

SYSTEMS AND COMPONENTS FOR BUSES

Original Manufacturer quality from WABCO



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 wear.

The "Technology around the bus" user brochure offers bus professionals a compact overview of the different component functions and product features. The integrated service tips and maintenance instructions make the brochure a practice-oriented reference and daily work in your workshop a little easier. Benefit from our know-how and apply it to provide quality, safety and comfort to your customers.

WABCO will be happy to provide further information.

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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 plant 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 optimising costs.

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Brake and Stability Control

ABS or EBS

- Modular pneumatic and electronic braking systems
- ESC and several other functions available, e.g. Traction Control (only possible for 6×2 vehicles, 3 axles), Hill-Start-Aid, Tire Pressure Indicator etc.

EBS Standard System

- Cost-effective solution covering several functions
- Easily customised by programming
- Future support for hybrid systems

Electronic Stability Control (ESC) and Steering Angle Sensor (SAS)

- Helps support the driver in critical driving conditions
- Aims to improve direction stability, especially during dynamic manoeuvres
- Aims to increase protection against tipping over, skidding and spinning

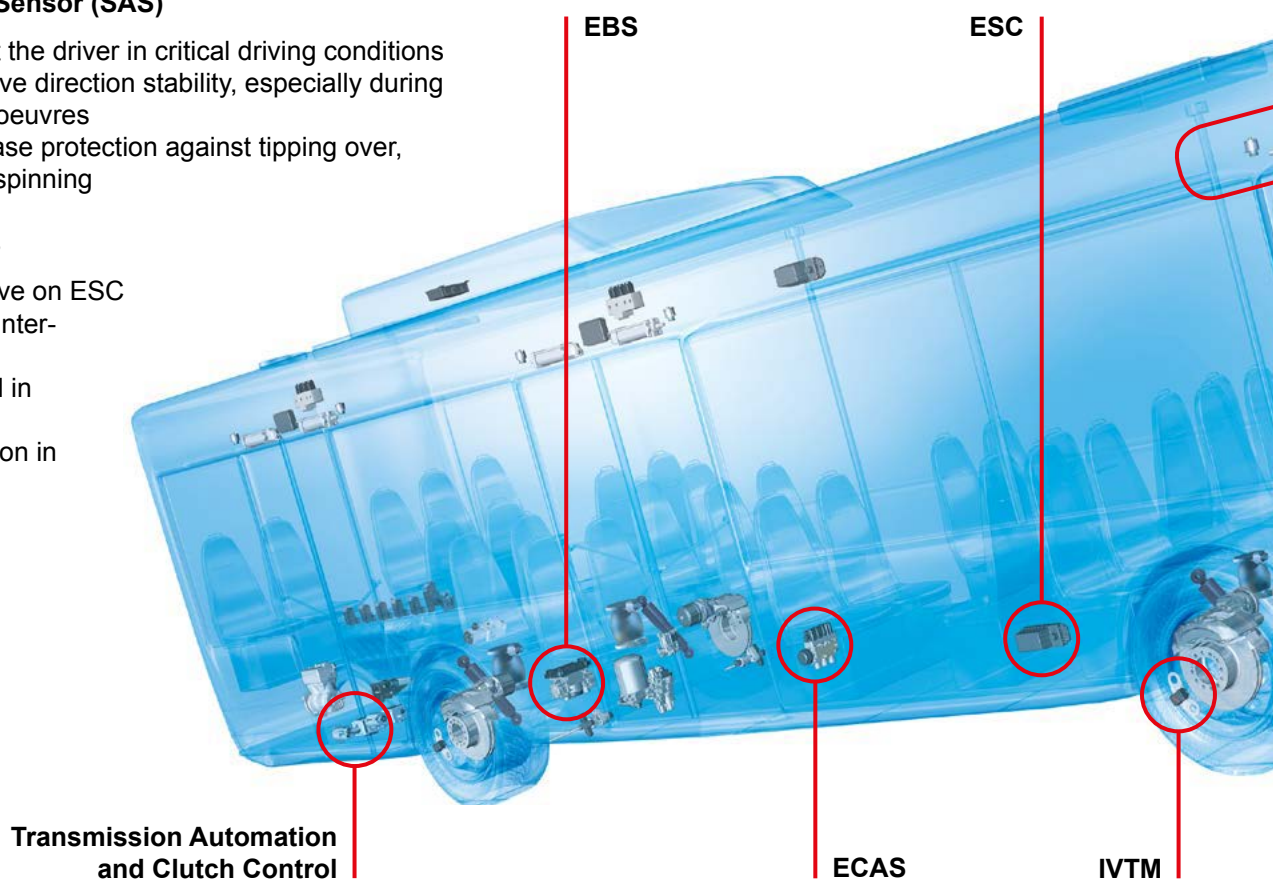
Important Dates

European Directive on ESC for coaches and inter-city buses:

- Type approval in 2011
- New registration in 2013

Door Control

- Control of pneumatically and electrically driven doors
- On-board diagnosis
- Fits the majority of bus types and different door manufacturers
- Easy calibration without tools
- Wide range of safety features



Driveline Controls

Transmission Automation

- Shifts gears according to driving situation and driver demand
- Supports more economic and safer driving

Clutch Control

- Clutch control system for manual and automated manual transmissions
- Improved and thus safer gear-shift operation
- Reduced pedal force

Suspension Control

ECAS

- Kneeling
- Automatic driving level adjustment
- Quick traction help in 6×2 vehicles
- ESAC option available

Chassis Levelling Valves

- Mechanically controlled air suspension valves for added driver comfort

Climate Control

- Automatic temperature adjustment via one control unit and up to 8 substations
- Highly modular and extensive parameter setting options
- Standard WABCO diagnostics available for all systems

Advanced Driver Assistance Systems

Lane Departure Warning Systems (LDWS) OnLane™

- Warning of unintentional lane departure (visual, acoustic, haptic)
- For use on freeways and similar roads

Adaptive Cruise Control

- Enhanced conventional cruise control
- Controls stable and safe distance to vehicle in front
- Allows driver to set speed and distance
- Controls engine and brakes
- Includes Forward Collision Warning

OnGuardPLUS™

Advanced emergency braking system (AEBS) for prevention or mitigation of rear-end accident impact with vehicle ahead

- Meets European Union AEBS regulation
- Integrated ACC functionality helps save on fuel consumption
- Actuates brake when system detects both moving and decelerating vehicles
- Applies partial braking when stationary vehicles are detected

Important Dates

European Legislation on AEBS and LDWS:

- Type approval from November 2013
- New registration from November 2015



Lane Departure Warning (LDW) OnLane™

Adaptive Cruise Control (ACC) OnGuardPLUS™



Tire Pressure Monitoring

IVTM and TPMS

- Reliable measurement of absolute tire pressure by external wheel modules
- Analysis of the tire pressure profile: compares parameterised thresholds and early detection of leakages by comparing values on the same axle
- Wireless transmission of pressure information and warnings to a display
- External wheel modules fit most types of rims

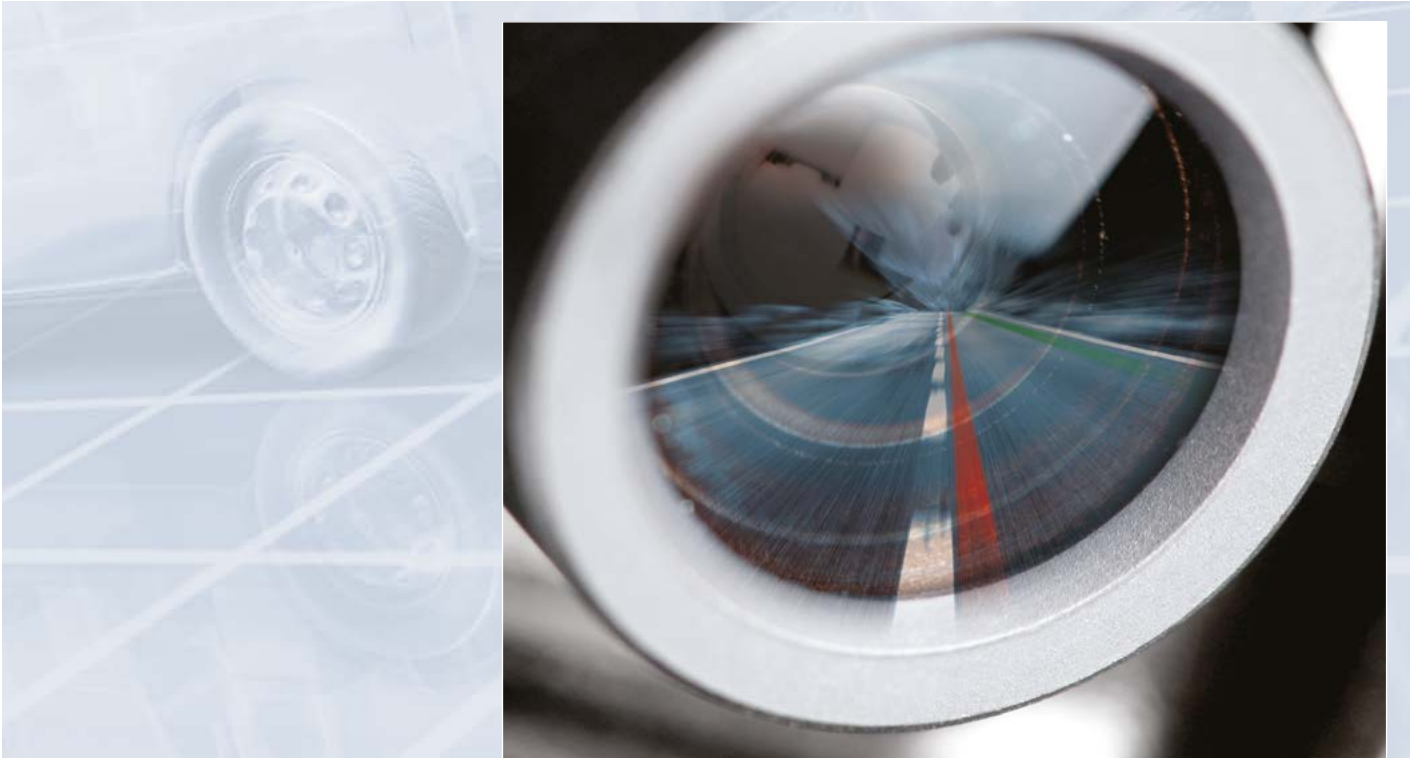
Vehicle Electronic Architecture

MUX / CVC / CVM to control

- Lights, sensors, external loads
- Chassis (brakes, suspension)
- Powertrain (retarder, engine, gear-box)

Standard Bus System

- Fully OEM programmed system for control of electrical loads and subsystems via CAN
- General sensor and switch signal processing



An extra eye on safety



OnLane™ camera

OnLane™ - LANE DEPARTURE WARNING SYSTEM

At the cutting edge of active road safety, WABCO's OnLane™ system is a Lane Departure Warning System (LDWS) device developed specifically for commercial vehicles.

With unintentional lane departure being a primary cause of accidents involving trucks and buses, OnLane™ significantly improves vehicle safety by providing a driver with visual and acoustic warning, or an optional haptic alert, when the vehicle begins to stray.

OnLane™ is a camera-based system and is the first in a new generation of safety products that will soon also include driver fatigue detection, traffic signal recognition and headlight control.

Advanced safety

With OnLane™ vehicle manufacturers can choose different warning types – warning tones, visual indicators and haptic signals. Furthermore, the system reliably provides the warning signal on the side where the unintentional lane departure takes place.

OnLane™ has the intelligence to distinguish between a deliberate lane change and an unintentional drift by automatically identifying the driver's turn signal usage.

Designed for highways and similar roads, OnLane™ ceases operation at speeds lower than 60 km/h or 38 mph and will not interfere with normal turns or navigation around urban areas.

Retrofit for aftermarket

OnLane™ also enables fleets to operate more efficiently and with improved vehicle safety. Improved safety leads to reduced vehicle downtime and repair costs. Satisfying customers due to on-time deliveries.

WABCO supplies an aftermarket kit to retrofit existing trucks and buses with OnLane™ for a reduced installation effort. OnLane™ is designed to be easily retrofitted across a broad spectrum of commercial vehicle types.

WABCO experts are also on-hand to support fleets with OnLane™ retrofit installation and workshops. Fleets further benefit from a global WABCO Service Partner Network featuring access to more than 1,800 high-quality workshops.

Cost-effective technology

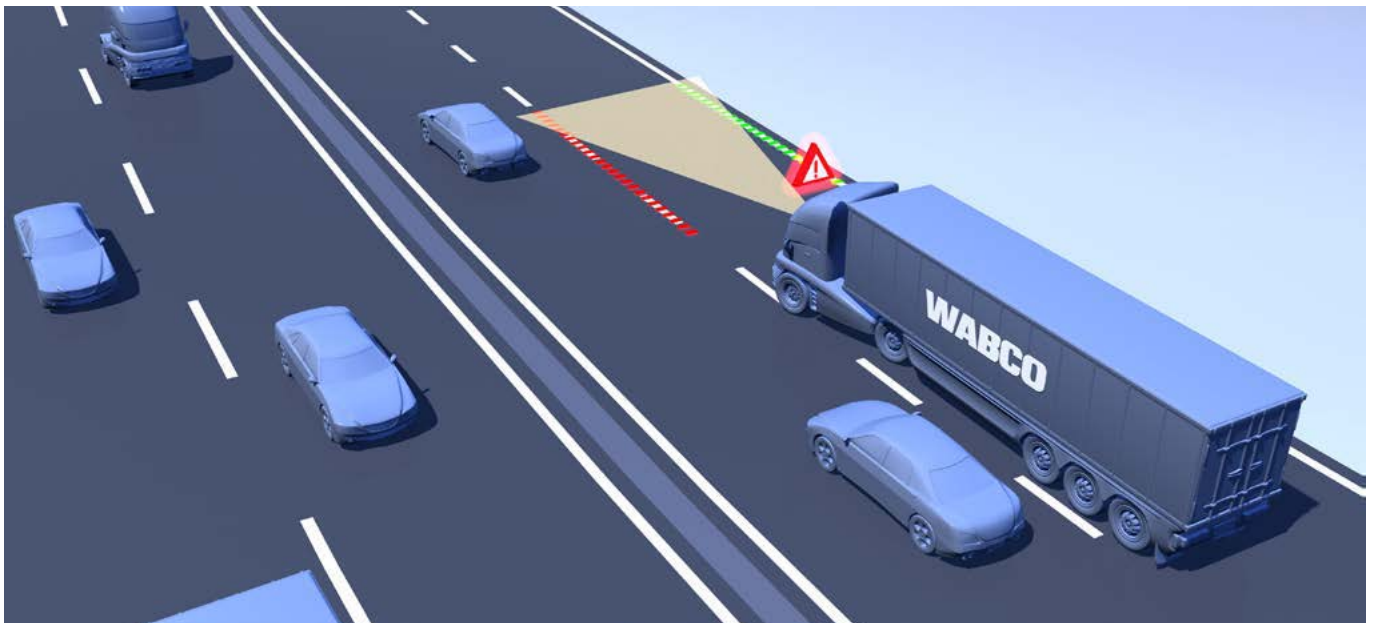


OnLane™ is a compact, one-box solution containing all necessary functionality at optimized cost – no extra Electronic Control Unit is required.

Specifically designed for commercial vehicles, OnLane™ has the flexibility that allows it to be mounted in a variety of positions on the windshield and it can be easily adapted to different windshield angles. Minimal adaptation is required for installation.

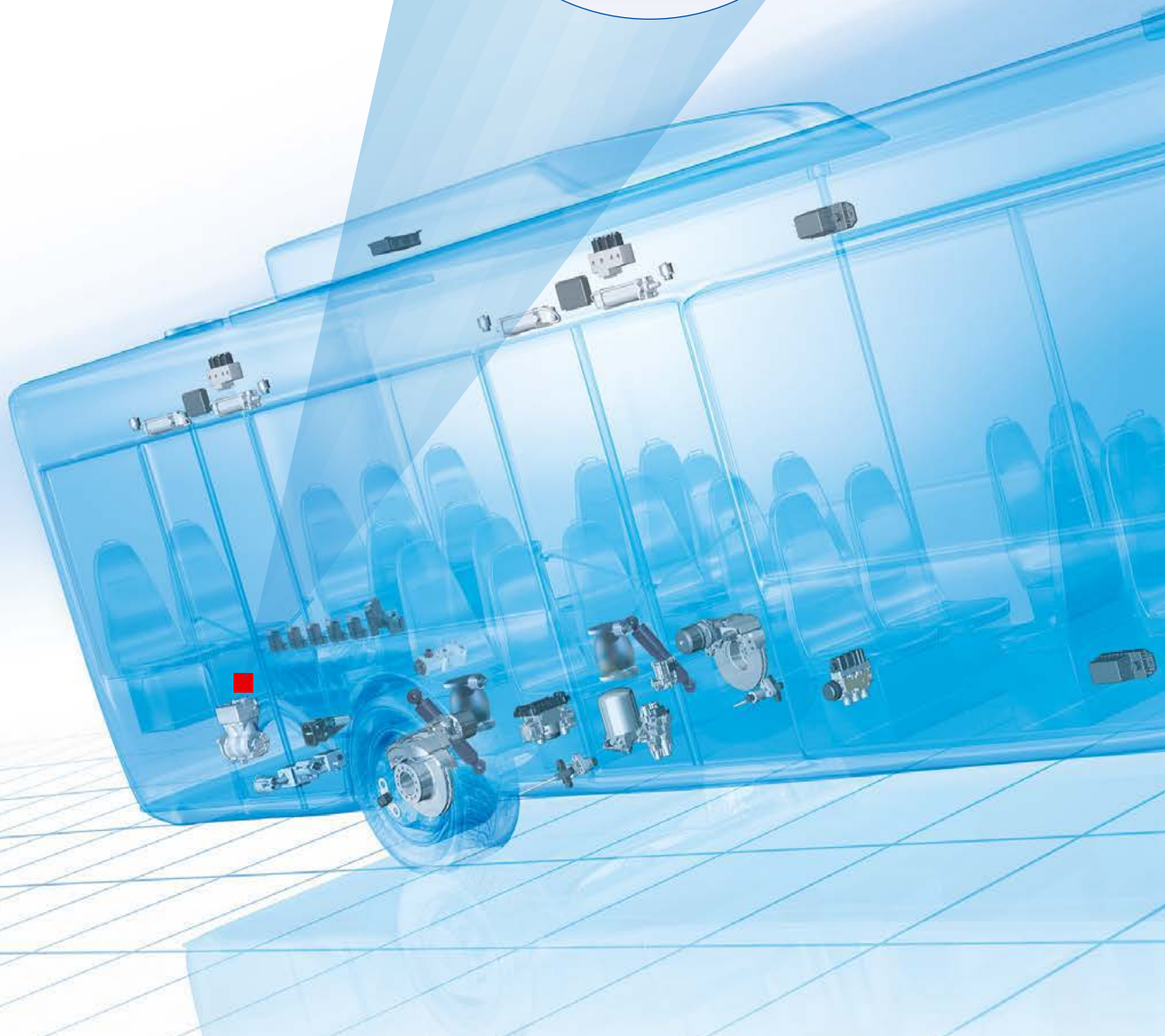
For vehicle manufacturers OnLane™ is a simple installation step that can be easily integrated within an assembly process or even after end-of-line release.

Optional camera mounting positions - top or bottom with 180° panoramic rotation



OnLane detects road markings and vehicle position

Compressors





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 braking system and the secondary consumers such as the air suspension and the door controls for instance. Compressors are piston compressors of single or dual stage design.



Product benefits and characteristics

The compressors are normally driven by gear wheel drives from the vehicle engine or by means of belt drives in older older vehicles.

Features of the compressors:

- Number of cylinders: one or two cylinders
- Compression principles: 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) is now commonly used; in special applications splash lubrication, also supplied from the engine (TD) or through manual refilling (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 as required. An 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 far above 300°C in the compression chamber of the compressor with single stage compression.

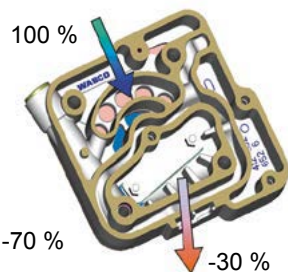
These high temperatures trigger undesirable chemical reactions that can cause malfunctions in the compressor itself and in the downstream devices. These problems are greatly reduced by using dual stage compression compressors.



