ECAS FOR BUSES

SYSTEM DESCRIPTION

ECAS for buses

System description

Edition 2

WABCO

The right of amendment is reserved
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1 Important instructions and explanations

1.1 Safety instructions and hazard notes

ECAS is a system for fails performance in vehicles. Changes to the system's settings may only be performed by suitably qualified persons in command of the required specialist knowledge.

! ECAS was designed only for control of the air suspension system in vehicles.

When the ignition is turned on, or while diagnosis starts, unexpected movements of the vehicle may occur.

If you work on the air suspension system, advise other persons by attaching an information sign to the steering wheel of the vehicle.

Following points have to be observed when welding work is performed on the vehicle:

- The electronic systems must be disconnected from the power supply (interrupt terminals 31, 15, and 30).
- System components (ECU, sensors, actuators, lines etc.) must never come into contact with welding and ground electrodes.

Never drive while the vehicle is lowered onto the buffer, because the vehicle may be badly damaged.

1.2 Requirements for the operation of ECAS

- Compressed air supply must be sufficient.
- Power supply has to be ensured.

⚠ Only draw on information from the approved circuit diagrams identified by a ten-digit WABCO number for work on the ECAS system.

Circuit diagrams without a WABCO-number may be incorrect. They must be considered as diagrams that have not been approved by WABCO.

WABCO does not assume any warranty for systems whose structure differs from the one described here.

You require WABCO's approval for the following actions:

- Use of components other than those shown in the circuit diagrams (cables, valves, sensors),
- Integration of any appliances by other manufacturers in the system, or
- Settings for functions that are not system functions.

! The structure of the ECAS system is shown defined by several circuit diagrams chapter 11.

1.3 Explanation of symbols

⚠ Potential risks:
Personal injury or material loss

! Additional instructions, information, tips

- List

– Step

2 Introduction

The name ECAS stands for Electronically Controlled Air Suspension.

ECAS is an electronically controlled air suspension system with a large number of functions.

Air suspension systems have been used in motor vehicles since the mid 50s – especially in buses. Air suspension systems are used in them as a standard and are increasingly being used in trucks and trailers. The advantages of air suspension over mechanical suspension (steel springs) are listed below:

- Increase in ride comfort due to lower spring rate and low natural frequency
- constant vehicle height irrespective of the load
- precise load-dependent activation of the brakes through use of the air bellows pressure as control pressure for the proportioning valve
- Kneeling function (lowering of one side of the vehicle to facilitate entry and exit)

The control system was initially designed with pure mechanically operating leveling valves, soon afterwards electromechanical control systems were developed . This served to enhance ease of operation and to facilitate raising/lowering processes.

ECAS is the most advanced development in this direction. Using electronic control units enabled decisive improvements in the conventional system; it enabled many functions for the first time ever:

- Reduction of the air consumption – none while the vehicle is moving. Air savings of approximately 25 % were determined using ECAS compared to a conventional air suspension system in low-floor buses for scheduled route services.
- High speed of all control processes due to large valve cross-sections (nominal size 7 per air bellows).
- Easy installation. Only one air line is required from the solenoid valve block to each bellows and one to the storage tank.
- Raising/ lowering function and kneeling conform to the legal requirements
- High system flexibility for different kneeling types
- Extensive safety concept, error storage and diagnostics capabilities.

In mechanically controlled air suspension systems, the device that measures the level also controls the air spring. With ECAS, an electronic system takes over control, regulating the air springs by means of solenoid valves informed by measured values from sensors.

Apart form controlling the normal level, the electronic unit also covers control of the other functions: working together with control switches and sensors for the tyre deflection compensation, the ECU achieve this without the need for numerous additional valves required by conventional air suspension control.

ECAS at different configuration levels can be fitted in various bus types .

The ECAS system in a bus consists of the following components:

- an ECAS electronic unit (ECU)
- a solenoid valve (solo vehicle)
- 3 distance sensors
- optionally 1 pressure sensor
- Operating switches
- Sidewalk detector

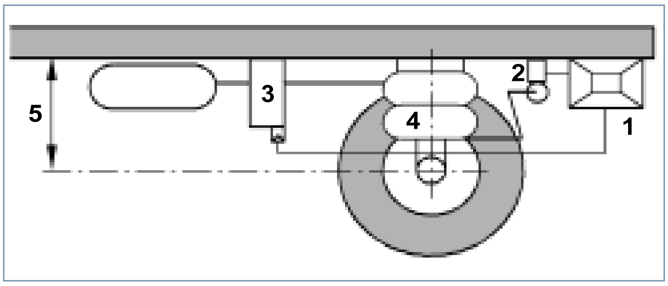


Abb. Example ECAS base system

1 ECU (electronics)
2 Distance sensor
3 Solenoid valve
4 Air-suspension bellows
5 Distance body/axle

ECAS with CAN bus

The most recent generation of the ECAS systems has CAN bus capability. Here the electronic systems are networked by means of a CAN bus and information is transmitted via SAE-CAN identifiers.

The CAN Bus (Controller Area Network) is a serial databus system, which was developed for networking controllers in automobiles with the aim to reduce cable harnesses. Instead of using an electrical circuit for each transmitted signal, the "bus" is based on a communication platform which regulates the relaying of messages between several devices.

The "BUS network" in the MB CITARO city bus is used for illustration. In principle, however, this description also applies to other well-known vehicle manufacturers.

