

# VARIO COMPACT ABS 2ND GENERATION

## SYSTEM DESCRIPTION



**WABCO**



# Vario Compact ABS 2nd generation Part 1: System description

4th Edition

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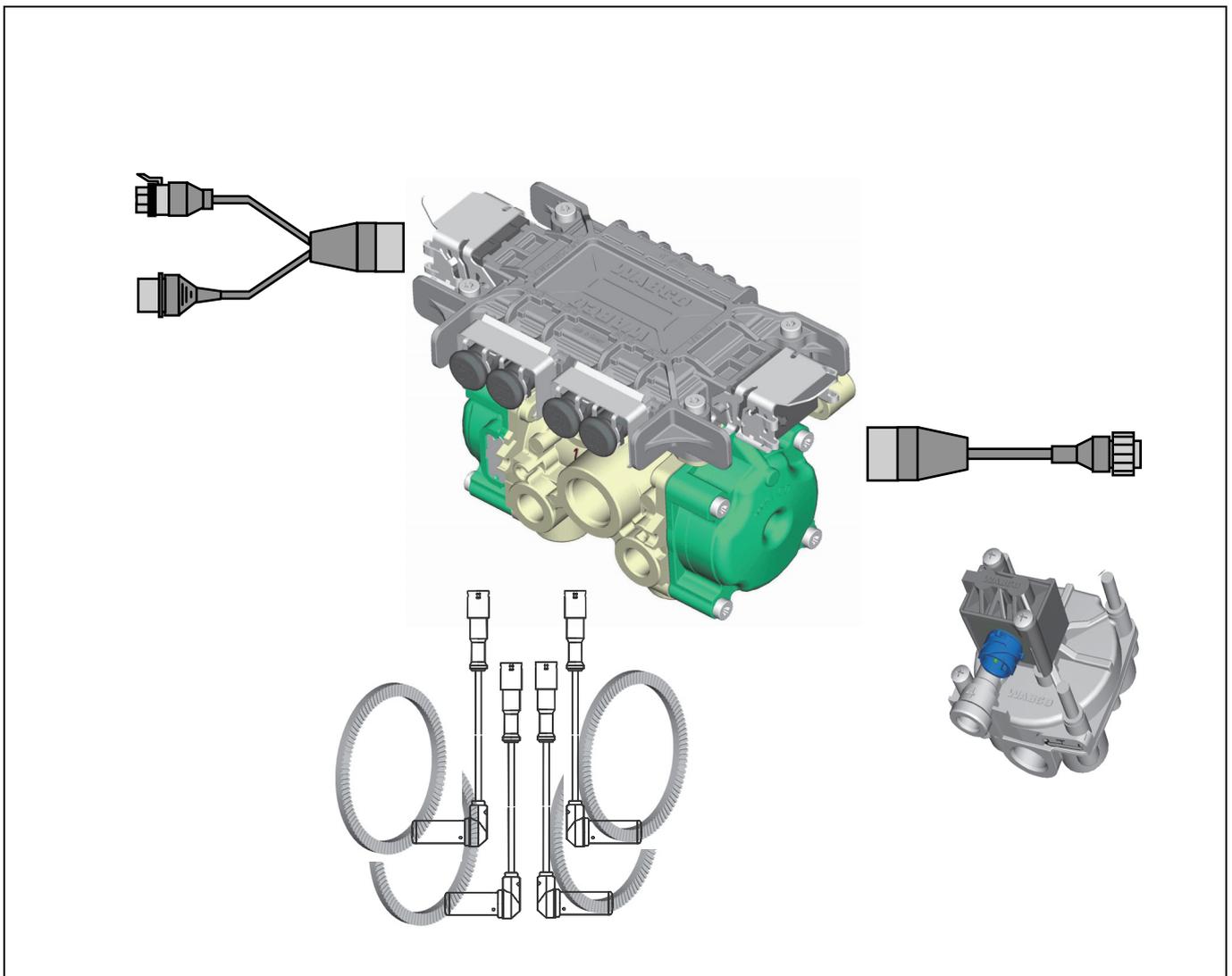
# 1 The concept of Vario Compact ABS

When in the early 80s commercial vehicles were equipped with series-produced ABS for the first time, the ABS system used was a WABCO system. The application in the towing vehicle was soon followed by the application in the trailer. With regard to system versatility and diagnosis, VARIO B and, from 1989, VARIO C provided the customer with new options. This was the main reason for the development of WABCO's next ABS generation in 1993 - VARIO Compact ABS - VCS. Series production of this system was started in 1995. Due to its flexibility, reliability and high quality it soon gained the market leader position.

Today, the VCS is one of the most successful WABCO products for trailers all round with over one million sys-

tems sold. In order to maintain and extend this position in a time of increasing automation, WABCO developed the VARIO Compact ABS of the 2nd Generation (VCS II). Here, once again the modular principle is implemented because the VCS II technology is based on the established ABS system for the NAFTA market, TCS II. Further, a ISO 11992 interface and the 8-pin connector principle of the Trailer EBS was integrated.

Thus, the development of VCS II results in an even more powerful system having, as compared with the predecessor model, reduced installation dimensions and a considerably reduced weight.



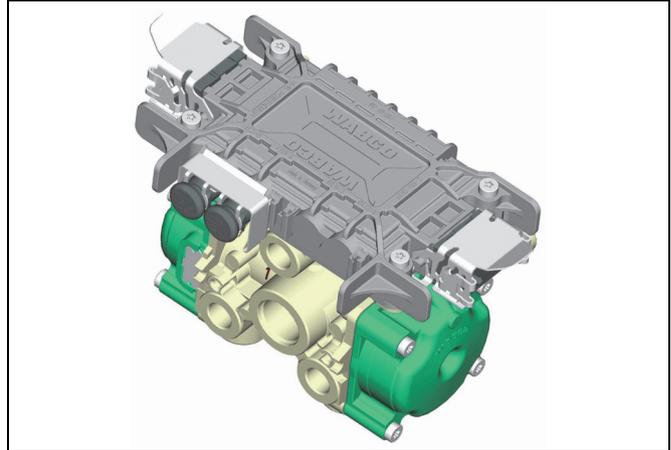
## 1.1 Scope of the System

VCS II is an ABS system for trailers, ready for installation. It meets all the statutory requirements defined for category A. The range of models reaches from the 2S/2M system designed for semitrailers to the 4S/3M system which is used for drawbar trailers or for a semitrailer equipped with steering axle for example.

According to the specific requirements defined by the vehicle manufacturers, VCS II is available as a compact unit or in modular design (i. e., ECU and valves can be installed separately).

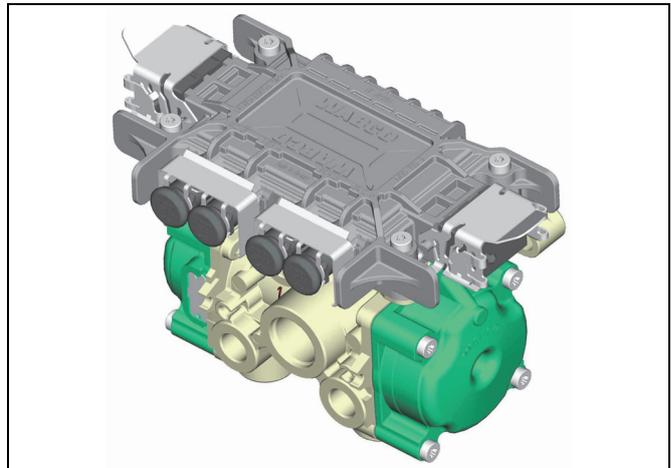
### Standard variant 400 500 070 0:

- Voltage supply ISO 7638
- Additional 24 V supply
- Two speed sensor inputs
- Maximum configuration: 2S/2M
- GenericIO functions D1, D2



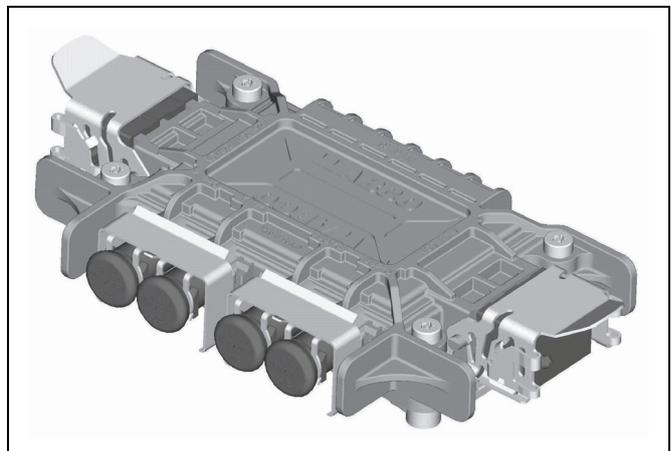
### Premium variant 400 500 081 0:

- Voltage supply ISO 7638
- Additional 24 V supply
- Four speed sensor inputs
- Maximum configuration: 4S/3M (with additional external 3rd ABS relay valve)
- ISO 11992 interface (CAN)
- GenericIO functions D1, D2, A1
- Battery charge output
- 12 volt version: 400 500 083 0



### Separate ECU 446 108 085 0:

- Voltage supply ISO 7638
- Four speed sensor inputs
- Maximum configuration: 4S/3M
- External ABS relay or solenoid control valves
- ISO 11992 interface (CAN)
- GenericIO function D1



## 2 Description of the System and Function

### 2.1 Design of the ABS

The Vario Compact ABS (VCS) is applicable for all-purpose air-braked trailers. The scope of the system extends from 2S/2M to 4S/3M. The Anti-Blockier-System (ABS) is a complement to the conventional braking system and essentially consists in:

- two to four inductive speed sensors and toothed pole wheels (for directly picking up the speed at the wheels)
- two to three electro-pneumatic modulators with the following functions:
  - building up brake pressure
  - maintaining brake pressure
  - reducing brake pressure
- an electronic control unit (ECU, Electronic Control Unit) with two or three control channels divided into three functional groups:
  - Input circuit
  - Main circuit
  - Safety circuit
  - Valve actuation

In the input circuit the signals generated by the respective inductive sensors are filtered and converted into digital information for determining period lengths.

The master circuit consists of a microcomputer. It contains a complex program for the computation and logical operation of the control signals and for outputting the actuating variables for the valve control system. The safety circuit monitors the ABS system, i. e. the sensors, solenoid control valves, ECU and wiring, before the vehicle moves off and also whilst it is in motion, even if the brakes are being actuated or not. It alerts the driver to any errors or defects by means of a warning lamp and shuts off the whole system or parts of it. Whilst the conventional brake remains operational, it is only the anti-lock system which is entirely or partially deactivated. The valve actuation contains power transistors (output stages) which are actuated by signals from the main circuit and which switch the current for actuating the control valves.

ABS relay valves as well as ABS solenoid valves can be used. Their selection depends on the braking system and especially on the response time. Consequently the corresponding electronic control unit will be used. Without electrical actuation of the ABS relay valves the normal brake pressure building-up and reducing requested by the driver will not be influenced.

### 2.1.1 Modular System Structure

The Vario Compact ABS is a modular unit with the system configurations 2S/2M, 4S/2M and 4S/3M. This means a suitable variant is existing for each vehicle type. At least one sensor and one modulator constitute a control channel.

In the **2S/2M configuration** each sensor and modulator on one side of the semitrailer are integrated in a control channel. Any other wheels on one side are indirectly included in the control function. The braking forces are controlled according to the principle of the so-called Individual (Wheel)-Control (**IR**). In this case, each side of the vehicle is controlled depending on road conditions and the brake characteristic. When unsensed wheels of a multi-axle vehicle are controlled by this configuration, the system is called "Indirect Individual Control" (**INIR**). In some instances, the 2S/2M configuration is also meant to represent a control per axle. For this purpose, the 2S/2M Diagonal Axle Control (**DAR**) was developed. Here the brake cylinders of one axle are respectively connected to an ABS modulator (control per axle). The modulator of the first axle is controlled by a sensor on the right side of the vehicle and the modulator of the second axle is controlled by a sensor on the left side of the vehicle (diagonal arrangement). In this way, an the braking pressure can be adjusted separately for each axle. On  $\mu$ -split roads, the unsensed wheel on the lower friction value will block however.

In the **4S/2M configuration** two sensors are located on each vehicle side. The sensor signals of both wheels are used by the electronic control unit for controlling one modulator. Here too, control is separate for each side. The brake pressure is the same for all wheels on each side. The two sensed wheels of this vehicle side are controlled according to the principal Modified- Sidewise-Control (**MSR**). In this case, the first wheel to block on one side of the vehicle is the determining factor for ABS control. In contrast, the two modulators are individually controlled. For the both vehicle sides the principle of the individual control is used. When unsensed wheels of a multi-axle vehicle equipped with this configuration are controlled, the system is called "Indirect Sidewise Control" (**INSR**).

A **4S/3M configuration** is to be preferred for full trailer or semi-trailer with a follower steering axle. On the steering axle two sensors and one modulator are located. The control occurs axle-wise because the brake pressure is equal at all wheels of this axle. The wheels of the L-axle are controlled by the ABS modulator A. The control is made according to the principle of the Modified Axle Control (**MAR**). On one further axle one sensor and one mod-

ulator are used for a sidewise control. These wheels are individually controlled (IR).

Valid for all configurations: Additional brake cylinders of other axles can be connected to the available modulators beside the brake cylinders of the sensed wheels. These indirectly controlled wheels do not send any information to the electronic control unit. Consequently no lock efficiency of these wheels can be ensured.

### 2.1.1.1 Self configuration

In order to offer an improved comfort to the user, the electronic control unit is programmed with a mechanism for self-configuration. At start the modulator unit automatically recognises what components are connected. When no failure is detected, this configuration is accepted and memorised.

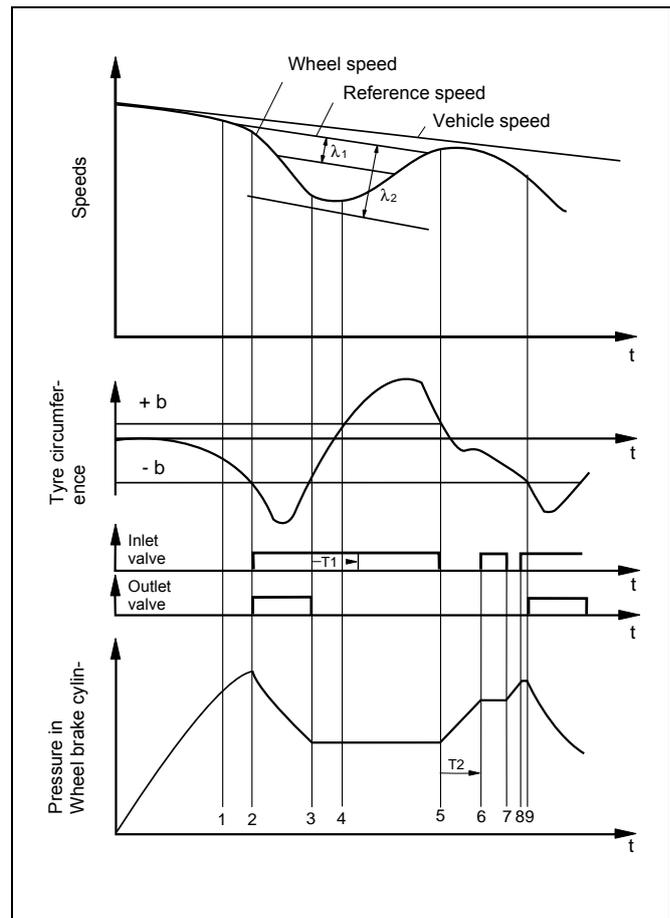
**On delivery, all devices are originally programmed as 2S/2M.** When another configuration (4S/2M or 4S/3M) is recognised at the initial operation, it is automatically adopted. The so-called "baptising" is therefore no longer required for initial start-up in this case.

This mechanism only operates in case of more powerful configurations (i.e. from 2S/2M to 4S/2M or 4S/3M), but not conversely, in order to avoid that the configuration will be automatically modified when single components have been removed (for inst. modulator A). Should it become necessary to modify the configuration in downward direction, this modification must be performed using the corresponding diagnostic tools.

The mechanism of self-configuration is not available in the Standard variant because only 2S/2M is possible here.

