maximum and average speed	Driving hours	RSS interventions, stage 1 & 2
Aggregate load	Maximum and average speed	Average centripetal acceleration
Average centripetal acceleration	Average control pressure	
Travel distance and time	Brake actuations and frequency	

Histogram

Histograms	Retrievable information
Measured values related to brake pressure, axle load and speed are constantly captured during operation. Histograms represent the frequency of events with the respective measured values. This is to determine whether the driver applied the brake in a forward-thinking manner, for instance, soft or sharp braking behavior during the recorded trips.	Total distance / Axle(s) load
	Braking time / Control pressure
	Number of brake applications / Control pressure
	Total distance / Lateral acceleration
	Number of brake applications / Downhill gradient at start of braking
	Number of brake applications / Deceleration

Event recorder

Event recorder	Retrievable information
The event recorder stores the a maximum of 500 events, e.g., braking system events. Each event is saved in the iEBS modulator, together with the time of occurrence and the odometer reading at that time.	ABS and RSS interventions
	Warning display illuminated and messages
	Manual deactivation of TailGUARD
	Immobilizer events or events that can be defined with GIO parameter setting (e.g., if a connected door contact switch indicates the opening of a door)
	OptiTurn activity and OptiTire warnings
	Bad road detection for trailer equipped with OptiLevel

Bad road detection

This option is used to detect if the current driving level is deviating from the parameterized level, and whether this could be too close to the air bellow internal bumper level. An operation range for the stroke of the bellow pressure is monitored to avoid that the trailer could be damaged when driving over bad roads.

If a bad road has been detected (e.g: the height value of the bellow pressure is out of the parameterized safe range), an ODR event will be registered. The bad road detection is done via an analysis of the height sensor position and the pressure in the load bellows of the trailer. The sensitivity of the function can be parameterized to low, medium and high sensitivity.

4.3.3 Odometer

Application

The iEBS modulator is equipped with an integrated odometer that measures the distance (in km) covered during a trip.

To determine the distance covered, iEBS counts the average values of all wheels, therefore the accuracy is determined by the tire size and the pole wheel parameters.

If iEBS is not supplied with power, the odometer does not work, and is therefore not secured against unauthorized alterations.

Functions

Cumulative odometer: The cumulative odometer records the entire trailer life-time mileage since the first installation of the iEBS system.

Trip odometer: The trip odometer can determine the distance travelled between two service intervals or within a specific time span.

The values are saved regularly and can be read out using the iEBS diagnostic software or electronic SUBSYSTEMS like the SmartBoard (sub-menu Odometer).

The trip odometer can be deleted by using the iEBS diagnostic software or the SmartBoard.

Odometer adjustment: When an iEBS modulator is replaced the odometer reading of the new unit can be increased to adjust it to the mileage of the trailer. It is only possible to adjust the trailer milage within the first 1000 km of the iEBS modulator.

Reducing the odometer reading is not possible. The odometer reading can be set via the iEBS diagnostic software in the menu Tools > Service and milage counter > Increase Odometer Reading.

No special calibration of the trip odometer is necessary. A calibration factor is calculated based on the tire rolling circumferences and the number of pole wheel teeth from the iEBS parameters.

Parameter setting

The odometer of the device can be set via the iEBS diagnostic software in tab Tools > Service and mileage counter.

4.3.4 Service Interval

Application

The service interval reminds the driver that service work to be performed is due.

Warning lamp: When the trailer has covered a set distance (e.g., 100,000 km), the yellow warning lamp is activated and will flash 8 times every time the ignition is switched ON. Additionally, the service notices are stored in the ECU-internal operating data recorder.

If the service work has been successfully completed, the service signal should be reset via the iEBS diagnostic software (Tools, Service and mileage counter).

If the trailer reaches the next defined service interval (e.g., 200,000 km), the service signal is generated again.

Parameter setting

By default, the iEBS modulator service signal is not active.

The service interval function can be configured in the iEBS diagnostic software in tab System > Parameters > (6) Common functions > Service Interval.

4.3.5 Axle load monitoring

Application

This function monitors information about the trailer axle weights (RGE 22 messages) and total bogie weight (EBS 22 messages) of he trailer. The information is gathered by the iEBS modulator and frequently delivered to the towing vehicle via the ISO 11992 CAN connection (via pins 6 and 7 of the ISO 7638 connector).

The data can be provided to the driver if the towing vehicle is equipped with a suitable display device. Otherwise, a SUBSYSTEMS device like Smartboard can be used to read such information.

Using the function

The information about axle load can be displayed for pneumatic and mechanical suspension trailers.

For air suspension trailers the calculation is based on the bellow pressure signal. To transmit the axle load data, the following conditions must be fulfiled:

- Drawbar trailers: An additional pressure sensor must be installed on the axle where the EBS relay valve is mounted to detect the axle loads.
- Semitrailers with tag axle: An additional pressure sensor must be installed on the axle where the tag axle valve is mounted to detect the axle load.

For mechanical suspension trailers the calculation is done by measuring the compression of the leaf spring via the height sensor. In the case of trailers with mechanical suspension the accuracy is restricted by the construction.

Axle loads can be output via the CAN interface to the towing vehicle or via SUBSYSTEMS to the user interfaces.

- Towing vehcile display:Transmission of the axle load to the towing vehicle via CAN is the default configuration in iEBS that can be displayed on the dashboards of most towing vehicles. How the axle loads are displayed in the towing vehicle is depending on whether the "trailer axle load display" function is supported and activated.
- User interfaces:A SmartBoard device can be used to display the axle load information and to calibrate the axle load function.

An additional axle load sensor can be installed on semitrailers with a 4S/3M configuration to increase the precision of the measurements. In the absence of additional axle load sensors, the axle load is distributed evenly over all axles.

NOTICE

For trailers equipped with lift axle(s) that are not controlled by the iEBS, it is not possible to transmit the axle load. The axle load is not going to be stored in the operating data recorder (ODR) either.

In some towing vehicles faults can occur if the transmitted data appears implausible. In such a situation, one of the messages should be deactivated. The deactivation of the transmition of load information can be done in in the iEBS diagnostic software in the tab System > Parameters > (6) Common functions > CAN settings ISO 11992-2

- EBS22: If this parameter is checked, the data transmition for total load from the sum of the single axles is stopped to the towing vehicle.
- RGE22: If this parameter is checked, the data transmition for the individual loads of the axles is stopped to the towing vehicle.

Axle load output via SmartBoard

In order to attain higher precision for the axle load output, the output can be calibrated via the SmartBoard. The calibrated value is transferred to the towing vehicle via the ISO 7638 port and is also displayed on the SmartBoard.

A 3-point characteristic curve must be stored in the iEBS based on the weights of an unladen, partially laden and fully laden vehicle. Once a value has been calibrated it is immediately integrated in the characteristic curve for the axle load output. The calibrated minimum/maximum values may only deviate up to max 20 % from the characteristic curve defined in the braking pressure table (System > Parameters > (2) Brake).

Example

If the trailer in unladen conditions has load value per axle of 2000 kg, then axle load output can be calibrated between 1600 and 2400 kg.

If the trailer in laden conditions has load value per axle of 8500 kg, then axle load output can be calibrated between 6800 and 10200 kg.

The calibrated values for the unladen, partially laden and laden vehicle must not be below a defined minimum distance of 10 % from one another.

Before starting the calibration, the lift axle(s) should be lowered, the trailer height brought to driving level and the brake pressure released. Because the air bellows material properties change over the service life, a recalibration may be necessary.

⚠ CAUTION

A calibration that has already been started in the SmartBoard must always be concluded, otherwise a fault message will be triggered. The fault message will not be stored in the diagnostic memory in the event of a failed calibration.

Overload warning message: Optionally, it is also possible to program the SmartBoard so that the warning message will appear on the SmartBoard's display when the axle load has reached 90 %, and 100 % of the overloading threshold (e.g., when loading bulk material).

Components

Part number	Description	Additional information
446 192 210 0	SmartBoard (optional)	Cable for SmartBoard: 449 929 . . . 0
446 105 523 2	External green warning lamp (optional)	Cable for green warning lamp: 449 940 . . . 0

4.3.6 ServiceMind

Application

This function is used to count the operating hours for devices and GIO functions. This allows to monitor the operating time of GIO functions by setting a reminder (e.g., Set a reminder for an air suspension system check after the parameterized working hours for ECAS usage have been reached).

When the predefined operating time has been reached, an event (service notice) can be started and displayed by the iEBS diagnostic software or via the SmartBoard.

Optionally, the event can also be indicated via the warning lamp (yellow, ABS) or via an external warning lamp mounted to the trailer. The service notice will be displayed showing the respective service that is to be performed.

Parameter setting

The function can be configured via the iEBS diagnostic software in the tab System > (7) Additional functions > GIO operating hours counter.

To parameterize the function it is necessary to define the following information:

Parameter	Description
Service name	Assigned service name for the function to be monitored.
Service interval (hours)	Interval time for the reminder of the selected component/function.
Reset service interval	Allows to reset the tracker with the iEBS diagnostic software or SmartBoard
Edit service interval	Allows to change the service interval via iEBS diagnostic software or SmartBoard
Internal input signal	Define the internal signal that is used to monitor the status of a GIO function. Only active functions can be selected to be monitored. The internal signal measures the operating time of the active function. Inverting the signal allows to measure the time of the inactive function.
Analog input signal	A threshold value (value of a switch that is activated) must be assigned to the analog signal. This option allows to track operating time above or below the threshold.
Lamp display for analog signal	Option to select whether the warning should be indicated via the warning lamp (yellow, ABS) and/or via an external warning lamp attached to the trailer.

Components

The following components can be used for indication and operation:

Part number	Description	Additional information
446 192 210 0	SmartBoard (optional)	Cable for SmartBoard: 449 929 . . . 0
446 105 523 2	External green lamp (optional)	Cable for Green Lamp: 449 940 . . . 0

4.3.7 Notebook Memory function

Application

The notebook function supports the user to view and save iEBS data (e.g., list of installed components), or trailer data (service history, e.g., rectified faults, last service date).

The data is stored in a table format to the memory of the iEBS modulator.

Using the function

Open the function in the iEBS diagnostic software (go to menu Tools, Notebook).

The notebook function does not require any additional parameter setting or activation.

Read data: Click the button " Read from ECU" to read the data out of the ECU. To read the data from a previously prepared (CSV) file, click the button "Read from file".

Editing data: If necessary, edit the data using the input window in the iEBS diagnostic software.

Writing data to the ECU: To save data in the ECU, click the button "Write to ECU". To save data on your PC, click the button "Write to file".

CSV file: You can create this file on your PC (using a spreadsheet program for example).

ⓘ	The data must be alphanumeric (no formatting or special characters). In total, approximately one A4 page can be saved (based on the number of characters), which can be divided into a maximum of 10 columns.

4.3.8 Service documentation

Application

A reference (URL) of the trailer specific service information can be saved to the iEBS modulator.

Storing such information (e.g., the trailer wiring diagram) is of great support for a workshop to pinpoint faults, it also cuts down the need for contacting the manufacturer.

The URL can be displayed via a pop-up window of the iEBS diagnostic software (subject to the workshop computer being connected to the internet).

The information can also contain a schematic diagram, or a service document from the trailer manufacturer. A URL can be saved with up to 150 characters. The referenced document can have any number of pages. We recommend storing documents in PDF format.

Using the function

For the following example the schematic diagram 841 701 180 0 is used as reference:

The URL with specific trailer information can be stored in the system diagnostics in the tab > System > (1) Vehicle > Vehicle data > URL for vehicle information
To enable the function, click on the check box and paste the URL
(e.g., https://www.wabco-customercentre.com/catalog/docs/8417011800_en.pdf).

4.3.9 ECU operation modes

Normal operation mode

Normal mode offers full functionality of iEBS. When iEBS is powered via ISO 7638 and simultaneously the ignition is turned ON during trailer standstill, then the system boots into normal mode.

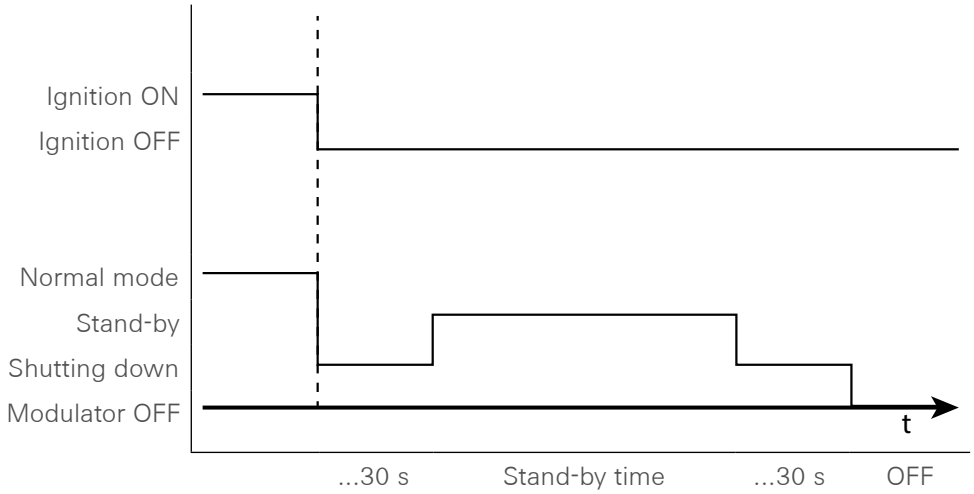
Shutdown mode

iEBS enters into shutdown mode after the ignition is turned OFF. The shutdown mode is designed to provide enough time to the driver to activate the standby mode if it is required by the user, otherwise iEBS will switch OFF.

This mode will keep the system active for a fixed 30 seconds (by default), allowing the user to have enough time to activate the standby mode via a user interface as SmartBoard (usually mounted to the rear most end of the trailer)

Standby mode

Standby mode is an optional mode that provides electrical power to SUBSYSTEMS and GIO functions during trailer standstill. The standby mode can be activated, automatically or by request. During the standby mode the system has the option to be powered via an external battery or can be powered from the truck via ISO 7638 while the ignition is turned OFF.



The system can be set to standby mode by a request from a user interface such as SmartBoard. It is the driver's responsibility to use this function accordingly. The activation time and the duration of the standby mode can be parameterized via the iEBS diagnostic software.

Activating standby mode via ignition OFF:

This option allows iEBS to enter into standby mode automatically every time the ignition switch in the truck has been turned OFF. After the standby time has elapsed, the system enters into shutdown mode.

Re-entering into standby is not possible after the standby delay time has elapsed. To re-enter into standby mode, the ignition must be switched ON and switched OFF.

Activating standby mode via user interface:

This option allows the user to choose if iEBS enters into standby mode via a user interface (e.g., Smartboard). Once the standby time delay has elapsed, iEBS enters into shutdown mode, the reactivation of the standby mode is possible during a short period of time (default 30 seconds), otherwise iEBS will switch OFF. If the standby mode is not requested during the shutdown mode period, then the system will switch OFF.

Fault supply mode

Fault supply mode offers limited iEBS functionality and will prioritize braking over other non-safety critical functions.

If, due to a faulty power cable or loose contact, the power supply to iEBS (ISO 7638) is interrupted while driving, the system will enter into fault supply mode.

During fault supply mode, the system will be powered via stop light supply (optional installation from ISO 12098) until the ISO 7638 connection is reestablished.

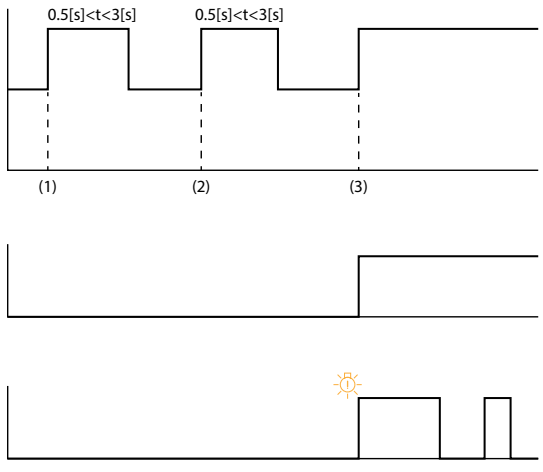
Roller test bench mode

The roller test bench mode function deactivates the standstill function and the emergency brake function for testing purposes. This is used to check the load sensing characteristic curve in a stationary vehicle, for example during the brake roller tester procedure.

In this test mode, the automatic load-dependent brake force control can be checked, depending on the hose coupling pressure (p_m) in relation to the current axle load or the current bellows pressure.

Trailer laden simulation: The "laden" status can be simulated when the trailer is unladen by venting the load bellows (< 0.15 bar) or lowering the trailer onto bumpers. The full braking pressure is applied in an analog format to the safety function "Vehicle on bumper".

Mechanical suspension: Unhook the linkage for the height sensor and turn the lever to the position that corresponds with the spring-deflection of the laden trailer.

<table>
<tr><th colspan="3">Test mode start by truck</th></tr>
<tr><td rowspan="2">Switch the ignition ON and OFF 3 times with a power ON interval between 0.5 and 3 seconds to activate the test mode.</td><td>Ignition
ON
OFF</td><td rowspan="3"> 
</td></tr>
<tr><td rowspan="2">A long warning lamp flash followed by a short warning lamp flash will indicate that the test mode is active. The sequence to activate the test mode can be configured via the system diagnostics</td><td>Test mode active</td></tr>
<tr><td>Trailer Warning Lamp</td></tr>
<tr><th colspan="3">Test mode activation by diagnosis</th></tr>
<tr><td colspan="3">The iEBS diagnostic software can be used to activate the test mode from tab Control > Measured value simulation.</td></tr>
</table>

4.3.10 SUBSYSTEMS power supply and data communication

Purpose

The iEBS SUBSYSTEMS port provides data communication with externals ECUs in the trailer. In addition, power supply is provided.

CAN is used for communication between SUBSYSTEMS devices and the iEBS modulator.

Power supply for external devices

The current output via the available SUBSYSTEMS ports is defined in chapter "10.3 iEBS modulator specifications", page 211.

A port duplicator SUBSYSTEMS cable (PN 894 600 161 2) can be used to duplicate the number of SUBSYSTEMS ports and increase the number of electronic SUBSYSTEMS devices that can be connected simultaneously. Cable pin description can be found in chapter "10.6 Cable overview", page 217

	Basic	Standard	Premium
# SUBSYSTEMS ports	1	2	2

The power output is provided from iEBS under the following conditions

- Truck and trailer coupled and ignition ON
- Truck and trailer coupled and the iEBS modulator in standby mode (in this case terminal 30 remains ON after ignition OFF)

NOTICE

Please consider that the function will be disabled if the overall current consumption will exceed the permitted maximum. For details go to section "iEBS modulator specifications" on page 211

A 3rd party device can also be power supplied via a GIO port. For further information see chapter "5.21 GIO power service", page 184.

Supported CAN devices

The following devices use CAN data communication

- SmartBoard
- OptiTire
- Telematics (e.g., TX-TRAILERPULSE, SCALAR EVO Pulse, SCALAR EVO Guard)

⚠ CAUTION

During vehicle operation, it is not permitted to connect the ground connections of the trailer EBS to the vehicle chassis

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. In the case of connecting a SUBSYSTEMS device to the iEBS modulator, one terminal resistor is located in the connected CAN device and the other termination is in the iEBS modulator itself.

If two or more CAN devices are connected to one iEBS SUBSYSTEMS port, iEBS will switch OFF its own CAN termination based on the parameterized configuration.

When 3 or more CAN devices are connected simultaneously to the same SUBSYSTEMS port, the CAN termination of the middle device (i.e., the device with the shortest path connection) must be switched OFF. This is usually done by using the appropriate diagnostic software.

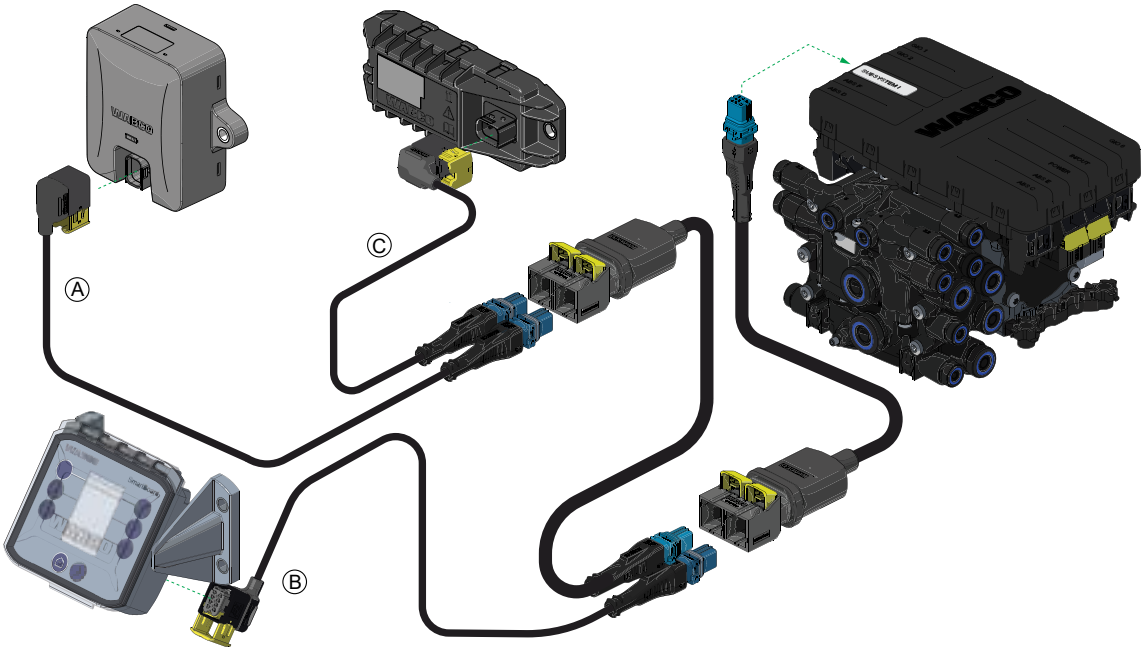
Example:

The following example shows a system configuration that includes 3 SUBSYSTEMS devices (Telematics, SmartBoard and OptiTire) connected to one SUBSYSTEMS port.

For this configuration SCALAR EVO Pulse and SmartBoard will be connected to the CAN, while the termination resistor for OptiTire will be switched OFF. The OptiTire CAN termination must be switched OFF by using the OptiTire diagnostic software. For further details, refer to the section "OptiTire™" on page 78.

The device with the termination resistor switched OFF must have a short path connection. Therefore, the cable length for the OptiTire (C) must be as short as possible.

The cable length for the SCALAR EVO Pulse (A) and the SmartBoard (B) shall be longer than the cable length selected for OptiTire.



The external devices can be enabled in the tab System > Parameters > (6) Common functions.

CAN termination for OptiTire

- Open the OptiTire diagnostics software and then select the “EBS system parameter settings” menu.
- Activate the “Display expert parameter” in the “Module configuration” tab to enable the “Expert parameter” tab.
- In the “Expert parameter” tab, check the “Activate CAN termination” option
- Once all modifications have been performed, press "Write to ECU" (PIN code required to save the parameters)

4.3.11 OptiTire™ Integrated function

Application

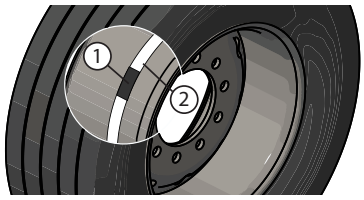
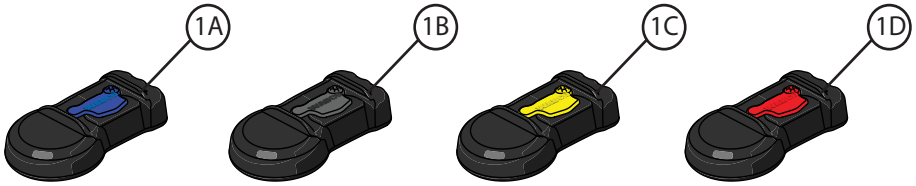
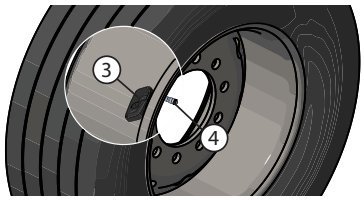
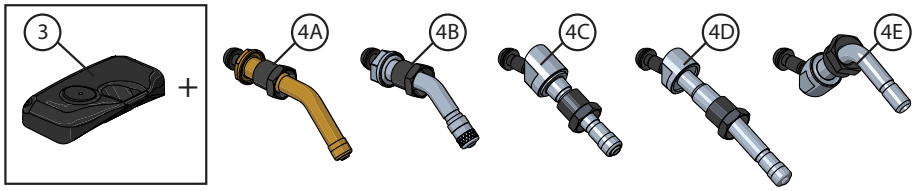
OptiTire integrated is a Tire Pressure Monitoring System (TPMS) that is incorporated in the preactivated iEBS Standard and iEBS Premium modulators.

OptiTire integarted can be set up for trailers with up to 6 axles. For trailers with more than 6 axles or trailer applications that require an extended range of radio receiving, up to 3 additional OptiTire ECUs might be added as Range Extender to improve the receiving performance on complex applications.

Function

In the same way as with the external OptiTire, the pressure from the tires is measured by individual sensors. The measured values obtained by the sensors are repetitively transmitted to the iEBS modulator via radio signal.

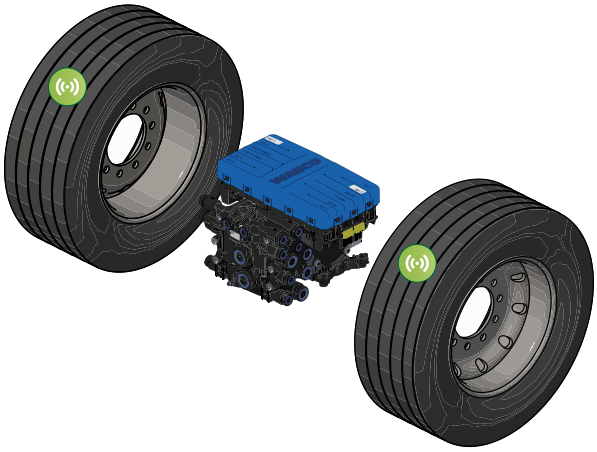
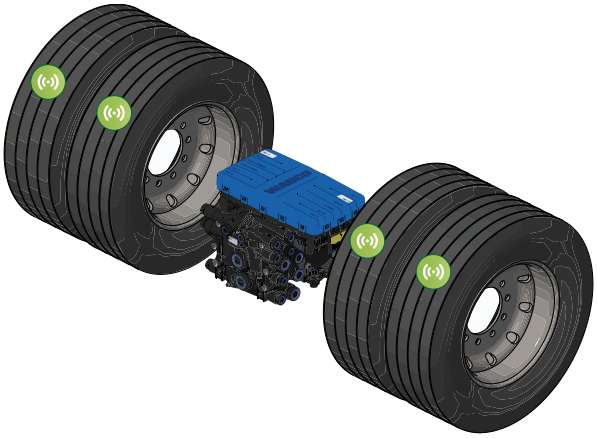
Connecting the components

Sensor type	Sensor devices
	
	

Item	Part number	Description	Maximum receiving distance	
			Single/Super single tires	Twing tires
1A	960 733 000 0	Blue strap mounted sensor	1.6 m	-
1B	960 733 001 0	Grey strap mounted sensor	2.5 m	2.2 m
1C	Not supplied	Yellow strap mounted sensor	-	-
1D	Not supplied	Red strap mounted sensor	-	-
2	960 733 117 0	Strap for rim size 17.5“	-	-
2	960 733 119 0	Strap for rim size 19.5“	-	-
2	960 733 122 0	Strap for rim size 22.5“	-	-
2	960 733 124 0	Strap for rim size 24.5“	-	-
3	960 732 000 0	Internal wheel sensor	2.5 m	2.2 m
4A	960 732 100 0	Steel rims 17 ... 22.5"		
4B	960 732 102 0	Steel rims 17 ... 22.5", additional 5° inclined section		
4C	960 732 104 0	ALU Rim		
4D	960 732 105 0	ALU Rim		
4E	960 732 117 0	ALU rim		

With iEBS as the gateway to the ISO 7638, all tire data according to the UN/ECE R13 can be forwarded to the driver’s dashboard.

Each tire of the trailer must be equipped with a pressure sensor.

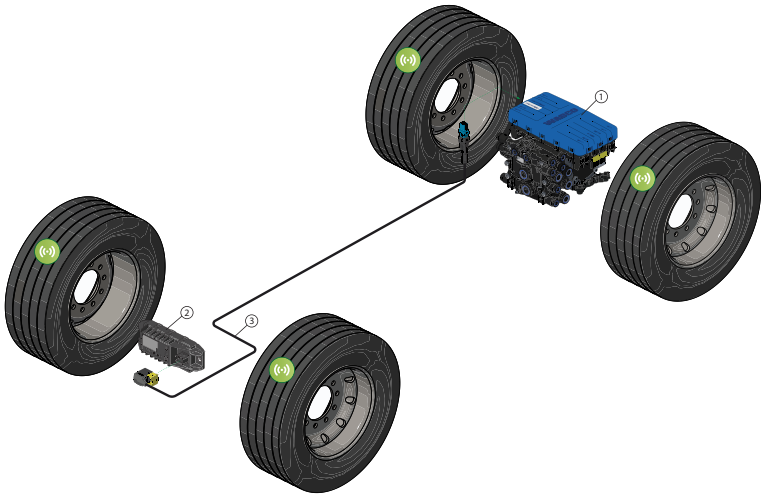
Single / Super single tires configuration	Twin tires configuration
	

Item	Part number	Description	Comments
1	480 102 31 . 0	iEBS Standard	Only iEBS modulators with functions activated. Further information can be found on chapter "5.1.5 Integrated functions", page 130
1	480 102 41 . 0	iEBS Premium	

Range extender

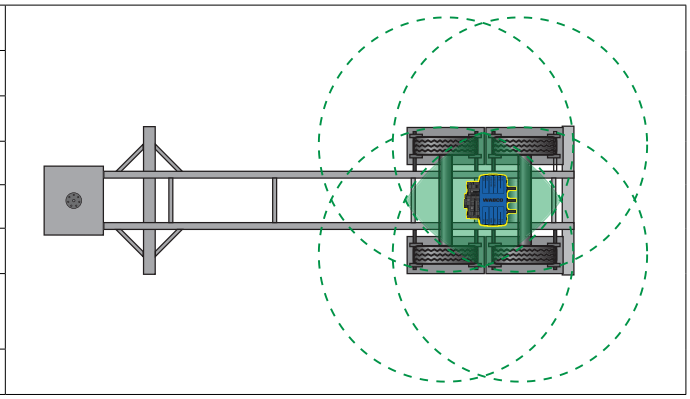
The range extender is used when the communication distance between the tire pressure sensor and the main receiver exceeds the effectiverange of the radio signal. This can occur due to obstacles undert the trailer, interferance with other devices, or when trying to cover large distances (e.g., distance between the front and rear axle on a drawbar trailer).

If the trailer application requires the use of a range extender, this can be achieved by installing an OptiTire ECU that will be used to receive the radio messages from the wheel-modules. The received information will be forwarded over the CAN-bus to the iEBS modulator which will perform the complete data handling and inform the diver in case of pressure warnings issues.

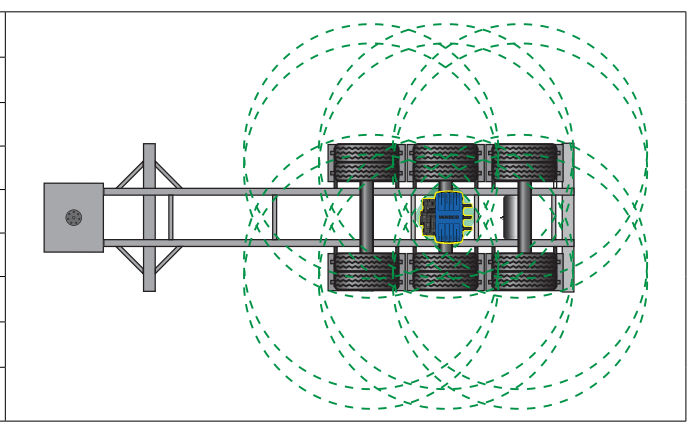
Range extender connection			
Item	Part number	Description	Scheme connection
1	480 102 31 . 0	iEBS Standard (Only with functions activated)	
1	480 102 41 . 0	iEBS Premium (Only with functions activated)	
2	446 220 110 0	Range extender (OptiTire ECU)	
3	449 928 . . . 0	HDSCS cable	

Common OptiTire integrated trailer configurations

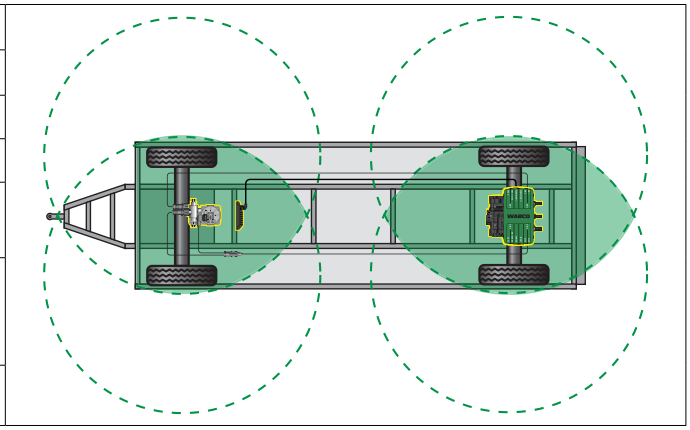
Trailer type	Semitrailer
Number of axles	2 axles
ABS control	4S/2M
Modulator	iEBS Standard
	iEBS Premium
Reception support	Not required
Tire configuration	For single/super single tires: 4 sensors
Spare tires	Maximum 2 sensors



Trailer type	Semitrailer
Number of axles	3 axles
ABS control Modulator	4S/2M
	iEBS Standard
ABS control Modulator	4S/2M - 4S/3M
	iEBS Premium
Reception support	Not required
Tire configuration	For twin tires:12 sensors
Spare tires	Maximum 2 sensors



Trailer type	Drawbar
Number of axles	1 front, 1 rear axle
ABS control Modulator	4S/3M
	iEBS Premium
Reception support	1x OptiTire ECU as range extender
Tire configuration	For single/super single tires:4 sensors Optional:or twin tires:8 sensors
Spare tires	Maximum 2 sensors



Parameter setting

The OptiTire integrated function can be configured in the iEBS diagnostic software in the tab System > Parameters > (6) Common functions > OptiTire integrated

The parameters allow the selection of:

- Sensor type: WIS, blue SMS, grey SMS or yellow SMS
- Tire configuration: Single tire, twin tire or super single tire
- Number of spare tires: 1 spare tire, 2 spare tires or none
- Range extender configuration: This option indicates that the iEBS modulator receives information from an OptiTire ECU that worKs has a range extender. Up to 3 range extenders can be connected.
- Temperature warning threshold: If internal sensors are used, a warning message can be given out when the defined temperature value is exceeded. The defaul value for this parameter is 100 °C (maximum value: 115 °C).