The "CAN-BUS Vehicle" in accordance with ISO 11898 forms the basis for the CITARO BUS system. Four "Flexibly Programmable Controls", representing the link to the four Sub-BUS systems, are connected to this vehicle CAN-BUS.

Because the sensors, actuators and switches are distributed throughout the vehicle, a large amount of cabling was previously required to connect the relevant devices to the corresponding control electronics. The increasing use of complex control systems and their interactive access to sensor and switching statuses necessitated the design of a system that makes the operating states, etc. mutually transparent for the electronic systems.

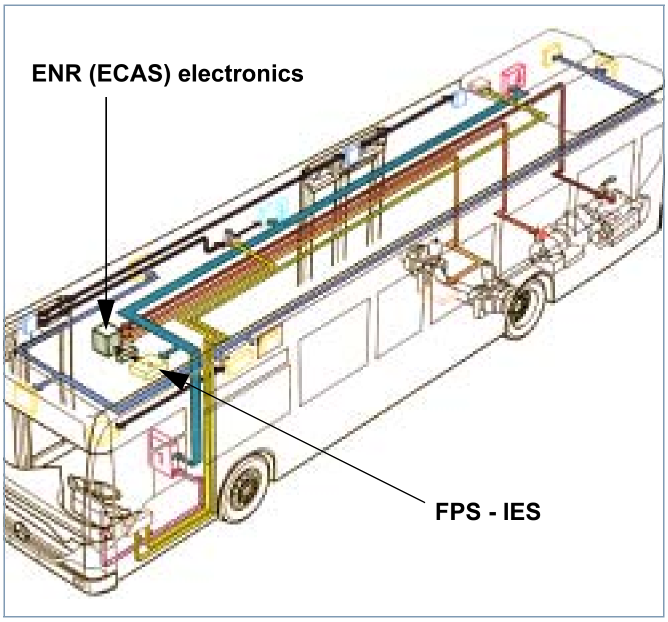
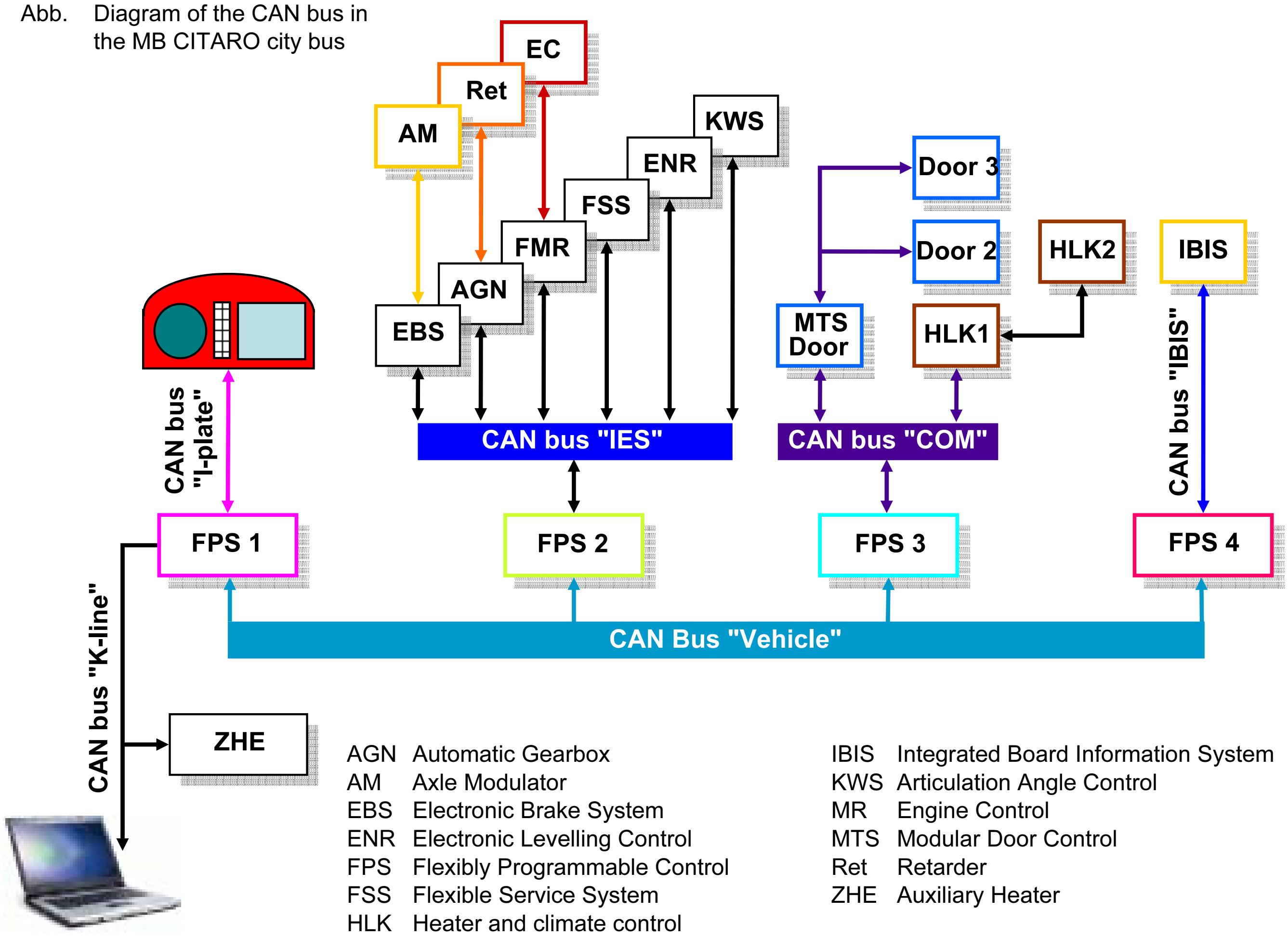


