

EBS

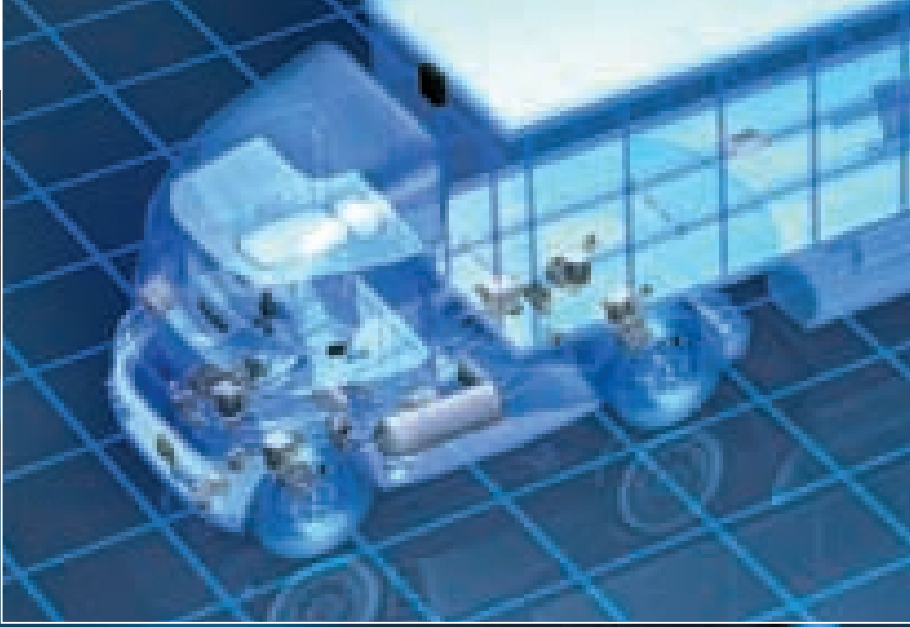
Electronic Braking System
New Generation



NEW

WABCO

EBS – New Generation



In terms of road safety, the quality of the braking system is a crucial vehicle characteristic. In 1996, WABCO pioneered volume production of EBS. Since then, WABCO, a leading global supplier of electronic braking systems, has further developed EBS for light- to heavy-duty trucks with trailers or semi-trailers, and buses. Increasing traffic volume and growing customer demand require continuous quality improvement in braking systems. Therefore, WABCO has further enhanced EBS to meet changing market needs.

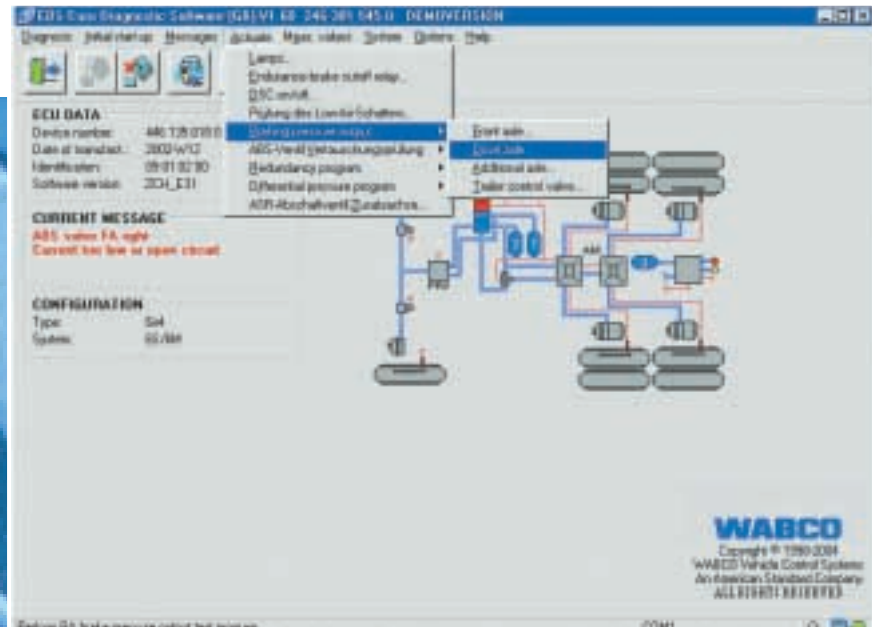
As the next evolution, WABCO offers a modular system, to meet a range of different customer needs. Two system types are offered:

- **EBS Evolution:**
an “open structured” design
- **EBS Compact:**
integrates different system components

EBS Benefits

- Increased braking comfort
- Superior vehicle safety
- Optimized brake wear
- Easier maintenance

Significant benefits



EBS improves braking comfort

By actuating the brake pedal the driver defines the deceleration request. The EBS ECU transmits this input electronically to all braking system components. The braking system's shorter response times provide a more comfortable and finely-tuned braking feeling, independent of the vehicle's load situation.

