# SYSTEMS AND COMPONENTS | for Buses



WABCO

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## Introduction

Complex mechanical and electrical systems are responsible for safety and comfort of the bus and its passengers. These must be serviced regularly and repaired professionally according to the wear.
Bus professionals are provided with a compact overview of the functionality and the product features for the individual system components in the "Technology around the bus" user brochure. The integrated service tips and maintenance instructions made the brochures into a practice-oriented reference and simplify the daily work in your workshop. Profit from our know-how and apply it selectively to provide your passengers with quality, safety and comfort.
WABCO will be glad to provide any further information.



WABCO
Vehicle Control Systems

We reserve the right to any changes.
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**WABCO Original Quality**
WABCO is a reliable supplier and development partner for almost all regional and global vehicle manufacturers and original equipment manufacturers. WABCO is also a distinguished manufacturer of products and services for selective dealers on the replacement parts market.

Every WABCO manufacturing plan around the world produces high-quality WABCO brake products in accordance with internationally recognized quality standards.

WABCO components such as brakes, control-, drive-, stability- and suspension-systems provide a significant contribution to improving the utility vehicle and traffic safety as well as to optimizing costs.

# Compressors


WABCO

**Compressors pump and compress the environmental air cleaned by an air filter and provide the created air pressure via the air processing unit for all devices of the vehicle that require compressed air. This mainly concerns the service brake circuit of the brake system and the secondary user devices such as the air suspension and the door controls for instance.**
**Compressors are piston compressors in a single or dual stage design.**

## Product advantages and features

The compressors are normally driven by gear wheel drives from the vehicle engine and via belt drive on older vehicles.

**Features of the compressors:**

- Number of cylinders: One or two cylinder
- Principles of compression: Single or dual stage
- Drive types: Gear wheel or belt drive
- Operating pressures: Normal pressure (NDR) ≥ 8 bar to ≥ 14 bar (in extreme cases, up to 18 bar)
- Cooling: Water and/or oil cooling, air cooling
- Type of lubrication: Force-feed lubrication (UD) common these days, in special applications by splash lubrication supplied from the engine (TD) as well or with manual refill (TH)

To ensure maximum pressures, unloader valves are integrated in the compressed air generation and the air processing unit between the compressor and air reservoir. They monitor the system pressure and switch the compressor to load- and no-load when necessary. In integrated filter cleans the compressed air. The control for an automatic antifreeze pump or an air dryer is handled by additional control ports integrated in the unloader valve. The unloader valve is normally integrated in the air dryer as a function unit these days.
The system pressures of up to 14 bar in present day vehicles cause temperatures of far higher than 300°C in the compression chamber of the compressor with single stage compression.

This physical specific high temperature triggers undesirable chemical reactions that can cause faulty functionality in the compressor itself and in the downstream devices. These problems are greatly reduced by using dual stage compression compressors.

**The functionality is as follows:**

- Pre-compression in the first stage
- Inter-cooling for pre-compressed air in cylinder head
- Final compression in the second stage on the supplied system pressure and further return cooling in the cylinder head

This staged compression greatly reduces the final compression temperature in the compression chamber of the compressor. The air quality is therefore improved and the life-span of the unit is saved.

Reduced thermal load leads to the oil lasting longer in the compressor and therefore to reduced oil consumption. Consequently, you can count on an improved life-span of the devices in the compressed air system. The overall operating costs are reduced by the longer life-span where maintenance and downtimes are concerned.

Single cylinder compressor

**Single cylinder compressors** have a feed volume between 250 and 600 l/min and are used in a pressure range between 8 and 14 bar. Besides depending on the size of the compressor, the air feed volume is also dependent on the engine speed, the gear ratio and the system pressure. In later WABCO compressors, a combination of the systems

- Power Reduction = PR and
- Temperature Reduction = TR

are used. Both systems are integrated in the compressor cylinder.

Two cylinder compressor

**Two cylinder compressors** have a feed volume of 600 to 1,200 l/min and are used in a pressure range of 8 to 14 bar.

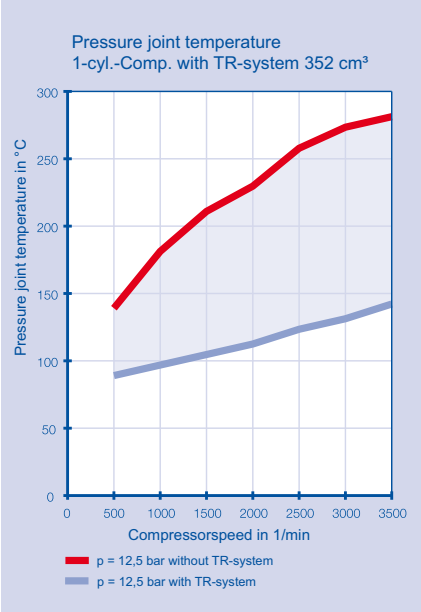
**Compared with compressors without an energy saving system, the WABCO PR system offers the following advantages in idle operation:**

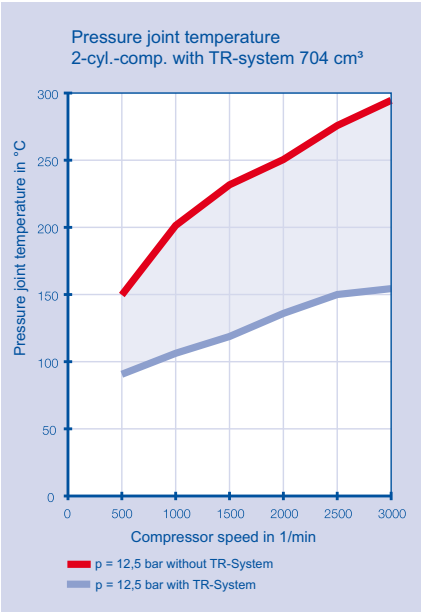
- Reduced power consumption
- Decreased oil consumption in pressurizing the cylinder chamber
- Sufficient temperature level in the pressure line by distribution of volume flow to minimize the risk of freezing
- Reduced noise levels

**Function description of the PR system**

A control piston integrated in the compressor cylinder head opens an additional opening between the compression and suction chambers with a moving plate in the idle phase. A portion of the air sucked in by the piston is fed into the suction chamber and the switching chamber in the compression stroke. The resulting increase in pressure also allows a flow of air into the atmosphere through the pressure valve, through the pressure line via the blow-off nozzle of the unloader valve so that the risk of freezing is reduced in the pressure line (see images on the left).

The **WABCO TR system** reduces the temperature of the compressed air outflow at the discharge outlet of the compressor cylinder head. The longer route and exposure time of the heated compressed air through the larger heat exchanging surfaces cause a considerable reduction in temperature.




**This produces the following advantages:**

- Intensive cooling of the air flow
- Possible reduction in the pressure line length
- Possible elimination of existing pressure line cooling lines

## Device overview

| Application | Cylinder | Product number |
|---|---|---|
| Mercedes-Benz | 1 | 411 151 003 0 |
| Mercedes-Benz | 1 | 411 154 000 0 |
| Mercedes-Benz | 1 | 411 142 711 7 |
| Mercedes-Benz | 1 | 411 141 818 7 |
| Mercedes-Benz | 1 | 411 141 818 7 |
| Mercedes-Benz, Setra | 1 | 412 352 014 0 |
| Mercedes-Benz | 2 | 911 553 003 0 |
| Mercedes-Benz | 2 | 911 553 103 0 |
| Mercedes-Benz | 1 | 412 636 001 0 |
| Neoplan | 1 | 411 145 057 0 |
| MAN | 1 | 411 147 062 0 |
| MAN | 1 | 411 151 004 0 |
| MAN | 1 | 412 352 003 0 |

## Service and maintenance information

The general status of the compressor should be checked visually.
The seal on the suction and pressure lines and that of the brake system is to be checked and confirmed regularly.
The air filter is to be checked or cleaned and the suction lines up to the compressor are to be checked for damaged and replaced if necessary.
The inspection of the flow rate is done during the periodic legal inspections such as visual checks and main inspection for example (note manufacturers specifications).

## Tips and trivia for the workshop

The flow rate (fill time) is to be checked in accordance with the specifications of the vehicle manufacturer. If respective test values are unknown or are not available, the legal specifications for fill times (EC directives for brake systems) are to be used for the inspection.

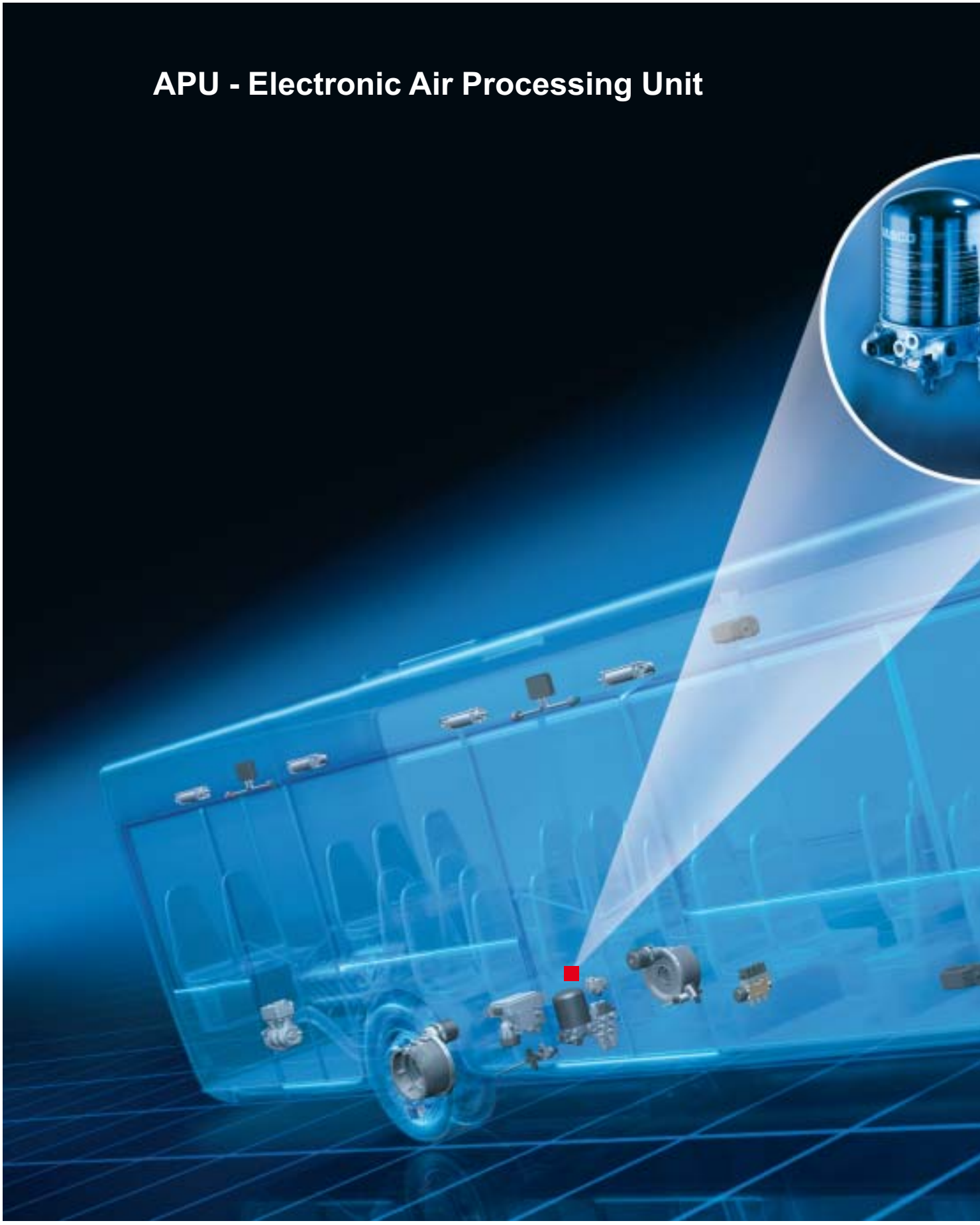
The compressor is connected to the engine lubricating oil circuit. The principle of operation and physical properties of the system cause the compressed air to be infiltrated during the compression process with water particles and fine oil particles. Chemical reactions are triggered in the oil particles under the high thermal loading and lead to the release of oil-crack products and ester compositions. These reaction particles then enter the compressed air as fine particulate matter (aerosols). In this case, they can cause faulty functionality in the compressor, in the devices downstream from the compressor and in the brake system.

**Important:** If the compressor runs for too long under load, because of
- the unload valve pressure is too high
- dirty suction filter,
- a plugged pressure line or a
- leak in the system,

it wastes fuel and the life-span of the compressor is decreased.

In order to protect the devices in the braking system from this contamination reliably, WABCO has developed a new desiccant cartridge, the WABCO Air System Protector with integrated coalescence filter (see chapter "APU – Electronic Air Processing Unit"). The coalescence effect leads to melting the smallest oil particles into a compact liquid phase and ensures improved oil separation this way.

For compressors with circulation pressure lubrication the maintenance instructions of the vehicle manufacturer or the engine manufacturer that concern the oil change intervals and oil quality are to be observed.
On belt drive compressors, the belt tension is also to be checked regularly.
When replacing the compressor, the pressure line is to be checked for carbonization caused by oil contamination and then the pressure line is to be replaced if necessary. The replacement line must be of the same diameter and the same length.


APU - Electronic Air Processing Unit


WABCO

**In order to remove moisture and other hazardous materials such as oil from the compressed air, an air processing unit is integrated between the compressor and the air reservoir.**

## Product advantages and features

The atmospheric air that the compressor sucks in contains a certain amount of humidity. That means that the compressor compresses a gas mixture of air and water vapor. The saturation limit of the moisture in the gas mixture, the so-called dew point, depends on the air temperature and the absolute humidity in this case. The heating of the supplied air during the compression phase of the compressor keeps the absolute humidity constant but the maximum possible moisture accumulation still increases. When the temperature falls, the portion of moisture condenses and is separated from the air as water.
The Air-Processing Unit (APU) is a combination of various devices:
This includes an air dryer with or without heating system, a safety valve and a tire valve.
A multiple-circuit protection valve (also Four-circuit protective valve) with one or two integrated pressure limit valves and two integrated check valves are flange-mounted on the air dryer. Some variations also have a double-pressure sensor, which is connected to the multiple circuit protection valve to measure the pressure in the brake circuits.
The air dryer integrates the replaceable desiccant cartridge and the unloader valve. This independently regulates the operating pressure inside the compressed air braking system by interrupting the supply process of the compressor when achieving a defined shut-off pressure.