Abb. Illustration of the CAN bus in the MB CITARO city bus

Abb. Diagram of the CAN bus in the MB CITARO city bus



AGN Automatic Gearbox
AM Axle Modulator
EBS Electronic Brake System
ENR Electronic Levelling Control
FPS Flexibly Programmable Control
FSS Flexible Service System
HLK Heater and climate control

IBIS Integrated Board Information System
KWS Articulation Angle Control
MR Engine Control
MTS Modular Door Control
Ret Retarder
ZHE Auxiliary Heater

The Flexibly Programmable Controls serve as an interface to provide each individual system a precise process I/O image, i.e. information on the inputs and outputs in the overall system, via a CAN data bus.

One of these SUB-CAN BUS systems is the CAN-BUS "IES". The ENR (ECAS) and various other systems, such as the electronic brake system EBS, are currently connected to it.

The systems are connected to their sub-systems via a system bus. The ECAS system is integrated in a vehicle system based on the CAN-BUS to ISO 11898.

The electronics provide the connection with the vehicle electrics via a CAN data bus and via separate inputs and outputs.

When this highly standardised technology was introduced, the vehicle manufacturers specified that the system suppliers are responsible for the systems.

2.1 System configuration

ECAS has a modular structure to ensure that different vehicle types can be equipped with the system. The choice of system components to be used is determined by what is required of the system.

With the most basic configuration level, only one axle is equipped with the ECAS air suspension and only one height sensor monitors the body height. With this configuration, the support bellows of a tandem axle can be interconnected.

However, if the body is to be kept parallel to the axle even when the load is distributed unevenly in the vehicle, it is necessary to arrange distance sensors on both sides and to control the support bellows of the axle or tandem axle by separate solenoid valves.

A vehicle with full air suspension is usually equipped with three distance sensors. The front axle, for example, has one distance sensor and the rear axle has two in this configuration.

Vehicles are also equipped with four distance sensors however. This applies mainly to vehicles with independent wheel suspension. With two front distance sensors it is possible to implement cornering detection and ESAC. The mean value from the two distance sensor signals is used for ECAS control.

The two bellows of the axles with only one distance sensor are interconnected by a restrictor to enable pressure equalisation. During brief changes in the direction of travel however, this restrictor prevents rapid pressure equalisation. This prevents exhaust of the bellows on the outermost side of the curve, thereby reducing tilt of the vehicle against the curve direction. If cornering is detected, automatic level correction is interrupted or is not started. This prevents correction of any rolling movements of the vehicle body occurring at this moment. The transverse restrictor is deactivated analogous to deactivation during kneeling. Calculation of this lateral acceleration is based on the front wheel speed information that is is transmitted from the EBS to the ECAS-ECU via the CAN-BUS.

In an articulated bus the axle of the trailer section is equipped with two additional distance sensors and its own control electronics.

A further breakdown of possible system configurations, illustrated by a circuit diagram and part numbers, is provided in the appendix.

Pressure test connections

The support bellows should be fitted with pressure test connections so that the control pressure of the LSV can be measured when testing the braking system.

These test connections also provide a makeshift solution for filling the support bellows in the event of a fault in the air suspension system. With the assistance of a tyre inflation hose, the vehicle can usually be driven to the workshop under it's own power.

3 System functions

Although ECAS offers a wide range of functions, not all of them need to be implemented in any given system. The respective vehicle manufacturer is responsible for the system configuration and for setting all the parameters, both of which must never be changed without prior consent from the manufacturer.

3.1 Functions of the ECAS-ECU

3.1.1 Controlling the nominal level

Nominal level control is the basic function of ECAS. The continuous comparison of the actual values supplied by the distance sensors with the nominal values stored in the ECU keeps ECAS permanently informed of the vehicle's current ride height. If deviations exceed a certain tolerance range, solenoid valves are triggered and the actual level is adjusted to the nominal level by means of air intake or air exhaust of the air suspension bellows.

Unlike with conventional air suspension, the ride height is not only adjusted to the vehicle's normal level but any other preselected level. This means any level level that was set is maintained regardless of the number of passengers who who get on or off the bus.

In the event of greater level changes, the solenoid valves are pulsed (CAN II), shortly before the nominal level is reached, relative to the lifting speed and the distance to nominal level in order to prevent overshooting.

All control processes can be executed in parallel on the different axles (front and rear axle simultaneously) within the tolerance limits.

3.1.2 Normal level 1/2/3

Normal level 1 is the level that was defined by the vehicle manufacturer for normal driving. The normal level 1 determines the ride comfort, road safety and body height, which must comply with the legally prescribed limits.

Normal level 2 is level that deviates from normal level 1 as an adjustment to special driving conditions. Speed-dependent adjustment to this level is also possible. The height of normal level 2 is permanently defined by a set value (parameter) in the electronic unit. A switch is used to choose between normal level 1 and normal level 2.