EBS increases vehicle safety

Electronic activation of the EBS braking components clearly reduces response and build-up times in the brake cylinders. This in turn reduces braking distance by several meters, which can be decisive in some situations. The integrated ABS function ensures driving stability and steerability throughout the braking procedure. The

differential slip control (DSR) provides for automatic braking force distribution between the front and rear axles according to the load situation. In trailer operation, optimal alignment of the vehicle combination is ensured: Each part of the vehicle combination is braked according to its own relative mass, thus optimizing the coupling force. The integrated ATC function facilitates traction control.

EBS optimizes brake wear

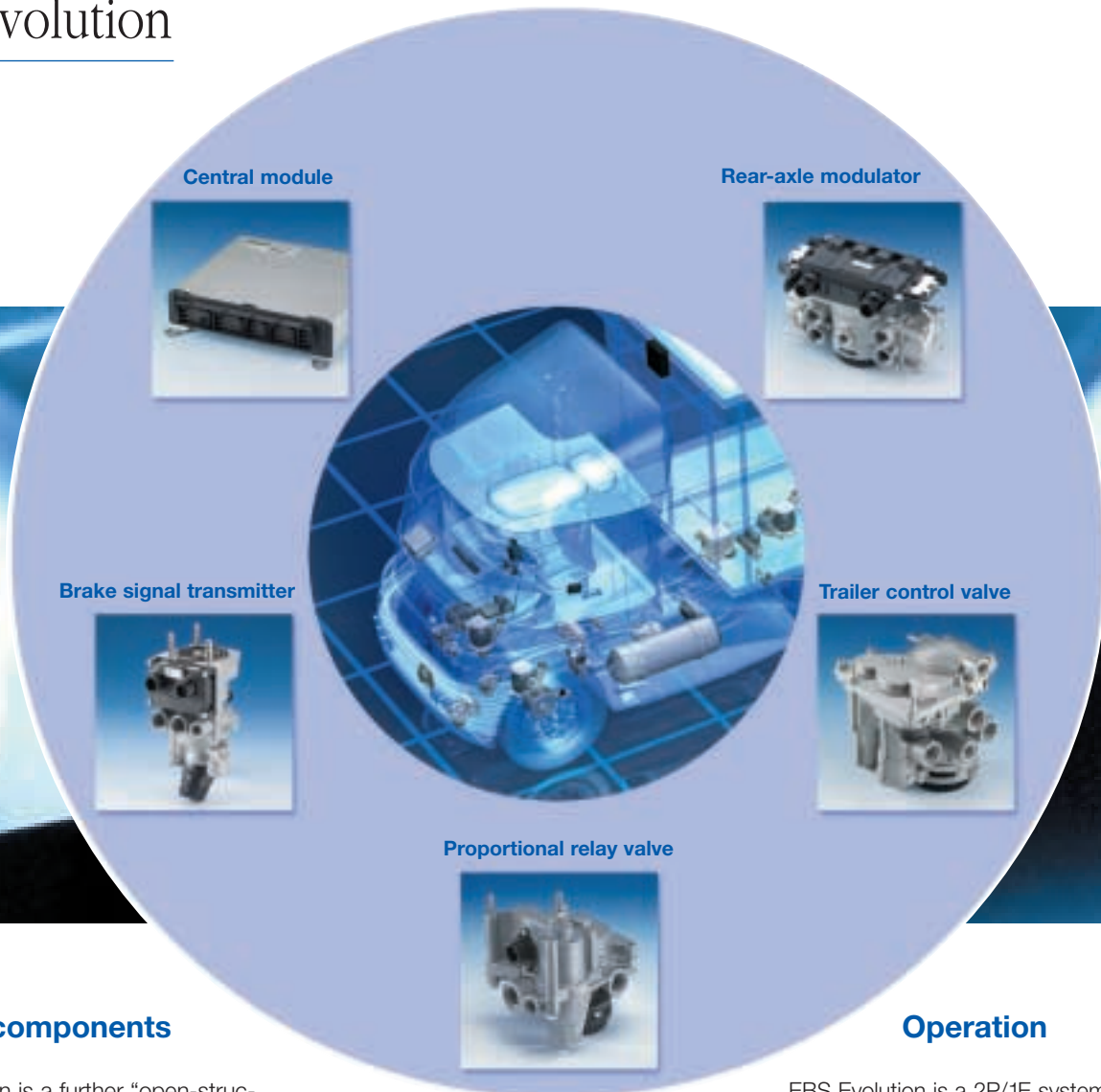
WABCO EBS provides for continuous brake wear monitoring as well as brake wear harmonization between the axles. This function can be used to align dates of maintenance with that of brake relining. The integration of non-wearing brakes, such as retarder and engine brake (endurance brake integration) also contributes to preserving brake lining material