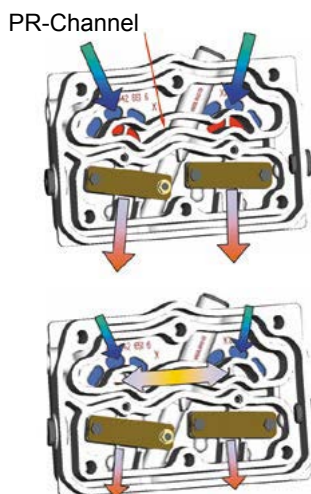
Single cylinder compressor



Two cylinder compressor



Single cylinder compressor



Two cylinder compressor

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 service life of the unit extended.

Reduced thermal loads make the oil in the compressor last longer, reducing oil consumption.. Consequently, you can count on an improved life-span of the devices in the compressed air system. The devices in the compressed-air system will therefore have a longer service life, reducing downtimes, maintenance and operating costs.

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.

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.

In later WABCO compressors, a combination of the systems is used. Both systems are integrated in the compressor cylinder:

- Power Reduction = PR and
- Temperature Reduction = TR

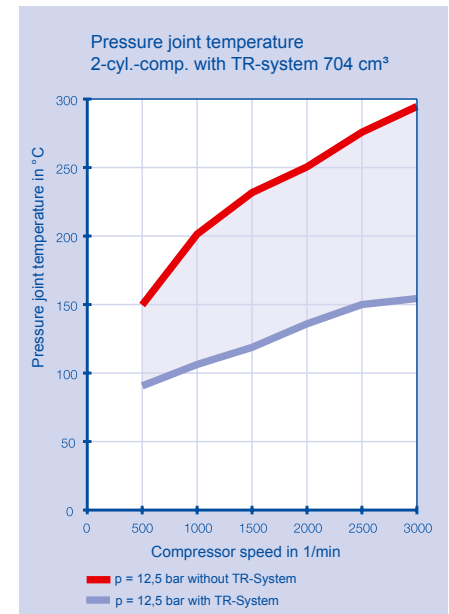
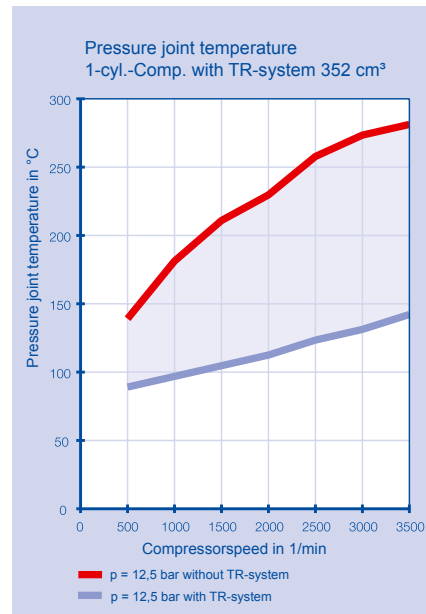
Compared with compressors without an energy saving system, the WABCO PR system offers the following advantages during idle operation:

- Reduced power consumption
- Decreased oil consumption in pressurising the cylinder chamber
- Sufficient temperature level in the pressure line by distribution to minimise 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 provides the following benefits:

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

Device overview

Application	Cylinder	Product number
Mercedes-Benz	1	411 151 009 0
Mercedes-Benz	1	411 154 004 0
Mercedes-Benz	1	411 142 818 7
Mercedes-Benz	1	411 141 818 7
Mercedes-Benz, Setra	1	412 352 026 0
Mercedes-Benz	2	911 553 007 0
Mercedes-Benz	2	912 510 103 0
Mercedes-Benz	1	912 510 001 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
MAN	1	912 116 000 0
MAN	1	912 117 000 0

Service and maintenance information

Tips and other information for the workshop



The general status of the compressor should be checked visually. tightness of suction and pressure lines as well as the braking system must be checked and verified at regular intervals.

The air filter and the suction lines to the compressor must be checked for damage and replaced as required.

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).

The flow rate (fill time) is to be checked in accordance with the specifications of the vehicle manufacturer. If adequate test levels are not known, the replenish time required by law (EC directive Braking System) must be observed.

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 braking system.

Important: If the compressor runs under a load for long periods because of

- unload valve pressure setting too high
- dirty suction filter
- plugged pressure line or a
- leak in the system

fuel is wasted and the service life of the compressor is reduced.

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. Coalescence filters up- and downstream of the desiccant ensure optimal separation of oil residues and finest aerosols.

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





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.



APU - AIR PROCESSING UNIT

Product benefits and characteristics

The atmospheric air that the compressor sucks in contains a certain amount of moisture. That means that the compressor compresses a gas mixture of air and water vapour. 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 called: four-circuit protection 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 un-loader 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 function (see section "Several terms, described briefly") or
- Four-circuit protective valve with APU flange and additional features such as pressure limiter or pressure sensor in some cases

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

Product benefits and characteristics



Single-chamber air dryer

AIR DRYER

Air dryers are responsible for reducing the portion of moisture in the compressed air. This is done by means of what is known as 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 using a “back-flushing” process with air that has already been dried. The entire drying process is controlled by the air dryer. The air for regeneration is normally supplied from regeneration tanks, which usually have a volume of 5 litres.

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 using a single-chamber air dryer only during 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 compressor duty cycles exceeding 50%. Here the regeneration is time-controlled. After 60 seconds cartridges are switched and the one not supplying air is then regenerated. The drying interval of 60 seconds is controlled by 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.

Air dryers are generally certified for a maximum operating pressure of 13.0 bar. Special variants (with a special cartridge) for up to 20 bar are available for special vehicles with high-pressure systems.

Why is the correct drying of the air so important?

Moisture penetrating into reservoirs and valves causes corrosion. This corrosion remains hidden to begin with but can then lead to the connected devices failing as surfaces 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 cause compressor failure. 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 contamination and adhesion of the sealing surfaces of the brake valve over time.

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 convert into aerosols in the compressor and can get into the braking 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 braking system and protects it from damage. To also ensure improved separation of oil residues and aerosols, WABCO has developed the Air System Protector^{PLUS} cartridge (**432 410 244 2**).

Device overview

Application	Type	Product number
Various Omnibuses	Single chamber	432 410 102 7
MAN	Single chamber	432 410 115 7
Irisbus	Dual chamber	432 433 273 0
Setra, MAN, Napoleon	Dual chamber	432 431 199 0
Various Omnibuses	Dual chamber	432 433 299 7

Service and maintenance information

- The air dryer function is tested by actuating the drain valves on the supply reservoirs. If water leaks out, this indicates a problem in the air dryer. In newer vehicles this is achieved by means of electronic sensors (condensation sensors).
- The air dryer must be checked for tightness and proper regenerating function. During this test, note any air outlet via port 3. Once the cut-off pressure is reached, the regeneration air will briefly continue to flow out of port 3 in the case of single-chamber dryers. In the case of dual-chamber dryers, there is a continuous flow of air during the supply phase.
- This outflow of air must not be interpreted as a malfunction or even leak of the compressed air system.
- Oil leaking from the muffler of the air dryer can indicate that the compressor is pumping oil. In this case, the compressor should be checked following the specifications of the manufacturer.
- To gain the best efficiency, the inlet temperature of the compressed air should be around 28°C above the ambient temperature.
- The inlet temperature of the air in the air dryer should not be higher than 65°C. Too high an inlet temperature impairs the air dryer's function.
- If the compressed air system leaks, the regeneration cannot be initiated correctly. This can cause moisture to enter the system and result in failures of components or the compressed air system.
- No anti-freeze devices must be fitted upstream of the dryer.

Tips and other information for the workshop

If the air dryer is equipped with a heating cartridge, this cartridge is switched on when the temperature drops below approx. 6°C and off again when it exceeds approx. 30°C.

DESICCANT CARTRIDGE

Product benefits and characteristics

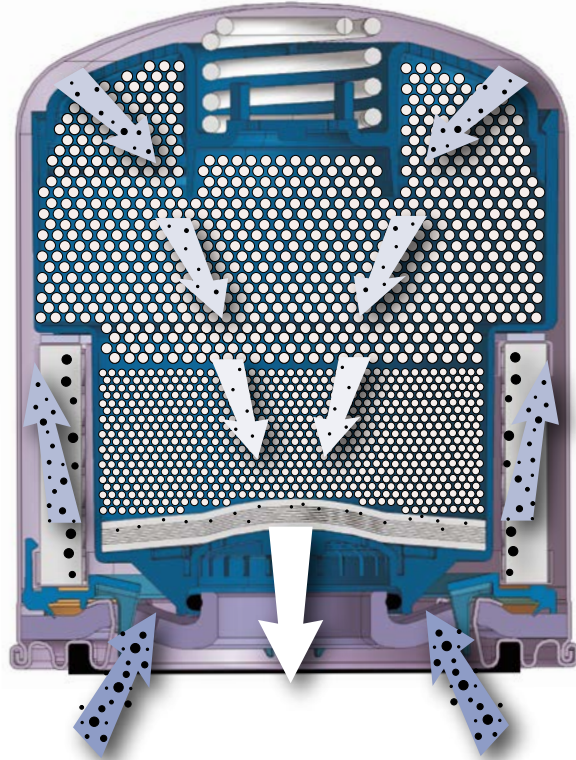
The quality of the air drying mainly depends on the desiccant used. In order to dry the air supplied by the compressor, specially designed desiccant beads with especially good drying properties and excellent mechanical resistance are used in WABCO cartridges. The latter ensures that the desiccant beads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



Desiccant cartridge Air System Protector^{PLUS}

As a premium solution, WABCO offers the **Air System Protector^{PLUS} Cartridge** with integrated coalescence filter. This innovative product provides optimal protection against contamination and damage due to oil, moisture and aerosols. Greatest possible filter performance and a service life extended by around 50% make this an ideal cartridge for vehicles with an intensive air consumption – even under toughest conditions.

Operating principle of the Air System Protector^{PLUS} cartridge



The following images clearly show the difference in using a standard cartridge and the Air System Protector^{PLUS} (integrated coalescence filter).

While the standard air dryer cartridge (Fig 1) has traces of oil, the Air System Protector^{PLUS} (Fig. 2) shows no contamination.

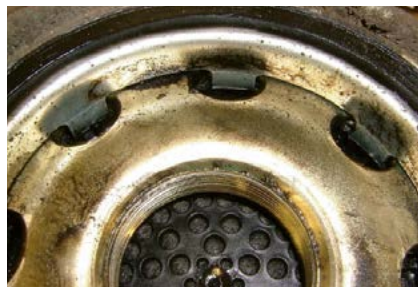


Figure 1: Desiccant cartridge without coalescence filter after 60,000 km



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

Device overview

Application	Thread	Product number
Air System Protector ^{PLUS} cartridge	M 39 × 1.5	432 410 244 2
Air System Protector cartridge	M 39 × 1.5	432 901 223 2
Standard cartridge	M 39 × 1.5	432 410 020 2
Recycling cartridge	M 39 × 1.5	432 410 222 7

Service and maintenance information

- On older devices, the safety screw must be loosened before replacement.
- The standard cartridge, as well as the WABCO Air System Protector should be replaced after two years under normal conditions. With the ASP^{Plus} cartridge, WABCO recommends a replacement cycle of three years. Your WABCO partner guarantees that he will accept the return of the old cartridges.
- If any condensate is found, the regenerating function must be checked and the cartridge replaced as required.
- The air dryer must be depressurised for maintenance work.
- Before screwing in the new cartridge, the ring seal should be lightly greased. The tightening torque of the cartridge is 20 Nm (if present, tighten fastening screw).

Tips and other information for the workshop

WABCO recommends:

- Regularly changing the cartridge(s)
- Frequent actuation of the drain valves on the reservoirs to check the air dryer function
- Taking problems with compressor or air dryer into account as possible causes when soiled or corroded components of the braking system are detected.

Product benefits and characteristics



Four-circuit protective valve

FOUR-CIRCUIT PROTECTIVE VALVE

Four-circuit protective 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 braking system and for the supply of secondary consumer devices.

In the event of any circuit failing, that circuit is switched off automatically, the others continuing to be supplied with compressed air up to the opening pressure in the defective circuit.

There are different types:

Four-circuit protection valve with limited return flow in serial or parallel arrangement, with or without a bypass.

Four-circuit protection valve in series connection with one or two integrated pressure limiting units 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/EC, the four-circuit protection valves are equipped with a bleed-back function (see: "A few terms, briefly described").

Several terms, described briefly

- Opening pressure: Pressure that is required to open the circuit.
- Closing pressure (stabilisation pressure): Closing pressure is the pressure that triggers shutting down the failed circuit. A limited return flow enables, above closing pressure, a pressure equalisation between the respectively combined circuits.
- Series switching: This means that the ancillary consumers (circuits 3 and 4) follow the primary consumers (circuits 1 and 2). No return flow is possible from the ancillary consumers to the primary consumers.
- Parallel switching: In a parallel arrangement, all circuits are connected with one other. This means that a limited return flow from the ancillary consumers to the primary consumers is possible, and normal.
- Bypasses: These permit prioritised filling of systems equipped accordingly when the entire system is at zero pressure. They are often used in circuits 1 and 2. With valve variants in parallel arrangement, bypasses can also be used in circuits 3 and 4.
- Bleed-back function: The parking brake circuit 3 is connected to air circuit 1 via a throttled check valve. If the service braking system circuit 1 fails, circuit 3 is also vented to meet the requirements according to 98/12/EC (see below).

Device overview

Designation	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 directive 91/422/EEC and directive 98/12/EC

For vehicles with initial registration date after October 1994, the 6th Adaptation directive 91/422 EEC requires that, when the pressureless supply system is filled, the spring chamber brakes must only be released when the pressure in the service brake circuits is sufficiently high to effect actuation of the service braking system (BBA) to achieve the action required by the auxiliary brake.

Directive 98/12/EC also requires that the actuated spring chamber brakes are only allowed to be released if the pressure in the service braking system circuits ensures 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.

What is tested is the closing pressure (or stabilising pressure) with the engine stopped. Pressure in the circuit that has not failed must not drop to the respective closing pressure. This test must be repeated with a 'simulated defect' in the other circuits respectively after the system has been refilled.

Driveline Control







WABCO has more than 40 years experience in Clutch Servos

CLUTCH CONTROL

Clutch Servos have been used in buses for over 40 years. When buses started growing in capacity, the engine and drive train had to grow with it. Clutches had to cope with higher torque and power loads, therefore they became heavier and more robust in design. The problem arose that drivers were no longer able to engage the clutch without hydropneumatic assistance.

Clutch Servos are based on the principle of air-hydraulic assistance.

When the driver activates the clutch pedal, hydraulic pressure from the clutch pedal's master cylinder (mounted under the cabin) is built up in the clutch servo (mounted against the clutch bell housing). This causes a cartridge to open and air pressure from the engine's compressor to enter a pneumatic chamber. A pneumatic piston is forced forward by air pressure and distributes its power towards the clutch lever via a steel pushrod. The clutch group is activated and the clutch disengaged. The driver can now shift the desired gear without damaging the gearbox.

When the driver releases the clutch pedal, hydraulic pressure goes back to the master cylinder and forces the cartridge in the clutch servo to close again. The air pressure in the pneumatic chamber can now escape to the exhaust and the steel pushrod moves back inwards. The clutch group is released and the clutch engaged.



Master cylinder

The master cylinder is mechanically connected to the clutch pedal and translates the drivers foot force into hydraulic pressure. The master cylinder can also be integrated in the IPU (Integrated Pedal Unit). The IPU consists of the clutch pedal as well as integrated throttle and brake actuators.

Specifications:

- Clutch servos in buses can be found in different pneumatic cylinder diameters, mostly 3" or 4", depending on the clutch and gearbox.
- With stroke sensor, mechanical wear indicator or 3/2 way valve
- Mineral oil or brake fluid

Service and maintenance information

Important!

Never activate the clutch servo or the clutch pedal if the clutch servo is not installed in the vehicle. Otherwise the clutch servo will be damaged.

Repair:

It is imperative that the vehicle manufacturer's specifications and instructions are complied with.

- Clean the cables and connections on the vehicle before filling.
- Only use new hydraulic fluid that has been authorised for the clutch servo (mineral oil or brake fluid). Reuse of hydraulic fluid is not permitted.
- First, fit the linkage.
- Screw the clutch servo to its bracket. Ensure a correct seat on the clutch housing.
- Connect the pneumatic lines.
- Connect the hydraulic lines.
- Bleed the hydraulic system.



Segment description

RETARDER CONTROL

Retarders or wearless brakes (permanent brakes) have been popular devices on buses for a long time. Retarders were introduced to ensure safe, efficient and secure road grip when driving down long slopes. In some regions they were needed to fulfil legal requirements - StVZO §41 (15) in Germany for example.

Retarders or wearless brakes (permanent brakes) can function on the basis of different principles, such as hydrodynamic, electromagnetic or pressure build-up concepts.

They all have one thing in common: a friction-free means of braking the vehicle. The vehicle's dynamic force is converted into heat or pressure so that the mechanical drum or disc brakes can be partly or fully relieved when the vehicle is braked over long periods of downhill driving.

Hydrodynamic retarder



Product advantages and features

The hydrodynamic retarder is controlled by an ECU and a proportional valve. The ECU collects vehicle parameters and commands the proportional valve accordingly.

Some hydrodynamic retarder variants use WABCO devices for the proportional valve, for example, which is mounted directly to the retarder. The variant depends on the retarder solution/application.

Device overview

Application	Type	Product number
VOITH Retarder	Proportional valve	472 260 005 0
		472 260 006 0
		472 260 011 0

Retarder ECUs are available only from manufacturers/suppliers of retarders or vehicle manufacturers.

Service and maintenance information

Devices are maintenance-free. Repair kits are not available. If necessary, the device needs to be replaced.

Engine brake



Product advantages and features

Engine brakes are mounted directly on the cylinder head, but the precise variant depends on the engine type. The engine brake can effect the vehicle's retardation quickly and with precision by means of the engine. Here the exhaust valve is opened by the engine brake just as the power stroke begins, thereby preventing the compressed air from supporting the downward motion of the piston.

Device overview

Application	Type	Product number
IVECO Cursor engines	Cylinder	428 750 006 0
		428 750 007 0
	Control unit	428 750 008 0
		428 750 018 0

Service and maintenance information

Devices are maintenance-free. Repair kits are not available. If necessary, the device needs to be replaced.

Exhaust brake



Product advantages and features

The engine retarder controls the engine's exhaust back-pressure to improve the engine brake efficiency over the complete range of speeds. It contains a pneumatic or vacuum actuator controlling a throttle valve that is mounted directly to the exhaust manifold.

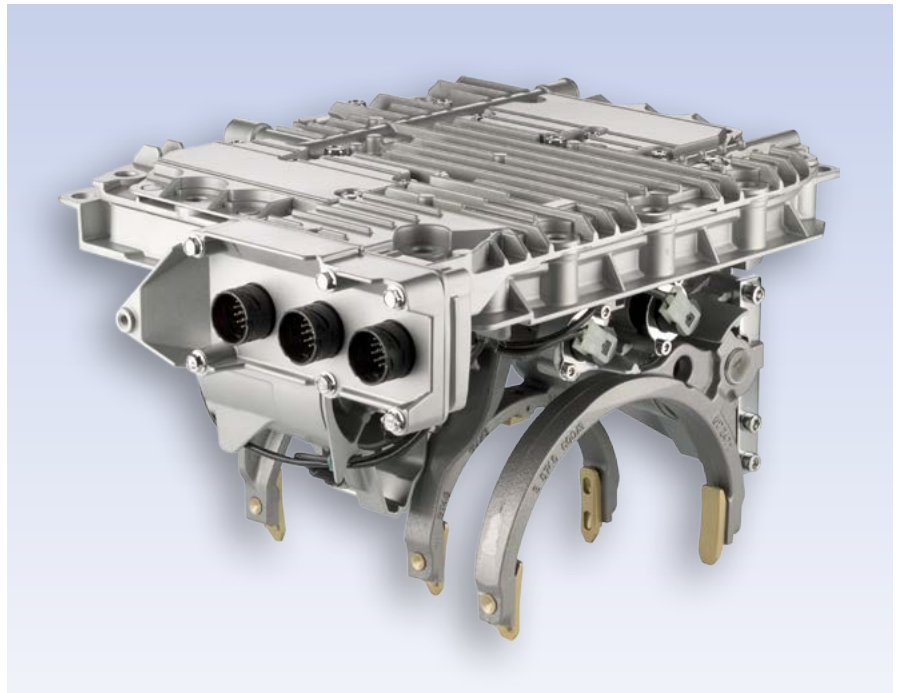
Device overview

Several applications in South America and India.