For safety reasons, it is possible to automatically adjust the level to normal level 1 as soon as the vehicle exceeds a certain speed threshold (20 km/h for example); the level is then readjusted to the previous level once the speed drops below a lower speed threshold (10 km/h for example).

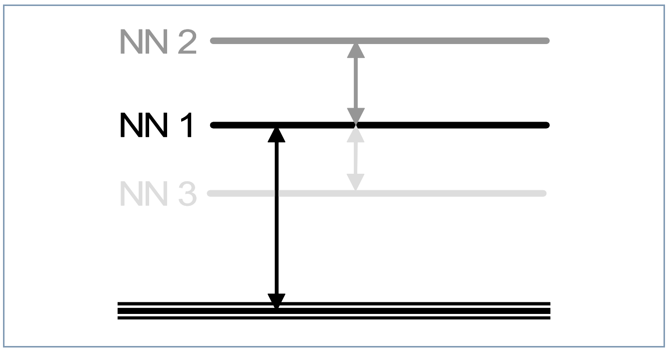


Abb. Illustration of the ride height

Special aspects with regard to CAN II electronic systems

- CAN II electronic systems also permit setting parameters for normal level 3 as a speed-dependent level
- Customer Level: Independent parameters can be set for levels on rear axle left and rear axle right.
- All levels are obtained via CAN identifier ASC2_… .

Manual level adjustment using switches/ pushbuttons

In certain cases it may be necessary to set a certain level which differs from normal levels 1/2. Pushbuttons can be used for lifting and lowering. When these are actuated, the bus is raised or lowered at the selected axle(s) by means of a preselector switch.

Height limitation

The electronic unit automatically discontinues height limitation when programmed (calibrated) values for the upper or lower limit positions are reached.

3.1.3 Kneeling

Kneeling is a special function for buses. The regulations for kneeling systems are described in section 35d of the StVZO (road traffic regulations). Kneeling describes a process whereby the bus is lowered to make it easier for passengers to get on and off. Depending on the parameter settings of the electronic control unit, this can take place towards on one side on both axles at the axle with one distance sensor (usually the front axle). ECAS provides the option to take the door position into account and to safeguard the lowering process by means of a contact strip that is monitored by ECAS. If the contact strip reacts during a kneeling process, the bus reverts to normal level.

Diverse kneeling function actuation types are possible depending on the electric wiring and the parameter settings of the electronic unit.

Supply pressure monitoring

One precondition for kneeling is the availability of sufficient supply pressure to quickly raise a lowered and fully laden vehicle back to normal level. If the supply pressure has dropped below a value monitored by a pressure switch, ECAS will not permit kneeling in order not to prolong the time spent at bus stops.

3.1.4 Traction help with 3-axle vehicles (6 × 2)

When the traction help function is activated in three-axle vehicles, the axle load of the drive axle is increased by relieving the trailing axle. This makes it possible to transfer greater drive torque on slippery road surfaces.

The permissible pressure and the permissible ride height are monitored during traction help action and corrected, if necessary. All manual and automatic level changes are still possible during this process.

Traction help is categorised into 5 types. The respective type of traction help is parameterised (with or without time limit, speed and load limit, with or without forced pause) in accordance with the applicable legal provisions.

In 6x2 vehicles with a lifting or trailing axle, and depending on the functions of the ECAS system, it is possible to pursue different control strategies for the supporting bellows pressures in the rear axle unit between the driven and the lifting/trailing axle.

Pressure ratio control

It is possible to define 2 pressure ratio settings between drive axle and trailing axle. The selected pressure ratio is abandoned in the event of overloading. In this case, the pressure is adjusted to a level matching the ratio of the permissible pressures.

Optimal traction

In this event, the load is predominantly placed on the drive axle bellows. Is is ensured that there is always sufficient residual pressure in the unloaded support bellows to prevent the bellows from becoming crushed.

Pressure equality control

Behaviour as with 4×2 vehicles. The bellows of the drive and the trailing axle have the same pressure.

3.2 Control algorithm

Level control is a function that controls the distance between vehicle body and axle. The level (ride height) control is the basic function of ECAS.

It may be necessary to readjust that distance because of disturbance factors, or because the nominal value changes.

Long control times are the result of slow readjustments of the actual value to the new nominal value. High control accuracy is here achieved at the expense of speed.

When speeding up the readjustment process, the time required for reaching new nominal value is reduced, the system's tendency to overshoot increases.

The large nominal width of the ECAS solenoid valves, which is beneficial for adjusting major differences in nominal values, is detrimental if the differences in nominal values are minor. The latter increases the tendency to overshoot.

As far as the correct design of the pneumatic system is concerned, the attempt must be made to achieve a pressure drop at the ECAS solenoid valve in every operating condition. This means the pressure on the supply pressure input side must be greater than the pressure at the bellows pressure output side.

During rapid level changes the effect of the vibration damper plays a particularly important role. The result is a force counteracting the motion of the vehicle body, preventing oscillation of the vehicle body and the wheel from losing contact with the road. The damper counteracts level changes in the same manner.

If the level is to be increased, air is blown into the bellows. The pressure in the bellows increases as a result, initially to accelerate the sluggish mass of the body and later to overcome the damper force.