## Components

**APU components:**

- Air dryer with regeneration function
- Desiccant cartridge
- Standard four-circuit protective valve with APU flange and bleed-back (see section "Several terms, described briefly") or
- Standard four-circuit protective valve with APU flange and additional features such as pressure limiter or pressure sensor

The modular construction of the unit enables simple installation of Air Processing Units. They combine excellent service properties with low space requirements.

## Product advantages and features

Single-chamber air dryer

**Air dryer**

Air dryers are tasked with reducing the portion of moisture in the compressed air. This is done by means of so-called cold regeneration adsorption drying. The compressed air supplied by the compressor is routed over the granulate of the desiccant cartridge. This absorbs the moisture contained in the compressed air. The especially important regeneration of the granulate is done via so-called "back-flushing" with air that has already been dried. The entire drying process is controlled by the air dryer.
The air supply for the regeneration is normally done from a so-called regeneration tanks, normally with a volume of 5 liters.

There are single- and dual-chamber air dryers.
The basic variant, the single chamber air dryer can be used with flow rates of up to ~500 l/min. The regeneration of the desiccant is pressure-controlled. The regeneration process is done with a single-chamber air dryer only in the idle phase of the compressor, i.e. when the operating pressure has been achieved.

Dual-chamber air dryers on the other hand cover a range starting at 500 l/min and duty cycles of the compressor above 50%. Here, the regeneration is time-controlled. After 60 seconds, the switch is made between cartridges and the cartridge that is not supplying air is regenerating during that time.
The drying interval of 60 seconds is controlled with a solenoid valve with an integrated timer switch for dual-chamber dryers. This ensures that good drying takes place even when duty cycles of the compressor are high.
Dual-chamber air dryers are mainly used in vehicles with high air consumption (high compressor duty cycle count).
Air dryers are generally certified for a maximum operating pressure of 13.0 bar. For special vehicles with high-pressure systems, special modifications (with special cartridges) are available and are certified to max. 20 bar.

**Why is the correct drying of the air so important?**

Moisture that infiltrates the reservoir and the valves cause corrosion. This corrosion remains hidden to begin with but can then lead to the connected devices failing due to surface rust.
The moisture that remains in the tanks, decreases the storage volume and therefore the number of possible braking applications when the engine is stopped or can lead to the compressor failing. Experience shows that drivers trust the functionality of the air dryer and therefore seldom use the drain valve on the tanks. Engine oil lubrication for the compressor causes small quantities of oil to enter the compression chamber, which then burn during the compression process because of heat generation. The cartridge of the air dryer filters the majority of these combustion products (such as oil particles for example) out of the compressed air. This prevents the sealing surfaces of the brake valves from being contaminated or from sticking in the long term.
Highly developed engine oils extend the oil change intervals but are also associated with new hazards because of the chemical additives in the oils: These additives can change into aerosols in the compressor and can get into the brake system. There, they can attack the rubber parts of the valves.
The WABCO Air System Protector (**432 901 223 2**), a Premium-Cartridge with coalescence filter, prevents the infiltration of these aerosols into the brake system and protects it from damage.

## Device overview

| Application | Type | Product number |
|---|---|---|
| Various buses | Single-chamber | 432 410 102 7 |
| MAN | Single-chamber | 432 410 115 7 |
| Irisbus | Dual-chamber | 432 431 173 0 |
| Setra, MAN, Neoplan | Dual-chamber | 432 431 199 0 |
| Various buses | Dual-chamber | 432 432 199 7 |

## Service and maintenance information

- The functionality checking for the air dryer is done by actuating the drain valve on the supply reservoir. If water comes out, it means there is a problem in the air dry dryer. On newer vehicles, this is done using electrical sensors (condensation sensor).
- The air dryer is to be checked for leaks and correct regeneration functionality. During this check, pay attention to the flow of air via connection 3. After achieving the shut-off pressure, the regeneration air flows out of connection 3 for a short time in the single-chamber dryer. On dual-chamber dryers, a continuous flow of air exists during the supply phase.
- This outflow of air is not to be interpreted as faulty functionality or as a leak in the compressed air system.
- Oil leaking from the silencer of the air dryer can indicate that the compressor is pushing oil. In such cases, the compressor should be inspected according to the manufacturer's specifications.
- In order to achieve good effectiveness, the input temperature of the incoming compressed air should be at approximately 28 °C above the ambient temperature.
- The input temperature of the air in the air dryer should not be higher than 65 °C. If the input temperature is too high, it has a negative effect on the functionality of the dryer.
- If the compressed air system leaks, the regeneration cannot be routed properly. This can cause moisture to infiltrate the system which can lead to the devices of the compressed air brake system failing.
- No antifreeze equipment is to be installed before the air dryer.

## Tips and trivia for the workshop

If the air dryer is equipped with a heating cartridge, it switches on when dropping under a temperature of approximately 6 °C and off again after exceeding a temperature of approximately 30 °C.

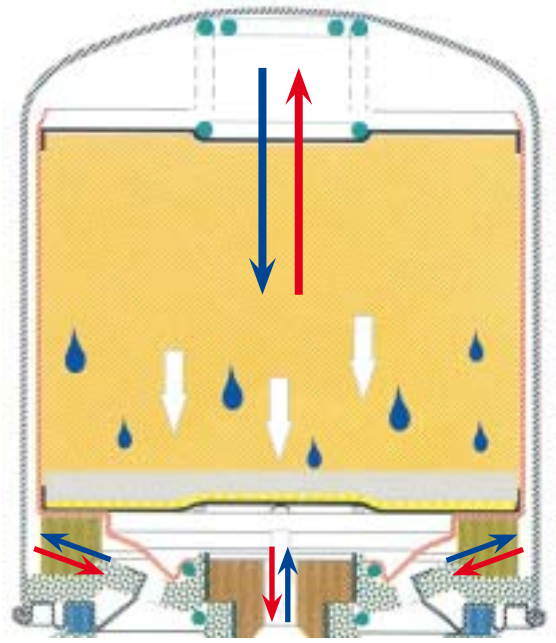
## Product advantages and features

Desiccant cartridge

**Desiccant cartridge**
The quality of the air drying mainly depends on the desiccant used.
In order to dry the air supplied by the compressor, specially designed desiccant beads with especially good drying properties and excellent mechanical resistance are used in WABCO cartridges. The latter ensures that the desiccant beads do not disintegrate into dust. Compared with the market standard granulate, the functionality of WABCO desiccant beads is more secure and can be recycled.

As a premium solution, WABCO offers the **Air System Protector Cartridge** with integrated coalescence filter. This innovative product prevents fine oil particles (aerosols) from entering the brake or compressed air systems. The protection is improved immensely.

Functionality of the desiccant cartridge




The following images clearly show the difference in using a standard cartridge and the Air System Protector (integrated coalescence filter).
While traces of oil are found on standard air dryer cartridges (Fig. 1) while the air flows out to the brake system, no contamination exists with the Air System Protector (Fig. 2).

Fig.1: Desiccant cartridge without coalescence filter after 60,000 km

Fig. 2 : Desiccant cartridge with coalescence filter after 60,000 km

## Device overview

| Application | Threads | Product number |
|---|---|---|
| Air system protector cartridge | M 39x1.5 | 432 901 223 2 |
| Conventional cartridge | M 39x1.5 | 432 401 222 7 |

## Service and maintenance information

- On older devices, the safety screw must be loosened before replacing the cartridge.
- The conventional cartridge and the WABCO Air System Protector should be changed after two years under normal conditions. Your WABCO Partner guarantees the return of old cartridges.
- If condensation is found in the system, the regeneration functionality of the device is to be tested and the cartridge may have to be replaced.
- The air dryer must be depressurized for maintenance work.
- Before threading the new cartridge in, the ring seal should be greased lightly. The tightening torque for the cartridge is 20 Nm (if existing, tighten the safety screw).

## Tips and trivia for the workshop

**WABCO recommends:**

- Regularly changing the cartridge(s)
- Frequent actuation of the drain valve on the containers to check the air dryer functionality
- Inference of compressor or air dryer problems, if dirty or corroded brake components are found when working on the system.

## Product advantages and features

Four-circuit protective valve

**Four-circuit protective valves**

Four-circuit protection valves, often referred to as multiple circuit protective valves, are used for controlling the supply of multiple, independent air pressure circuits on commercial vehicles for the service brake system and for the supply of secondary consumer devices.
If a circuit fails, it is switched off automatically, while the remaining continue to be supplied with compressed air up to the height of the opening pressure in the defective circuit.

**There are different Types:**

Four-circuit protection valves with limited return flow in series or in parallel with and without bypass.
Four-circuit protective valves in series with one or two integrated pressure limiters and check valves for circuits 3 and 4 as well as electronic pressure sensors for circuits 1 and 2.
To comply with directive 98/12/EG, the four-circuit protective valves are equipped with bleed-back functionality (see: "Several terms, described briefly").

## Several terms, described briefly

- Opening pressure: Pressure that is required to open the circuit.
- Closing pressure (stabilization pressure): Closing pressure is the pressure that leads to shutting the failed circuit down. A limited return flow enables pressure compensation above the closing pressure on the combined circuits.
- Series switching: This means that the secondary consumer devices (circuits 3 and 4) are downstream from the main consumer devices (circuits 1 and 2). A return flow from the secondary consumers to the main consumer devices is not possible because of the integrated check valves.
- Parallel switching: Parallel switching means that all circuits are connected with one-another. Accordingly, a limited return flow between all circuits above the closing pressure is normal, i.e. also from secondary consumer devices to the main consumer devices.
- Bypasses: These enable an advance filling of the circuits that are equipped in this way in the depressurized complete system. These are often used in circuits 1 and 2. With valve variants in parallel circuits, bypasses can also be used in circuits 3 and 4.
- Bleed-back function: A throttle check-valve is used for connecting the parking brake system circuit 3 with air circuit 1. If the service brake system circuit 1 fails, circuit 3 is also depressurized to meet the requirements of 98/12/EG (see following).

## Device overview

| Name | Product number |
|---|---|
| Four-circuit protective valve | 934 702 322 7 |
| Four-circuit protective valve | 934 714 125 0 |
| Four-circuit protective valve | 934 702 040 7 |
| Four-circuit protective valve | 934 705 003 7 |

## Service and maintenance information

Please note the requirements for periodic legal tests.

## Legal characteristics

**6. Adaptation directives 91/422/EWG and directive 98/12/EG**
For vehicles with initial registration date after October 1994, the 6 is required. Adaptation directive 91/422 EWG, indicating that the spring chamber brakes are only to be released upon filling the depressurized supply system if the pressure in the service brake circuit is sufficiently high to achieve the required effect for the secondary brakes when actuating the service brake system (BBA).
Directive 98/12/EG also requires that the actuated spring chamber brakes are only allowed to be released if the pressure in the service brake system circuits ensure at least the residual braking effect for loaded vehicles with the BBA for vehicles with the initial registration date after March 2001.

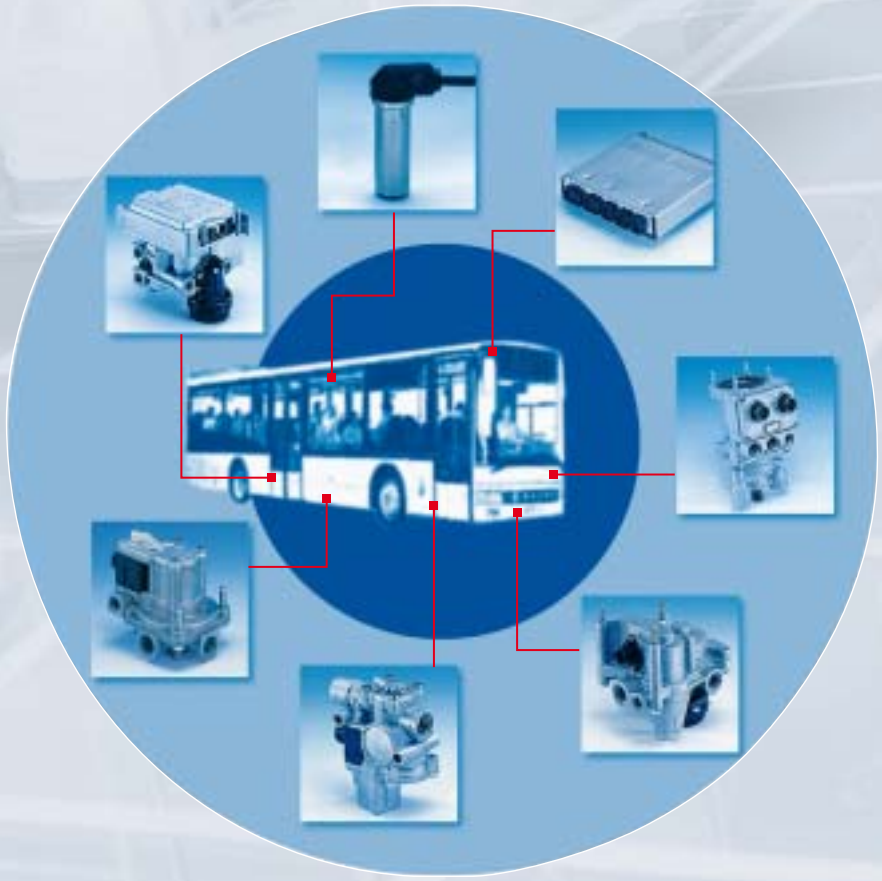
Special maintenance that extends beyond the legally specified inspections is not required.

The closing pressure (or stabilization pressure) is inspected with the engine stopped. When depressurizing a circuit, the circuit that has not failed is only to drop to the respective closing pressure. After refilling the system, this test is to be repeated with a "simulated defect" in the other circuits respectively.


EBS - Electronic Braking System


WABCO

**A cleverly devised concept in safety makes EBS into one of the safest braking system in utility vehicles. In this case, several brake circuits (redundancy) are ensured that the utility vehicle is slowed securely.**



## Product advantages and features

An EBS generally has two brake circuits and one additional redundant, which can be single or dual circuit. With EBS, the normal brake pedal valve is replaced with a so-called brake signal transmitter. It controls an electro-pneumatic brake circuit and two pneumatic brake circuits separated from one another. The „driver‘s wishes“ are registered through electrical impulses in parallel with the standard pneumatics and are processed electronically. This impulse is a pulse width modulated signal that is generated according to the Hall principle (in relation to the distance that the signal encoder has travelled in the brake signal transmitter). The electrical signal is slightly advanced in comparison with the pneumatic redundancy.