Common OptiTire integrated trailer configurations

Trailer type	Semitrailer	Semitrailer	Drawbar	Drawbar
Number of axles	2 axles	3 axles	1 front, 1 rear axle	2 front, 2 rear axle
ABS control	4S/2M	4S/3M	4S/3M	4S/3M
Modulator	iEBS Standard	iEBS Premium	iEBS Premium	iEBS Premium
Reception support	Not required	Not required	1x OptiTire ECU as range extender	1x OptiTire ECU as range extender
Tire configuration	• For twin tires: 8 sensors • For single/super single tires: 4 sensors	• For twin tires:12 sensors • For single/super single tires: 6 sensors	• For twin tires: 8 sensors • For single/super single tires: 4 sensors	• For twin tires: 16 sensors • For single/super single tires: 8 sensors
Spare tires	Maximum 2 sensors			

Sensor type	Part number	Transmission baud rate	Maximum receiving distance	
			Single/Super single tires	Twing tires
Internal wheel sensor	960 732 000 0	19200 [bauds]	2.5 m	2.2 m
Blue strap mounted sensor	960 733 000 0	19200 [bauds]	1.6 m	-
Grey strap mounted sensor	960 73 001 0	9600 [bauds]	2.5 m	2.2 m

4.3.11.1 OptiTire function overview

The overview of the OptiTire integrated system can be reviewed in the iEBS diagnostic software in the module Measure values > OptiTire integrated.

All the relevant information to determine the status of the tire pressure sensors is displayed in that module.

Overview

The tab overview shows the trailer configuration with the ID of each sensor as well as the actual pressure of each tire and

- Warning messages
- The type of sensors installed
- If a range extender is configured

In case of an unexpected behavior of the sensors, a DTC warning symbol will be displayed on the specific sensor/tire that shown that issue.

The color of the warning symbol represents the status of the fault

- red for currently present warning
- blue for fault that has been resolved
- grey if no fault are detected.

An assignment test can be perfomed to check the correct assignment of the wheel modules.

Signal strength

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).

If no bar is displayed on an internal sensor, rotate the affected wheel so that the sensor points toward the iEBS modulator or the OptiTire ECU that is working as a range extender. If there is still no sensor received, the distance to the receiver is too great and repositioning of it is recommended.

Signal availability

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.

Good signal availability is considered when more than 50 % of the messages transmitted by the sensor are available for each wheel position. Below 33 %, a high probability of fault messages due to sensor messages not being received must be expected.

Reset data: Allows to reset all stored data related to the signal availability

Standstill test: This test allows to check the reception of the sensor's messages around one revolution of the circurfence. The test result is the overall availability of the system.

The standstill test is typically performed for trailers with complex axle configuraions in the following way:

- Place the vehicle in an open area where it will be possible to move forward the trailer in 12 equal parts.
- To measure the 12 positions it is recommended to mark the surface of the tire with chalk in 12 equal parts (e.g., like the hours of a clock) or to make 12 lines on the ground that will represent the circunference of the tire (e.g., the tire circumference of a 385/65R22.5 tire size is around 3350 mm, therefore the distance between the lines shall be around 28 cm)
- Place the trailer at the first measuring position and start the reception test.
- The measurment of messages at each position takes 3 minutes.
- Once the measurement of the messages has finished, move the vechicle to the next position and click start to measure again.
- Repeat the process untill al the 12 positions are completed.
- After the last measurement, the overall result is output, and details are displayed in a log.

OptiTire Integrated – Sensor assignment.

The sensor assignment of the OptiTire integrated system can be reviewed in the iEBS diagnostic software in the module System > OptiTire sensor assignment.

The assignment ensures that all entries, including the sensor ID, have been made correctly during configuration. The sensors can be assigned by means of:

- Free assignment: Used to assign specific sensor(s). Typically used after a wheel or sensor replacement
- Sequential assignment: This option will perform the assignment of all the sensors installed on the vehicle in a determined sequence.

The sensor's information is commonly gathered by the system via stimulation. For this purpose, a diagnostic message is stimulated for the selected sensors and the corresponding ID is inserted automatically at the selected position. Otherwise, it is possible to manually enter the data of the sensors.

5 GIO functions

5.1 Introduction to GIO

The GIO interface of an iEBS modulator can provide additional functions to control various trailer equipment / features beyond the braking functions.

Example functions are: control of air suspension (RtR), lifting axle, lock control for self-steering axles, rolling floor.

Further functions can be defined according to individualized specific requirements and are freely configurable. Important GIO functions are described in the following specified chapters

5.1.1 Functional limitations

The number of functions is limited to the available GIO ports according to the iEBS variants.

GIO functions are subject to the availability of proper power supply and connected components being fault free. In case of voltage drop, the brake functions will be prioritized and secured by switching OFF the GIO functions.

In order to keep Multi-Voltage functionality, all connected devices shall be specified with 12 V. This will ensure proper functionality under the condition that 12 V trucks are used as a towing vehicle. In case of 24 V trucks, the GIO's output stage will modulate 12 V control for these components.

The maximum current for each individual GIO switching output is described in chapter "10.3 iEBS modulator specifications", page 211

5.1.2 GIO port operation

GIO ports count with a maximum of 4 pin contacts to allocate components. Every GIO port have at least one output stage (pin 1) and a ground contact (pin 2). The rest of pins (pin 3 and pin 4) are assigned differently, therefore not all functions can be allocated equally to all ports.

GIO output stage: The GIO output stage can be used to switch electrical components (e.g., solenoid valves, lights). Most of the GIO switching outputs can also be used as inputs. Whether a switch has an open or closed circuit can be sensed this way. The GIO is protected against damage through short-circuits.

GIO analog input: The GIO analog input can be used to read in analog signals (e.g., from the pressure sensor, where a voltage value represents the pressure) or to detect the status of buttons and switches.

GIO pulse width modulation (PWM): The GIO PWM input is used to connect ECAS height sensors.

GIO 1 (all variants except iEBS Basic Air) and GIO 9 (only Premium) are dedicated ports for PWM devices.

Further information can be found in chapter "10.5 Pin assignment for iEBS", page 214.

5.1.3 Parameter setting

Via the parameter menu of the iEBS diagnostic software, individual parameter settings and functions can be assigned to each GIO port. Outputs can be monitored to ensure the proper function of the system, e.g., to recognize and warn about cable breaks. The parameter settings will define the appropriate observation method according to the type of the connected component.

iEBS is designed to control various types of components (see section "Trailer iEBS components" on page 46). Default settings for these control functions are already prepared within the iEBS diagnostic software. This includes a proposal for the GIO port that shall be used for connecting the related components.

Additionally, various other functions for specific devices can be freely configured, e.g., the rolling floor function. Conditional dependencies for specific trailer conditions can be specified.

GIO functions can be configured in the iEBS diagnostic software in tab:

- System > Parameters > (6) Common functions
- System > Parameters > (7) Additional functions

5.1.4 Error detection

To allow a safe operation of specified functions and its connected devices, it is recommended to set up the error monitoring. The component that is connected to a GIO port can be configured according to its load type (e.g., solenoid, relay, lamp, or ECU). The recommended setting for error detection is:

Connected component	Load type	Nominal voltage	Error detection
Solenoid valve	Solenoid/Relay	12 V or 24 V	ON
Electric relay (low resistance types)	Solenoid/Relay	12 V or 24 V	OFF
Bulb type lamp	Lamp	12 V or 24 V	ON
LED type lamps	LED/ECU	Multi-Voltage only	Not possible
Electronic Control Units	LED/ECU	Multi-Voltage only	Not possible

5.1.5 Integrated functions

Integrated functions refers to functionalities that are readily available for use in some iEBS variants.

Functions integrated	Basic Steel	Basic Air	Standard	Premium
OptiTire integrated	-	-	✓	✓
Immobilizer	-	-	✓	✓
TailGUARD	-	-	-	✓

Further details on chapter "10.1 iEBS variants", page 210.

5.1.6 GIO connection logic

Default GIO assignment

The following recommendation table provides an overview of valves and related compatibility to individual GIO ports.

Port	Default component nomination	Port availability			
		Basic Steel	Basic Air	Standard	Premium
GIO 1	Height sensor or TASC with RtR	✓(height sensor)	✓(TASC with RtR)	✓	✓
GIO 2	LACV	✓	✓	✓	✓
GIO 3	Additional GIO function				✓
GIO 4	Additional GIO function				✓
GIO 5	Additional GIO function				✓
GIO 6	LACV-IC or switch		✓(switch only)	✓	✓
GIO 7	ECAS or eTASC			✓	✓
GIO 8	EBS relay valve (3rd modulator)				✓
GIO 9	Pressure sensor				✓
GIO 10	Additional GIO function				✓

Advanced trailers

The following table provides an overview of common valves and the GIO ports applicable for the connection. The default assignment of the GIO port is no longer kept.

The assignment of components shall be done in the following way:

The component group number represents the priority of the selected devices. The selection of GIO ports must be done from the components group number from 1 to 10. The two columns at the right side of the table are describing the possibility to connect a second device to the same GIO port by the use of a port duplicator. A duplicator connected to the GIO port can be used to increase the number of devices that can simultaneously be connected.

The cable pin description can be found in chapter "10.6 Cable overview", page 217

Group #	Device	Related cable	Applicable GIO port	Port duplicator for 2nd device	2nd device group
1	3rd modulator (conventional) +Pressure sensor (Group #6)	449 414 ... 0	GIO 8	-	-
2	ECAS eTASC	449 509 ... 0 449 403 ... 0	GIO 3	894 600 131 2	9
			GIO 7	894 600 131 2	9 / 10
3	Height sensor	449 829 ... 0	GIO 1 (or 9)	894 600 131 2	9
4	ECAS 2-point valve	449 508 ... 0	GIO 7 (or 8)	-	-
5	Proximity switch	449 827 ... 0	GIO 3 (or 6)	894 600 121 2	9 / 10
6	Pressure sensor	449 826 ... 0	GIO 6	894 600 121 2	9 / 10
			GIO 1 (or 4 / 9)	-	-
7	LACV-IC	449 509 ... 0	GIO 3 (or 4 / 6)	894 600 131 2	9
			GIO 7 (or 8)	894 600 121 2	9 / 10
8	Lining wear	449 836 ... 0	GIO 1 (or 6)	894 600 131 2	9
			GIO 6 (or 7)	894 600 121 2	10
			GIO 2 (or 5 / 10)	-	-
9	Switch or push buttons	449 408 ... 0	GIO 1 (or 4 / 6 / 9)	894 600 131 2	9
			GIO 4 (or 6)	894 600 121 2	9 / 10
			GIO 2 (or 5 / 10)	-	-
10	Solenoids (RtR, LACV) or lamps	449 408 ... 0	GIO 1 (or 3 / 4 / 6 / 9)	894 600 131 2	9
			GIO 3 (or 4 / 6 / 7 / 8)	894 600 121 2	9 / 10
			GIO 2 (or 5 / 10)	-	-

5.2 Lifting axle control

⚠ WARNING

Risk of injury from trapped limbs when lowering the lift axle

The lifting axle functions are usually controlled by changing the load status. In seldom cases, a height change of the chassis can also affect the status of the lift axle.
A sudden lowering of the lift axle can endanger people in the immediate vicinity. This applies particularly to persons who are underneath the trailer, to carry out repairs for example.

– To prevent accidents, trailer manufacturers should draw attention in their operating manual to the hazard posed by the automatic lifting axle control mechanism.
– Lift axles must be lowered and the ignition turned OFF before any repair work is carried out on the trailer.

Purpose

Lift axles and tag axles are designed to significantly reduce operational costs upon the axle that has been lifted. Depending on the application and trailer use in service this may contribute to fuel savings, reductions in CO_2 emissions and reduction in tire wear.

Lift axles are typically used to be controlled based on the trailer load (a laden trailer will keep the lift axle on the ground and an unladen trailer will lift the axle if possible). Used on the rearmost axle of the trailer, lift axles can be used to reduce the turning circle of the truck-trailer combination.

Tag axles are a special variant of lift axles. Tag axles remain on the ground and reduce the axle load, the purpose of these axles is to improve the trailer maneuverability.

Function

To control a lift axle the iEBS modulator measures the air pressure of the load bellows to determine the axles load status. Depending on the parameterized conditions, the iEBS modulator raises/lowers the axle(s).

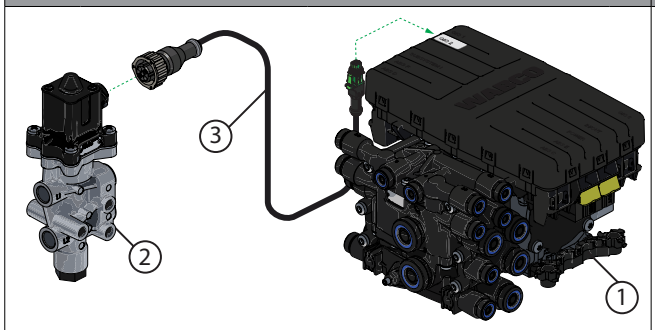
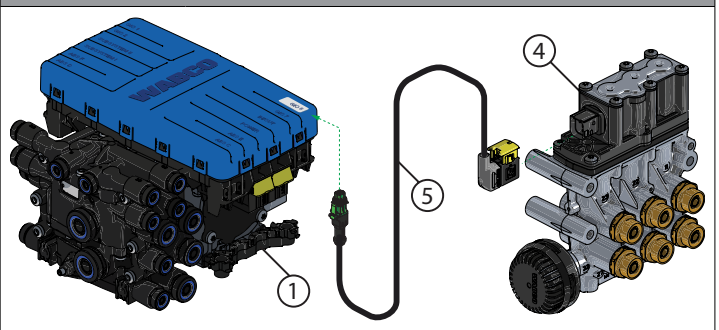
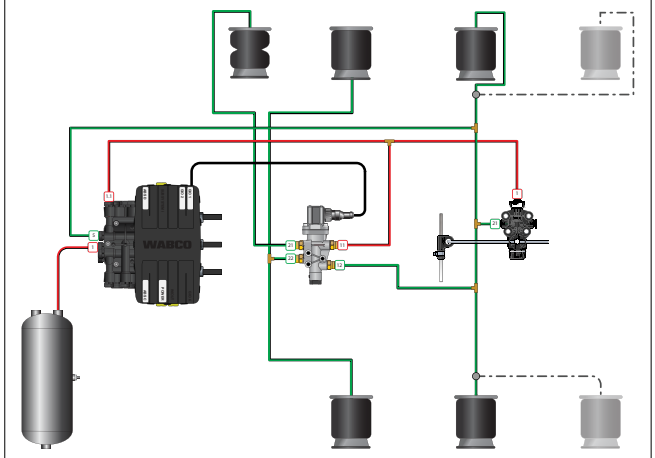
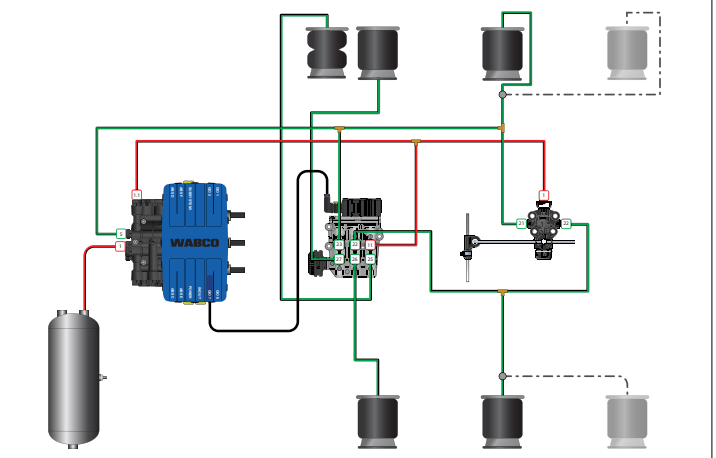
Lift axles can be configured as a single-circuit or a dual-circuit types:

- Single-circuit: Both load bellows of the lift axle are directly connected to one another. This is the predominant circuit type due to the stiffness of the axles for typical trailers
  The typical valve type used for this configuration is the LACV (spring-returned). The lift axle is lowered or raised without intermediate positions. If the voltage of the lift axle control valve is switched OFF, the lift axle is lowered.
  A single-circuit configuration is recommended for standard trailers with support of automated lifting of axles or Traction Help.
- Dual-circuit: The load bellows for the lift axles are connected separately (by side).
  The typical valve type used for this configuration is the LACV-IC (impulse-controlled). The valve has two solenoids that will trigger a pneumatic control switch function. When the solenoids will no longer be powered, the valve will hold the last activated position to partially relieve the lift axle.
  The lifting/lowering response time of an LACV-IC is faster than a LACV, that makes the dual-circuit configuration the recommended circuit for tippers that require a fast response to changes in the load condition.
  The LACV-IC valve is also recommended for tag axle configurations.

Limitations

Lifting axle control function is disabled if there is no ISO 7638 power supply to the iEBS modulator.

Connecting supported devices

Single-circuit	Dual-circuit
	
	

Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		iEBS modulator compatible with lifting axle control function
2	463 084 060 0 463 084 061 0	Lift Axle Control Valve (LACV)	449 408 . . . 0	All variants: Single-circuit, spring-returned
3	449 408 . . . 0	Cable for LACV		Cable variant lengths: chapter "10.6 Cable overview", page 217
4	463 084 103 0 463 084 104 0	Lift Axle Control Valve - Impulse Controlled (LACV-IC)	449 509 . . . 0	Dual-circuit compatible with iEBS Standard and Premium.
5	449 509 . . . 0	Cable for LACV-IC		Cable variant lengths: chapter "10.6 Cable overview", page 217

Parameter setting

The lifting axle control function can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control.

More information concerning switch parameters definition for lift axle functions can be found in chapter "5.7 Switch control", page 149.

5.2.1 Automatic mode

Function

The automatic mode is the default mode for lift axles. Depending on parameter setting, the automatic mode can be manually deactivated by forced lowering or lift axle OFF commands.

Additionally, the automatic mode can be overruled by other functions such as Traction Help, OptiTurn, etc.

The automatic mode can be configured inside the system diagnostics. The pressure and speed thresholds for the lifting and lowering sequence are predefined in the system diagnostics configuration.

The load on the axle aggregate is calculated based on the measured bellow pressure and the number of axles on the ground. These values are stored in the Operational Data Recorder and broadcasted on CAN 5 V and CAN 24 V.

If lift axles are not controlled by iEBS but e.g., through manual operation, it is recommended to read in the status of the lift axle to ensure correct broadcast of axle load values

Parameter setting

The iEBS diagnostic software allows the parameterization of:

- Pressure: Adjustable threshold for controlling the lift axle.
  Default parameters for a 3-axle semitrailer: raise axle below 3 bar / Lower axle above 5 bar
  Note: To avoid oscillating (frequent raise and lowering) when the load is near to the switching point, the system requires a difference of minimum 0.3 bar between the switching pressures.
- Speed: Indicates the speed threshold at the start of the ride, at which is determined if the automatic raised of the lift axle can be performed.
  Default parameters for a 3-axle semitrailer: raise lift axle at 0 km/h (trailer in stationary condition)

⚠ CAUTION

Lift axle lowering while driving
Lowering a lift axle during driving conditions is not a foreseen situation but might become necessary when the load moves inside the trailer.

In the event of a displacement of the cargo that produces an overload of 20 % (maintained longer than 5 seconds) while driving at speeds above 30 km/h, the lowering of the lift axle will be triggered.

Manual request and lift axle behavior

The automatic mode can be overruled by:

- Manual request from the driver: The system gives priority to the new manual request by deactivating the last active operating mode .
- Other priorities of parameterizations: According to the table below, the function with highest priority will be realized when preconditions are fulfilled.

Mode	Activation	Priority	Overload	Modulator
Manual user operation	By user request	High	Variable	Air variants
Seasonal Off-road Traction Help	Via system		>30 %	Air variants
Off-road Traction Help	Via system		>30 %	Air variants
Reverse Gear OptiTurn	Via system		30 %	Air variants
Reverse Gear Traction Help	Via system		30 %	Air variants
Seasonal Traction Help	Via system		30 %	Air variants
Traction Help (speed lim. ~30 km/h)	Via system		30 %	Air variants
OptiTurn	Via system		30 %	From Premium
Seasonal Optimum Traction	Via system		0 %	From Premium
Optimum Traction	Via system		0 %	From Premium
OptiLoad	Via system		0 %	From Premium
Automatic Mode	Via system	Low	0 %	Air variants

5.2.2 Lift axle OFF

Application

The purpose of lift axle OFF is to deactivate lifting and lower the respective lift axles by manual request. The deactivated lift axle(s) does not execute any lift axle functions that were assigned to it.

Lift axle OFF is recommended to avoid sudden lowering of the lift axle (i.e to carry out repairs on the trailer or in cases where a particular axle shall be excluded from the lift axle function).

Lift axle OFF activation

To deactivate a lift axle it is required to have a device that will switch it OFF. A switch or SmartBoard can be used to turn off a lift axle.

Up to two separately controlled lift axles can be permanently lowered individually, by means of two separate switches, or by using the SmartBoard.

In case a trailer is equipped with more than one lift axle, only the deactivated lift axle does not execute lift axle functions that were assigned to it. This does not affect the lift axle functions of other available lift axles installed on the trailer.

Parameter setting

The lift axle OFF mode can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > Lift axle OFF by GIO.

The switch used for lift axle OFF can be configured in the iEBS diagnostic software in the tab System > Parameters > (8) Switches.

More information concerning switch parameters definition can be found in chapter "5.7 Switch control", page 149.

5.2.3 Forced lowering of the lift axle

Application

This function is used to override the automatic mode of the lift axle by lowering the raised lift axles.

The forced lowering is recommended during the loading process while the ignition is OFF, this will avoid overloading of the axles on the ground while others are lifted.

Forced lowering activation

The forced lowering of lift axles can be initiated by the operator or automatically by the system due to various conditions.

Forced lowering by system (according to parameter setting)

- Ignition status: Ensures the lowering of the lift axle while the ignition is OFF
- In combination with OptiLevel while on unloading level: When entering the unloading level, the lift axle of the trailer is lowered. When switching from unloading level to other OptiLevel mode (e.g., driving level), the forced lowering is deactivated.
- Standby: The lift axle can be lowered when the iEBS modulator is on standby mode after ignition OFF
- Hand brake applied: Forced lowering is active while the truck's hand brake is applied.
- SafeStart: The lift axle is lowered if the SafeStart function is active.

Manual forced lowering activation via switch control

Push buttons can be used to lower the lift axles on user's demand.

- Temporary forced lowering: The forced lowering function will be activated temporarily if it is activated by a push button. The activation of the forced lowering mode can be disabled by manually selecting a different mode (i.e., Traction Help) or by turning the ignition of the truck OFF and ON again.

More information concerning switch parameters definition for temporary and permanent forced lowering can be found in chapter "5.7 Switch control", page 149.

Parameter setting

The forced lowering mode can be configured in the iEBS diagnostic software in tab System > Parameters > (3) Lift axle control > Forced lowering.

To enable the lift axle control tab, the lift axle option must be selected in the iEBS diagnostic software from the tab (1) Vehicle > Axle definition section

5.2.4 Traction Help

Application

Traction Help raises the trailer lift axle to increase the traction on the truck's driving axle, improving safety and operating efficiency on slippery ground or on steep hills, where trucks find it difficult to pull away or cannot do so at all. The Traction Help mode is compatible with trailers equipped with lift axles and tag axles.

Function

Traction Help uses the lifting of an axle to shift weight to the fifth wheel. This will lead to an increase of the load of the drive axle of the towing vehicle. The effect of the Traction Help depends on the load status of the trailer and the effective wheelbase of the trailer. The best traction performance is expected with a fully laden trailer and the longest effective wheelbase distance. The load will be monitored via the load bellow pressure of the trailer's main axle.

Traction Help function comes in 2 different modes:

Traction Help: This mode allows to overload any axle by up to 30 % of its permitted maximum load. When a speed of 30 km/h is attained, the system returns into automatic mode and the lifted axle is lowered.

Traction Help Off-road: The lift axle is raised even in situations where the overload is greater than 30 %. The Off-road Traction Help function is restricted only to non-public roads.

⚠ CAUTION

Traction Help Off-road overload
The parameterized pressure value for overload should not exceed the maximum axle load specified by the axle manufacturer.

NOTICE

The activation conditions and general behavior of the Traction Help function must be different from OptiTurn in order to avoid conflicts between the functions.

Traction Help with lift axles

The position of a lift axle determines if the axle should be raised or lowered to increase the load on the fifth wheel. The Traction Help mode is typically used with a lift axle positioned in front of the main axle. By fully raising the front axle, the effective wheelbase is increased, and simultaneously the load supported by the lifted axle is transferred to the tractor and the trailer's axles that remain on the ground.

It is also possible to use the Traction Help mode with a lift axle positioned behind the main axle. In this situation the lift axle is fully lowered while Traction Help mode is ON. The increase of load on the tractor is based on the increase of the effective wheelbase.

Pressure limit parameter: Defines the maximum average pressure on the carrying axle bellows at which the Traction Help is terminated. It is commonly set to 130% of "bellows pressure laden". The Traction Help mode is deactivated if the trailer reaches a speed of 30 km/h (by default).

Traction Help with tag axle

The Traction Help mode can be used with a tag axle positioned in front of the main axle.

By deflating the load bellows of the tag axle, the effective wheelbase is increased, and simultaneously the load supported by the tag axle is transferred to the tractor and the rest of trailer's axles that remain on the ground.

Pressure limit parameter: Defines the target pressure that shall be reached in the bellows of the main axle by adjusting the pressure in the tag axle.

When the target pressure in the main axle is reached, the pressure in the load bellows for the tag axle is held.

Parameter setting

The Traction Help mode can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > Traction Help.

The Off-road Traction Help mode can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > Off-road Traction Help.

The iEBS diagnostic software allows the parameterization of:

- Pressure: Adjustable pressure for the main axle. Used for controlling the lift axle or the tag axle
  Default parameters for Traction Help mode: 6.5 bar, deactivation at 30 km/h.
  Default parameters for Off-road Traction Help mode: 7 bar, deactivation at 30 km/h.
- Time: The duration of the function can be limited to certain periods of time
  Default parameter: 0 seconds. No abort due to duration.

Traction Help & Off-road Traction Help activation/deactivation: The Traction Help mode, as well as the Off-road Traction Help mode, is started either manually by the driver or automatically via:

- Anti-Slip Regulation: Function activated when the traction control of the truck is active
- Indicator light: The Traction Help is automatically started when a flashing indicator light is detected (except hazard light). For this functionality the trailers right and left indicator light must be connected to the iEBS modulator.
- Brake actuation: Function activated by applying the brake 3 times during standstill. The brake must be actuated and released three times within 10 seconds with a pressure between 3 and 8 bar. Deactivation is possible only if the setting values for pressure or speed are reached.
- Temperature: A temperature threshold can be defined to activate the function. Function available with iEBS Premium and only with SmartBoard
  Default parameters: Activation below 5.0 °C
- Curve detection: Function can be activated during slow cornering.
  Default parameter: function is aborted 5 seconds after the curve
- Speed: The function can be activated/deactivated at a certain speed threshold
  Default parameters: Activation at 5 km/h; Deactivation below 5 km/h (only if speed activation has been enabled)
- Reverse gear: Engaging the reverse gear can activates the function
- Seasonal Traction Help: The Traction Help is permanently available between the calendar start and end dates set in the parameters. During that period (e.g., winter) the driver does not need to repeatedly activate the Traction Help every time he starts the truck-trailer combination. The date can be made available from the truck or by using a battery-powered SUBSYSTEMS device such as SmartBoard or SCALAR EVO Pulse.
  This function can also be disabled on the SmartBoard by the driver during a period of mild weather. Traction Help is only started when it is activated again by the driver.
  Outside of the seasonal period, Traction Help can be started using one of the other activation options mentioned above.
- Seasonal Traction Help via switch: The Traction Help can be permanently made available with an ON/OFF switch installed on the trailer. When the switch is closed, the Traction Help is active every time the trailer pulls away. If the switch is open, the Traction Help can be started using one of the activation options mentioned above.
- Load dependent operation: Additional load range condition to start the function mode. The load ranges are defined in the “Definition of load range” parameters. Load dependent operation is only possible if load ranges are defined.
  The condition for starting the function can additionally be used for aborting it by selecting start and abort conditions. The mode is aborted when the load of the trailer is out of the load range.

- Seasonal load dependent operation: Additional condition to start the function during a particular period of time. The "Seasonal activation" option must be enabled to use the seasonal load dependent operation.

5.2.5 Optimum Traction

Application

The purpose of Optimum Traction is to increase the king pin load of the tractor and thereby provide a higher traction on its driving axle. The resulting weight shift from trailer to tractor facilitates a start off driving on e.g., slippery ground or steep hills. Unlike Traction Help, the function "Optimum Traction" will increase the axle load up to a 100 % of the maximum permissible axle load, therefore the function can operate without any speed range limitation.

Function

Optimum Traction uses the lifting of an axle to shift weight to the fifth wheel. This will lead to a load increase on the drive axle of the towing vehicle. The load increase of the towing vehicle depends on the load status of the trailer and the effective wheelbase of the trailer. The best traction performance is expected with a fully laden trailer and the longest effective wheelbase distance. The load will be monitored via the load bellow pressure of the trailer's main axle.

Optimum Traction with lift axle(s)

The position of a lift axle determines if the axle should be raised or lowered to increase the load on the fifth wheel. The Optimum Traction is typically used with a lift axle positioned in front of the main axle. By fully raising the front axle, the effective wheelbase is increased, and simultaneously the load supported by the lifted axle is transferred to the tractor and the trailer's axles that remain on the ground.

Optimum Traction can be used with a lift axle positioned behind the main axle as well. In this situation the lift axle is fully lowered while Optimum Traction mode is ON. The increase of load on the tractor is based on the increase of the effective wheelbase.

For trailers with 2 or more lift axles, then the Optimum Traction will start lowering all the axles behind the main axle, and after that lift all the lift axles in front of the main axle until the maximum supported load in the towing vehicle is reached.

Pressure limit parameter: Defines the threshold for the main axle at which the front lift axle is raised (lowered for lift axles behind the main axle).

Activation

The function can be manually activated via user interfaces as SmartBoard, GIO switches or via 24 V CAN connection. The function can be also automatically activated:

- Based on speed and pressure.
- Seasonal activation is also possible by defining the season when the function should be available.

The automatic Optimum Traction can be deactivated temporary (until next ignition reset) or permanently (until manually activated again) via user interface

Parameter setting

The Optimum Traction mode can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > Optimum Traction.

5.2.6 OptiTurn

Application

OptiTurn function is used on semitrailers or central axle trailer with at least one lift axle, or tag axle, to increase the maneuverability of the trailer by minimizing the rear axle's traction on the ground.

Function

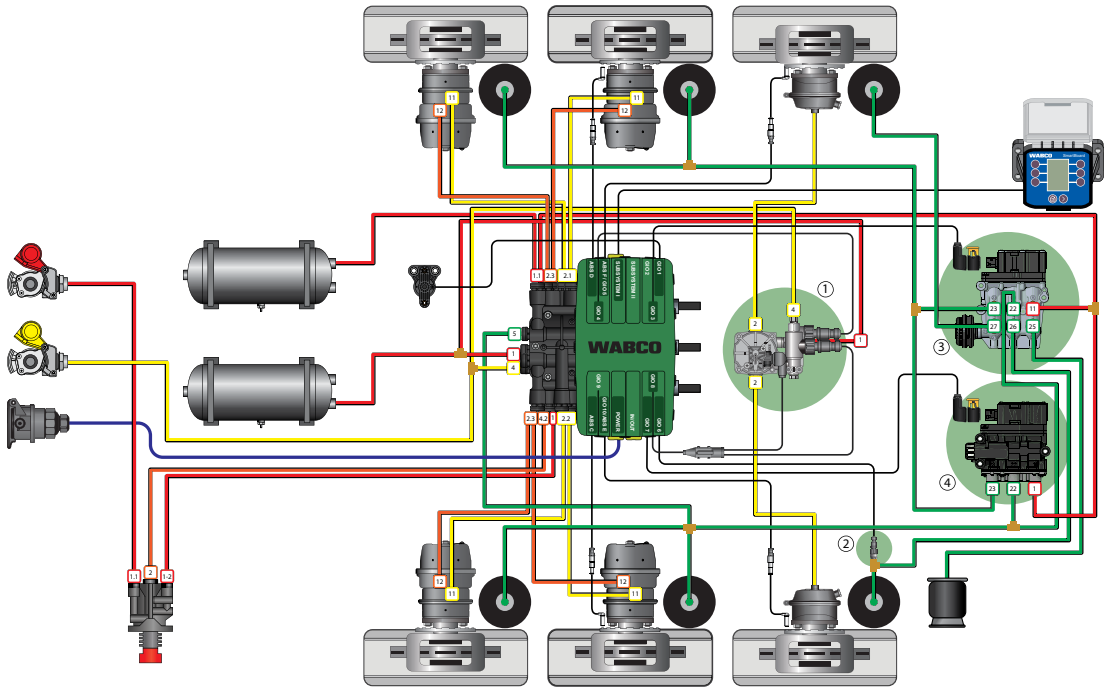
The OptiTurn function for iEBS consists of two mode options: OptiTurn and OptiTireWear.

The OptiTurn configuration controls the lift axles, or tag axles in a way that will reduce the turning radius whilst improving the maneuvering ability when cornering. This option will optimize the curve handling and tire wear.
Lift axles: All lift axles in front of the main axle are lowered and all possible lift axles behind the main axle are lifted.
Tag axles: The bellows of all tag axles in front of the main axle are inflated and the bellows of all possible tag axles behind the main axle are deflated.

OptiTireWear: This option is used to reduce as much as is feasible the wear of tires by lifting all possible lift axles (or deflating all possible tag axles) in front and behind the main axle.

Function requirements

Required components for an optimal operating of the OptiTurn function



Item	Designation	Designation
1	EBS relay valve	Installed to the last axle (4S/3M configuration) to provide the optimum braking pressure when braking with a partially relieved axle and to prevent the wheels from locking on the last axle
2	Additional pressure sensor	An external bellow pressure sensor on the axle E-F is used to determine the axle load.
3	LACV-IC	The valve must be installed to the last axle for optimum response and efficient control of the lifting & lowering functions.
4	iEBS OptiLevel valve	An ECAS or eTASC valve is necessary to ensure a quick readjustment to the target level (thus quickly reducing the wheelbase) when the last axle is relieved as the vehicle drives into a bend

NOTICE

The activation conditions and general behavior of the OptiTurn function must be different from Traction Help in order to avoid conflict between the functions.

Automatic OptiTurn activation/deactivation

The following parameters determine the automatic activation of the maneuvering assistance function (OptiTurn).

- Pressure limitation: This value represents the average pressure on the load bellows which may not be exceeded during the manoeuvring assistance (according to EC directive 97/27/EC), or at which the manoeuvring assistance is terminated. Normally this is set to 130 % of "bellows pressure laden" according to the specification of the axle manufacturer.
- Anti-Slip Regulation: Function deactivated when the traction control of the truck is active
- Automatic activation/deactivation via speed: OptiTurn is activated for a fixed period of 60 seconds when the speed will be lower than the specified speed setting. The maneuvering assistance will be terminated if the defined speed will be exceeded or the time limit has been reached.
  A conditional parameter "only during partial/full-load" can be enabled to prevent the maneuvering assistance to work when the trailer is unladen. The bellow pressure threshold for partial/full-load must be specified in a separate window.
- Seasonal OptiTurn: The OptiTurn function is permanently available between the calendar start and end dates set in the parameters. During that period (e.g., winter) the driver does not need to repeatedly activate the OptiTurn every time he starts the truck-trailer combination. The date can be made available from the truck or by using a battery-powered SUBSYSTEMS devices such as SmartBoard or SCALAR EVO Pulse.
  This function can also be disabled on the SmartBoard by the driver during a period of mild weather. OptiTurn is only started when it is activated again by the driver.
  Outside of the seasonal period, OptiTurn can be started using one of the other activation options mentioned above.
- Automatic curve detection: OptiTurn is activated if the speed drops below a threshold value and a curve path is detected. A conditional parameter "only during partial/full-load" can be enabled to prevent the maneuvering assistance to work when the trailer is unladen. The bellow pressure threshold for partial/full-load must be specified in a separate window.