Once the solenoid valves are closed and the nominal level has been reached, the proportion of the pressure required to overcome the damper force causes an imbalance. The air in the bellows expands until the pressure multiplied by the bellows surface area corresponds to the static load again. The additional volume created by this expansion raises the body beyond the nominal level.

To prevent this overshooting of the nominal level, the air intake is already reduced before the nominal level is reached. The lifting speed is reduced and overshooting is prevented altogether when perfectly tuned. Because the solenoid valve can only pass or block the air flow, without being able to throttle the air flow, the solenoid current of the ECAS solenoid valve is pulsed, briefly interrupting the air-flow and thereby simulating the effect of throttling.

The ECU computes the pulse length relative to the the difference between the nominal level and the actual level, as well as the lifting speed. A long lifting path results in a long pulse since the danger of overshooting is not yet present; a high lifting speed, on the other hand, reduces the pulse length.

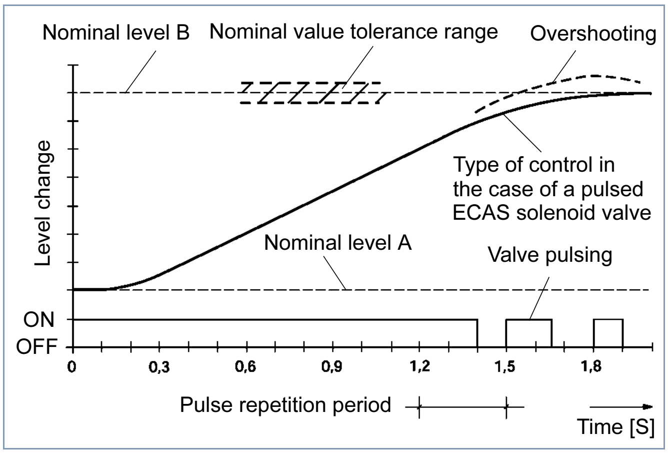


Abb. Type of control in the case of nominal value changes

The extent to which the two parts of the calculation become effective is determined by factors that can be parameterised:

Pulse length = lifting path × proportional coefficient – lifting speed × proportional coefficient

The pulse length is re-computed for each pulse repetition period. A computed pulse length which exceeds the pulse repetition period (normally 0.3 sec) causes the solenoid to be energised continuously ('continuous pulse'). The shortest pulse length to be executed is 75 ms (0.075 sec) pulse times would jeopardize the switching process of the solenoid valve.

3.2.1 Self-learning controller

Another type of controller works in a self-learning manner. With this method, the solenoid valves are no longer pulsed and this leads to a longer service life for the ECAS solenoid valves.

In the case of non-CAN electronic systems, the pulse times are obtained my means of defined coefficients. If CAN electronic systems are installed, the pulse time is adjusted according to the changing vehicle mechanics (determination of dead time).

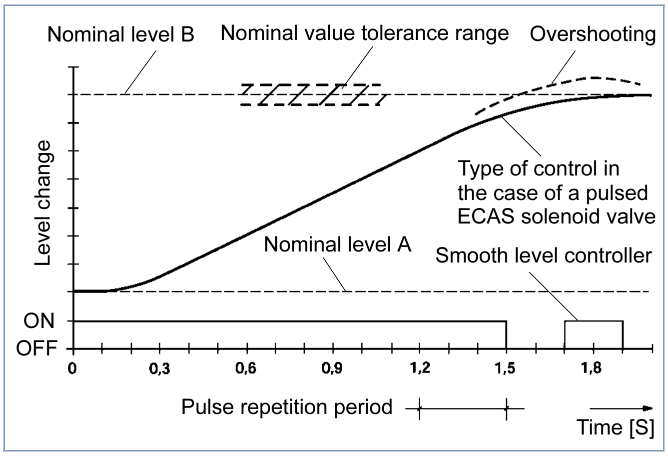


Abb. Type of control in the case of a nominal level change with a self-learning controller

This type of control is used with all CAN electronic systems. ECAS learns the overshoot behaviour after the very first control process. With regard to subsequent control processes, switch-off already occurs before the nominal level is reached. The vehicle body then accurately "swings" into the nominal level.

The smooth level controller is responsible for preventing overshooting in vehicles with a very light body.

These learning processes are not performed with every control process; they are only performed under specific conditions:

- Vehicle at a standstill
- The duration of the control process must be at least 0.6 seconds. Then there must be a pause of at least 4 seconds.
- The control process must be initiated manually (e.g. kneeling or normal level).

The raising or lowering speed is used to determine when the open solenoid valves need to be closed for the subsequent ride height to be as close as possible to the nominal level. The learned overshoot behaviour is saved to the electronic unit as characteristic curves at the moment the ignition is switched off.

NOTE: After each calibration process (or in the condition as delivered) the level adjustments are initially carried out using the preset standard characteristic curves until the actual control behaviour has been learnt for the first time.

Should the control behaviour be agitated, the controller is quickly adjusted to the vehicle by pressing the kneeling pushbutton several times.

4 Legal Requirements

Regulations for ECAS in the bus

part 30 StVZO in conjunction with part 35d StVZO

Guidelines for powered access aids in buses (extract)

1. Range of application

These guidelines apply to buses equipped with powered entry aids.

2. Definition of terms

....

2.2 Kneeling system

A kneeling system within the meaning of these guidelines is a facility for raising and lowering the bodies of buses.

....

3. Requirements

....