**Braking Safely With Confidence**

EBS uses extensive diagnostic and monitoring functions to permanently perform its own inspections. In the case of limited operability, the driver is immediately informed with respective warning equipment. A diagnostic device or the display on the onboard diagnostics (OBD) through a vehicle display allows you to quickly and easily determine the cause of any fault. Maintenance and shop times can also be decreased greatly with the extensive test functions of the diagnostics.

**Integrated brake management functions of a modern EBS:**

- Delay control/braking force control
- Braking force distribution
- Brake lining wear optimization
- Endurance brake integration
- Brake assist system
- Halt brake (for city buses)
- Anti-roll brake for overland bus (ARB)
- ABS functionTraction control system (ASR)

**Other supporting functions:**

- Determining the brake set value
- Pressure regulation on the axles
- Rotational speed sensing and tire balancing

**Explanations for functions/features**

If a circuit fails (electrical or pneumatic), the functionality of the other circuits is maintained. The pneumatic redundancy pressures are opened on circuits 1 and 2. The pressure of the second circuit is held back slightly in this case. The driving stability/steering ability of the vehicle is maintained during the braking procedure by the ABS functions integrated in the EBS.

The differential wheel slip control automatically distributes the braking forces between the front and rear axles depending on – status of the load.

The integrated traction control system (ASR) ensures that the wheels do not slip. Brake lining wear control ensures harmonious wear of the brake linings and therefore for service and lining change times that match. The life-span of the linings can be extended this way.
Quickly and easily determining the causes of faults is possible via the vehicle display (OBD).

**Note:** Since the EBS works with no load-dependent braking force control, the pneumatic redundancy can cause over-braking on the rear axle. A special valve (redundancy valve) prevents any influence from the pneumatic circuit, if the EBS is intact.

**Special features with EBS in buses:**

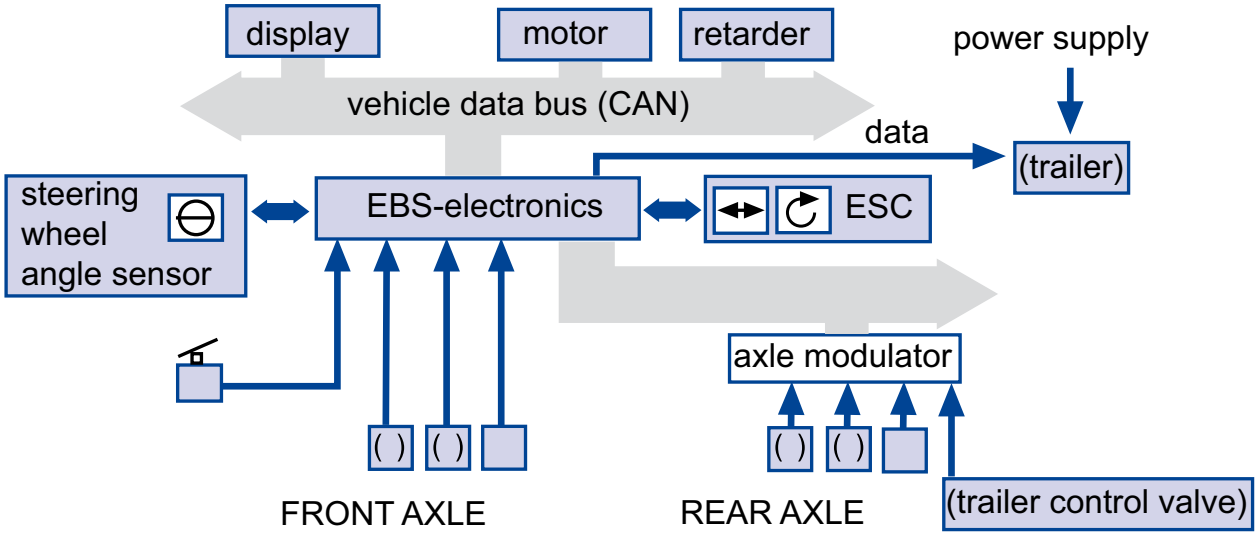
- The load/no-load ratio on buses is lower than with trucks or tractor-trailer units. Therefore, the redundancy pressure in buses is transferred at a 1:1 ratio and not like in trucks or tractor-trailer units where it is reduced at a 2:1 ratio.
- In city buses (three axle or articulated bus), the EBS works with a two axle modulator.
- The anti-rolling function is modified to a halt brake in the city bus.

As soon as the drive actuates the switch of the halt brake or activates the door control, the request is sent via the CAN bus or the switch of the halt brake to the EBS electronics. This causes a brake pressure actuation of e.g. 2 bar.

The brake cylinders on the front axle are filled via the proportional relay valve and those / the axle modulator(s) of the rear axle with brake pressure. On many vehicles, depending on the manufacturer, only the brake cylinders of the drive axle are filled with brake pressure.

If the halt brake request is switched off by actuating a switch or by the door electronics and then the gas pedal is actuated, then the “Halt brake” request is cancelled by the EBS electronics.

**Connection of ESC with the EBS (general representation)**



**EBS components in buses**


Central module

The **central module** controls and monitors the electronically controlled brake system. It determines the set delay (signal from the brake signal transmitter) along with the wheel speeds measured by the rotational speed sensors and creates the input signal for the electro-pneumatic control. The central module communicates with other systems (engine controller, retarder, display, etc.) via a vehicle data bus in accordance with SAE J 1939 (Standard for data exchange in commercial and utility vehicles).


Brake signal transmitter

The **brake signal transmitter** creates electronic and pneumatic signals for pressurizing and depressurizing the brake cylinders. The device is dual-circuit pneumatics and dual-circuit electrical. The actuation start is registered electrically via a dual switch. The distance of the actuation plunger is sensed and processed as an electrical signal.


Axle modulator

The **axle modulator** regulates the brake cylinder pressure on both sides with one or two axles.
Specifications for the set pressures and the external monitoring is done via the central module. The specified set value is adapted for blocking or slipping tendencies.


ESC control module

Prerequisite for the installation of **ESC** (electronic stability control) is a CAN data bus system with at least 500 Kbit/s and EBS electronics that permit an ESC. In addition to the EBS components, an ESC control module and a steering wheel angle sensor must be installed.


Proportional relay valvel

The **proportional relay valve** is integrated in the electronically controlled brake system as an actuator for setting the brake forces on the front axle.

The **redundancy valve** is used in case of redundancy for quick pressurization and depressurization of the brake cylinder on the rear axle and for switching the redundancy off, if the EBS is functioning.

**System design as 4S / 4M:**

- four rotational speed sensors
- four solenoid valves, of which two are integrated in the axle modulator

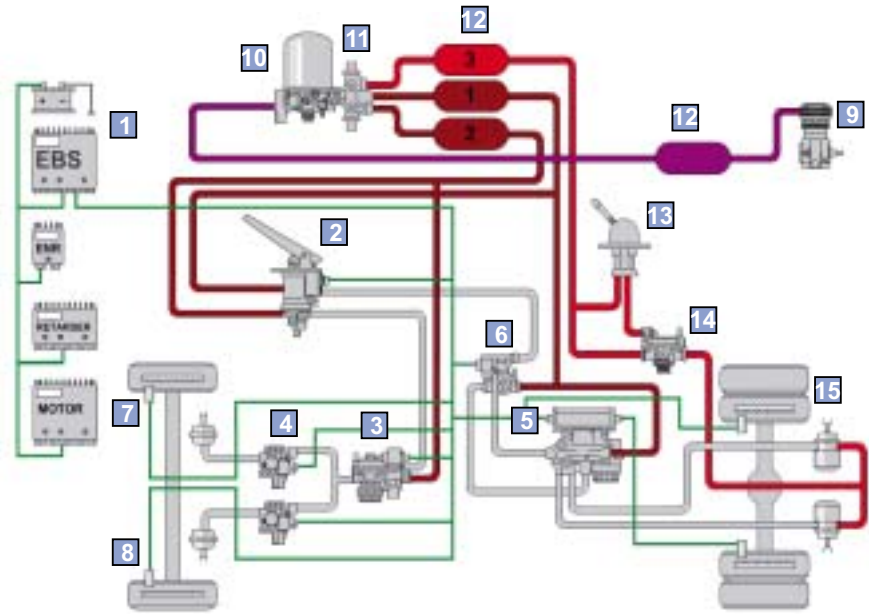
In this variant, an EBS on each wheel can perform individual ABS control (see figure “4S / 4M EBS system design for Solo-Bus”).

1 Central module
2 Brake signal transmitter
3 Brake signal transmitter
4 ABS solenoid valvel
5 ABS solenoid valve
6 Redundancy valve
7 ABS sensors
8 Wear sensors

**Additional components**

9 Compressor
10 Air dryer
11 Four-circuit protective valve
12 Air reservoir
13 Hand-brake valve
14 Relay valve FBA
15 Brake cylinder

**4S / 4M EBS system design for Solo-Bus**




## Device overview

| Application | Name | Product number |
|---|---|---|
| Mercedes-Benz | EBS central module 4S / 4M | 446 130 028 0 |
| Mercedes-Benz | EBS central module 6S / 6M | 446 130 029 0 |
| Mercedes-Benz | EBS axle modulator | 480 103 011 0 |
| Mercedes-Benz, Setra | EBS axle modulator | 480 103 015 0 |
| Mercedes-Benz, Setra | EBS axle modulator | 480 103 061 0 |
| Mercedes-Benz | Brake signal transmitter | 480 001 005 0 |
| Mercedes-Benz, Setra | EBS proportional relay valve | 480 202 004 0 |
| Mercedes-Benz | Relay valve, 3/2 directional | 480 205 010 0 |
| Solaris | EBS central module 4S / 4M | 446 135 030 0 |
| Solaris | EBS central module 6S / 6M | 446 135 031 0 |
| Solaris | EBS axle modulator | 480 103 063 0 |
| Solaris | EBS axle modulator | 480 103 061 0 |
| Solaris | Brake signal transmitter | 480 002 003 0 |
| Solaris | EBS proportional relay valve | 480 202 004 0 |
| Solaris | Relay valve, 3/2 directional | 480 205 010 0 |
| MAN, Neoplan | EBS central module 4S / 4M | 446 135 030 0 |
| MAN, Neoplan | EBS central module 6S / 6M | 446 135 031 0 |
| MAN, Neoplan | EBS axle modulator | 480 103 063 0 |
| MAN, Neoplan | EBS axle modulator | 480 103 061 0 |

## Device overview

| Application | Name | Product number |
|---|---|---|
| MAN, Neoplan | EBS proportional relay valve | 480 202 004 0 |
| MAN, Neoplan | Relay valve, 3/2 directional | 480 205 010 0 |
| **EBS Compact as of 2004** | | |
| MAN, Neoplan | Central braking unit | 480 020 005 0 |
| MAN, Neoplan | EBS axle modulator | 480 104 105 0 |
| MAN, Neoplan | EBS axle modulator | 480 104 104 0 |
| MAN, Neoplan | 3/2 directional control valve | 472 176 316 0 |

## Service and maintenance information

### Monitoring functions

An EBS is basically maintenance-free. It monitors itself and its components itself. If a fault occurs, the driver is given the message that the vehicle should be taken to a repair shop or the vehicle is no longer to be operated.
Various error recognition functions are integrated in the EBS.
These are to decrease the effects of system failures and inform the driver of function interference.In cases, these functions correspond with the standard ABS monitoring functions, some are also EBS-specific however.

**Warning notice:** In order to guarantee the safety of the functions of the entire EBS, components must be completely replaced if a fault occurs. In cases, transferring the parameter sets of the ECU to a new component may be necessary.

### Checking the braking effect

Ensuring the specified braking effect for the vehicle is normally verified on a roller test stand in a workshop. This requires that each axle brakes with maximum possible force. In this case, the EBS brake management functions such as load-dependent brake force control, remain ineffective (see information under “Legal characteristics”).

## Legal requirements

### Visual and function test during safety testing

**Note:** A safety and functionality test (SP) of commercial vehicles may only be performed by respectively trained personnel. The legal requirements are the foundation for this. Please observe the information provided by the vehicle manufacturer.

### Inspecting the warning equipment

The EBS has has a clearly advanced self-monitoring that the previous ABS. Detected faults in the vehicle are saved and shown to the drive either via warning lamps or on the display. This warning equipment must be checked for proper functionality during the safety check.

### Checking the air supply system

Checking the air supply system is done the same as on conventional vehicle braking.

### Checking the wheel brake

Checking the effectiveness of wheel brakes can be done on a roller test stand, analogue to every other compressed air braking system.

### Projection

The projection is done using the same process as with conventional braking vehicles. The information of the vehicle manufacturer is to be noted for the calculation pressure.

## Conventional valves in the EBS brake system

The function and requirements of current products installed in commercial vehicles are defined and released in close cooperation between the vehicle manufacturer and the system providers. Intensified legislative demands also ensure the greatest possible degree of safety in traffic. This applies equally for the established, so-called „conventional“ valves that are required, e.g. for the EBS.
The following types of valves are required for the entire brake system of a vehicle and for performing the different “Braking procedures”. In this case, there is a difference between whether a bus is equipped with or without an electronic braking system.

A modern EBS braking system integrates a number of functions from conventional valves, which are explained briefly to follow.

## Hand-brake valve

Hand-brake valves are used for actuating the secondary and the parking brake system. Here, a sensitive staged actuation of the hand-lever performs a pressurization or depressurization of the Tristop®- or spring chamber cylinder.

### Device overview

| Application | OE Reference | Product number |
|---|---|---|
| Mercedes-Benz | A 003 430 45 81 | 961 722 232 0 |
| MAN | 81.52315-6090 | 961 722 262 7 |
| MAN | 81.52315-6166 | 961 722 326 0 |
| MAN | 81.52315-6150<br>81.52315-6158 | 961 723 019 0 |
| MAN | 81.52315-6149<br>81.52315-6151 | 961 723 112 0 |
| MAN | 81.52315-6156<br>81.52315-6161 | 961 723 118 0 |
| MAN | 81.52315-6157 | 961 723 120 0 |
| MAN | 81.52315-6183 | 961 723 426 0 |
| Setra | Q 8.285.300.000.0 | 961 722 262 7 |

## Tow-vehicle brake valve

The tow-vehicle brake valve is designated as a brake signal transmitter on vehicles with EBS (see „EBS components in buses“). It is tasked with sensitive staged pressurizing and depressurizing the brake cylinder. If a pneumatic circuit fails, the second circuit remains fully functional. The characteristic is progressive, i.e. the increase in actuated brake pressure is directly dependent of the pedal distance.
Brake valve and treadle are available as replacement parts.