### 2.1.2 Description of an ABS Closed-loop Control Cycle

The figure shows an example of a control cycle with the main control functions: wheel deceleration threshold  $-b$ , wheel deceleration threshold  $+b$  as well as the slip thresholds  $\lambda_1$  and  $\lambda_2$ .



By increasing brake pressure the wheel will steadily decelerate. In point 1 the wheel deceleration exceeds a value which the vehicle deceleration cannot physically exceed. The reference speed, which is in accordance with the wheel speed till then, leaves the value of the wheel speed and comes to a reduction according to the specified vehicle deceleration. The maximum value is built from the determined reference speeds and generally used as common reference speed to the wheels. The corresponding wheel slip is calculated from the respective wheel speed as well as from the common reference speed. In point 2 the deceleration threshold  $-b$  is exceeded. The wheel runs in the instable range of the  $\mu$ - $\lambda$ -slip curve. The wheel has now reached its maximum brake force, so that each further increase of the brake torque exclusively results in an increased wheel deceleration. Consequently the brake pressure is quickly reduced and after a short time the wheel deceleration is also decreasing. This deceleration time is essentially determined by the hysteresis of the wheel brake and by the course of the  $\mu$ - $\lambda$ -slip curve within the instable range. After running of the wheel brake hysteresis a further pressure reduction results in a shorter wheel deceleration. In point 3 the deceleration signal  $-b$  releases by falling below the threshold and the brake pressure remains constant for a firm time  $T1$ . Generally the wheel acceleration exceeds the acceleration threshold  $+b$  (point 4) within this holding

time. The brake pressure is kept constant for as long as this threshold continues to be exceeded. When (e. g. on low coefficient of friction) the +b signal is not generated within the time T1, the brake pressure is further reduced via the slip signal  $\lambda_1$ . The higher slip threshold  $\lambda_2$  will not be reached in this control cycle. The +b signal releases after falling below the threshold in point 5. The wheel is now within the stable range of the  $\mu$ - $\lambda$ -slip curve and the used  $\mu$ -value is slightly under the maximum value. Now and for a defined time T2 the brake pressure is steeply regulated to override the hysteresis of the brake. This time T2 is firmly prescribed for the first control cycle and then for each following control cycle. After this step regulating phase the brake pressure is increased by pulsing, i. e. by alternating brake pressure maintaining and brake pressure holding.

The presented logic is not firmly specified but is adapted to the respective dynamic wheel behaviour on the various coefficients of friction, i. e. the system is adaptively working. The thresholds for wheel deceleration, wheel acceleration resp. wheel slip are also not constant, but depend on many parameters as for instance the parameter of the wheel speed. The number of the control cycles results from the dynamic behaviour of the whole control circuit ABS modulator unit - wheel brake - wheel - road surface. The adhesion coefficient is also significant in this regard. Usually there are 3 to 5 cycles per second, but fewer on wet ice.

### 2.1.3 Voltage Supply

The VCS II works with a nominal voltage of 24 V. A 12V variant with the product number 400 500 083 0 is available. The prime supply is made by a 5- resp. 7-pole supply connection according to ISO 7638. WABCO recommends using this supply mode. Therefore, all Standard and Premium modulator units are designed for the additional voltage supply via ISO 1185 or ISO 12098 (brake lamp supply 24 N). They can optionally be selected. **If more than one supply type is connected, the control device selects the one that delivers the highest voltage.** If one supply mode fails, the system automatically switches to the other one.

After switching-on, all solenoid valves are shortly switched on. A slight clicking noise is noticeable.

#### Note:

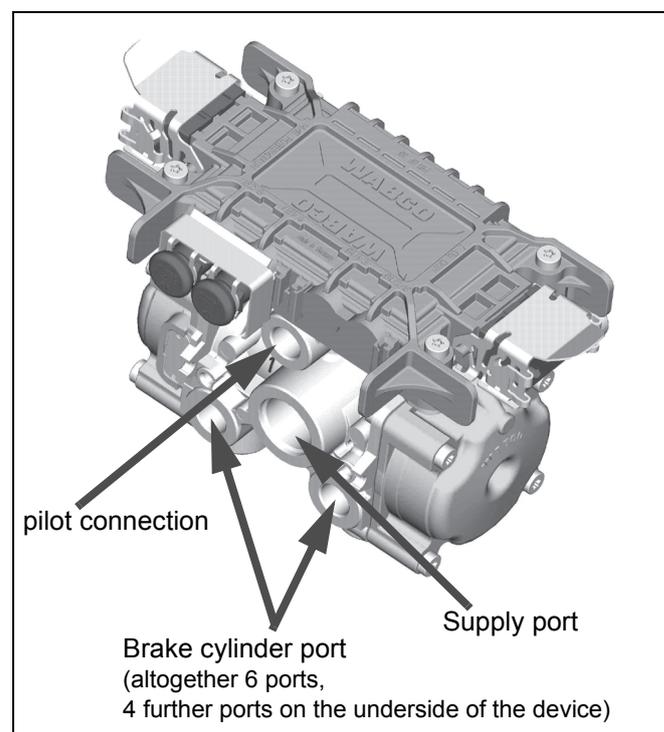
A 12 V variant is available under the product number 400 500 083 0.

If the standby function is activated (e. g. in the case of ECAS supply), the ECU and the voltage supply output remain switched on for the specified time after the terminal 15 is switched off so that any initiated control functions can be completed.

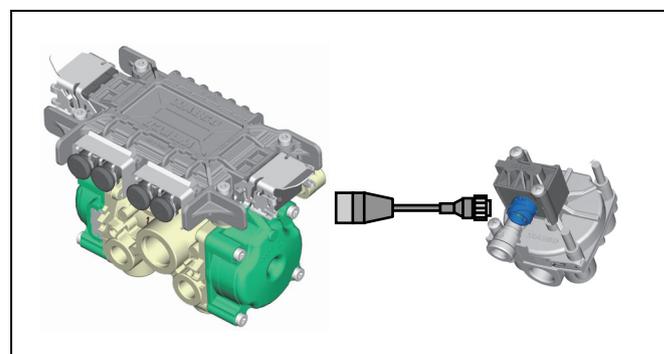
### 2.1.4 ABS Modulators

VCS II as standard and premium variant is equipped with an ABS double relay valve. It is a (Two-Channel) modulator, which can control two almost independent brake pressures during the ABS control. Three solenoid valves, which are internally bonded directly with the ECU, are integrated for pressure modulation. An external cable connection is no more necessary such as in case of the previous system.

The pneumatic connections are made via two supply ports (generally only one of both will be used), via a control port and six brake hoses.



The 4S/3M configurations are equipped with an ABS relay valve in addition to this two-channel modulator.

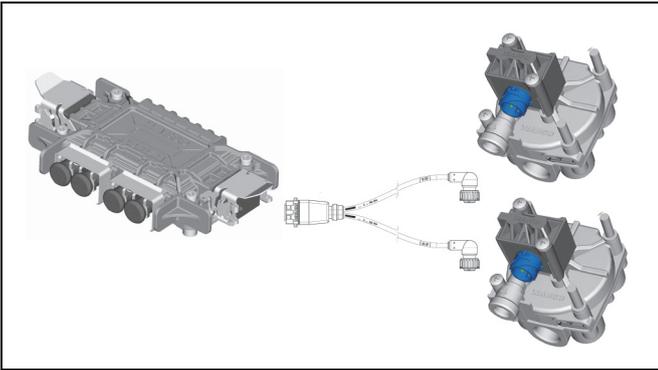


#### 4S/3M Configuration

Generally, this has to be pneumatically connected separately. Additionally there is a VCS II variant planned with

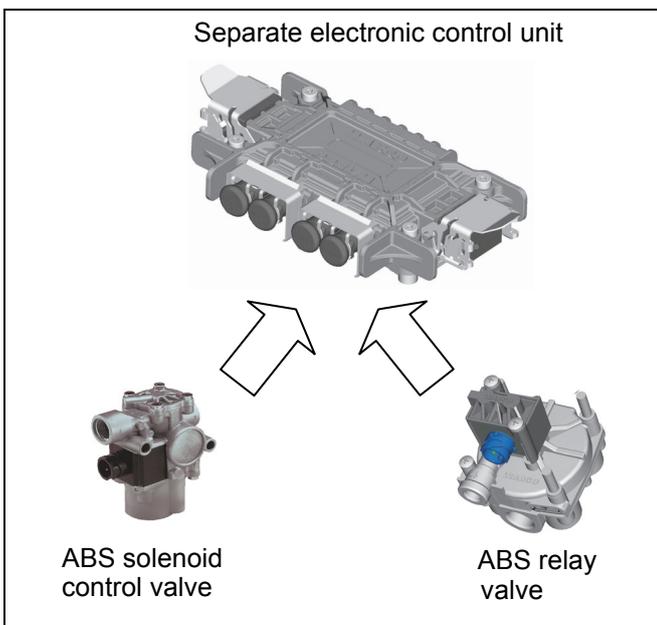
integrated ABS relay valve. This variant will be pre-installed in terms of the electrical and the pneumatic system, and will form a compact assembly in conjunction with the premium device.

Beyond the Vario Compact ABS of the 2nd generation as separate electronic control unit variant can also actuate one or two ABS relay valves (e.g. WABCO No. 472 195 031 0 or 472 195 041 0). This may be required for special vehicles or particular contexts for installation.



### Separate electronic control unit

In certain cases, it makes sense to install ABS solenoid control valves (e.g. WABCO No. 472 195 018 0). Especially for small full trailers or central trailers, which have such a favourable response time that they need no relay valves. These valves, however, may only be combined with the separate electronic control unit variant.



### Modulator variants of the separate ECU

The VCS-II brochure "Installation Instructions" (WABCO No. 815 010 009 3) provides examples for installations in the vehicle using these modulators.

## 2.1.5 Warning lamp control

An output (pin 7 on connector X1) is available for control of the trailer ABS warning lamp, enabling control of the warning lamp in accordance with ISO 7638. To switch the warning lamp on, this output is connected with ground in the ECU. This is also the case when the ECU is switched off.

### 2.1.5.1 Connecting the warning lamp

The warning lamp must be connected in accordance with the type of power supply:

- In the case of supply via ISO 7638, the trailer ABS warning lamp installed in the towing vehicle must be connected between terminal 15 and pin 5 of the ISO 7638. This pin is then connected directly with the warning lamp output of the ECU.
- If power is (optionally) supplied via ISO 1185 or ISO 12098, an additional ABS warning lamp can be installed on the trailer. This lamp must be connected between the warning lamp output and pin 4 (brake light supply) of the ISO 1185 or Pin 7 of the ISO 12098. The optional external warning lamp at the trailer is only active when the system is supplied via one of these plug connections at brake actuation. The behaviour of this warning lamp is identical to the behaviour of the warning lamp in the towing vehicle.

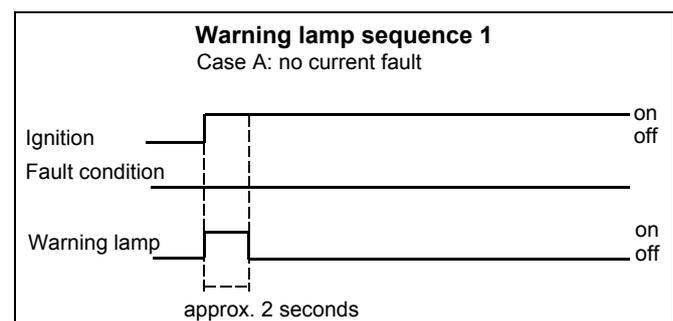
### 2.1.5.2 Warning lamp switch-on sequences

The VCS II is capable of executing two different warning lamp switch-on sequences. In the following these alternatives are described. They can always be modified by setting the parameter accordingly.

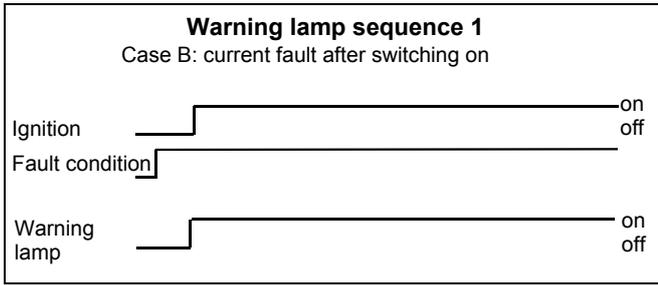
#### Warning lamp sequence 1

The first possibility is the most frequently used in commercial vehicles and cars.

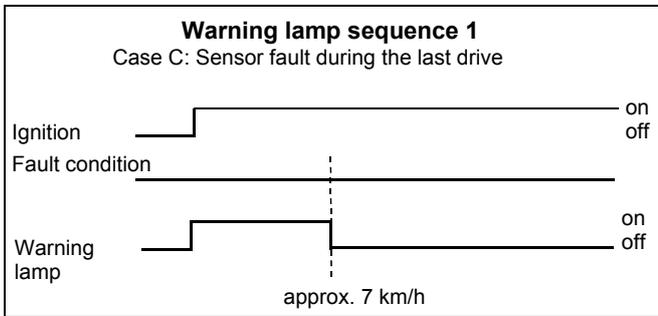
The warning lamp will go out as soon as 2 seconds after switching-on if no static fault (that can be detected while the vehicle is at a standstill) is present.



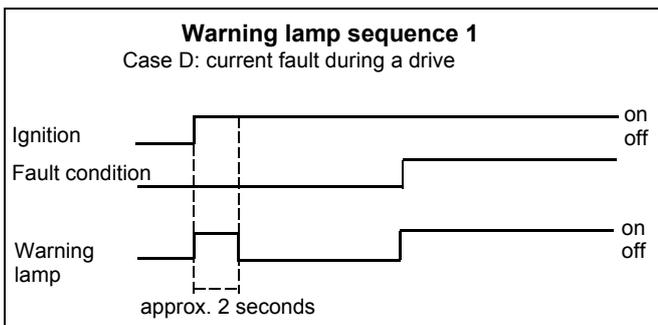
If a fault is current after the ignition is switched on, the warning lamp is not switched off.



If a fault occurred on an ABS rotational speed sensor during the last drive, and this fault could only be detected whilst driving, the warning lamp will only be switched off once the vehicle has exceeded a speed of approx. 7 km/h and it is ensured that the sensor signal is available again.



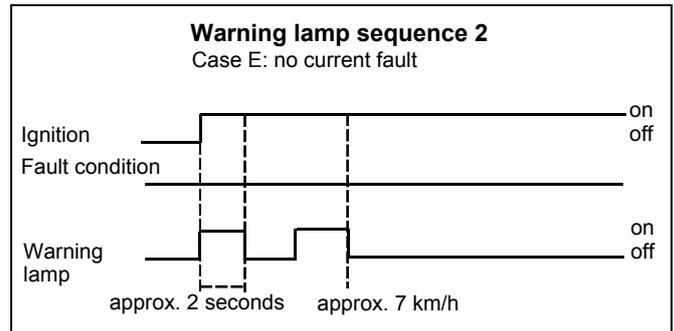
During driving when a failure is detected, the warning lamp continuously lights up.



**Warning lamp sequence 2**

Second possibility: In the case of the second possibility, the warning lamp is switched on again, provided there is

no static fault. At approx. 7 km/h it goes completely off.



If a fault is present after the ignition is switched on, the warning lamp will not go out. This case is identical with the warning lamp function 1, case B.

**2.1.5.3 Further warning lamp functions**

When the vehicle is switched on, but stationary for one hour, the warning lamp goes on. It prevents that the ABS, which does not receive any sensor signal (e. g. after repair at the brake) because of a too large a sensor air gap, always let go off the warning lamp, without detection of failures. If this condition is not detected, the warning lamp is switched off immediately as soon as sensor signals become available. The period of one hour can be made up of a combination of a number of separate time periods (e. g. 4 times 15 minutes).

In addition, the warning lamp is switched on as soon as the service signal is activated. This function is described in chapter 2.3.1.

The warning lamp can also be activated when wear sensing is being conducted. This function is described in chapter 2.2.1.

**2.1.6 Fault Monitoring**

In operation the electronic control unit is monitored by an integrated safety circuit. When faults are detected by the ABS system either the failed components are switched off (selective switching-off) or the complete ABS system itself. The normal braking function remains operative. Fault mode or fault frequencies are durably memorised in an EEPROM (not-permanent memory). They can then be read out using diagnostic devices.