3.2 Kneeling system

3.2.1 Actuation

An additional, lockable switching device is required to activate a kneeling system.

3.2.2 Actuation types

Both manual and automatic control must be implemented for lifting and lowering the vehicle body.

Manual control devices

The manual control device for the lowering process must be designed so that it automatically returns to zero position when enabled during lowering. Here the lowering process must be stopped immediately and reversed into lifting process. A renewed lowering process must only be possible starting from the vehicle body's normal position (position while the vehicle is moving).

Automatic control device

In the case of an automatic control device, the driver must be able to stop the lowering process by means of an emergency switch within his immediate reach and so convert the lowering into a lifting process.

Renewed start-up of the lowering process must only be possible starting from the vehicle body's normal position (position while the vehicle is moving).

3.2.3 Lowering of the vehicle body

The lowering process may only take place when the vehicle is travelling at a speed below 5 km/h. It must be ensured that the bus cannot start driving while the body is lowered.

In the case of automatic control of the lowering process, it must be ensured that the process can only be initiated when the passenger doors are closed. Furthermore, a substantial part of the lowering process controlled by an automatic control device must be completed (at least 80 % of the height) before the passenger doors are completely opened.

Remark:
This new version now permits kneeling while the doors are open (VkBl. 1999 page 246).

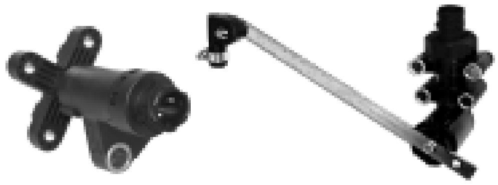
3.2.4 Lifting and lowering the vehicle body

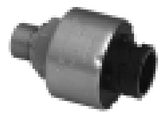
The lifting process may not start while a passenger door is still completely opened. The raising process should be interrupted when the reversing device of a door reacts.

5 Components

5.1 Overview


Control electronics (ECU)


Angle-of-rotation sensor / Distance sensor


Pressure sensor


ECAS solenoid valve

The ECAS system essentially consists of the following components:

- Control electronics (ECU)
- Distance sensor(s),
- Pressure sensor(s) (optional): The use of pressure switches or pressure sensor(s) is optional, i.e. it depends on the selected system variant.
- ECAS solenoid valve(s)
- Pneumatic components (air suspension bellows; possibly lifting bellows; pressure limiting valves; pipes; compressed air reservoir).

The pneumatic components are not described here since they correspond to the pneumatic components in a conventional air suspension system and do not require any particular explanation in the context of ECAS.

5.2 The Electronic Control Unit (ECU)

The electronic control unit is the heart of the ECAS system. The individual components are connected with the ECU via plug connections. The ECU is located inside the bus.

Function

The design of the ECU includes a microprocessor that only processes digital signals. Memory is allocated to this processor for data management. The outputs to the solenoid valves are switched via driver modules.

Tasks of the ECU

- Constant monitoring and conversion of the incoming sensor signals into numerical values (counts or timer ticks),
- Comparing these values (actual values) with the stored values (nominal values),
- Computation of the required control response in the event of a deviation and control of the solenoid valves,
- management and storage of the parameterised, calibrated and otherwise defined nominal values (normal levels, memory, etc.),
- the data exchange with the operating unit and the diagnostic unit via the CAN-BUS,
- monitoring the function of all system components and the axle loads (in systems with pressure sensors),
- output and storage of messages, as well as checking the plausibility of received signals in order to detect faults.

In order to ensure swift control responses to any changes in actual values, the microprocessor runs a certain program in cycles that take only the fraction of a second (25 milliseconds). One programme cycle performs all the tasks described above. This programme is permanently written into a program module (ROM). However, it uses numerical values (parameters) which are written to a freely programmable memory. These parameters affect the computing operation and thus the control responses of the ECU. They are used to transmit the system configuration and the other preset values pertaining to the vehicle and functions to the computer program.

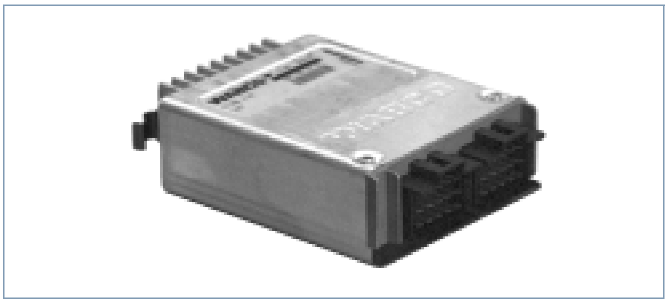
5.2.1 ECAS 4×2/6×4 (without CAN)

Product no.:	446 055 . . . 0
Connection:	terminal strip 35-pin
Diagnosis:	K-line ISO 9141 / JED 677 Diagnostic card, PC Diagnosis
Indicators:	lamps for errors, warnings and kneeling

System integration: logical connection (analogue) to the door control

Kneeling: kneeling to the side or the front is possible

5.2.2 ECAS 4×2/6×2 CAN



Product no.: 446 170 0. 0

Connection: connector 15/15-pin or 15/18-pin

Diagnosis: K-line ISO 9141 / JED 677
Diagnostic card, PC Diagnosis

5.2.3 ECAS 4×2/6×4 CAN II and 6×2 CAN II

Product no.: 446 170 2 . . 0

Connection: connector 18/15/9-pin

Diagnosis: CAN SAE J 1939 (KWP2000)
PC Diagnosis

Indicators: Indication via display (SAE J 1939)

System integration: CAN interface (SAE J 1939)

Sensors: support for angle-of-rotation sensor and acceleration sensor

Functionality: additional ECAS functionality (such as smooth level controller, measurands and parameters in quantities)

This generation of ECAS electronic units provides additional functions such as optimal traction, pressure ratio control and pressure equality control for 6x2 vehicles, axle load indication / passenger detection, as well as an anti-tilt function. Series production for buses started in 2004.