### Device overview

| Application | OE Reference | Product number |
|---|---|---|
| MAN | 81.52130-6128 | 461 316 002 0 |
| MAN | 81.52130-6098 | 461 318 003 0 |
| Setra | Q 8.285.579.000.0 | 461 318 026 0 |
| Diverse Busse | | 461 318 501 0 |
| Mercedes-Benz | A 004 431 06 05 | 461 318 502 0 |
| Mercedes-Benz | A 003 431 92 05 | 461 318 550 0 |

## Relay valve

The relay valve with overload protection has the task of shortening the pneumatically-dependent trigger time and threshold time of a braking procedure by quickly pressurizing the brake cylinder. They work simultaneously as a quick release valve when releasing the brake. An overload protection is required to add force when the service brake and the parking brake are applied simultaneously and to therefore protect from over-loading.

## Device overview

| Application | OE Reference | Product number |
|---|---|---|
| Various Buses | | 473 017 000 7 |
| MAN, Neoplan | 81.52150-6012 | 473 017 001 7 |
| Mercedes-Benz | A 005 429 23 44 | 480 205 010 0 |
| Various Buses | | 973 001 021 7 |
| MAN, Neoplan | 81.52150-6011 | 973 001 221 0 |
| MAN, Neoplan | 81.52116-6060 | 973 003 002 0 |
| Mercedes-Benz | A 004 429 63 44 | 973 006 003 0 |
| MAN, Neoplan | 81.52116-6075 | |
| Mercedes-Benz | A 004 429 76 44 | 973 011 200 0 |
| MAN, Neoplan | 81.52116-6071 | |

## Service and maintenance information

Special maintenance that extends beyond the legally specified inspections is not required.

## Tips and trivia for the workshop

Please note that when replacing components (a device is replaced with a new variant), on vehicles with pneumatic emergency release system for spring chamber actuator, the following information concerning connections must be taken into consideration:

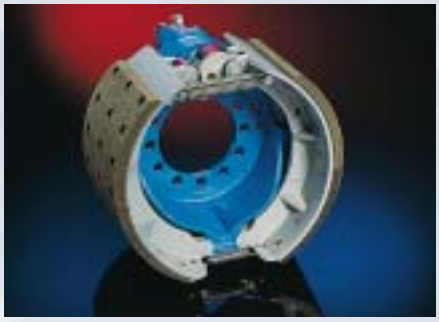
In order to prevent pressure differences in the downstream two-way valve, the hand-brake valve must be connected on connection 41 and the tow-vehicle brake valve on connection 42 of the relay valve.

# Wheel Brakes in Buses


WABCO

**The topic of "Wheel brakes in Buses" includes all typical brake types – from the robust drum brake to the hydraulic drum and disc brake right up to modern compressed air disc brakes – like those of the PAN series with patented single piston technology.**

## Product advantages and features



Drum brakes

Compressed air disc brakes

Where, previously, the requirements of wheel brakes were simply the desire for safety, decreasing speed and stopping the vehicle, today the main focus for product innovation are topics such as install space, weight, comfort, maintenance times and costs as well.
The S-cam version of the drum brake with its uncomplicated, robust construction is still well established.
One of the reasons is the long life-span and low service requirements. A fully encapsulated brake shaft mount guarantees high mileage without high wear. Brakes of this type consist of the brake shaft mounted in the brake support the rollers and springs mounted in the brake shoes. The brake shoes are held against the cam of the brake shaft by springs over the rollers and on the opposite side, the recesses in the brake anchor plate with force and form-fitting. In order to avoid axial shifting of the brake shoes, there are two bolts on the supports of the brake anchor plate and a recess is provided in the brake shoe. The braking effect is almost the same in forwards and reverse. The lining wear is checked via view-holes provided in the brake cover plate using wear-edges on the brake lining. Actuation and adjustment of the brake is done via the brake lever or a so-called slack adjuster.

The compressed air brake asserts itself in the bus market right away as being extremely comfortable and maintenance friendly. Especially the ABS- and EBS-capabilities provide the advantages for these brakes over drum brakes.

**Advantages of the compressed air disc brake:**

- Excellent, constant performance, even under extreme conditions (very little fading, advantages in wet)
- Optimal pressurization with open construction
- Low weight
- Lower portion of unsprung masses
- Increased comfort
- Compact design
- Improved ABS-/EBS-response with quick reaction time
- Hysteresis < 10% (allows high-frequency control and leads to shortened braking distance)
- Reduced service requirements (e.g. easier lining change)

Lining wear indicators (BVA)

Continuous wear sensor (CWS)

**Wear indicators**

Depending on the vehicle, wheel brakes are delivered with lining wear indicators (BVA). This increases the safety of the vehicle and maintenance work can be planned better.
The thickness of the lining is monitored permanently with these wear indicators. If the lining reaches its critical wear limit, warning lamps indicate that the brakes require maintenance.

As an alternative, a continuous wear display (CWS) provides information on the current lining wear status.
In combination with an EBS, the brake system uses sensor signals to compare the wear of the linings on all axles and wheels by controlling the pressure of the different axles and monitoring the thickness of the brake linings on all wheels. This way, all brake linings are worn equally. If the critical lining thickness of the brake lining is reached, it is indicated via the ABS-/EBS-warning lamps on the instrument board so that the driver is informed of a required brake service.
Another advantage: The continuous wear sensor (CWS) can be simply replaced, just like the BVA, using plug-and-play without any other set-up.

## Device overview

| Application | Description | Product number |
|---|---|---|
| Setra | S cam brake 410x160 ZG | 10 410 229<br>10 410 230 |
| Setra | S cam brake 410x140 ZG | 10 410 264<br>10 410 265 |
| Setra | S cam brake 410x220 ZG | 10 410 650<br>10 410 651 |
| Neoplan | S cam brake 410x160 ZG | 10 410 580<br>10 410 581 |
| Neoplan | S cam brake 410x220 ZG | 10 410 658<br>10 410 659 |
| Neoplan | S cam brake 410x220 ZG | 10 410 664<br>10 410 665 |
| Neoplan | Compressed air disc brake 1000 VG | 40 100 003<br>40 100 004 |

**Information on replacement parts can be obtained through the Internet in our product database INFORM.**

## Service and maintenance information

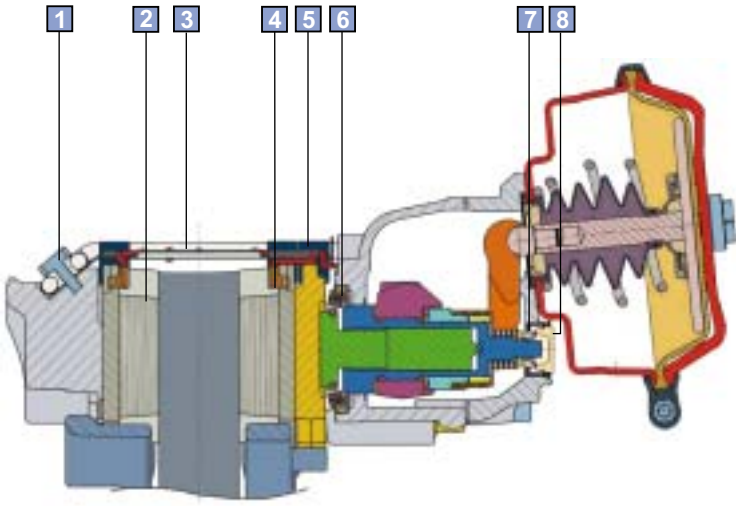
Before working on brakes, refer to the respective service instructions. Only start repair work if you have read and understand all (safety-) information that is required for the repair.

## Tips and trivia for the workshop

- Replacing the brake linings must always be done per axle.
- With glued and riveted linings, the special gluing regulations and drawings must be observed.
- With safety brakes, the retainer springs and liner retainer clip must be replaced each time the brake lining is replaced.
- Use only the linings that are approved by the vehicle manufacturer.
- When installing replacement parts, note that they are to be installed without using any force.
- During maintenance work, the seals must be checked for damages and replaced if necessary.

**Compressed air disc brake cross section**

1 Bolt
2 Brake linings
3 Retainer clip
4 Wear sensor
5 Retainer spring
6 Piston protector cap
7 Redundant seal
8 Plug




## Legal characteristics

On vehicles that are allowed to be driven on public streets, the regulations according to EG/ECE apply. The safety inspection is also specified.


Brake Cylinder


WABCO

**Brake cylinders provide the required force to execute the braking procedures for the wheels in combination with the wheel brakes. This converts the pneumatic energy into mechanical movement energy.**

Brake cylinders are designed to perform the respective job reliably and safety for many years. The highest quality standards ensure a noticeable reduction in operating costs and for maximum safety. Important distinctive features of the cylinder are the size, stroke, plunger length, spring chamber strength and overall length.

## Product advantages and features

Brake chambers for S cam brake

Brake chamber for disc brake

**With the brake cylinders installed in the Buses, the following product types exist:**

- Brake chamber
- Tristop® cylinder

Both types exist in diverse versions for disc brakes, S cam brakes and wedge brakes.

The main focus of new development lies in reliability, operational comfort, simple installation, compact dimensions and long service life.

**In order to achieve these product advantages brake chambers are offered with the following features for example:**

- Strengthened interface to wheel brake
- View slots at top and on side
- High performance diaphragm
- Powder coating for optimized corrosion protection

Brake chambers are a component of the service brake system and are normally installed on the front axles.


Tristop® cylinder for disc brake

Besides excellent service brake performance, **Tristop® cylinders** also integrate the functions of a parking brake and a secondary brake.

**The main product features of Tristop® cylinders are:**

- Modular design
- Equipped with integrated breathing valve (IBV)
- Spring chamber spring without coil clash enables high life-spans and shortest construction
- Powder coating for optimized corrosion protection
- Optional half release bolts (HRB) or integrated release bolt with travel readiness indicator (IMA) for reduced installation length
- Normally used on the drive axle

Original cylinders can normally be installed in the vehicle without any modifications.

Because of the amount of vehicle manufacturers and the available applications related to the brake system (disc and drum brakes) and the requirements of the vehicle, there is a multitude of products available.
In order to accommodate the requirements of the various vehicle manufacturers, there are about 1,500 different variants available for the cam brake type alone at WABCO.


Tristop® cylinders for S cam brakes

For repairing a brake system of the vehicle, this kind of variety is unfavorable. We are happy to make modifications when required for simplified mounting.
When using Universal-Tristop® cylinders, the majority of repairs can be performed quickly and reliably. A suitable stock of these Universal cylinders enables short-term repairs and saves the operation for intricate replacement part logistics.

## Device overview

**Brake chamber for disc brake**

| Application | OE Reference | Type | Product number |
|---|---|---|---|
| MAN, Neoplan | 81.51101-6378 | 20 | 423 105 700 0 |
| MAN, Neoplan | 81.51101-6377 | 20 | 423 105 701 0 |

**Brake chambers for cam brake**

| Application | OE Reference | Type | Product number |
|---|---|---|---|
| Mercedes-Benz | A 002 420 07 24 | 20 | 423 105 408 0 |
| Mercedes-Benz | A 002 420 08 24 | 20 | 423 105 409 0 |

**Tristop® cylinder for disc brake**

| Application | OE Reference | Type | Product number |
|---|---|---|---|
| MAN | 81.50410-6804 | 24/24 | 925 461 022 0 |
| MAN | 81.50410-6805 | 24/24 | 925 461 023 0 |

**Tristop® cylinders for S cam brakes**

| Application | OE Reference | Type | Product number |
|---|---|---|---|
| Bova<br>Setra | 190576<br>Q 8.283.938.000.0 | 24/24 | 925 321 285 7 |
| Bova<br>Setra | 190615<br>Q 8.283.939.000.0 | 24/24 | 925 321 295 7 |
| Setra | Q 8.285.558.000.0 | 24/24 | 925 421 344 7 |
| Setra | Q 8.285.548.000.0 | 24/24 | 925 421 347 0 |

For the Tristop® cylinder for cam brakes indicated above, the Universal Tristop® cylinder 925 491 141 0 / 499 202 853 00 can also be used.

## Service and maintenance information

Special maintenance that extends beyond the legally specified inspections is not required.

The cylinders are checked for leakage, proper fastening and cylinder stroke with full braking. The diaphragm stroke should be one third to max. half of the possible total stroke if the wheel brake is set correctly.

The brake chamber is set up for a response pressure of 0.2 to 0.3 bar. If the response pressure is 0.5 bar, an internal inspection is required.

When **replacing** the cylinder, the console is to be checked for damage and replaced according to the recommendations of the axle manufacturer or the vehicle manufacturer if necessary.

The opened drain/breather hole must point downward. Additional drain holes must be closed and the fastening nuts tightened to 180 to 210 Nm.

With Universal Tristop® cylinders with bellows seal, the plunger length is only to be shortened to the point that the bellows cannot be damaged during operation.

To achieve the braking force according to the brake calculation, replacing requires that the same size of WABCO Tristop® cylinders are used as the original installation by the vehicle manufacturer.

## Tips and trivia for the workshop

**What is IBV**
A breather valve integrated in the cylinder makes the small external connecting tube between the spring chamber and the brake chamber redundant.

**This technology provides a multitude of advantages:**
- Only dry and clean air in the spring chamber for the parking brake
- Less requirements for modifications – the position of the breather tube no longer has to be taken into account
- Greater variability – with the greater adjustment range, more variants can be swapped
- Lower logistic requirements because there are less variantsExternal breath
- ing tubes will no longer be misused as handles (less danger of accidents and defects)

Original cylinder with external tube can easily be replaced with an IBV type.

**What does e.g. 24/24 mean?**
The type information (e.g. type 24/24) indicates the effective plunger surface (in square inches) in the diaphragm and spring chamber part.

With Tristop® cylinders, a simultaneous actuation of the service and parking brake system can lead to a brake force addition in the wheel brake. If this is to be prevented, an overload valve or a two-way valve should be installed upstream.