The following conditions will allow for personalizing the OptiTurn function.

- Activation only via SmartBoard: If this option is selected, no additional electrical switch will be required for the maneuvering assistance. This function can be activated via the SmartBoard.
- Activation by engaging the reverse gear: OptiTurn starts automatically when the reverse gear is engaged. Additionally, it can be defined whether OptiTurn shall be terminated via speed and/or time.
- Automatic OptiTurn only when lifting axle 1 is lowered: With this option, OptiTurn will only be started automatically if all axles are on the ground. Therefore, if the first axle is liftable, the load must be such that the first axle is on the ground.

Parameter setting

The OptiTurn mode can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > OptiTurn.

5.2.7 OptiLoad

Application

The OptiLoad mode is able to lift and lower axles that are installed before and/or behind the main axle (i.e., axle C-D) to reduce the risk of damage to the truck's rear axle, that are caused by overload, and to avoid law enforcement penalties from overloading the truck's drive axle.

OptiLoad is applicable for semitrailers and central axle trailers with at least one lift axle (or a tag axle). Additionally, an EBS relay valve with external bellows pressure sensor E-F must be installed on the last axle to adjust the optimum braking pressure when braking with a partially relieved axle (OptiLoad function is activated), and to prevent the wheels on the last axle from locking. Further information about the function of the EBS relay valve in chapter "3.1.1.4 EBS Relay valve", page 53.

For optimum and efficient use of the functions (response and control behavior), it is necessary to use an electronically controlled air suspension system (for lifting & lowering, and to control the function).

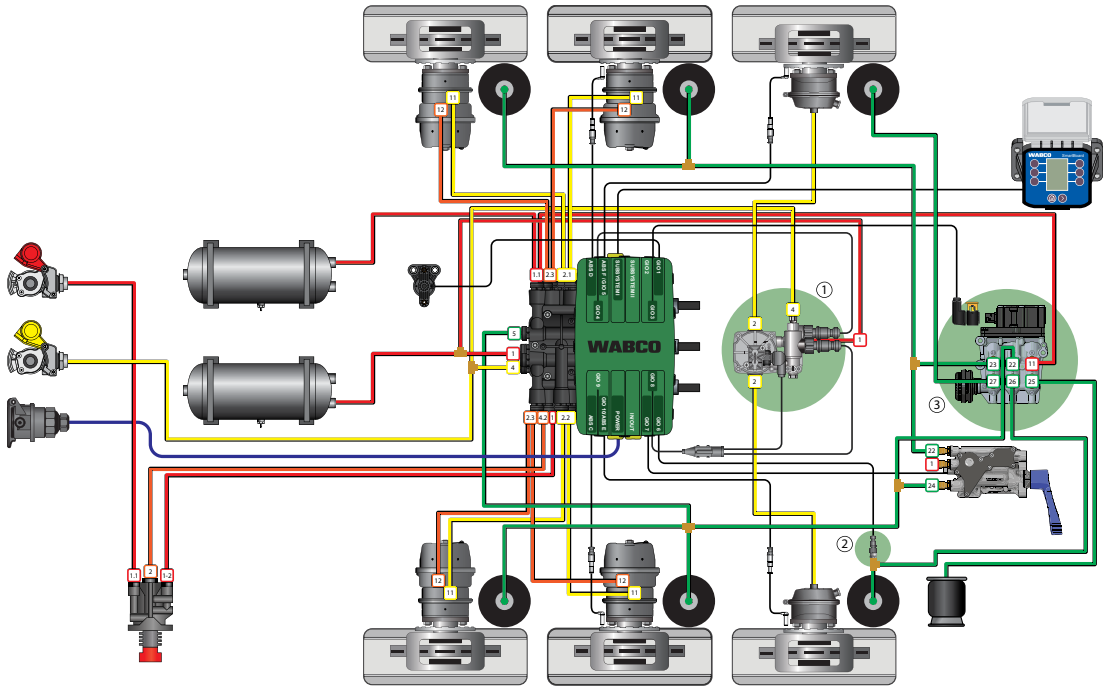
Function

OptiLoad: This function shall balance the trailer in a way, to achieve a better load balance between the trailer axles and the king pin. The axle load of the tractor's drive axle shall be reduced.

Seasonal OptiLoad: This option allows the activation of the OptiLoad mode that is based on the calendar date to increase traction on the tractor's drive axle.

Function requirements

Required components for an optional working of the OptiLoad function



Item	Designation	Designation
1	EBS relay valve	Installed to the last axle (4S/3M configuration) to provide the optimum braking pressure when braking with a partially relieved axle and to prevent the wheels from locking on the last axle
2	Additional pressure sensor	An external bellow pressure sensor on the axle E-F is used to determine the axle load.
3	LACV-IC	The valve must be installed to the last axle for optimum response and efficient control of the lifting & lowering functions.

To realize the OptiTurn function, the following components are required:

- EBS relay valve: As a 3rd modulator installed on the last axle (4S/3M configuration) is required to adjust the optimum braking pressure when braking with a partially relieved axle (OptiTurn function is activated) and to prevent the wheels on the last axle from locking.
- Additional pressure sensor: An external bellow pressure sensor on the axle E-F is used to determine the axle load.
- LACV-IC: The valve must be installed on the last axle for optimum response and efficient control of the lifting & lowering functions.

Automatic OptiLoad activation/deactivation

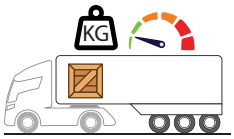
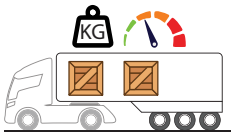
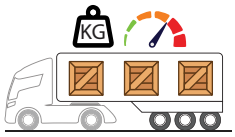
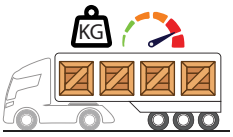
- Pressure limitation: Average pressure of the trailer carrying load axle bellows, which must not be exceeded when reducing the load on the fifth-wheel coupling and towing vehicle drive axle.
  A maximum value of 100 % of the "bellows pressure laden" value should not be exceeded.
  In countries with a permissible axle load of 9 tons, the pressure limitation can be set to 100% of the "bellows pressure laden" value.
  In countries with a permissible axle load of 8 tons, the pressure limitation can be set to about 88 % of the 9 tons for a 3 axle trailers, in order to avoid overloading the axles.
- Anti-Slip Regulation: Function deactivated when the traction control of the truck is active
- Automatic activation/deactivation via speed: When this option is selected, OptiLoad is started automatically when the threshold speed is exceeded. The default speed value of 0 km/h will start the function right after ignition "ON".
  A conditional parameter "only during partial/full-load" can be enabled to prevent the automatic activation of OptiLoad when the trailer is unladen. The bellow pressure threshold for partial/full-load must be specified in a separate window.
- Seasonal OptiLoad: The OptiLoad function is permanently available between the calendar start and end dates set in the parameters. During that period (e.g., winter) the driver does not need to repeatedly activate the OptiLoad every time he starts the truck-trailer combination. The date can be made available from the truck or by using a battery-powered SUBSYSTEMS devices such as SmartBoard or SCALAR EVO Pulse.
  This function can also be disabled on the SmartBoard by the driver during a period of mild weather. OptiLoad is only started when it is activated again by the driver.
  Outside of the seasonal period, OptiLoad can be started using one of the other activation options mentioned above.
- Manual activation: This option allows to activate the OptiLoad mode only when activated via a push button. The OptiLoad is active at all speeds within the range once the function was initially activated upon reaching the speed threshold.

Parameter setting

The OptiLoad mode can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > OptiLoad.

5.2.8 Definition of load range

The definition of the load status is required for the load depending operation of the lift axle control function. The load status is defined as unladen, partially laden and fully laden.

Unladen	Partial load	Laden
The load status of the trailer is considered as unladen if the bellow pressure is below the "partial load pressure" threshold.	The load status is considered as partially laden if the bellow pressure is above the "partial load pressure" or below the "full load pressure" threshold.	The load status of the trailer is considered as laden if the bellow pressure is above the "full load pressure" threshold.
	 	

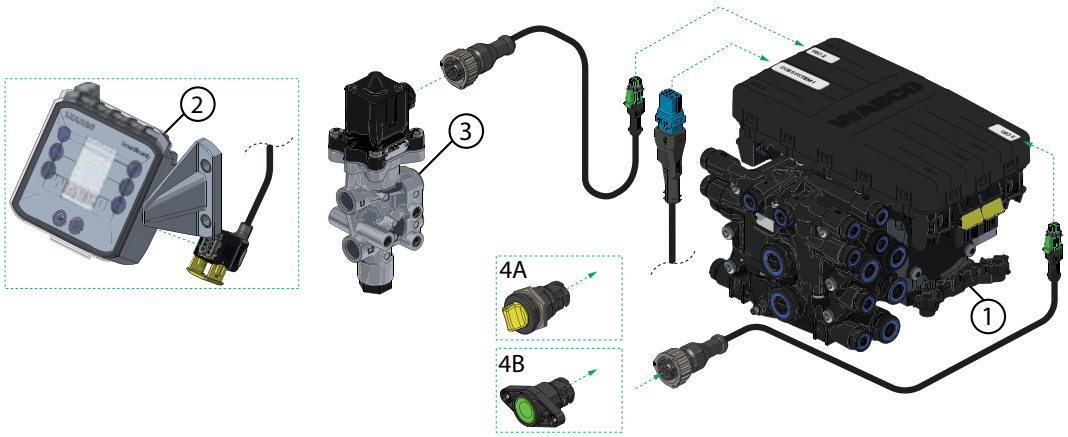
Trigger for load detection: The load detection can be started by two triggers. Either if the trailer speed exceeds the Return-to-Ride speed (trailer's suspension system is set to driving level and is in a stable driving condition) or if the towing vehicle's ignition is switched on. Additionally, it can be selected to use both triggers to start the load detection.

This parameter is being ignored from the iEBS if OptiLevel is activated for the trailer. In case of OptiLevel, the load detection is triggered automatically if the trailer is in standstill.

Parameter setting

The definition of load range can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > Definition of load range

5.2.9 Interfaces connection for lift axle control



Item	Part number	Description	Cable required	Comment
1	480 102 2 . . 0	iEBS modulator		Only iEBS Air variants
2	446 192 210 0	SmartBoard	449 929 . . . 0	Interactive display with batteries included
	446 192 211 0	SmartBoard	449 929 . . . 0	Interactive display without batteries for ADR trailers
3	463 084 060 0	Lift Axle Control Valve (LACV) 12 V	449 408 . . . 0	
	463 084 061 0			
4A	441 006 0 . . 0	Switch	449 448 060 0	iEBS Basic Air: GIO 6 is dedicated port for switches. pin 2 (ground), pin 3 (analog in).
4B	441 006 0 . . 0	Push button	449 448 060 0	

5.3 Return-to-Ride function (RtR)

Application

Return-to-Ride is applicable for all trailers equipped with conventional air suspension and a TASC valve to adjust the chassis height.

The RtR function ensures that the trailer is automatically set to the driving height after leaving the loading dock.

Function

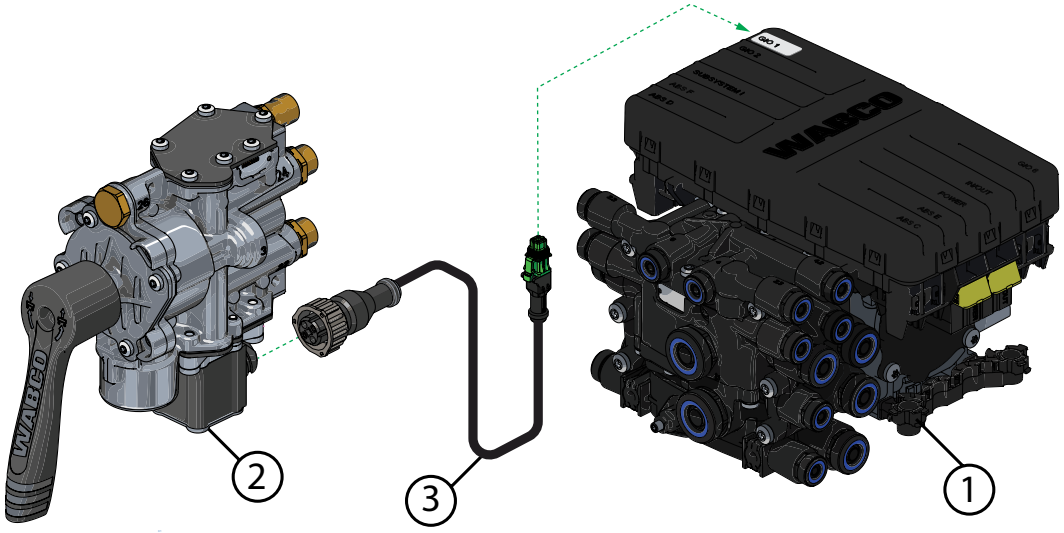
The RtR function is triggered by an Integrated Speed Switch function (ISS1). This function ensures a return to the driving level as soon as the vehicle reaches a parameterized speed threshold.

After the trailer speed exceeds the activation speed, the switching threshold for this function can be:

- Permanent power: The output is switched ON continuously. If the vehicle speed falls below deactivation speed, the output is switched OFF.
- 30sec pulse: The output is switched ON for 30 seconds and the deactivation speed is ignored.
- RTR pulse: This output sequence is used to activate the TASC valve. The deactivation speed is ignored.

The default activation speed at which the trailer will approach the driving level is set to 15 km/h. The deactivation speed must be at least 2 km/h less than the value set for the activation.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 2 . . 0	iEBS modulator		Only iEBS Air variants
2, 3	463 090 301 0	TASC standard	449 408 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
	463 090 302 0	TASC with height limitation	449 408 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217

For further information about additional variants and functionality, see chapter "3.1.2.5 Trailer Air Suspension Control (TASC) with Return-to-Ride (RtR)", page 60

Parameter setting

The trailer speed threshold for the RtR function shall be parameterized in the iEBS diagnostic software in tab System > Parameters > (7) Additional functions > ISS1/RtR

The "inverting switching behavior" option allows the solenoid valve to be switched ON or OFF depending on the speed setting.

5.4 Active signals (RSS & ABS) function

Application

Function available for trailers equipped with an iEBS modulator and properly configured RSS, and ABS functions. When the RSS or the ABS function is triggered, it produces a signal that can be used to activate a secondary function, for example a warning lamp to inform that a RSS/ABS event has occurred.

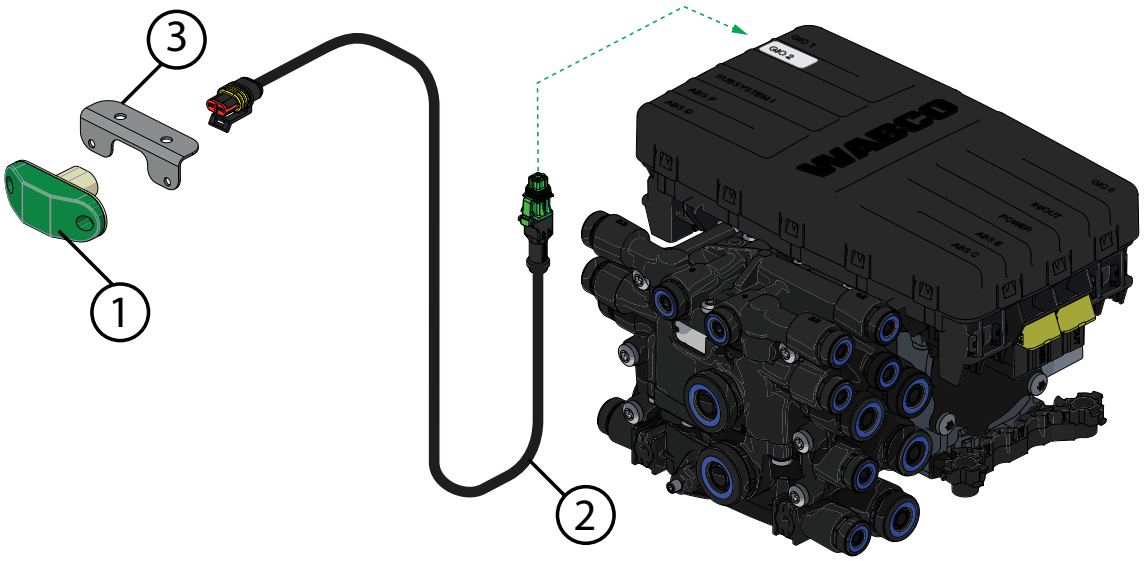
RSS function

During an active RSS intervention, the stop lights on the towing vehicle will not be actuated/triggered if the truck-trailer combination is not equipped with CAN communication through the pins 6 and 7 of the ISO 7638 power supply interface . This is because the braking is performed automatically by the iEBS modulator and not requested from the towing vehicle.

An external warning lamp can be used to indicate that an RSS intervention is taking place. The allocated GIO port is powered/activated during an active RSS intervention (e.g., the green warning lamp can be activated to show that the RSS function is active).

ABS function

An external warning lamp can be used to indicate that an ABS control process is taking place. The allocated GIO port is powered/activated during an active ABS control process (e.g., the green warning lamp can be activated to show that the ABS function is active).



Item	Part number	Description	Cable required	Comment
1	446 105 523 2	Green warning lamp	449 940 . . . 0	
2	449 940 . . . 0	Green warning lamp cable		Cable variant lengths: chapter "10.6 Cable overview", page 217
3	Not supplied	Bracket for lamp		

Parameter setting

The ABS active signal function can be parameterized in the iEBS diagnostic software in tab System > Parameters > (7) Additional functions > ABS active signal

The RSS active signal function can be parameterized in the iEBS diagnostic software in tab System > Parameters > (7) Additional functions > RSS active signal

5.5 Separate brake light

Application

The separate brake light is designed to activate an additional brake/stop light every time a brake response is initiated by the iEBS.

Function

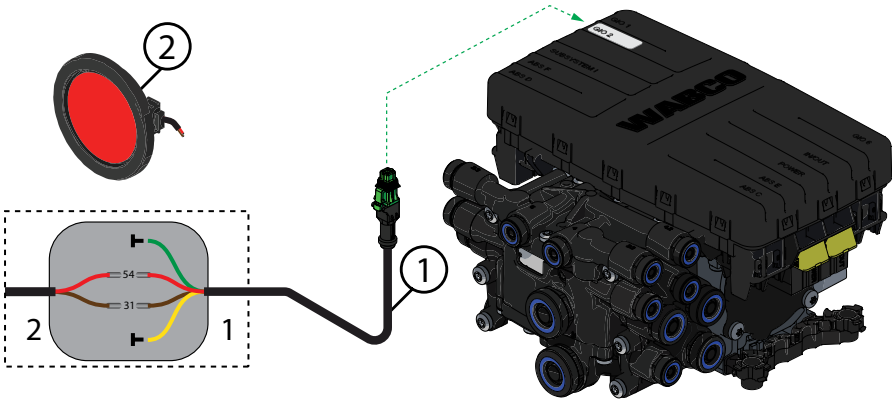
The independent stop light has to be mounted to the tail of the trailer to warn other vehicles. The function is automatically activated if a brake event is independently initiated by the iEBS modulator.

Any event that triggers the separate brake light will be registered by the ODR.

NOTICE

The installation of the additional light must comply with the lighting devices regulations and must be verified if complies with the regional legislation.

Components



Item	Part number	Description	Cable required	Comment
1; 2	Not supplied	Stop light	449 827 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217 The connection box is not supplied.

Parameters settings

The separate brake light function can be parameterized in the iEBS diagnostic software in tab System > Parameters > (7) Additional functions > Separate brake light.

5.6 Trailer ABS warning lamp

Application

The ABS warning lamp is intended to inform the driver about potential failures in the iEBS system. A green warning lamp is installed in the trailer and gets activated whenever the amber warning light is triggered by the iEBS. This function is typically used with conventional trucks, where the amber warning lamp is not available in the dashboard of the truck.

NOTICE

The installation of the additional light must comply with the lighting devices regulations and must be verified if complies with the regional legislation.

Function

The green warning lamp will behave differently depending on the type of communication that exist between the truck and the trailer.

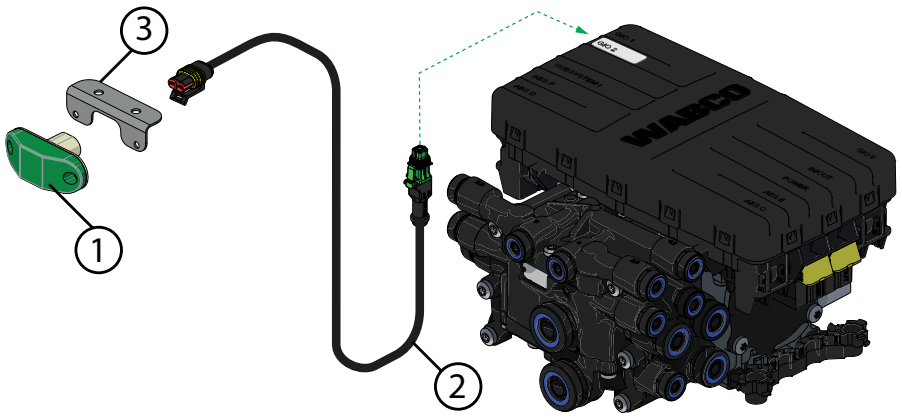
If the trailer is power supplied via ISO 7638, the error check is performed automatically after ignition ON.

- If no error are present in the system after the check, then the warning lamp shall turn OFF
- If the system has active errors, then the warning lamp will be constantly ON.

If the trailer is equipped with a complementary power supply via ISO 12098, the warning lamp will be ON after every ignition ON. By pressing the brake pedal for 5 seconds, the error check is performed.

- If no error are present in the system after the check, then the warning lamp shall turn OFF.
- If the system has active errors, then the warning lamp will be ON as long as the brakes are pressed.

Components



Item	Part number	Description	Cable required	Comment
1	446 105 523 2	Green warning lamp	449 940 . . . 0	
2	449 940 . . . 0	Green warning lamp cable		Cable variant lengths: chapter "10.6 Cable overview", page 217
3	Not supplied	Bracket for lamp		

Parameters settings

The trailer ABS warning lamp can be parameterized in the iEBS diagnostic software in tab System > Parameters > (7) Additional functions > Trailer ABS warning light.

5.7 Switch control

Application

Switch control provides the possibility to configure iEBS for a switch output with parameterized GIO functions.

The switch control functionality can be used for standard functions like lowering lift axles as well as to program sophisticated functions for non-brake related functions.

Function

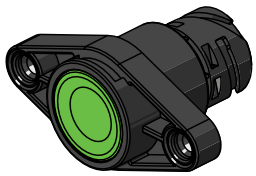
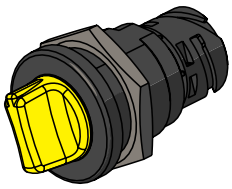
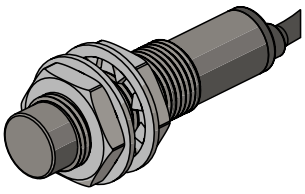
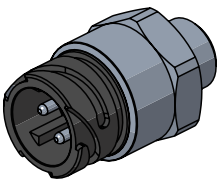
The type of switch operation configuration can decide about which function(s) should be started (e.g., a short push of a button can be programmed for Traction Help whereas a 5 sec push of the same button can lower the lift axle).

The operation configuration also allows you to control the same function with multiple switches (e.g., switches at several places of the trailer or truck can trigger one single function).

Switch types

Different type of switches can be configured based on how the switch is connected into the harness.

Switch type	Description
Switch S1 - To ground	A switch can connect to ground. Typical connection type
Switch S11 - To plus	A switch can connect to plus. Often used with cabin mounted switches
Switch S16 - Plus & Ground	A switch can connect either to ground or plus (most times having three positions, the third position is open)
Further switch types do not use real closing contacts and can be set up for Standard and Premium iEBS modulators	
Switch S20 - Proximity switch	It switches when detecting metal is close by, especially steel. This switch requires special input circuits which are provided on some iEBS port
Switch S23 - Pressure sensor	The switching pressure is defined by parameters
Switch S28 - FKA output	Virtual analog switch. It represents the logical result of programmed dependencies and conditions.
Switch S29 - FKD output	Virtual digital switch. It represents the logical result of programmed dependencies and conditions.

Push button	Rotary switch	Proximity switch	Pressure switch
			
Operation configurations			

• Short push
• Long push (>5s)
• Double push
• Dead man's switch
	• Switch connected to:
	  • Ground only
	  • Supply only
	  • Ground and supply
		• Switching threshold (e.g., 600 µA)	• Switching threshold (e.g., 2.5 V)

Compatible switches can be found in chapter "3.3.1 Electrical switches and push buttons", page 74			

Expert mode

Expert mode is available to configure the following parameters of switches and buttons

Function request: Beside default modes, where a function is active if the contact is closed, further modes are possible:

- Activation: The function can only be switched ON, the function is switched OFF only when the ignition is OFF. Only for push buttons
- Deactivation: The function is ON with ignition by default, the switch is used only to switch the function OFF. Only for push buttons
- Toggle mode: Only for push buttons. The switch button performs two options, ON and OFF. The first button push switches the function ON, a second push of the button switches the function OFF

Behavior: Allows you to invert the signal value. It can be parameterized so that a standard button which is "normally open" can be virtually inverted to replace a button which is "normally closed"

Control logic: Within this section, dependencies can be defined, e.g., to ensure the safety of the operator. Typical example is a function which can be started only when two buttons are pressed by two hands simultaneously. More than one switch operation for the same function is needed to enable this option.

Parameter setting

The usual process to define switches is:

1. Define the required function, such as lift axle control or finisher brake.

2. Define a switch in conjunction with the function. The switch control function can be configured in the iEBS diagnostic software in the tab System > Parameters > (8) Switches.

3. Define the switch type and operation type. Multiple switches can liaise to the one function.

To ensure distinction in case of larger numbers of switches, all switches receive an individual number like "S11" already during the definition. These switch individuals must be allocated one by one to the GIO ports and their pins.

The system supports up to:

- 10x Ground level switches
- 5x Supply level switches
- 5x Supply and ground level switches
- 2x Proximity switches
- 5x Pressure sensor switches

A maximum of 20 switch configurations are permitted.

5.8 OptiFlow™

Application

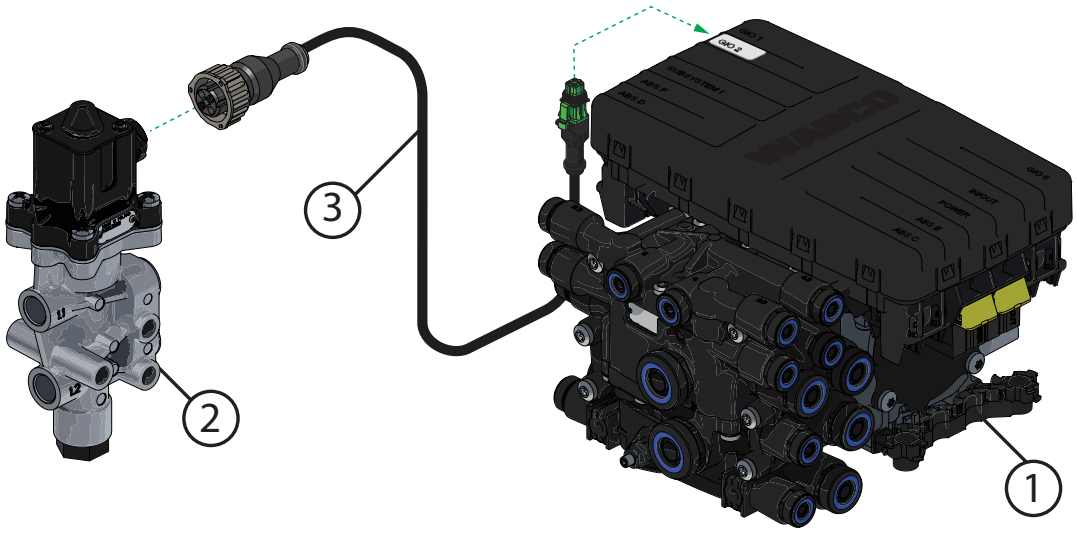
Aerodynamic rear fairings for trailers equipped with iEBS. Improves the aerodynamic performance of the trailer, therefore it helps to save fuel and reduce the CO_2 emissions. Available in both, automatic and manual mode.

Function

OptiFlow™ Tail is a manual deploying and retracting mechanism for the aerodynamic rear fairings for trailers that can be completed in simple steps. Levers are used to collapse the top panels, and fold the side panels to the center. The manual version can be upgraded to AutoTail, for auto-deployment and retraction.

OptiFlow™ AutoTail automatically deploys and retracts the aerodynamic rear fairings based on driving speed. Automatically deploys at trailer speeds of 75 km/h and retracts at 15 km/h. The automatic mode can be enabled and disabled via a respective parameter or an assigned switch.

Connecting the components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS modulator		
2	463 084 060 0	Lift Axle Control Valve (LACV) 12 V	449 408 . . . 0	
3	449 408 . . . 0	Cable for LACV		Cable variant lengths: chapter "10.6 Cable overview", page 217

Parameter setting

The AutoTail function can be configured in the iEBS diagnostic software in tab System > Parameters > (6) Common functions > AutoTail

Additional information

Description	QR code
OptiFlow™ landing page Please contact your ZF partner for further information.	

5.9 OptiLevel - Electronic Air Suspension Control

Application

The OptiLevel control functionality provides chassis height control for trailers that are equipped with electronically controlled air suspension valves and require chassis height adaptations.

The electronic air suspension system includes a height sensor instead of the traditional levelling valve. The height sensor allows to read the distance between the trailer's axle and the trailer's chassis. The height sensor signal is constantly sent to iEBS which then periodically controls the solenoids of the OptiLevel device(s) to compensate for any chassis height changes that might occur (i.e. a change of the load status or manual height changes via electronic controlled devices).

Function

The Optilevel function will bring, and keep the chassis at a desired height. This is known and described as target level. Via the OptiLevel valves and sensors, the function will keep the trailer at the required height, regardless of the operations (e.g., fast and smooth loading and unloading operations and comfort driving).

It is compulsory to set and calibrate the driving level I. This will set the driving level I as the default target level. OptiLevel function also enhances the driving comfort and allows for additional GIO functions that require fast control and constant level (e.g., road finisher or forklift control functions).

To select other levels as user defined target level, whether for standstill (e.g., Unloading level) or driving (e.g., Driving level II) operations, those must be parameterized via the iEBS diagnostic software. The set height for any level must be between the upper and lower calibrated level.

		Level type	Condition	Activation	Height regulation
Target Level	Standstill	User manually defined	Possible via user interface	• On user request	Once one level is selected (e.g., unloading or memory level), or manually adjusted (e.g., lifting or lowering the chassis according to user demand), then this level is the actual target level. When powered, OptiLevel will keep this height even when loading or unloading. During standstill, the chassis height is constantly analyzed to provide fast chassis height corrections.
		Unloading level	Optional	• Automatic • Manual	
		Memory level Up to 6 different levels	Optional	• On user request	
	Driving	Driving level I	Mandatory	• Via speed	The driving level I will automatically set the chassis to the driving height after leaving the loading dock. The driving levels II, III, and IV, can be automatically or manually activated (according to its parameterization). During driving, the frequency of chassis height adjustments is reduced to save air and fuel consumption.
		Driving levels II / III / IV	Optional	• Via speed • On user request	

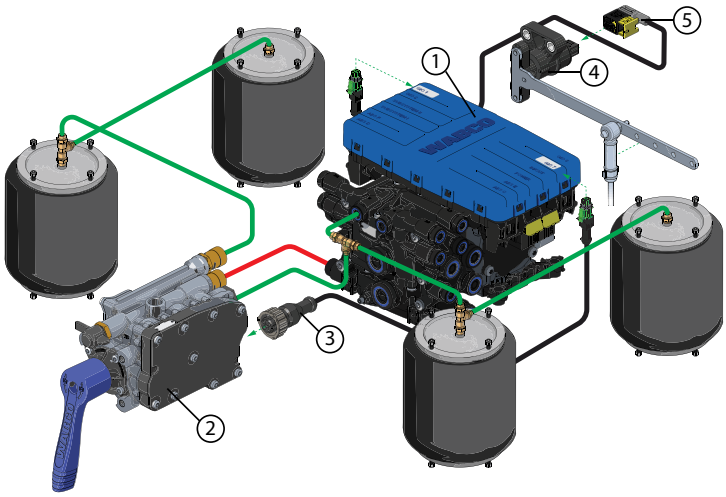
NOTICE

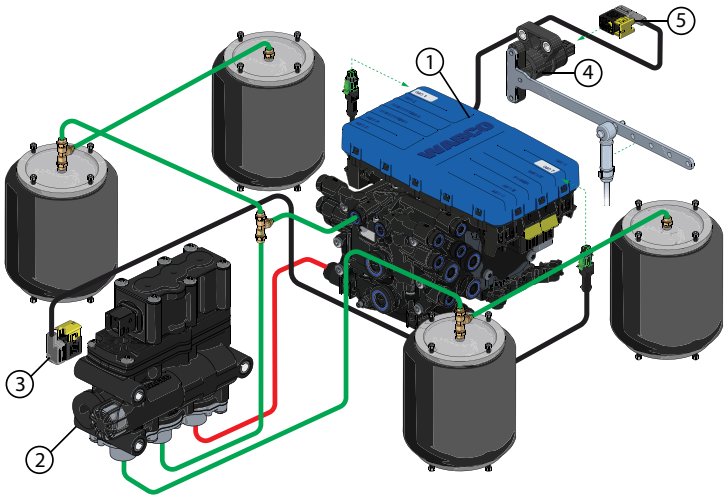
If an OptiLevel failure is detected (e.g., defective cables), only manual lifting/lowering is possible

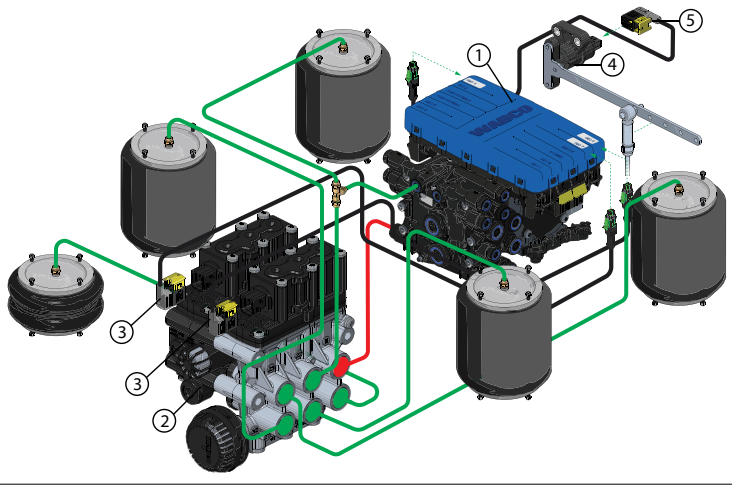
OptiLevel control

- 1-point control: Applicable to semitrailers, central axle trailers and dolly trailers. This function keeps the trailer platform in the user defined height while loading or unloading. This function requires the installation of 1 height sensor that shall control the entire trailer.
- 2-point control: This function maintains the parameterized level when the cargo is unequally loaded. It enables the optimal control of two trailer sides: front & rear (i.e. for drawbar trailers) or left & right (e.g., for inloaders semitrailers). This function requires the installation of 2 height sensors (one for each control point).