and increases the wheel brake service life. This reduces downtime and improves the cost-benefit ratio.

EBS makes maintenance easier

Comprehensive integrated diagnostic and monitoring functions enable EBS to permanently self-test. In the event of restricted operability, warning features immediately provide the driver with the relevant information. Diagnostic equipment – both external and onboard – can be used to quickly and easily locate the cause of the malfunction. In addition, the comprehensive diagnostic functions considerably reduce maintenance and workshop times.

EBS Evolution



System components

EBS Evolution is a further “open-structured” development of WABCO EBS. It offers new functions as well as many lighter weight components.

Brake signal transmitter

- Generates an electrical signal and pneumatic back-up pressure from the driver's pedal actuation

Central module

- Braking system ECU
- Controls all essential brake management functions for the front axle, the rear axle and trailer pressure control, as well as front axle ABS control
- Evaluates sensor signals and communicates with other vehicle systems as well as the diagnostic interfaces

Proportional relay valve

- Performs front-axle braking pressure control

Rear-axle modulator

- Controls the rear-axle brake pressure, including ABS/ATC

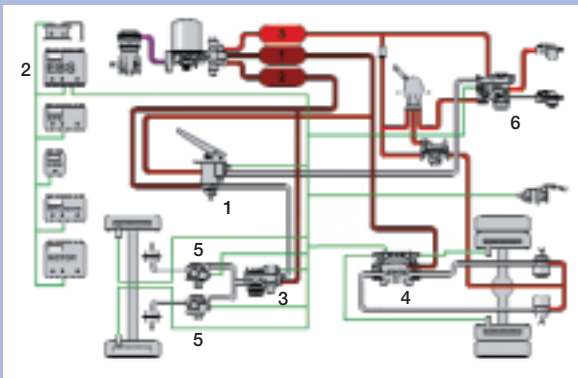
Electro-pneumatic trailer control valve

- Regulates trailer control pressure

Operation

EBS Evolution is a 2P/1E system and consists of a single-circuit electro-pneumatic section, supported by a dual-circuit, pneumatic section as a redundancy. Depending on the pedal position, the **brake signal transmitter** generates electrical signals and pneumatic pressures. The electrical signals are used to control the electronic braking system. The pneumatic signals are used in redundancy case only and perform – to a limited extent – the same functions. The electrical signal is transmitted to the **central module**. According to the vehicle's load situation, the system calculates the appropriate pressures for the individual brake cylinders, causing deceleration of the vehicle. The determined values are then sent to the proportional relay valve and via the system's data bus to the rear-axle modulator.

EBS Evolution



- 1 Brake signal transmitter
- 2 Central module
- 3 Proportional relay valve
- 4 Rear-axle modulator
- 5 ABS solenoid modulator valves
- 6 Electro-pneumatic trailer control valve



The rear-axle modulator contains its own ECU, which integrates the control algorithms for the rear-axle wheels. The front-axle algorithms are controlled by the central module. **ABS** is integrated in the EBS: Inductive sensors measure individual wheel speeds, enabling the central module and the rear-axle modulator to detect lockup tendency on either the front axle or the rear axle. Braking pressure is reduced for the relevant cylinder by the ABS valve or by the axle modulator. In this process, several control algorithms maintain vehicle stability as well as – if possible – deceleration with the desired value. EBS functions according to the **deceleration control principle**. Potential deviations between actual and desired deceleration are determined and adjusted. This leads to a comfortable braking feeling.