Service and maintenance information

Devices are maintenance-free. It is permissible to clean and lubricate it using a suitable grade of WABCO approved lubricant.

TRANSMISSION AUTOMATION



Segment description

AMT – Automated Manual Transmission – is a system that converts a manual into an automated transmission. The bus does not have a clutch pedal. The driver may choose between manual and automatic mode. In manual mode the driver initiates gear changes via a gear control unit but the AMT executes the gear shift automatically. In automated mode, gear changes are initiated and executed automatically by the AMT system, depending on the requested speed and driving conditions.

Product advantages and features

AMT systems may have different configurations:

- European modular system, comprising shift cylinders with integrated ECU, range cylinder, split cylinder and sensors. Here the components are mounted to the transmission according to their function and replace manual actuators on standard transmission. This configuration enables a flexible solution for automation in existing transmissions.
- An integrated transmission control unit where all AMT components (ECU, shift actuators, solenoid valves and sensors) are part of a single unit. This unit is directly mounted to the transmission or even partially integrated in the gearbox. This customised solution is advantageous for high performance transmissions which are specially designed for automation.
- OptiDrive is a modular AMT system that includes gear actuator, clutch actuator, range cylinder, split cylinder, gear lever unit with integrated ECU or cabin-mounted standalone ECU and speed sensors. Its components can be adapted to existing manual transmissions and are mounted accordingly. OptiDrive's state-of-the-art system functionality offers an efficient and effective solution for gearbox automation of 5 - 16 speed transmissions.



OptiDrive components: Gear actuator, clutch actuator, shift lever unit, range cylinder

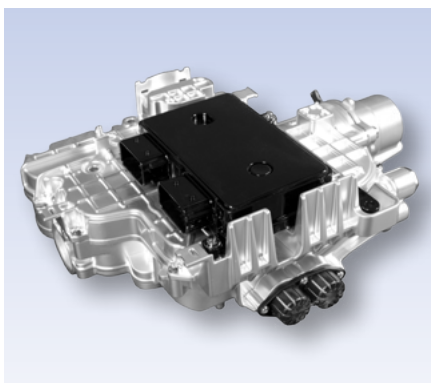
Gear actuation is realised with pneumatic or hydraulic mechatronics. Different sensors provide the system with information on transmission speed, pressure and shifting distances.

The AMT system is equipped with an ECU – Electronic Control Unit – receiving relevant information from other vehicle components, e.g. engine ECU, via CAN SAE J 1939.

WABCO offers software development for several transmission control applications, such as transmission shift procedures, clutch control, system diagnostic, etc. Currently, KWP2000 is used as the diagnostic interface.

Additional device

Type	Product number
EPS 3 (Gear cylinder)	421 350 085 0
	421 350 086 0



Automated Manual Transmission

Based on this modular system, WABCO's AMTs provide enhanced system integration into existing or new transmissions. Furthermore WABCO offers high performance software models for various applications.

For vehicle manufacturers, the benefits of AMT systems are:

- Improved efficiency:
 - Reduced vehicle weight
 - No clutch pedal
 - No synchronized transmission necessary
 - No linkage between cab and chassis
 - Simplified assembly
- Operational reliability
 - Decreased shift errors and overspeed situations
 - Increased protection against external influences
 - Easy access
 - Simple and robust design of transmission and all components

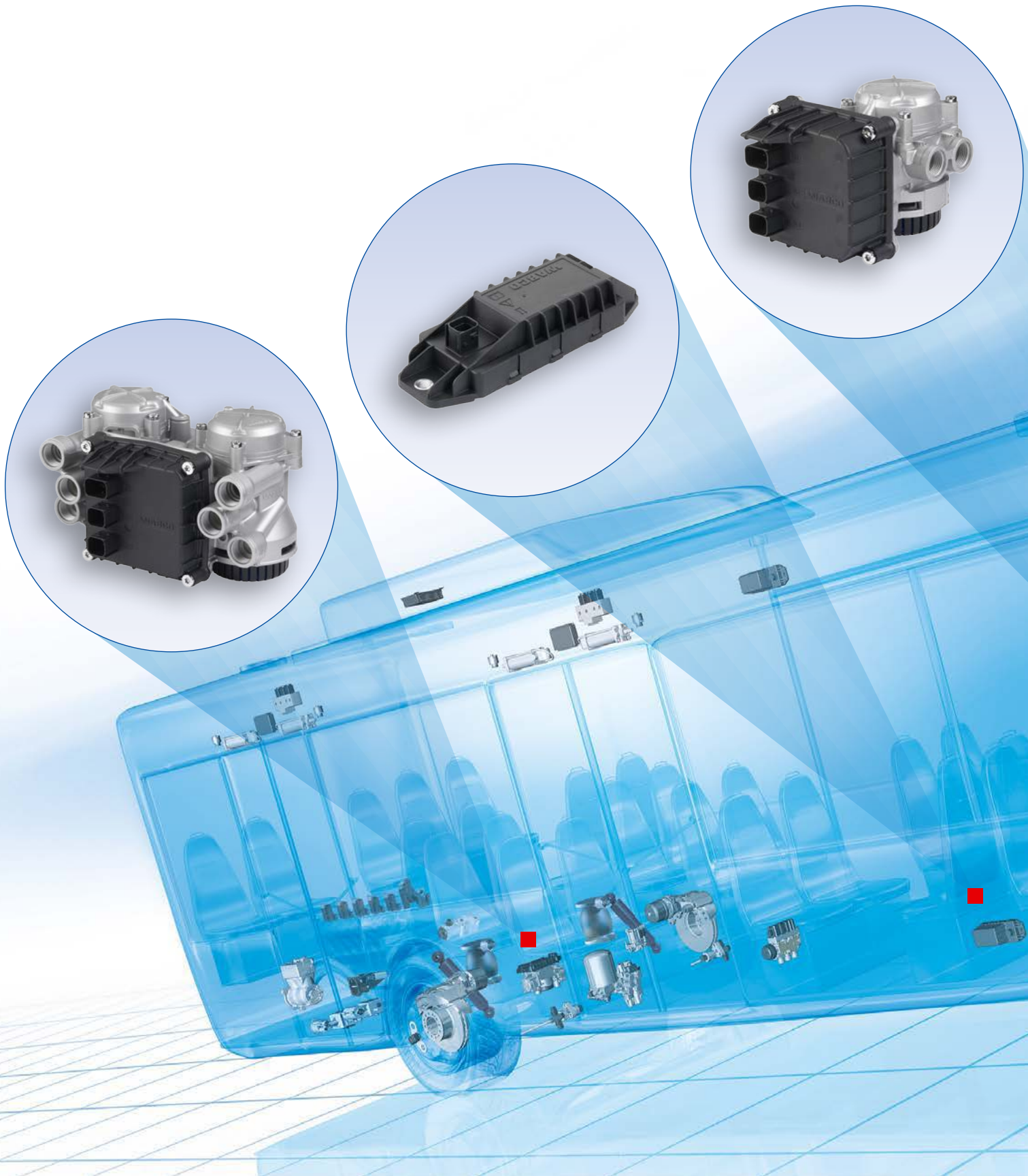
For drivers, the benefits of AMT systems are:

- Improved efficiency:
 - Increased fuel economy
 - Extended clutch and transmission life
 - Increased payload
 - Improves performance of inexperienced drivers
- Operational reliability
 - Less gear change and clutch errors
 - Gear shifting within optimum speed range
- Safety
 - Fast selection of gears, particularly in challenging situations
- Comfort
 - Easy handling: effort for shifting is reduced
 - Less stress for the driver, especially when moving in metropolitan areas

Service and maintenance information

Service and maintenance is fully provided by vehicle manufacturers.

EBS - Electronic Braking System





A sophisticated concept makes EBS one of the safest braking systems in utility vehicles. In this case, several brake circuits (redundancy) make sure that the vehicle is securely decelerated.



EBS BASIC FUNCTION

WABCO EBS operates with electronic signals. The EBS electronic control unit controls the system through these signals and can communicate with the individual components at any time. The valves on the brake cylinders generate the required braking pressure according to the control signals.

Speed sensors, installed on the wheels of the vehicle for the integrated ABS function, constantly provide the EBS with up-to-date wheel speed information. Different integrated brake management functions detect any deviations from normal driving conditions and intervene in the driving process in the event of hazards. Apart from improving safety, specific functions also optimise driving comfort and lining wear.

If the electronic control system malfunctions, all valves simultaneously coordinate operation as in a conventional pneumatic system. In this case, backup pressures are conducted to the brake cylinders where the pneumatic system is effectively applied. What is known as a backup valve blocks the effect of the pneumatic circuit on the rear axle brake cylinders while EBS functions normally.

Product advantages and features

Braking comfort and improved safety through EBS

The driver enters his deceleration command by operating the brake. EBS then electronically transmits this command to all braking system components. Response and build-up times at the brake cylinders are reduced significantly due to electronic actuation. The ECU also facilitates a sensitive application of the braking system during this process. The result: a comfortable braking “feeling”, independent of the load status, and a much shorter braking distance.

The functions integrated in EBS ensure that both the vehicle’s driving stability and steerability are maintained during the braking process. The Differential Slip Control (DSC) system automatically distributes the braking forces between the front and rear axle according to the respective load status. The integrated anti slip regulation applies traction control.

Lining wear optimisation and ease of maintenance through EBS

EBS from WABCO provides the option to continuously monitor and balance lining wear. The Brake Lining Wear Control intervenes in the distribution of braking forces during uncritical braking events if a difference in the linings of the different axles is detected. This means that service and lining replacement times can be coordinated. All linings on the vehicle are then replaced simultaneously. The integration of endurance brakes, such as retarder and engine brake, also help to protect brake linings for longer operating times.

Extensive integrated diagnostic and monitoring functions constantly carry out self-inspections of EBS. Corresponding warnings will alert the driver immediately if operational readiness is impaired. A diagnostic device or the on-board diagnostic display in the vehicle can be used to determine the causes quickly and easily. Maintenance and workshop periods can also be significantly reduced by means of the extensive test functions of the diagnostic system.

Integrated brake management functions of a modern EBS



Stability control

Feature	Benefit
Anti-Lock Braking Function (ABS)	Prevents locking of wheels and maintains steerability for more safety
Integrated Automatic Traction Control (ATC)	Maintains control of the vehicle even on slippery surfaces
Electronic Stability Control (incl. RSC)	Increases protection against tipping over, skidding, spinning and jackknifing
Engine / Drag Torque Control	Improved stability on slippery surfaces

Brake control

Feature	Benefit
Deceleration Control	Same brake performance regardless of the load
Brake Force Distribution	Optimal distribution of braking pressure leads to shorter braking distances and more safety
Endurance Brake Integration (Brake Blending)	Less brake lining wear
Hill Start Aid / Hill Holder	Increased road safety by preventing rolling back / Driver assist and safety functionality during daily operation
Halt Brake	Driver assist and safety functionality during daily operation

**Performance monitoring**

Feature	Benefit
Tire Pressure Indicator	Reduced wear and maintenance costs
Lining Wear Control	Reduced maintenance costs
Brake Temperature Monitoring	Reduced maintenance costs
Brake Performance Monitoring	Increased road safety
Hybrid support	Regenerating braking, fuel savings

FUNCTIONS AND FEATURES

Anti-Lock Braking Function

Inductive sensors measure the rotational speed of individual wheels so that any tendency to lock is detected early. The EBS ECU can reduce, stop or increase the braking pressure for the brake cylinders on the front axle accordingly via the ABS solenoid valves.

The axle modulator at the rear axle (optional at the additional axle), whose electronic control unit includes the relevant control algorithms, performs the same task.

Integrated Automatic Traction Control (ATC)

The ATC function detects the tendency to spin and reduces the driving torque via the engine control electronics. If only one wheel tends to spin, ATC differential braking will be applied to it.

Engine control interventions as well as differential brake control interventions may act in parallel.

Electronic Stability Control (ESC)

ESC is an extension to the EBS system. While EBS is responsible for stability during driving and braking in longitudinal direction, ESC aims to increase vehicle stability during manoeuvres like cornering and lane change.

Using the information from various sensors, the ESC system detects such critical situations and adjusts engine and braking power accordingly as required. This assists the driver and improves road safety.

Engine / Drag Torque Control

Drag torque occurs in the driveline due to gear shifting or gas exchange. The resulting braking torques can cause the driving wheels to lock, making the vehicle unstable. The Drag Torque Control function prevents this situation.

When a defined slip state is exceeded, the engine torque is increased relative to the speeds of the driving wheels, reducing the drag torque that occurs. The Drag Torque Control terminates as soon as the driving wheel values are stable again.

Deceleration Control / Braking Force Control

The Deceleration Control function is used to adjust the braking pressure level to the braking command from the driver. EBS ensures that with identical pedal operations the vehicle is always braked with the same effect, regardless of the load status.

If the brake linings are wet for example, EBS will increase the braking pressure until the desired deceleration is achieved. For this reason there is no need for a separate axle load sensing system for braking force control.

Brake Force Distribution

The distribution of braking forces depends on different vehicle measurements and data. An evaluation of the sensor signals provides exact information on the slip on each axle and thus their braking performance. If the slip differs, one axle contributes more towards deceleration than the other. Consequently, this axle is also subject to greater wear. EBS applies differential slip control to regulate the pressures on each axle for optimum distribution of braking forces.

Endurance Brake Integration (Brake Blending)

The Endurance Brake Integration function ensures the full integration of available endurance brakes to all brake applications automatically only by normal brake pedal actuation. It ensures that the endurance brakes, such as retarder and engine brake, contribute the maximum possible portion of braking torque for the vehicle as a whole. The wheel brakes thus stay cool, reducing wear of brake linings and drums or brake discs.

Different control strategies for the Endurance Brake Integration function are available for city busses as well as for coaches and for different drive-lines (e.g. hybrid).

Hill Start Aid / Hill Holder

EBS offers automatic roll brake functions to allow the driver to comfortably start uphill by preventing the vehicle from rolling backwards. Variants differ according to activation conditions.

The function may be selected by a switch signal. The driver has to activate the function by briefly tapping the brake pedal. The system will hold the brakes as long as the activation conditions are fulfilled. If the incline is too steep for the preselected brake pressure the driver may increase the holding pressure by actuating the brake pedal with increased force. After the driver stepped off the brake pedal, the pressure will not be released before the transmission reports "ready for brake release" or after a predefined period of time has elapsed.

For safety reasons the EBS monitors the required operation of at least one pedal by the driver (clutch, brake or accelerator). This is designed to avoid misuse of hill holder as a parking brake.

Halt Brake

The driver activates the Halt Brake via switch. The request “actuate the halt brake” is sent to the EBS ECU via the CAN Bus or a hardwired switch signal. This signal can also be combined with appropriate external functions like a door control or other devices which indicate a short stop.

Using the EBS modulator(s), the brake cylinders are supplied with the respective braking pressure on the front and rear axle(s). The pressure levels of the individual axles are adjustable by parameter as well as application and release gradients.

The Halt Brake is deactivated via the hardwired switch or via a CAN signal sent by an external device. Deactivation may also be triggered by actuation of the accelerator pedal. The braking pressure will be released by a predefined gradient to permit driving off.

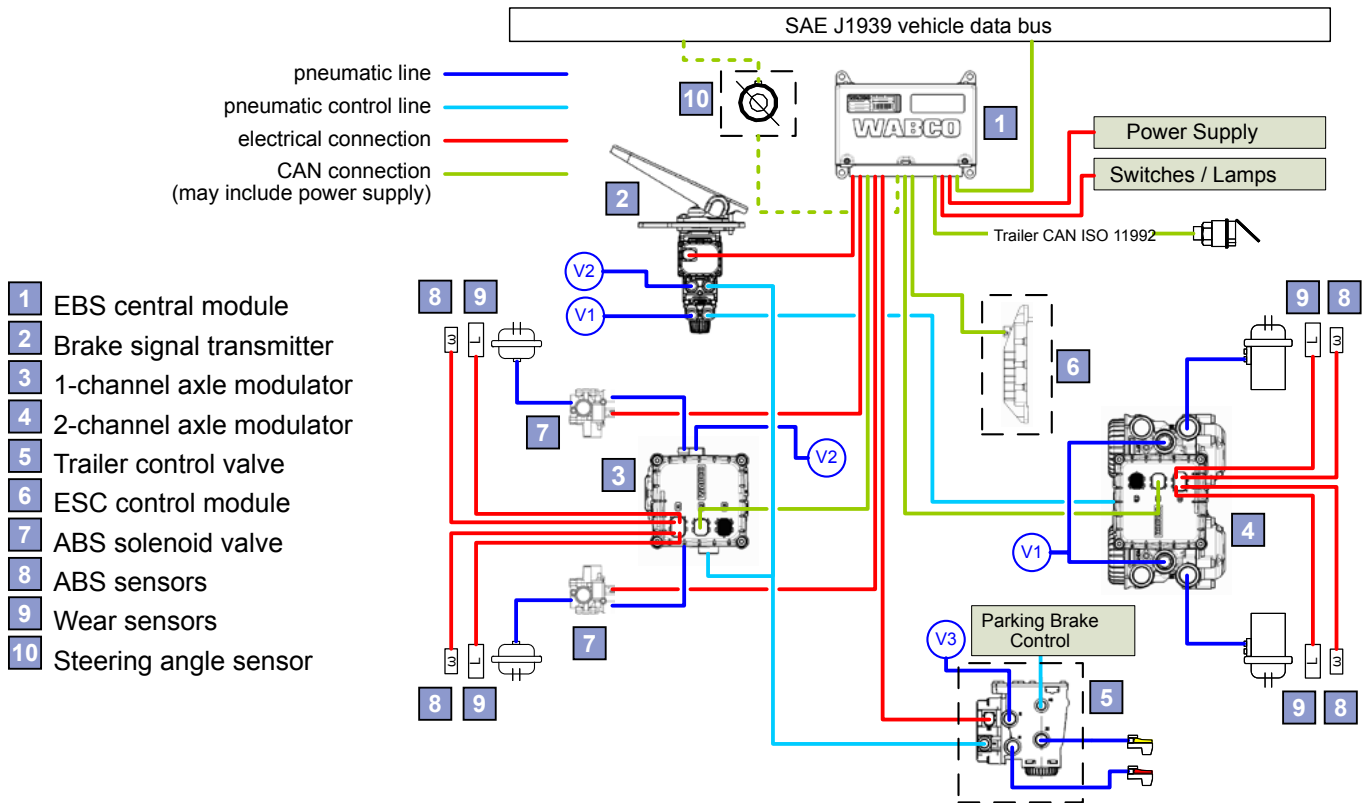
A combination of the Halt Brake function and engine control may be selected to limit the engine torque during a stopping interval.

Special features with WABCO EBS in buses:

- Besides conventional drivetrains, EBS supports a variety of hybrid and purely electric drivetrains (e. g. series hybrid, fully electric and trolley buses). The EBS system is optimised for maximum energy recuperation during braking processes without additional driver intervention, apart from pressing the brake pedal.
- The comfort stop function ensures a smooth braking action without harsh jerks by slightly decreasing braking pressure just before standstill. Additionally, the braking pressure can be distributed to the rear axle shortly before standstill to increase braking comfort, especially in city buses.
- In buses, EBS works with two or three axle modulators, depending on vehicle type (three axle or articulated bus) and drivetrain layout.

EBS COMPONENTS IN BUSES

System Layout EBS3 / System Configuration 4S / 4M with LWS



Central module

The **central module** controls and monitors the electronically controlled braking system. It determines the vehicle's nominal deceleration from the signals received by the brake signal transmitter and external deceleration demands (e.g. ACC, AEBS). The set deceleration and wheel speed measured through the speed sensors create a collective input signal for the electro-pneumatic control system. The central module calculates the pressure values for the front axle, the rear axle, the additional axle in a 6S6M system and the trailer from the input signals.



Brake signal transmitter

The **brake signal transmitter** receives the deceleration request from the driver via the brake pedal and generates the electrical signals and pneumatic pressures for charging and venting the actuators. The device has a dual-circuit electronic and a dual-circuit pneumatic structure. When actuating the brake pedal, two mechanical switches are initially actuated. These are connected to the electronic control unit and are used for the operational execution and monitoring of the braking procedure. The pedal stroke is recorded by two sensors and transmitted from the Brake Signal Transmitter as a Pulse Width Modulated signal (PWM).



1-channel axle modulator



2-channel axle modulator

Since the introduction of EBS into serial production in 1996, WABCO has developed four **axle modulator** generations.

The new design of a **1-channel version** is intended for front and rear axles. In a **2-channel** version, the axle modulator is used on rear axles only. The axle modulator in different variants controls the brake actuator pressure on both sides of a single or dual axle; on the front axle as a 1-channel modulator version, on the rear axles as 1- or 2- channel modulator version.