Connecting components

1-point control connection with eTASC			
Item	Part number	Description	Scheme connection
1	480 102 . . . 0	iEBS modulator (up from Standard variant)	
2	463 090 5 . . 0	eTASC See page 63	
3	449 403 . . . 0	eTASC cable See page 217	
4	441 050 202 0	Height sensor See page 71	
5	449 829 . . . 0	Height sensor cable See page 217	

1-point control connection with ECAS single block			
Item	Part number	Description	Scheme connection
1	480 102 . . . 0	iEBS modulator (up from Standard variant)	
2	472 890 076 0	ECAS single block (1-point control) See page 65	
3	449 509 . . . 0	ECAS cable See page 217	
4	441 050 202 0	Height sensor See page 71	
5	449 829 . . . 0	Height sensor cable See page 217	

1-point control connection with ECAS dual block			
Item	Part number	Description	Scheme connection
1	480 102 . . . 0	iEBS modulator (up from Standard variant)	
2	472 890 11 . 0	ECAS dual block valve (1-point control) See page 65	
3	449 509 . . . 0	(2x) ECAS cable	
4	441 050 202 0	Height sensor See page 71	
5	449 829 . . . 0	Height sensor cable See page 217	

NOTICE

The OptiLevel control function with a single OptiLevel valve is also suitable for trailers with more than 3 axles, however it may compromise the raising and lowering speed of the air suspension.

NOTICE

The trailer manufacturer is responsible to ensure the capability of the compressed air system. The system shall supply sufficient air pressure and volume to the bellow pressures to perform all the configured functions

Ensure to follow the recommendations of the axle and air suspension manufacturer with regard to overload.

It is recommended to include a height limitation cut-off valve for applications that use large stroke bellows.

5.9.1 Calibration process

The calibration of the height sensor(s) is a mandatory step to activate OptiLevel. Three different reference height values are to be defined and calibrated (driving level 1 = ride height, upper and lower height levels). Components for the height sensor installation can be found chapter "3.2.2 Height sensor", page 71

NOTICE

To perform a calibration process, a successfully completed E-Learning course is mandatory. Only after obtaining the PIN 2 authorization is granted to perform the calibration. For further information go to chapter "8.2 System training and PIN", page 199

Before starting the calibration of the height sensor, ensure that the trailer is in horizontal position and at driving height level. A tolerance of ±3° in respect to the horizontal is accepted. The following calibration methods can be used to calibrate the height sensors:

Calibration type	Using case	Description
3-point calibration	For calibration of an individual trailer	This calibration method allows to configure the range of operation of the height sensor according to: • Driving height (driving level I) • Upper level (distance between the ground and the highest possible chassis level) • Lower level (distance between the ground and the lowest possible chassis level, e.g bumper level) The heights are specifics for every trailer according to its application and type of air suspension.
Calibration "Input of mechanical values"	Calibration of trailers of the same type (series)	This calibration method only requires to entering the following values: • The length of the lever of the height sensor (distance between height sensor's shaft and anchor point of the linkage) • The distance of the upper level relative to the driving level I (in mm) • Vehicle height within driving level I (nominal level)(in mm) • The distance of the lower level relative to the driving level I (in mm) The value "Angle of rotation / compression travel" is calculated automatically. Then driving level I needs to be calibrated.
Calibration "Load calibration data from file"	Calibration method used for large series	Calibration data is determined by using a sample vehicle and then saved to trailers with the same characteristics with a calibration file. A separate adjustment to the level is not required. Important! The position of the height sensor, the lever length as well as the length of the linkage to the axle must be identical in all vehicles.

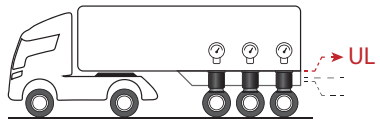
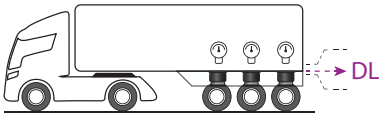
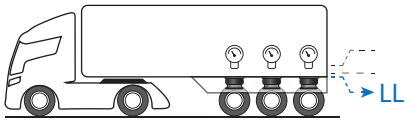
Height sensor calibration process

A calibration error will appear in the iEBS diagnostic software if the height sensor calibration has not been successfully performed. Typical situations where the calibration error appears are:

- After setting up the system: After the parameterization of the OptiLevel function, a calibration error will appear because the process has not yet been performed. In order to delete that error, it is necessary to complete the calibration of the height sensors.
- Unsuccessful calibration: In the event of an unfinished, or invalid calibration process (parameters outside the permissible range according to height restrictions), the calibration error will remain in the diagnostic memory. Check the linkage of the height sensor, change the hole position of the horizontal lever, and adjust the upper/lower level if necessary. After that, repeat the height sensor calibration process to delete the error.

Height restrictions

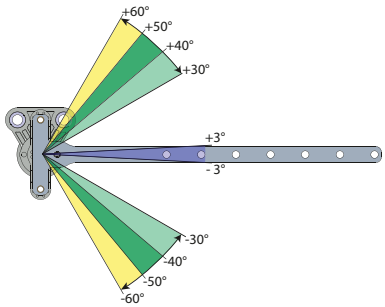
The calibration of the height sensor requires 3 reference levels

Reference image	Reference level	Level limitation
	Upper level (UL)	Upper level > driving level + 3x tolerance + 5 mm Default value for tolerance is 10 mm
	Driving level (DL)	The driving level shall be calibrated between a range of ±30° according to the installation instructions. See page 71
	Lower level (LL)	Lower level < driving level - 2x tolerance Default value for tolerance is 10 mm

Calibration quality

To control the chassis height with an accuracy that is within small tolerances, the height sensor should be used in its full rotational range. This means that the lever should rotate between ± 40° and ± 50° between the upper and lower calibration level. In best case, the driving level should be calibrated with the lever in a horizontal position (tolerance ± 3°).

Overturning of the linkage must be avoided under all conditions (rotational range shall not exceed ± 60°). This must especially be considered for trailers which are lifted by crane(e.g., railway transport).

Hints for a height sensor installation	Reference image
• When installing the height sensor, the height sensor arm must be kept in horizontal position (tolerance ± 3°). • The lever length shall be defined so that the entire suspension travel between the frame and axle will utilize a deflection of at least ±30° but shall not exceed ± 60° The recommended lever travel range is between ± 40° and ± 50° • It is important that the height sensor always moves freely across its operating range, and that the lever can only move in the way intended.	

Parameter setting

The calibration of ECAS can be configured in the iEBS diagnostic software in tab System > ECAS

5.9.2 Target level control

The target level is the value for the distance between the vehicle's body and axle. This target level is defined by calibration, setting its parameters, or by the driver (e.g., by using SmartBoard).

In general, the target level is by default the driving level I, but any other parameterized height level(s) (e.g., memory level) are considered to be a target level.

Function

The OptiLevel valves (ECAS or eTASC) will adjust the height by inflating and deflating the load bellows to bring the measured level by the height sensor in line with the target level.

Changes in chassis height can occur through:

- Changes in trailer weight due to a loading/unloading process, or by a displacement of the load's center of gravity (e.g., caused by an uphill/downhill, or during cornering movements).
- Trailer's target height level is changed by the user (e.g., by selecting a memory level).

The defined target level can only be controlled only with continuous power supply and sufficient air supply.

Height control logic

A height sensor is mounted to the trailer body and is connected to its axle via a lever linkage. The height sensor measures the distance between the axle and the trailer body. The measured value is used as the actual value in the control loop and will be processed by iEBS.

iEBS compares this actual value to the nominal value which is predefined by calibration in the ECU. In case there is a difference between the actual value and the target value (control deviation), the OptiLevel valve receives an actuating signal by iEBS. Depending on this actuating signal, the OptiLevel valve inflates or deflates the load bellows. The pressure change in the load bellows alters the distance between the axle and the trailer body. The new distance is also measured by the height sensor, and the cycle begins again.

NOTICE

For precise bellow pressure readings, it is advised to obtain the pressure value from the main axle, which is equipped with a wheel speed sensor (c-d), and to utilize the most direct connection to read the pressure from the load bellows through the pressure sensor situated at port 5 of the PDM.

Control delay and control tolerance

The control delay determines the frequency at which the control cycle is performed based, on a speed threshold. Trailer speeds below the speed threshold will trigger a standstill control delay. Trailer speeds above the threshold, will trigger a driving control delay.

- Standstill control delay: During standstill or at low speeds (adjustable via diagnostic software, by default: 10 km/h), the OptiLevel valve will correct the height of the chassis when the load status changes (by default: 1 control cycle per second) .
- Driving control delay: While driving, load status changes are typically caused by bumpy and uneven roads. To avoid repetitive inflation and deflation of air bellows, the OptiLevel intelligent control reacts in longer intervals (by default: 1 control cycle per minute).

The control tolerance determines the acceptable deviation that might exist between the actual height level of the trailer and the target level. It is possible to set different control tolerances based on the trailer situation (e.g., standstill, driving, stand-by, or an alternative level control is active).

The default value for the control tolerance is 10 mm and can be parameterized to customer needs via iEBS diagnostic software.

Parameter setting

The control delay and tolenace can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Tolerances

Level control after ignition ON

It is possible to parameterize an OptiLevel mode that can be realized after the ignition is turned ON.

- Last stored level
- Actual level
- Driving level I
- Last manually requested driving level from user interface

Parameter setting

The target level set after ignition ON can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Controller properties.

Plausibility detection

As long as the chassis is inside the upper and lower calibration levels, pressurizing of the bellows must result in a raising of the chassis, with change of height sensor to higher values, whereas venting of the bellows must lead to reduced values of the height sensor.

To determine the plausibility of the system when raising or lowering the chassis, a minimum height change of 20 mm must be measured in a period of 30 seconds. The minimum displacement and the time period for plausibility can be adjusted via the iEBS diagnostic software.

When the system detects a non-plausible height change after a predefined time, the system will indicate a plausibility error and the control request shall be aborted by the system for a default period of 3 minutes.

A typical case for a plausibility error is when a heavily leaden trailer cannot reach the target level due to insufficient reservoir pressure. If a lifting process cannot be performed during a period of 30 seconds, then the valve shall be deactivated.

Parameter setting

The time for plausibility check can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Controller properties.

5.9.2.1 Level correction OFF

The function "Level correction OFF" disables the automatic level correction during standstill. This means, when a deviation between the current level and the target level is present, the OptiLevel function will not change the current chassis height.

The level correction OFF is used to reduce the air consumption during loading and unloading processes at the loading dock, or when the height changes are not wanted, to remain at user defined fixed level.

Activation options

- Permanently disabled: If selected, no automatic level correction shall be performed during standstill. Any request from any user interface will be ignored (e.g: like activation/deactivation).
- Activation via user interface: Devices such as Smartboard or GIO switches, provide the possibility to activate the function temporarly (i.e., only for the current ignition cycle), as well as permanently (function remains in the last state after ignition reset).
- Special behavior with eTASC: This option is intended to temporarily deactivate the level correction of the trailer after a manual regulation was performed via the eTASC lever.

Parameter setting

The level correction OFF function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Controller properties.

5.9.3 Special Levels - Pre-configured Levels -

5.9.3.1 Driving level

Application

This function ensures a return to the driving level as soon as truck-trailer will reach the parameterized speed threshold. The default activation speed at which the trailer reaches the driving level can be set by parameters. Up to 4 different driving levels can be configured.

- Driving level I: This driving level I is commonly known as the Return-to-Ride level. It refers to the calibrated level that was defined by the vehicle manufacturer (optimum body height).
- Driving levels II / III / IV: The driving levels II / III / IV are defined relative to the driving level I. If the alternative driving level is lower than driving level I, this value must be entered as a negative value into the iEBS diagnostic software.

NOTICE

The driving levels are defined by the overall vehicle height, and are subject to legal guidelines, as well as the height of the vehicle's center of gravity, playing a crucial role in driving dynamics. The driving level I is the designated basic design parameter for the vehicle.

The driving levels are commonly used to:

- Adjust the trailer to various platform heights
- Adjust semitrailer's height to different towing vehicles, which the trailer will be operating behind (e.g., for trailer that are used in countries with different tractor specifications)
- Achieve more lateral stability by lowering the vehicle's centre of gravity
- Reduce the fuel consumption at higher speeds by improving the aerodynamics of the truck-trailer combination.

Lowering the chassis, depending on the vehicle's speed, assumes that higher speeds can be achieved on good road surfaces, and do not require the utilization of the entire load bellow stroke.

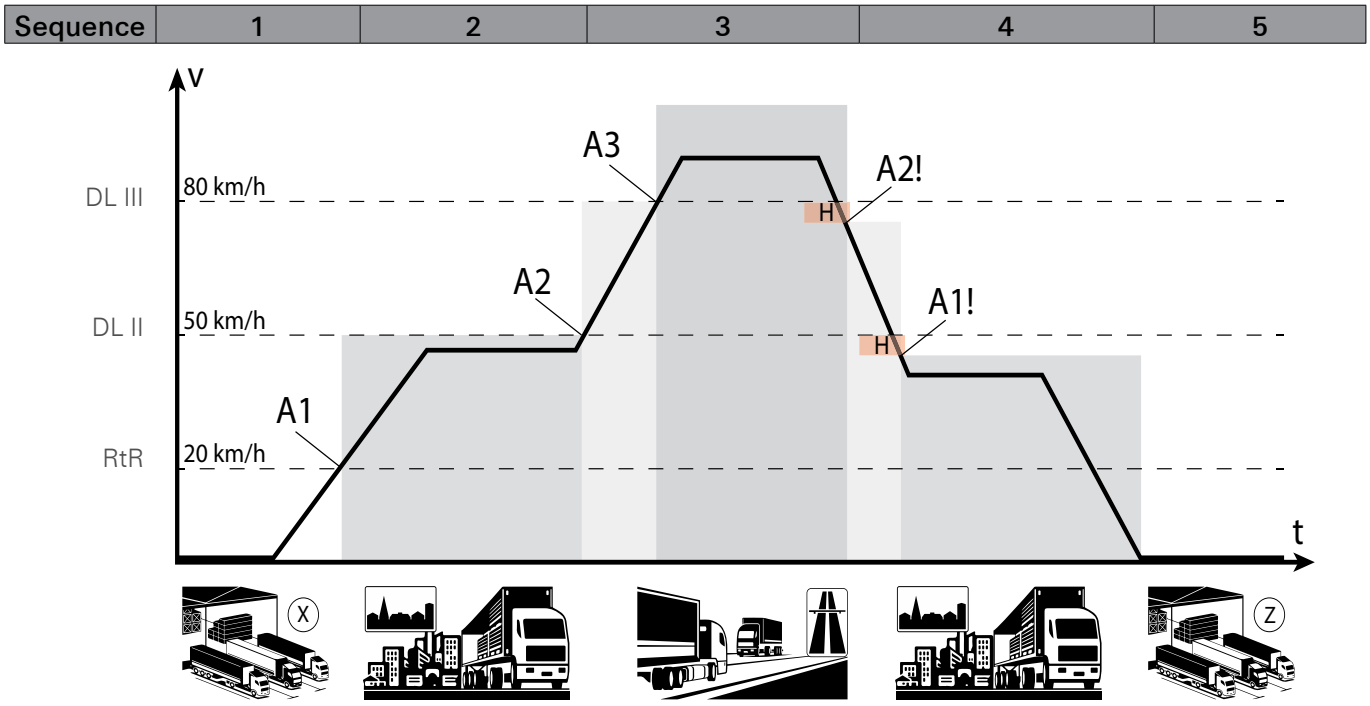
The driving levels are active within the defined speed ranges. The activation request for the corresponding driving levels brings the trailer height to the parameterized driving level for the specific speed threshold(s).

<table>
<tr><th>Driving level</th><th>Speed threshold range</th><th>Default value</th><th>Activation</th><th>Use case</th></tr>
<tr><td>I (RtR)</td><td>0 - 30 km/h</td><td>20 km/h</td><td>• Automatic via speed threshold</td><td>Automatically set to the driving height after leaving the loading dock.</td></tr>
<tr><td>II</td><td rowspan="3">30 - 100 km/h</td><td rowspan="3">User defined

Deactivation hysteresis: 5 km/h</td><td rowspan="3">• Automatic via speed threshold
or
• Manual activation via user interface</td><td rowspan="2">Lowering the trailer height allows to achieve more lateral stability and reduce the fuel consumption while driving at higher speed.</td></tr>
<tr><td>III</td></tr>
<tr><td>IV</td><td>Used with semitrailers that are being operated behind different towing vehicles (with different fifth-wheel heights)</td></tr>
</table>

Example: The below example considers the speed threshold parameters for the different driving levels:

- Driving level I (RtR) = 20 km/h
- Driving level II (DL II) = 50 km/h
- Driving level III (DL III) = 80 km/h
- Driving level IV (DL IV) = Not parameterized
- Deactivation hysteresis (H) for DL II and DL III = 5 km/h



Sequence	Situation place	Driving level description	Activation method
1	Loading dock "X":	Trailer height set to loading dock level by the user	User defined
2	Trailer at slow speeds (e.g., urban area)	Automatic switch to driving level I (RtR) when reaching the set speed of 20 km/h (A1)	Automatic via speed threshold
3	Trailer at high speed (e.g., highway)	Automatic switch to driving level II when reaching the set speed of 50 km/h (A2)	
		Automatic switch to driving level III (A3) after reaching the set speed (e.g., speed above 80 km/h)	
4	Trailer at low speeds (e.g., urban area)	Automatically returns to the driving level II (A2!) when reaching the speed of 75 km/h (DL III - Hysteresis)	
		Automatically return to the driving level I (RtR) (A1!) when reaching the speed of 45 km/h (DL II - Hysteresis)	
5	Loading dock "Z":	Trailer height set to loading dock level by the user	User defined

The driving levels are active within the defined speed ranges. The activation request for the corresponding driving levels shall be instantly executed, when exceeding a higher speed threshold. When the speed drops below the speed thresholds, the hysteresis value is considered to avoid frequent switching between levels (e.g., while driving at speeds similar to the speed threshold).

Manual activation via user request

It is possible to manually activate a driving level at any speed. The manual request of a driving level will deactivate the automatic selection of the driving speed. The activation can be done temporarily (until the next ignition reset), or permanently (until manually deactivated again) via user interfaces such as SmartBoard or GIO switches. If a permanent activation is requested, the parameter that determines the driving level at RtR speed must be kept as "last chosen driving level".

Parameter setting

The driving level function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Driving level.

5.9.3.2 Unloading level

When the trailer is stationary or while driving at low speeds the unloading level can be selected for easier unloading. The unloading level usually corresponds to the bumper or lower calibration level to avoid overstrain of the axle suspension during sudden load changes. For 2-point control configurations, it is possible to set a different level for each point control.

The function will automatically be deactivated when the trailer is moving (default deactivation speed threshold:10 km/h). Once the deactivation occurs, the last manual requested driving level, or the last saved level, will be readjusted automatically.

Application

The unloading level can be used with any trailer type, and is commonly used in the following situations:

- When lowering a dump trailer; to prevent hard rebounds due to a sudden discharge (dumping the load).
- To automatically move road tankers to the best unloading position.
- To improve stability.

Activation types

- Automatic & trigger: An additional signal is required to automatically lower the trailer during standstill. The signal can come from a generic switch (e.g., proximity switch, pressure switch, function states, etc)
  Example: If the switch is attached to a tipper body, the trailer will be lowered automatically to a defined level, right after the tipper body will raise for tipping.
- Automatic: The trailer will be lowered to the lower calibrated value every time the trailer is on standstill. This function can be temporary, or permanently, activated/deactivated via user interface (GIO switch or SmartBoard).
  Note: The function can be optionally deactivated if the finisher brake function is active
- Manual activation/deactivation: The trailer will be lowered to the lower calibrated value, according to the user request, via user interface (GIO switch or SmartBoard), or via hand brake (activated by applying the hand brake 2 times within 5 seconds during standstill)

Height limitations

If the parameterized value for the unloading level is outside the parameterized value (i.e., outside of the lower or upper level) then the suspension travel (stroke) is restricted to the maximum permissible level (lower or upper level).

Parameter setting

The unloading level function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Unloading level.

5.9.3.3 Memory level

Unlike the unloading level, which is pre-defined in the ECU, the memory level can be defined and changed by the driver at any time. Once defined, the system will store the individual memory level until it will be changed by the user again. The stored memory level will not be deleted after the ignition has been switched OFF. The memory level applies to the entire vehicle. For 2-point control configurations, both control points are adjusted to the stored levels. Six different memory levels are available for user defined settings.

Application

Recurring loading operations at loading docks, where the height has been defined and specified before. A user interface (e.g: SmartBoard or switches) is required to perform the setting and calling up for the memory level function.

Parameter setting

The memory level function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Memory level.

5.9.3.4 User Defined Level - Manual Control

Application

The function user defined level can be manually controlled to allow the lifting and lowering of the chassis height according to user demand. The user is able to adjust the height of the chassis via interface devices or via the manual lever of the eTASC device. The defined level now is used in the system as the target level to be controlled further on.

Function

User defined level via interface

- SmartBoard: Display and operating panel for adjustments of the chassis height level. Commonly installed on the side of the trailer.
- eTASC: Valve that allows for manual and automatic chassis level adjustment. By monitoring the bellow pressure and chassis height, the iEBS smart control is able to distinguish if there is a change in the chassis height due to a loading/unloading process or if the chassis height is manually adjusted (lifted or lowered) by using the manual lever.

Manual lifting and lowering with eTASC

By turning the manual lever anti-clockwise, the load bellows are pressurized and the body of the vehicle is raised. By turning the lever clockwise, the load bellows are de-pressurized, and as a result, the body of the vehicle will be lowered. Once the chassis height level will reach a stable position, the target level will be set equal to the actual chassis level.

When a manual lowering process is initiated via the eTASC lever, the height adjustment will be done until the lever will be released, or the lower level has been reached.

While the system is powered, the lowest level that can be achieved by the eTASC valve can be defined via parameters as "lower parameterized level" or "bumper level". When the system will detect that the chassis has reached the lower level (lower parameterized level or bumper level), will stop the electrical activation of the valve.

Level changes, resulting from loading and unloading, can be manually adjusted by the operating lever as required. This is the case when the eTASC valve does not receive power (e.g., the trailer is uncoupled, or the towing vehicle will switch OFF the terminals 15, as well terminal 30, when the ignition will be switched OFF). In this case, the air supply source is directly supplied from the suspension reservoir. The height limitation can only be implemented with an optional auxiliary valve

Parameter setting

The lifting/lowering function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > lifting/lowering.

The adjustment of the height is only permitted between the upper and lower defined levels.

The target level handling can be performed only during standstill, or at low speeds (default speed threshold: 10 km/h). The speed parameter for level handling must not be greater than the speed threshold for driving level (RtR).

- Lifting/lowering via eTASC valve: Option designed to prevent tampering.
- Fast mode (with tag axles): If this option is selected, the lifting/lowering process is performed quickly. This is a beneficial option for large chassis height adjustments (e.g., when the trailer needs to be moved to the upper position, or being lowered to the bumper level),.This will require higher air consumption.

5.9.4 Target Level adjustment

5.9.4.1 Lift Axle offset

The function will correct the trailer's height to achieve the target level every time a lift axle will be lifted/ lowered, or a tag axle is inflated/deflated. As some lift axles come with short lifting stroke, the trailer chassis will be lifted to increase the lift axle's clearance (e.g., to prevent the lift axle from touching the ground while driving).

The lift axle offset can be parameterized differently according to the following situations:

- Raised lift axles
- Automatic lift axle function
- Other functions activated (e.g., Traction Help / OptiLoad / OptiTurn)
- While driving at the actual target level or any other driving level

Parameter setting

The lift axle offset function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Lift axle offset

5.9.4.2 Tire deflection offset

This function allows compensation for the chassis height, in line with the tire deformation, that is produced by the load status of the trailer.

Depending on the current loading status of the trailer (according to bellow pressure values), the tires will be compressed, hence the total height of the trailer will be lower. This effect will change the actual trailer height, and the distance from chassis to road surface. To compensate the different compression of the trailer's tires, an offset value can be applied.

The offset value can be set according to the laden and unladen conditions of the trailer. The maximum offset will be applied if the load bellow pressure in laden condition is reached, while no offset will be applied if the trailer is in the unladen condition. A linear offset will be applied for load conditions between unladen and laden.

Parameter setting

The tire deflection compensation function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Controller properties.

5.9.5 Additional parameters

5.9.5.1 Target bellow pressure function

This function allows for setting a higher bellow pressure to the load bellows (during lifting) to increase stability during the loading/unloading process, or when locking on raising the OptiLevel device to elevated loading docks. This pressure regulation will only be applied during standstill, and the maximum value cannot be greater than the bellow pressure load limit.

The function is activated on demand via user interfaces (e.g: SmartBoard or switches).

This function can be manually deactivated, even when the trailer is in driving conditions. Once the function will be deactivated, the trailer will automatically adjust the chasis height to the last valid target level, or to the last manual requested driving level via the user interface.

NOTICE

The activation of the target bellow pressure function will result in the deactivation of the height limitation (upper and lower parameterized levels are no longer considered).

Parameter setting

The target bellow pressure function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Target bellow pressure

5.9.5.2 Overload protection

The overload protection function is used to protect the load bellows from bursting in case the trailer will be loaded above the permissible value (overloading). This option requires to enter the maximum permissible load bellow pressure value via the iEBS diagnostic software.

During standstill (e.g., when loading), whenever the load bellow pressure will exceed the maximum permissible load bellow pressure, then the trailer shall be lowered until the load bellow pressure reading will reach 0,3 bar (lowered to bumper level).

Parameter setting

The permissible bellow pressure can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Controller properties.

5.9.6 Status lamp

The status lamp is an optional device that can be used to indicate the status or abnormalities in the ECAS system. It is possible to parameterize the green warning lamp as status lamp. By enabling this option the LED is considered by the iEBS as load device and the cable break test is deactivated.

If a failure is detected, the lamp will be flashing 4 times at a frequency of 1 Hz (0.5 s ON / 0.5 s OFF)

OptiLevel mode	Priority	Indication setting options	Lamp sequence/behavior
ECAS failure	High ↕ Low	The lamp will be active during standstill	4x flashing (1 Hz) after ignition ON
Driving level		Active lamp during: • Standstill • Driving • Standstill & driving	Fast flashing (3 Hz) of the lamp when actual level is not equal to driving level
Unloading level			The lamp is steady ON when actual level is within tolerance for unloading level
Level control			Slow flashing (0.5 Hz) during active level control

If more than one warning lamp sequence will be active simultaneously, then the mode with the highest priority shall be active.

Parameter setting

The status lamp function can be configured in the iEBS diagnostic software in tab System > Parameters > (4) OptiLevel > Status lamp.

5.10 Bounce Control

Application

The bounce control function is designed to overcome the tension produced in the suspension system, caused by changes of the trailer's chassis height, while the trailer's brakes being applied (service brake). The function is available for premium variants of iEBS and compatible with all type of trailers that are equipped with electronically controlled air suspension.

Function

When the trailer is in standstill and the parking brake is applied from the towing vehicle, tension might appear in the trailer's suspension caused by changes of the trailer's chassis height. The chassis height changes when the suspension system is inflated or deflated, or when the trailer is significantly loaded or unloaded.

When the parking brake from the towing vehicle is released (e.g., after an unloading process), the vehicle body can bounce abruptly. The bounce control function prevents the body from jumping up by intermittently releasing, and then reapplying the service brakes of the trailer.

- Side by side (for semitrailers/ central axle trailers): The releasing of the service brakes is alternating between the sides of the trailer. If the system is equipped with a EBS relay valve as a 3rd modulator, the releasing process is done first on the main axle, and then on the axle where the 3rd modulator is installed.
- Axle by axle (for drawbar trailers): The brake release is done alternating between the front axle's and rear axle's service brake.

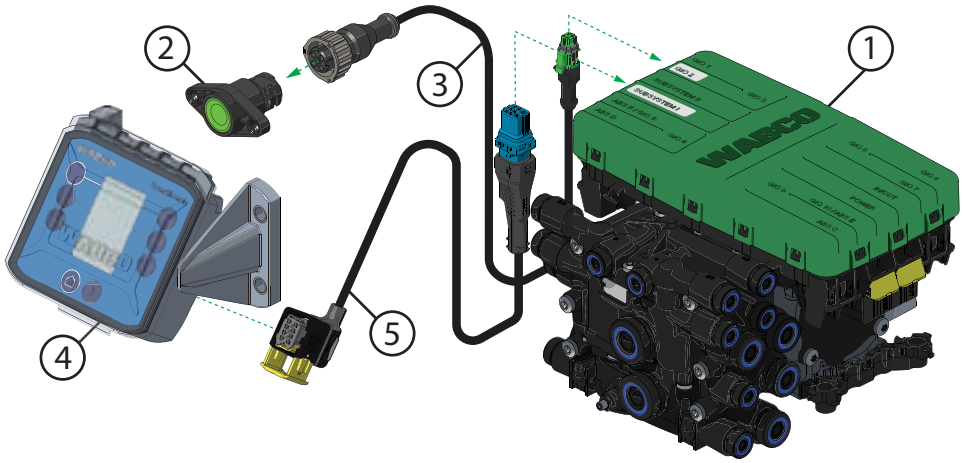
The gradually release process of the bounce control function allows to easily reach the desired chasis height reducing the risk of damage.

Activation

The function can be enabled via the Smartboard or GIO switch.

As a safety measure, the function will be automatically disabled if the system pressure is below the supply cut OFF pressure limit, or if the brake demand pressure is less than 3.5 bar. Bounce control function will automatically switch OFF when the vehicle speed is exceeding 2.5 km/h.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available for Premium variant
2; 3	441 006 030 0	Push button	449 448 060 0	For further information go to section "Push button" on page 74
4; 5	446 192 21 . 0	SmartBoard	449 929 . . . 0	See chapter "SmartBoard™" on page 76

Parameter setting

The bounce control function can be configured in the iEBS diagnostic software in tab System > Parameters > (5) Brake functions > Tension release

5.11 Brake Release Function

Application

The brake release function is intended for extendable trailers equipped with an extension mechanism. This type of trailers are usually equipped with a hydraulic or electric systems that allows the trailer body to extend or retract as needed to improve the chasis length or expand its storage capacity.

The brake release function allows the driver to release the service brake of the extendable portion of the trailer. This ensures that the trailer extends or retracts smoothly without any unnecessary resistance from the brakes which is particularly useful when maneuvering the trailer in tight spaces or when adjusting the length of the trailer to accommodate different cargo loads Typical trailer applications are car transporters trailers or log trailers for timber transporters.

Function

The brake release function can be performed with 2 different behaviours:

- Standard brake release: The brake release function allows for very slow movement of the extendable part of the trailer (maximum speed limit by the trailer is 1.8 km/h)
- Advanced brake release: The brake release function allows the movement of the extendable part of the trailer to 5 km/h by default (maximum speed limit can be set to 10 km/h)

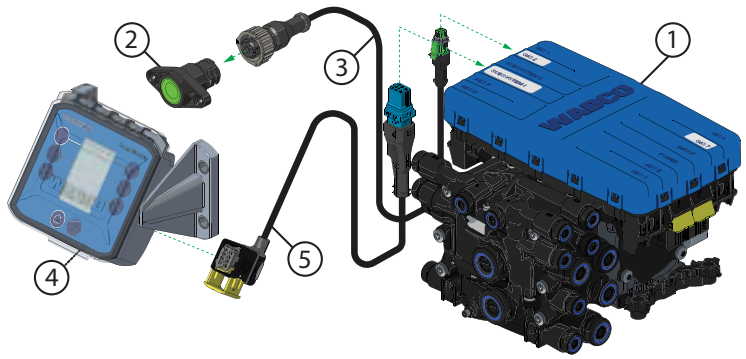
Activation

The brake release function can be activated via a external button or SmartBoard. The activation is possible only if:

- The towing vehicle in standstill condition (i.e., parking brake actuated)
- The pressure signal at the control coupling head is greater than 6.5 bar (subject to the hand control valve behaviour in the towing vehicle)
- The service brakes are applied on the trailer.

The function will be aborted if the pressure on the control coupling head drops below the pressure threshold or if the trailer speed overcome the maximum speed limit.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available from iEBS Standard variant
2; 3	441 006 030 0	Push button	449 448 060 0	For further information go to section "Push button" on page 74
4; 5	446 192 21 . 0	SmartBoard	449 929 . . . 0	See chapter "SmartBoard™" on page 76

The function will be aborted if the pressure on the control coupling head drops below the pressure threshold or if the trailer speed overcome the maximum speed limit.

It is recommended that the activation of the function is done only while the button is pressed, allowing to release the service brake for the time the extention of the trailer takes place only. If that is the case, the releasing of the push-button or the respective button of the SUBSYSTEMS devices shall immediately abort the brake release function and apply the service brake of the trailer.

NOTICE

When the bounce control function is active, it is not possible to release the service brake.

Parameter setting

The brake release function can be configured in the iEBS diagnostic software in tab System > Parameters > (5) Brake functions > Brake relase.

5.12 Tilt Alert

Application

Function meant to monitor the tilt angle of tipper trailers during standstill or low speed (v ≤ 7 km/h). This function warns the driver when the tilt angle is too high for secure lifting of the tipper body.

Function

The lateral acceleration sensor integrated in the iEBS for Rollover Stability Support function can be used to monitor the inclination of the trailer relative to the horizontal line. This is especially useful for tipper trailers when raising the tipper body. If the frame inclination exceeds the threshold angle, the iEBS can send a warning to the SmartBoard (warning and actual tilt angle are displayed) or warn via shared buzzer, shared warning lamp, and/or via an arbitrary device powered via the power stage allocated to the Tilt Alert function. The SmartBoard device can be used to enable/disable the tilt alert function even while iEBS is in standby mode.

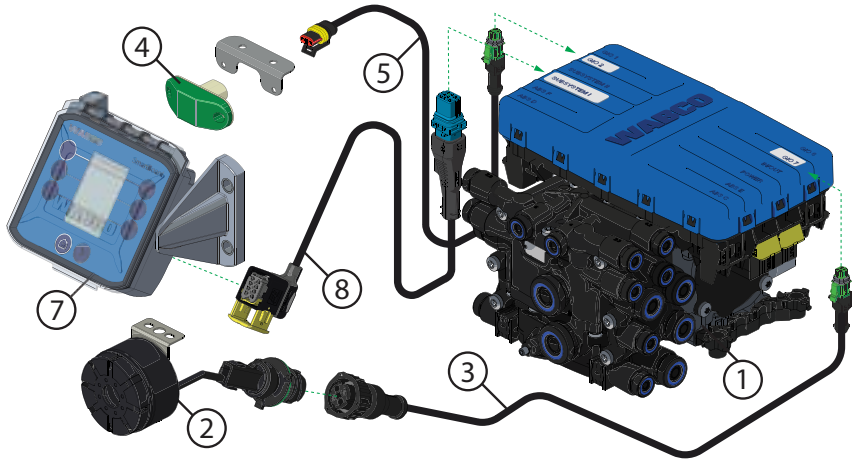
The lateral acceleration sensor allows an angle resolution of 0.1°. The warning threshold always depends on the specific vehicle and must be defined by the vehicle manufacturer. The default tilt angle is 2° but can be adjusted in a range operation from 0 – 20° in the iEBS diagnostic software.

Every time the Tilt Alert warning will be activated, an event with the corresponding tilt angle will be stored by the ODR.

⚠ CAUTION

The Tilt Alert function is for assistance only and does not release the driver from his obligation to monitor the vehicle himself. The driver must be instructed to interrupt actions such as tipping the dumping body immediately if he receives a warning.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available for Standard variant
2; 3	894 450 000 0	Buzzer (optional)	449 408 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
4; 5	446 105 523 2	Green warning lamp	449 940 . . . 0	
7; 8	446 192 21 . 0	SmartBoard	449 929 . . . 0	See chapter "SmartBoard™" on page 76

A switch (e.g., a proximity switch or a mechanical switch) can be used to start the function only when the tipper body is being raised. Further information in section "Switch control" on page 149

Parameter setting

The tilt alert function can be configured in the iEBS diagnostic software in tab System > Parameters > (6) Common functions > Tilt alert

5.13 SafeStart

Application

The SafeStart function prevents the truck-trailer combination from being driven during unsafe conditions by warning the driver, e.g., when the tipping body is raised.