**The following points are to be observed when switching to a Universal Tristop® cylinder for example:**
- Position of the clamp
- Position of the bolted joints
- Position of the breather tube
- Position of the drainage hole, closed at top, open at bottom
- Length of the plunger rod

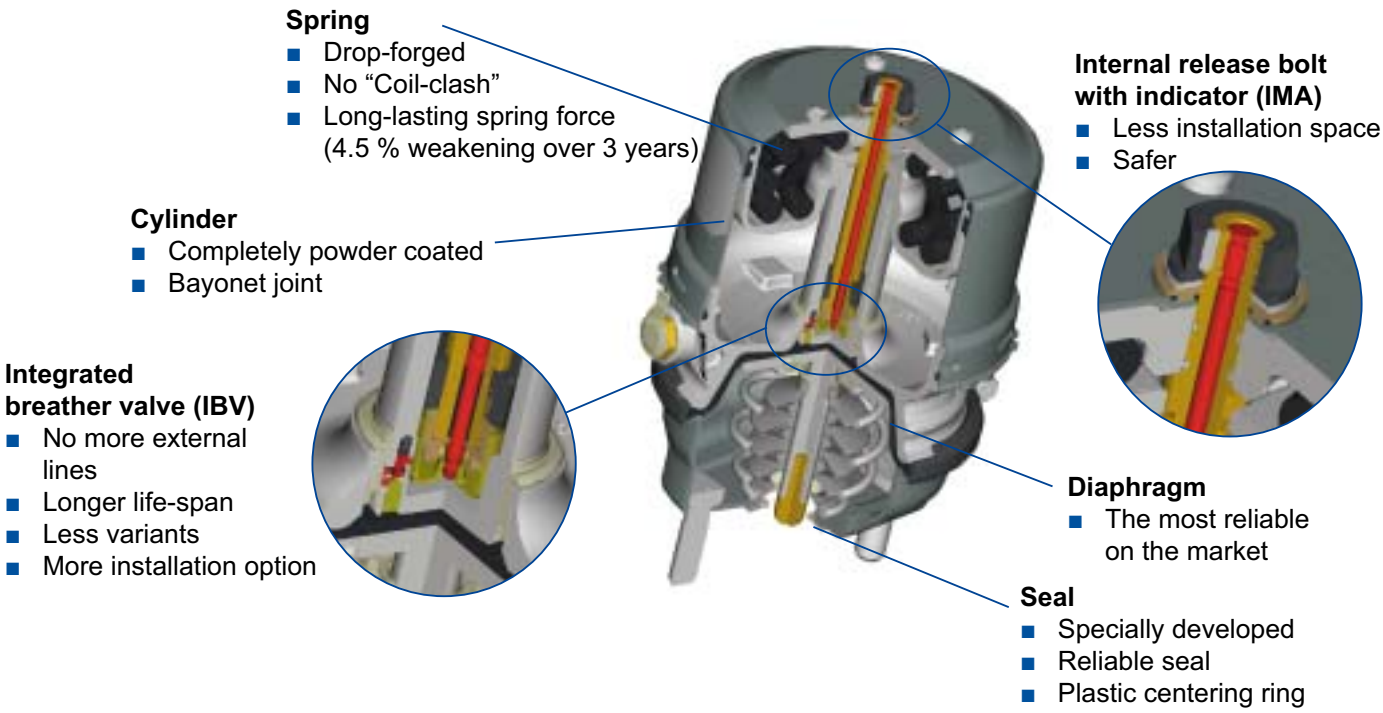
The plunger of the Tristop® cylinder must be retracted completely when the brake is not actuated and is not to be under tension. A test of the effectiveness is to be performed on the brake test stand.

Tristop® cylinders are to be replaced by axle! For older cylinders, the spring force of the spring chamber can be weakened, which will cause uneven braking.

When replacing cylinders, ensure correct installation as well as making sure that the seal to the disc brake is not damaged.

**Note:** Never open the spring chamber housing!
Parts flying apart in an explosion-like manner is hazardous. The spring chamber is only to be replaced as a complete part.

**Tristop® cylinder with IBV and IMA, schematic diagram**




ECAS – Electronically Controlled Air Suspension


WABCO

**ECAS is an electronically controlled air suspension system for buses and other vehicles, which includes a multitude of various functions as "one" system.**

**Air suspension in buses has almost completely replaced the standard mechanical suspension systems.**

## Product advantages and features

The advantages of the electronic air suspension are in the combination of many different functions.

**Advantages of ECAS:**

- Constant vehicle height independent of total weight
- Decreased air consumption: With ECAS, in comparison with conventional air suspension systems in a low-floor bus in line applications, air savings of approximately 25% were determined
- Extensive safety concept, diagnostics storage and diagnostic capabilities
- High speed for all control processes with large valve cross-section (nominal diameter 7 per bellow)
- Less components: From the solenoid block, only one line runs to each bellow and one line to the supply reservoir
- High system flexibility for different kneeling types
- Protection of the road surface

## System functions

The ECAS electronic controls are based on the measurement values of the sensors of the air suspension. Besides the control for the normal level, the electronics cover – in combination with operational switches and sensors for the tire impression compensation – the control of the remaining functions as well.
Latest ECAS generations are purely CAN-bus systems.

**ECAS includes the following functions among others:**

- Nominal level control
- Normal level I and II
- Height limitation
- Kneeling
- Supply pressure monitoring
- Raising and lowering the front and rear axle

ECAS-CAN control electronics bus

Not all of the capabilities have to be integrated into every system.
**Note:** The system configuration and especially the setting for all parameters is in the responsibility of the respective vehicle manufacturer and is not to be changed without their permission.

**The safety concept**
For monitoring the orderly functionality of the system, the ECU checks the majority of the electrical connections in rotation and compares the voltage and resistance values with specified values.
The signals of the sensors are also checked for plausibility. An unchanged level for example, is implausible even though a support bellow is pressurized and is therefore classified as faulty.
Recognized information is indicated to the driver via a display in the instrument board.

**Nominal level control**
If there are deviations from the specified level above a tolerance range, solenoid vales are actuated and the actual level is adjusted to the specified level by pressurizing/depressurizing the air suspension bellow. Driving levels that have been defined previously are also maintained, independent e.g. of the number of passengers that get in or out.

**Normal level I / II**
The normal level I is defined by the vehicle manufacturer for normal driving operation. This level determines the suspension comfort, the driving safety and the installation height.
Normal level II deviates from normal level I. This is defined by a parameter in the electronics. A switch is used to select between normal level I and normal level II.
For reasons of safety, the normal level can be adjusted automatically if the vehicle exceeds a predefined speed limit; after dropping below a lower speed limit, the previous level is adjusted again.

**Height limitation**
A height adjustment is ended automatically, if value parameters for the upper and lower end position are achieved.

**Kneeling**
Kneeling is a special function for buses (see "Legal characteristics" at the end of the chapter as well). Kneeling is tilting the bus to ease the entry and exit for passengers. This can be done on a complete side, on a single wheel or on an axle with a distance sensor. ECAS can e.g. ensure the proper lowering procedure with a contact strip.

**Supply pressure monitoring**
ECAS does not allow kneeling if the existing supply pressure is insufficient to raise a lowered, fully loaded vehicle to its normal level again.

## ECAS components

ECAS solenoid valve

ECAS distance sensor

ECAS pressure sensor

**Control electronics (ECU)**
The control electronics is the core of the system, to which the individual components are connected with plug-in connections.

**Solenoid valves**
Combining specially developed solenoid valves into compact block valves are of overall installed size and the effort required for connecting is greatly reduced.
The solenoid valves, controlled as actuators by the electronics, convert the applied voltage to a pressurizing or depressurizing process (such as raising, lowering or stopping the air flow in the bellows).

**Distance sensor**
A rotary movement of the lever registers every change in the distance between the assembly and the axle (comparable with a standard air suspension valve).
The value of the change in inductivity is measured in short intervals and is converted into a distance signal by the electronics.

**Pressure sensor**
The pressure sensor is only required for systems with tire impression compensation (load-dependent travel height change resulting from tire impression).

## Service and maintenance information

The ECAS system is maintenance-free. A diagnosis in the ECU program allows the system to inspect itself. Another check of the system is not required, besides checking the system parts, which cannot test themselves (distance sensor rod, linkage, warning lamps, etc.).
If an ECU error is detected, it is indicated to the driver via the display. Only then does the system have to be tested in a workshop.

## Device overview

| Name | Application | Product number |
|---|---|---|
| ECAS Electronics without CAN | Mercedes-Benz | 446 055 501 0 |
| | MAN, Solaris | 446 055 503 0 |
| | MAN | 446 055 508 0 |
| ECAS Electronics with CAN | Mercedes-Benz | 446 170 084 0 |
| | Mercedes-Benz | 446 170 085 0 |
| | Solaris | 446 170 210 0 |

## Device overview examples

| Name | Note | Product number |
|---|---|---|
| Distance sensor | DIN bayonet with temperature compensation | 441 050 011 0 |
| | DIN bayonet without temperature compensation | 441 050 012 0 |
| | DIN bayonet straight lever | 441 050 100 0 |
| | DIN bayonet Cruciform lever | 441 050 120 0 |
| | Schlemmer bayonet with temperature compensation | 441 050 006 0 |
| | Kostal M 24x1 with temperature compensation | 441 050 008 0 |
| Solenoid valve block | FA/RA 3x DIN bayonet | 472 900 056 0 |
| | FA/RA 6x Kostal M 27x1 | 472 900 050 7 |
| | FA DIN bayonet | 472 880 061 0 |
| | FA DIN bayonet | 472 880 064 0 |
| | FA DIN bayonet | 472 880 001 0 |
| | FA DIN bayonet | 472 880 000 0 |
| | FA Kostal M 27x1 | 472 900 021 7 |
| | FA DIN bayonet | 472 880 024 0 |
| | FA/SA 2x DIN bayonet | 472 905 111 0 |
| pressure sensor | DIN bayonet M 16x1.5 | 441 044 102 0 |

## Tips and trivia for the workshop

To calibrate the ECAS system successfully, the following must be observed:

**Before the calibration:**
- The right function of the distance sensor must be ensured.
- No entries are to exist in the diagnostics memory.
- The vehicle must be positioned on a level, horizontal surface for calibration.
- The distance sensors are to be checked for the correction position before calibration (normally 90° to the angle of installation).

**Safety information:** Always use chocks!
- The parking brake and the halt brake must be released (Status of the doors: closed).
- Tire pressures must be checked or corrected.
- Sufficient supply pressure must be available.
- The power supply must be ensured.

**Calibration:**
- When calibrating, the vehicle manufacturer's information must be observed. A defined driving height of 320 +/- 20mm is often set as the default for city buses (measured from the ground to the entrance edge).

**Features of the articulated bus:**
- The respective diagnostic addresses of the ECUs can be different (towing vehicle and trailer).
- The addresses are stored in the diagnosis software. For articulating bus tow-vehicles, the address is 16, for the trailer, the address is either 17 or 19 (vehicle manufacturer-specific).
- The second ECU is to be electrically disconnected from the system for the diagnosis or for calibrating, since otherwise, a proper diagnosis cannot be performed because of the cabling.

## Legal characteristics

Specifications for ECAS in the bus are found in §35d StVZO "Directives for externally powered boarding aids in buses" (Excerpt):

**1. Application area**
These directives are used for buses that are equipped with externally powered boarding aids.

**2. Term specifications**
**2.2 Kneeling system**
A kneeling system where these directives are concerned, is a device for raising and lowering the vehicle body for buses.

**3. Requirements**
**3.2 Kneeling system**
**3.2.1 Actuation**
To activate a kneeling system, an additional detachable switching mechanism is required.
**3.2.2 Methods of actuation**
Raising and lowering the vehicle body must be able to be controlled manually or automatically.
**Automatic control equipment**
With an automatic control unit, the lowering process must be able to be stopped and switched to raising using an emergency switch within the driver's immediate reach.

Actuating the lowering procedure again should only be possible from the normal position (position during travel) of the vehicle body.

**3.2.3 Lowering the vehicle body**

The lowering procedure is only to be possible with the doors closed. It should only be possible at a driving speed under 5 km/h.

The lowering procedure must be mainly complete (at least 80% of the distance) before the passenger doors are completely open.

The bus must not be able to drive when lowered.

**3.2.4 Raising the vehicle body**

The raising procedure is not to start as long as a passenger door is still completely open. If the door reversing device is triggered, the raising procedure should be aborted.

**Note:** Since 13. February 2005, the lowering apparatus in the bus must also conform with EC directive 2001/85/EG.

## ESAC

The chassis suspension ESAC (Electronic Shock Absorber Control) is based on the ECAS system and is integrated in the ECAS as well. Existing sensors – and information existing from them – can be used.

ESAC-ECU

ESAC

**Features of ESAC:**

- Sensors installed directly or indirectly in the vehicle detect the load status as well as information on the profile of the street, the vehicle speed, the body movements and the lateral acceleration.
- The ESAC electronics determine the optimum suspension requirements, actuate the proportional valves of the chassis suspension electrically and change the suspension characteristics within milliseconds.
- ESAC can be used for leaf-/air suspension and full air suspension vehicles.