The axle modulator records the wheel speeds, using speed sensors, evaluates and sends them via the CAN bus to the central module, which subsequently calculates the nominal pressure. ABS control is applied directly by the rear axle modulators. If a wheel locks or spins, the rear axle modulator modifies the nominal pressure. The front axle modulator supports the ABS function on the front actuated by the ABS solenoid valves, which are fitted to control the pressure on the front axle brake actuators. Provision is made on specific device variants for connecting two sensors to detect brake lining wear.

All axle modulators are equipped with an additional connection for the backup pressure control circuit of the brake signal transmitter. 6S/5M or 6S/6M systems can be designed with three axle modulators for controlling the individual wheels.



Trailer control valve

The **Trailer Control Valve (TCV)** controls the pressure at the coupling heads. In this way it controls the braking behaviour of the trailer using an electro-pneumatic circuit and a pneumatic circuit. It receives the nominal pressure values from the Electronic Control Unit.



ESC control module

For the ESC functionality, an **ESC (Electronic Stability Control)** module and a steering wheel angle sensor (SAS) have to be attached to the system CAN bus.

The ESC module contains a yaw rate sensor to measure the vehicle's rotary motion around its vertical axis as well as an acceleration sensor to measure the lateral acceleration and both provide this information on the CAN data bus.



Steering wheel angle sensor

The **Steering wheel angle sensor** is installed at the steering column of the vehicle and provides a measured value of the absolute angle (position) of the steering wheel. This includes the capability of identifying the steering wheel zero position (centre position) by means of sensor calibration.



Hand-brake valve

Device overview

Hand-brake valves are used for actuating the secondary and the parking brake system. In this case a sensitively stepped actuation of the hand-lever pressurises or depressurises the Spring Brake Actuators.

Application	Name	Product number
Evobus / Daimler	Electronic Control Unit	446 130 203 0
		446 130 207 0
		446 130 209 0
Evobus / Daimler	Brake Signal Transmitter	480 003 030 0
		480 002 101 0
Evobus / Daimler	Hand Brake Valve	961 722 232 0
		961 722 262 7
Evobus / Daimler	Axle Modulator 2 Channel	480 106 051 0
		480 106 052 0
Evobus / Daimler	Axle Modulator 1 Channel	480 106 551 0
		480 106 552 0
Evobus / Daimler	Electronic Stability Control (ESC)	446 065 050 0
		446 065 051 0
MAN	Hand Brake Valve	961 722 262 7
		961 722 326 0
		961 723 019 0
		961 723 112 0
		961 723 118 0
		961 723 120 0
		961 723 426 0
Standard Bus	Electronic Control Unit	446 135 24x 0
Standard Bus	Brake Signal Transmitter without pedal	480 003 039 0
Standard Bus	Brake Signal Transmitter with pedal 25°C	480 002 102 0
Standard Bus	Brake Signal Transmitter with pedal 46°C	480 002 103 0
Standard Bus	Axle Modulator 2 Channel	480 106 201 0
Standard Bus	Axle Modulator 1 Channel	480 106 701 0
Standard Bus	Axle Modulator 2 Channel with bridge option	480 106 202 0
Standard Bus	Trailer Control Valve	480 204 031 0
Standard Bus	Electronic Stability Control (ESC)	446 065 052 0

Service and maintenance information

Monitoring functions

An EBS system is basically maintenance-free. It monitors itself and its components independently. If a fault occurs, a message is sent to the driver indicating that the vehicle should be taken to a workshop or that it should no longer be operated. Various fault recognition functions are integrated in EBS

Warning notice: To ensure safe function of the overall EBS system, a defective component must be replaced as a unit. In these cases it may become necessary to transfer the parameter sets from the ECU to the new component.

Checking the braking action

Whether the braking action of a vehicle satisfies legal requirements is generally tested on a roller test stand in the workshop. For this purpose, it is necessary to brake each axle with the maximum possible force. At the same time the EBS brake management functions, such as load-dependent braking force control, must remain unimpaired.

Legal requirements



Visual and function test during safety testing

Note: A safety and functionality test (SP) of commercial vehicles may only be performed by correspondingly trained personnel on the basis of legal requirements. Please observe the information provided by the vehicle manufacturer.

Inspecting the warning equipment

The EBS has a much more advanced self-monitoring system than the previous ABS system. Faults detected in the vehicle are saved and indicated to the driver via warning lamps or the display. This warning equipment must be checked for proper function during the safety check.

Checking the air supply system

Checking the air supply system is identical to the procedure for conventional braking systems.

Checking the wheel brake

Wheel brake effectiveness can be checked on a roller test stand, analogous to any other compressed air braking system.

Projection

Projection is subject to the same process as conventional braking systems in vehicles. Note the vehicle manufacturer's specifications for calculating pressure values.

Wheel brakes





This chapter introduces the compressed-air disc brakes of the PAN™ and MAXX™ series that have enjoyed great market success - in particular with regard to application in buses.



While previously wheel brakes were simply required to provide safety, decrease speed and stop the vehicle, the focus for product innovation today also concerns installation space, weight, comfort, maintenance times and costs.

PAN™ COMPRESSED-AIR DISC BRAKES

Outstanding reliability of WABCO's compressed-air disc brakes with single-piston technology

The WABCO PAN™ series has become one of the most successful compressed-air disc brake concepts for commercial vehicles due its reliable and proven technology. The compact design with low weight is based on the elaborate combination of FEM (Finite Element Method) calculations and the unique single-piston technology.

The PAN™ brake's reliability is enhanced by an encapsulated guidance system with robust metal fasteners as well as redundant seal systems for the guidance system and the adjuster unit.

The result is a significant reduction in vehicle weight for all vehicle classes as well as outstanding reliability, which is reflected in high customer satisfaction.

Benefits

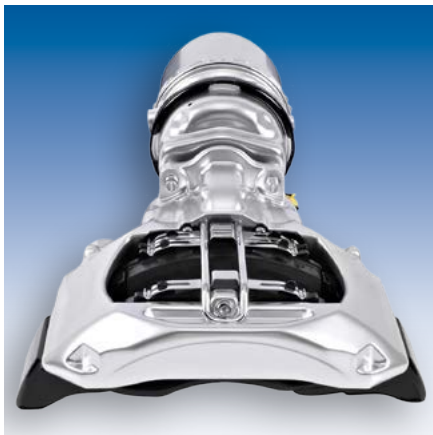
- Compact design enables easy axle adjustment
- Excellent braking performance even in difficult road conditions
- CDP coating as standard corrosion protection for longer service life
- High quality standard reduces maintenance and warranty costs
- Significant reduction of the braking distance as compared to drum brakes.



Compressed-air disc brake PAN™ 19

Selective product overview PAN™ 17

Vehicle application	OE reference	WABCO brake PAN™ 17	Replacement brake PAN™ 17	Brake pad repair kit
Anadolou Isuzu	377777399051	40 175 056	40 175 072	12 999 697VT
	377777420051	40 175 057	40 175 073	12 999 697VT
Otokar Otomotiv	13C25-08236-11	640 175 105 0	40 175 064	640 175 931 2
	13C25-08238-11	640 175 106 0	40 175 065	640 175 931 2



Compressed-air disc brake MAXX™ 22

MAXX™ COMPRESSED-AIR DISC BRAKES

New single-piston compressed-air disc brakes with optimum weight to performance ratio

MAXX™ – the new complete WABCO range of compressed-air disc brakes for the extreme demands in trucks, buses and trailers around the world. The MAXX™ disc brake range will represent the lightest and most powerful compressed-air disc brakes with single-piston technology for the commercial vehicle sector on the market.

The outstanding, compact design of MAXX™ compressed-air disc brakes from WABCO reduces the overall weight of the vehicle, increasing the fuel efficiency or the payload.

Product properties

- New generation of compressed-air disc brakes for all common wheel sizes
- Reinforced actuating unit in a monoblock brake calliper
- Redundant seals combined with robust metal fasteners
- Replaceable brake pad wear sensor (analogue or wear indicator)

Benefits

- Light-weight construction in combination with a high braking torque provides an outstanding weight-performance ratio
- Bidirectional reset unit ensures optimum clearance and helps to avoid running hot
- Replaceable plug-and-play sensor reduces maintenance costs
- High reliability thanks to tried and tested single-piston technology
- Significant reduction of the braking distance as compared to drum brakes

Wear indicators

Depending on the vehicle, wheel brakes are delivered with pad wear indicators (BVA). This makes the vehicle safer and downtimes for maintenance more predictable.

The thickness of the pad is monitored permanently with these wear indicators. If the pad reaches its critical wear limit, warning lamps indicate that the brakes require maintenance.



Pad wear indicators (BVA)



Continuous wear sensor (CWS)

As an alternative, a continuous wear sensor (CWS) provides information on the current pad wear status.

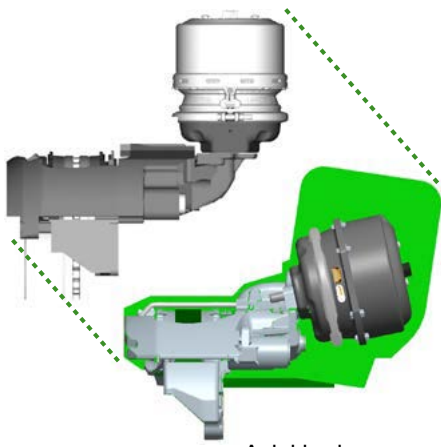
In combination with an EBS, the braking system uses sensor signals to compare the wear of the pads on all axles and wheels by controlling the pressure of the different axles and monitoring the thickness of the brake pads on all wheels. In this way, all brake pads are worn evenly. If the critical pad thickness of the brake pad 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 benefit: The continuous wear sensor (CWS) can be easily replaced - plug-and-play - without the need for further settings, as was the case with the BVA.

You will find information about the replacement parts on the Internet in our product database INFORM.

BRAKE SOLUTIONS FOR PORTAL AXLES

Radial brake +
Standard TRISTOP™



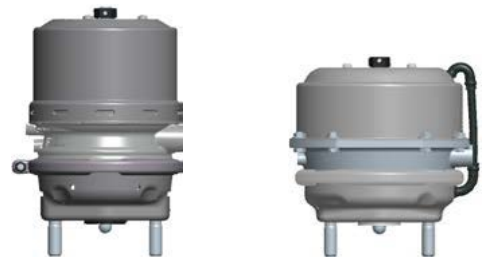
Axial brake +
Compact TRISTOP™

WABCO brake cylinders are used by many major commercial vehicle manufacturers and have proven their reliability in millions of applications.

In many buses the axial compressed-air disc brake MAXX™ with the Compact TRISTOP™ can be used instead of a heavy radial brake - taking into account the special installation situation in this vehicle segment.

Benefits

- Enables the installation of lighter axial brakes
- Identical brake design on front and rear axle
- Weight reduction due to lack of unwieldy, heavy radial brake

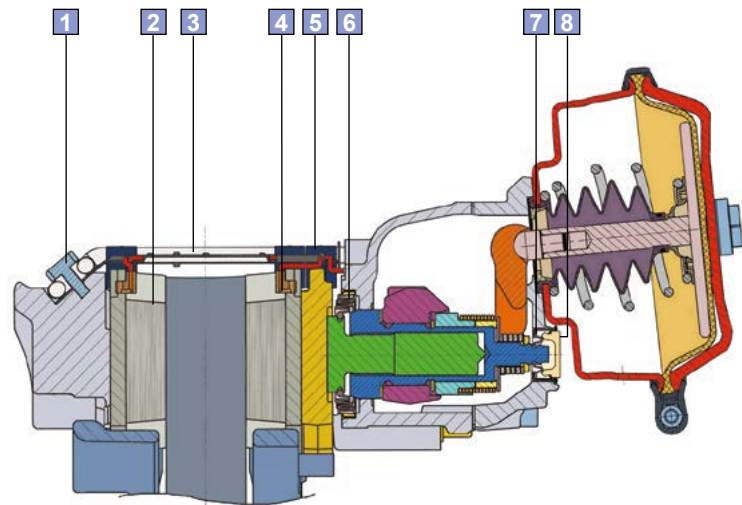


Technical data	Standard TRISTOP™ Type 20/24	Compact TRISTOP™ Type (30)/14
Length	259 mm	202 mm
Diameter	191 mm	246 mm
Weight (4 brakes, 4 brake cylinders)	207 kg	186 kg
Braking force	2× 8.5 kN*	2× 6.3 kN*
Release pressure	6 bar	6 bar

* complies with the legal requirement of 5.3 kN

Compressed air disc brake cross section

- 1 Screw
- 2 Brake pad
- 3 Retainer clip
- 4 Wear indicator
- 5 Retainer spring
- 6 Piston protection cap
- 7 Redundant seal
- 8 Sealing plug



Service and maintenance information

Before carrying out work on brakes, it is essential that you refer to the respective service instructions. Only start repair work if you have read and understood all (safety) information that is required for the repair.

Tips and other information for the workshop

- Brake pads must always be replaced per axle.
- With glued or riveted pads, the special adhesive regulations and drawings must be observed.
- With each brake pad replacement on disc brakes, the retainer springs and pad retainer clips must also be replaced.
- Use only the pads that are approved by the vehicle manufacturer.
- When fitting spare parts, please bear in mind that these have to be fitted without using force.
- When carrying out maintenance work, check all seals for damage and replace as necessary.

Legal characteristics



On vehicles that are allowed to be driven on public roads, the regulations according to § 29 StVZO apply. The safety test is also required.

Brake cylinder





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 motion energy.



Brake cylinders are designed to perform reliably and safely for many years. The highest quality standards ensure a noticeable reduction in operating costs and greatest possible safety. Major features that distinguish cylinders are size, stroke, piston length, spring chamber strength and overall length.

The following product types of brake cylinders are installed in buses:

- UNISTOP™ Diaphragm brake cylinder
- TRISTOP™ Spring chamber brake cylinder

Both types exist in diverse variants for disc brakes, S-cam brakes and expansion wedge brakes.

UNISTOP™ DIAPHRAGM BRAKE CYLINDER

WABCO diaphragm brake cylinders are used by many major commercial vehicle manufacturers and have proven their reliability in millions of applications. With more than 500 variants, diaphragm brake cylinders offer many different options for compressed-air disc, S-cam and expansion wedge brakes.

Product properties:

- Operating pressure up to 13 bar
- Stroke length up to 75 mm
- Piston rod can be supplied in different lengths
- Various connection positions and thread types
- Diaphragm brake cylinders are a component of the service braking system and are normally installed on the front axles.



UNISTOP™ Diaphragm brake cylinder for disc brakes

Device overview

UNISTOP™ Diaphragm brake cylinder for disc brakes

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

UNISTOP™ Diaphragm brake cylinder for cam brakes

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™ spring chamber brake cylinder for disc brakes

TRISTOP™ SPRING CHAMBER BRAKE CYLINDER

Brake cylinder with service, parking and emergency brake function

The WABCO TRISTOP™ - a technology that is one of the market leaders in Europe - has been tried and proven in millions of applications. It is one of the most mature products on the market.

With more than 1,500 variants for compressed-air disc, S-cam or expansion wedge brakes, TRISTOP™ is easily adapted to customer requirements.

The integrated breather valve (IBV), the powerful parking brake spring as well as different release systems (standard, half release screw, integrated release screw with indication) have contributed substantially to the technological standards of today.

Product properties:

- Operating pressure up to 13 bar
- Stroke length up to 75 mm
- Piston rod can be supplied in different lengths
- Various connection positions and thread types
- Normally used on the drive axle

Device overview

TRISTOP™ cylinder for disc brakes

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™ cylinder for S-cam brakes

Application	OE reference	Type	Product number
Bova Setra	190576 Q 8.283.938.000.0	24/24	925 321 285 7
Bova Setra	190615 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™ cylinders listed above for cam brakes, the Universal TRISTOP™ cylinder 925 491 141 0 / 499 202 853 0 can also be used.

Service and maintenance information

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

The cylinders must be tested for tightness, correct fastening and actuator stroke during full braking. With a correctly adjusted wheel brake, the diaphragm stroke should be one third to max. half of the possible total stroke.

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

When **replacing** the cylinder, the console must be checked for damage and replaced according to the recommendations of the axle manufacturer or the vehicle manufacturer as required.

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

The piston rod of Universal TRISTOP™ cylinders with bellow seals must only be shortened to the extent that the bellows will not be damaged during operation.

To achieve the braking force determined by the brake calculation, a replacement requires that the same size of WABCO TRISTOP™ is used as the original installation by the vehicle manufacturer.

Tips and other information for the workshop

What is IBV?

A breather valve integrated in the cylinder makes the small external connecting tube between the parking brake component and the service brake component redundant.

This technology provides a multitude of advantages:

- Long service life of the brake cylinder
- Only dry and clean air in the spring chamber for the parking brake
- Reduced expenditure for adaptation – the position of the breather tube does not need to be considered
- Greater variability – more variants can be used as a replacement due to the greater adjustment range
- Lower logistic requirements because there are fewer variants

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

What does 24/24 mean, for example?

The type information (e.g. type 24/24) indicates the effective piston 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 an addition of braking force in the wheel brake. If this is to be prevented, an overload protection valve or a two-way valve should be installed upstream.

These are some of the points that must be observed when switching to a Universal TRISTOP™ cylinder:

- Position of the clamp band
- Position of the threaded connections
- Position of the breather tube
- Position of the drainage hole, closed at top, open at bottom
- Length of the piston rod

The piston of the TRISTOP™ cylinder must be retracted completely while the brake is not actuated and must not be pre-tensioned. A test of the effectiveness is to be performed on the brake test stand.

TRISTOP™ cylinders must be replaced per axle! For older cylinders, the spring force of the spring chamber can be weakened, which will cause uneven braking.

When replacing cylinders, make sure they are installed correctly and that the seal to the disc brake is not damaged.

Note: Never open the housing to the spring chamber! Risk of fatal injuries due to parts coming explosively apart. The spring chamber part is only to be replaced as a complete unit.