The trailer needs to be equipped with a switch (e.g., a proximity switch or a mechanical switch) to automatically activate the SafeStart function during unsafe conditions. For some trailer applications, the loading or unloading procedure are typical situations where the SafeStart function is activated.

The switched is commonly installed in a place where can detect if the tippingg body of a tipper or a roll-off container trailer is lifted, or if the fuel door of a tanker trailer is open. The status of the input signal from the switch is monitored by the iEBS and triggers the SafeStart activation. Once the function is active, iEBS can engage the brakes in standstill, activate warning brake applications, or perform a braking procedure to stop the moving vehicle.

As a safety measure, the switch should be "normally open". In this situation the circuit of the switch is closed if the tipper body is lowered.

Function

The following warning/braking methods are possible:

SafeStart (no movement) - Typically used with road tankers / roll-off containers	
The trailer is fully braked using the service brake or the spring brakes. This configuration prevents any movement of the trailer while the function remains active. The vehicle can only be moved again if the sensor detects that the loading or unloading procedure has been completed (e.g., by closing the control cabinet) and the brake pedal is pressed for the first time.	
SafeStart (limited movement): Typically used with dumper trailers	
Low speeds are allowed to facilitate the unloading procedure. Two speed thresholds are defined to determine the braking actions (warning and full brake applications) • Warning brake application: From a speed of 18 km/h (by default), 10 short braking actions to warn the driver that the tipper body has not yet been lowered. • Full brake application: From a speed of 28 km/h (by default) the vehicle is brought to a standstill. Once the vehicle is stationary (v = 0 km/h), the brake will only release after 20 seconds. The function is then deactivated and will only function again after restarting the ignition.	
SafeStart (customized movement): Typically used for specific trailers applications	
The SafeStart function can be defined to comply with specific trailer applications. • The warning and full brake applications speed threshold can be set between 0 - 30 km/h. • The warning brake application can be disabled via parameter setting. If the warning brake application is deactivated, only full brake application will be performed.	

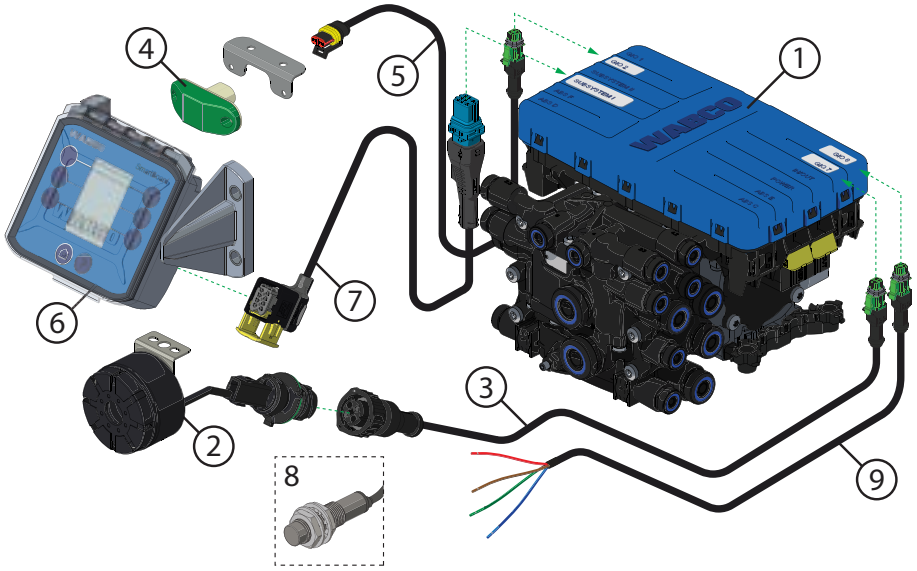
⚠ CAUTION

The SafeStart function does not release the driver or the user from the duty to check the state of the tipper body and secure the load (according to regulations, STVO §22, BGV D29, §22). before driving off.

SafeStart is usually implemented with the service brake system of the trailer but can optionally be braked via the spring-loaded cylinders (only with iEBS Premium variants).

The SafeStart function can be activated via the spring brake cylinders with a LACV-IC valve (section "Impulse Controlled Lift Axle Valve (LACV-IC)" on page 57).

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 3 . . 0	iEBS Modulator		Function available up from Standard
2; 3	894 450 000 0	Buzzer (optional)	449 408 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
4; 5	446 105 523 2	Green warning lamp	449 940 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
6; 7	446 192 21 . 0	SmartBoard	449 929 . . . 0	See chapter "SmartBoard™" on page 76
8; 9	Not supplied	Proximity switch	449 831 . . . 0	For further information go to section "Proximity switch" on page 75

⚠ CAUTION

The vehicle manufacturer is responsible for proper positioning and installation of the sensor on the trailer so that iEBS can recognize the safe or unsafe situation.

The use of a proximity switch is required to comply with ADR regulations.

– The driver must be instructed to correct the trailer status immediately if a warning will be displayed.

Parameter setting

The SafeStart function can be configured in the iEBS diagnostic software in tab System > Parameters > (5) Brake functions > SafeStart

5.14 Road finisher brake function

Application

The road finisher brake function is used to brake tipper trailers while driving in front of road finishers. This function ensures that the trailer and the road finisher machine remains in close proximity during tipping.

The road finisher brake function is commonly used together with the unloading level mode from the OptiLevel valves and can be activated or deactivated based on the customer's requirements. For further information go to section "Unloading level" on page 160.

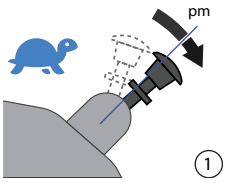
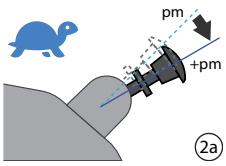
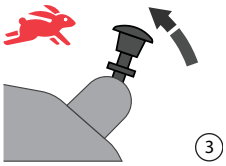
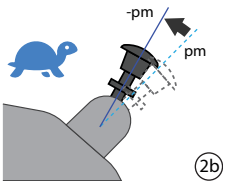
Function

The road finisher brake function is intended to be active at low speeds (permissible range between 0 and 10 km/h). As a security measure, the function is aborted if the vehicle speed is above the threshold set in the parameters.

The control pressure that slows down the trailer is defined by the pressure test value (pm). The brake pressure application can be set in a range between minimum 0 bar and maximum 6.5 bar. A brake pressure value of 1.5 bar is set by default as a sensible value. The final value for the brake application will vary in order to match the current load of the trailer (load regulating function is enabled by default).

Finisher brake pressure adjustment: SmartBoard can be used to enable/disable the finisher brake function and adjust the brake control pressure in steps of 0.1bar.

The road finisher brake pressure can also be adjusted by means of the hand brake valve in the towing vehicle to either increase or decrease the trailer speed. This option can be activated by parameter setting and is an alternative solution for trailers without SmartBoard.

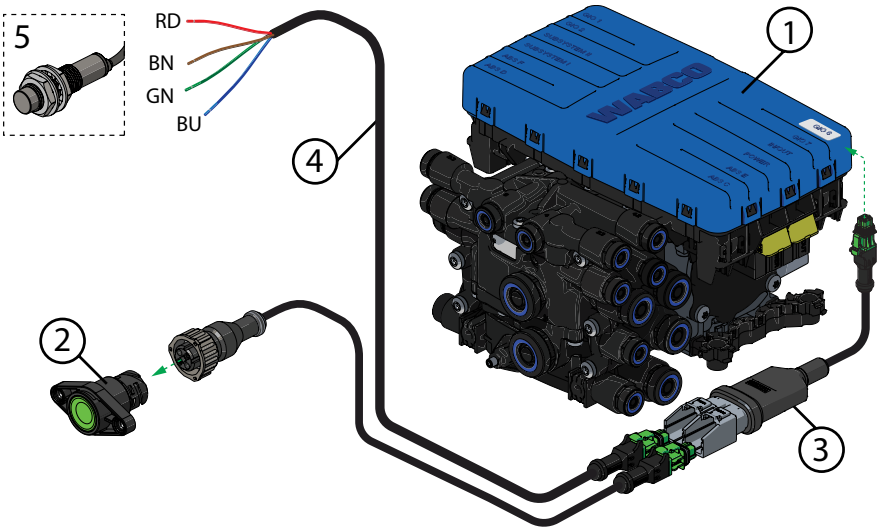
<table>
<tr><th colspan="3">Hand brake valve pressure adjustment</th></tr>
<tr><th>Step 1</th><th>Step 2</th><th>Step 3</th></tr>
<tr>
<td rowspan="2">Slowly pull the hand brake lever until a speed reduction of the trailer is noticeable.
 
</td>
<td>To reduce the trailer speed, continue pulling the hand brake until the desired speed has been reached (brake pressure increase (+pm))
 
</td>
<td rowspan="2">Once the speed has been adjusted, then the lever has to be suddenly released.
The sudden release of the lever is crucial to set and complete the brake pressure adjustment
 
</td>
</tr>
<tr>
<td>To increase the trailer speed, slowly release the lever until the desired speed has been reached (brake pressure decrease (-pm))
 
</td>
</tr>
</table>

⚠ CAUTION

The road finisher brake function is for assistance only and does not release the driver from his obligation to monitor the vehicle himself. Once the function is active, it can be override by the driver at any time.

– The driver must be instructed to interrupt actions if necessary and take control of the combination by applying the service brake as normal.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available for Standard and Premium variants
2	441 006 030 0	Push button	449 448 060 0	For further information go to section "Push button" on page 74
3	894 600 131 2	Duplicator 1x3		Optional, only required if the proximity switch is installed
4	Not supplied	Proximity switch	449 831 . . . 0	For further information go to section "Proximity switch" on page 75

Button: A push button can be mounted in the towing vehicle cabin to activate the road finisher brake function. Once the road finisher brake function is active, the iEBS will start to apply the trailer brakes. The same (or an additional button) can be used to activate the unloading level function (if available).

Switches: A mechanical switch or a proximity switch can be used to monitor the trailer's body condition (lifted or lowered). A normally-open switch is recommended to avoid unnecessary activation of the function. The switch will keep the function deactivated (open circuit) unless the body of the trailer is lifted (circuit is then closed and function is activated).

Green warning lamp is recommended to indicate to the driver that the finisher brake function is ON.

Parameter setting

The road finisher brake function can be configured in the iEBS diagnostic software in tab System > Parameters > (5) Brake functions > Finisher brake

5.15 Brake lining wear indication

Application

The brake lining wear indicator is a function that monitors the health status of the brake pads from a trailer equipped with disc brakes, and consequently the need of its replacement. A warning will indicate to the driver that the friction material of the disc pads (with integrated wear wires) have reached a predetermined worn condition.

A typical configuration consists of 6 brakes equipped with wear indicators that can be connected to iEBS. All wear indicators are connected in series and are connected to the wear input.

Function

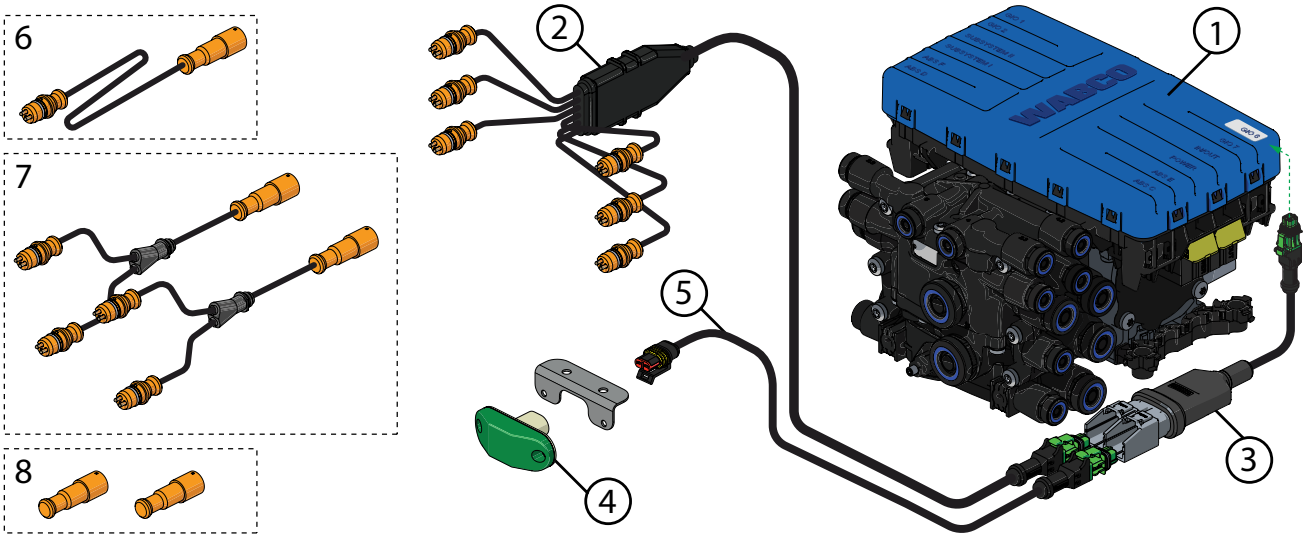
Warning signal: If the pad's wire is worn out (open circuit for a period of at least 4 seconds), the warning shall be activated. If SmartBoard is installed, the warning message will also be displayed.

The warning indicates the need for a replacement of the brake pads. The warning lamp will flash every time the ignition is switched ON (4 cycles = 16 times) and will stop to light up when the vehicle speed exceeds 7 km/h.

The system will automatically recognize the replacement of the brake pads, and the warning message will disappear after 8 seconds.

Saving the data for the brake pads change: The last five brake pads changes (including odometer and operating hours when the second warning message occurred) are stored in the ECU and can be read out via the iEBS diagnostic software.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available for Standard and Premium variants
2	449 836 . . . 0	Brake pad wear indicator cable		4 plugs have a cable length of 3.5 meters 2 plugs have a cable length of 4.5 meters.
3	894 600 121 2	Duplicator 1x4		Optional, only required if the green warning lamp is installed
4; 5	446 105 523 2	Green warning lamp	449 940 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
6	449 720 0 . . 0	Brake pad wear extension cable		Optional - for trailers with a long distance between axles (e.g., drawbar trailers)

Item	Part number	Description	Cable required	Comment
7	894 590 082 0	Brake pad wear splitter cable		For trailers with more than 3 axles 2 splitter cables are required for any additional sensed axle
8	441 902 312 2	Blind plug		Blind plug for vehicles with less than 3 axles

Parameter setting

The brake lining wear indicator function can be configured in the iEBS diagnostic software in tab System > Parameters > (6) Common functions > Lining wear sensor

5.16 Integrated Speed Switch (ISS)

Application

The integrated speed switch (ISS) can be used to control speed dependent functions. The RtR (Return-to-Ride) function is one example for the use of an integrated speed switch.

Function

The switching output state of a GIO slot changes when the trailer speed exceeds or drops below a specified speed limit as per parameter setting (e.g., a solenoid valves being switched ON or OFF according to the speed of the trailer).

Two speed limits for the switching condition (switching ON and OFF) can be set by the parameters between 0 and 120 km/h. A minimum switching hysteresis of 2 km/h must be observed.

The output stage delivered by the GIO port can be configured in three different operating modes:

- Permanently ON: When the speed threshold is reached, the output is switched ON and supply voltage is applied. The output will be permanently ON until the speed falls below the OFF threshold.
- Electric pulse: When the speed threshold for switching ON is reached, a 30 seconds pulse is triggered. The threshold value for switching OFF is not required for this option. This operation behavior can be observed in the RtR function from TASC valves.
- Electric pulsing sequence: A pulsing sequence (5 sec ON, 10 sec OFF) is started when trailer speed is greater than the switch ON speed threshold. The sequence will be repeated as long as the supply pressure is below a specified threshold value. This operation behavior can be observed in electronically controlled air suspension valves.

The inverted mode can be set by the parameters to invert the switching function for all three operating modes. When the inverted mode is selected, the supply voltage is applied in the opposite way.

⚠ CAUTION

In the event of a fault (e.g., a power supply failure) it must be ensured that the solenoid that is controlled by the switch does not remain in a state that will impair driving safety.

Parameter setting

The ISS function can be configured in the iEBS diagnostic software in the tab System > Parameters > Additional functions > ISS1 / RTR

A second ISS function can be configured in the iEBS diagnostic software in the tab System > Parameters > Additional functions > ISS2

5.17 Overload detection

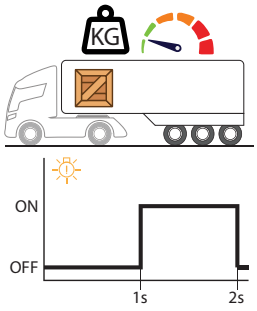
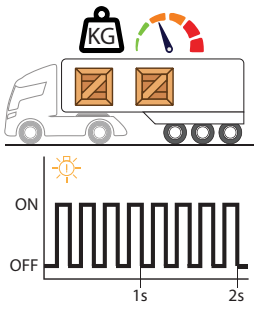
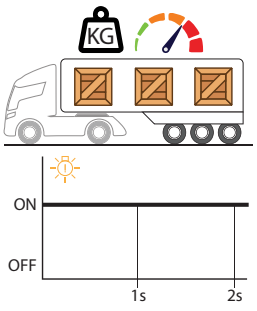
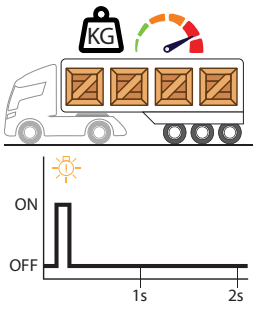
Application

The function monitors the actual load status of trailers with air suspension by means of measuring the pressure value of the load bellows. A safety warning shall inform of the status of load on the axle group whether the predefined limit value has been exceeded. This function helps to avoid overloading trailers.

Function

The function is started automatically as soon as a change in load is detected. The overload detection is only possible at standstill or speeds below 10 km/h. The output signal turns OFF when reaching the speed threshold (v > 10 km/h) and turns ON when loading starts again. Optionally, the function can be switched ON/OFF via a switch (e.g., by a push button). If the function is turned OFF, the automatic overload detection is no longer available.

The permissible weight defines the type of output warning signals. The pre-warning, warning, or overload status will inform the driver about the load status via a lamp or buzzer. The different states can be distinguished by the frequency of the output signal.

Pre-warning		Warning	Overload
Unladen	Laden		
This status indicates how close the load is to the permissible weight limit. The frequency of the output signal increases as the load increases (0,5Hz for an unladen trailer up to 4Hz for a laden trailer)		When the permissible weight has been reached, the output signal is permanently ON	In the event of overloading short warning flashes are followed by long pauses (200 ms ON/1800 ms OFF)
			

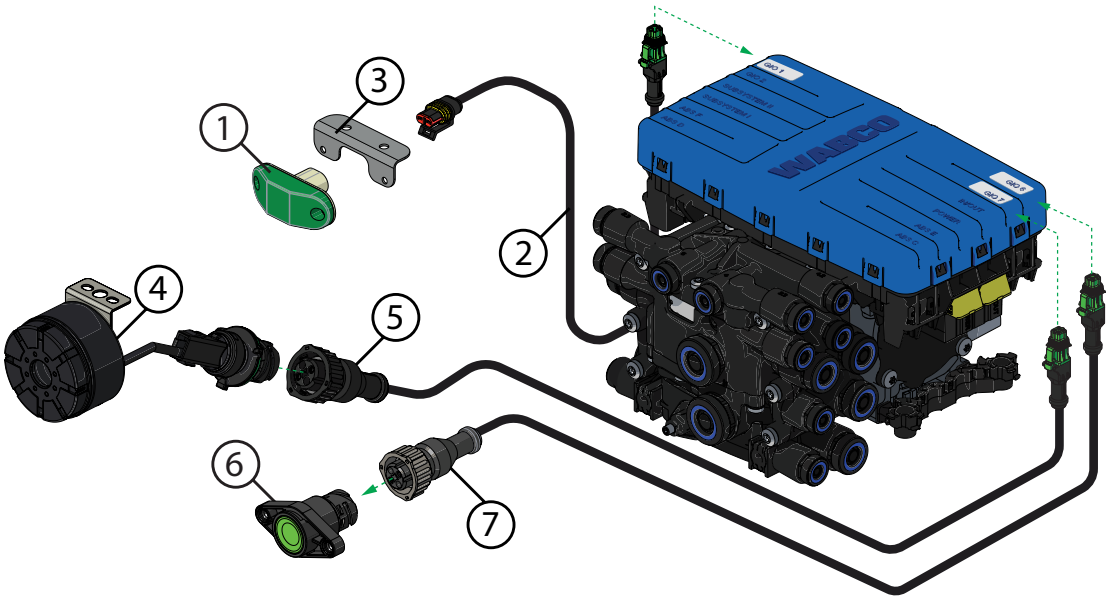
If a EBS relay valve is installed in the trailer (i.e., 4S/3M system configuration) it is possible to distinguish the overload detection between main axle(s) and the axle where the EBS relay valve is mounted. The warnings will match the respective load status for each axle configuration separately.

The warning device(s) used for the overload function can be connected to any GIO port with an output stage and ground pin available. The following devices can be triggered by the output signal

- Shared warning lamp: The shared warning lamp can either be used exclusively for this function or as a "shared warning lamp" for several functions. For further information go to section "Shared warning lamp" on page 182.
- Shared buzzer: The shared buzzer can either be used exclusively for this function or as a "shared warning buzzer" for several functions. The buzzer is only actuated when the vehicle is fully laden. pre-warning and overload are not possible with the buzzer. For further information go to section "Shared buzzer" on page 183.
- LED installed: An external LED device can be used for this function. The error detection it is not possible with LED devices.

A pre-warning can be configured to activate the warnings with partially laden vehicles. This option allows to activate the warning a few seconds ahead of the overload limit is reached. If the parameter is not set, the output is only actuated when the vehicle is fully laden

Connecting components



Item	Part number	Description	Cable required	Comment
1; 2	446 105 523 2	Green warning lamp	449 940 . . . 0	
3	Not supplied	Bracket for lamp		
4; 5	894 450 000 0	Buzzer	449 408 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
6; 7	441 006 030 0	Push button	449 448 060 0	For further information go to section "Push button" on page 74

Parameter setting

The Overload detection signal function can be configured in the iEBS diagnostic software in the tab System > Parameters > (6) Common functions > Overload detection

5.18 Steering axle lock

Application

The steering axle lock function is intended for semitrailer with self-steering axle. The iEBS modulator will control the self-steering axle to engage in locking, or unlocking, depending on vehicle speed, or when reversing will be detected. The locking mechanism of a self-steering axle will lock the track rod to prevent self-steering only when the trailer wheels are at track zero (same position as rigid axle).

NOTICE

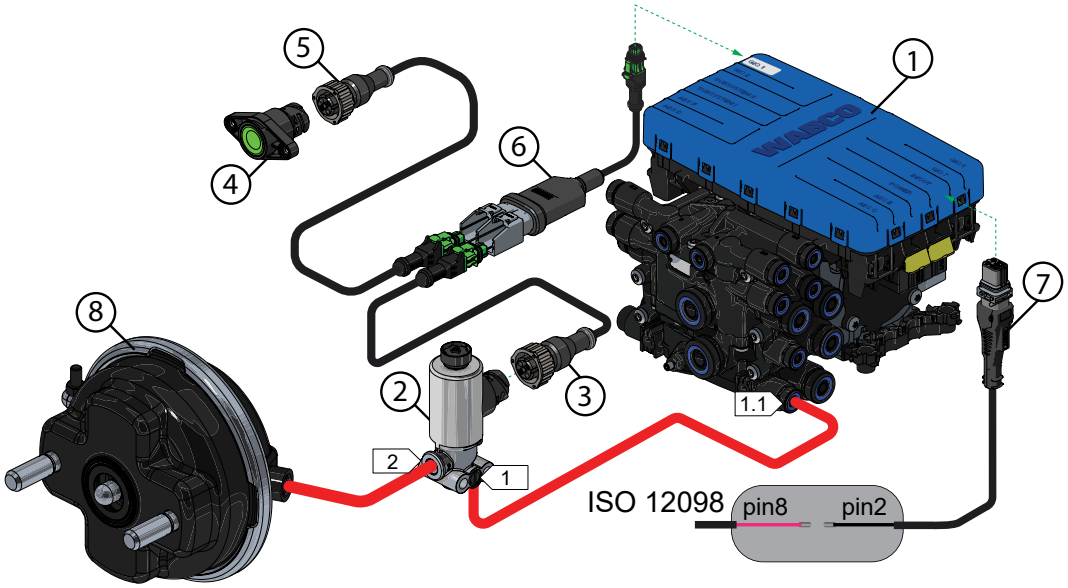
Observe the guidelines for safe operation of the self-steering axles. Once the self-steering axle is locked, there is no electric power to the 3/2 way solenoid valve

Function

Depending on the parameter setting of trailer speeds, iEBS will switch a solenoid valve that is used to pneumatically control the locking cylinder.

- Activation via Speed: When travelling at specified speed (e.g., v > 30 km/h), the self-steering axle shall be locked via the GIO function. If the speed is below the parameterized value, the GIO function shall send a signal to unlock and enable the self-steering axle to turn when cornering. When stationary (v < 1.8 km/h), the self-steering axle shall be locked again.
- Activation via ABS: The lock is maintained whenever an anti-lock braking system becomes active. The steering axle lock shall be released when the anti-lock cycle has ended.
- Activation via reverse gear: The lock is maintained by engaging the reverse gear (when reversing lamps are active) to prevent self-steering during reversing. If the vehicle moves forward again, the lock shall be maintained up to a specified speed defined in the parameters (> 1.8 km/h).
- Manual activation: The steering axle lock function can be activated via a switch, a button, or a user defined interface like SmartBoard.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available for Standard and Premium variants
2; 3	472 170 637 0	3/2 way solenoid valve	449 408 . . . 0	Cable variant lengths: chapter "10.6 Cable overview", page 217
4; 5	441 006 030 0	Push button	449 448 060 0;	For further information go to section "Push button" on page 74
6	894 600 171 2	Duplicator 1=1		Optional, only required for the push button installation
7	449 838 . . . 0	IN/OUT cable		Reversing light signal from pin 8 of the ISO 12098 must connect to an analog input from the IN/OOU port (e.g., pin 2) Cable variant lengths: chapter "10.6 Cable overview", page 217
8	Not supplied	Locking cylinder		

Parameter setting

The steering axle lock function can be configured in the iEBS diagnostic software in the tab System > Parameters > (6) Common functions > Steering axle lock

5.19 Shared warning lamp

Application

The shared warning lamp function allows to control an external lamp that will be signaled by other GIO functions.

This function allows to have multiple GIO functions controlling the same warning lamp. A list of GIO functions compatible with the shared warning lamp function is shown in the table below. If two or more functions signal to the same warning lamp, then the system will prioritize the GIO function in the following order:

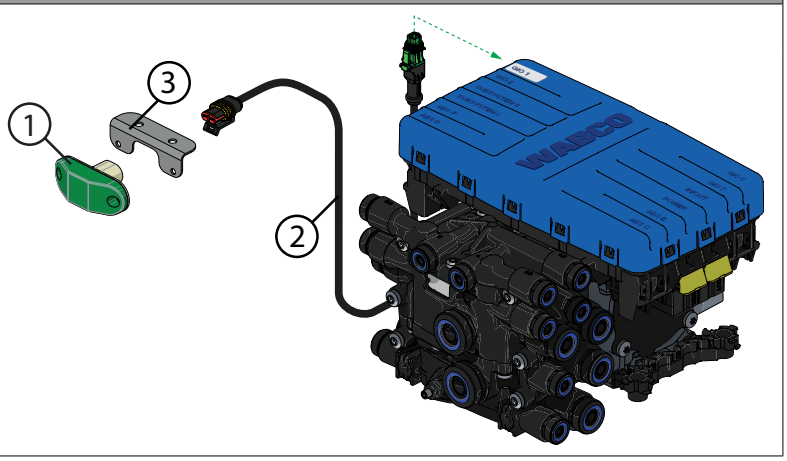
GIO functions with optional use of a lamp	Priority	
Immobilizer	High ↑ ↓ Low	The output signal for the warning lamp is indicated for the function with the highest priority first
TailGUARD		
SafeStart		
Tilt alert		
Overload detection		
Free configurable		
ServiceMind		

Function

The shared functionality is available if the modulator is power supplied via ISO 7638 or during stand-by mode, but it is not available if the modulator is power supplied via the stop light. The output signal for the warning lamp can be continuous (lamp ON) or intermittent (lamp flashing) based on the type of lamp connected.

- Lamp with its own flashing hardware: The connected lamp is driven with a continuous output signal and does the flashing on its own. The function specific frequencies and duty cycles are not considered.
- Lamp without flashing hardware: The connected lamp is driven with the function specific frequencies and duty cycles.

Components

Item	Part number	Description	Scheme connection
1	446 105 523 2	Green warning lamp	
2	449 940 . . . 0	Green lamp cable	
3	Not supplied	Bracket for lamp	

Parameter setting

The shared warning lamp function can be configured in the iEBS diagnostic software in the tab System > Parameters > (7) Additional functions > Shared warning lamp

5.20 Shared buzzer

Application

The shared buzzer function allows to control an external acoustic device that will be signaled by other GIO function.

The shared buzzer function allows to have multiple GIO functions controlling the same buzzer. A list of GIO functions compatible with the shared buzzer function is shown in the table below. If two or more functions signal to the same warning buzzer, then the system will prioritize the GIO function in the following order:

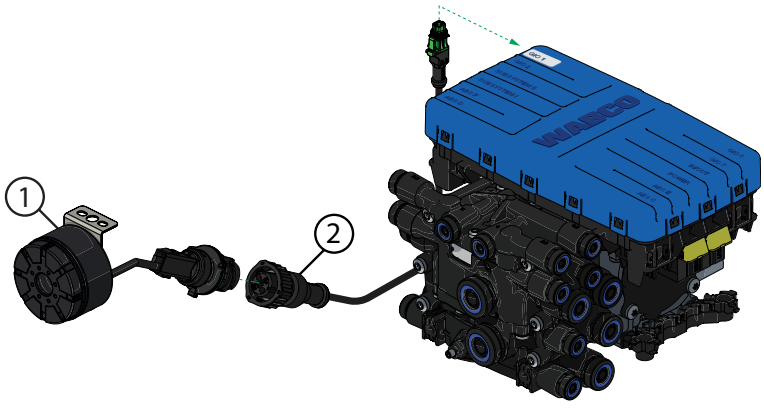
GIO functions with optional use of a buzzer	Priority	
Immobilizer	High ↕ Low	The output signal for the warning lamp is indicated for the function with the highest priority first
TailGUARD		
Tilt alert		
Overload detection		
Free configurable functions		

Function

The shared functionality is available if the modulator is power supplied via ISO 7638 or during stand-by mode, but it is not available if the modulator is power supplied via the stop light. The output signal for the buzzer can be continuous (constant buzzing) or intermittent (buzzing at a configurable frequency) based on the type of buzzer connected.

- Buzzer with its own buzz frequency: The connected buzzer is driven with a continuous output signal and does the buzzing on its own. The function specific frequencies and duty cycles are not considered.
- Buzzer with constant buzzing: The connected buzzer is driven with the function specific frequencies and duty cycles.

Components

Item	Part number	Description	Scheme connection
1	894 450 000 0	Buzzer	
2	449 408 . . . 0	Buzzer cable	

Parameter setting

The shared buzzer function can be configured in the iEBS diagnostic software in the tab System > Parameters > (7) Additional functions > Shared buzzer

5.21 GIO power service

Application

This function allows to have two permanent voltage outputs, which can be used with all trailer that are equipped with the iEBS Standard or Premium variant. The steady positive voltage (terminal 15) is an output that can provide power supply to 3rd party devices while ignition is ON.

Function

Two outputs with a steady load of maximum 1.5 A can be connected to the iEBS modulator. The voltage for the output supply can be set to 12 V or 24 V. The voltage output delivered by the GIO ports can be the same (steady positive voltage 1 = steady positive voltage 2) or they can be set independently from each other (e.g., steady positive voltage 1 = 12 V; steady positive voltage 2 = 24 V)

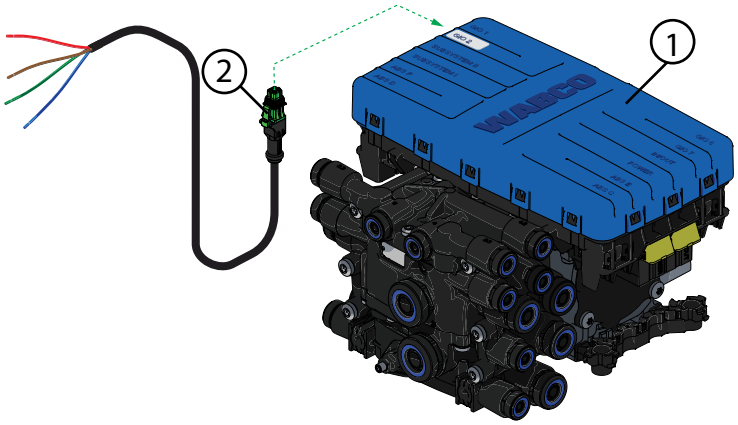
The power supply can be taken from any available GIO port with a free output stage pin. If the GIO port counts with 2 output stage pins, then it is possible to power supply one or two devices simultaneously. In this case, the maximum power consumption for each device is up to 1.5 A.

The output can be monitored for error detection while the iEBS modulator is switched ON. It is always recommended to keep the error detection ON unless:

- An optional switch is added to the circuit to turn ON/OFF this power supply.
- The connected device has a current consumption lower than 100 mA.

Deactivating the error detection prevents inappropriate error codes while the 3rd party device is power supplied.

Connecting components



Item	Part number	Description	Cable required	Comment
1	449 827 . . . 0	Open-end cable		Cable variant lengths: chapter "10.6 Cable overview", page 217

Parameter setting

The GIO power service function can be configured in the iEBS diagnostic software in the tab System > Parameters > (7) Additional functions > Permanent power 1 and/or Permanent power 2

In stand-by mode the continuous power supply is active by default. This option can be disabled via the parameter setting.

NOTICE

Please consider that the function will be disabled if the overall current consumption will exceed the permitted maximum. For details go to section "iEBS modulator specifications" on page 211

A 3rd party device can also be power supplied by a SUBSYSTEMS port. For further information see chapter "4.3.10 SUBSYSTEMS power supply and data communication", page 122.

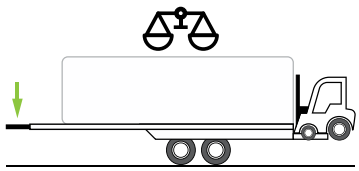
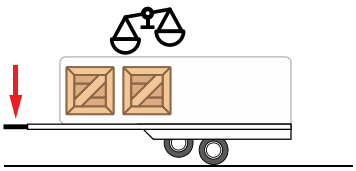
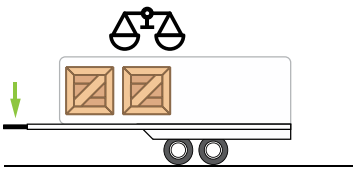
5.22 Forklift control

Application

The forklift control function is used to optimize the support load of semitrailers and central axle trailers with forklift transport. The forklift attached to the trailer is used in the loading/unloading of the trailer.