Automatic Traction Control (ATC) is integrated in the EBS. If the central module detects any signs of wheel spin, the engine control is activated via CAN inter-

face. Engine performance is reduced accordingly. At the same time, driving axle brakes are actuated. In this way, the vehicle's acceleration is adapted.

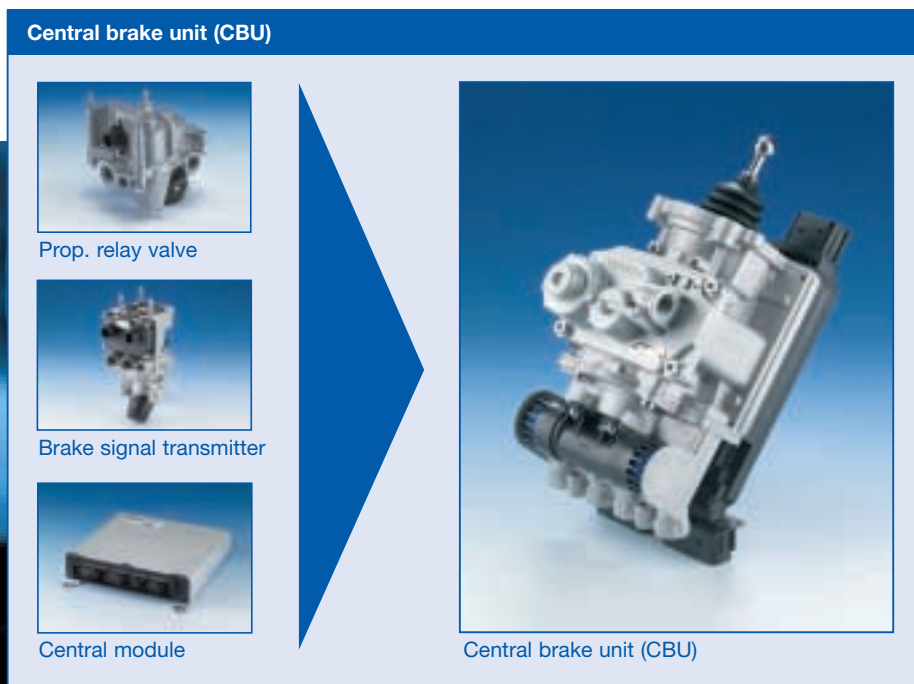
EBS creates axle-wise brake wear harmonization by performing slight braking pressure transfers from the axle with a higher degree of wear to the one with less wear. This promotes more even brake wear and increases vehicle operational time. In addition, **non-wearing brake control** (retarder and engine brake) is integrated in the service brake application via the EBS brake management, ensuring a low overall brake wear. In general, the system is not affected by pneumatic signals sent by the brake signal transmitter. This dual-circuit part of the system largely corresponds to the structure of a conventional braking system. It is used only in case of malfunction in the electrical system section. During trailer operation, **automatic truck-trailer compatibility** is provided. Truck-trailer compatibility control ensures that

each vehicle unit brakes according to its individual weight. This results in an optimal coupling force between towing vehicle and trailer.

With the aid of **extensive diagnostic functions**, the central module permanently receives information on the actual condition of the braking system. The system detects malfunction as it occurs, stores it and informs the driver. During workshop inspections the diagnostic memory can be read, and the detected malfunctions localized and eliminated immediately.

EBS provides the basis for the integration of further safety systems like e.g. WABCO **ESC** (Electronic Stability Control). ESC is a system which independently intervenes in critical driving situations and adjusts engine and brake control. Within physical limits, ESC protects vehicles from rollover, skidding, spinning and jack-knifing.

EBS Compact



System components

EBS Compact is a further development of WABCO EBS, combining the benefits of EBS Evolution with the integration of components.

Central brake unit (CBU)

- Combines the functional groups
 - central ECU
 - brake signal transmitter
 - proportional relay valve
- Provides the primary brake management function for front axle, rear axle and trailer pressure control and evaluates the sensor signals
- Generates an electrical signal and pneumatic back-up pressure from the driver's pedal actuation; controls the required front-axle brake pressure automatically

- Communicates with other vehicle systems and diagnostic interfaces

Rear-axle modulator

- Controls the rear-axle brake pressure and actuates the electro-pneumatic trailer control valve

Electro-pneumatic trailer control valve

- Regulates trailer control pressure

Operation

EBS Compact is a 1P/1 E system and consists of a single-circuit electro-pneumatic section with a secondary single circuit, pneumatically operated section as a redundancy.