TRISTOP™ cylinder with IBV and IMA, schematic diagram

Spring

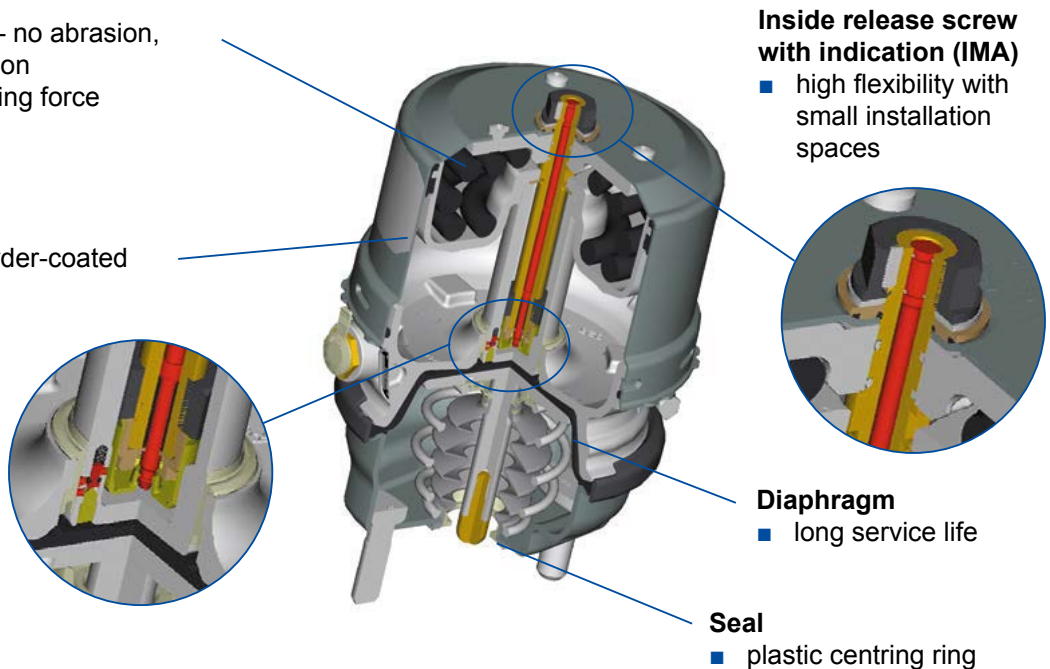
- no "coil-clash" – no abrasion, reduced corrosion
- long-lasting spring force

Cylinder

- completely powder-coated
- bayonet lock

Integrated breather valve (IBV)

- no external line
- longer service life
- fewer variants
- more installation options



Inside release screw with indication (IMA)

- high flexibility with small installation spaces

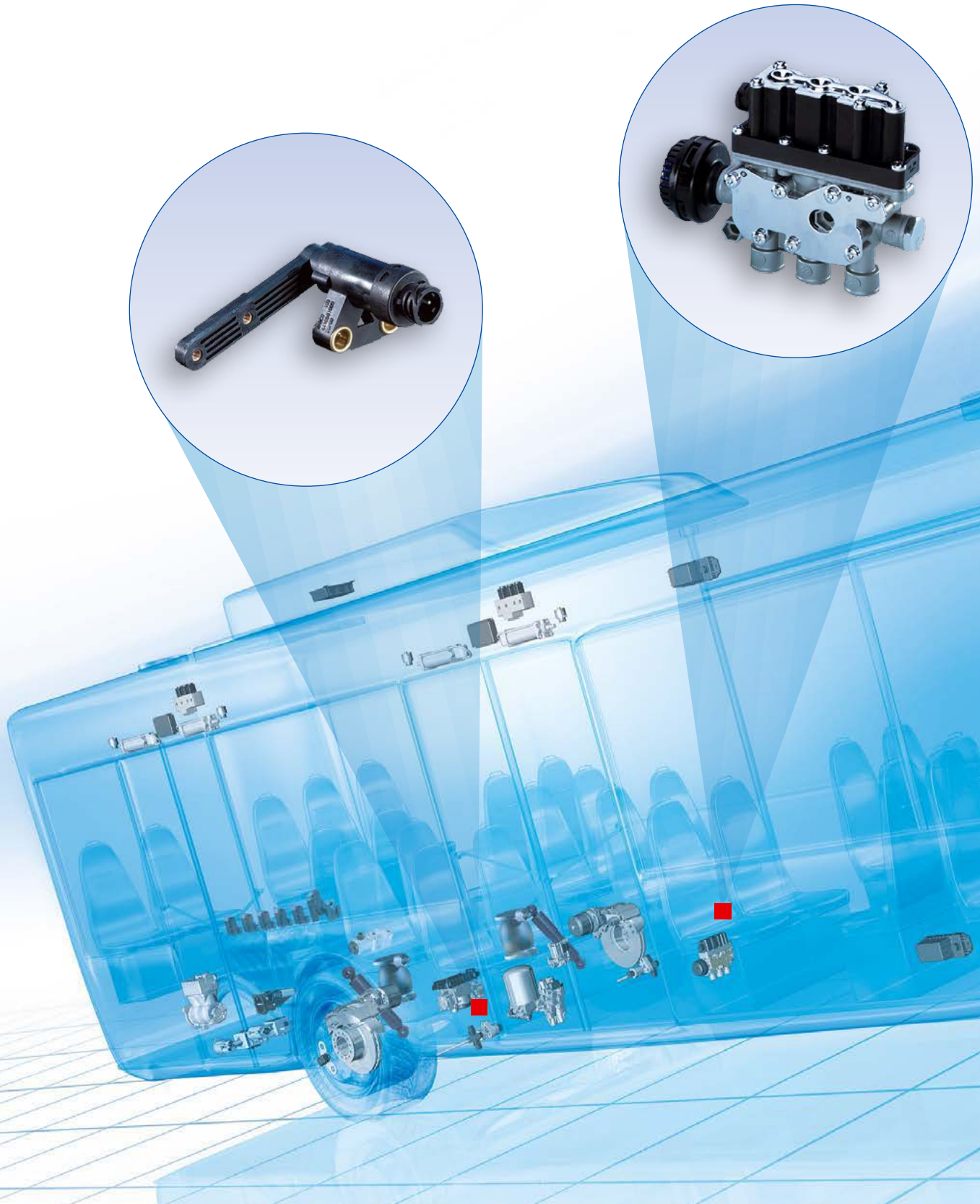
Diaphragm

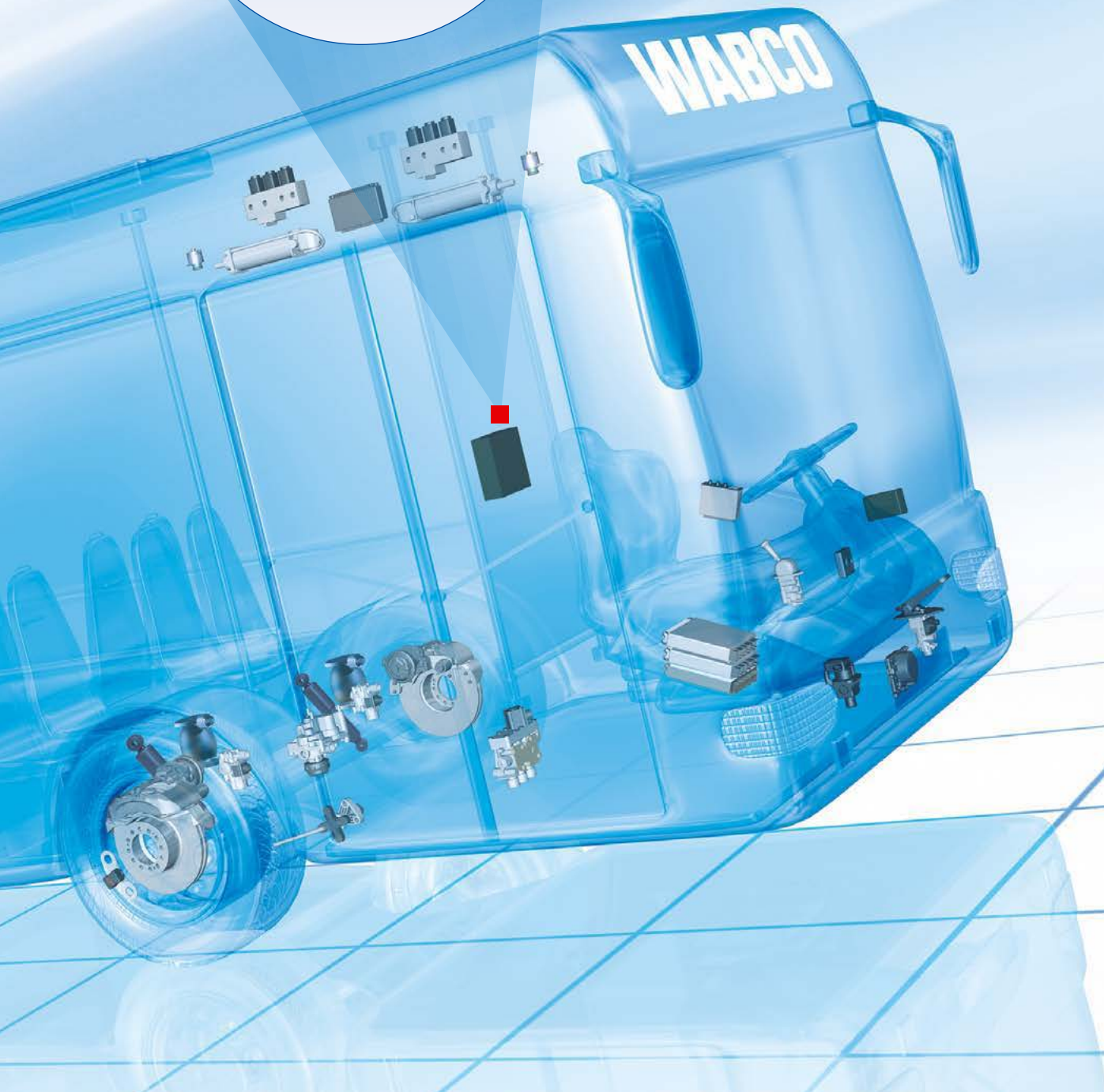
- long service life

Seal

- plastic centring ring

ECAS – Electronically Controlled Air Suspension





ECAS is an electronically controlled air suspension system for buses, trucks and other commercial vehicles that includes a variety of functions within an “all-in-one” system.

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



ECAS – ELECTRONICALLY CONTROLLED AIR SUSPENSION

Product advantages and features

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

Advantages of ECAS:

- Constant vehicle height regardless of total weight
- Decreased air consumption: It was found that ECAS can save around 25% of air in low-floor buses during normal operation as compared to conventional air suspension systems
- Extensive safety concept, diagnostics memory and diagnostic capabilities
- High speed for all control processes with large valve cross-section (nominal diameter up to 8 mm per bellow)
- Fewer 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
- Protects road surfaces

System functions

The ECAS electronic controls are based on the measurement values from the sensors of the air suspension system. Besides controlling the normal level, the electronics cover – in combination with operational switches and sensors for tire impression compensation – 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 axles

Not all of the capabilities are necessarily integrated into every system.

Note: The system configuration and parameter settings are the vehicle manufacturer's responsibility and must not be changed without the vehicle manufacturer's consent.

The safety concept

For monitoring the proper 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 despite a support bellow being pressurised, for example, is implausible and is therefore classified as a fault.

Recognised information is indicated to the driver via a display in the instrument panel.

Nominal level control

If there are deviations from the specified level above a tolerance range, solenoid valves are actuated and the actual level is adjusted to the specified level by pressurising/depressurising the air suspension bellow. Driving levels that have been defined previously are also maintained, independent of the number of passengers that get in or out for example.

Normal level I / II

Normal level I is defined by the vehicle manufacturer for normal driving operation. This level determines suspension comfort, 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 level is adjusted to the previous level again.

Height limitation

A height adjustment is ended automatically if value parameters for the upper and lower end position are reached.

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 the entire side, on a single wheel or on an axle by means of a distance sensor. ECAS can also ensure a proper lowering procedure using 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-CAN electronic control unit bus

Electronic Control Unit (ECU)

The electronic control unit is the core of the system to which the individual components are connected by means of plug-in connections.



ECAS solenoid valve

Solenoid valves

By combining specially developed solenoid valves into compact block valves, the required installation space and effort is greatly reduced. The solenoid valves, controlled as actuators by the electronics, convert the applied voltage to a pressurising or depressurising process (such as lifting, lowering or stopping the air flow in the bellows).



ECAS distance sensor

Distance sensor

A rotary movement of the lever registers every change in the distance between the assembly and the axle (comparable to 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.



ECAS pressure sensor

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, except checking those system parts that cannot test themselves (distance sensor rod, linkage, warning lamps, etc.).

If an ECU fault is detected, this is indicated to the driver via the display. Only then does the system need to be tested in a workshop.

Device overview



Name	Application	Product number
ECAS Electronics without CAN	Mercedes-Benz	446 055 501 0
	GAZ, Iveco, VDL	446 055 503 0
	Iveco, Otokar	446 055 508 0
ECAS Electronics with CAN	Iveco	446 170 211 0
	DAF	446 170 218 0
	DAF	446 170 219 0
ECAS remote control	DAF, Renault	446 056 129 0
	MAN	446 056 138 0
	Universal	446 056 146 0
	Mercedes-Benz	446 056 333 0
ECAS solenoid valve	Remote control holder	446 056 010 4
	4x2-2 channel, DIN bayonet	472 880 000 0
	4x2-2 channel, DIN bayonet	472 880 001 0
	4x2-1 channel, DIN bayonet	472 880 030 0
	4x2-2 channel, DIN bayonet	472 900 053 0
	Double valve 6x2 -1&2 channel, DIN bayonet	472 900 056 0
	4x2-2 channel, DIN bayonet	472 900 060 0
ECAS distance sensor	Double valve 6x2 PE, DIN bayonet	472 905 111 0
	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
	DIN bayonet, cruciform lever	441 050 121 0
ECAS pressure sensor	DIN bayonet, cruciform lever	441 050 123 0
	DIN bayonet, M16x1.5	441 044 101 0
	DIN bayonet, M16x1.5	441 044 102 0
	DIN bayonet, M16x1.5	441 044 104 0
	DIN bayonet, M16x1.5	441 044 107 0

Tips and trivia for the workshop

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

Prior to calibration:

- The correct function of the distance sensor must be ensured.
- There must be no entries in the diagnostics memory.
- The vehicle must be positioned on a level, horizontal surface for calibration.
- The distance sensors must be checked for correct position prior to 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 edge of 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 diagnostic software. For articulated buses and towing vehicles the address is 16, for trailers the address is either 17 or 19 (depends on vehicle manufacturer).
- The second ECU must be electrically disconnected from the system for diagnosis or calibration, otherwise the cabling prevents a correct diagnosis.

Legal characteristics



Specifications for ECAS in buses 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 must only be possible with the doors closed. It should only be possible at a driving speed under 5 km/h.

The lowering procedure must be almost 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 to EC directive 2001/85/EEC. From 1 November 2014 onwards, EU regulation ECE R 107 replaces EU directive 2001/85/EC.

ESAC – ELECTRONIC SHOCK ABSORBER CONTROL

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



ESAC-ECU

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.



ESAC

Advantages of ESAC:

- Maximum driving comfort
- Improved driving stability during rapid driving manoeuvres or fast cornering by reducing the roll angle
- Great reduction of brake and acceleration pitching (especially in vehicles with a short wheel base)
- Improved control behaviour of the air suspension system through intelligent interaction with ECAS and ESAC
- Reduced burden on the roads

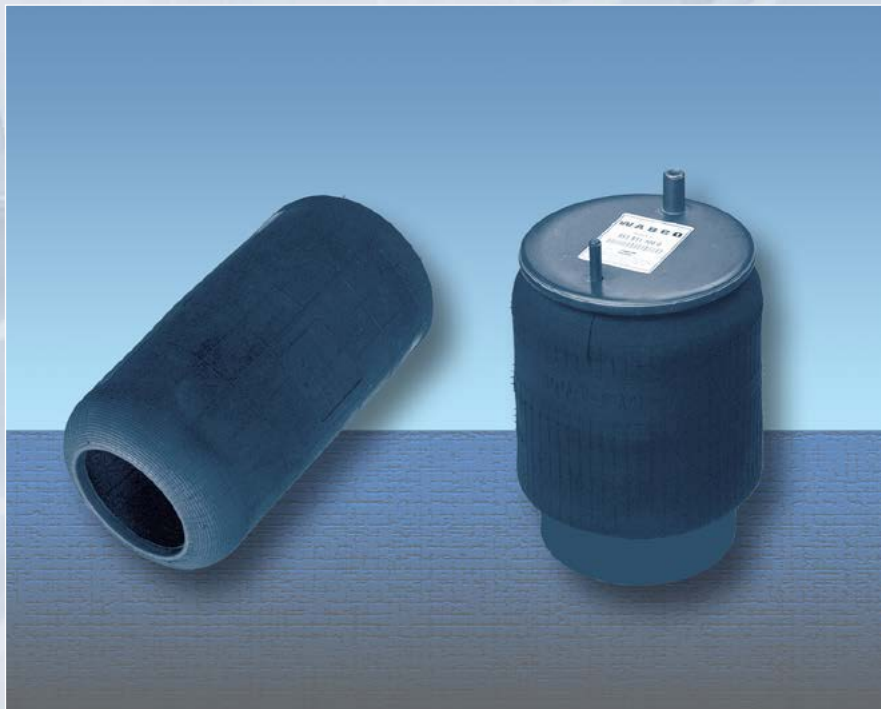
Air springs in buses





WABCO has been a recognised provider of suspension control systems for years.

Electronically controlled air suspension systems (ECAS), air suspension valves and the electronic levelling module (ELM) are evidently just as much a part of the WABCO product range as the ABS and EBS braking systems.



Commercial vehicles used to be exclusively fitted with steel springs, but the mid-20th century saw the development of rolling lobe and coil spring air suspension for buses, trucks, trailers and cars. The technical advantages of air suspension and ongoing development of components ensure that the market share is still growing today.

WABCO put its expertise in suspension technology to use and expanded its product range to air springs. We have now been offering air springs for buses, trucks and trailers since 2002.

Product features and benefits

WABCO air springs protect the load, offer a constant ride height and enable long-term, reliable usage.

They provide the highest levels of productivity and service for your vehicles and ensure a smooth, cushioned ride. The air springs transfer less vibration and so give bus bodies a longer length of service than with conventional steel springs. Passengers travel in greater comfort, and the driver becomes less fatigued and stays more alert.

When a vehicle is empty or is only partially loaded, steel suspension systems are too stiff to allow the deflection necessary to prevent oscillation and shock from being transmitted from the wheels to the frame. With WABCO air springs this phenomenon is eliminated by the compensating spring rate.

Air springs allow for a change in spring rate, or stiffness, to accommodate load changes. A lightly loaded vehicle operates with lower air pressure in the springs, while a fully loaded vehicle operates with a high spring pressure. Changing from low to high pressure happens automatically via special distance sensors.

For bus operators, WABCO air springs mean:

- improved vibration damping in both loaded and unloaded conditions
- increased driver comfort
- and higher resale value due to improved damping of the frame.

Improved damping of the frame leads to:

- reduced need for electrical and instrument maintenance
- limited body damage
- limited axle, transmission and tyre wear
- reduced downtime
- reduced driver fatigue

Device overview

The WABCO range of air spring products includes many variants for trucks, buses and trailers.

There are variants for bus applications from manufacturers such as Bova, DAF, Dennis, Evobus, Ikarus, Inbus, Iris, Iveco, Kässbohrer-Setra, Leyland, MAN, Mercedes, Neoplan, Pegaso, Renault, Scania, Van Hool and Volvo.

The number range for WABCO air springs essentially covers two different types of product:

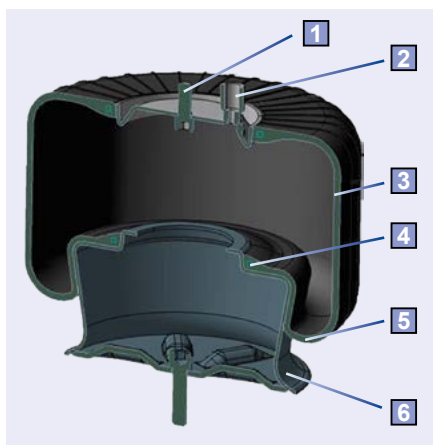
- Part number 896 130 xxx 4 represents a simple air suspension component such as individual bellows with no crimped plate or rolling lobe piston
- Part number 951 8xx xxx 0 represents a complete air spring with pistons and/or end plates (rolling lobes or bellows)



Air suspension bellow

Complete air spring

Service and maintenance information



- 1 Assembly pins
- 2 Air connection
- 3 Air suspension bellows
- 4 Clamping plate
- 5 Bead edging
- 6 Piston

WABCO offers various options for piston material:

- steel or
- plastic

To identify the correct WABCO part number, WABCO products have ten-digit part numbers for bellows vulcanised into the rubber of the bellows and the part number for the complete air spring on a sticker on the crimped plate.

Attention!

The bellows number on the rubber membrane of the rolling lobe or bellows does not refer to the complete air spring. The rubber bellows are installed in various air springs depending on the various combinations of crimped plate and rolling lobe piston.

The following contains important maintenance information for air springs:

- Pneumatic lines and fittings should be regularly checked for leaks: Rubbing against the air spring should be prevented
- Check for proper clearance around the air spring when inflated. Generally, a minimum of 36mm will allow for the increase in diameter which occurs with heavy bouncing
- Regularly check suspension for correct height. This dimension should be maintained at +/- 7mm to protect the springs and shock absorbers from over-extension or frequent bottoming out of the suspension.
- When doing routine vehicle maintenance, block up the suspension and check for irregular wear or material build-up on the flexmember. If necessary, clean using a non-petroleum based cleaning solution.
- Check rolling lobe piston for material build-up. Hardened debris on the piston will shorten spring life and should be removed as part of your regular maintenance.
- Check shock absorbers for any signs of leaking hydraulic fluid, broken end connections, worn bushings or cylinders and over-extension.
- Regularly check nuts and bolts for proper torque. See vehicle manufacturer's manual for specific recommendations.
- Check the normal level control valve is functioning properly. Clean or replace if necessary. A properly maintained valve will save unnecessary repair costs.
- Routine inspection of all of the above, according to a pre-determined odometer reading maintenance schedule, will extend the life of your vehicle and reduce your overall maintenance costs.

Tips and other information for the workshop



Before you start replacing air springs, make sure you have all the necessary tools to perform the repair safely. Familiarise yourself with the suspension on which you are performing the repair by reviewing the vehicle manufacturer's service guide.