The control channels - still available because of selective switching-off - enable a partial availability of the ABS system, i.e. not only a brake action, but also a secondary vehicle stability.

### 2.1.7 Towing Vehicle - Trailer Interface According to ISO 11992 (CAN)

The Premium variant and the separate ECU are equipped with a towing vehicle - trailer interface according to ISO 11992. The Standard variant does not dispose of it. This interface assures the communication between towing vehicle and trailer via pin 6 and 7 of the ISO 7638 plug connection.

VCS II supports the standardised data of ISO 11992 where these are available. When the ECAS interface is activated, the standardised air spring data are also supported.

The messages supported by VCS II are listed in the system specification 400 010 203 0.

### 2.1.8 Diagnostic Interface

The electronic is equipped with a diagnostic interface according to ISO-Standard 14230. As diagnostic protocol the KWP2000 standard (ISO 14230-2) or JED 677 is used. These interfaces permit:

- to read out stored failure modes according to type and frequency and to erase them
- to carry out function tests
- changing system parameters
- setting GenericIO functions

For the Standard and Premium variant the diagnostic K line is on the connector X 6, pin 8 (casing identification MOD RD 7).

If the Separate ECU is installed, the diagnostic K line is located on the connector X1, pin 2 (casing identification 14/15 POWER/DIAGN).

In addition to this, diagnosis via can interface is supported with the Separate ECU and the Premium variant as of 2005.

### 2.1.9 Recognition of lifting axles

When the trailer is equipped with a lifting axle, fitted with speed sensors, the electronic control unit automatically detects, whether this axle is lifted. The VCS II brochure "Installation instructions" (815 010 009 3) also lists examples regarding the system selection for vehicles with lifting axles.

The lifting axle has only to be equipped with the sensors e and f. The installation of the sensors c and d is not allowed at the lifting axle.

### 2.1.10 Mileage counter

The VCS II is fitted with an integrated mileage counter, which calculates the driven distance when the ABS system is running. Two individual functions are possible:

1. The **cumulative mileage counter** calculates the complete driven distance from the period of the initial system installation. This value can be displayed by all diagnostic devices.
2. Furthermore a so-called **distance mileage counter** is available. It can be reset at any time. This permits, for example, determining the distance driven between two maintenance intervals or the distance driven within a specific period of time. The determined value can be displayed, and reset, by the PC diagnosis and the Diagnostic Controller. The value is greyed out in the PC diagnosis if the ECU was switched on while driving since the last reset of the distance mileage counter (24N operation). The indicated kilometre reading is then too low.

For the function of the mileage counter the electronic control unit must receive the information through the rolling circumference of the tire and through the number of teeth of the pole wheel at the axle via sensors c and d. The standard calibration of the mileage counter in respect of rolling circumference and number of teeth is 3250 mm and 100 teeth. With these nominal conditions the resolution is 4.16 mm. In order to acquire a value with the greatest possible accuracy, these data should be modified if the tyre actually installed differs from the default settings of the mileage counter. The tire charts of the tire manufacturers indicate the dynamic rolling circumference.

In the event that these data were entered incorrectly, a subsequent adjustment is possible because the indicated kilometre reading is calculated on the basis of data currently stored in the ECU (number of pole wheel teeth, tyre circumference, and the number of wheel rotations). The deviation of a correctly calibrated mileage counter is below 3% and is essentially determined by the manufacturing tolerance of the tyre and by tyre wear. The mileage counter can be calibrated using the PC diagnosis software. The latter provides a selection menu for common pole wheel teeth counts. The rolling circumference is also to be registered.

The mileage counter requires a permanent power supply and is therefore not secured against manipulation. If power is supplied via ISO 1185 or ISO 12098 (24N), the mileage counter data cannot be processed.

### 2.1.11 Allocation of the Pole Wheels to the Tire Circumference

The right allocation of the pole wheels to the tire circumference is necessary for the ABS function, because various control functions refer to the wheel speed or to absolute resp. relative deviated values. For a certain range of tire dimensions one pole wheel with a defined number of teeth is allowed.

#### Note:

The standard tire has been newly defined for VCS II, in order to comply with the technical development of trailers. The present standard tyre with a rolling circumference of 3425 mm has been replaced by the actual standard tyre with a rolling circumference of 3250 mm.

**For this reason, the correlation diagram tyre rolling circumference - number of pole wheel teeth of the VCS I has become invalid.**

Only the up-to-date diagram according to appendix 1 is valid for VCS III!

In principle each tire circumference has to correspond to a number of pole wheel teeth. This correlation is illustrated by the centre line within the hatched area of the diagram in accordance with appendix 1. For reducing the number of the used pole wheels an admissible tire circumference range is defined for each pole wheel based on tolerance observations. It is illustrated by the hatched range. Each combination of tire circumference and number of pole wheel teeth has to be within this range. **Combinations which are out of this range are not admitted!**

#### Procedure:

- The default parameter setting of the control device is applied (delivery status). In this regard, the correlation represented in appendix 1 applies.
- **OR** the actual tyre size is parameterised. In this case, a ratio of tyre circumference to pole wheel tooth count of 23 to 39 is permissible.  
The VCS II diagnosis as of version 2.11 checks the validity of the entered ratios when parameters are set.

#### 2.1.11.1 Different tyre sizes per axle

In special cases it is necessary or reasonable to install different tyre sizes on different axles. When the difference of the rolling circumference does not exceed the admissible value of 6.5 %, the installation is authorised and has no influence on the ABS function. When the difference exceeds 6.5 % a parameter setting of the VCS II has to be carried out. This procedure prevents from the

utilisation of special pole wheels. The parameters of different tire sizes on different axles are set in the PC diagnostic software.

For the data concerning one axle the allocation of tire circumference and number of pole wheel - as described before - are to be fulfilled.

## 2.2 GenericIO Functionality

All variants of the VCS II are equipped with additional in- and outputs or an analogue input. This enables functionalities in the trailer other than the ABS function. These inputs/outputs are called Generic Input/Output (Generic IO).

Available GenericIOs for VCS II - Variants:

	GenericIO D1	GenericIO D2	GenericIO A1
<b>Standard variant</b>	X	X	
<b>Premium variant</b>	X	X	X
<b>Separate ECU</b>	X		

The functionality of a GenericIO is set via parameter.

At delivery state all inputs and outputs are switched off.

The following predefined GenericIO functions can be set via the PC diagnosis software:

- Wear indication (BVA)
- Integrated speed-dependent switch (ISS)
- Voltage Supply
- Speed signal
- ECAS interface
- ELM interface
- Lifting Axle Control

Per input/output only one function can be actuated. For a couple of functions, additional function parameters can be defined to adapt the function to customer requirements.

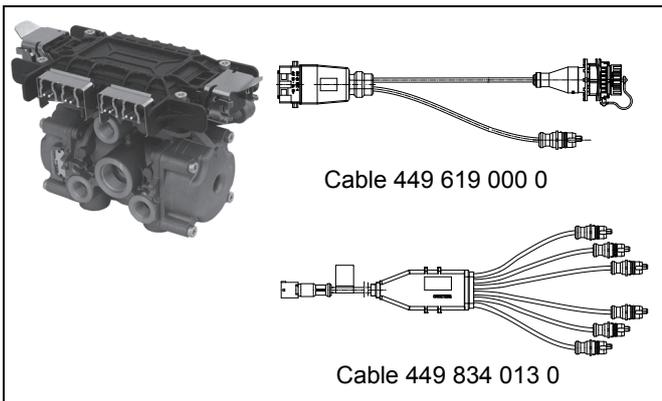
In case of failure please make sure that the equipment controlled by a GenericIO have been transferred back to a safe position. In the event that the voltage supply fails, a steering axle should be locked, for example, because this ensures a safe condition. The vehicle manufacturer must design the equipment to be controlled so that this is guaranteed.

### 2.2.1 Wear indication (BVA)

The wear indication permits the two-stage detection and indication of brake lining wear for vehicles with disk brakes. Wear is sensed by replaceable wear indicators (612 480 040 2) that are mounted on the brake lining and which cause an interruption when the brake linings are worn or establish ground contact (electrical connection of brake lining to battery ground required) on reaching what is referred to as the advance warning stage.

The brake lining wear indication is implemented via a digital GenericIO input/output. This input/output must be connected to pin 3 of the WABCO wear distributor wiring harness (449 894 013 0). Pin 2 of the wiring harness must be connected to ground, pin 1 remains vacant. A ready made-up connection cable (446 619 000 0) can be supplied for Standard and Premium devices. The wiring harness is connected to GenericIO-D1 via this cable. All wear indicators are switched in series through the wiring harness.

Examples of designs for the wear indication:



Different configurations for wear sensing with various trailer vehicles are listed in appendix 4.

As soon as an interruption or a contact to ground occurs on at least one indicator while driving, wear is registered by the ECU. A flashing sequence of the warning lamp then indicates the wear condition very time the system is switched on until the worn brake linings and associated wear indicators are replaced. Corresponding information is also transmitted on the CAN interface if such an interface is installed and activated.

The GenericIO input used must be set in the context of GenericIO parameter settings. The wear wiring harness mentioned above is connected to GenericIO D1. In addition, the optional detection of the advance warning stage can be selected.

### Forewarning level

When at least one of the indicator wires is abraded, a short circuit to ground is the consequence (ground connection between brake and battery ground is required). This means the the advance warning stage has been reached. It can be activated via the parameter settings but is switched off by default.

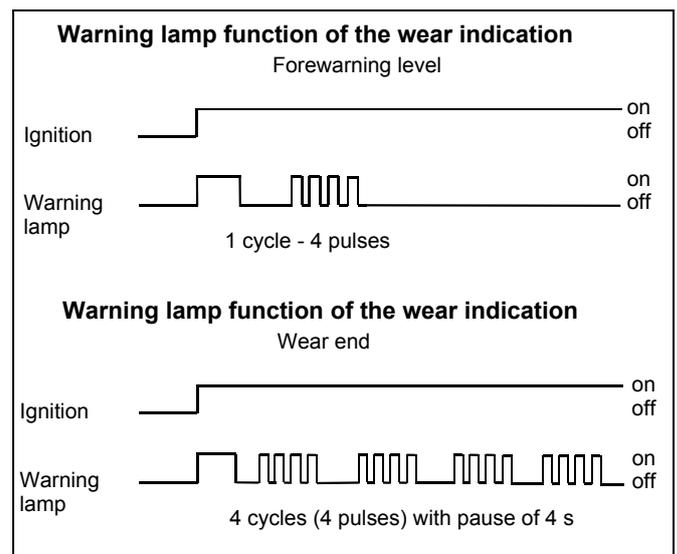
### Wear end

As soon as an interruption of at least one second occurs while driving at one of the indicator wires, this interruption is registered, and a flashing warning lamp will indicate the wear limit when the system is switched on again the next time.

### indicator

The driver is warned by the warning lamp flashing each time the ignition is switched on. When the warning step is reached, a flashing cycle is initiated. This cycle consists of 4 flash pulses (500 ms on / 500 ms of). Once the wear limit has been reached, four cycles flash with a pause of 4 seconds in-between.

Flashing starts around 4 seconds after the ignition is switched on. The warning is cancelled if the ECU detects speed. A currently detected failure in the ABS system has priority and superimposes itself on the wear warning. The wear warning, on the other hand has priority over any service signal that may be output.



### Resetting the wear indications

The system automatically detects the connection of new wear indicators after the linings are replaced once the vehicle has reached a speed beyond 40 km/h and is then

stopped (vehicle permanently supplied via ISO 7638 in this case).

This drive can be simulated even at a standstill by switching on the ECU three consecutive times for around 2 seconds and then for at least 5 seconds via terminal 15. If the reset was successful, the warning lamp flashes 3 pulses of the first cycle when switched on for the fourth time.

## 2.2.2 Integrated speed-dependent switch (ISS)

The "Speed-dependent switch" permits executing, activating, or disabling function speed-dependently. It is therefore possible to switch relays or solenoid valves on and off speed-dependent. The following examples are possible:

- Steering axles which must be locked depending on speed
- Lifting axles are to be lifted or lowered speed-dependent

The selected GenericIO output is switched when the vehicle speed exceeds the parameterised speed threshold. Repeating the switching action is only possible again after the speed drops below the speed threshold again by 2 km/h (hysteresis). This function is available above 3.8 km/h.

Three different functional variants of the speed-dependent switch can be set via parameter settings:

- ISS-Standard function
- 10 seconds pulse function
- At least 10 seconds pulse function

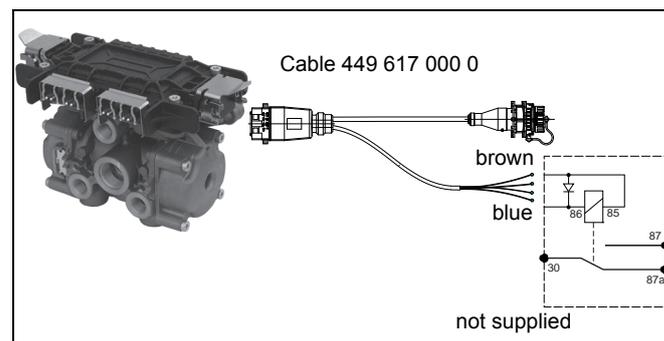
These functions are available for the GenericIO D1 or D2 (also see wiring plan 841 801 933 0).

The output level is monitored and a fault message is generated in the event of deviations (short-circuit monitoring). It is also possible to perform load monitoring (cable break) if this was activated by parameter settings. The connected load may then have a maximum resistance of 4 kOhm.

Various cables are available for using these functions (see VCS II cable overview).

In the case of high resistance consumers, a parallel resistor (4 kOhm) must be connected to ground.

Wiring example for the ISS function:

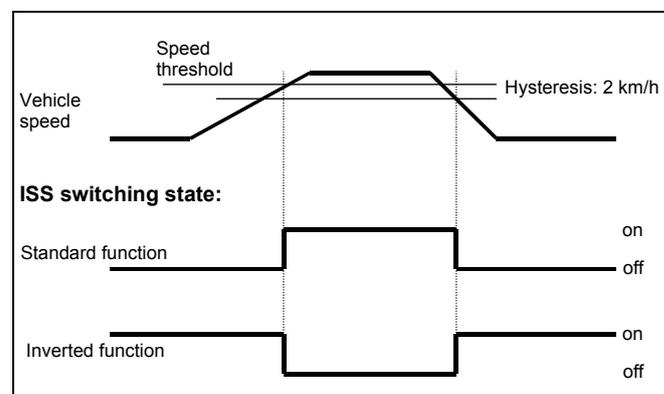


In this example, the ISS function is used via the GenericIO D1. If GenericIO D2 is to be used, the core RED (instead of BLUE) must be used.

Only one ISS can be implemented in a system.

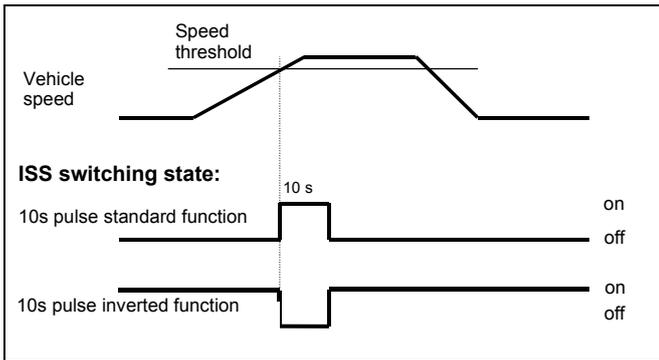
### 2.2.2.1 ISS-Standard function

The speed threshold, which modifies the switching status of the output, is to be freely set in parameter within the speed range between 1.8 and 100 km/h. The switching output is switched off below the speed threshold set in the parameters. The output is switched on when the threshold is reached. When the output drops below the threshold again, a hysteresis of approx. 2 km/h is initially available before the output is switched off again. This function can also be inverted.