**Advantages of ESAC:**

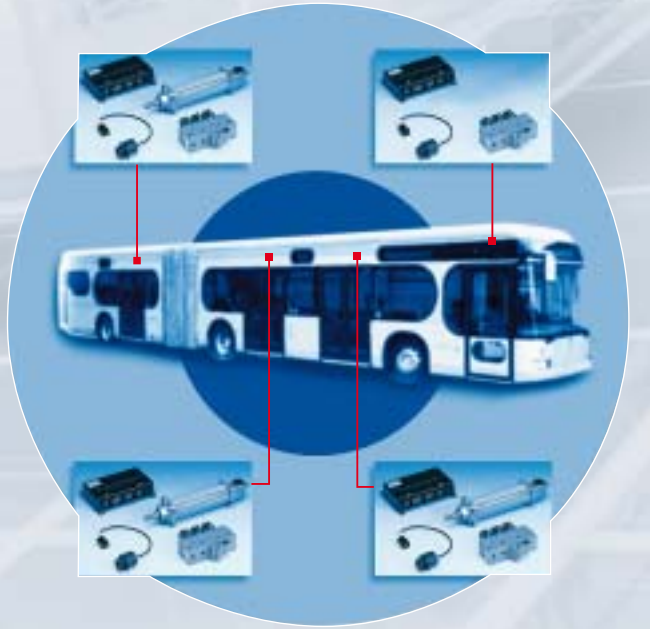
- Maximum driving comfort
- Improved driving stability with violent driving maneuvers or fast curves by reducing the roll angle
- Great reduction of brake and acceleration pitching (especially with vehicles with short wheel-base)
- Improved control behavior of the air suspension with intelligent interaction of ECAS and ESAC
- Reduced burden on the roads


MTS - Modular Door Control


WABCO

**The modular door control has been developed based on the experiences with the electronic door control (ETS). Using MTS, for the first time in a vehicle, up to five doors of different constructions can be actuated and monitored with identical control devices.**

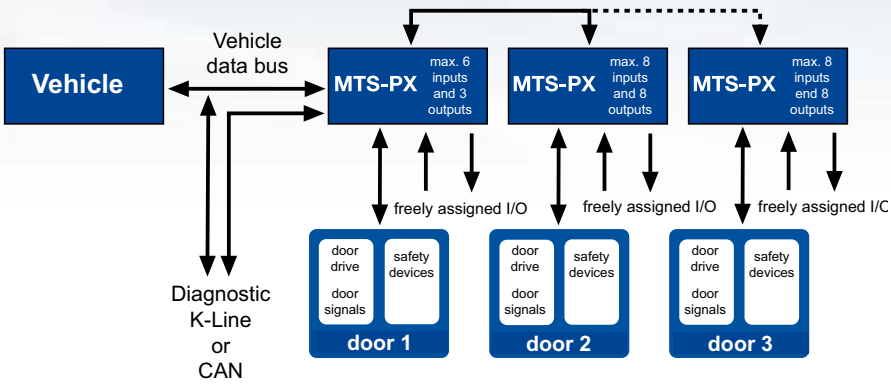
**MTS can be used for a number of different door types, inward pivot, outward pivot doors with and without lift-locking or sliding plug doors. In a single vehicle, it is possible to use pneumatic and electrically driven doors in any order.**



## Product advantages and features

**Advantages of MTS**

- Easy system comprehensibility
- Cost reduction with less components / cable than with ETS
- Reduction in intensive adjustment work
- No complex relay connections of standard controllers
- Parameter setting via software enabling easy adjustment of the controller to customer-specific desires is possible.
- Replacement capabilities for electronics in doors 2 to 5 without regard to the parameters, since data for all doors is saved in the controller for door 1.
- Complete diagnostics capabilities (CAN-bus or K-line)
- Independence of door type (inward pivot, outward pivot and sliding doors with pneumatic or electric drive)
- Connection of up to 5 MTS electronics with a CAN data bus (up to 5 doors can be controlled)
- Conventional cabling is still possible
- No matter whether with CAN or conventional means - in either case, the individual doors are connected via the System CAN bus.



**Door monitoring**
Monitoring the pneumatic doors is done via installed potentiometers on the turning column. These sensors do not have to be set because of the mechanical coding.

Electrically driven doors are sometimes also monitored with potentiometers. The use of pulse generators integrated in the motor along with one or more limit switches is also possible.

For electric doors, because of the respective construction, a separate control device variant is used.

## Components


MTS components

**Components of MTS:**
- Electronics (for electronic or pneumatic door)
- Sensors for swinging doors
- MTS door control valve
- MTS door cylinder
- Emergency valve with switch
- Pressure switch

In order to ensure the trouble-free interaction between door electronics and door mechanics – and therefore the safety of operation and passengers – the proper mechanical adjustment and mobility of the door must normally be guaranteed

.

## Device overview


MTS control electronics


MTS control electronics

| Name | Product number |
|---|---|
| Electronics type PX for pneumatic doors | 446 190 001 0<br>(also replaces 446 190 000 0 and 446 190 002 0) |
| Electronics type EX for electronic doors | 446 190 011 0<br>(also replaces 446 190 010 0) |
| Door valve | 472 600 022 0 |
| Door sensor 125°, for inward pivot door with surge insulator | 446 190 150 0 |
| Door sensor 125°, for inward pivot door without surge insulator | 446 190 152 0 |
| Door sensor 180°, for outward pivot door without surge insulator | 446 190 151 0 |
| Door cylinder | 422 812 000 0 |
| Emergency valve | 952 003 032 0 |
| Pressure switch | 441 014 017 0 |

## Service and maintenance information

**The following points are to be observed for service with an MTS system:**
- The correct status of the door is always to be checked for servicing. The door should be plumb and horizontal and voltage-free.
- All moveable parts must be free-moving and have no play (lubricating may be necessary, manufacturer‘s specifications are to be observed)
- For regular legal inspections, such as the visual check (SP) or the main inspection (HU), the closing forces are to be checked.

**Jam detection for doors:**

- The doors are equipped with so-called jam protection mechanisms, which must be checked during servicing.
- In monitoring the opening apparatus, the doors are switched to a powerless state (both door cylinder chambers are under the same pressure). The door wings can be moved by hand. An indicator light in the door button in the drivers workplace indicates the activated jam protection mechanism.
- When reversing in the closing direction, the function of the door is opposite (“door open”).

**The learning process of a door occurs as follows:**

- Opening and closing each door with continuous actuation of the workshop button (duration per teach cycle: approx. 5-7 sec.)
- Number of expansion modules and operating mode (CAN or conventional) are learned on door 1
- Learn process is acknowledged by flashing the boarding lighting
- Number of flash pulses corresponds with the door position in the vehicle
- Sequence for initial operation:
  - Teach door 1
  - Switch ignition off/on
  - Teach remaining doors

The MTS system can be checked with the PC diagnostics software.

- Only if replacing the electronics for door 1 must the data of the old ECU be transferred. In each case, the system must be taught afterward.

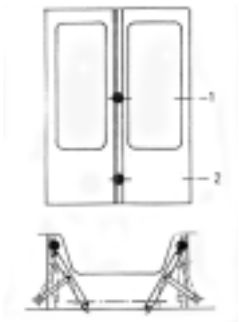
**Note:** Old and new calibration values can obtained from the diagnosis and allow conclusions to be made concerning the status of the mechanics of the door.

- Sensor replacement: Observe installation notes of the vehicle or door manufacturer.
- The positioning is defined with a positioning stub on the distance sensor. The sensor is therefore set in a certain position in relation to the turning column.
- The damping of the doors can be changed with a set screw. In this regard, only the damping strength is changed and not the beginning or the start of the damping. This affects the opening and the closing directions.

**Caution:** Adjusting the cushioning effect will not correct any defects in the door mechanics.

- The door speed is defined with so-called fixed throttle. With two wing doors, the door speed of the front wing must be progressively slower in the closing direction, so that the rubber flap will lay over the rear door wing. This ensures a good seal and wind noise is dampened.

## Legal characteristics



Measurement points, e.g. with an inward pivot door

For the main inspection (HU) and the safety test (SP), a check according to § 29 StVZO is required for passenger doors.

This test includes the measurement of door closing forces among other things. Here, mainly a measuring device of so-called class 2 is recommended by the German Institute for Occupational Health and Safety. This device only determines the peak force Fs. Closing force is to be measured on two measurement points of the main closing edges (door centre and 150 mm above the lower door edge). For doors with jam protection, three measurements are to be made in the opening direction on the secondary closing edges as well (possible jam points). The average is to be maintained.

**Note:** For both measuring points, the measured peak force Fs is not allowed to exceed the value of 200 N in the closing direction and 250 N in the opening direction.
In order to perform the measurements, existing reversing equipment (e.g. regulator switch) must be fully functional.

**Safety test (Excerpt from SP specifications)**
On busses with more than 22 (previously 16) passenger seats, during the safety test along with the test of the flooring, steps and existing mobile boarding aids (ramps) with “vehicles with initial registration” as of July 1990, the passenger doors are to be checked for proper functionality of the jam protection:

Conforming with § 35e Para. 5 StVZO and the respective, publicized “Directives for externally actuated door systems”, equipment that should prevent passengers from being jammed must introduce a reversal of the closing movement (reversing) or stop the closing force at a jamming force (effective force $\mathbf{F_e}$) of not more than **150 N**.

For the repeat tests according to § 29 StVZO in combination with the system VIII (HU, SP), measurements of the effective force $F_s$ with measuring devices of class 1 or measurements of the peak force Fs with measuring devices of class 2 are to be made in the door centre and 150 mm  For both measuring points, the measured peak force $F_s$ is not allowed to exceed the value of 200 N in the closing direction and 250 N in the opening direction.

For externally actuated door systems in busses, besides the national regulations (StVZO § 35e besides directives) EU directive 2001/85/EG (the so-called bus directive) and the ECE-R36 (the content of which has mainly be taken over in 2001/85/EG) and ECE-R107 are applicable.

**The following requirements are mainly formulated in the various specifications:**

- There must be no danger of accident/injury
- Regular inspections including documentation
- Definition of the maximum permitted forces, the measuring points and the measuring procedures
- Minimum monitoring range “30 mm test stick”
- Fingers or anything else jammed in must be easy to remove “Test stick, tapered” (2001/85/EG 7.6.5.6.1.2.)
- Emergency actuation installation site, inside/outside, blockage outer emergency valves

# ATC - Automatic Temperature Control


WABCO

**Heating, ventilation and climate control (HLK) now belong to the standard equipment for city and overland buses.**

**ATC offers maximum comfort for driver and passengers. Different operational equipment and expansion stages, ATC is adapted by the vehicle manufacturer to the respective vehicle-specific requirements. The possibilities offered through parameter definition enables the ATC to be adapted to the various customer-requirements.**

All requirements on an ideally acclimatized city bus are compiled in regulation 236 of the VDV (Association of German Transport Undertakings), which is the basis for regulating the city bus ATC.

ATC regulates more than just the climate.

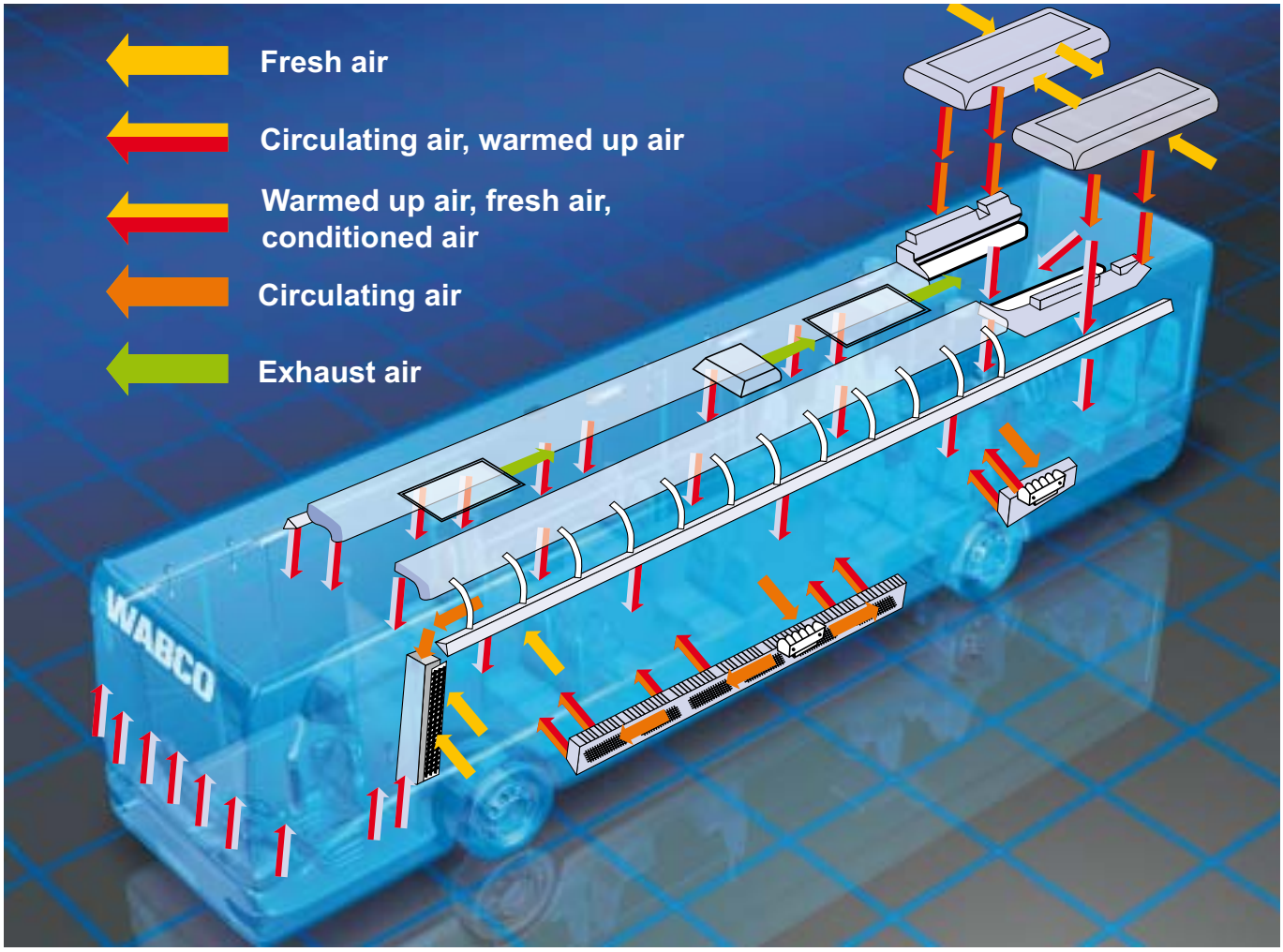
**Advantages of ATC:**

- Automatic regulation of the heating, ventilation and air-conditioning (HLK), so that the driver no longer has to perform extensive adjusting
- Manual access to flap control, temperature control and fan control for the driver's workstation
- Fully automatic air-conditioning of the passenger area (can be switched on or off on the control element)
- More comprehensive setting capabilities for the passenger area regulation in overland buses
- Setting and regulation of the work area of the driver to personal requirements
- Quick diagnosis of the ATC possible via diagnosis program; Faults can be read and localized

**Features of the ATC:**

- Master-Slave system, which communicates with the vehicle via a CAN interface: directly reading of required vehicle data (such as e.g. coolant temperature)
- Connection for substations via internal HLK CAN bus
- Control element with integrated display for vehicle without central display
- Desired value setting via control element
- Temperature control precision of approximately 1°C
- Connection of additional and engine-dependent heating possible
- Control of fan speeds and optimization for closing doors via signals from door movements
- Detailed onboard diagnosis in control element with display
- Functions such as smog switching, defrost function and reheat operation request integrated in control elements

**Functionality of ATC**




## Components

**An HLK system in an Bus consists of the following components:**

- Control element for driver position and passenger area control
- Substations (a special interface is used for exchanging all control element data such as sensor values, set values and naturally diagnostics messages.)
- Temperature sensor for recording the outside, inside and air outlet temperatures to heat exchangers
- Water temperature sensor
- Blower module
- Water valve for regulating the flow through the heat exchanger

An ATC system in a bus contains, besides the control element, up to 8 other substations that are connected via a CAN-bus system. In a double-deck overland bus of the luxury class, up to 6 substations are used.