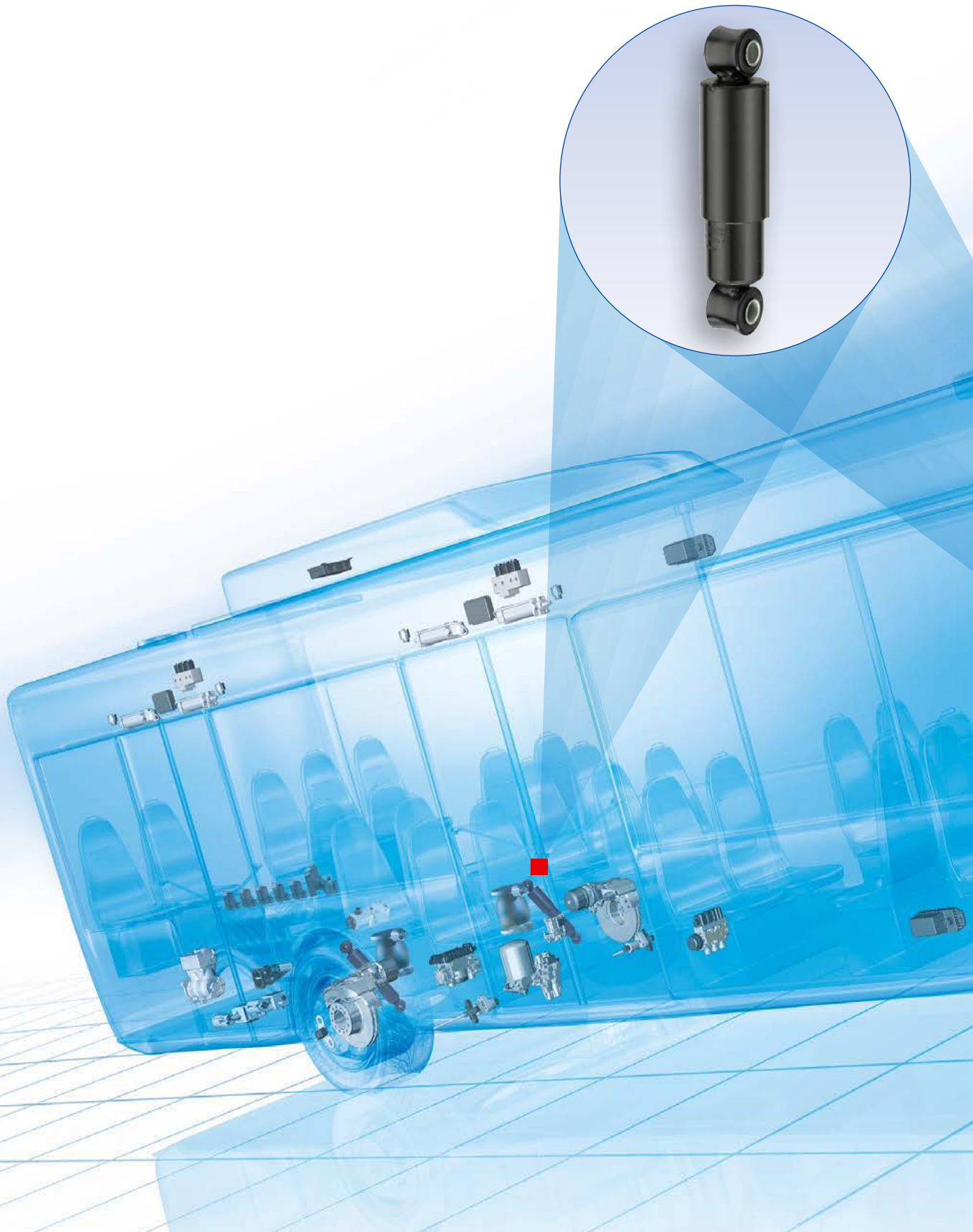
Below is some important information on installing new air springs.

- When disconnecting the levelling valve linkage, check if the linkage is bent or broken; replace damaged parts if necessary.
- Once the air lines are disconnected, check their entire length for cracks or other damage. Any worn parts must of course be replaced.
- Sometimes the cause of air spring failure is visible and / or readily apparent; other times it is not. If not, inspect the air spring after you have removed it to determine the cause of failure, then correct the cause of the problem.
- With the air spring removed, other parts of the air suspension become more accessible. Check for wear or damage of the frame hangers, trailing arm bushings, torque rods, the trailing arms and the air spring mounts. Again, replace components where necessary.
- Also check the area around the air spring mounting to ensure there are no obstacles or sharp edges that can damage the new air spring.
- Before installing the new unit, clean the air spring mounting plates to ensure proper attachment to the suspension.
- WABCO recommends always using new attachment screws when replacing.
- Check the levelling arm for proper operation. Under load, the levelling arm should move from the neutral position up to the intake position. This lets air into the springs, which brings the arm back to the neutral position. On removing the load, the arm should drop back down to the neutral position. That opens the outlet valve, allowing air to escape until the arm returns to the neutral position.

Legal characteristics

With vehicles that are allowed to be driven on public streets, the regulations according to § 29 StVZO (German Traffic Regulations) apply.

Shock absorbers in buses







From simple tube shock absorbers to cab shock absorbers with an air suspension unit



The first developments in terms of shock absorbers for two- and four-wheeled vehicles were already being made at the end of the 19th century. The first hydraulic shock absorber for cars was developed at the beginning of the 20th century. During the course of the century, these were improved more and more, leading to the shock absorbers we are familiar with today.

Nowadays there are virtually no vehicles without shock absorbers. As a specialist in suspension, WABCO is known for systems such as the ECAS electronic air suspension system, and has been including shock absorbers in its range for many years now. The well-known product range, including ECAS, air suspension bellows and air suspension valves, is completed with WABCO shock absorbers.

The WABCO offering includes a wide range of shock absorbers. This includes variants for towing vehicles, trailers, cabs and buses.

The selection of bus applications covers all the major bus manufacturers, such as DAF, Ikarus, Iveco, Kaessbohrer, MAN, Mercedes, Neoplan, Scania, Van Hool and Volvo.

Product advantages and properties



Device overview

Service and maintenance information



Benefits of WABCO shock absorbers at a glance:

- Wide range of shock absorbers
- WABCO quality guarantees a long service life even under demanding road conditions
- Improved driver comfort

Benefits for drivers and bus operators:

- Optimised operation of conventional and electronic braking systems (safety)
- Retention of vehicle control under sudden braking or changes of track (safety)
- Maximum road grip under a sudden change of surface due to the influence of water or oil (safety)
- Shorter braking distance in all situations (safety)
- Reduced tyre wear (cost saving)
- Better protection of essential axle components (cost saving)
- Reduced maintenance costs through longer service life (cost saving)
- WABCO sales and service network (service and availability)

The WABCO number system:

WABCO shock absorbers are numbered separately according to their application. The ten-digit number is composed as follows:

- Towing vehicle chassis: 438 600 xxx 0
- Trailer: 438 601 xxx 0
- Cab: 438 604 xxx 0
- Bus: 438 606 xxx 0

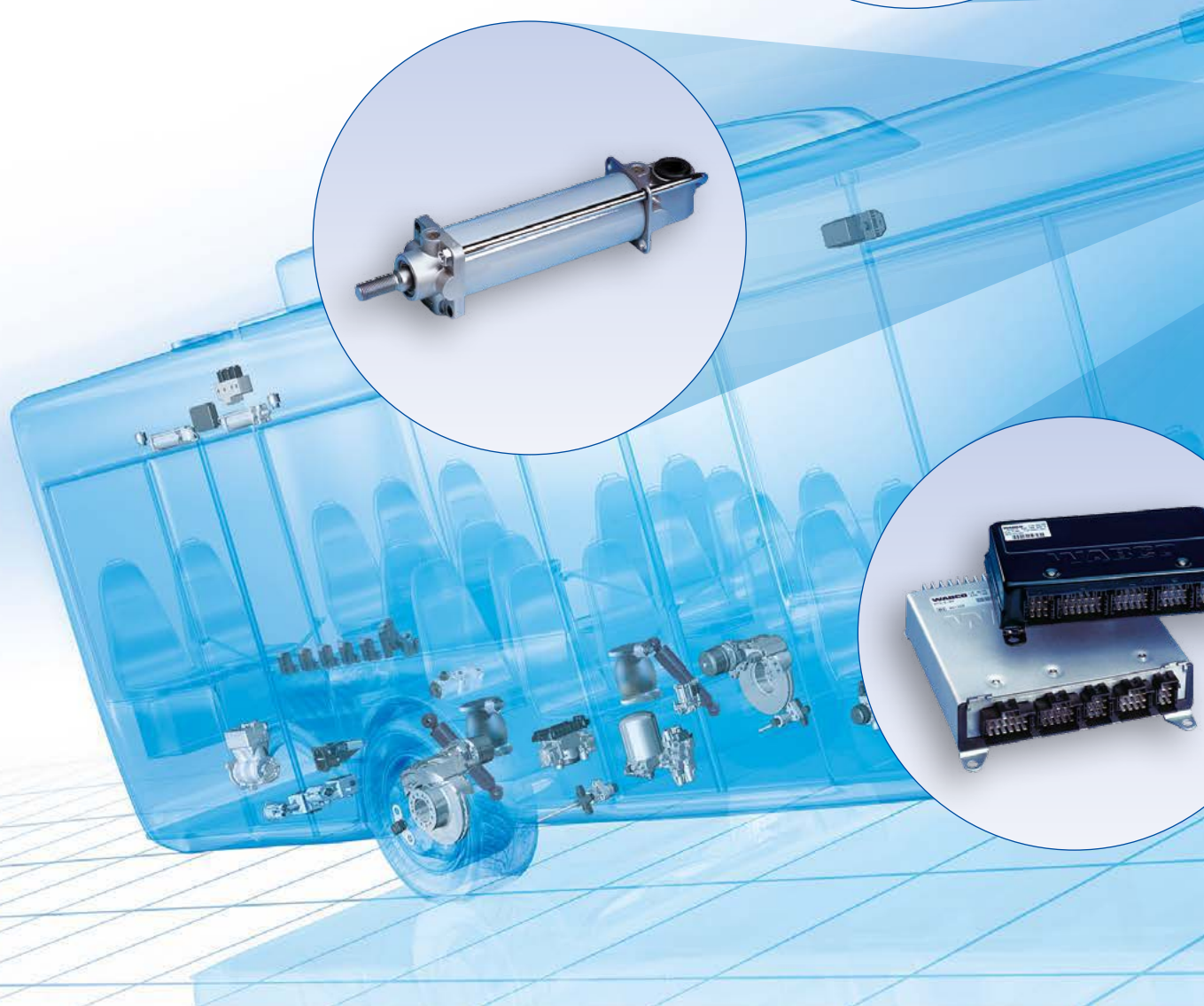
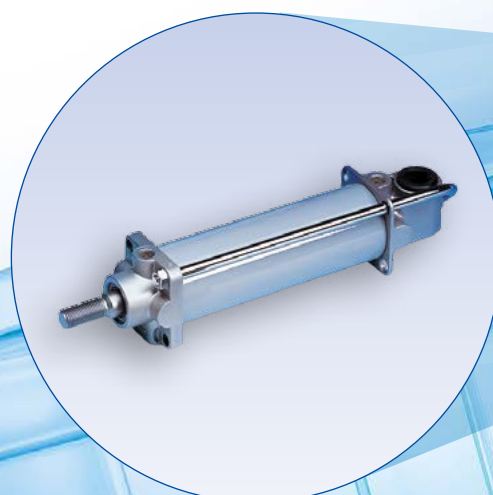
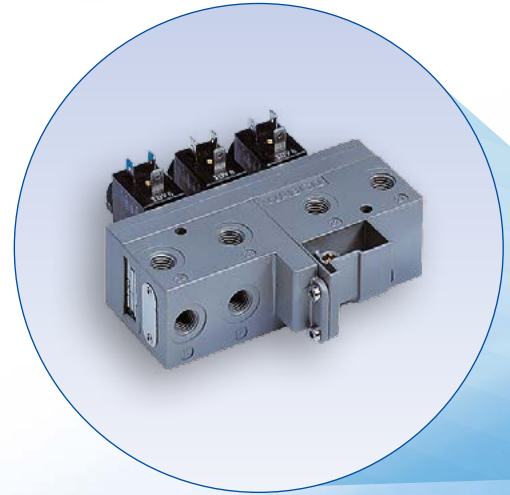
Indicators of shock absorber wear:

- Leaks (sign of hydraulic fluid leak)
- Broken or split bushes
- Dents in the shock absorber line
- Broken attachment components
- High mileage
- Excessive corrosion

Shock absorber check points:

- Tyres - undulated wear
- Split air suspension bellows
- Broken bulbs
- Broken battery boxes
- Loose screws on the heat sink
- Broken brake linings
- Worn bump stops on the chassis

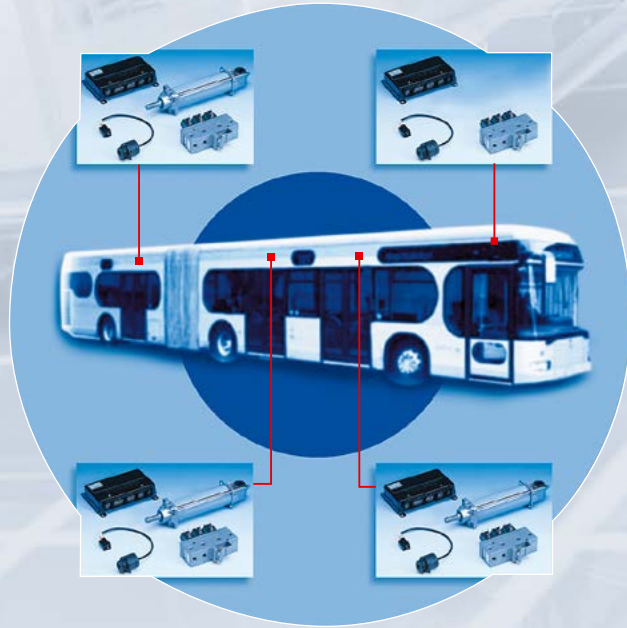
MTS - Modular Door Control





Development of the modular door control system was based on the experience of electronic door control (ETS). With MTS it is possible for the first time to operate and monitor up to five doors of different types using identical control devices.

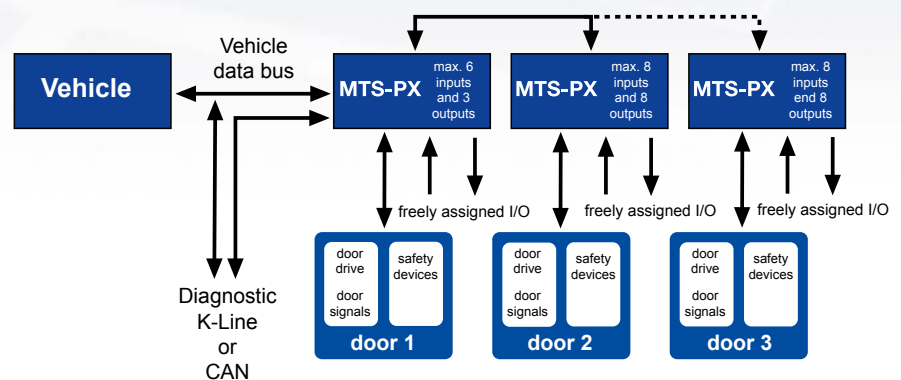
MTS can control inward pivot, outward pivot doors with and without lift-locking or sliding plug doors. In a single vehicle, it is possible to use pneumatic and electrically driven doors in any order.



Product advantages and features

Advantages of MTS

- System is easy to understand
- Cost reduction due to fewer components / cables than with ETS
- Less adjustment required
- No complex relay connections of standard controllers
- Parameter setting possible via software for easy adjustment of the controller to customer-specific requirements.
- ECUs in doors 2 to 5 can be replaced without needing to consider parameter settings, because data for all doors is saved in the controller for door 1.
- Complete diagnostics capabilities (CAN bus or K-line)
- Different door types can be used (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
- Regardless of whether can or conventional methods are use - the individual doors are connected via the system CAN bus.



Door monitoring

The pneumatic doors are monitored via installed potentiometers on the turning column. These sensors do not need to be configured due to mechanical coding.

Electrically driven doors are sometimes also monitored by 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:

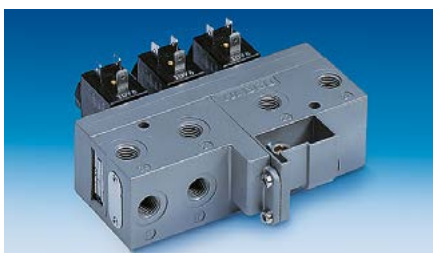
- Electronics (for electronic or pneumatic doors)
- Sensors for swinging doors
- MTS door control valve
- MTS door cylinder
- Emergency valve with switch
- Pressure switch

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 unrestricted door movement must be ensured for normal door operation.

Device overview



MTS control electronics



MTS door valve

Name	Product number
Electronics type PX for pneumatic doors	446 190 001 0 (also replaces 446 190 000 0 and 446 190 002 0)
Electronics type EX for electronic doors	446 190 012 0 (also replaces 446 190 011 0 and 446 190 010 0)
Door valve	472 600 022 0 472 017 480 0 (also replaces 446 002 302 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 0 446 190 153 0
Door cylinder	422 812 000 0 422 812 002 0
Emergency valve	952 003 032 0
Pressure switch	441 014 017 0

Service and maintenance information

The following points must be observed for service with an MTS system:

- The correct status of the door must always be checked for servicing. The door should be plumb, 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 legally required inspections, such as the visual check (SP) or the main inspection (HU), the closing forces need to be checked.

Jam detection for doors:

- The doors are equipped with so-called jam protection mechanisms, which must be checked during servicing.
- To monitor the opening mechanism, the doors are switched to a state without force (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 motion is reversed in the closing direction, the function of the door is opposite ("door open").

The learning procedure for a door is as follows:

- Opening and closing each door with continuous actuation of the workshop button (duration per learning cycle: approx. 5-7 sec.)
- Number of expansion modules and operating mode (CAN or conventional) are learned on door 1
- Learning process is acknowledged by flashing the boarding lighting
- Number of flash pulses corresponds to 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 diagnostic software.

- Only if the ECU for door 1 is replaced is it necessary to transfer the data from the old ECU. In either case the system needs to be learned again.

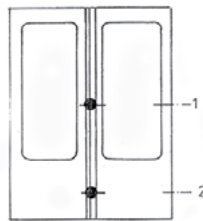
Note: Old and new calibration values can be obtained from the diagnosis and these allow deductions concerning the status of the mechanics of the door.

- Sensor replacement: Observe the installation instructions of the vehicle or door manufacturer.
- The position is defined by a positioning mark on the distance sensor. The sensor is therefore located at a certain position relative to the turning column.
- The damping of the doors can be changed by means of a set screw. In this regard, only the damping strength is changed and not the beginning or the start of 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 by what is known as a 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 overlap the rear door wing. This ensures a good seal and wind noise is reduced.

Legal characteristics



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



Measuring device of class 2

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 a measuring device of class 2 is recommended by the German Institute for Occupational Health and Safety. This device only determines the peak force F_s . The closing force is to be measured at two measurement points on 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 F_s 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)

For buses with more than 22 (previously 16) passenger seats, the following applies: during the safety test, along with the test of the flooring, steps and existing mobile boarding aids (ramps) and for “vehicles with initial registration” as of July 1990, the passenger doors must be checked for proper function of the jam protection:

Conforming with § 35e Para. 5 StVZO and the respective published “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 F_o) of no more than **150 N**.

For repeat tests required by § 29 StVZO in combination with system VIII (HU, SP), measurements of the effective force F_o using measuring devices of class 1 or measurements of the peak force F_s using measuring devices of class 2 must be carried out at the door centre and a distance of 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 buses, besides the national regulations (StVZO § 35e as well as other directives), EU directive 2001/85/EC (the so-called bus directive) and ECE-R36 (the content of which has mainly been included in 2001/85/EC) and ECE-R107 are applicable.