### 2.2.2.2 10 seconds pulse function

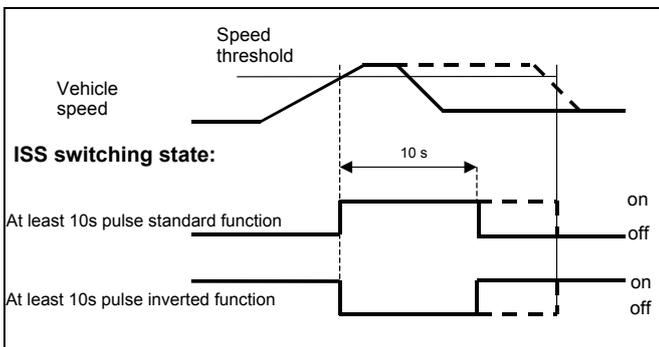
This GenericIO function also evaluates the vehicle speed. In contrast to the ISS, the output is switched on for 10 s (10 s - pulse) when the speed threshold is exceeded. After expiration of this time period the output is again switched off, independently from the driving state. Its function firstly consists in switching on devices or functions, where a permanent activation is not permitted. This is identical to the ISS function.



### 2.2.2.3 At least 10 seconds pulse function

A third variant of the ISS function is the "At least 10 seconds pulse function". Here the control process is not cancelled after the speed threshold is exceeded until a period of 10 seconds has elapsed. Even if the speed drops below the speed threshold before this time, the output will not be switched off.

Additionally, the output remains switched on for as long as the speed is above the speed threshold. The period of 10 seconds can therefore be extended as required.



### 2.2.3 Output speed signal

The speed signal provides an information about the vehicle speed and is based on the sensed wheels. It is a signal modulated by pulse frequency and serves to provide speed information. A detailed description of this signal is found in the system specification 400 010 203 0. The signal level, for instance, can be inverted via parameter settings.

This function of the GenericIO D1 is available on Pin X6.1 or of D2 on Pin X6.2 (also see wiring diagram 841 801 933 0).

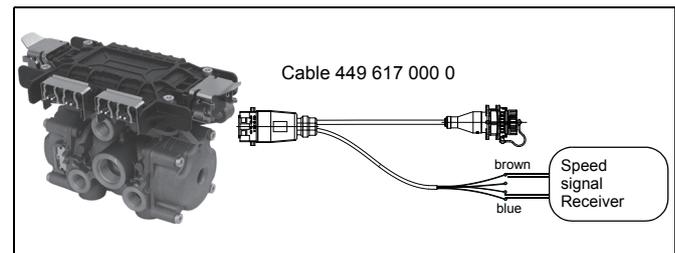
The output level is monitored and a fault message is generated in the event of deviations (short-circuit monitoring). It is also possible to perform load monitoring (cable

break) if this is activated by parameter settings. The connected load may then have a maximum resistance of 4 kOhm.

In the case of high resistance consumers, a parallel resistor (4 kOhm) must be connected to ground.

Various cables are available for using this output (see overview of VCS II cables).

Example for wiring the speed signal:



In this example, the ISS function is used via the GenericIO D1. If GenericIO D2 is to be used, the core RED (instead of BLUE) must be used.

### 2.2.4 Power supply for connected systems

The power supply output also permits supplying downstream systems (auxiliary functions) with power. This output is switched on and off synchronously with terminal 15. When the service voltage is not sufficient at the terminal 30, the output is inactive. If inductive loads occur, the shut-off voltage peaks must be limited by protection diodes.

When the ignition is switched off (terminal 15), a voltage standby time via terminal 30 can be generated for a time defined in the parameter settings (0 to 10 s). The VCS II ECU and this output remain switched on for this period. This is useful to finish running operations.

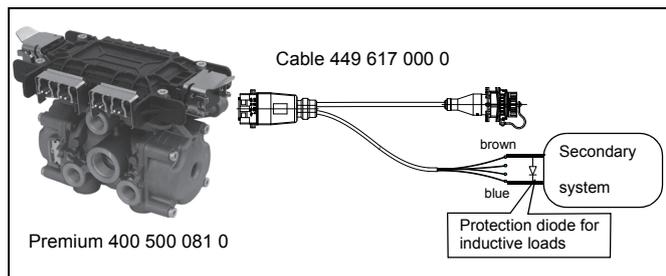
#### Note:

This function is available for the GenericIO D1 with a max. load 1 A or with a max. load of 2 A for D2 (also see wiring diagram 841 801 933 0).

The output level is monitored and a fault message is generated in the event of deviations (short-circuit monitoring). It is also possible to perform load monitoring (cable break) if this is activated by parameter settings. The connected load may then have a maximum resistance of 4 kOhm.

Various cables are available for using this output (see overview of VCS II cable).

Example for wiring the voltage supply output:



In this example, the ISS function is used via the Generic IO D1. If Generic IO D2 is to be used, the core RED (instead of BLUE) must be used.

## 2.2.5 ECAS interface

The Generic IO D1 output is used for the connection of ECAS. This interface also comprises the diagnostic K line and, if appropriate, a battery charging output on pin X6.4 of the Premium device.

ECAS is supplied with power via the Generic IO D1. This output works as described in chapter 2.2.4. The stand-by time is set to 5 s. Via operating data exchange, the ECAS ECU receives information on the power-down procedure in this period. A failure monitoring occurs on the output, so that cable breaks and short circuits are detected.

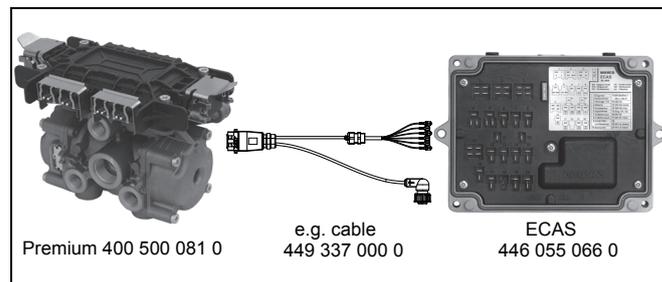
The diagnostic line K is led to the ECAS-ECU in order to ensure the exchange of operating data via this interface. VCS II uses this line to transmit speed information and ECAS uses it to transmit operating data. VCS II processes this information for the towing vehicle - trailer interface in accordance with ISO 11992 (CAN) and is therefore available in the towing vehicle.

If the trailer vehicle is equipped with a battery, the output at Pin X6.4 can be used for battery charging if the Premium variant is used. When ignition is off, the voltage at terminal 30 will be connected through to the connected battery. When ignition is on, control of this output will be effected by the VCS II ECU. This output also has the function of providing the voltage supply for diagnostic devices.

The ECAS interface is provided in the Standard and Premium variant.

Different cables are used for the connection of ECAS (see also VCS II list of cables).

Examples for the connection of ECAS (for further information also see ECAS cabling diagram):



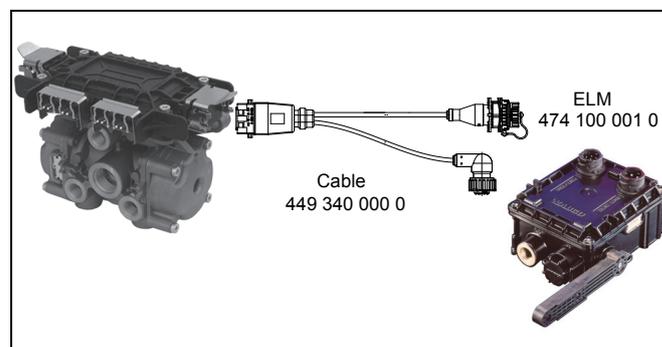
This example illustrates the cable of 4S/3M application. For 4S/2M or 2S/2M configurations, the cable 449 336 000 0 is available.

## 2.2.6 ELM interface

The Generic IO D2 is used to supply ELM with voltage. Moreover, this interface comprises the Generic IO D1 output that is used for speed-signal output as described in chapter 2.2.3. A failure monitoring occurs on the output, so that cable breaks and short circuits are detected.

The ELM interface is also provided in the Standard and Premium variant. Corresponding cables are supplied for connecting ELM.

Example for connecting ELM (for further information also see ELM cabling diagram):



## 2.2.7 Customer-specific Functions

By setting parameters accordingly, it is possible to generate other functions to the ones described here at the Generic IO outputs.

On customer's request, WABCO will create the parameter sets required for this purpose. These parameter sets can then be downloaded to the ECU via the PC diagnosis. Existing GIO data sets are available via [www.wabco-auto.com](http://www.wabco-auto.com)

## 2.3 Special functions

### 2.3.1 Service signal

The service signal is a function that informs the driver that a predefined distance has now been travelled.

This function is switched off in the condition as supplied.

The PC diagnosis can be used to activate this function, to define inspection intervals for example.

Once the vehicle has driven this distance, the warning lamp is activated and will flash 8 times each time the ignition is switched on.

After execution of servicing, the service signal can be reset by means of the PC diagnosis. The service interval is initiated again, and once the specified distance has been driven the signal is also generated again.

### 2.3.2 Integrated Notebook

The control device includes a section of memory that is referred to as an integrated notebook. The PC diagnostic allows access to this memory. Generally, any alphanumeric data can be entered here.

The memory can be protected by a password consisting of four alphanumeric characters. When the user has defined a password, the data can no longer be changed without entering the password. Read-only access is always permitted.

In delivered condition the notebook memory is empty.

## 2.4 Further Electronic Control Units in the Trailer

The following chapters describe the possible combinations of WABCO ECUs with the VCS II system.

### 2.4.1 VCS II and ECAS

The VCS II Standard and Premium variant provide the option of connecting ECAS via a GenericIO interface. The function is described in detail in chapter 2.2.5. "ECAS interface".

The full functionality comprises the voltage supply, optional battery charging and the exchange of operating data. The ECAS-ECU 446 055 066 0 has to be used for this purpose.

Both systems use a shared diagnostic socket that is integrated in the ECAS casing or installed on the vehicle frame.

### 2.4.2 VCS II and ELM

The VCS II Premium variant also provides the option of connecting ELM via a GenericIO interface. The precise function is described in chapter 2.2.6 "ELM interface".

The full functionality of this interface comprises the voltage supply and the speed signal. The ELM device 474 100 001 0 has to be used for this purpose. It is connected by means of suitable cables.

### 2.4.3 VCS II and Infomaster

VCS II can only be combined with the Infomaster 446 303 007 0 (mileage counter).

## 3 Planning an ABS System

### 3.1 General

In many cases, a 2S/2M configuration is sufficient for the semitrailer/central axle trailer. The standard version 400 500 070 0 is available for this purpose. It includes an electronic control unit with two sensor inputs which is mounted on a two-channel modulator.

The Premium version 400 500 081 0 is provided for more advanced sensing modes and additional functions (e. g. CAN and GenericIO). It is an electronic control unit with four sensor inputs and is mounted on a dual-channel modulator. A separate ABS relay valve can be connected as well for 4S/3M applications.

The separate electronic control unit 446 108 085 0 is intended for special applications where one of the aforementioned integrated designs cannot be deployed. In addition, it can be used as a replacement for an old VCS I unit with the help of cable adapters. The ABS valves are here connected externally using cables. These may be ABS relay valves or ABS solenoid control valves.

### 3.2 On speed sensing

Only wheels equipped with sensors can be prevented from locking up under all circumstances. To save costs, it is possible, for example, to group two wheels on one side of a semitrailer together. In this case, it cannot be ruled out that the unsensed wheels lock up. A more radical compromise between ABS control and cost is achieved by the minimum configuration of a 2S/2M system.

### 3.3 Series Equipment / Retrofitting

While optimisation (and the trials required) with regard to required systems may be beneficial in terms of series production, one should opt to fit sensors to a further axle rather than save costs. Usually, the added cost of the equipment is lower than the cost of the additional work needed if the result proves to be unsatisfactory.

### 3.4 VCS II Used in Vehicles Intended for the Transport of Dangerous Goods

All components of the 2nd generation Vario Compact ABS comply with GGVS / ADR requirements, so no difficulties should be expected when applying for TÜV approval for a trailer which has the systems installed correctly.

The conditions are listed in TÜV code of practice 5205 („Electrical equipment of vehicles for transporting dangerous goods, notes on directives 11 251 and 220 000 (Appendix B.2) GGVS/ADR“).

#### Explanation:

GGVS: Regulations on road transport of dangerous goods

ADR (English): European Agreement Concerning the International Carriage of Dangerous Goods by Road.

ADR (French): Accord européen relatif au transport international des marchandises Dangereuses par Route.

ADR and the German GGVS regulations are approximately equivalent.

GGVS is frequently equated with explosion protection. **This is a mistake!** No ABS components are allowed to be installed in parts of the trailer (e. g. pump compartment) where explosion-proof parts are prescribed.

Compliance with GGVS/ADR requirements is acknowledged by the TÜV certificate 858 800 075 4 and TÜV approval. The certificate can be obtained under the corresponding part number in the product catalogue INFORM ([www.wabco-auto.com](http://www.wabco-auto.com)).

### 3.5 Fording ability

Fording ability is often required for vehicles deployed by the military. VCS II also provides a solution for this requirement.

Fording ability is specified for the Separate ECU 446 108 085 0. This control unit is combined with ABS relay valves 472 195 031 0 or ABS solenoid control valves 472 195 018 0. These ABS modulators have a special snap-on contour at the venting port that enables fitting the adapter 899 470 291 2. A plastic tube, which is then conducted upwards beyond the maximum water level, can be connected to this adapter. This ensures that no water can penetrate into the braking system via the discharge system.

#### Note:

The Standard or Premium variants are not suitable for vehicles with fording ability.

## 4 Components

Compared to VCS I, the new electronic control unit or ECU/valve unit has been designed to be significantly smaller and lighter.

The main features are:

- External 8-pin connection
- ECU housing made of plastic
- Internal direct contacting of the modulator (no external solenoid cable)

An overview of the complete scope of the system is provided by the VCS II brochure part 2 "Installation instructions" (815 010 009 3).

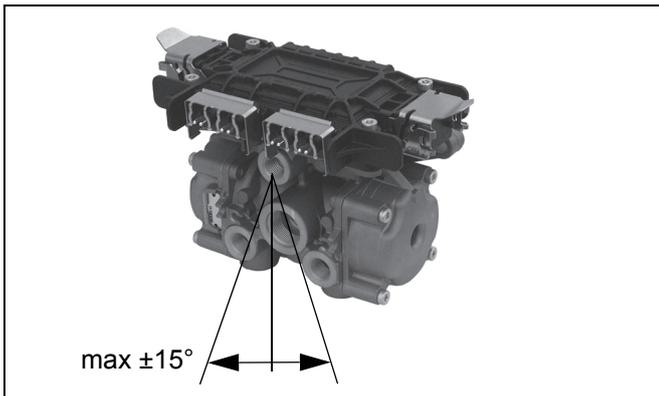
### Notes:

**Sensors and modulators for one side of the unit must be installed on the same side of the trailer** (e. g. YE2 and modulator B right). Unused sensor slots must be closed using cap 441 032 043 4. General requirement in order to maintain seal integrity:

**Opening the electronic control unit is not permitted!**

### Instructions on installation position

The Standard and Premium variants must be installed with the vent pointing downwards. The maximum slant position of  $\pm 15^\circ$  must not be exceeded.



#### 4.1 Standard variant 400 500 070 0

The standard version permits a maximum configuration of 2S/2M. Cabling diagram 841 801 930 0 shows the cabling for this version.

#### Electrical power supply connection

The connection for the electrical power supply (cap marked POWER) is coded and is therefore protected

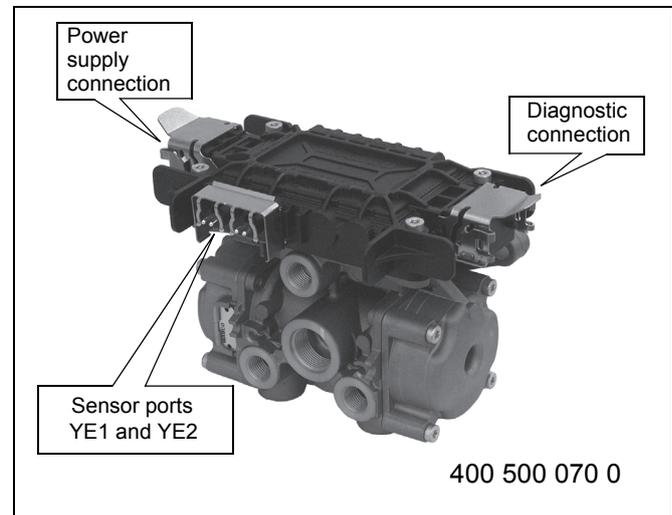
against cross-polarity. It must always be connected. In addition, the brake light supply (24 N) can also be connected here.