**For example:** In a Solo city bus, the control element can be operated as a stand-alone unit and controls the blower speed and heating temperature for driver and passenger areas. When using air conditioning, an additional substation is required.

In the regulator of the control element or in the connected substations, the sensor values (temperature measurements) are processed and the control signals for the actuators, such as flap servo motors and sensitive adjustable water valves are made ready and set to the defined set levels.

## Device overview

| Application | Name | Product number |
|---|---|---|
| Mercedes-Benz | ATC control element for city bus | 446 195 003 0 |
| | 5-button city bus front cover | 446 195 034 2 |
| Mercedes-Benz | ATC control element for city bus | 446 195 001 0 |
| | 3-button city bus front cover | 446 195 032 2 |
| Mercedes-Benz | ATC control element for city bus | 446 195 002 0 |
| | 4-button city bus front cover | 446 195 033 2 |
| MAN, Neoplan | ATC control element for city bus | 446 195 004 0 |
| | 5-button city bus front cover | 446 195 037 2 |
| Mercedes-Benz | ATC control element for over-land bus | 446 197 001 0 |
| Mercedes-Benz, Setra | ATC control element for over-land bus | 446 197 004 0 |
| Mercedes-Benz | ATC control element for over-land bus | 446 197 005 0 |
| Bova | ATC control element for over-land bus | 446 197 040 0 |
| | Overland bus front cover for all WABCO control elements 446 197 00X 0 / 446 197 04X 0 | 446 197 030 2 |
| Various Buses | Substation | 446 196 000 0 |
| Various Buses | Water valve | 446 091 002 0 |
| Various Buses | Water valve | 446 091 004 0 |
| Various Buses | Water valve | 446 091 200 0 |
| Various Buses | Temperature sensor, Interior | 446 092 003 0 |
| Various Buses | Temperature sensor, exterior | 446 097 000 0 |
| Various Buses | Temperature sensor, water | 446 097 001 0 |
| Various Buses | Blower module | 446 024 012 0 |
| Various Buses | Starting module | 446 024 020 0 |
| Setra, Solaris | ATR-E control element | 446 095 003 0 |
| MAN, Neoplan | ATR-E control element | 446 095 006 0 |
| MAN, Neoplan | ATR-E control element | 446 095 007 0 |
| Setra | ATR substation | 446 096 000 0 |
| Setra | ATR substation | 446 096 003 0 |
| MAN, Neoplan | ATR substation | 446 096 007 0 |
| Mercedes-Benz | ATR substation | 446 096 006 0 |

Repair kits are available for many control elements.

## Service and maintenance information

The CAN system control element contains the entire parameter set for the complete ATC system, including the parameters for the sub-modules. If one or more sub-module(s) have to be replaced, no other settings are required because they are already defined in the control element and are automatically transferred to the sub-module(s).

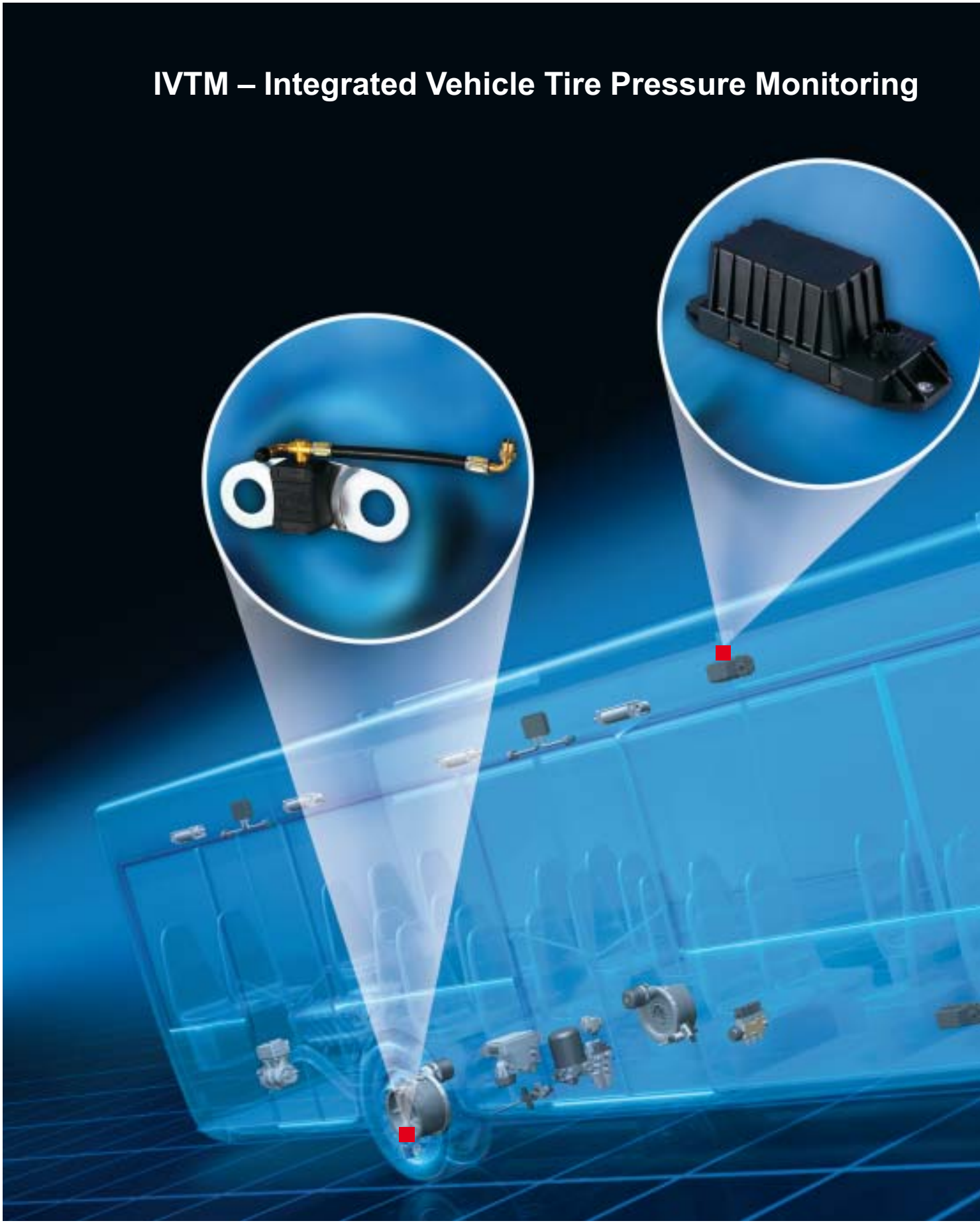
**Replacing the control element**
When replacing the control element, the standard parameter set must be changed or adjusted specific to the respective vehicle, with the support of the vehicle manufacturer if necessary. Using the vehicle ident. no., the respective parameter set can be determined from the vehicle manufacturer. Another possibility is reading the parameter set from the ECU to be replaced using the diagnosis software. This can then be transferred to the replacement ECU.

## Tips and trivia for the workshop

**More information**
ATC is basically maintenance-free. Any faults that occur are indicated respectively and can be read via the diagnosis.
To fill the system with coolant, on many types of vehicles, the values must be opened in a certain sequence with the diagnosis option. This system is to be depressurized in this context. Please note the operating instructions of the vehicle manufacturer.
With HLK and air-conditioning vehicles, all air filter mats should be replaced or cleaned every 6 months or when required. The same applies for the so-called active carbon filter, as long as the vehicle is equipped with this equipment. Please note the interval-related service instructions of the vehicle manufacturer.
It is worth storing sub-modules for service. Addressing in the system is done via PC diagnosis with older components and automatically with newer. Please note the part number master.
If system faults occur, the mechanical transfer components should be checked, such as e.g. the flap control or the water valves, on which the mechanical position could be interpreted incorrectly if necessary.The temperature sensor should be free of contamination, since otherwise the measurement cell is not immediately in connection with the environmental air and so the actual temperature of the system cannot be reported.

## Legal characteristics

The legal guidelines and regulations regarding disposal of used materials and consumables of air conditioning units must be maintained.


IVTM – Integrated Vehicle Tire Pressure Monitoring

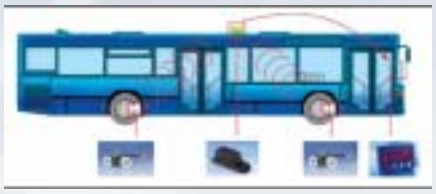

WABCO

**IVTM (Integrated Vehicle Tire Monitoring System for Commercial Vehicles) stands for increased safety, mobility and economy.**

**With the tire pressure monitor system IVTM for buses, which can be installed at any time, you are automatically informed when "the air goes out" of the tires.**


**IVTM Increases Safety**
Proper tires are life insurance for driver, passengers, vehicle and load. With IVTM (Integrated Vehicle Tire Pressure Monitoring), WABCO provides a system that monitors the tire pressure in motor vehicles, tow vehicles or buses permanently and using direct means of measurement.

**Investigations resulted in**
Tire damages are the second most frequent cause of breakdowns. With around 15 % of all tire breakdowns, a tire blows with sudden, large-area damage. 25 % of breakdowns are the result of tire damage.
With 85 % of tire breakdowns however, a slow leak occurs that the driver normally does not notice, especially on commercial vehicles.
IVTM identifies slow pressure losses and warns the driver in a timely manner - long before the tire suddenly fails. This is a means of preventing accidents causing serious damage, flat-repairs in dangerous areas or even unnecessary downtimes with costly consequences.



Time-consuming tire installation for installing sensors in the rims is not required. Measuring the pressures is done on the tire valve through a wheel module, simply screwed on with the wheel nuts. The IVTM ECU is mounted on the vehicle chassis and receives the pressure data for all wheels by radio signal.

The pressure can be called up for each tire from the driver's seat. The display in the instrument panel warns the driver optically and acoustically of critical deviations from the defined nominal pressure. May original equipment manufacturers integrate the display for tire pressure in the instrument panel already.

**Product advantages and features**

Saving time and money.

**Advantages of IVTM:**
- Increased traffic safety
- Savings with fuel costs with less rolling resistance
- Reduction in maintenance costs and tire damage because of insufficient tire fill pressure
- Increased tire life-span by driving with optimal
- tire pressure
- Ideal for retrofitting in buses
- Uncomplicated operation
- No intensive manual tire checks for personnel directly on the tire valve, since the pressures of all tires can be displayed on the IVTM display

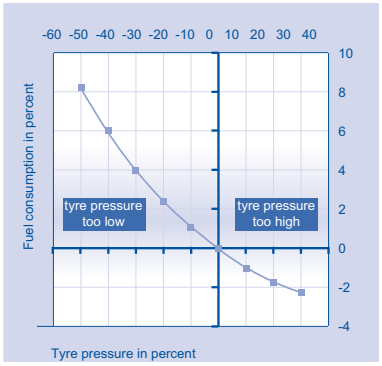
- Fast localization and correction of operational and system faults with diagnostics memory

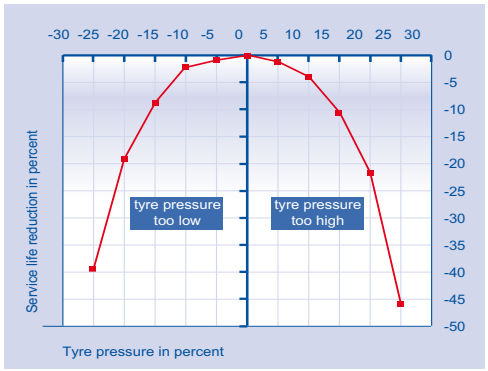
**The operating costs can be lowered by more than 400 Euro per bus per year by using the IVTM! ***

With only a single prevented breakdown and all of the costs connected with it, the system will pay for itself in most cases.

* Calculation applies for Solo bus 4x2 (6 tires) with an annual driving distance of 50,000 km. Presumed low pressure: 10 %. Fuel consumption: 35 liters over 100 km (price per liter 0.90 Euro). Tire mileage: 80,000 km (Tire price 250 Euro). Manual tire pressure checks: Every four weeks. Accepted maintenance costs: 30 Min. each 40 Euro per hour.

**Display of the relationship between tire fill pressure and fuel consumption - and tire life-span**




## Functionality and components

IVTM wheel module

IVTM-ECU

IVTM display

### Wheel module

For permanent monitoring of the tire pressure, each wheel is equipped with a wheel module mounted on the wheel bolts and a hose connection directly to the valve.
The tires therefore do not have to be removed from the rim during wheel module installation. With a wheel or a tire change, the system does not have to be reconfigured.

### Pressure sensor

The wheel module contains a pressure sensor, the measured values of which are transferred in regulator intervals to the IVTM ECU (Electronic Control Unit) via a 433 MHz radio link.
In the electronics, an evaluation algorithm, which was especially designed for commercial vehicle tires by Michelin experts, detects all critical deviations from the set pressures of the tires.

### IVTM display

The driver can be warned on time of critical pressure losses by the system through an IVTM display. The risk of a sudden flat tire can be greatly reduced.

### Display features:

- Acoustic warning
- Display of the position of the faulty tire and its current pressure
- One ECU can monitor up to 12 wheel modules
- Integrated antenna in the ECU for proper reception of the pressure signals, even on 18 meter articulating buses

## Device overview

| IVTM components (Example) | Product number |
|---|---|
| IVTM electronics | 446 220 012 0 |
| IVTM Display | 446 221 000 0 |
| Rear axle wheel module | 960 730 001 0 |
| Front axle wheel module | 960 730 012 0 |

**Note:** Because of a multitude of different tires and valve connections on buses or commercial vehicles, IVTM sets are available for the standard configurations such as Solo-buses and articulating buses for many other variations.
Please ask your WABCO consultant for More Information or for a consultation. We would be glad to provide you with a proposal for an IVTM retrofit on your buses.

## Service and maintenance information

IVTM is maintenance-free. Only if the display indicates a faulty function must troubleshooting be done via the diagnostics.

## Tips and trivia for the workshop

All work on a wheel, hose and wheel module or tire pressure corrections must be done with the ignition "OFF", since otherwise a notice entry will be made in the ECU. A system reset is then performed automatically.

Because of the external fastening of the wheel module on the wheel bolts, no new sensor has to be installed when changing tires. It is only necessary to guarantee that the wheel module is installed in the same position when changing a wheel or tire, i.e. on the same wheel bolts.