The electrical signals control the braking system on an electrical basis. The pneumatic signals are used in redundancy

case only and perform – to a limited extent – the same functions.

When the brake pedal is actuated, the **CBU** transforms the driver's request into electrical signals, controlling front-axle and rear-axle brakes, depending on the position of the pedal. The algorithms of the front axle are managed by the CBU. The pneumatic pressure at the brake cylinders is controlled directly by the CBU (4S/3M systems) or via the ABS solenoid modulator valves. The pneumatic pressure at the brake cylinders of the rear axle is controlled by the **rear-axle modulator**, which receives the nominal pressure value from the CBU via an integrated databus. The rear-axle modulator has a separate ECU with integrated control algorithms for the rear-axle wheels. Brake pressure is calculated according to vehicle load and brake wear. EBS Compact functions according to the **deceleration control**



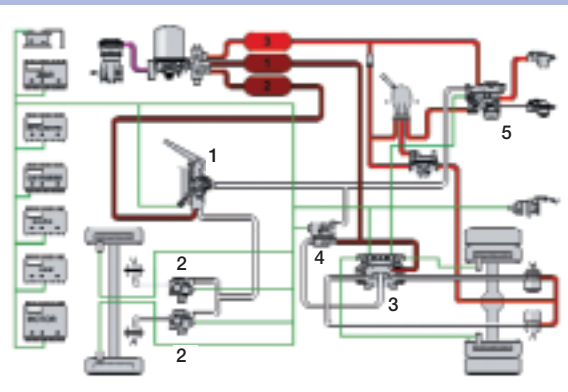
Rear-axle modulator



Trailer control valve



EBS Compact



- 1 Central brake unit
- 2 ABS solenoid modulator valve
- 3 Rear-axle modulator
- 4 Back-up valve (optional)
- 5 Electro-pneumatic trailer control valve

principle. Potential deviations between actual and desired deceleration are determined and adjusted. This leads to a comfortable braking feeling.

ABS is integrated in EBS: Inductive sensors measure the speed of the individual wheels. Lockup tendency can thus be detected by the CBU at the front axle, respectively by the rear-axle modulator at the rear axle. The braking pressure is reduced for the relevant cylinder by the CBU (or the ABS valve), respectively the rear-axle modulator. Different control algorithms maintain vehicle stability as well as – if possible – deceleration with the desired value.

Automatic Traction Control (ATC) is integrated in EBS.

EBS creates axle-wise brake wear harmonization by performing slight

braking pressure transfers from the axle with a higher degree of wear to the one with less wear. This promotes more even brake wear and increases vehicle operational time. In addition, **non-wearing brake control** (retarder and engine brake) is integrated in the service brake application via the EBS brake management, ensuring a low overall brake wear. In general, the system is not affected by pneumatic signals sent by the CBU. The single-circuit section of the system largely corresponds to the structure of a conventional braking system. It is only used in case of malfunction in the electric section of the system. During trailer operation, **automatic truck-trailer compatibility** is provided. Truck-trailer compatibility control ensures that each vehicle unit brakes according to its individual weight. This results in an optimal coupling force between towing vehicle and trailer.

With the aid of **extensive diagnostic functions**, the actual status of the braking system is permanently monitored, and potential malfunctions are recognized, recorded and displayed to the driver. The data stored in the diagnostic memory can be read during regular maintenance intervals. Repairs are thus faster and limited to more specific areas.

EBS provides the basis for the integration of further safety systems like e.g. WABCO **ESC** (Electronic Stability Control). ESC is a system which independently intervenes in critical driving situations and adjusts engine and brake control. Within physical limits, ESC protects vehicles from rollover, skidding, spinning and jack-knifing.



WABCO, the vehicle control systems business of American Standard Companies, is the world's leading producer of electronic braking, stability, suspension and transmission control systems for heavy duty commercial vehicles. WABCO products are also increasingly used in luxury cars and sport utility vehicles (SUVs). Customers include the world's leading commercial truck, trailer, bus and passenger car manufacturers. Founded in the US 135 years

ago as Westinghouse Air Brake Company, WABCO was acquired by American Standard in 1968. Headquartered in Brussels, Belgium, the business today employs nearly 6500 people in 29 office and production facilities worldwide. In 2003, WABCO contributed US\$ 1.358 billion to American Standard's total sales of US\$ 8.568 billion.

Website: www.wabco-auto.com