Diagnosis of these electronic control units is only be possible using a PC. The reasons for this are the increased functional range and the completely revised design of the electronic control unit, including a structure of parameter sets. No provision is made for use of a Diagnostic-Controller card.

5.3 Sensors

The starting point of the control process is the sensor. These sensors pick up the quantities to be controlled, and transmit them to the ECU via the sensor cable.

! You must always install at least one distance sensor in the ECAS system.

Pressure sensor(s) are used for controlling additional functions.

5.3.1 Distance sensor

The distance sensor acts as an actual value transmitter for continuous detection of any changes in the height of the superstructure. The inductive measuring principle is used.

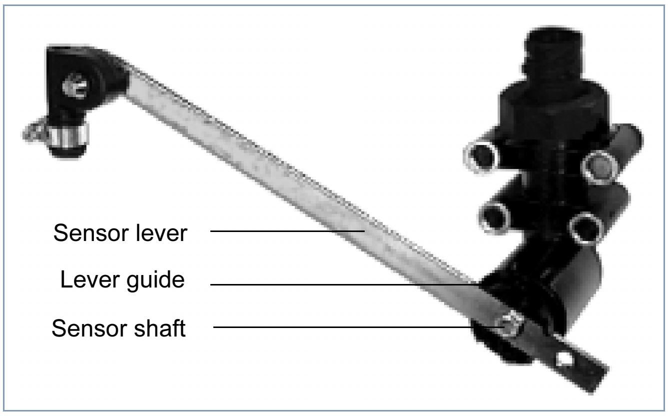


Abb. Distance sensor 441 050 0.. 0 and lever 441 050 718 2

With distance sensor 441 050 0.. 0 a rotary motion is transferred to the inside of the sensor by a lever. This movement is translated, following crank mechanism logic, without play into a linear movement of the armature in the coil. The 'dipping movement' of the ferro-magnetic armature into the stationary coil causes a phase displacement between current and voltage. The ECU receives these signals and converts them into count values or timer tick values.

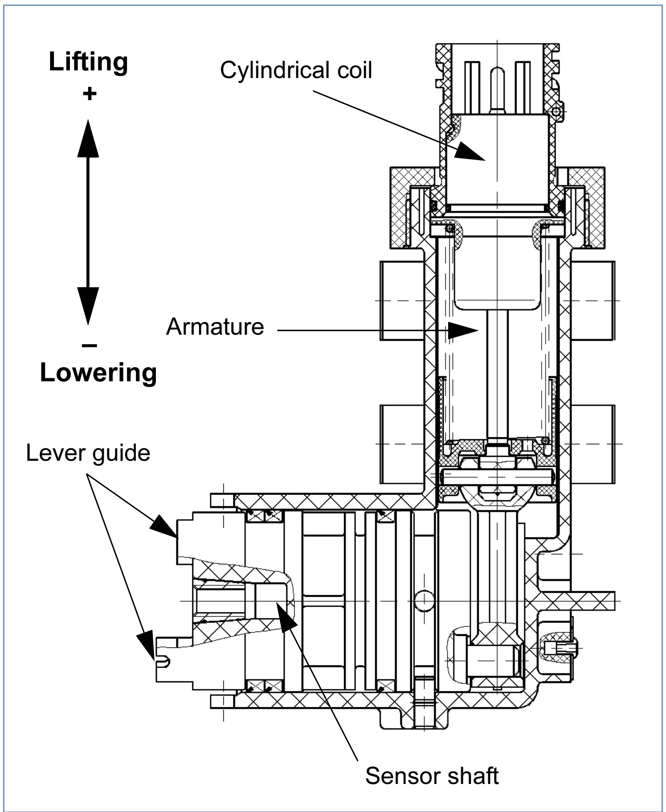


Abb. Sectional view of the distance sensor 441 050 0.. 0

The angle-of-rotation sensor 441 050 0.. 0 is a distance sensor in which the change in inductance is generated by the rotary movement of the sensor shaft.

The motion of the sensor lever, which is attached to the cross connector, causes the sensor shaft to be rotated into the magnetic field within a coil. One half of the sensor shaft consists of a ferro-magnetic material and the other half of a non-conducting magnetic material. When the ferro-magnetic part of the sensor shaft is turned into the magnetic field, the inductance changes.