The following requirements are mainly stated 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 easily removed “Test stick, tapered” (2001/85/EC 7.6.5.6.1.2.)
- Emergency actuation installation site, inside/outside, blockage outer emergency valves

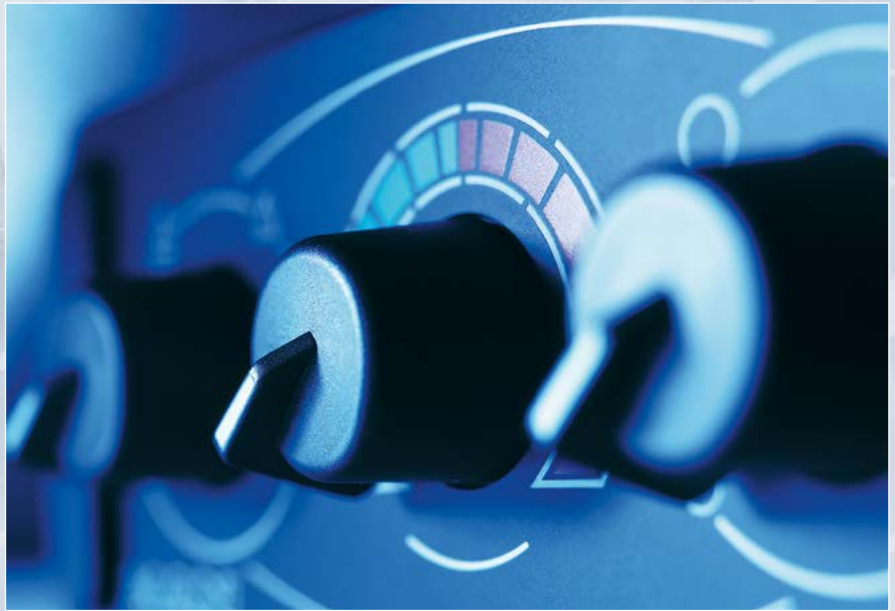
HVAC - Heating, Ventilation and Air Conditioning





Heating, Ventilation and Air Conditioning (HVAC) now belong to the standard equipment for city and intercity buses and coaches.

HVAC offers maximum comfort for driver and passengers. The highly modular structure and extensive parameter setting options of the HVAC components enables vehicle manufacturers to easily create systems which cover the needs of all kinds of bus variants.



All requirements on an ideally acclimatised city bus are stated in regulation 236 of the VDV (Association of German Transport Companies), which is the basis for regulating the city bus HVAC.

HVAC regulates more than just the climate.

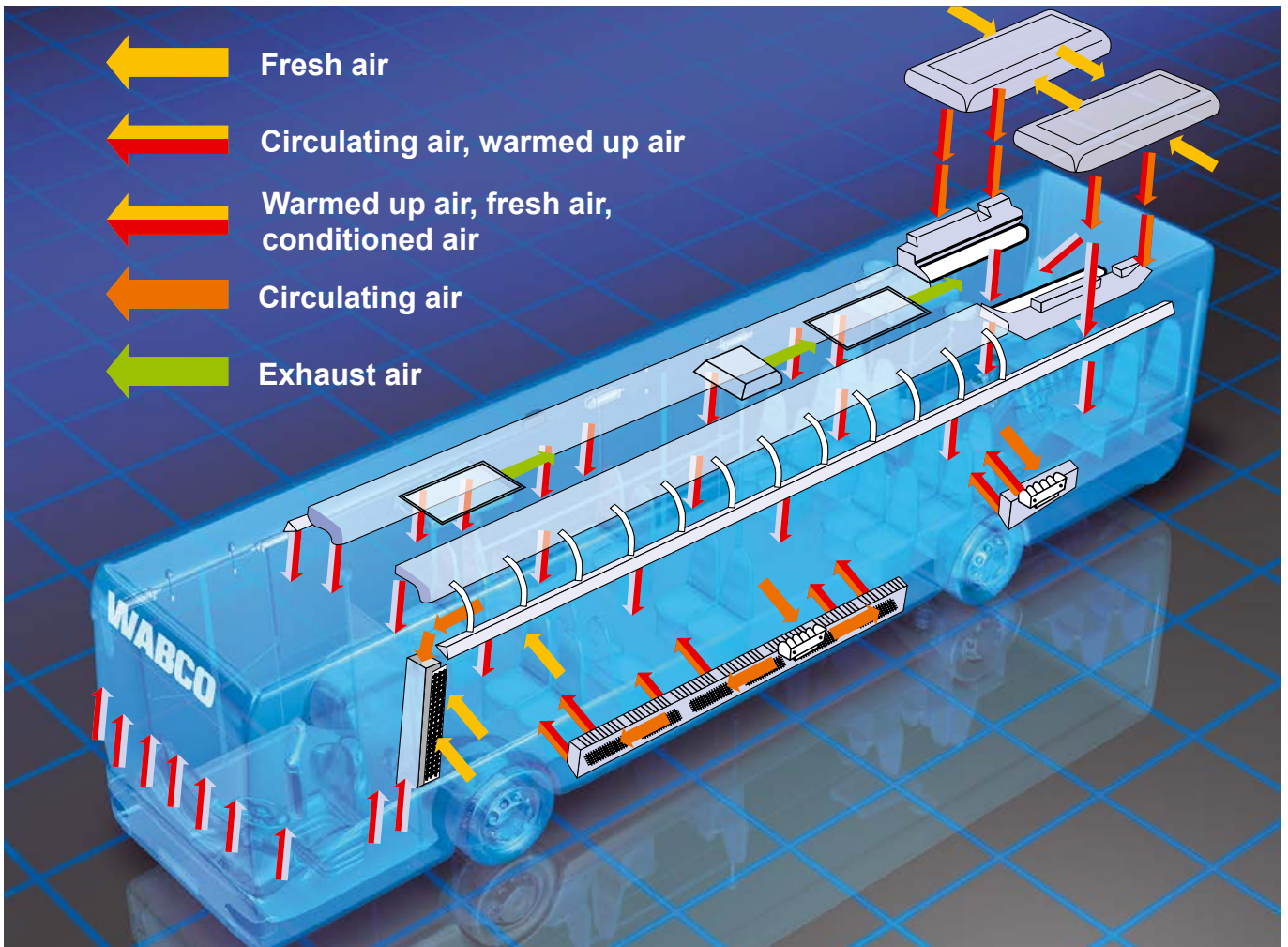
Advantages of HVAC:

- Automatic regulation of the heating, ventilation and air-conditioning (HVAC), so that the driver no longer has to perform extensive adjustments
- Manual access to flap control, temperature control and fan control for the driver's area
- Fully automatic air-conditioning of the passenger area (can be switched on or off on the control unit)
- More comprehensive setting capabilities for the passenger area regulation in intercity buses and coaches
- Quick diagnostics of the HVAC possible via diagnostics program; faults can be read out and localised

Features of the HVAC:

- Master-Slave system, which communicates with the vehicle via a CAN interface
- Connection to substations via internal HVAC CAN bus
- Control unit with integrated display for vehicle without central display
- Desired value setting via control unit
- Temperature control with a precision of 1°C
- Connection of additional and engine-independent heater possible
- Control of fan speeds and optimisation for closing doors via signals from door movements
- Detailed on-board diagnostics in control unit with display
- Functions such as smog switching, defrost function and reheat operation are integrated in control units

Functionality of HVAC



Components



HVAC control elements

An HVAC system in an Bus consists of the following components:

- Control element for driver position and passenger area control
- Substations
- Temperature sensor for measuring the outside, inside and air outlet temperatures of heat exchangers
- Water temperature sensor
- Blower module
- Water valve for regulating the flow through the heat exchanger

An HVAC system in a bus contains, besides the control unit, 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 unit can be operated as a stand-alone unit to control the blower speed and heating temperature for driver and passenger areas. When using air conditioning, an additional substation is required.

The connected substations include the control element regulator that processes the sensor values (temperature measurements) and the control signals for the actuators (such as flap servo motors and adjustable water valves). These are defined to the set levels.

Device overview



Application	Name	Product number
Mercedes-Benz	HVAC control unit for citybus	446 195 001 0
	3-button city bus front cover	446 195 032 2
Mercedes-Benz	HVAC control unit for citybus	446 195 002 0
	4-button city bus front cover	446 195 033 2
Mercedes-Benz	HVAC control unit for citybus	446 195 003 0
	5-button city bus front cover	446 195 034 2
MAN, Neoplan	HVAC control unit for citybus	446 195 004 0
	5-button city bus front cover	446 195 037 2
Mercedes-Benz	HVAC control unit for coach	446 197 001 0
Mercedes-Benz, Setra	HVAC control unit for double decker and coach	446 197 002 0
Mercedes-Benz, Setra	HVAC control unit for intercity bus and coach	446 197 004 0
Mercedes-Benz	HVAC control unit for coach	446 197 005 0
	Coach front cover for all WABCO control units 446 197 00X 0	446 197 030 2
Mercedes-Benz, Setra	HVAC control unit for intercity bus and coach	446 197 011 0
Setra	HVAC control unit for double decker and coach	446 197 012 0
	Coach front cover for WABCO control units 446 197 011 0 and 012 0	446 197 031 2
Bova	HVAC control unit for coach	446 197 040 0
Various Buses	Substation	446 196 000 0
Mercedes-Benz, Setra	HVAC control unit for city and intercity bus and coach	446 295 000 0
Mercedes-Benz, Setra	HVAC substation	446 296 000 0
Setra, Solaris	ATR-E control unit	446 095 003 0
MAN, Neoplan	ATR-E control unit	446 095 006 0
MAN, Neoplan	ATR-E control unit	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
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

Repair kits are available for many control units.

Service and maintenance information

The CAN system control unit contains the entire parameter set for the complete HVAC system, including the parameters for the substations. If one or more substation(s) have to be replaced, no other settings are required because they are already defined in the control unit and are automatically transferred to the substation(s).

Replacing the control unit

When replacing the control unit, 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 diagnostic software. This can then be transferred to the replacement ECU.

Tips and trivia for the workshop

HVAC is basically maintenance-free. Any faults that occur are indicated accordingly and can be read via the diagnostics.

In many types of vehicles it is required to open the system valves in a specific order before filling the system with cooling fluid. Proper exhaust of air from the system can only be achieved if this specific sequence is adhered to. Always refer to the manual instructions provided by the vehicle manufacturer.

With HVAC and air-conditioning vehicles, all air filter mats should be replaced or cleaned every 6 months or when required. The same applies to the so-called active carbon filter, provided the vehicle is equipped with such a filter. Please note the interval-related service instructions of the vehicle manufacturer.

We recommend you service the substations within the interior. For older components, the allocation of is done via PC diagnostics. For new components, the allocation is done automatically via the control unit. Please refer to the part number log for details.

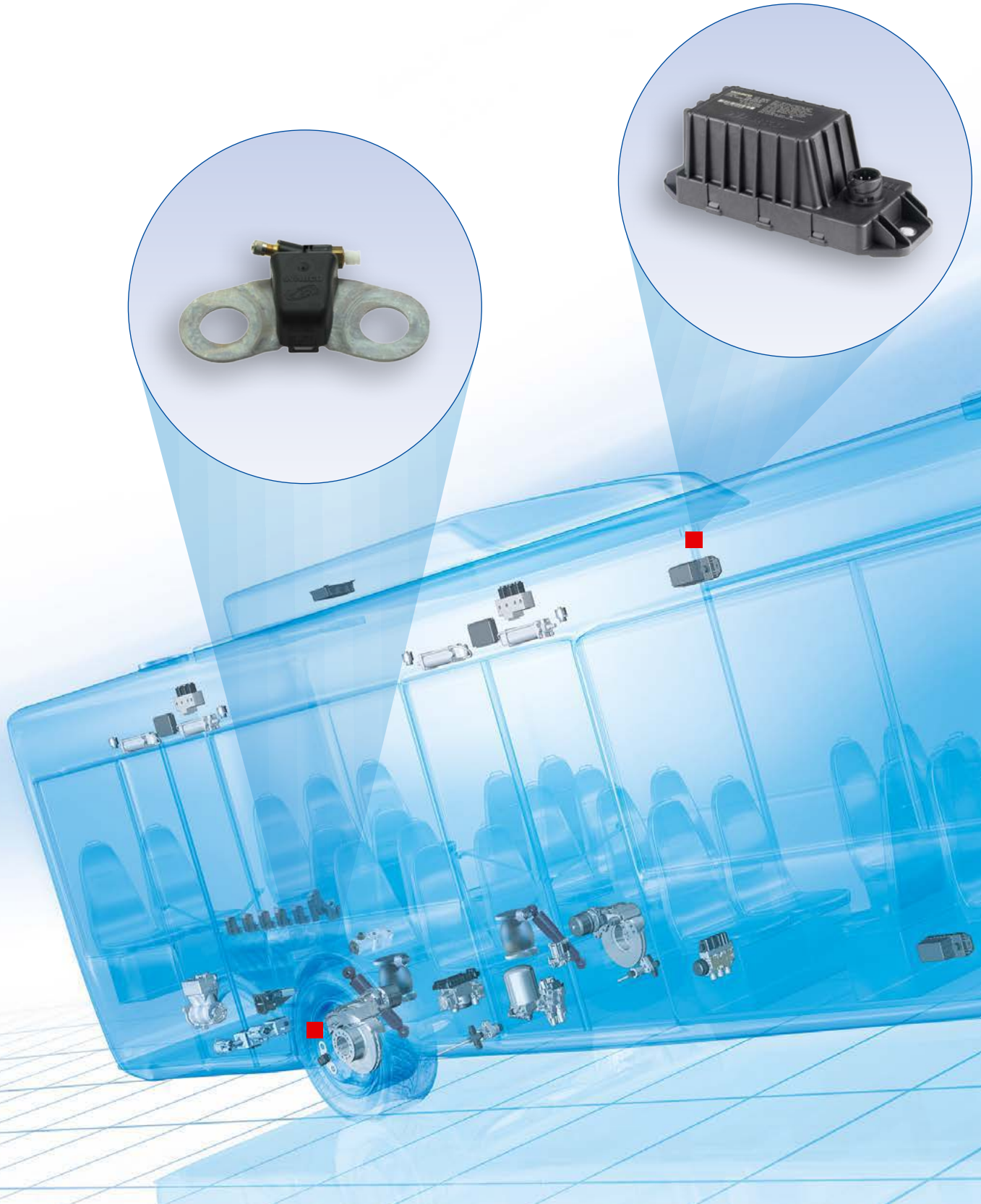
If system faults occur, the mechanical transfer components should be checked, such as the flap control or the water valves, where the mechanical position could be interpreted incorrectly. The temperature sensor should be free of contamination, otherwise the measurement cell is not in direct contact with the ambient air, so that the actual temperature in the vehicle cannot be reported.

Legal characteristics

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



IVTM – Integrated Vehicle Tire Pressure Monitoring





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 retrofitted at any time, you are automatically informed of pressure loss in the tires.



IVTM increases safety

Proper tires are a 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, towing vehicles or buses permanently using direct means of measurement.

Research results

Tire defects are the most common reason for commercial vehicle downtime. In 2011 an ADAC study estimated that over 30 % of commercial vehicles breakdowns were caused by tire failure.

Around 85 % of punctures are caused by a creeping pressure loss, however, that normally goes unnoticed by the driver, particularly in commercial vehicles.

IVTM identifies these pressure losses and warns the driver in due time - long before the tire suddenly bursts. IVTM effectively helps prevent accidents caused by serious tire damage and flat tire repairs in dangerous areas. Additionally, the system helps avoid unnecessary, and costly, vehicle downtime.

A time-consuming installation of sensors in the rims is not required. Wheel modules, which are simply screwed on with the wheel nut, measure the pressure on the tire valves. The IVTM ECU is mounted on the vehicle chassis and receives the pressure data for all wheels via radio signal.

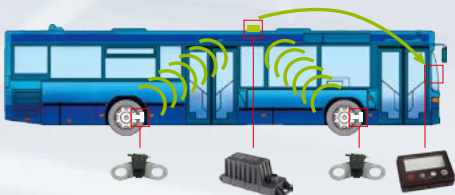
The pressure for each tire can be retrieved for each tire from the driver's cabin. The display in the instrument panel warns the driver optically and acoustically of critical deviations from the defined nominal pressure. Many original equipment manufacturers enable the display for tire pressure information from IVTM in the vehicle's instrument panel.

Product advantages and features

Saving time and money.

Benefits of IVTM:

- Increased traffic safety
- Fuel cost savings by ensuring optimum tire pressure and avoiding unnecessary rolling resistance



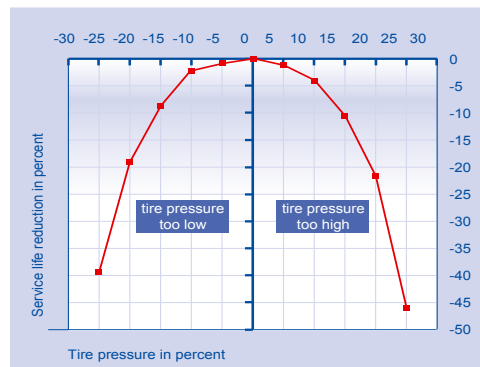
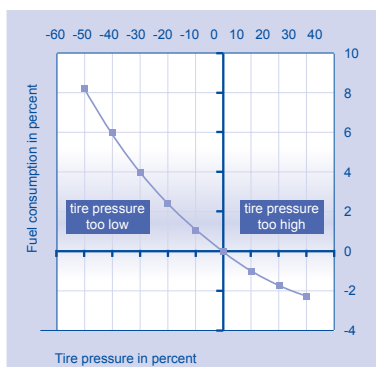
- Reduction in maintenance costs and tire damage due to insufficient tire pressure
- Increased tire life by driving with optimum tire pressure
- Ideal for retrofitting in buses
- Uncomplicated operation
- No need for time-consuming manual tire checks by personnel directly on the tire valve since the pressures of all tires can be displayed on the IVTM display
- Fast localisation and correction of operational and system faults by means of diagnostics memory



The operating costs can be lowered by more than 600 Euro per bus and year using IVTM! *

If it prevents only a single breakdown - and associated costs - the system will generally have paid for itself.

Display of the relationship between tire pressure and fuel consumption - and tire service life



Functionality and components



IVTM wheel module

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.

The wheel module contains a pressure sensor, the measured values of which are transferred at regulator intervals to the IVTM ECU (Electronic Control Unit) via a 433 MHz radio link.



IVTM-ECU

IVTM ECU

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.

* 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 1.30 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.



IVTM display

IVTM display

The driver can be warned in due time of any critical pressure loss by the system through an IVTM display. The risk of a sudden flat tire is thus greatly reduced.

Display features:

- Acoustic warning
- Display of the faulty tire's position 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 in 18 m articulated buses

Device overview

IVTM components (Example)	Product number
IVTM electronics	446 220 012 0
IVTM display	446 221 000 0
Rear axle wheel module	960 731 031 0
Front axle wheel module	960 731 051 0

Note: A large number of IVTM components are available covering the requirements of multiple tires sizes, rim types and vehicle configurations. IVTM sets are available for standard configurations such as solo-buses. Please ask your WABCO contact for more product information or for IVTM configuration assistance. We will be happy to provide an offer for retrofitting your vehicle with IVTM.

Service and maintenance information

Tips for the workshop

IVTM is maintenance-free. Only when the display indicates a malfunction is troubleshooting via diagnostics necessary.

All work on a wheel, hose and wheel module or tire pressure corrections must be carried out with the ignition "OFF", otherwise a message will be entered 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 needs be installed when changing tires. You only need to make sure that the wheel module is installed in the same position when changing a wheel or tire, i.e. on the same wheel bolt.

With twin tires in particular, the correct allocation to the inner and outer wheel must be taken into account. With twin tires, the wheel modules must lie opposite one another (to prevent imbalance). With single tires, counter-weights 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 as required.

Valve connections must always be frictionless and not twisted. Hose brackets may need to be used in some cases. The hose position should be checked after replacing a tire.

Check the seal on the valve and wheel module with leak detector spray if necessary.

When using SuperSingle tires, such as Michelin X-One, tire pressure monitoring systems are specified by the vehicle manufacturer.

SEND YOUR BUSES *on an economy drive!*



**RETROFIT NOW AND SAVE MORE
THAN € 600 PER YEAR AND PER
BUS WITH IVTM!***

More time, lower costs: With WABCO's retrofit tire pressure monitoring system IVTM for buses, you can instantly see when tires begin to run low on air. It can save money and reduce operating costs by more than € 600 per year and per bus!* WABCO IVTM – an investment that pays off.