Trailers that carry a forklift, are designed in a way that the weight distribution between the front and rear part of the trailer is balanced when the forklift is attached. The Forklift control function will adjust the load distribution and provide a better counterbalance when the forklift is absent.

Function

Example of the function		
Central-axle trailers with an attached forklift are designed to achieve balanced weight distribution between the front and rear parts of the trailer when the forklift is attached. A correspondingly broad support load serves as a counterweight to the additional weight of the forklift.	However, if such a central-axle trailer is: • driven partially loaded, • driven without a forklift, and • driven with the lift axle raised it may cause excessive loading on the trailer coupling due to the forklift is not available as a counterweight.	Activating the "Forklift Control" function keeps the lift axle on the ground, resulting in a shorter wheelbase that reduces the load on the coupling. Keeping the axle on the ground allows for better load distribution on the trailer and ensures a more even load balance, even without a forklift.
		

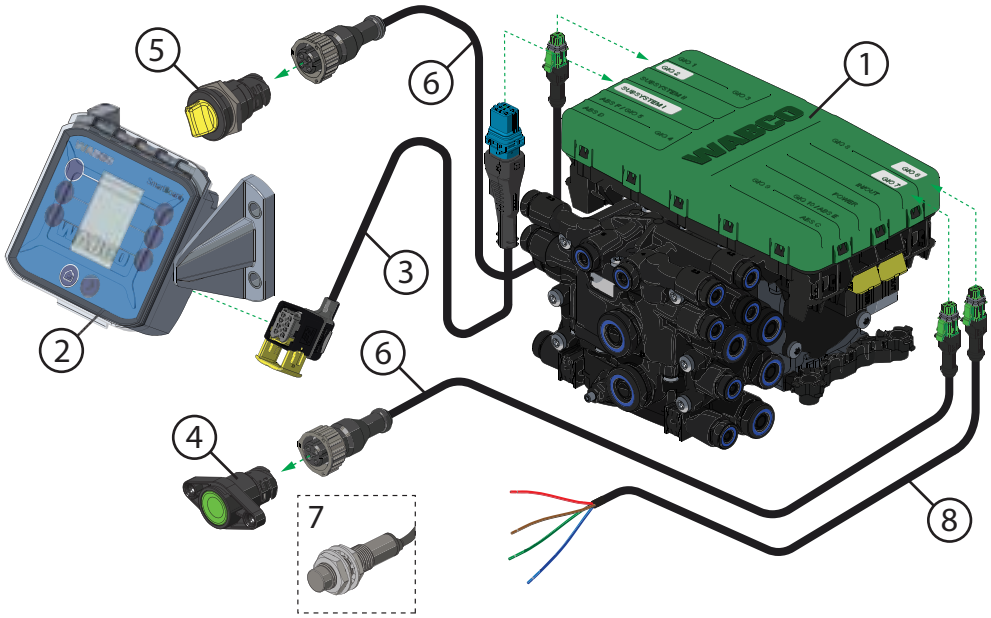
The manual activation or automatic detection of the attached forklift can be done in the following way:

- Manual activation: An user interface like SmartBoard or a switch (i.e., push button or a rotary switch) can be used to activate the forlifter control function manually.
- Automatic detection: The trailer uses the switch (proximity switch or mechanical switch) to detect whether a forklift is docked on the trailer and activate the function

Once the function is active,the funtion will raise the lift axle positioned in front of the main axle or lowered the lift axle if it is behind the main axle.

For trailers equipped with 2 or more lift axles, the funtion will raise the lift axle(s) positioned in front of the main axle and lowered the lift axle(s) behind the main axle.

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 4 . . 0	iEBS Modulator		Function available for Premium variants
2; 3	446 192 21 . 0	SmartBoard	449 929 . . . 0	See chapter "SmartBoard™" on page 76
4; 6	441 006 030 0	Push button	449 448 060 0	For further information go to section "Electrical switches and push buttons" on page 74 Cable variant lengths: chapter "10.6 Cable overview", page 217
5; 6	441 006 031 0	Rotary switch	449 448 060 0	
7	Not supplied	Proximity switch or Mechanical switch	449 831 . . . 0	For further information go to section "Proximity switch" on page 75
8	449 831 . . . 0	Open end GIO cable		Cable variant lengths: chapter "10.6 Cable overview", page 217

Parameter setting

The forklift control function can be configured in the iEBS diagnostic software in the tab System > Parameters > (3) Lift axle control > Forklifter Control

5.23 Trailer Extending Control

Application

The trailer extending control is intended for extendable drawbar trailers equipped with a 4S/3M braking system configuration.

The trailer extending control function allows the driver to extend or retract the trailer body without having to use additional tools such as brake wedges or other locking mechanism.

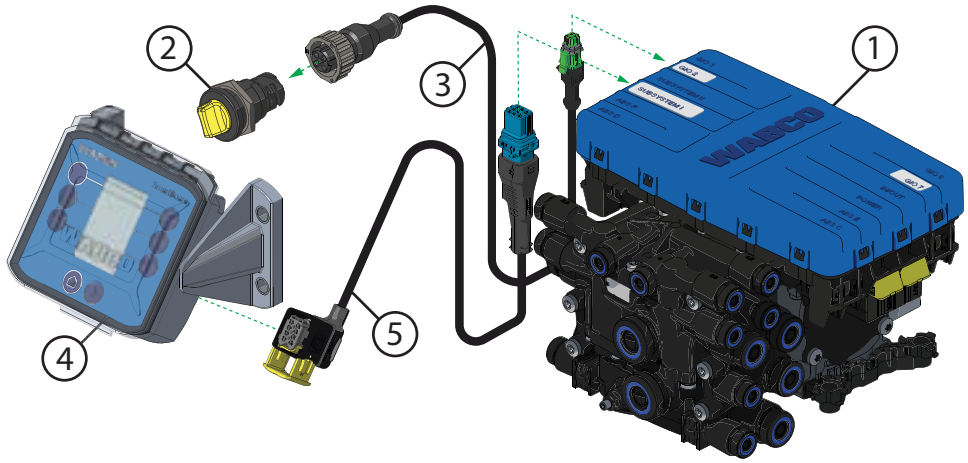
This function brakes the final multi-axle combination of the trailer so that the trailer lenght can be adjusted by slowly driving the towing vehicle.

Function

The trailer extending control will only brake the rearmost axle (axle group) allowing the towing vehicle to extend the trailer. The parameter responsible for braking the rear axle group must be enabled in the iEBS diagnostic software.

The brake release function can be activated via a external switch, or SUBSYSTEMS device like SmartBoard

Connecting components



Item	Part number	Description	Cable required	Comment
1	480 102 . . . 0	iEBS Modulator		Function available for Standard variant
2; 3	441 006 031 0	Rotary switch	449 448 060 0	For further information go to section "Push button" on page 74
4; 5	446 192 21 . 0	SmartBoard	449 929 . . . 0	See chapter "SmartBoard™" on page 76

Parameter setting

The trailer extending control function can be configured in the iEBS diagnostic software in the tab System > Parameters > (7) Additional functions > Finisher Brake Trailer > (enable)Brake last axle only

6 Installation guide

6.1 Safety information

⚠ WARNING

Damage to the iEBS modulator caused by not using original cables

Unauthorized ZF cables may result in functional issues and diagnostic fault entries.

To prevent damage to the iEBS modulator, cables with open ends shall be connected in a way that ensure that no water can enter through the open end of the cable.

⚠ WARNING

Dangerous voltages during electrostatic painting and welding can damage the iEBS modulator.

If electrostatic painting or welding work is carried out on the trailer the following measures must be implemented:

Moving or insulated components (such as axles) must be conductively connected to the trailer frame (chassis) using suitable earth terminals to ensure that no potential differences are allowed to build up which could lead to discharges.

The ABS connection lines on the iEBS modulator must be disconnected and the electrical terminals covered (e.g.,with sealing plugs). Ground connections for welding and paint spray systems must always be connected to the parts on which work is being performed.

⚠ CAUTION

Damage to the iEBS modulator due to painting over

The iEBS modulator must be protected during any painting process to avoid being damaged.

The connector locks and plastic pipes of the pneumatic couplings can no longer be released after painting if they are not protected.

6.2 Installation on the trailer

⚠ CAUTION

Electrostatic Discharge
Before you start the installation, you must note the safety instructions with regard to Electrostatic Discharge (ESD).
For further information see chapter "III Safety information", page 11

NOTICE

iEBS modulator fixation
The trailer manufacturer shall ensure that the iEBS modulator has been installed according to the information on the outline drawing. Nut selection and tightening torque are crucial in the mounting process.

NOTICE

Regular inspections must be performed to check the fitness of the brake system

Outline drawing for the iEBS modulator

Go to www.wabco-customercentre.com/catalog

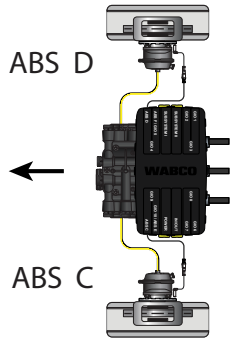
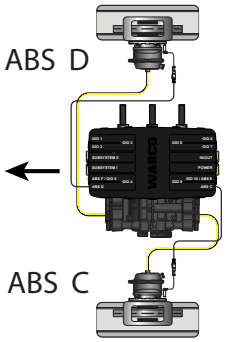
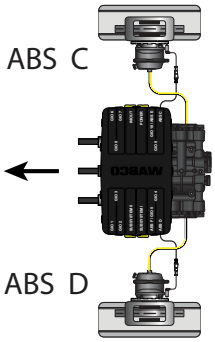
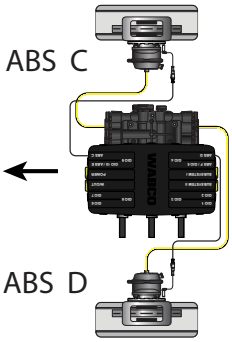
Search for the iEBS modulator by entering the part number (e.g., 480 102 201 0) in the search box

Select the product from the results to be directed to the details of the device

The outline drawing can be found under the reference image of the product or in the documents section

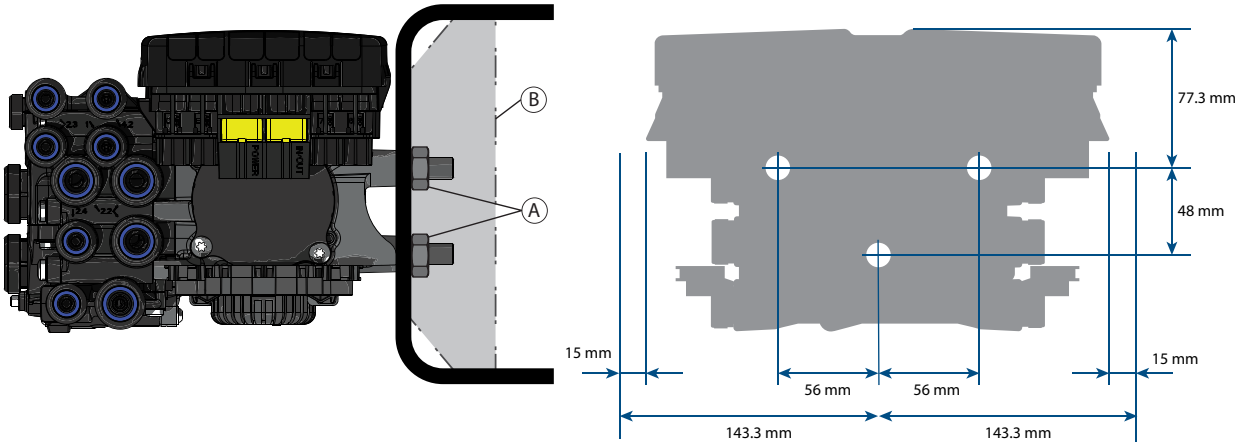
Installation on frame

The installation position of the iEBS modulator in relation to the trailer can be done in 4 ways:

iEBS Installation frame positions (arrow points on driving direction)			
Driving direction Predetermined position	Left installation 90° anti-clockwise	Against driving direction 180° anti-clockwise	Right installation 270° anti-clockwise
			

Mounting on cross member

The cross-member must be connected to the two longitudinal beams of the vehicle mass in a friction locked manner.



- Mount the iEBS modulator on a sufficiently sized U-section, angle section, or a suitable reinforced steel bracket that is at least 4 mm thick with sufficient surface protection. Do not use stainless steel.
- A flat surface mounting area must be ensured. Flatness deviation between each of the contact points should not be greater than 0.3 mm
- 3x M12 nuts (A) shall be used (not supplied). Flange lock nuts are recommended (according to DIN 6923 / ISO 4161). The recommended tightening torque of the mounting nuts is 75 ± 5 Nm
- The installation position must be adequate to protect the iEBS modulator against any stone impact.
- A 15 mm clearance to the side is required to allow later release of the yellow sliders to connect cables.
- The iEBS modulator must not be installed in the vicinity of heat radiation or hot air.
- The silencers must be open to the atmosphere and always pointing downwards.
- The installation in trailers with fording ability requires further measures to prevent water to ingress through the silencers.

6.3 Cable / blind plug installation

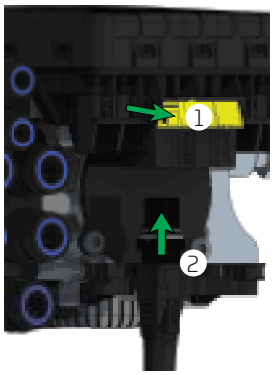
⚠ CAUTION

Damage to the cable

- Water that enters the cable core can damage the iEBS modulator. Only use original ZF cables. Using cables of third-party manufacturers will void any claims or damage.
- Plan your installation position so that cables are free of stress and cannot become kinked.
- Fasten the cable and plug so that no tension or lateral forces affect the plug connections.
- Never route cables over sharp edges or in the vicinity of aggressive media (e.g., acids).
- Route the cable connection in such way that water cannot enter the plug-in connector.

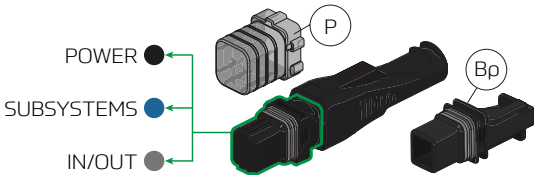
Cable / blind plug installation

8-pin cables connection



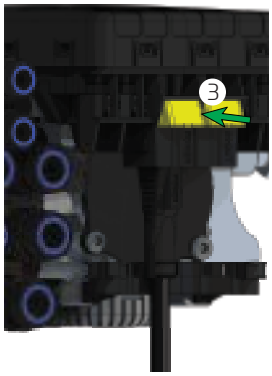
- Unlatch the yellow retainer clip by hand (1). Remove the blind plug (Bp) from the modulator connector frame (if fitted).

8-pin connectors



The coding between the connector and the slot (POWER, SUBSYSTEMS or IN/OUT) ensures that they can only be inserted if the two parts match.

- Remove the protection cap (P) from the plug and insert the cable end connector (2) into the corresponding slot of the connector frame.

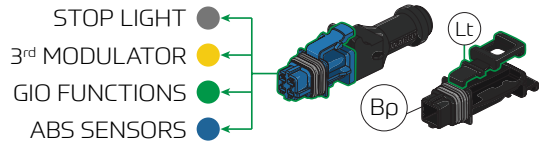


- Push-in the yellow retainer clip (3) until you hear it locks. An audible “click” sound confirms the correct latching

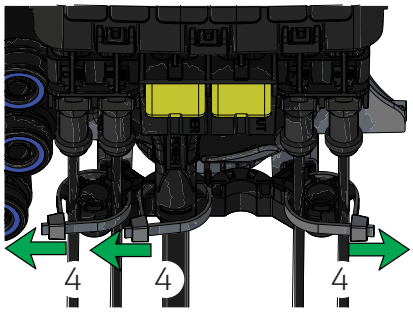
4-pin cable connection

- Remove the blind plug (Bp) from the modulator connector frame (if fitted) by pressing the locking tag (Lt) and pulling out the connector end.
- Insert the cable connector end into the corresponding slot of the connector frame.
- Push-in the cable until you hear the locking tag (Lt) of the connector lock. An audible “click” sound confirms the correct latching

4-pin connectors

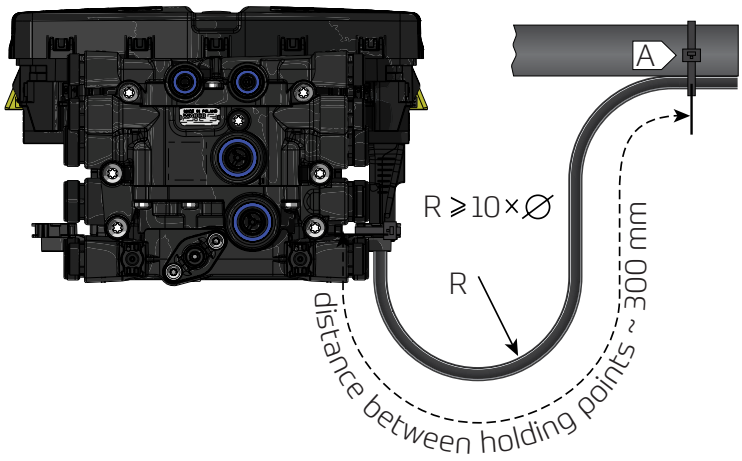


The coding between the connector and the slot (ABS sensor, GIO, 3rd modulator GIO, or the ABS modulator & Stop Light) ensures that they can only be inserted if the two parts match.

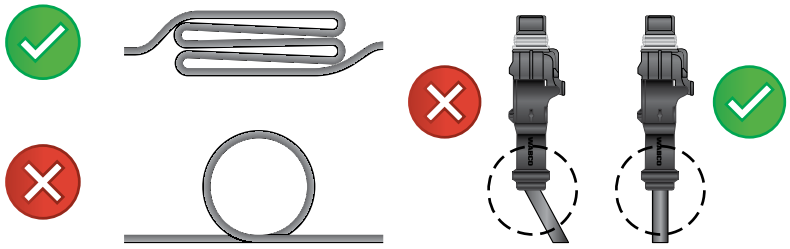


- After all the cables are connected, use zip ties to hold the cables in position to the dedicated cable holder (4).
- All slots of the connector frame without cables must be fitted with blind plugs. The blind plugs (Bp) are not coded and match the respective slot.
- The color coding is found in the overview of cables chapter "10.6 Cable overview", page 217.

Cable fixation

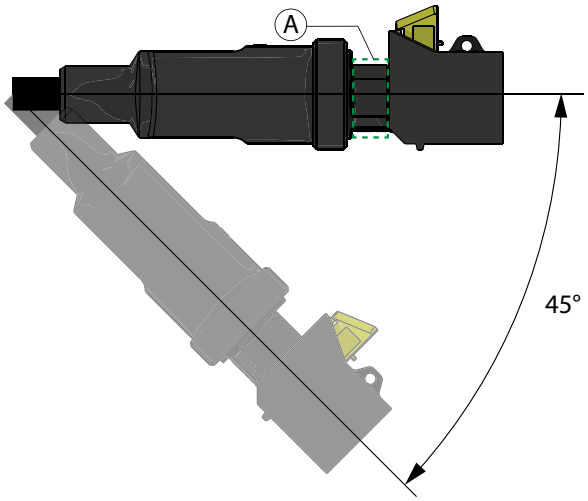


- The bending radius (R) of the cable shall be equal to or greater than 10 times cable diameter (D).
- Cables shall be fastened to the dedicated cable holder and further to the trailer frame.
- Fix the cables (maximum 300 mm cable length distance to the iEBS modulator) using cable ties (A).
- Not fastening the cables may lead to cable breakdown and the possibility of water ingress.



- All slack remaining in the cable once the connections are made can be bundled in a Z-shaped loop.
- Do not coil the cable into a circular bundle.
- All cable fasteners should be tightened in a manner only to the extent that the cable is held sufficiently in place. Over tightening can result in damage to the cable.

Port duplicator installation

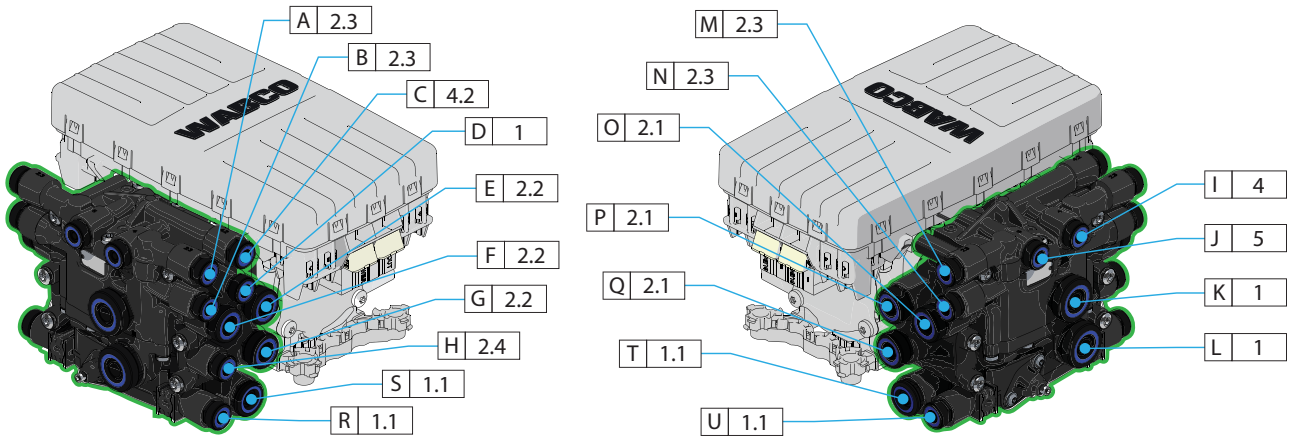


- The port duplicator needs to be installed in horizontal position.
  A 45° inclination respecting the horizontal is allowed (ports interface facing downwards).
- Upside down or side mounting position is allowed.
- The narrow part of the duplicator (A) is the fixation point for cable tie.
- The port duplicator shall be fastened to the trailer frame.

6.4 Pneumatic piping

Nylon tubes according to DIN 74324 / ISO 7628 are used for the pneumatic piping to the PDM.

Permissible lengths and diameters pneumatic piping



PDM Port	#	Port purpose description	Fittings (Ø tube size)	Push-in lenght (mm)	Max. tube lenght (m)	Min. bending radius (mm)
2.1	O / P / Q	Service brake actuator	12x1.5	25	6	60
2.2	E / F / G	Service brake actuator	12x1.5	25	6	60
2.3	A / B / M / N	Spring brake actuator Port 12 of TriStop cylinder	8x1	20.5	* *	40
2.4	H	Test connection for brake pressure	8x1	20.5	* *	40
1	D	Supply - port 1-2 PRV	8x1	20.5	* *	40
1	K / L	Brake reservoir	15x1.5 / 16x2	27	3*	100
4	I	Control line - yellow coupling head	8x1	20.5	*	40
4.2	C	Park brake control - port 2 of PRV	8x1	20.5	* *	40
5	J	Air suspension bellows	8x1	20.5	* *	40
1.1	R / S / T / U	Supply for air suspension	8x1 / 12x1.5	20.5 / 25	* *	40 / 60

⚠ CAUTION

*) The piping between the reservoir and the iEBS modulator shall only be long enough to fulfill the response time pursuant to UN/ECE R13, Annex 6.

* *) The pipe lengths should be as short as possible for optimum performance of the system.

Piping for special applications

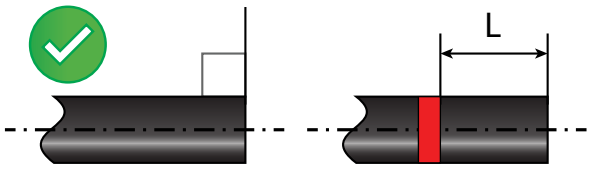
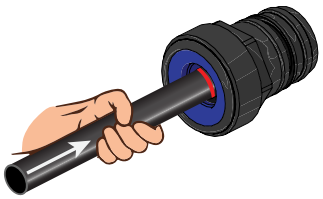
Pneumatic piping requirements for trailer configurations equipped with a EBS relay valve as a 3rd modulator:

Supply pipe from the reservoir to the port 1 of the modulator: Minimum inside diameter = Ø 12 mm.

Delivery from the modulator (port 2) to each service brake actuator: Minimum inside diameter = Ø 9 mm.

The length of the pipe shall only be long enough to fulfill the overall response time for the trailer.

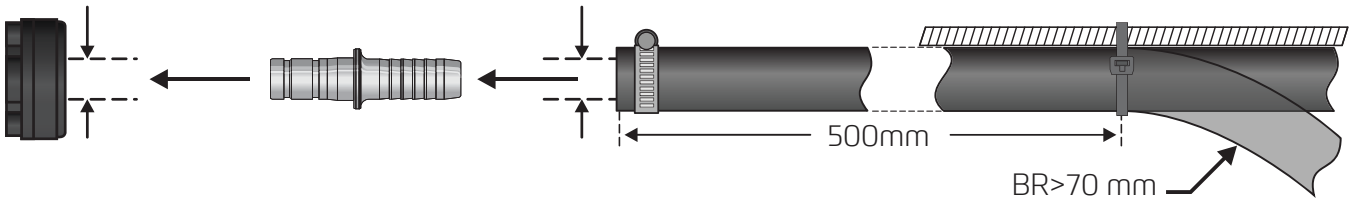
Nylon tube assembly

Cut the pipe at a right angles. Mark the length pushed into the pipe (L) to be able to check the insertion depth later. Push-in-length (L) according to cartridge size.	Carefully push the marked length of the tube into the plug connection.
	

Rubber hose assembly

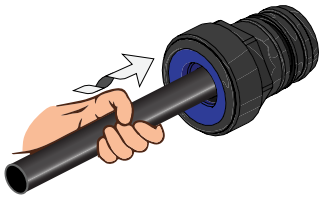
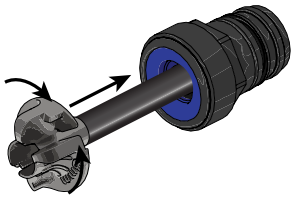
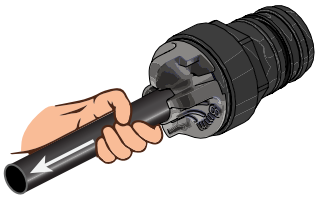
For trailer applications where the use of rubber hoses is required, the hose adapter must be inserted prior to installation. Hose adapter 893 129 467 4 must only be inserted into fittings for tube dimensions ø12 x 1.5 mm (i.e., it must only be inserted into ports 2.1 and 2.2 which are responsible for actuating the service brake).

Due to the geometry of the adapter, once it has been inserted in the composite fitting, it cannot be removed again.

Push-in fitting for tube ø12x1.5 mm	Hose adapter 893 129 467 4	Brake hose ø11 x 3.5 mm In accordance with DIN 74310	Hose to be clipped after each 500 mm. Minimum bending radius (BR) >70 mm
			

Tubes releasing procedure

Release the pipes by using the tube release tool (PN 899 700 920 2). Make sure that neither dirt nor water or other foreign objects can enter the fitting during the release process, this would damage the sealing element.

Loosen the plastic tube through pressing and rotating the pipe into the fitting. This movement will release the locking mechanism between the fitting and the pipe.	Place the release tool over the tube, positioning the slim side to the screw connection. Close the tool to ensure that it is tight against the tube and then press the tool into the fitting connection.	Pull the tube out of the screw connection using a rotating movement. In doing so, the tool must be kept in the screw connection. Once the pipe is out, remove the tool.
		

NOTICE

Dismantling of the device is possible only according to the repair instructions and by using the original repair kits available for customers. Further dismantling or repair of the device or its fittings is not permitted.

7 Start-up

The start-up is a mandatory process that activates the iEBS modulator according to the desired functionality. A successful start-up process for the trailer to go into service includes:

- Writing of the parameters into the iEBS modulator,
- Performing of all test and calibrations,
- Set the trailer status to ready

The entire start-up process is logged by an individual fingerprint that allows to trace the modifications and settings to the system parameters. The start-up can only be performed by individuals that have taken part in the dedicated iEBS training course. The training course will provide you with a user ID and PIN.

Start-up sequence

A start-up of a typical configuration is performed in the following sequence:

- Configuration of parameters: All configurations steps must be filled according to the trailer's specifications. For series production, a predefined parameter file can be prepared offline and stored in a directory.
- Functional test and calibrations: The start-up allows the testing of a series of different aspects of a trailer. Electrical connections, air pressures, piping status, devices calibration and overall trailer status are part of the tests that can be performed according to the configured trailer.
- The end of line test is automatically performed after the start-up calibration process and tests are completed.

7.1 Configuration of parameter

The system parameter setting for the iEBS system can be read in from a file stored on the diagnostic PC or in the company network. All parameters can be changed and stored in the iEBS modulator or can be saved as a file.

The parameters are configured using the iEBS diagnostic software. As a base for all configurations a brake calculation program provides all data about the basic brake and load conditions in the form of a *.xml file.

Trailer functions modification and/or retrofit: The existing parameter set of the iEBS modulator can be read out of the ECU and changed in the diagnostic PC accordingly. With the “write to ECU” command all changes are applied to the system.

7.1.1 General parameters setting

The parameter configuration is launched from the Start-up menu of the iEBS diagnostic software.

Applications and functions are grouped on the different screens using tabs. Settings are defined by clicking option fields, selecting text fields, or entering numbers.

The tab connectors on the right-hand side of the screen allows assignment of GIO functions to the different ports. The number of ports available depends on the iEBS modulator version:

If the parameterized configuration requires more ports than available on the iEBS modulator, it is possible to increase them by using a port duplicator. Port duplicators are available for GIO and SUBSYSTEMS ports.

Please note that new iEBS modulators require the most recent version of the iEBS diagnostic software.

User guidance in the iEBS diagnostic software is based on the required configuration steps. A help system within the software is available to provide an extended description of the parameters.

7.1.2 Brake parameters

The brake parameters are filled in the iEBS diagnostic software in the tab "Brake" with source data from the brake calculation.

Brake calculation

A brake calculation is an obligatory process that is designed to find an optimal distribution of brake forces for the best braking performance and to ensure the harmonization between the towing vehicle and the trailer.

A brake calculation is needed to set-up an iEBS, for a specific trailer or series of trailers. This process takes into consideration:

- The trailer's geometry
- Braking force in correlation to the load
- Brake diagram layout
- Trailer configuration (brake cylinder’s size, trailer’s purpose, etc).

The braking behavior shows if it is in line with the compatibility braking bands (see UN/ECE R13 regulation), as well as ensuring the brake wear characteristics fulfil legal performance requirements.

Brake calculation reports are submitted for certification and homologation of specific trailer or series of trailers. The reports comply with the latest UN/ECE R13 regulation for braking systems, ensuring that your trailer is complying to the regulatory standards & specifications prescribed in this regulation.

Description	QR code
Contact us Please contact your ZF partner for further information.	

Load sensing parameters

These values can be manually entered from the brake calculation within the tab 2 "Brake" of the iEBS diagnostic software. Ensure the values are entered to the corresponding field in the table.

- Axle load: Represents the axle load values for the unladen and laden condition.
- Bellow pressure: This information corresponds to the unladen and laden axle loads. The suspension characteristics shall be obtained from the axle or suspension manufacturer.

NOTICE

The corresponding bellow pressure values for laden and unladen condition are not provided by the brake calculation and must be entered manually to the corresponding field in the table.

- Braking pressures: Represents braking pressure for unladen or laden conditions

It is recommended to upload the brake data file (*.xml) that was produced by the brake calculation program. This will improve the parameter setting process by saving time and making it more robust by excluding the potential of typographical errors.

The *.xml format file with the brake calculation parameters can be uploaded in the tab "Vehicle" > "Read from file".

7.1.3 Offline parameter procedure

Defining a parameter set directly on the trailer is easier because the iEBS variant is recognized automatically. However, parameter setting can also be prepared without a trailer and stored as a file for later use.

The offline procedure follows the same steps as in online procedure. An offline configuration can be started in tab System > Parameters.

The parameters can be saved via the iEBS diagnostic software in tab System > Parameters > (9) Connector > Option "Write to file". The saved file can be later used for uploading the stored parameters into an iEBS ECU during the start-up.

7.2 Functional test and calibrations (End of Line test)

End of line test

The end of line test is a check test that confirms every function works accordingly to the trailer designed. The end of line test is successfully performed if all the specific test selected for the start-up process have been passed. This will change the factory default settings by deleting the end-of-line bit in the ECU.

In the event one (or more) of the test performed during the start-up process has not been passed or the end of line test has failed, corrective actions need to take place and the testing and calibration process must be repeated until all tests are passed.

After the end of line test has been completed, it is possible to:

- Print a report with the results of the start-up process by clicking on the "Print start-up log" button
- Print the trailer data plate with the trailer information by clicking on "Print system plate" button.

Mandatory and optional tests can be performed in the following sequence:

Test name	Test type	Description
Parameters	Mandatory	This test determines if the parameter settings were correctly saved in the ECU.
Calibration of height sensors for axle load	Mandatory	Test used to determine the correct sensing operation range of the ECAS height sensor. Test dedicated for mechanically suspended trailers only. For further information go to section "Parameterization and calibration of the height sensor" on page 107
EBS pressure test	Optional	Test used to check if the braking system correctly modulates the parameterized braking pressure distribution to the brake cylinders.
Redundancy test	Mandatory	Testing of the pneumatic piping from the yellow coupling head to the actuators.
ABS sensors	Mandatory	This test confirms the correct assignment of the ABS sensors. If the modulator is installed on the predetermined position, the test will check if the wheels sensors D and F are connected to modulator side 2.1 and if the wheels sensors C and E are connected to modulator side 2.2.
Digital input	Optional	Test used to display the different states of the connected and parameterized switches. It is possible to test whether the components are functioning fault-free and if the cabling is OK.
Calibrate EBS modulator installation position	Optional	Test used to calibrate the installation position of the EBS modulator. To perform the test, Ensure the trailer is parked on a flat and level surface (horizontal deviation < 1°). This calibration is critical for the correct operation of the RSS functionality.
Lift/Tag axle	Optional	Automatic and manual test of the lift axle and tag axle control. The iEBS lifts and lowers the lift axles of the trailer.

Test name	Test type	Description
RtR valve	Optional	The iEBS modulator will simulate trailer conditions to determine if the RtR function is triggered and brings the trailer chassis to the driving level. Two different types of test modes can be performed: • Automatic: iEBS will automatically perform the RtR function (the bellows pressures of the trailer are monitored, and the trailer speed is simulated) • Manual: iEBS will perform the test only after manual lowering of the chassis (the trailer speed is simulated only).
Leak valve	Optional	Test used to check the tightness of the air suspension and braking system. The default test duration is 2 minutes whereas the permissible pressure drop is 0.02 bar.
Signal outputs	Optional	Testing of the outputs of the iEBS (e.g., additional brake light, ServiceMind warning lamp, trailer warning lamp, Safety Brake, RSS active signal, warning lamp 'Axle load C-D').
Warning lamp	Mandatory	Testing of the correct warning lamp cabling. Warning lamp on the towing vehicle dashboard or dedicated lamp can be used for the test (connected to plus).
Diagnostic trouble code (DTC)	Mandatory	Testing of the diagnostic memory to ensure that all failures/messages present in ECU were cleared. In the event of an active message/failure, the test fails.