Especially with dual tires, the correct allocation to the inner and outer wheel must be taken into account. With dual tires, the wheel modules must lie opposite one another (prevent imbalances). With single tires, counterweights are installed accordingly.

When removing the hose from the wheel module, contamination in the wheel module connection should be prevented. Check for damage to the O-rings of the plug-in connection when changing the hose. Replace defective O-rings if necessary.

Valve connections must always be frictionless and not twisted. Hose brackets may have to be used in cases. Especially after changing tires, the hose position should be checked.
Check the seal on the valve and wheel module with leak detector spray if necessary.
When using so-called SuperSingle tires, such as e.g. the Michelin X-One, using tire pressure monitoring systems from the vehicle manufacturers is specified.

# Tire Premium Seal

**First aid for flat tires**
**The tire sealant has been tested and approved by the most renowned of vehicle manufacturers. Tests have also been performed on equipment such as DEKRA with positive results. Distinction with the official DEKRA seal of approval.**

- Simple, quick and safe
- Reduced downtimes on the street
- Latex-free technology
- Environmentally friendly
- Continued travel up to 1000 km with the repaired tire
- Spare tire not used

Tedious tire changes are a thing of the past with WABCO Tire Premium Seal. Avoid changing tires on the edge of busy streets, where you are in the way of passing vehicles and hinder the flow of traffic. Decrease the time needed to repair a flat. Time is money - especially with tight schedules. A flat tire is especially unpleasant and dangerous, especially in the dark, rain, snow and cold.

This innovative, latex-free tire sealant is simply sprayed into the tire with the help of the compressed air system of the vehicle. It seals up to 10 mm diameter holes from the inside and enables immediate travel again. The spare tire is not required.

**Simple application**
The WABCO Tire Premium Seal flat set contains a valve key set, which enables quick and easy removal of the valve and filling the tire with WABCO Tire Premium Seal through the valve stem. This creates a closed system between the tire and the sealant container, which prevents the residual air from escaping when removing the valve and the tire from separating from the rim.

**Approved up to 80 km/h**
The tire sealant has been tested and approved by the most renowned vehicle manufacturers, and DEKRA has certified the product. The tire sealant serves to save downtime in the case of a low or flat tire and is not meant to be a final tire repair. A final repair of the tire must be done at least after 1,000 km or within 14 days by a certified specialist.

**The clean solution**
WABCO Tire Premium Seal is environmentally friendly and water-soluble. If the time has come to perform a permanent repair, WABCO Tire Premium Seal can be removed with a cloth. The remnants can be washed off with water and disposed of through the sewage system. National and regional disposal regulations must be observed.

# Diagnostics and Testing Equipment


WABCO

## General information on diagnosis

**WABCO Diagnosis Software**
For the electronic systems in commercial vehicles, there are various suppliers of diagnostics systems. Most of the programs allow unlimited system diagnostics, whereby parameter definition is limited (see PIN assignment).

The diagnosis software for electronic WABCO systems is offered with an annual subscription, etc. In this case, you will automatically receive all updates and software supplements and are always at the latest status of vehicle and safety technology. WABCO offers a special diagnostics software package for bus customers. It currently includes 26 system-related diagnostics programs.
It is to be obtained directly via the Internet under www.wabco-auto.com.

Laptop "Toughbook"

**For a system diagnosis, you require:**
- A "Toughbook" laptop or standard PC/Laptop
- The required diagnostics software
- Diagnostic interface for WABCO diagnosis
- Connecting cable to vehicle electronics or diagnostics connecting socket

All of the components required for diagnosis can be obtained directly from your WABCO dealer.

## Why do I need the PIN?

The PIN is the verification of the respective system knowledge and allows changes to parameters in electronic systems. Every participant in a system training is given a license letter, with which he/she can call up their PIN on the Internet. With this "Personal Identification Number", it is possible to enable extended functions in the software and to use them to change settings in the controller electronics (Parameter definitions).

When using the PIN, a so-called fingerprint is left in the diagnosed electronics, i.e. every change, especially for parameters, can be traced thereafter.

The PIN is **always** related to a certain person. This separates between the company-related diagnostics software via the subscription number and the person-related training. An employee can therefore change to another subsidiary and "take" his PIN data along with him/her.

## Testing and additional devices

Serial diagnostic interface

USB diagnostic interface

Diagnostic software accessories case

**Diagnostic Interface**
The PC/laptop is connected with the vehicle electronics via the diagnostic interface. The diagnostic interface is available optionally with a COM interface or USB connection. It can be used for all WABCO diagnostic software products.

- Diagnostic Interface 446 301 021 0 (serial) or
- Diagnostic Interface 446 301 022 0 (USB)

**Diagnostic cable**
For the connection between the vehicle and the interface, WABCO offers various pre-fabricated diagnostics cables.

**Diagnostic software accessories case**
**446 301 020 0**
With this case, you always have the most important connecting elements between the vehicle and your PC. After completing the inspection of the vehicle, the cables can be stored in the case again, in order and safe.

**Test case for compressed air brake systems**
**435 002 007 0**
Calibrated test pressure gauges, connecting hoses and other parts of the test case enable quick and precise inspection of compressed air brake systems according to the guidelines for performing the safety testing for commercial vehicles.

## WABCO expert diagnostics


Premium diagnostic solution

Compact diagnostic solution

WABCO Expert Diagnostics provides you with the capability to diagnose systems of different vehicle manufacturers / system suppliers.
Because of its modular construction, you can use Expert Diagnostics to offer exceptional service for many different vehicles. WABCO will also ensure the support for new and older vehicles of different manufacturers in the future.

WABCO Expert Diagnostics is available in different versions – from the portable Smart-Handheld solution (Compact), which was designed for use with existing diagnostic equipment up to the comprehensive extended diagnostic solution (Premium), Expert Diagnostics meets the specific requirements of your workshop.

The Advanced and Premium packages include additional hardware as well as the WABCO Diagnostic Software.

The "Toughbook" laptop can also be used for other office activities because of its open operating system.

**The following packages are available:**

- Toughbook* 446 302 040 0
- Compact 446 302 001 0
- Advanced 446 302 002 0
- Advanced* 446 302 004 0
- Advanced** 446 302 006 0
- Premium 446 302 003 0
- Premium* 446 302 005 0

* without WABCO cable set and without WABCO software
** without laptop

## Tips on diagnosis

- For work on the respective systems, the diagnostics memory is to be read and saved first. The diagnostic memory is then to be deleted and a test run is to be made with the vehicle. The diagnostic memory is then read again and the existing entries are processed.
- If a diagnostics structure is not possible, check for whether the existing system in the vehicle is supported by the currently selected software (Diagnostics software => Help => Supported ECUs). The respective diagnostics cable and diagnostics software are to be used.
- For the diagnosis via the USB interface, the USB driver must be installed first. The installation information is provided on the WABCO Internet site under www.wabco-auto.com.
- With multiple systems installed in articulating buses (ECAS), the diagnostic call may be required via different addresses.
- If the computer does not have a diskette drive, the driver software can be obtained via the Internet as well.

Please contact your WABCO consultant. He will gladly help you in creating system-oriented testing means surveys.
This provides vehicle-specific diagnostic cables and various connecting adapters for ATC for example.

# TIRE PREMIUM SEAL

*Move on fast*

## Innovative first aid kit for your leaking tire

Tire Premium Seal from WABCO is the simple, fast, safe way to get drivers back on the road after a tire leak. This complete kit for commercial vehicles makes tubeless tire repair at the roadside in mere minutes a reality, eliminating the need to wait for assistance and cutting drivers' exposure to danger. The environmentally friendly latex-free technology in Tire Premium Seal means repaired tires can be driven up to 1,000Km at a maximum speed of 80Km/h before permanent repair by an authorized workshop.

Tire Premium Seal helps your drivers achieve the safe, timely delivery you need. For more information, visit www.wabco-auto.com

Part number: 899 900 001 0

**www.wabco-auto.com**

WABCO


Product Training and E-Learning
TECHNICAL TRAINING
E-LEARNING


WABCO

WABCO University

**For busses, WABCO provides a full range of special training sessions and seminars with various contents and durations.**

**Content:**

- Structure and functionality of EBS-, ECAS-, ETS-, MTS-, IVTM- and ATC systems and their components
- Explanations of system structure and electronic circuit diagrams and on control behavior
- Testing and troubleshooting with WABCO PC diagnostics
- Calibration of the ECAS system (setting the drive height)
- Descriptions for parameters from EBS, ECAS, MTS and ATC in busses

**Note:** The participants are given a certificate after successfully completing the course. After successfully completing a system course, the participant can be provided with the system-related PIN (Personal Identification Number) for using special diagnostics functions on WABCO systems for busses

## E-Learning

**Knowledge and competence on the commercial vehicle market**
Online-Training means computer-aided learning at an internet-capable computer at an E-Learning portal. WABCO offers this new method for training as another online service for its customers. The content of the course is passed on in audio-visual modules, which are often made up of several training units and are normally concluded with a qualification test.
The E-Learning offer is available on the Internet under the direct link www.wabco-university.com or http://wbt.wabco.info and currently includes systems ECAS, VCS II and IVTM. This offer is being continually expanded upon and provides you with the ability to test the demo version before deciding to actually take the course.

**Advantages of E-Learning:**
- Complete course with completion test and license letter
- Simple, structured learning with interactive elements
- Unrestricted time management, breaks possible at any time

**Prerequisites for participation are:**
- Computer with audio, headphones if possible
- Internet access via ISDN, DSL (recommended)
- Personal Email address

**More information on:**
- Schedules
- Training locations
- Registration
- E-Learning

can be obtained on our Internet site www.wabco-auto.com
or directly from your WABCO consultant.

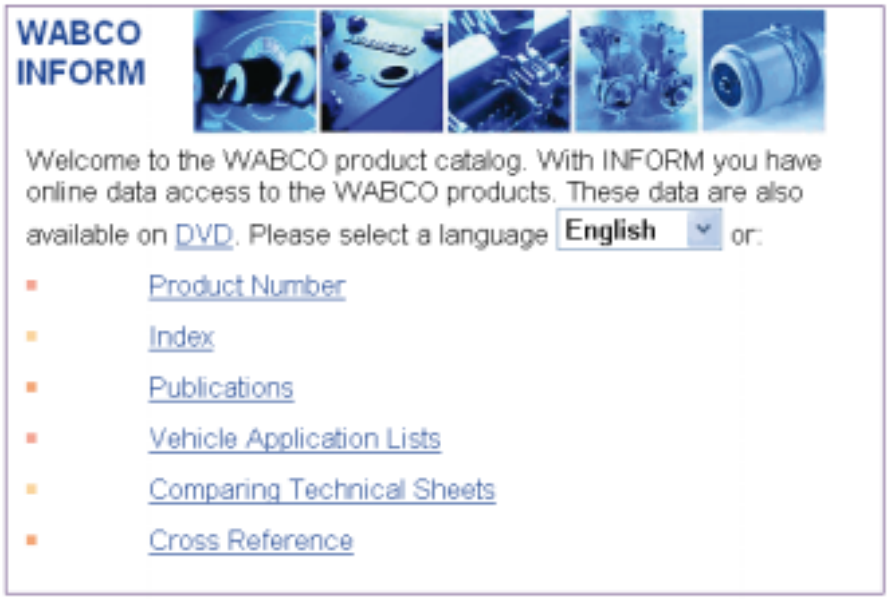
## WABCO INFORM

The functionality and maintenance of mechanical and electronic bus systems is a complex topic. We've been able to provide a brief glimpse on the previous pages. If you happen to have more questions during your daily work, WABCO has developed an application that you can use to call up all available product data and documents at any time.

Under www.wabco-auto.com, WABCO provides you with the product catalogue INFORM giving access to the following content:

- Replacement/successor products
- Product prices
- Brochures (test instructions, product information, training documentation, user manuals, etc.)
- Repair sets
- Replacement part sheets
- Data sheets (information on products)
- Vehicle equipment lists
- Cross-reference numbers
- Diagnostic capabilities for electronics
- Diagrams and circuit diagrams

As an alternative, you can also use WABCO INFORM on DVD without the Internet.



## Index of abbreviations

| | |
|---|---|
| ABS: | Anti-Blocking System |
| APU: | Air Processing Unit |
| ARB: | Automatic Roll Brake |
| ASP: | Air System Protector |
| ASR: | Traction Control System (Antriebsschlupfregelung) |
| ATC: | Automatic Temperature Control |
| ATR: | Automatic Temperature Regulation |
| BBA: | Service Brake System (Betriebsbremsanlage) |
| BVA: | Lining Wear Indicator (Belagverschleißindikator) |
| CAN: | Controller Area Network |
| CWS: | Continuous Wear Sensor |
| DSR: | Differential Slip Control (Differenzschlupfregelung) |
| EBS: | Electronic Braking System |
| ECAS: | Electronically Controlled Air Suspension |
| ECU: | Electronic Control Unit |
| ESAC: | Electronic Shock Absorber Control |
| ESC: | Electronic Stability Control |
| ETS: | Electronic Door Control (Elektronische Türsteuerung) |
| HLK: | Heating, Ventilation and Climate Control (Heizungs-, Lüftungs- und Klimasteuerung) |
| HRB: | Half Release Bolt |
| HU: | Main Inspection (Hauptuntersuchung) |
| IBV: | Integrated Breather Valve |
| IMA: | Internal Release Bolt with Display (Innenliegende Löseschraube mit Anzeige) |
| IVTM: | Integrated Vehicle Tire Monitoring System |
| MTS: | Modular Door Control (Modulare Türsteuerung) |
| OBD: | Onboard Diagnosis |
| PR-System: | Power Reduction System (Compressor) |
| TR-System: | Temperature Reduction System (Compressor) |

WABCO Vehicle Control Systems is one of the world's leading providers of electronic braking and vehicle control systems as well as of suspension and drive systems for commercial vehicles. Our customers are some of the most well known manufacturers of commercial vehicles and busses. WABCO was founded in 1869 as the Westinghouse Air Brake Company in the USA and was then taken over by American Standard in 1968 to be then set apart as an independent company in 2007. WABCO is based out of Brussels, in Belgium and employs around 7,700 personnel in 31 countries around the world. In 2007, the total turnover of WABCO was approximately 2,4 billion US dollars. WABCO is one of the most well known companies on the New York Stock Exchange and is identified with ticker symbol WBC.
**www.wabco-auto.com**



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