- Save maintenance costs
- Reduce fuel costs
- Longer tire service life
- Increased safety and mobility

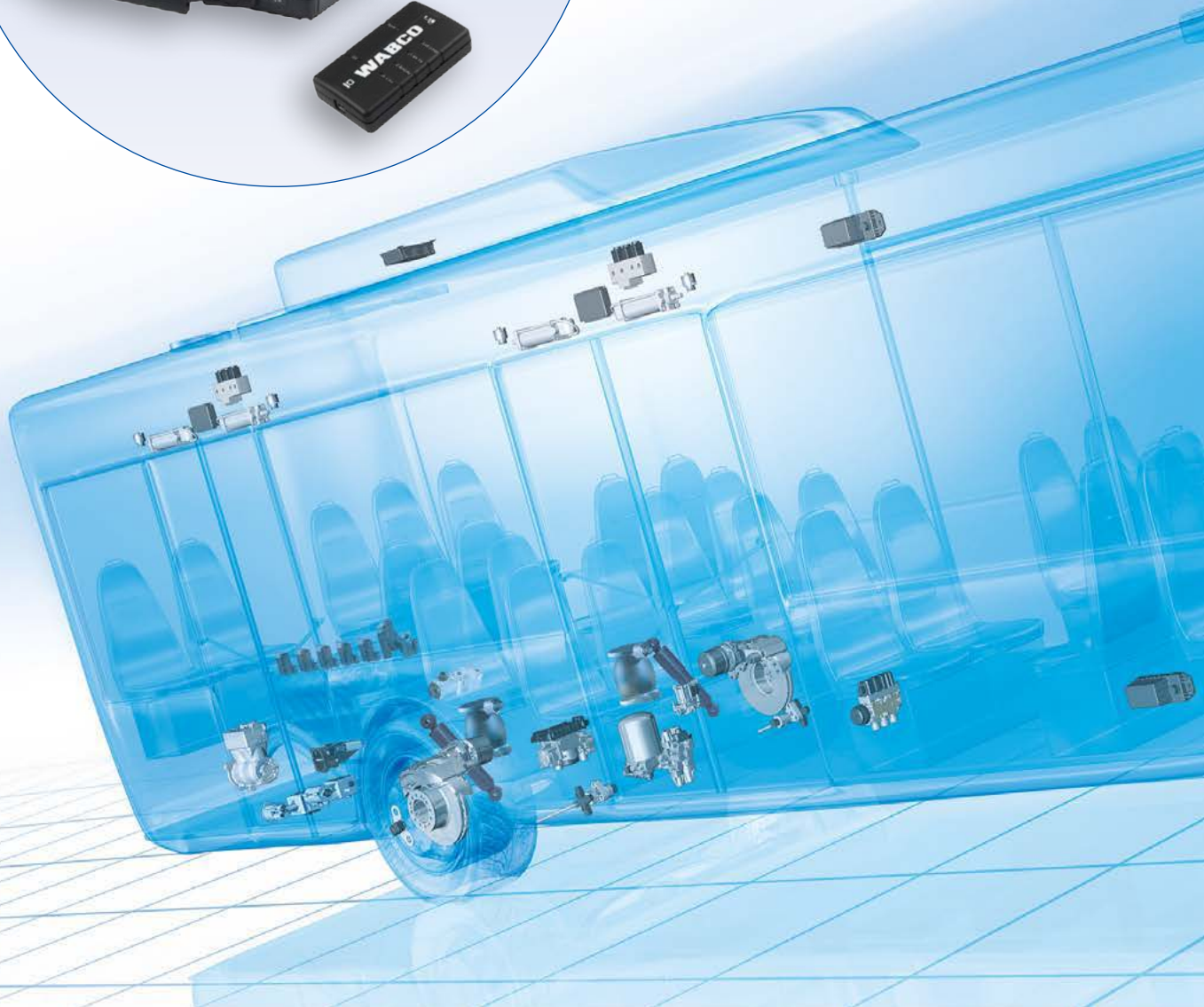
* Calculation for single 4x2 bus (6 tires) with an annual operating distance of 50,000 km. Estimated minimum pressure: 10 %. Fuel consumption: 35 litres per 100 km (price per litre € 1.30). Tire performance: 80,000 km (price per tire € 250). Manual tire pressure control: every four weeks. Estimated maintenance costs: 30 min at € 40 per hour.

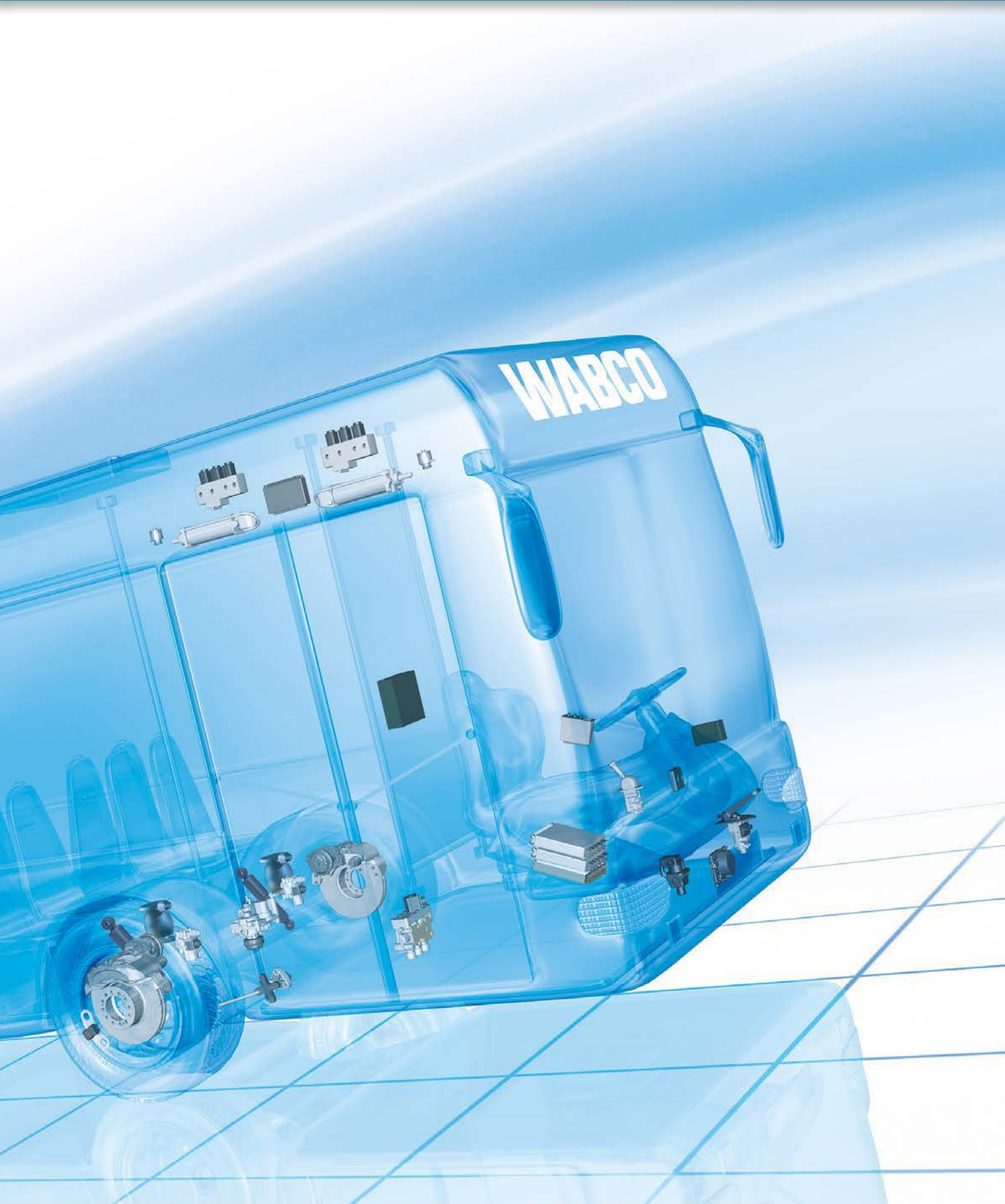
Developed in co-operation with



WABCO

Diagnostic Tools and Test Equipment





While previously a separate test device was required for the diagnosis of each system on the bus, a PC or laptop with the corresponding Diagnostic Software is now sufficient for diagnosis.



WABCO SYSTEM DIAGNOSIS

WABCO Diagnostic Software

For the diagnosis of WABCO components, WABCO has developed the "System Diagnostic Software". This system diagnosis consists of special programs with extensive functions.

The WABCO System Diagnosis allows you to perform a diagnosis on all electronic WABCO systems.

The diagnosis software for electronic WABCO systems is offered, among other options, as an annual subscription. In this case, you will automatically receive all updates and software supplements and so you will always benefit from the latest developments in vehicle and safety technology.

WABCO offers a special Diagnostic Software package for bus customers. It currently includes more than 20 system-related diagnostic programs. The most recent version of the programs can be downloaded from the internet any time and used immediately. Visit <https://www.am.wabco-auto.com/mywabco/> to purchase the Diagnostic Software "Bus" package.

For a system diagnosis you need:

- the "Toughbook" laptop on which the WABCO Diagnostic Software is already installed or a commercially available PC or laptop
- the required WABCO Diagnostic Software
- the Diagnostic Interface Set
- connecting cable to vehicle electronics or diagnostic socket

You can purchase all hardware components required for diagnosis from your WABCO partner.



"Toughbook" laptop

What do I need the PIN for?

Diagnosis with the Diagnostic Software can be carried out by any user. If settings in electronic control units are to be changed, however, authorisation is required (PIN). The PIN verifies knowledge of the respective system and permits changing parameters in electronic units.

You can obtain this PIN through relevant training at the WABCO Academy. Every participant in a system training course receives a PIN letter with his/her purchased PINs. The PIN can be used to enable extended functions in the software and to define parameters in the electronic control units.

When using the PIN, a so-called fingerprint is left in the diagnosed electronics, i.e. every change, especially regarding parameters, can be traced. The PIN is **always** person-related. This separates the company-related diagnostic software via the subscription number and person-related training. An employee can therefore change to another subsidiary and "take" his PIN data along with him/her.

Testing devices and ancillary equipment



Diagnostic Interface USB



Diagnostic accessory case Bus



Test case for compressed-air braking systems

Diagnostic Interface Set

446 301 030 0

The WABCO Diagnostic Interface Set is required to start a diagnosis of the electronic control unit. The set includes the Diagnostic Interface and an USB connecting cable to the PC or laptop.

The vehicle connection on the Diagnostic Interface matches the connection for the Diagnostic Controller and earlier versions of the diagnostic interface, permitting the continued use of connecting cables used in the past.

Diagnostic cable

For the connection between the vehicle and the interface, WABCO offers various pre-fabricated diagnostic cables.

Diagnostic accessory case Bus

446 301 026 0

With this case - designed especially for the requirements of buses - you always have the most important connecting elements between the vehicle and your PC. Once the vehicle has been diagnosed, all cables can be stored in a manner where they are protected as well as easily identified.

Test case for compressed-air braking 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 braking systems according to the guidelines for performing safety tests on commercial vehicles.



The only multi-brand diagnostic system for buses that integrates WABCO competence into a comprehensive solution.



WABCOWÜRTH W.EASY

With its innovative and modular solutions, WABCOWÜRTH makes diagnosis easy, transparent and efficient – and efficient diagnostic systems get your business moving.

An overview of the benefits provided by bus diagnosis

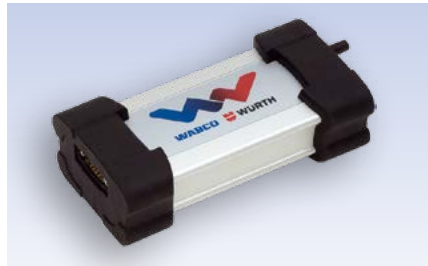
- Only W.EASY integrates the original WABCO system diagnosis in a single system. WABCO is one of the main suppliers for safety-relevant systems in buses. This is a great benefit to you in terms of safety, because only the original WABCO system diagnosis puts you in position to fully diagnose all WABCO systems.
- Visual vehicle selection and representation of the diagnostic sockets facilitates navigation and saves valuable time, thereby reducing any downtime.
- Broad manufacturer coverage: Evobus, MAN, Scania, Solaris, Volvo and many more
- The diagnostic solution for buses can be purchased as an independent bus diagnosis or in combination with the diagnosis for towing vehicles, trailers or light commercial vehicles.
- Reduced number of cables and adapters with integrated multiplexing technology.
- Our robust diagnostic trolley provides you with a clear, clean and ergonomic workplace for diagnosis.
- W.EASY is the only diagnostic system to offer genuine multitasking for convenient and more efficient diagnosis. The real-time display of various functions and information in up to four windows makes diagnosis clearer and saves valuable time.
- Regular updates always keep the system up-to-date.
- We can offer you the E-Learning course “Electronic WABCO Systems” specially for buses. Further WABCO training courses can also be booked.



Diagnostic case

Hardware

- Panasonic Toughbook CF-53 laptop
- Diagnostic case
- Vehicle communication unit VCI with OBD cable, USB and Bluetooth capability



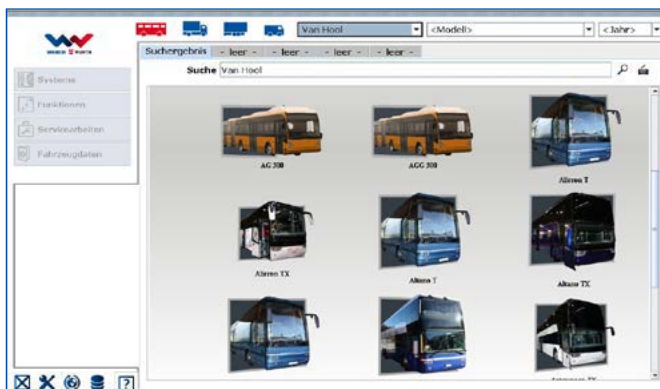
Vehicle communication unit

- Extensive selection of diagnostic cables and connection adapters for towing vehicles, trailers, light commercial vehicles and buses from various manufacturers
- Robust diagnostic trolley
- Accessories, e.g. printer

Software

We provide the software for buses of all major manufacturers. You can either use the complete licence or book the individual licences:

- Bus software package for multi-brand diagnosis and/or WABCO Bus
- Complete software package (towing vehicles, trailers, light commercial vehicles, buses) incl. WABCO complete package



Comprehensive service, personalised advice

Apart from our multi-brand diagnosis solution, we also offer extensive services, personal consultation, a product and vehicle technical hotline and user training. Since the requirements of our customers vary widely, we have made WABCO WÜRTH products both flexible and modular. With WABCO WÜRTH, all our customers get exactly what they want.

Contact us: In close consultation with you we will put together the package of hardware, software and training modules that best suits your needs. WABCO WÜRTH is your reliable partner for commercial vehicle workshops – uncomplicated, comprehensive and always available.

More information can be found under www.wabcowuerth.de

Technical Training and E-Learning





WABCO

ACADEMY

For buses WABCO offers a number of special training courses on different subjects and of varying duration.



TECHNICAL TRAINING

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 control response
- Testing and troubleshooting with WABCO PC diagnosis
- Calibration of the ECAS system (setting the ride height)
- Descriptions of EBS, ECAS, MTS and ATC parameters in buses

Note: After successfully completing the training, participants will receive a certificate. Having successfully participated in a system course, the participant receives on request the system-related PIN (personal identification number) so he or she can use the special diagnostic functions on WABCO systems for buses.



E-LEARNING



Knowledge and competence on the commercial vehicle market

Web Based Training (WBT) – this means computer-assisted learning when- and wherever you wish. All you need is a computer with internet access. Determine your own learning speed and save time and costs for travel and overnight stays.

All courses are at the level of the latest technical developments. Even complex content is presented in an easily comprehensible manner using sound and images. Animations and video make learning diversified and interesting. Tasks, questions and a final test ensure successful learning. The courses are available in various languages.

The prices are stated on the first page of the respective demo course. Order your access code (see WABCO part number) or pay online by credit card.

You will find further details on E-Learning on the Internet on the WABCO Academy website at www.wabco-academy.com or directly at <http://wbt.wabco.info>.

We offer training courses on the subjects ABS, EBS, electronic air suspension, tire pressure monitoring, disc brakes, basic knowledge of braking systems, telematics and WABCO electronic systems in buses. This programme is constantly expanded.

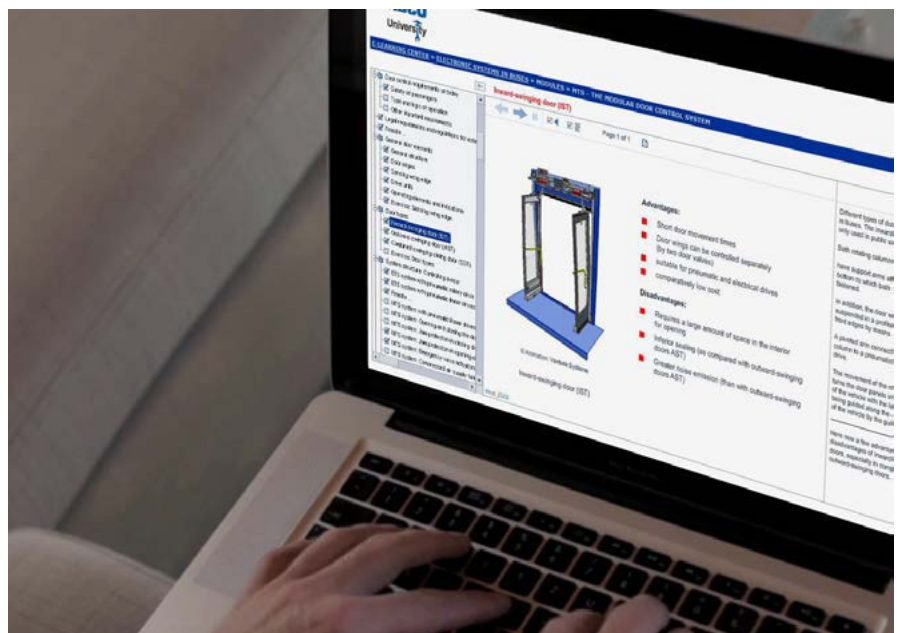
Make use of the opportunity to test our demo versions before you decide on a course.

Advantages of E-Learning:

- Complete course with completion test and PIN letter
- Simple, structured learning with interactive elements
- Personal time & course management

Prerequisites for participation are:

- Computer with audio, headphones if possible
- Internet access via ISDN, DSL (recommended)
- Personal email address



Online product catalogue INFORM



WHERE CAN I OBTAIN MORE INFORMATION

The online product catalogue INFORM provides you with convenient access to the complete technical documentation: product data sheets, outline drawings, cross references, vehicle applications, repair notes and wiring diagrams.

- Open our website wabco-auto.com
- Click the INFORM link in the “Quick Access Links” box.



Technical documents in many different languages

The technical publications describe the functions of systems and components as well as installation, retrofitting and diagnosis:

- System descriptions
- Catalogues
- Installation / Maintenance instructions
- Diagnostics documentations
- Posters

All brochures are available in PDF format from the INFORM product catalogue. Please contact your WABCO partner for printed versions.



Your direct contact to WABCO



In addition to our online services, trained members of staff are there to help you in our WABCO Service Centres to directly answer any technical or business-related questions you may have.

Contact us if you need assistance:

- Find the right product
- Diagnostics support
- Training
- System support
- Order management

Your will find your WABCO partners on the internet at www.wabco-auto.com. In the Quick Access Links box, click on ‘Service Partner Locations’ (www.wabco-auto.com/findwabco)

Choose genuine WABCO parts



WABCO reassurance

GENUINE WABCO PARTS OFFER RELIABLE PROTECTION

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

Because WABCO, as a tier one supplier, works with the world's leading Original Equipment Manufacturers, WABCO has the experience and scale to meet the most accurate production standards. The quality of every genuine WABCO part is supported by:

- Tooling made for serial production
- Regular sub-supplier audits
- Exhaustive end-of-line tests
- Quality standards below 50 PPM (parts per million defects)

A genuine WABCO part is as unique as your fingerprint. Accept no substitute.

The package you will get with a genuine WABCO part:

- 24 month product warranty
- Overnight delivery
- Technical support from WABCO
- Professional training solutions from the WABCO Academy
- Access to diagnostics tools and support from the WABCO Service Partner network
- Straightforward claims handling

Plus, of course, the confidence that the Original Equipment Manufacturers' rigorous quality standards are met.

Installing copy parts can cost lives – genuine WABCO parts protect your business.

WABCO Service Partner



WABCO Service Partners – the network you can rely on. You can access 2,000 high quality workshops with more than 6,000 specialist mechanics, all trained to WABCO's exacting standards and equipped with our most up-to-the-minute systems diagnostic and support technology.



When purchasing a WABCO product, please make sure it has the typical WABCO product marks (particularly on packaging, labels and identification plate) as evidence that it is an original WABCO part. In case you have any doubts, please contact your WABCO sales partner.

WABCO (NYSE: WBC) is a leading global supplier of technologies and control systems for the safety and efficiency of commercial vehicles. Founded nearly 150 years ago, WABCO continues to pioneer breakthrough electronic, mechanical and mechatronic technologies for braking, stability and transmission automation systems supplied to the world's leading commercial truck, bus and trailer manufacturers. WABCO is headquartered in Brussels, Belgium. For more information, visit www.wabco-auto.com

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