#### Modulator and diagnostic connection

In the standard version, the modulator connection (MOD RD) is used as a connection for the diagnostic cable 449 615 000 0 or the GenericIO application as well.

#### Sensor connections

Only ports YE1 and YE2 are used in this version.



#### 4.2 Premium Version 400 500 081 0

The Premium version provides the full range of functions of the VCS II system.

The maximum configuration is 4S/3M. 4S/2M and 2S/2M configurations can be derived from it.

In the case of 4S/2M, this is done by not connecting the A-modulator and in the case of the 2S/2M, by not connecting the A-modulator and sensors e and f. This version also includes CAN communication, ECAS/ELM interface and GenericIO functions.

Cabling diagram 841 801 933 0 shows the cabling for the Premium version.

#### Electrical power supply connection

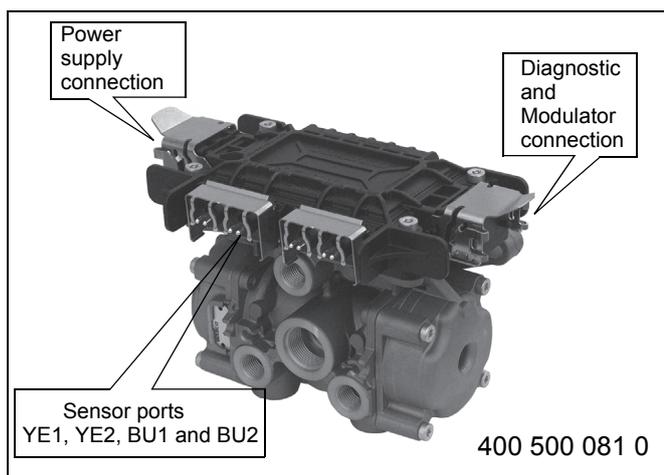
The connection for the electrical power supply (cap marked POWER) is coded and is therefore protected against cross-polarity. It must always be connected. A mixed supply via ABS plug connection and brake light supply (24N) is also possible by means of a Y cable.

### Modulator and diagnostic connection

The connection marked MOD RD 7 is available for the functions of the 3rd modulator, diagnosis, ECAS/ELM or GenericIO functions.

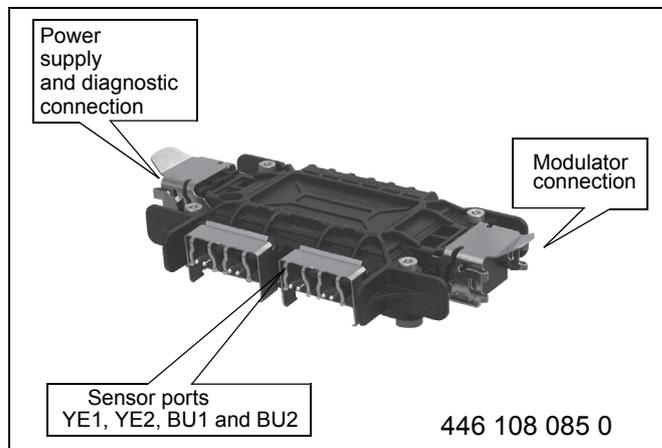
### Sensor connections

Only ports YE1 and BU1 are used in a 2S/2M system. Ports YE2 and BU2 must be used if a 4S/2M or 4S/3m system is connected.



### Sensor connections

Only ports YE1 and BU1 are used in a 2S/2M system. Ports YE2 and BU2 must be used if a 4S/2M or 4S/3m system is connected.



### 4.3 The Separate ECU 446 108 085 0

The separate ECU is provided for special applications in which the integrated versions cannot be used. These may involve special vehicles, for example. All ABS valves are connected externally using solenoid cables. ABS relay valves or ABS solenoid control valves can be used.

Cabling diagram 841 801 932 0 shows the cabling for the separate ECU.

### Electrical power supply connection

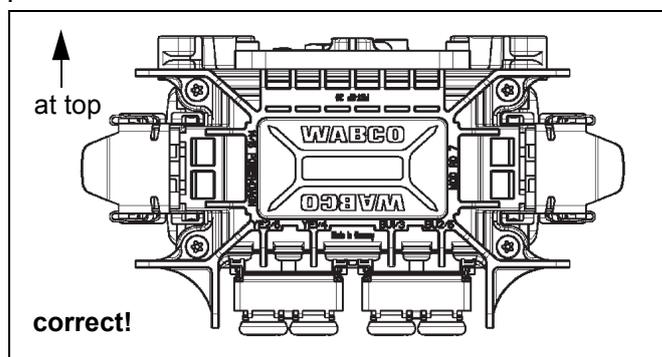
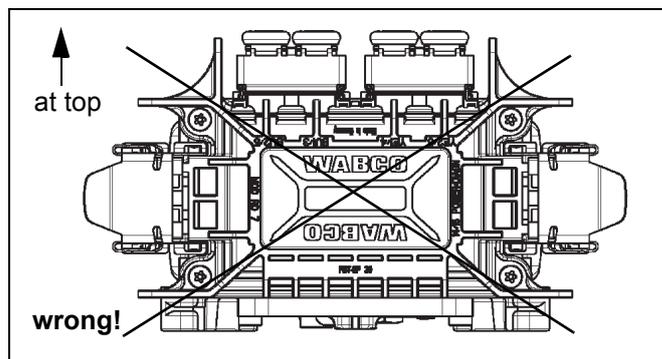
The connection for the electrical power supply (cap marked POWER) is coded and is therefore protected against cross-polarity. Power supply cable 449 144 000 0 or 449 244 000 0 is used, and it must always be connected. **Diagnosis is also performed using this Y-cable with a diagnostic connection.**

### Diagnostic connection

Different solenoid cables are used depending on the configuration (number of ABS valves). Triple cable 449 544 000 0 is required in 4S/3M systems as the connection to the ABS valves. A Y-cable 449 534 000 0 is used in 2S/2M and 4S/2M.

### ATTENTION! Impermissible installation position

The installation position shown here is not permitted! In this case, water may collect between the cover and the plug frame without being able to drain off.



### 4.4 ABS solenoid valves

ABS valves (ABS relay valves or ABS solenoid control valves) are responsible for reducing, maintaining, and renewed increasing of the pressure in the brake cylinders within milliseconds while braking and in accordance with

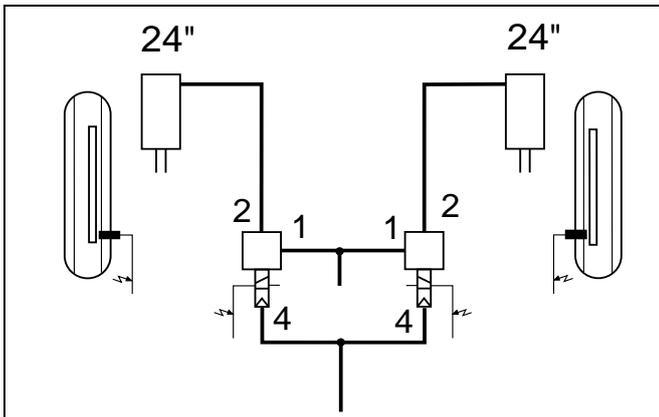
the control signals from the electronic control unit. Two ABS solenoid valves are already included in VCS II compact units

#### 4.4.1 ABS relay valve 472 195 03. 0

The ABS relay valve must be installed on the trailer frame. It is not permitted for it to be mounted on the axle.

It is important for proper ABS function that the braking pressure in the connected brake cylinders of the actuation is applied quickly and that all brakes of the vehicle are braked as simultaneously as possible. The following details must be observed:

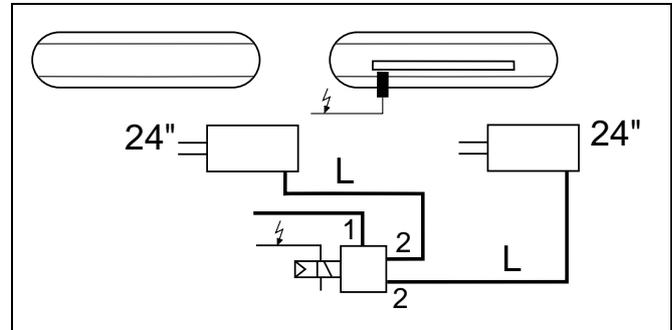
- The position of the ABS relay valves in the vehicle and their pipe connections to the left and right side of the vehicle must be designed as symmetrical as possible to the vehicle's longitudinal axis (Fig. 5).



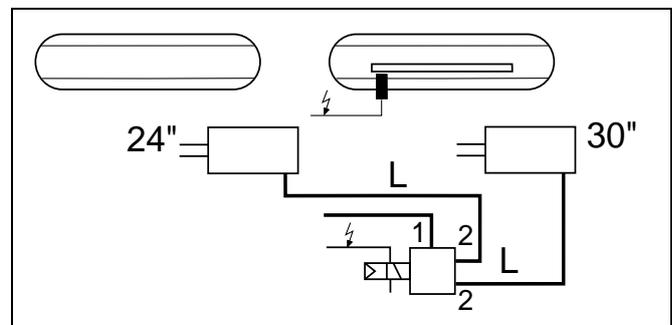
**Fig. 5** Pilot and supply lines leading towards the valves should be divided as symmetrically as possible.

- The supply lines to the ABS relay valves (connection 1) should have the largest possible nominal width (at least 9 mm respectively). Tees and unequal conditions of flow must be avoided.
- The control lines to the ABS relay valves (connection 4) should have a nominal width of at least 6mm with the routing conditions being as identical as possible.
- The lines from one ABS relay valve to multiple brake cylinders of the same size on one vehicle side must have the same length and the same cross-section (Fig. 6). In the case of cylinders with different line lengths, the line length L to the smaller brake cylinder must be longer (Fig. 7).
- The line length between the ABS relay valve and the brake cylinder should be as short as possible, but no longer than 3 m. The nominal width of the line should be, depending on the size of the brake cylinders, between 9 and 11 mm.

- The maximum volume of air of a ABS relay valve absorbed by the brake cylinders must be a maximum of 2 dm<sup>3</sup> if the lines have been routed in the best possible manner; this corresponds to 2 cylinders of type 30, or 3× type 24 or 4× type 20.



**Fig. 6** Length L is identical for identical brake cylinders.



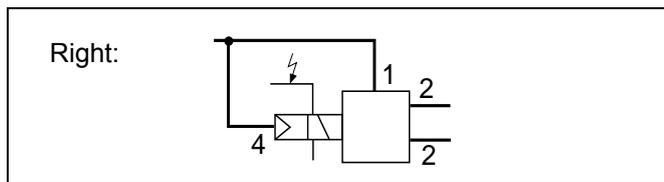
**Fig. 7** With cylinders of different sizes:  
Select longer L leading to the smaller cylinder.

#### Vehicles with small brake cylinders

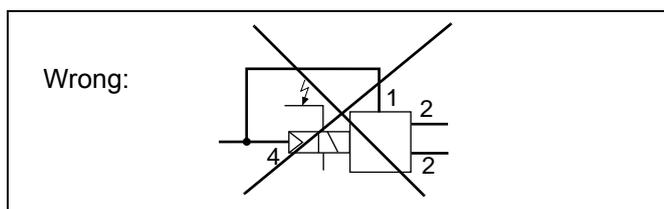
A throttle can be fitted ahead of control connection 4 if excessive locking up occurs in the case of small brake cylinders or a small fill volume (possibly short locking phases when braking because the electronic control unit is responding quickly but the mechanism is slow). For example, the nominal width of the brake pressure pipe/hose can be reduced to as little as NW 6 (e.g. 8 x 1 pipe).

In isolated cases it is possible to operate the ABS relay valve without a relay effect ("add-on" connection). In this case, the brake or control line from the relay emergency valve can be connected directly to connection 1 and connected to control connection 4 in the bypass with the shortest possible line (e. g. a T-piece directly in connection 1) if there are no other braking devices on the supply side. If there is an ALB, an adapter valve or the like fitted, this should be arranged in the bypass (between connection 1 and connection 4 of the ABS relay valve). This is only possible if the response time meets the requirements without a relay function (e. g. on the front axles of drawbar trailers with small brake cylinders where the

short lines mean there are steep pressure gradients).



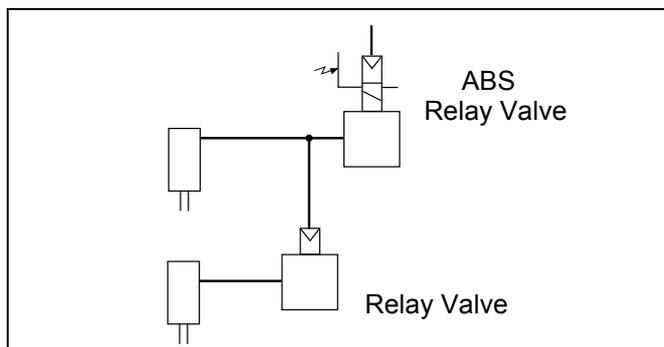
**Fig. 8** If the relay function is not required, the control connection (4) branches of the supply line (1) (referred to as an add-on **connection**), the supply pressure is applied a few milliseconds before the control pressure.



**Fig. 9** The straight-line routing means the control pressure acts on 4 sooner than the supply pressure. Result: Valve over-modulated.

**Vehicles with large brake cylinders**

If an especially large number of brake cylinders are connected to an ABS modulator (e. g. multiple-axle vehicles such as low loaders), it may be necessary to use additional conventional relay valves to achieve an acceptable response time and satisfactory ABS function. These relay valves are then actuated by the brake pressure modulated on port 2. In the event of ABS control, these valves are therefore pneumatically controlled as part of this process.



**Fig. 10** Integrating additional relay valves

**Note for retrofitting:** If there is a relay valve installed in the normal braking system (e. g. on the rear axles), this can be dispensed with if ABS relay valves are installed. This means the control and supply line can be routed directly to the ABS relay valves.

When designing an ABS system, the lock-up sequence of the axles should be determined first (laden / unladen). **Those wheels that tend to lock up first must be equipped with the sensors c and d.** Contact the axle manufacturer if it is not possible to undertake the necessary test drives on a private track!

**4.4.2 ABS Solenoid Control Valve**

The ABS solenoid valve can be used in smaller vehicles with small brake cylinders where if no relay valve is needed in order to achieve the correct response time. In this case, there is no need to install a control line. The unit is installed directly in the line ahead of the brake cylinder.

These valves can only be combined together with the Separate ECU 446 108 085 0. The ECU must be parameterised accordingly.

The following ABS solenoid control valves can be used:

<b>Order number</b> 472 195 ...	... 016 0	... 018 0	... 019 0
<b>Threaded connections</b>	M 22x1.5 Voss	M 22x1.5	M 22x1.5 Parker
<b>Operating voltage</b>	24 V		
<b>Solenoid connection</b>	Bayonet DIN 72585-A1-3.1-Sn/K1		

**4.4.3 Silencer 432 407 . . . 0**

Limit values defined for compressed air braking noise may necessitate the use of silencers in order to bring blow-off and venting noises in line with statutory requirements.

**Silencers for brake system components**

Only absorption silencers are used in this case due to the low pressure peaks. They are connected to the separate ABS valves either using an M 22 x 1.5 thread or a snap-on connection. The snap-on connection in particular makes it easy to retrofit silencers, provided that the basic equipment has got the necessary connection for this.

Part numbers of permissible silencers:

- 432 407 012 0
- 432 407 060 0
- 432 407 070 0

**4.5 ABS Speed Sensors**

As standard, two sensor types are associated with Vario Compact ABS and they only differ in terms of their cable length. Both have moulded sockets for connecting an ap-

appropriate plug and comply with the requirements of IP 68 when connected.

Cable lengths: 441 032 808 0 400 mm  
441 032 809 0 1000 mm

The sensors are installed in clamping bushes. Whenever a sensor is replaced, we recommend also replacing the clamping bush 899 760 510 4 or 899 759 815 4 as well.