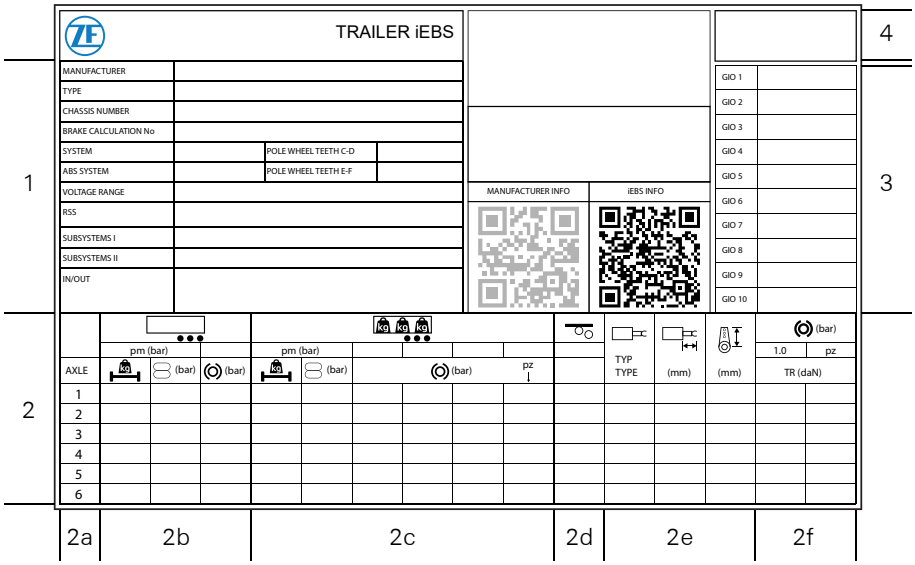
7.3 iEBS trailer data plate

After the start-up process has been successfully completed, the iEBS diagnostic software can be used to create a system label documenting the trailer parameterization on a printed label.

Printing system label

To print the system label, you require an adhesive label (PN 899 200 922 4) and a laser printer. This system label must be affixed in a clearly visible place on the trailer.

The iEBS data plate can be printed out from the iEBS diagnostic software in tab System > Parameters > (9) Connector > Option "Print system label".



Legend	
1	Trailer information (e.g., manufacturer, trailer type, brake calculation number, ABS and RSS data, SUBSYSTEMS devices)
2	Trailer brake information
2a	Axle position
2b	Unladen trailer braking configuration
2c	Laden trailer braking configuration
2d	Lifting axle information
2e	Brake cylinder
2f	Reference values for brake cylinders
3	GIO functions setup, Trailer type symbol with ABS configuration and QR codes for further information. The default QR code directs to the iEBS modulator landing page (right QR code in the image). An optional QR code can be generated automatically based on a URL provided by the trailer builder (left QR code in the image). The URL must be entered in the iEBS diagnostic software in the tab System > Parameters > (1) Vehicle > Vehicle data section.
4	ADR compliance and test approval

Printing PDF files

A PDF file with parameter information of the trailer and iEBS function configurations can be printed out from the iEBS diagnostic software in the tab System > Parameters > (9) Connector > System label

8 OEM and workshop hints

8.1 Maintenance

The iEBS system is maintenance-free. The iEBS monitors the performance of internal functions as well as the electrical values of the connected components. In case of detected faults or implausible system reactions, a warning messaged will be given based on the severity of the finding.

In case of issues, the fault codes are messaged on the CAN bus and can be shown:

- On an attached SmartBoard
- Broadcasted via a telematic unit to the fleet owner
- Via iEBS diagnostic software

NOTICE

Trailer builders should inform the drivers about warning messages and how to interpret them in their manuals accordingly.

Workshop staff receives a comprehensive information when using the iEBS diagnostic software as described in section "Diagnostic software" on page 200. The iEBS diagnostic software provides important iEBS system information and measured values, as well as a detailed description about occurring faults with the instruction of how to repair it.

A broader understanding of the iEBS will be provided by system trainings

8.2 System training and PIN

The ZF [pro]Academy offers a wide range of technical training programs, featuring the installation, diagnosis, and maintenance of electronically controlled braking - and driving dynamics control systems that are developed and manufactured by ZF for commercial vehicles.

This is usually provided as face-to-face training in one of our many training centers or also via online training. Nowadays, Digital Classroom Training is available as an alternative to the on-site training.

You can book your training in all available formats on our homepage: https://proacademy.zf.com

PIN Code

At the end of a successful training, participants of a ZF [pro]Academy product trainings receive a PIN (Personal Identification Number) code to enable enhanced functions in the related iEBS diagnostic software.

Two PIN variants are available

- PIN: Allows to perform a start-up parameterization. Is usually issued if the participant has attended a multiple day face-to-face training session. It also includes a practical part to put theory into practice. The PIN issuance applies also for Digital Classroom Training, and in addition a practical part that is conducted separately in our training center.
- PIN2: Allows calibration/ loading of an encrypted parameter files which allows the replacement of a modulator. PIN 2 is usually granted after you have successfully completed the extended training.

Digital Classroom Training registration

After booking the training you will receive a confirmation via email and a few days later a registration link for the Digital Classroom Training Tool. You can register directly for the course via the link. Shortly before the start of the course, you will receive a reminder with the corresponding link.

Participants will receive a certificate at the end of the training course.

8.3 Diagnostic software

The diagnostic softwares are special programs with extensive functions which allow you to carry out diagnosis on electronic systems such as iEBS. It provides direct access to the iEBS modulator to quickly diagnose and identify any problems that may occur.

The iEBS diagnostic software is used for all diagnosable systems and components in a variety of vehicles.

To perform a system diagnosis, you require:

- A standard PC or laptop with Microsoft Windows operation system (Windows XP or higher)
- The iEBS diagnostic software
- A diagnostic interface
- An adapter to the corresponding trailer type

The diagnosis connection can be performed in 2 ways

- 24 V CAN communication diagnosis: Use the 7-pin ISO 7638 diagnostic adapter between truck and trailer.
- 5 V CAN communication diagnosis: Connect the dedicated diagnostic cable directly to the SUBSYSTEMS port of iEBS. The diagnostic socket is intended to be mounted on the trailer's chassis.

Order system diagnostic

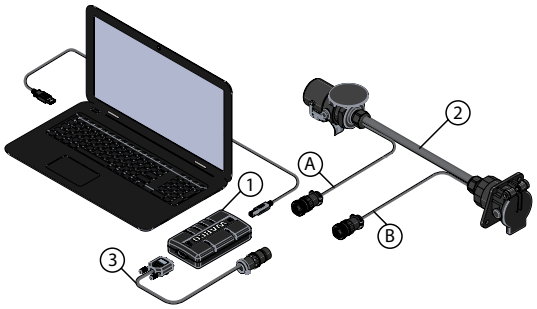
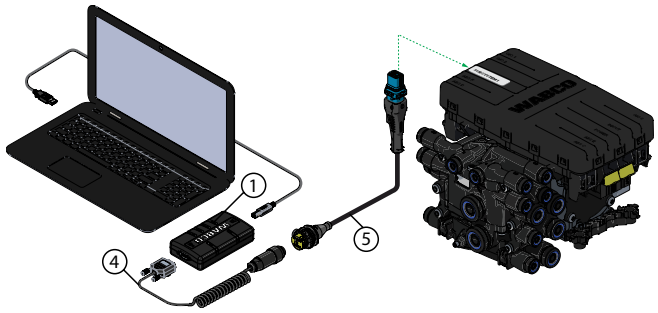
Open the WABCO Customer Centre website:

www.wabco-customercentre.com/

After you have successfully logged in, you can order the iEBS diagnostic software from the "Diagnostics" section in Customer Centre.

Please contact your ZF partner if you have any questions. Further information in chapter "9 ZF contact", page 209

Connecting components

24 V CAN communication	5 V CAN communication
	

Item	Part number	Description	Comment
-	446 301 023 0	Trailer case	Accessory case with the most important connecting elements between ECU and your PC.
-	246 301 . . . 0	iEBS diagnostic software	Latest iEBS diagnostic software overview at: http://www.wabco.info/i/852
1	446 301 030 0	Diagnostic Interface 2	Interface for connection to a PC or tablet with a Windows operating system and available USB port.
2	446 300 360 0	Diagnostic cable ISO 7638 (CAN 24 V)	Suitable for drawbar and semitrailers. Used as an intersection cable for the power connection to read the CAN signal from the trailer iEBS. (Note: not intended for driving operation)
3	446 300 361 0 (5m) 446 300 362 0 (20m)	CAN diagnostic cable	Cable connection between the Diagnostic Interface 2 and the Diagnostic cable ISO 7638. The connection must be established on the trailer side to read CAN data. For semitrailers, the diagnostic cable must be connected to side "A" of the adapter. For drawbar, the diagnostic cable must be connected to side "B" of the adapter.
4	446 300 348 0	Diagnostic cable (CAN 5 V)	Cable connection between the Diagnostic Interface 2 and the iEBS diagnostic cable ISO 7638. The diagnosis is performed via 5 V communication.
5	449 607 020 0 449 607 040 0	iEBS diagnostic cable (SUBSYSTEMS)	Suitable for drawbar and semitrailers. Used to read the CAN signal from the SUBSYSTEMS port of the iEBS modulator. Provides a quicker access and faster data communication than with the ISO 7638 cable.

Additional information

Further information about installation and activation of the diagnostic program is available in the following link.

Description	QR code
Diagnostic tools and test equipment product overview	

8.4 Tests / Simulations

Purpose

Uniform provisions concerning the approval of vehicles of category O regarding braking are covered in the UN/ECE Regulation N°13. All necessary test to comply with the UN/ECE regulations must be passed by the trailer manufacturer in order to get permission to circulate on public roads.

A registered technical service organization is responsible for conducting the approval test with regards to a braking system for a trailer.

The manufacturer of the trailer is responsible to submit the system test reports for the time of trailer type-approval to the technical service organization carrying-out the process. The type-approval might not be approved if considered not to be appropriate for the trailer under consideration (e.g., insufficient brake system will not get approval).

Test equipment

Equipment available for testing are the Conformity Test Unit (CTU) and the iEBS diagnostic software.

The Conformity Test Unit (CTU - PN 446 310 000 0) is a device compliant with the statutory regulations of UN/ECE R13 requirements. The Trailer expansion package (PN 446 310 011 0) is suitable for system verifications and optimization of trailer configurations at trailer manufacturers.

This CTU can be used to carry out the following tests:

- Test of the response and pressure rise characteristics at the least favorably positioned wheel brake cylinder when a pneumatic control signal is input (UN/ECE R 13 Annex 6 Item 3)
- Test of the response and pressure rise characteristics at the least favorably positioned wheel brake cylinder when a pneumatic and electronic control signal is input (UN/ECE R 13 Annex 6 Item 3)
- Testing of the data transfer at the ISO 7638 electronic towing vehicle port (UN/ECE R 13 Annex 16)
- Electrical simulation of the towing vehicle - Testing of reactions induced by means of CAN text blocks at the ISO 7638 electronic towing vehicle port (UN/ECE R 13 Annex 17 Item 4)
- Testing of supply pressure reservoir volume (UN/ECE R 13 Annex 7 Item A.1.3)
- Testing of supply pressure reservoir volume according to UN/ECE R 13 Annex 20 Item 7.3

Publication	QR code
CTU – Conformity Test Unit system description	

Additional tests and simulations can be performed using the iEBS diagnostic software:

- ABS sensors test: Used to test the correct assignment of the ABS-sensors of the iEBS. This also tests whether the sensors can output a wheel speed signal.
- Power supply test: With this test the power supply and cables between the towing vehicle and the trailer are checked. The current to the solenoids is applied in steps, and the voltage drop in the modulator is measured.
- Leakage test: This test is used to check the air tightness of the air suspension and braking system.
- Driving test: Allows to display and record the current vehicle measurements value while driving.
- Pole wheel test: Function that allows to determine the number of teeth and the run-out of the pole wheel.
- Digital input test: Used to display the different states of the connected and parameterized switches. Used to test if the components are functioning fault-free and if the cabling is OK. Additionally, the power supply via stop light can be tested in this menu.

The test section can be found in the tab "Measured values" of the iEBS diagnostic software.

Tests

<table>
<tr><th>What must be tested?</th><th>What must be done?</th></tr>
<tr><td>Brake system response time ≤ 0.4 s.
Contrary to the brake response time for trucks, there are no requirements for the trailer regarding actuating time.
Regulation: UN/ECE R 13, Annex 6 § 3</td><td>Preparations for tests with CTU:
• Activate the roller test mode (section "Roller test bench mode" on page 121) and simulate a laden condition for the trailer (section "Simulations" on page 204).
• Readjust brakes if necessary (slack adjuster with drum brakes only).</td></tr>
<tr><td>ABS energy consumption by equivalent actuations
Conduct equal service brake actuations (n_e) as per ABS certificate (§ 2.5). The last actuation must measure sufficient brake pressure to the actuators that is equivalent to a braking rate of 22.5 %.
Regulation: UN/ECE R13 Annex 20, § 7.3
<table><tr><td>Disc brake:
n_e ECE = 12 actuations</td><td>Drum brake:
n_e ECE = 13 actuations</td></tr></table></td><td>• Charge the brake system air reservoir to reach 8.0 bar.
• Shut OFF the supply.
• Apply 6.5 bar to the control line coupling (pm) for each number of actuations n_e (the number of actuations varies between disc and drum brakes).
Ensure to slowly apply and release the brakes (e.g., ~1 bar per second) until reaching 6.5 bar at the control line.
• For the last actuation, hold pressure and take pressure reading of the actuator. This value should be equivalent to the residual braking rate of 22.5 %.</td></tr>
<tr><td>Spring brake actuator energy consumption
To verify whether the parking brake of the unhitched trailer can be released at least 3 times.
Regulation: UN/ECE R13, Annex 8, § 2.4</td><td>• Jack up those axles equipped with spring brake actuators.
• Charge the trailer to 7.5 bar supply pressure.
• Uncouple the supply and control lines. By uncoupling the trailer, the emergency brake will automatically be applied and shall be released prior to the check.
PRV - Emergency brake release: The red knob shall be pushed fully inwards to release the spring brakes.
PREV - Emergency brake release: The black button shall be pushed inwards to release the service brakes.
• Spring brake release cycles: Apply and release the parking brake system 3 times by alternating fully pull-out and fully push-in the red knob of the PRV or PREV.
• After the third time, it must still be possible to turn the wheels equipped with spring brake actuators.</td></tr>
<tr><td>Spring brake reaction after operation of the service braking system
To verify whether after 4 full-stroke actuations of the service brake, if the system retains sufficient air pressure to avoid the spring brakes begin to actuate the brakes.
Regulation: UN/ECE R13, Annex 8, § 2.5</td><td>• Charge the trailer to 7.0 bar supply pressure.
• Isolate the supply line (close the air flow to the reservoir) and the auxiliary circuit (air suspension).
• Apply and release the service brake 4 times (p_m 7.5 bar).
• After the fourth application it must still be possible to turn the wheels with spring-type brake actuators.</td></tr>
<tr><td>Braking reservoir capacity
To verify that the service brake system retains sufficient air capacity after fully actuating the service brake nine times. The pressure of the ninth application should not be less than half of the pressure registered of the first application.
Regulation: UN/ECE R13, Annex 7, § 1.3</td><td>• Charge the trailer to 8.5 bar supply pressure.
• Isolate the supply line (close the air flow to the reservoir).
• Apply and release the service brake 9 times (p_m 7.5 bar).
• Remember to register the pressure in the service brake actuators for the first and the ninth brake application.
• The reading of the ninth service brake actuation should comply with the requirements.</td></tr>
</table>

What must be tested?	What must be done?
Measurement of brake forces on the roller tester Measure, on the roller tester, the brake forces for the service and spring brakes on all axles with an unladen trailer.	• Lift-axles that are lifted must be lowered for the test. • For service brake: set roller tester to axle mode. • For spring brake: set roller tester to side-by-side mode.
Load sensing characteristics when the trailer is stationary To check the service brake delivery pressure characteristics by iEBS for the unladen or laden condition with pressure gauges.	• Connect a fine pressure control valve and pressure gauge to the yellow coupling head (p_m). Set the pressure to 6.5 bar. • Connect a 3/2 way test port to iEBS port 5. • Connect a fine pressure control valve and pressure gauge to port 5 of iEBS. Set the pressure value to unladen (manufacturers input). • Connect a pressure gauge to the "Brake cylinder" test port. • Supply the trailer with electrical power. • Apply 6.5 bar to p_m and record the pressure gauge value of the brake cylinder. • p_m set to 0 bar, slowly increase the pressure value towards laden (manufacturers input) to port 5 by using the fine control valve. • Apply 6.5 bar to p_m and record the pressure gauge values of the brake cylinder.

Simulations

Simulate what?	What must be done?
Laden trailer	The laden condition on the trailer can be simulated either: • By means of the raise/lower valve (i.e., RSV, TASC, eTASC, ECAS), lower the trailer onto bumper (set air suspension load bellows to <0.15 bar) - or, • By connecting a test valve to port 5 of the PDM and simulate "laden" bellows pressure - or, • Simulate laden condition via the iEBS diagnostic software, from tab Control > Measured value simulation. ECAS trailer simulation: A 3/2 way test connection that features an integrated directional control valve (PN 463 710 998 0) to be installed to port 5 of the PDM in order to simulate a "laden" status if necessary. Please note: Reconnect plug "axle load sensor".
Lowering the lift axle(s) of the unladen trailer.	Set air suspension load bellows to <0.15 bar: • Vent the load bellows using the rotary slide valve. • Connect a pressure simulation to port 5 of the PDM. • iEBS diagnostic software.
Test mode for checking the LSV characteristic. The emergency braking function and standstill function are switched OFF in test mode.	Switch the ignition ON and OFF 3 times with a power ON interval between 0.5 and 3 seconds to activate the test mode. Trailer must be stationary and no pressure at the coupling head. Please note: Test mode is switched OFF when the trailer is moved at faster than 2.5 km/h or no later than after 10 minutes.

Simulate what?	What must be done?
Verify automatic application of the Emergency Brake	• Connect a pressure gauge to the test port of the spring brake actuator (port 12). • Charge the trailer to 7.0 bar supply pressure. • Release the parking brake of the trailer by pushing the red knob of the PRV to driving position, aligning the black indicator with the red knob. • Disconnect the supply coupling head to activate the emergency brake. • The pressure gauge reading shall drop to 0 bar. This verifies that the emergency brake function is correctly working, otherwise, check the assignment of the pneumatic lines from the PRV to the PDM, check section "PRV Installation" on page 50
Verify application of the Parking Brake	• Connect a pressure gauge to the test port of the spring brake actuator (port 12). • Charge the trailer to 7.0 bar supply pressure. • Assuming the PRV is in driving position: Apply the parking brake by pulling the red knob (black indicator inside the red knob). The pressure gauge reading shall drop to 0 bar. This verifies that the parking brake function is correctly working, otherwise, check the assignment of the pneumatic lines from the PRV to the PDM, check section "PRV Installation" on page 50

8.5 Replacement and repair

General safety instructions

- Only qualified personnel of a specialist workshop are authorized to perform repair work on a trailer.
- Always abide by the trailer manufacturer's specifications and instructions.
- Put special attention to the warnings and recommendations before carrying out electrical welding work on the trailer.
- Always comply with the company's accident prevention regulations as well as national regulations.
- Use protective equipment if required.

Replacing the iEBS modulator

- Connect the iEBS modulator to the system diagnostic and read out parameter setting (save them in the diagnostic computer).
- Disconnect the truck-trailer interface. Unplug the ISO 7638 electrical connection and pneumatic coupling heads (supply and control).
- Clean the pipes and the device. Remove any dirt and paint residues from all ports.
- Label the pipes and cables connections to the iEBS modulator. Take a picture to ease the connection and ensure right port allocation of the iEBS modulator during replacement.
- Release the pipes according to the procedure, see section "Tubes releasing procedure" on page 193.
- Unscrew the 3 bolts and take the iEBS modulator out of its position.
- Dispose the iEBS modulator according to your national regulation. Further information about disposal of the device can be found in chapter "8.8 Disposal / recycling guide", page 209.
- Replace the iEBS modulator. Install the iEBS modulator according to the installation guide. See chapter "6 Installation guide", page 188.
- Check the pipes for damage before reinserting into the fitting connection. Shorten the pipe if any creases or grooves can be observed (right angled, deviation of 15°).
- Mark the insertion depth on the pipe according to the details on the chart, e.g., using adhesive tape.
- Push the tube into the fitting connection until the marking reaches the edge of the fitting connection.
- Check if the pipe has a tight fit by pulling on the pipe (20 - 50 N).
- Set up the iEBS modulator according to the start-up procedure, See chapter "7 Start-up", page 194.

Repair kits

Repair solutions can be found by use of the device number in the Customer Centre web page. Service and repair.

- Go to https://www.wabco-customercentre.com/
- Insert the part number in the search bar and select the device
- Go to "service and repair" section to check the repair kits available for the product

NOTICE

Dismantling of the device is possible only according to the repair instructions and by using genuine repair kits. Further dismantling, or repair of the device, or its fittings is not permitted.

8.6 Truck/trailer harmonization

The iEBS diagnostic software features the "Advanced Response" tab that will help to fine-tune the compatibility between truck and trailer.

⚠ CAUTION

Interferences into the brake settings are not accepted to compensate weak brakes.

Change the braking pressures only if the wheel brakes are in good condition and the pads have recently been replaced.

Checking the response pressures

In order to exclude faulty wheel brake functionality, the response pressures have to be checked first:

Measure the braking forces of all axles on a roller test stand and determine the position of the individual trailers.

- For trailers the following values should be reached "unladen" and "laden":
- p_m = 0.7 bar = Beginning of brake engagement
- 2.0 bar = deceleration approx. 12 %
- 6.5 bar = deceleration approx. 55 %

If the start of braking is above 0.8 bar, the response pressures on all the wheel brakes must be measured.

Check the response pressures of all wheel brakes

- Provide the trailer with compressed air and power
- Connect the iEBS diagnostic software
- Click Actuation, Default pressure
- Jack up the trailer (1st axle)
- Simulate the bellow pressure for the laden trailer
- Turn one wheel and increase the control pressure in 0.1 bar steps (left and right cursor keys)
- Determine the braking pressure (cylinder pressure not control pressure!) at which the wheel becomes difficult or impossible to turn
- Repeat the test on the other wheels
- Calculate the average value of the determined response pressures and compare this value with the parameterized value

⇨ You may need to set the newly determined value in the parameters

Example

Defined response pressure = 0.3 bar

measured:

1st axle right = 0.6 bar; 2nd axle right = 0.5 bar; 3rd axle right = 0.5 bar

1st axle left = 0.5 bar; 2nd axle left = 0.5 bar; 3rd axle left = 0.6 bar

Mean response pressure = 0.53 bar => rounded down to 0.5 bar

The difference between the two values of 0.2 bar must be added to the braking pressures.

In this example the laden braking pressures would be adjusted thus:

- From 0.3 bar to 0.5 bar
- From 1.2 bar to 1.4 bar
- From 6.2 bar to 6.4 bar
- and the unladen braking pressure from 1.3 to 1.5 bar

⚠ CAUTION

Any modifications to the control - and braking pressures may lead to a loss of warranty.

Only deviate up to a maximum of 0.2 bar from values given in the brake calculation (parameter setting of the manufacturer). Otherwise a new brake calculation must be generated.

Contact your trailer manufacturer in this case.

Creating an advanced response

An advance response allows to adjust the braking parameter by increasing or reducing the brake pressure outcome. A positive value adjustment allows the trailer to brake earlier. A negative value adjustment causes the trailer to brake later.

The advance response can be set in the tab "Brake" of a system parameterization. The field "Enter Brake Data" is used to configure an advanced brake response. The advance response can be set to a value up to ± 0.2 bar (0 bar is defined as the default value).

Document the changes by a print-out of the system label sheet. Further information in chapter "7.3 iEBS trailer data plate", page 198.

Further information

More detailed information about truck/trailer harmonization can be found in the following publication.

Publication	QR code
Truck/Trailer Harmonization - Course	

8.7 Guidelines for trailer builders

This section provides reference to the following topics

Basic considerations	Comments	Referral
Pneumatic pipes	Nylon pipes according to DIN 74324 / ISO 7628	See chapter "6.4 Pneumatic piping", page 192
Torque settings	iEBS modulator	See chapter "6.2 Installation on the trailer", page 188
	Park Release Valve (PRV)	See chapter "3.1.1.1 Park Release Valve (PRV)", page 49
Cables	Power and component cables installation	See section "Cable fixation" on page 191
Electrostatic Discharging & contact corrosion	Proper bracket support material selection and mounting	See section "Avoid electrostatic charge and uncontrolled discharging (ESD):" on page 11
Test and certifications	RDW and TÜV reports	See section "Approval reports and standards" on page 18

8.8 Disposal / recycling guide

- Dispose of used parts in line with the applicable legal requirements in your country.
- You can also return your used parts and receive a deposit.
  You can find more information on the return procedure for used parts here:

Description	QR code
Core return	

9 ZF contact

Description	QR code
You can find your local ZF contact on the following page: Contact us	

10 Appendix

10.1 iEBS variants

The iEBS part number consist of 10 digits that represent the following information about the product:

- The first 6 digits (480 102) are the product family number for EBS modulators
- The 7th digit represents the variant (1 = Basic Steel, 2 = Basic Air, 3 = Standard, 4 = Premium)
- The 8th digit represents the status of the integrated functions (0 = disabled, 1 = enabled)
- The 9th digit represents the PDM variant
  (PDM port description can be found in chapter "10.4.2 Pneumatic connections for iEBS", page 213)
- The 10th digit (0) informs that the product is a completely new device.

Outline drawing for the iEBS modulator

Go to www.wabco-customercentre.com/catalog

Search for the iEBS modulator by entering the part number (e.g., 480 102 201 0) in the search box.

Select the product from the results to be directed to the details of the device.

The outline drawing can be found under the reference image of the product or in the documents section.

Part number						PDM type (x)
Basic Steel	Basic Air	Standard		Premium		
	480 102 201 0	480 102 301 0	480 102 311 0	480 102 401 0	480 102 411 0	1
	480 102 202 0	480 102 302 0	480 102 312 0	480 102 402 0	480 102 412 0	2
	480 102 203 0	480 102 303 0	480 102 313 0	480 102 403 0	480 102 413 0	3
480 102 105 0		480 102 305 0		480 102 405 0		5

10.2 Warning light signals

All faults are displayed according to its severity. The severity of errors is grouped as follow:

Class type	Severity	Signal light	Warning description	Actions to be taken
Class 0	High	Red and yellow	Indicates braking system faults (this includes a warning when the reservoir pressure is below 4.5 bar). The warning signal is actively present until the reset of the trailer iEBS modulator by switching OFF the ignition.	Stop the vehicle and call for service. Full braking power might not be available.
Class 1	Medium	Yellow	Indicates deactivation of partial functions (e.g., ABS). The warning signal is actively present until the reset of the trailer iEBS modulator by switching OFF the ignition.	Repair as soon as possible
Class 2	Minor	Yellow	Indicates minor faults if present (e.g., short CAN communication interruption between truck and trailer).	Repair at next service interval
Class 3	Minor	Yellow (flashing)	Indicates deactivation of GIO functions (such as speed signal). The warning signal is active after ignition ON and until the trailer exceeds 10 km/h. The respective function is switched OFF.	Repair at next service interval

⚠ CAUTION

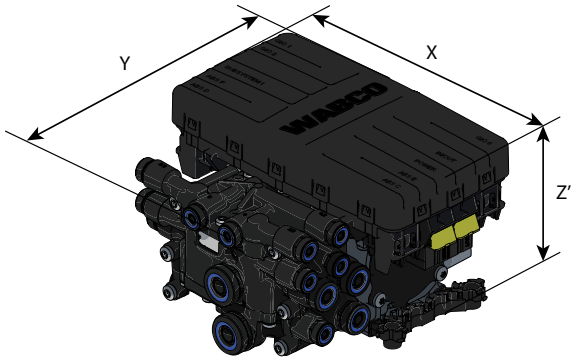
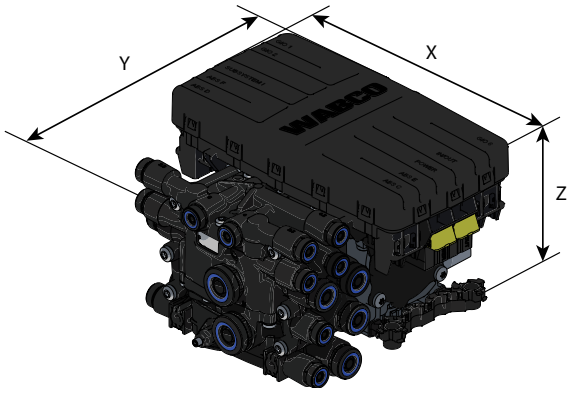
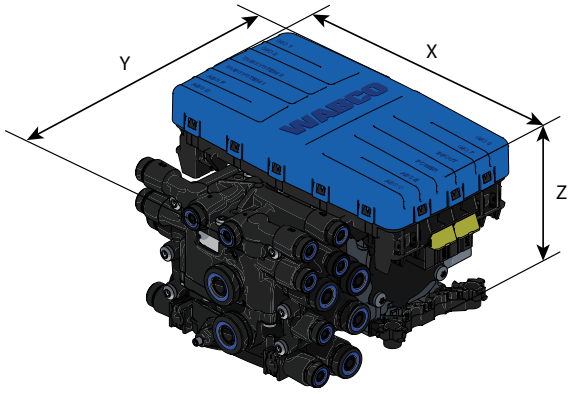
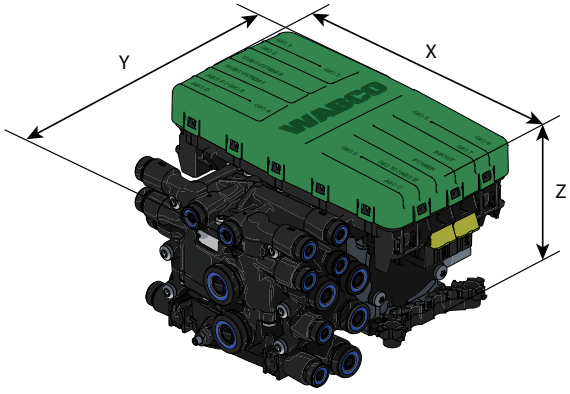
In the event a warning occurs, the trailer should be serviced at the next workshop. Drivers must be informed accordingly.

10.3 iEBS modulator specifications

Technical data of the iEBS modulator

Permissible maximum temperature	+65 °C permanent; +110 °C for 1 hour with no function
Reverse polarity protection	The system is protected against reverse polarity of the towing vehicle battery.
Undervoltage (terminal 30, terminal 15, 24N)	< 19 V for 24 V operation (9.5 V Multi-Voltage in 12 V operation)
Overvoltage (terminal 30, terminal 15, 24N)	> 30 V
Nominal voltage (terminal 30, terminal 15, 24N)	24 V (12 V Multi-Voltage in 12 V operation)
Regular power consumption for braking system	3.5 A for 2M system , 5 A for 3M system
Maximum overall input current for Basic Variants	7 A
Maximum overall input current for Standard Variants	10 A
Maximum overall input current for Premium Variants	10 A
GIO power stage (for each available GIO)	1.5 A maximum (2 A peak for no longer than 5 s)
SUBSYSTEMS I & II power stage	3 A maximum each (6 A maximum for both SUBSYSTEMS at the same time)
Nominal operating pressure (supply)	9 bar ± 0.2 bar

Dimensions of the iEBS modulator

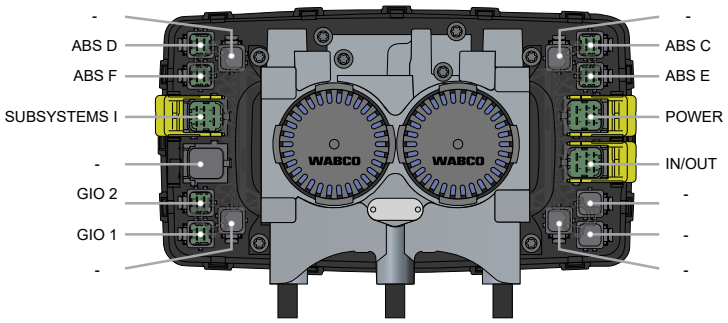
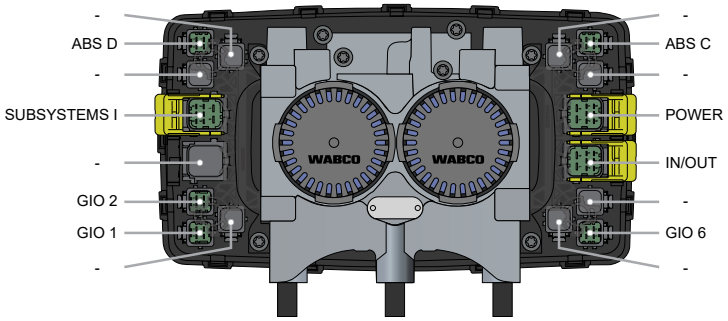
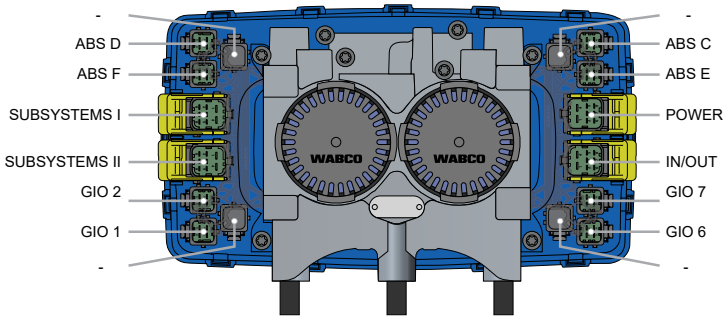
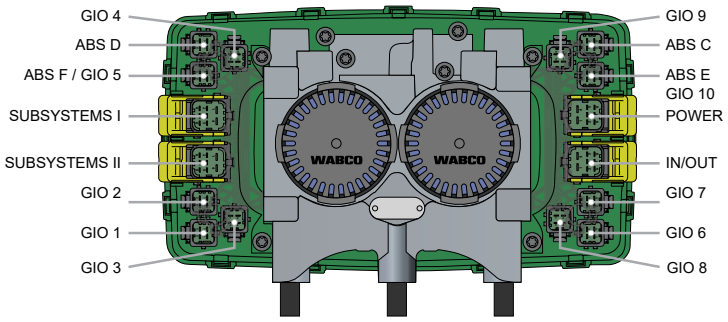
Basic Steel	Basic Air
	
Standard	**Premium**
	
Width (X): 257 mm / Depth (Y): 220 mm / Height (Z'): 165.2 mm / Height (Z): 169.5 ± 2 mm	

10.4 Connections

10.4.1 Electric connections

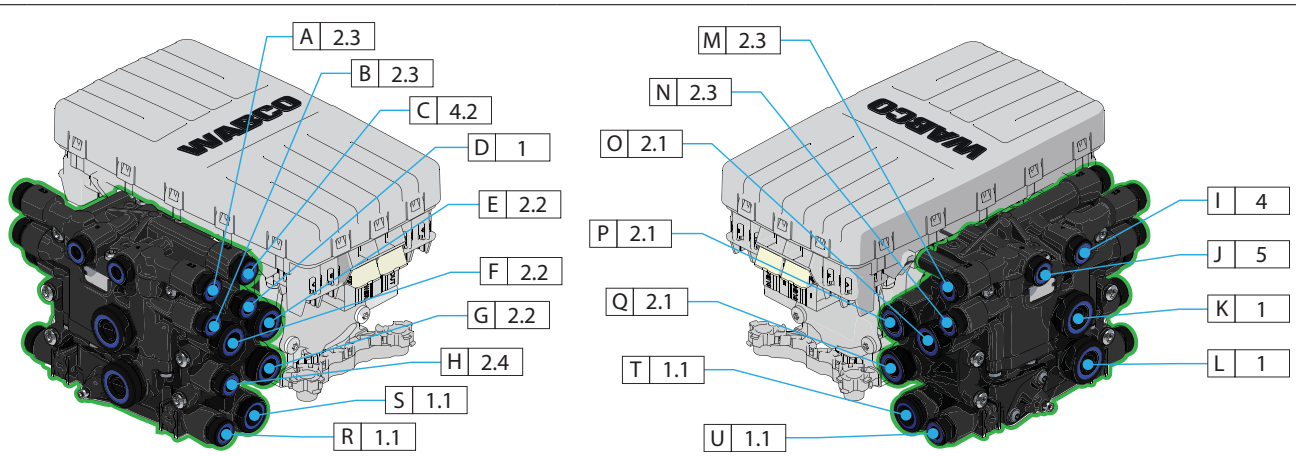
The electrical connections are clearly indicated on the top side of the iEBS modulator. The cables are inserted from the bottom. Appropriate cables are dependent on the connected component, see section "Cable overview" on page 217.

The connector coding prevents making an incorrect connection. Coding and pins are described in detail in the appendix.

	Socket description	Socket assignment - iEBS modulator bottom view
iEBS Basic Steel	1x Power port 1x IN/OUT port 1x SUBSYSTEMS port 2x GIO ports 4x ABS ports	
iEBS Basic Air	1x Power port 1x IN/OUT port 1x SUBSYSTEMS port 3x GIO ports 2x ABS ports	
iEBS Standard	1x Power port 1x IN/OUT port 2x SUBSYSTEMS ports 4x GIO ports 4x ABS ports	
iEBS Premium	1x Power port 1x IN/OUT port 2x SUBSYSTEMS ports 10x GIO ports 4x ABS ports	

The electrical connection ports for POWER, ABS D and ABS C have no protective plugs.

10.4.2 Pneumatic connections for iEBS



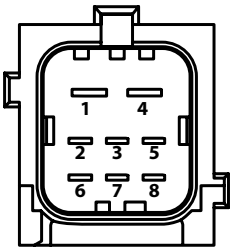
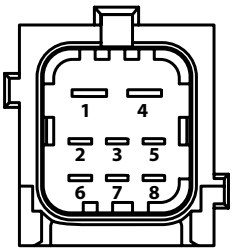
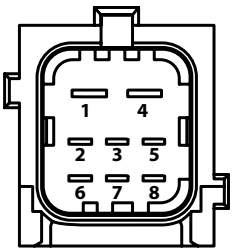
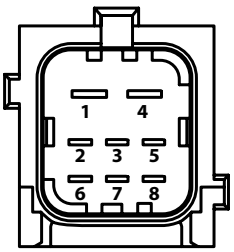
#	Port	Purpose description	PDM			
			Nr 1	Nr 2	Nr 3	Nr 5
A	2.3	Spring brake actuator - port 12 of TriStop cylinder	8x1	8x1	8x1	8x1
B	2.3		8x1	8x1	8x1	8x1
C	4.2	Park brake control - port 2 of PRV	8x1	8x1	8x1	8x1
D	1	Supply - port 1-2 PRV	8x1	8x1	8x1	8x1
E	2.2	Service brake actuator	12x1.5	12x1.5	12x1.5	12x1.5
F	2.2		12x1.5	12x1.5	12x1.5	12x1.5
G	2.2		12x1.5	12x1.5	12x1.5	12x1.5
H	2.4	Test connection for brake pressure	8x1	Closed	8x1	8x1
I	4	Control line - yellow coupling head	8x1	8x1	8x1	8x1
J	5	Air suspension bellows	8x1	8x1	8x1	Closed
K	1	Brake reservoir	16x2	15x1.5	15x1.5	15x1.5
L	1		16x2	15x1.5	15x1.5	15x1.5
M	2.3	Spring brake actuator - port 12 of TriStop cylinder	8x1	8x1	8x1	8x1
N	2.3		8x1	8x1	8x1	8x1
O	2.1	Service brake actuator	12x1.5	12x1.5	12x1.5	12x1.5
P	2.1		12x1.5	12x1.5	12x1.5	12x1.5
Q	2.1		12x1.5	12x1.5	12x1.5	12x1.5
R	1.1	Supply for air suspension	8x1	8x1	8x1	-
S	1.1		8x1	8x1	12x1.5	-
T	1.1		8x1	8x1	12x1.5	-
U	1.1		8x1	8x1	8x1	-

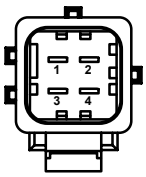
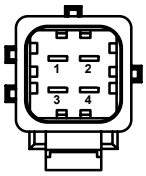
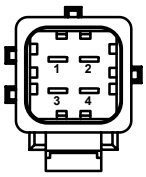
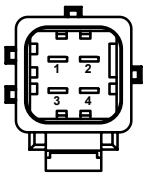
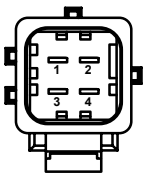
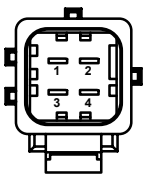
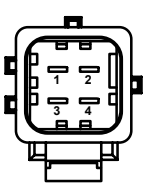
NOTICE

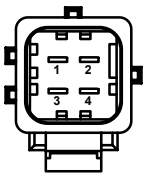
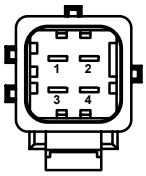
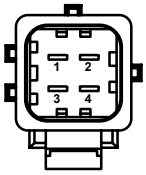
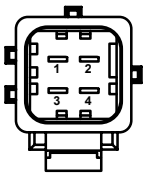
Dismantling of the device is possible only according to the repair instructions and by using genuine repair kits. Further dismantling, or repair of the device, or its fittings is not permitted.

10.5 Pin assignment for iEBS

iEBS modulator

Connections	Pin	Pin description	Basic Steel	Basic Air	Standard	Premium
POWER, 8-pin Code A						
	1	Steady positive voltage / Terminal 30	✓	✓	✓	✓
	2	Ignition / Terminal 15	✓	✓	✓	✓
	3	Ground warning lamp	✓	✓	✓	✓
	4	Ground valves	✓	✓	✓	✓
	5	Warning lamp	✓	✓	✓	✓
	6	CAN High 24 V	✓	✓	✓	✓
	7	CAN Low 24 V	✓	✓	✓	✓
SUBSYSTEMS I, 8-pin Code B						
	1	Power	✓	✓	✓	✓
	2					
	3					
	4	Ground (GND)	✓	✓	✓	✓
	5	CAN High 5 V	✓	✓	✓	✓
	6	LIN				✓
	7	LIN				✓
	8	CAN Low 5 V	✓	✓	✓	✓
SUBSYSTEMS II, 8-pin Code B						
	1	Power			✓	✓
	2					
	3					
	4	Ground (GND)			✓	✓
	5	CAN High 5 V			✓	✓
	6	LIN				✓
	7	LIN				✓
	8	CAN Low 5 V			✓	✓
IN/OUT, 8-pin Code D						
	1	Stop light supply	✓	✓	✓	✓
	2	Analog input		✓	✓	✓
	3	Analog input				✓
	4	Stop light ground	✓	✓	✓	✓
	5	Analog input		✓	✓	✓
	6	Marker lights (left & right)				✓
	7	GIO output stage				✓
	8	Ground (GND)		✓	✓	✓

Connections	Pin	Pin description	Basic Steel	Basic Air	Standard	Premium
ABS C & ABS D, Code A						
	1					
	2					
	3	ABS WSS	✓	✓	✓	✓
	4	ABS WSS	✓	✓	✓	✓
ABS E & GIO10, Code A/B						
	1	GIO output stage				✓
	2	Ground (GND)				✓
	3	ABS WSS	✓		✓	✓
	4	ABS WSS	✓		✓	✓
ABS F & GIO5, Code A/B						
	1	GIO output stage				✓
	2	Ground (GND)				✓
	3	ABS WSS	✓		✓	✓
	4	ABS WSS	✓		✓	✓
GIO1, Code B						
	1	GIO output stage	✓	✓	✓	✓
	2	Ground (GND)	✓	✓	✓	✓
	3	Analog input	✓	✓	✓	✓
	4	PWM for height sensor	✓		✓	✓
GIO2, Code B/C						
	1	GIO output stage	✓	✓	✓	✓
	2	Ground (GND)	✓	✓	✓	✓
	3	CAN Low 5 V			✓	✓
	4	CAN High 5 V			✓	✓
GIO3, Code B						
	1	GIO output stage				✓
	2	Switchable ground				✓
	3	Analog / proximity switch				✓
	4	GIO output stage				✓
GIO4, Code B						
	1	GIO output stage				✓
	2	Ground (GND)				✓
	3	Analog input				✓
	4	GIO output stage				✓

Connections	Pin	Pin description	Basic Steel	Basic Air	Standard	Premium
GIO6, Code B						
	1	GIO output stage			✓	✓
	2	Ground (GND)		✓	✓	✓
	3	Analog / proximity switch		✓	✓	✓
	4	GIO output stage			✓	✓
GIO7, Code B						
	1	GIO output stage			✓	✓
	2	Switchable ground			✓	✓
	3	GIO output stage				✓
	4	GIO output stage			✓	✓
GIO8, Code B/D						
	1	GIO output stage				✓
	2	Ground (GND)				✓
	3	GIO output stage				✓
	4	GIO output stage				✓
GIO9, Code B						
	1	GIO output stage				✓
	2	Ground (GND)				✓
	3	Analog input				✓
	4	PWM for height sensor				✓

10.6 Cable overview

The electrical cables of the peripheral devices are based on a new design that are ready-to-use and easy to install. Cables are designed with different point-to-point connector configurations, colors and coding to avoid mismatching. The vertically secure connection to the iEBS modulator (8 and 4 pin connectors facing upwards) will fulfil the water and dirt protection level IP6K9K.

Outline drawing for cables

Go to www.wabco-customercentre.com/catalog

Search for the cable by entering the cable number (e.g., 449 175 120 0) in the search box.

Select the product from the results to be directed to the details of the device.

The outline drawing can be found under the reference image of the product or in the documents section.

⚠ CAUTION

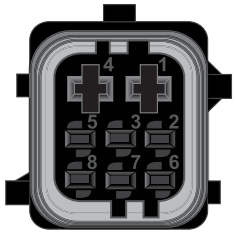
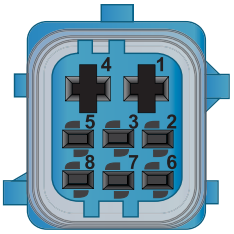
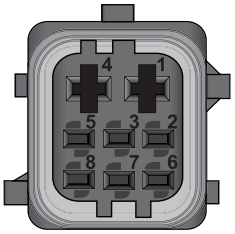
Malfunctions in components and damages to components by crossing the cables are possible.

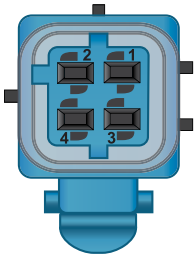
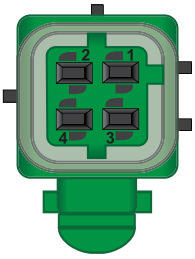
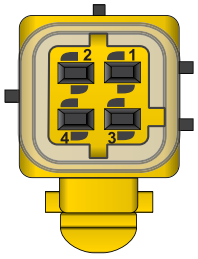
Due to the similar appearance between the cables, it is necessary to identify the cable from the product number and make sure that the proper cables are connected to the right component.

This wide range of different cables is necessary because the components to be connected have completely different pin assignments and the cables must not be interchanged, even if they look alike. A precise identification is necessary to rule out malfunctions and damage to components.

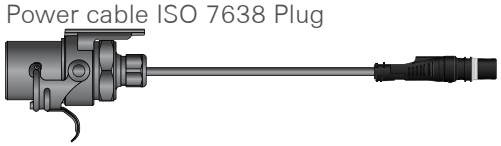
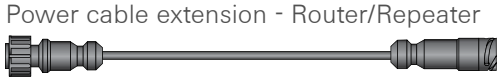
Color and coding of the connectors

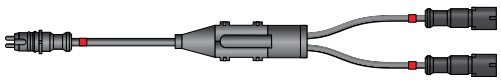
The connectors are colored and coded for better orientation.

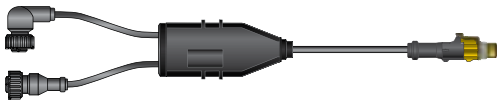
8-pin connectors		
Power - Black	SUBSYSTEMS - Light blue	IN/OUT - Grey
		

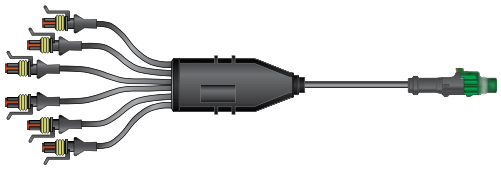
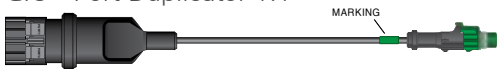
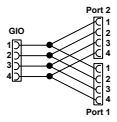
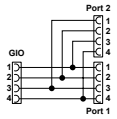
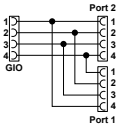
4-pin connectors		
ABS sensor - Light blue	Standard GIO - Green	3rd modulator GIO - Yellow
		

10.6.1 iEBS cable list

Application / Cable drawing	Part number	Length	Connect from	Connect to
Power cable ISO 7638 socket (with fuse) 	449 174 080 0 449 174 100 0 449 174 120 0 449 174 150 0	8 m 10 m 12 m 15 m	Coiled cable from truck (Semitrailer)	iEBS Power port
			For further information about this cable and the fuse exchange instructions please refer to www.zf.com/fuse	
Power cable ISO 7638 socket 	449 175 080 0 449 175 100 0 449 175 120 0 449 175 130 0 449 175 140 0 449 175 150 0	8 m 10 m 12 m 13 m 14 m 15 m	Coiled cable from truck (Semitrailer)	iEBS Power port
Power cable ISO 7638 Plug 	449 275 060 0 449 275 100 0 449 275 120 0 449 275 150 0 449 275 160 0	6 m 10 m 12 m 15 m 16 m	Truck interface (Drawbar)	iEBS Power port
Power cable - split type 	449 133 003 0 449 133 030 0 449 133 060 0 449 133 120 0 449 133 150 0	0.3 m 3 m 6 m 12 m 15 m	Coiled cable from truck (Semitrailer)	Split cable:449 309 . . . 0 Router: 446 122 050 0 446 122 056 0 Repeater: 446 122 051 0
Power cable - split type 	449 135 005 0 449 135 025 0 449 135 060 0 449 135 140 0	0.5 m 2.5 m 6 m 14 m	Coiled cable from truck (Semitrailer)	Not compatible with the cable 449 309 . . . 0 Router: 446 122 050 0 446 122 052 0 446 122 054 0 446 122 056 0 Repeater: 446 122 053 0
Power cable - split type 	449 233 030 0 449 233 100 0 449 233 140 0 449 233 180 0	3 m 10 m 14 m 18 m	Truck interface (Drawbar)	Split cable:449 309 . . . 0 Router: 446 122 050 0 446 122 052 0 446 122 054 0 446 122 056 0 Repeater: 446 122 053 0
Power cable - split type 	449 231 060 0 449 231 120 0	6 m 12 m	Truck interface (Drawbar)	Not compatible with the cable 449 309 . . . 0 Router: 446 122 050 0 446 122 056 0 Repeater: 446 122 051 0
Power split cable - modulator side 	449 309 005 0 449 309 030 0 449 309 080 0 449 309 100 0	0.5 m 3 m 8 m 10 m	Power cable - split type	iEBS Power port
Power cable extension - Router/Repeater 	894 600 049 0 894 600 051 0 894 600 032 0 894 600 033 0 894 600 034 0	20 m 30 m 40 m 50 m 60 m	Router/Repeater	Split cable:449 309 . . . 0

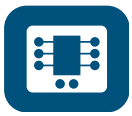
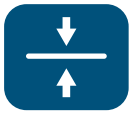
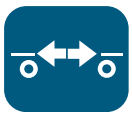
Application / Cable drawing	Part number	Length	Connect from	Connect to
SUBSYSTEMS - Diagnostic socket 	449 607 020 0 449 607 040 0	2 m 4 m	Diagnostic interface (CAN 5 V) via: 446 300 348 0	iEBS SUBSYSTEMS port
SUBSYSTEMS - OptiTire / SCALAR EVO Pulse 	449 928 020 0 449 928 050 0 449 928 120 0 449 928 150 0	2 m 5 m 12 m 15 m	OptiTire SCALAR EVO Pulse	iEBS SUBSYSTEMS port
SUBSYSTEMS - SmartBoard 	449 929 040 0 449 929 060 0 449 929 120 0	4 m 6 m 12 m	SmartBoard	iEBS SUBSYSTEMS port
SUBSYSTEMS - SCALAR EVO Guard 	449 936 050 0	5 m	SCALAR EVO Guard	iEBS SUBSYSTEMS port
SUBSYSTEMS - Telematics 	449 921 010 0 449 921 120 0 449 921 170 0	1 m 12 m 17 m	3rd party telematics	iEBS SUBSYSTEMS port
SUBSYSTEMS - Port duplicator 	894 600 161 2	0.5 m	SUBSYSTEMS devices	iEBS SUBSYSTEMS port
SUBSYSTEMS - TailGUARD sensors 	449 839 030 0 449 839 060 0	3 m 6 m	Joins with cable: 894 600 024 0 449 747 . . . 0	iEBS SUBSYSTEMS port
Splitter cable for TailGUARD sensors 	894 600 024 0	0.5 m	Joins with cable: 449 839 . . . 0 449 747 . . . 0	TailGUARD sensor or 449 747 . . . 0
Extension cable for TailGUARD sensors 	449 747 060 0	6 m	Joins with cable: 894 600 024 0 449 747 . . . 0	TailGUARD sensor or 449 747 . . . 0
IN/OUT - Open end for 24N 	449 321 040 0 449 321 060 0 449 321 100 0 449 321 150 0	4 m 6 m 10 m 15 m	Open end / 2-pin Pin 1 - Blue Pin 4 - Brown	iEBS IN/OUT port
IN/OUT - Bayonet for 24N and switches 	449 361 010 0 449 361 060 0 449 361 090 0	1 m 6 m 9 m	24N Interface with switches	iEBS IN/OUT port
IN/OUT - Cable with open end 	449 838 040 0 449 838 060 0 449 838 100 0 449 838 150 0	4 m 6 m 10 m 15 m	Pin 1 - Red Pin 2 - Black Pin 3 - Yellow Pin 4 - Brown Pin 5 - White Pin 6 - Green/white Pin 7 - Violet Pin 8 - Blue	iEBS IN/OUT port

Application / Cable drawing	Part number	Length	Connect from	Connect to
GIO - eTASC 	449 403 010 0 449 403 030 0 449 403 050 0 449 403 060 0	1 m 3 m 5 m 6 m	eTASC	GIO port 7 GIO port 3
GIO - LACV & TASC (RtR) valves 	449 408 008 0 449 408 010 0 449 408 020 0 449 408 040 0 449 408 060 0 449 408 100 0 449 408 120 0	0.8 m 1 m 2 m 4 m 6 m 10 m 12 m	TASC LACV	Default ports: GIO port 1 (TASC) GIO port 2 (LACV)
GIO - Bayonet + EBS 3rd modulator 	449 414 010 0 449 414 030 0 449 414 080 0 449 414 130 0	1 m 3 m 8 m 13 m	EBS 3rd modulator	GIO port 8
GIO - ECAS 2-points valve 	449 508 030 0 449 508 050 0	3 m 5 m	ECAS 2-point valve	GIO port 7 GIO port 3
GIO - ECAS and LACV-IC valve 	449 509 010 0 449 509 030 0 449 509 050 0 449 509 060 0	1 m 3 m 5 m 6 m	ECAS single block LACV-IC	GIO port with: Pin 1: GIO output stage Pin 2: Ground (GND) Pin 4: GIO output stage
ABS Sensor extension 	449 733 013 0 449 733 018 0 449 733 023 0 449 733 030 0 449 733 040 0 449 733 050 0 449 733 060 0 449 733 070 0 449 733 080 0 449 733 090 0 449 733 100 0 449 733 120 0 449 733 150 0	1.3 m 1.8 m 2.3 m 3 m 4 m 5 m 6 m 7 m 8 m 9 m 10 m 12 m 15 m	ABS sensor	ABS port of iEBS
GIO - Pressure sensor 	449 826 010 0 449 826 030 0 449 826 040 0 449 826 080 0 449 826 100 0 449 826 180 0	1 m 3 m 4 m 8 m 10 m 18 m	Pressure sensor	Default port: GIO port 1 (Standard) GIO port 3 (Premium)
			EBS relay valve's pressure sensor	Default port: GIO port 9 (Premium)
GIO - Height sensor 	449 829 010 0 449 829 030 0 449 829 050 0 449 829 080 0 449 829 120 0	1 m 3 m 5 m 8 m 12 m	Height sensor	GIO port 1 GIO port 9
GIO - Universal cable 	449 827 010 0 449 827 030 0 449 827 060 0 449 827 100 0 449 827 180 0	1 m 3 m 6 m 10 m 18 m	Pin 1 - Red Pin 2 - Brown Pin 3 - Green Pin 4 - Yellow	GIO port (Subject to application) Refer to section "GIO connection logic" on page 130

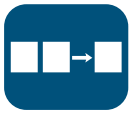
Application / Cable drawing	Part number	Length	Connect from	Connect to
GIO - Traction Help 	449 831 050 0 449 831 080 0 449 831 120 0 449 831 150 0	5 m 8 m 12 m 15 m	Switch or Push button Pin 2 - Brown (Ground) Pin 3 - Black (Positive)	GIO port with: Pin 2: Ground (GND) Pin 3: Analog / Proximity switch
GIO - Switch 	449 448 060 0	6 m	Switch	GIO port with: Pin 2: Ground (GND) Pin 3: Analog / Proximity switch
GIO - Wear indicator 	449 836 013 0 449 836 030 0	1.3 m 3 m	Wear indicator	GIO port with: Pin 1: GIO output stage Pin 2: Ground (GND)
GIO - Wear indicator (superseal connector) 	449 847 013 0 449 847 030 0	1.3 m 3 m	Wear indicator	GIO port with: Pin 1: GIO output stage Pin 2: Ground (GND)
GIO - Port Duplicator 1:1 	894 600 171 2	0.5 m	1:1 	Any available GIO port
GIO - Port Duplicator 1x3 	894 600 131 2	0.5 m	1x3 	Any available GIO port
GIO - Port Duplicator 1x4 	894 600 121 2	0.5 m	1x4 	Any available GIO port
GIO - Green warning lamp 	449 940 060 0 449 940 100 0	6 m 10 m	Green lamp	GIO port with: Pin 1: GIO output stage Pin 2: Ground (GND)

10.7 Intelligent Trailer Program, functions overview

Functions		Description	Basic steel	Basic Air	Standard	Premium
Advanced Safety						
	Anti-Lock Braking Function (ABS)	Anti-Lock Braking function (ABS) optimizes trailer control during emergency braking by preventing wheels from locking tendency. See chapter "Anti-Lock Braking function (ABS)" on page 89.	✓	✓	✓	✓
	Rollover Stability Support (RSS)	Rollover Stability Support (RSS) automatically brakes the trailer when it threatens to rollover during cornering. It helps to stabilize the trailer within the physical limits, significantly reducing the risk of rollover. See chapter "Rollover Stability Support (RSS)" on page 98.	✓	✓	✓	✓
	Router & Repeater	Router and Repeater reinforce the electrical control signal for extra-long trailers and trailer combinations. See chapter "Router / Repeater" on page 83.	✓	✓	✓	✓
	Emergency Brake Alert	Brake lights start flashing automatically during emergency braking to alert following vehicles. Note: An additional separate brake light is required. Function not covered in this document			✓	✓
	TiltAlert	When the tipper reaches a critical tilting angle, TiltAlert warns the driver to prevent the tipper from tilting over. Increasing the safety procedure when unloading. See chapter "Tilt Alert" on page 170.			✓	✓
	SafeStart	SafeStart keeps a trailer stationary (e.g., during loading process) or brakes the moving trailer to prevent critical situations (e.g., when a driver ignores a lifted tub on a tipper). See chapter "SafeStart" on page 171.			✓	✓
	Bounce Control	Bounce Control prevents damage to trailer and loading dock by controlled release of the trailer brakes. See chapter "Bounce Control" on page 166.				✓
	TailGUARD	Rear blind spot detection system that can automatically brake the trailer during reversing. Function not covered in this document				✓

Functions		Description	Basic steel	Basic Air	Standard	Premium
Driver comfort & Effectiveness						
	SmartBoard	An easy-to-use control pad that provides the driver with access to key trailer information and also allows operation of air suspension functions. See chapter "SmartBoard™" on page 76.	✓	✓	✓	✓
	Return-to-Ride	Automatically returns the trailer to normal driving height when starting to drive after leaving a loading dock. See chapter "Return-to-Ride function (RtR)" on page 145.		✓	✓	✓
	Traction Help	Traction Help lifts the trailer lift axle to increase the traction on the truck's driving axle, improving safety and operating efficiency on slippery surfaces and slopes. See chapter "Traction Help" on page 137.		✓	✓	✓
	Steering Axle Lock	Automatically locks the self-steering axle during reversing which will help to enable straight driving. Maintains trailer stability during high speed driving, also during reversing maneuvers for increased safety and comfort. See chapter "Steering axle lock" on page 180.			✓	✓
	Finisher Brake	Finisher Brake controls the trailer brakes to synchronize it to an asphalt finisher vehicle during unloading. Prevents asphalt spilling on uneven surfaces. See chapter "Road finisher brake function" on page 173.			✓	✓
	Trailer Extending Control	Trailer Extension Control quickly and safely simplifies the process of extending telescopic trailers See chapter "Trailer Extending Control" on page 187.				✓
Operational Efficiency						
	Operating Data Recorder	A trailer black box that records operating data including driver behavior, analysis and utilization to optimize maintenance planning, load capacity and fleet efficiency. See chapter "Operating Data Recorder (ODR)" on page 113.	✓	✓	✓	✓
	Advanced Multi-Voltage	Multi-Voltage simplifies truck-trailer operations by allowing the connection to 12 V and 24 V trucks to your trailer without a converter. See chapter "Multi-Voltage" on page 112.	✓	✓	✓	✓
	Telematics	ZF Trailer telematics solution boosts safety, security and efficiency through monitoring, reporting and analysis of all critical trailer data. See chapter "ZF Telematics" on page 80.	✓	✓	✓	✓

Functions		Description	Basic steel	Basic Air	Standard	Premium
	OptiLock	Electronic Locking System ELB-Lock Electronic high security locking system for trailer and container doors. For further information please refer to OptiLock - homepage	✓	✓	✓	✓
	Memory Level	A programmable memory for trailer height levels speeds up the unloading process and achieves optimum on-the-road efficiency and safety. See chapter "Memory level" on page 161.			✓	✓
	Notebook Memory	Important key trailer data that is stored in the memory of Trailer EBS for optimal service and support. Storing important information to the computer memory of the trailer braking system. See chapter "Notebook Memory function" on page 119.			✓	✓
	OptiLevel	Intelligent trailer height control that reduces trailer drag and air consumption when compared to conventional air suspension. See chapter "OptiLevel - Electronic Air Suspension Control" on page 152.			✓	✓
	Brake Lining Wear Indicator	Brake pad monitoring alerts the driver when the brake pads have reached a limited remaining life. See chapter "Brake lining wear indication" on page 175.			✓	✓
	Immobilizer	Secures the trailer with a unique PIN code locking system. Function not covered in this document			✓	✓
	Return-to-Load Level	Automatically maintain the trailer at the height of the loading bay during loading and unloading procedures. See chapter "OptiLevel - Electronic Air Suspension Control" on page 152.			✓	✓
	ServiceMind	ServiceMind allows for tracking operating hours of moving components and reminds of service intervals to minimize maintenance costs. See chapter "ServiceMind" on page 118.			✓	✓
	OptiTurn	OptiTurn improves trailer maneuverability on roundabouts and through sharp corners. See chapter "OptiTurn" on page 140.				✓

Functions		Description	Basic steel	Basic Air	Standard	Premium
Fuel & CO2 Reduction						
	OptiTire	Tire pressure monitoring system warns of over and under-inflation enhancing fuel economy and safety. See chapter "OptiTire™" on page 78.	✓	✓	✓	✓
	OptiFlow AutoTail	Automatically deploying rear fairing for trailers. See chapter "OptiFlow™" on page 151.	✓	✓	✓	✓
	OptiFlow Tail	Rear aerodynamic fairing for trailers, to reduce fuel consumption and CO2 emissions. OptiFlow Tail - home page	✓	✓	✓	✓
	OptiFlow SideWings	The proven aerodynamic side skirt for trailers reducing fuel consumption and the carbon footprint at highway speeds. OptiFlow SideWings - home page	✓	✓	✓	✓
	Lift Axle Control	Automatically lift axles when depending on load condition. See chapter "Lifting axle control" on page 132.		✓	✓	✓
	Fuel Saving Suspension	Automatically controls chassis height while driving allowing for improved stability and fuel economy. See chapter "OptiLevel - Electronic Air Suspension Control" on page 152.			✓	✓
	Overload Indicator	Continuously measuring load pressure of the air suspension, will automatically send a warning upon overloading, compared to the programmed data. See chapter "Overload detection" on page 178.			✓	✓
	OptiLoad	Automated load control to avoid overload on the fifth wheel Reducing risk of overload penalties and overload damage to your truck's rear axle. See chapter "OptiLoad" on page 142.				✓
	OptiLevel 2-Point	A level control system that automatically adjusts the trailer platform independently between left & right or front & rear. Keeps the trailer platform parallel to the ground when the cargo is unequally loaded. See chapter "OptiLevel - Electronic Air Suspension Control" on page 152.				✓
	Forklift Control	Keep your load balanced on central-axle trailers when a forklift is coupled or uncoupled. See chapter "Forklift control" on page 185.				✓

10.8 GIO schematic diagrams

GIO schematic diagrams
Search for the schematic by entering the diagram number (e.g., 841 803 000 0) in the search box.
Select the tab "PUBLICATIONS" to be redirected to the documents search results.
Click on "VIEW" to open the document

iEBS Modulator	Suspension Control	Lift Axle	Vehicle	Comments	Diagram number
Basic Air	Conventional	-	3 axle semitrailer	TASC 1C, LV, SS	841 803 000 0
Basic Steel	-	-	3 axle semitrailer	Height sensor for load sensing	841 803 001 0
Basic Air	Conventional	-	3 axle semitrailer	TASC 2C, LV, SS	841 803 002 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, SS	841 803 003 0
Basic Air	Conventional	1	3 axle semitrailer	RSV 2C, LACV, LV+HL, PB	841 803 004 0
Basic Air	Conventional	-	3 axle semitrailer	TASC 1C, LV	841 803 005 0
Basic Air	Conventional	-	3 axle semitrailer	TASC 2C, LV	841 803 006 0
Basic Air	Conventional	-	3 axle semitrailer	TASC 2C, LACV, LV	841 803 007 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, PB	841 803 008 0
Standard	Conventional	1	3 axle semitrailer	TASC 1C, LACV, LV, PB, SS	841 803 009 0
Standard	Conventional	1	3 axle semitrailer	TASC 1C, LACV, LV, PB, 3x SS.	841 803 010 0
Standard	Conventional	2	3 axle semitrailer	TASC 1C, 2x LACV, LV, 2x PB, SS	841 803 011 0
Standard	Electronically	1	3 axle semitrailer	eTASC 1C, LACV, PB, SS	841 803 012 0
Standard	Electronically	2	3 axle semitrailer	eTASC 1C, 2x LACV, PB, SS	841 803 013 0
Standard	Electronically	1	3 axle semitrailer	eTASC 1C, LACV-IC, PB, SS	841 803 014 0
Premium	Electronically	1	3 axle semitrailer	ECAS DB, PB, SS	841 803 015 0
Premium	Electronically	2	3 axle semitrailer	eTASC 1C, LACV, LACV-IC, PB, SS	841 803 016 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, 2x SS	841 803 017 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, PB, 2x SS	841 803 018 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, PB, 3x SS	841 803 019 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV+HL, PB, 2x SS	841 803 020 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV+HL, PB, SS	841 803 021 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, 2x SS	841 803 022 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV, SS	841 803 023 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 1C, LACV, LV, PB, 3x SS	841 803 024 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 1C, LACV, LV, 2x SS	841 803 025 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 1C, LACV, LV, SS	841 803 026 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV+HL, SS	841 803 027 0
Basic Air	Conventional	1	3 axle semitrailer	TASC 2C, LACV, LV+HL	841 803 028 0
Basic Steel	-	-	3 axle semitrailer	Height sensor for load sensing, 2xSS	841 803 029 0

Legend							
1C	Single-circuit	LV	Leveling valve	SS	SUBSYSTEMS	DB	Dual Block (ECAS+LACV-IC)

Legend							
2C	Dual-circuit	LV+HL	Leveling valve + Height limitation	PB	Push Button	RSV	Rotary Slide Valve

10.9 Brake diagrams

Brake diagrams
Search for the schematic by entering the diagram number (e.g., 841 710 000 0) in the search box.
Select the tab "PUBLICATIONS" to be redirected to the documents search results
Click on "VIEW" to open the document

Semitrailer, central axle and dolly trailers

Axle(s)	ABS system	Diagram number	Suspension type	Comment
3 to 4	4S/3M	841 710 000 0	Air	iEBS Premium with 3rd modulator
3 to 4	4S/3M	841 710 001 0	Air	Extra-long trailer with iEBS Premium with 3rd modulator and CAN repeater
2 to 3	2S/2M or 4S/2M	841 710 002 0	Air	All iEBS variants
3	2S/2M or 4S/2M	841 710 003 0	Air	Configuration with PREV
3	2S/2M + SLV	841 710 004 0	Air	Trailers with self-steering axles and select low valve
3	4S/2M	841 710 005 0	Mechanical	Mechanical suspension trailer with height sensor
3	2S/2M	841 710 006 0	Air	Inloader with single release valve configuration
3	2S/2M	841 710 007 0	Air	Inloader with double release valve configuration
3	4S/2M	841 710 008 0	Air	Inloader with single release valve configuration
3	2S/2M or 4S/2M	841 710 009 0	Air	All iEBS variants
2	4S/2M	841 710 010 0	Mechanical	Trailers with mechanical parking brake
3	4S/3M	841 710 011 0	Air	3rd modulator on rear axle
3	2S/2M + SLV ; 4S/2M + SLV	841 710 012 0	Air	Trailers with self-steering axles and select low valve. Self-steering axle equipped with unistop
3	2S/2M + SLV ;	841 710 013 0	Air	Trailers with self-steering axles and select low valve. Self-steering axle equipped with spring brake actuators (e.g. TriStop D)
2 to 3	2S/2M	841 710 014 0	Air	Lead trailer of a road train combination
2	2S/2M	841 710 015 0	Air	Dolly trailer for a road train combination
2 to 3	2S/2M	841 710 016 0	Air	Lead trailer of a road train combination. Router with pressure sensor
2	2S/2M	841 710 017 0	Air	Dolly trailer for a road train combination. Router with pressure sensor

Drawbar trailer

Axle(s)	ABS system	Diagram PN	Suspension type	Comment
1F1R	4S/3M	841 610 000 0	Air	With PREV
1F1R	4S/3M	841 610 001 0	Mechanical	Mechanical suspension with load sensing + PREV
2F2R ; 1F2R	2x 2S/2M	841 610 002 0	Air	Trailer equipped with 2 iEBS Modulators
3F3R	4S/3M	841 610 003 0	Air	Trailer equipped with 3rd modulator on front axle unit

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