**Note:** Grease the bush and the sensor when inserting.

This prevents the sensor from seizing. In order to adjust the speed sensor in the event of, for example, the air gap being too large, never use force or an unsuitable tool such as pointed or sharp objects. Doing so may otherwise lead to damage to the sensor cap.

### Repair unit

Complete set: Sensor ... 808 0  
clamping bush + grease: **441 032 921 2**

Complete set: Sensor ... 809 0  
clamping bush + grease: **441 032 922 2**

BPW axle:  
Complete set, sensor,  
clamping bush + grease: **441 032 963 2**

### 4.5.1 Electrical Values of the WABCO Sensors

All WABCO rotational speed sensors can be used. The following table also specifies the technical data of older types. The data relate to a speed of 1.8 km/h and an equal air gap (0.7 mm).

The letters are printed on the sensor cap.

Sensor type	Electrical resistance in $\Omega$	Part number
<b>Sensor S:</b>	1150 $\begin{smallmatrix} +100 \\ -50 \end{smallmatrix}$	441 032 578 0
<b>S<sub>Plus</sub> Sensor:</b>	1150 $\begin{smallmatrix} +100 \\ -50 \end{smallmatrix}$	441 032 808 0
<b>S<sub>Plus</sub> Mini</b>	1150 $\begin{smallmatrix} +100 \\ -50 \end{smallmatrix}$	441 035 001 0

The appropriate WABCO specifications 895 905 000 4, doc. code 435/535 must be complied with as far as the sensor/pole wheel adapter is concerned.

### 4.5.2 Towing-device bracket

The corresponding towing-device bracket is recommended for a secure connection between the sensor and

the connection cable.



## 4.6 Cabling Instructions

The cable connections are made using moulded plugs. All ports on the electronic control unit are on the outside. The diagnostic interface is also accessible from the outside.

### Note:

Opening the electronic control unit is not permitted.

The plugs for the electrical power supply, modulators and diagnosis are coded and thereby protected against cross-polarity. All plug connections are fitted with special locking clips. To connect a cable, it is necessary to fold up the locking clip, push in the plug and then close the locking clip again. If a locking clip is hard to move after a lengthy operating time, it is possible to use a screwdriver to lift the locking clip **carefully**.

### 4.6.1 Cable installation

The cables are attached to the trailer frame or cable holders using cable binders. Make sure that the unattached cable length in between two cable binders is no longer than 30 cm to avoid cable vibration. This applies in particular to the cable distributors on the Y-cables and triple cables.

Cables which have to be routed along permanently vibrating objects should be attached using double cable binders 894 326 012 4. Such rocking or vibration will eventually result in strain-hardening and thus premature damage to the cable. All cable binders should only be tightened to the extent that the cables are sufficiently held in place.

Any slack remaining in the cable once the connections have been made in the trailer can be gathered up in a Z-shaped loop, i.e. no coils.

If the vehicle is painted after the electronic control unit has been installed, avoid applying too much paint in the area of the plug connections so that disconnecting the plug connections is not impaired should fault finding or repair work become necessary at a later stage.

### 4.6.2 Extensions of power supply cables

A length of max. 18 m is permitted for the power supply cables. 5-wire as well as 7-wire supply cables may be used up to this length. If greater lengths are required, the extension is possible with a cable where the wires for pin 1 and 4 of the ISO 7638 plug connection have a cross-section of 6 mm<sup>2</sup>. The VCS II supply cable and this cable must be wired in a junction box as illustrated in appendix 3. Fuses may be dispensed with in this case. This combination of cables minimises the voltage drop. The max. possible lengths should be coordinated with WABCO for each case.

### 4.6.3 Overview of VCS II cables

Preassembled cables must be used for the VCS II.

A table listing all supply, modulator, and diagnostic cables is included in the VCS II brochure "Installation instructions" 815 010 009 3.

The sensor extension cables 449 712 ... 0 familiar from VCS I can still be used!

#### 4.6.3.1 Splice 446 105 750 2

The splice can be used under special circumstances when complete, prefabricated cables have to be extended or if it is necessary to repair an existing cable in the trailer which has been damaged during a repair. The cable connector is approved in accordance with GGVS / ADR. It is suitable for connecting the following cable types:

- Corrugated pipe - NW10 and / or
- Sheath cable 6 - 8.7 mm ø

"Standard" cable binders are often used when routing cables. This can lead to crushing and breakage, particularly with corrugated pipes. Use the cable binder with a double lock 894 326 012 4 to achieve cable routing which is technically correct and also looks professional.

### 4.6.3.2 Multiple VCS systems behind a towing vehicle

If multiple VCS systems are connected behind a towing vehicle, a special installation of the power supply is required. This may concern multiple VCS systems in one trailer vehicle or multiple trailer vehicles behind a single towing vehicle.

In principle, all VCS systems must then be switched in parallel in terms of power supply. The wiring is illustrated as a diagram in appendix 3. The supply line is distributed in wiring boxes.

A supply line with 6mm<sup>2</sup> wires on pin 1 and 4 (Vario C supply cable) must be used for the connection between the wiring boxes and the ISO 7638 plugged connection on the towing vehicle to minimise voltage drops due to increased current loads. Only 5-wire supply lines can be used.

#### Note:

The towing vehicle - trailer interface according to ISO 11992 (CAN) can not be implemented.

The lines on pin 1 (terminal 30) and 2 (terminal 15) must be fused separately with the fuses specified in appendix 3.

As a supplement, an alternative wiring with the info module 446 016 002 0 is shown in appendix 3. The info module ensures the the trailer ABS warning lamp in the towing vehicle is switched on when a system further down the line is no longer supplied with voltage (connector voltage drop detection).

## 4.7 Pneumatic Lines and Reservoirs

Long vehicles, large brake cylinders or a large number of brake cylinders can have a negative effect on response times. In this regard, ensure that T-connectors, elbows, and inadequately dimensioned supply lines (one supply line 18 × 2 or two parallel lines 15 × 1.5 are generally required) are avoided.

## 5 Diagnosis

The expression diagnosis comprises the following activities:

- Fault analysis (fault display and storage)
- Setting the system parameters
- Startup.

### 5.1 Diagnostic access

Access to the diagnostic functions is by way of the diagnostic interface according to ISO 14230 (diagnosis according to KWP 2000). It serves for connecting diagnostic devices such as the Diagnostic Interface for example.

### 5.2 PC Diagnosis

A PC diagnosis is available for the tasks specified above. This diagnosis supports the full scope of functions of the VCS II system. This includes the following menu items:

- **System startup:**  
End-of-Line test at the vehicle manufacturer's or after extensive repair work
- **Messages:**  
Display of current and stored messages, delete and save diagnostic memory
- **Actuation:**  
Perform test activations of the connected components
- **Measured values:**  
Display the values measured for the connected components
- **System:**  
ECU parameterisation, GenericIO parameterisation, saving of EEPROM content
- **Tools:**  
Setting and read-out of service intervals, trip counter, and notebook,

A number of functions that could have an effect on safety aspects of the braking system are protected by a PIN

(personal identification number). This includes system and GenericIO parameter settings. In order to obtain a PIN, it is a requirement to have participated in a WABCO VCS II system training course or an E-Learning course at <http://WBT.wabco.info>

The configuration of the diagnosis with the control unit requires the WABCO Diagnostic Interface Set, reference number 446 301 021 0 or 446 301 022 0 (USB version). The set comprises the interface and a connecting cable to the PC/Laptop.

### 5.3 Flash code

The flash code can be used for the simple diagnosis of current faults.

The flash code consists of a pattern of flashing pulses used for the display of faults. The flash code output device is the trailer ABS warning lamp installed in the towing vehicle, or, if present, the external ABS warning lamp mounted on the trailer. The two lamps are connected in parallel and they are activated synchronously.

The flashing code only indicates the current fault. Access to the diagnostic memory content is not supported.

The flash code is activated by switching the ignition on for a period of one to five seconds and then switching it off again. When the ignition is switched on the next time, the warning lamp will start to flash once a current fault is present.

After activation of the flash code, the current fault will be displayed. The number of flashing pulses indicates the nonconforming component. All relevant fault numbers are stated in the list of flash codes appendix 2. Moreover, these numbers are stamped on the ECU housing. A number that is identical with the fault number is provided behind each designation of a slot, (example: Fault on sensor E1/4: 4 flash pulses). After the ignition is switched on, the flash code will be repeated three times.

## 6 Installation and System Startup

The devices are fastened to the vehicle frame. The ECU-Valve units of the Standard and the Premium variant are fastened using two M8 screws with washers. The Separate ECU is fastened to the bottom of the housing by means of three screws M6.

The lengths and cross-sections of the pneumatic lines should be selected within the following limits:

### Notes:

The cross-sections and lengths of the lines between reservoir and ABS modulator have to be suitable to meet at least the response time requirements defined in annex II of 71/320/EEC and annex 6 of the ECE guideline No. 13.

For optimum ABS function, WABCO recommends a venting gradient of 20 bar/s from 5 to 2 bar.

Please note that no elbow couplings should be used for the connection of supply lines to the reservoir and modulator because these couplings adversely affect the response time to a considerable extent.

Please refer to chapter 4.6 for cabling installation instructions.

**The system startup procedure must be performed after initial installation and after extensive repair work!** In this procedure, the correct allocation of sensors and modulators with regard to the control channels is checked as well as the warning lamp function. The system startup procedure is performed using the VCS II PC diagnosis. The startup protocol created during this procedure is the documentation of the test results. **If a complete test of the control circuit consisting of rotational speed sensor and modulator must be performed, it is essential that all wheels are braked at the beginning of the test.**

Pneumatic lines and screw fittings	Minimum diameter (Recommendations)		Maximum length
	ECU/Valve unit	ABS relay valve	
Reservoir tank ABS modulator	18 x 2 or 2x15 x1.5	12 x 1.5	3 m
ABS modulator - Brake cylinder directly controlled wheels	9 mm		3 m
indirectly controlled wheels	9 mm		5 m

## 7 Compatibility and Service

The Vario Compact ABS 2nd generation is compatible with VCS I. **VCS II is also an ABS system of category A, meeting all requirements defined in ECE R 13 and 98/12/EC.**

Compatibility is based on the certificate 71/320-0920 of the Dutch RDW.

### 7.1 Replacing VCS I by VCS II

In the event of a replacement, the cabling adapter 894 607 411 0 is available for adapting a VCS II electronic control unit to an "old" VCS I vehicle installation. **The wheel speed sensors and the sensor extension cables can be continued to be used.** Whether the modulators still can be used, depends on the used VCS II variant. Two replacing cases are shown in the following.

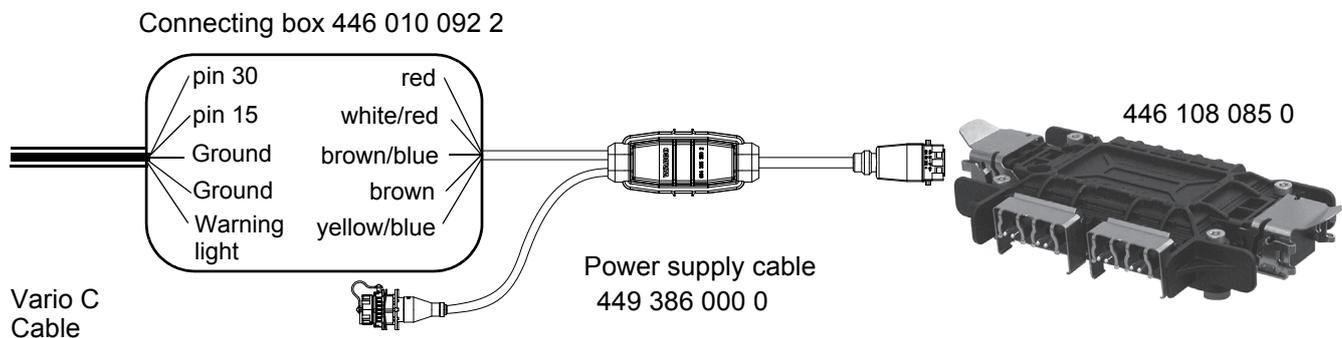
Appendix 5 shows a number of different replacement scenarios. The corresponding VCS device numbers are also matched here.

If the ISS or terminal 15 function was used, these are now taken over by a corresponding GenericIO function. For this purpose it is necessary to select a suitable modulator cable and to perform the GenericIO parameterisation.

### 7.2 Replacing Vario C by VCS II

In the event that a Vario C electronic control unit needs to be replaced, it is possible to connect the new VCS II-ECU to the existing Vario C power supply cable via a wiring box. The best choice here is the VCS II power supply cable 449 386 ... 0. The moulded plug is removed in this case however so that the separate wires can be wired in the wiring box.

The existing Vario C solenoid cables are replaced by the VCS II solenoid cables 449 534 ... 0 (for 2S/2M or 4S/2M systems) or 449 544 000 0 (in the case of 4S/3M configurations) and supplemented by the adapter cable 894 601 133 2. The sensor extension cables must be replaced as well.

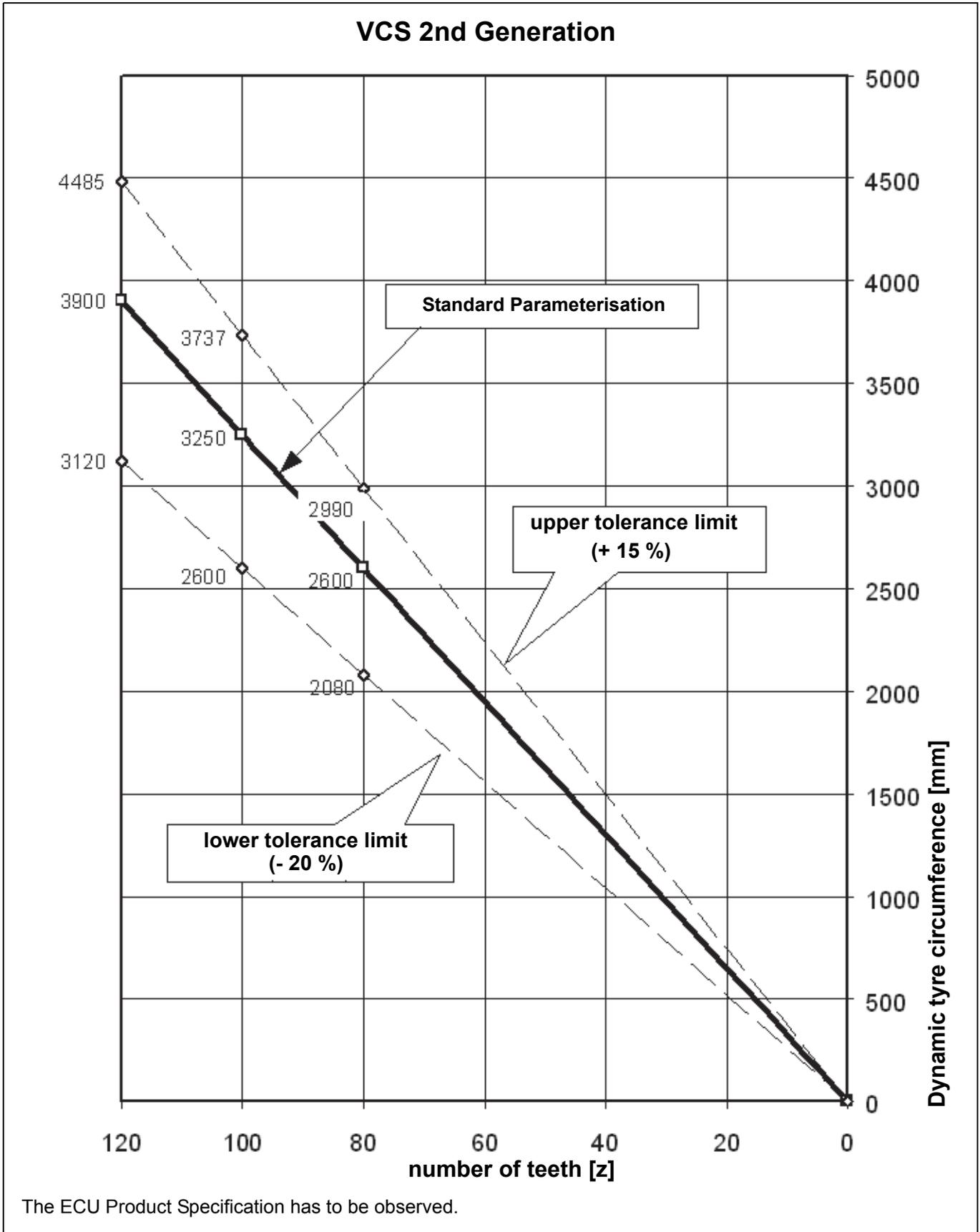


### Further documents

This system description is supplemented by the following documents amongst others:

Name	WABCO number
System specification	400 010 203 0
Program specification	respective device number
ABS certificate in accordance with 98/12/EEC or ECE R 13 (EB 140)	858 800 061 4
Certificate ECE R 13, Annex 19 "Safety Assessment" (EB 141)	858 800 060 4
ADR / GGVS - certificate (TÜV TB2003-085.00)	858 800 075 4
Certificate "Compatibility VCS I - VCS II" (RDW)	858 800 077 4
VCS II - cabling diagrams	841 801 930 0 to ... 933 0
VCS II part 2 Installation instructions (with overview of cables)	815 010 009 3
VCS II - Braking system diagram	841 700 970 0 to ... 993 0 841 601 100 0 to ... 140 0

Annex 1: Assignment of rolling circumference - number of pole wheel teeth

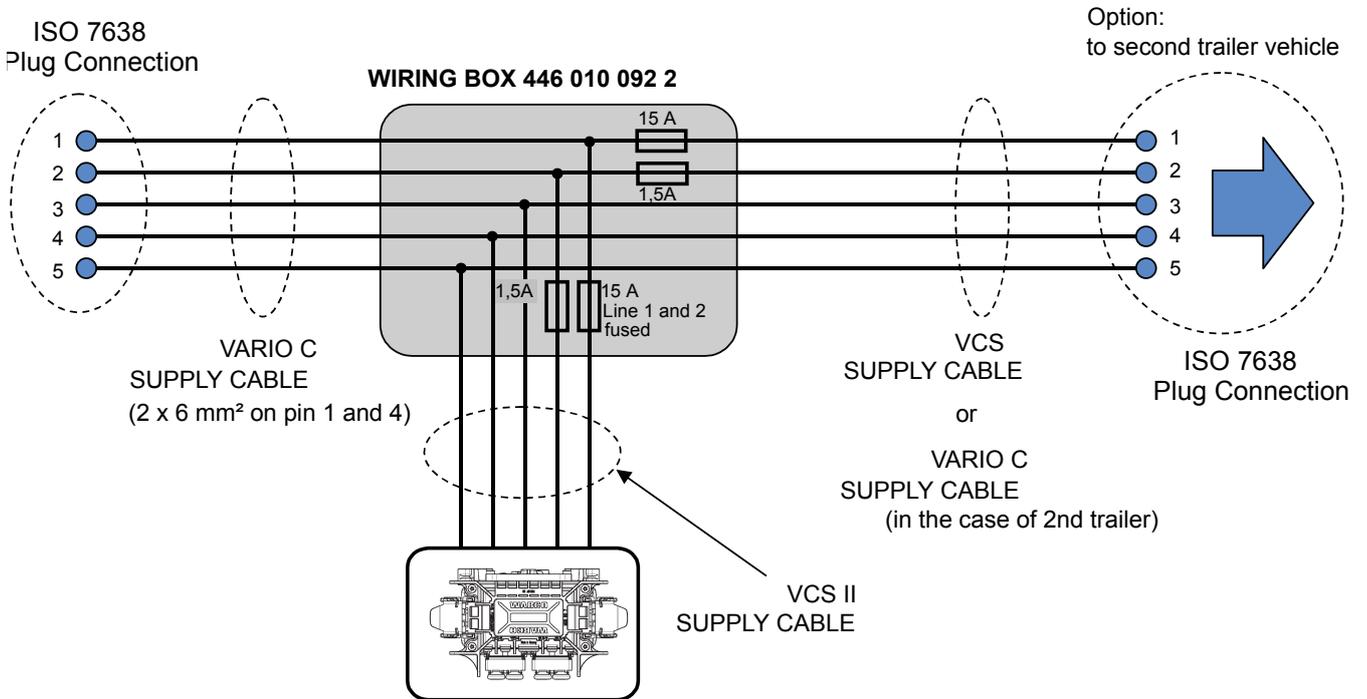


**Annex 2: List of Flash Codes**

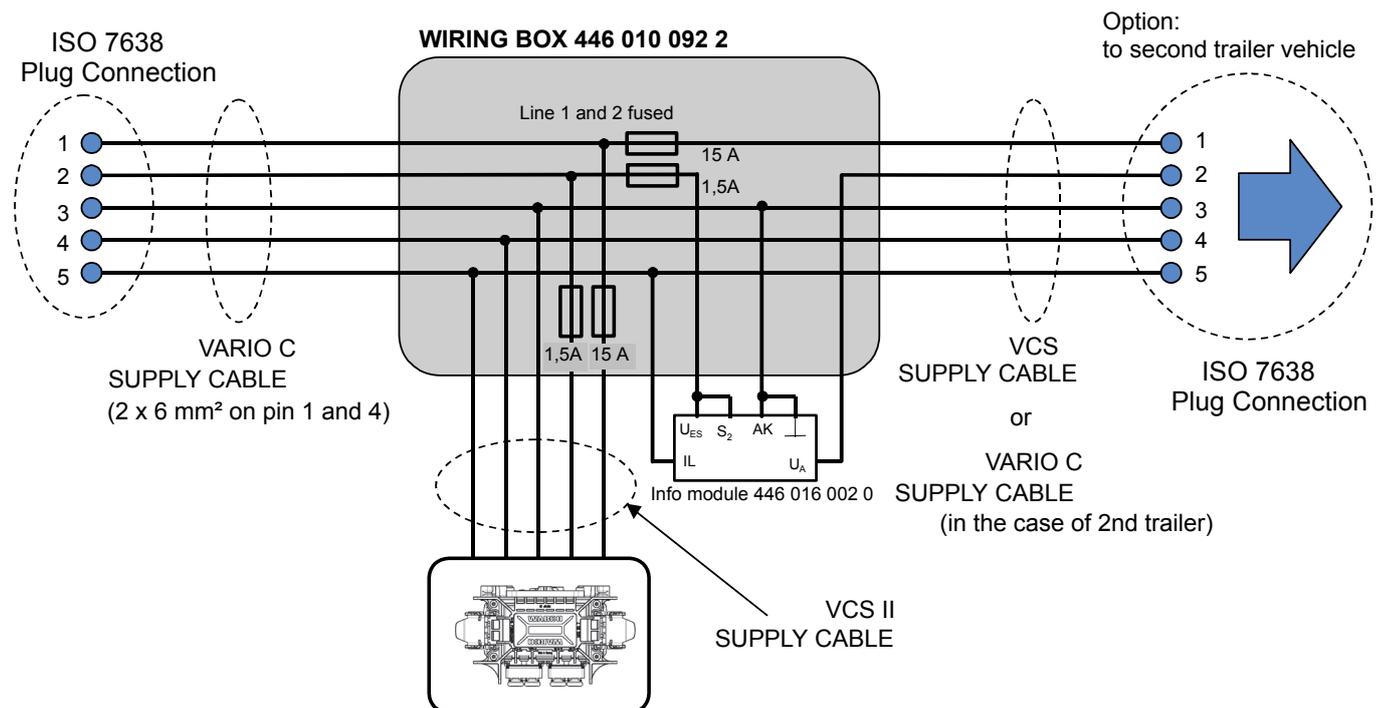
<b>Fault number</b>	<b>Component</b>
3	Sensor BU1 (H2) c
4	Sensor YE1 (H1) d
5	Sensor BU2 (Z2) e
6	Sensor YE 1 (Z1) f
7	External modulator RD (L)
9	Internal modulator inlet valve 2
10	Internal modulator inlet valve 1
11	Internal modulator outlet valve
14	Power supply
15	ECU internal fault
18	GenericIO fault

Annex 3:

Power supply cabling of multiple VCS II systems

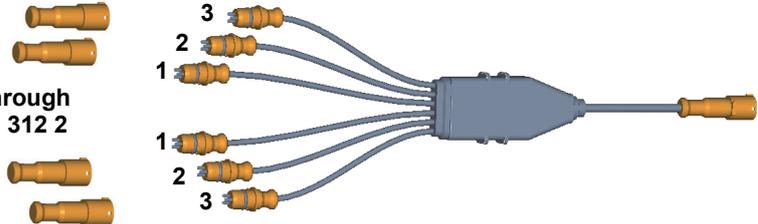
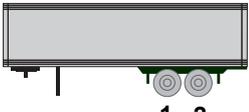
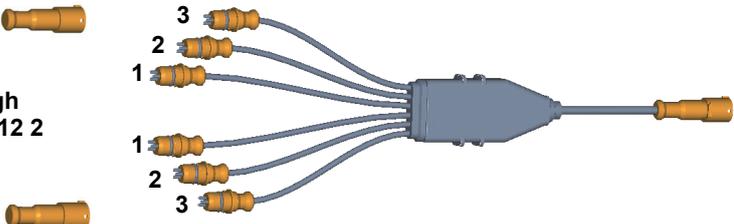
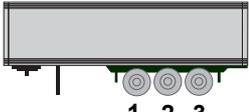
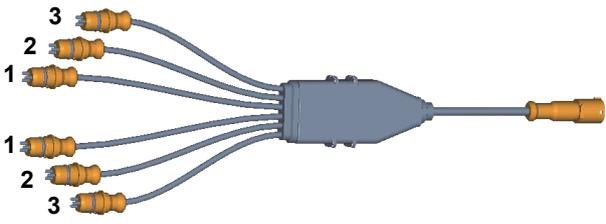
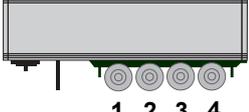
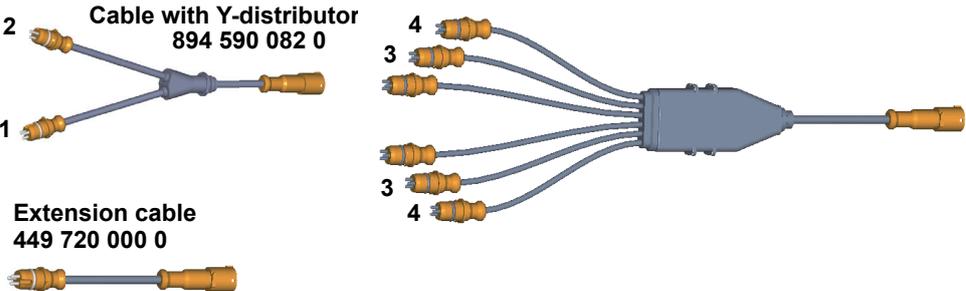


Cabling of the power supply for multiple VCS systems (with info module)

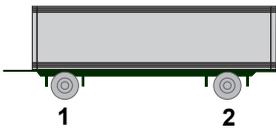
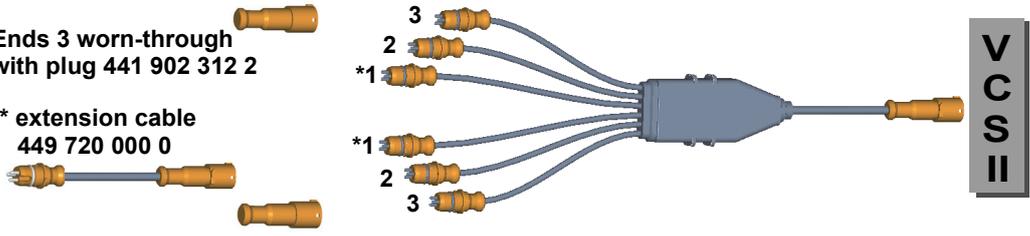
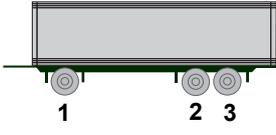
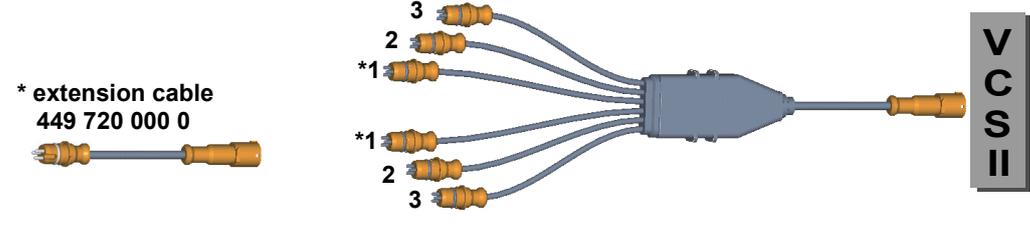
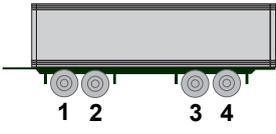
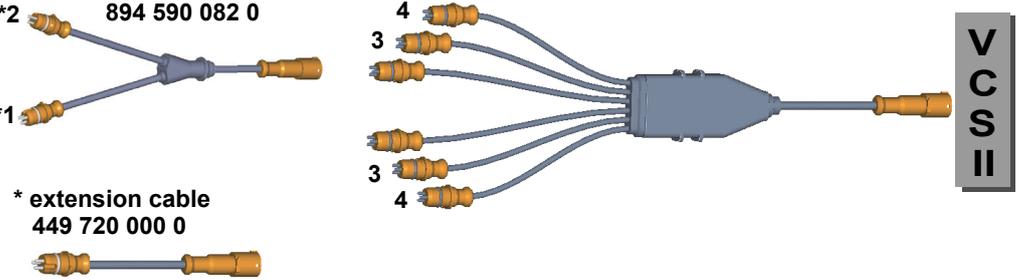
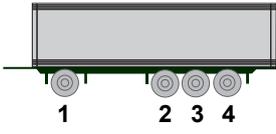
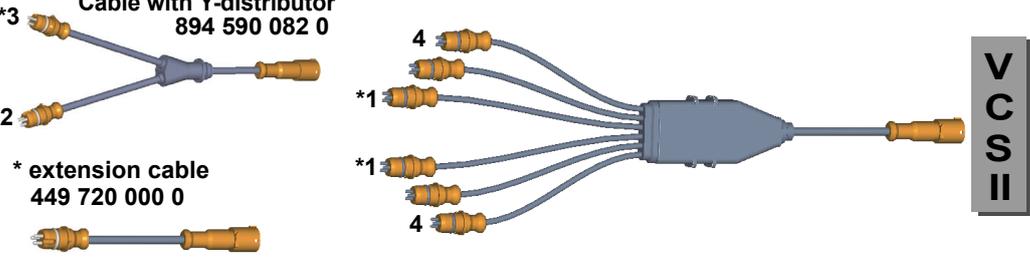
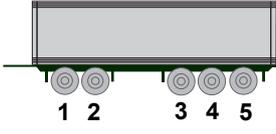
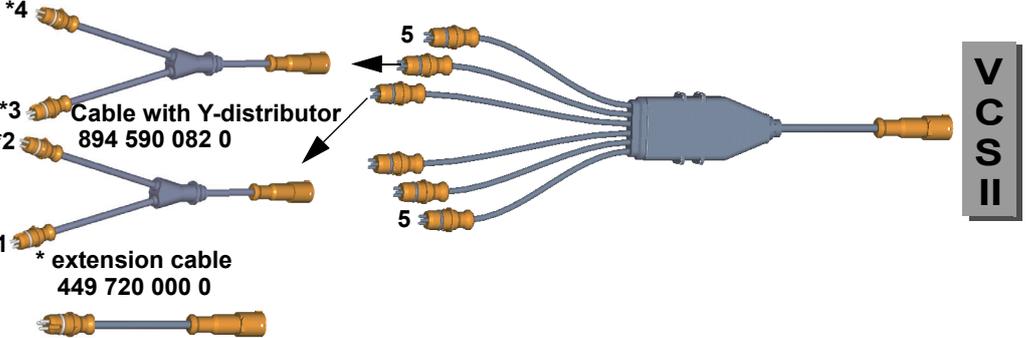


Annex 4: Wear sensing configurations

ABS wear indication, semitrailer- + central axle trailer

	<p><b>Cable with resistors 449 834 013 0</b></p> <p>Ends 2+3 worn-through with plug 441 902 312 2</p>  <p>VCS II</p>
	<p><b>Cable with resistors 449 834 013 0</b></p> <p>Ends 3 worn-through with plug 441 902 312 2</p>  <p>VCS II</p>
	<p><b>Cable with resistors 449 834 013 0</b></p>  <p>VCS II</p>
	<p><b>Cable with Y-distributor 894 590 082 0</b></p> <p><b>Extension cable 449 720 000 0</b></p> <p><b>Cable with resistors 449 834 013 0</b></p>  <p>VCS II</p>

ABS wear indication drawbar trailer

	<p>Ends 3 worn-through with plug 441 902 312 2</p> <p>* extension cable 449 720 000 0</p> <p>Cable with resistors 449 834 013 0</p>  <p>VCS II</p>
	<p>* extension cable 449 720 000 0</p> <p>Cable with resistors 449 834 013 0</p>  <p>VCS II</p>
	<p>*2 894 590 082 0</p> <p>*1</p> <p>* extension cable 449 720 000 0</p> <p>Cable with resistors 449 834 013 0</p>  <p>VCS II</p>
	<p>*3 Cable with Y-distributor 894 590 082 0</p> <p>*2</p> <p>* extension cable 449 720 000 0</p> <p>Cable with resistors 449 834 013 0</p>  <p>VCS II</p>
	<p>*4</p> <p>*3 Cable with Y-distributor 894 590 082 0</p> <p>*2</p> <p>*1 * extension cable 449 720 000 0</p> <p>Cable with resistors 449 834 013 0</p>  <p>VCS II</p>

## Annex 5: Replacing VCS I by VCS II

### Repairs to ABS Trailer Systems

Due to the fast-paced development of the semi-conductor industry, tested electronic control units – such as Vario C and VCS I – are no longer being manufactured. WABCO was therefore forced to discontinue both of these ABS systems for trailers at the end of 2006.

These units are to be replaced by the installation of a type VCS II control unit. To ensure that the units are exchanged easily, we have put together repair kits including appropriate cables and a comprehensive instruction sheet.

All kits can map 2S/2M, 4S/2M and 4S/3M systems and are therefore suitable for semi-trailers and drawbar trailers. When converting the VCS II you can use the extensive functional range of the new system at the same time. For further information on GIO functions (such as speed-dependent gear shifts) see the VCS III system description on our INFORM product database at [www.wabco-auto.com](http://www.wabco-auto.com)

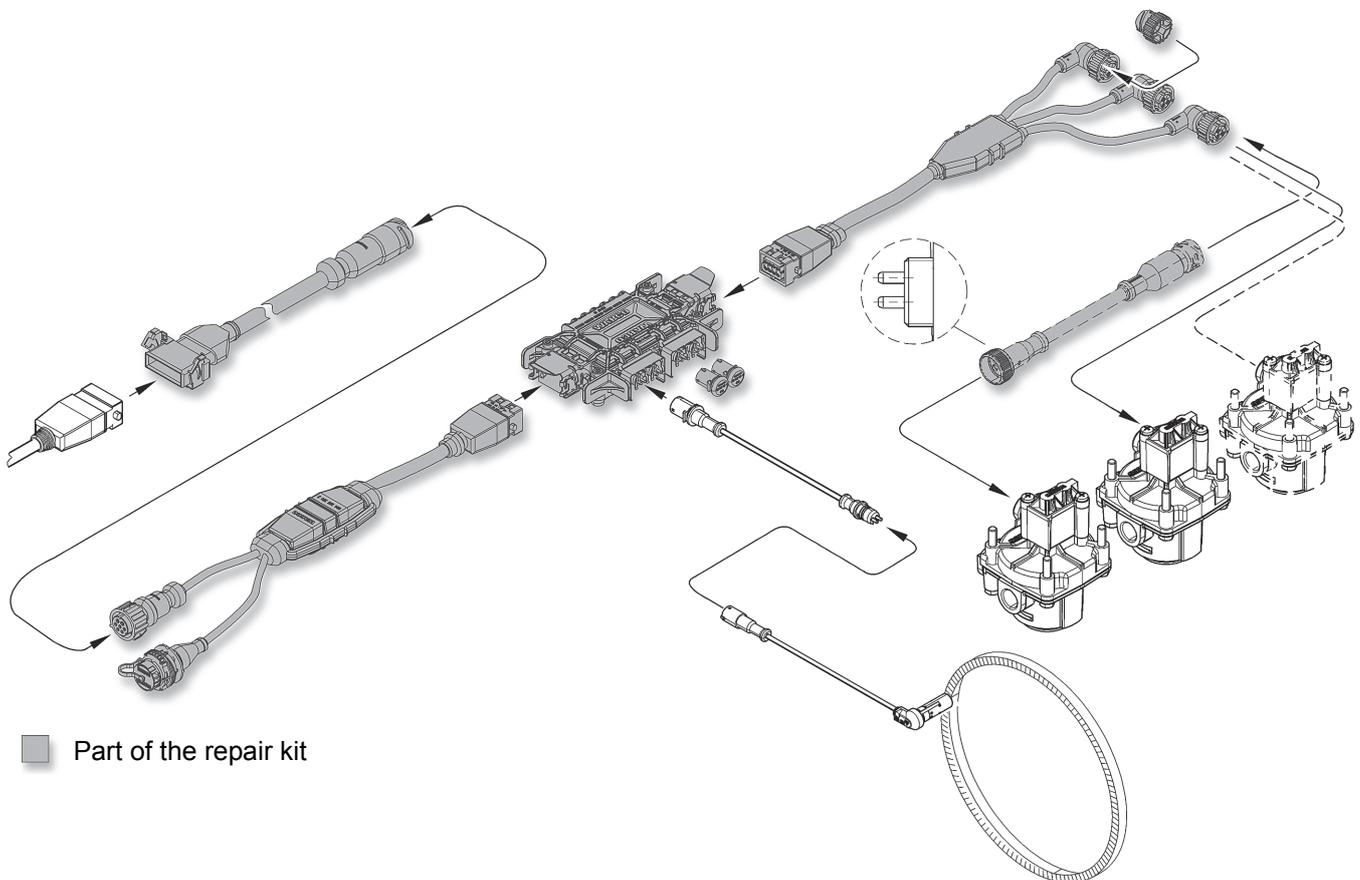
### Exchange VCS I Electronic Unit for VCS II ECU

Repair kit 446 108 920 2 includes a separate ECU type VCS II. Just replace the electronic unit and continue to use the modulators, sensors and most of the cables.

When replacing a VCS I compact unit, use of the dual relay valve block can generally be continued.

#### 446 108 920 2 replaces:

	446 108 030 0
	031
	032
	040
	041
	400 500 030 0
	032
	036
	040
	042
064	
066	

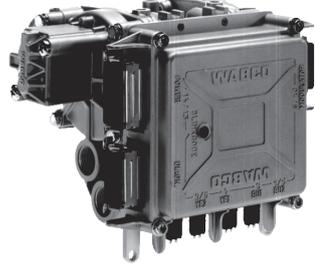


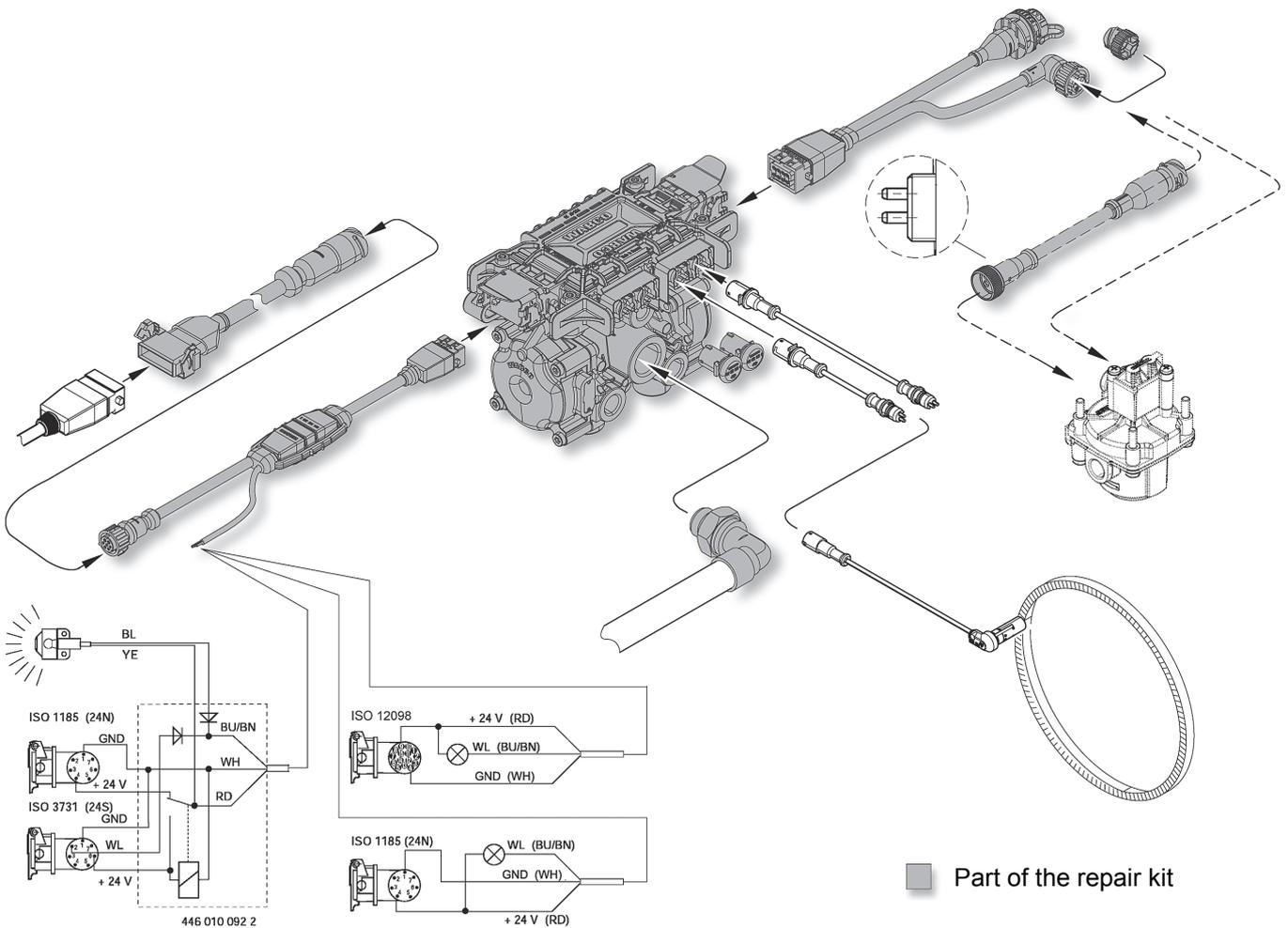
### Exchange of the Complete VCS I Compact Unit

Repair kit 446 108 921 2 contains a VCS II compact unit as well as the required cables and adapters. This way the modulators are also renewed.

This repair kit is also suitable for vehicles with mixed supply. Because this additional connector is fitted to the stop light supply at the 24 N plug, this system can also be used without an ABS plug connection in accordance with ISO 7638.

#### 446 108 921 2 replaces:

	446 108 035 0
	045
	400 500 034 0
	035
	037
	038
	045
046	



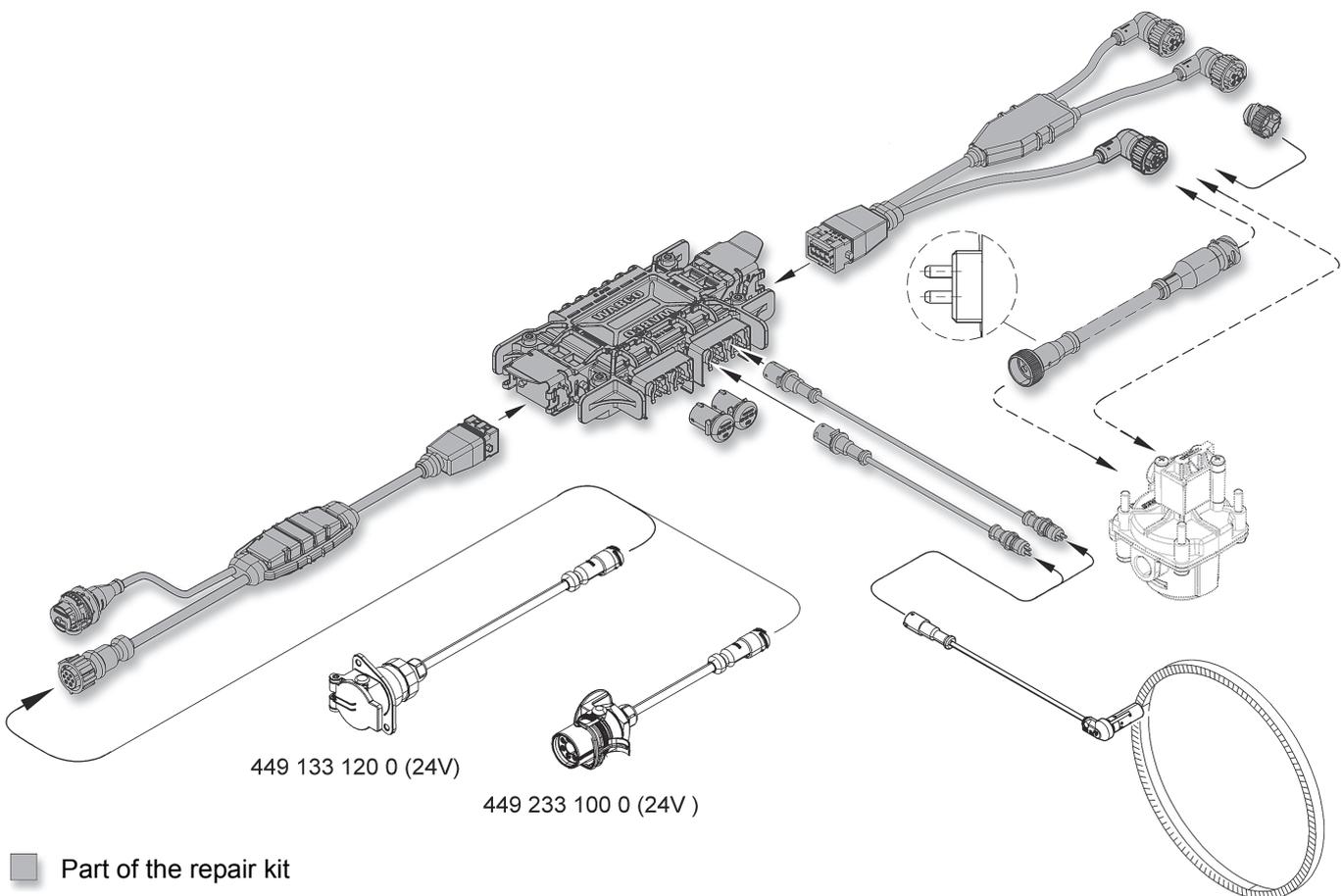
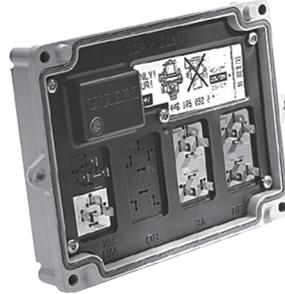
## Replacement of the Vario C system

In conjunction with the repair kit 446 105 927 2 for converting the Vario C system to an up-to-date system, it is also necessary to replace the ECU, supply cable, modulator cable, and the sensor extension cables. Existing ABS relay valves need not be replaced provided they are functioning.

Connection of the third modulator in the case of 4S/3M systems is provided for. Depending on the vehicle type (semitrailer or drawbar trailer), a matching supply cable must be obtained separately (also see WABCO overview of cables, 815 010 047 3).

### 446 105 927 2 replaces:

446 105 001 0
009
023
031
032
051
052



### Note:

Please note that many countries require a new acceptance inspection after the ABS system has been replaced by a system of the new generation. Further information on the repair kits is available under the specified product numbers on INFORM.









**WABCO**  
a **WORLD** of  
**DIFFERENCE**

**WABCO** (NYSE: WBC) is a leading global supplier of technologies and control systems for the safety and efficiency of commercial vehicles. Founded around 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. With sales of \$2.9 billion in 2014, WABCO's head office is in Brussels, Belgium.  
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