Abb. Angle or rotation sensor sensor 441 050 1.. 0

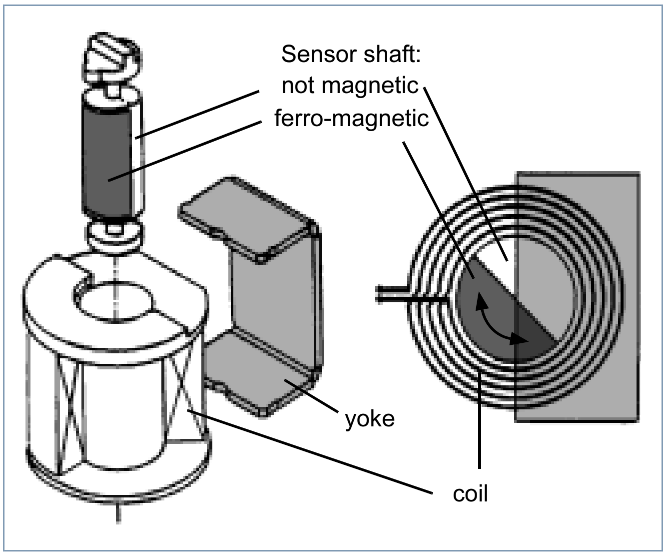


Abb. Function of the angle-of-rotation sensor 441 050 1.. 0

If the distance sensor needs to be checked, the resistance can be measured to verify proper function of the coil. The resistance must be approximately 120 ohm. The coil's induction is evaluated more than 50 times a second by a special evaluation circuit within the ECU. The ECU also monitors the sensor for proper function.

! It is not possible to test the distance sensor function using a voltage meter.

The distance sensor is located on the vehicle frame near the axle whose air suspension bellows are to be controlled.

A distance sensor (1-point control) is usually installed above the centre of the steering axle. Driving axles may also be equipped with 2 distance sensors as an alternative to the single sensor variant.

– Install the sensors so that they lie as far apart from one another as possible to achieve optimal controlling action of the individual distance sensors (2-point control on one axle).

The distance sensor is permanently linked to the axle to be controlled by means of a linkage. The rod has rubber end pieces acting as dampers and compensators.

With CAN II electronic units, the type of the installed sensors must be specified in the parameter settings (options parameter 2.5).

The ECAS ECU converts the respective sensor value into counts within a byte range between 0 and 255 counts. More recent ECAS ECUs have been changed to 16 bit processing. The sensor values are here specified as timer ticks (range from 0 to 65.535).

Instruction for installation

The optimum resolution range of the distance sensor is between + 50° and – 50° while the sensor lever is horizontal (initial position 90°) at normal level.

! The maximum deflection range of the lever (+/- 50°) should not be exceeded.

The length of the sensor lever is selectable. However, the length must be identical for all distance sensors on an axle.

Short sensor lever
A short sensor lever ensures a high resolution of the measured values even when the change in height is slight. However, it can only cover a small range of settings.

Long sensor lever
A long sensor lever covers a wide range of settings at the expense of the resolution of measured values. The objective is the best possible utilisation of the deflection angle.

! Cranking of the lever must be avoided because this might result in impermissible tilting torques acting on the sensor shaft. For this reason, all swivelling axles must be aligned in parallel.

There is only one variant of distance sensor for installation on the right and left-hand sides. The sensor level can, however, be mounted in steps of 90 degrees on the sensor shaft which can be turned in the sensor housing without stops. For accurate operation and accurate measured value acquisition, the sensor shaft must be properly aligned.

In the case of distance sensor 441 050 0.. 0 this is achieved by 2 lugs on the sensor shaft guiding the sensor lever. These projections point toward the right at right angles relative to the direction of armature movement (as shown in the illustration). This permits the best possible utilisation of the distance sensor's measuring range.

In the case of angle-of-rotation sensor 441 050 1.. 0 the sensor lever is screwed to the cross connector or the lever of the sensor shaft.

! It is important that the distance sensor lever moves freely across the whole of its setting range, and that the lever can only move within that range (i.e. does not overshoot).

After installing the distance sensors to the vehicle body, use the diagnostic software to check the measured values delivered by the distance sensors during lifting and lowering of the vehicle body. The displayed counts or timer tick values are represented in the "Control" menu:

- LIFTING increases the induction and causes an increase in counts or timer tick values
- LOWERING decreases the induction and causes reduction of counts or timer tick values.

5.3.2 Pressure sensor

Abb. Pressure sensor 441 040 0.. 0 and 441 044 1.. 0

The pressure sensor is required for the tyre impression compensation and for traction help. Traction help through axle load relief can only be implemented in 3-axle buses.

The pressure sensor produces a voltage output that is proportional to the applied pressure. The measuring range lies between 0 and 10 bar; a pressure of 16 bar must not be exceeded.

The signal voltage is sent to the ECU via a connecting plug. The sensor must also be fed with a supply voltage from the ECU via a third conductor.

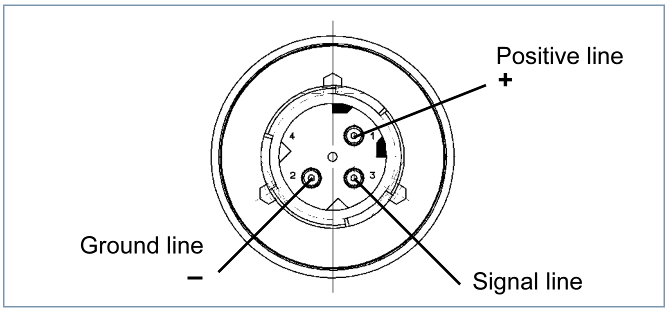


Abb. Electrical connection of the pressure sensor

The cable harness must be encased in a hose or similar material in such a way that the housing - which is otherwise waterproof - can ”breathe“.

Under no circumstances should the pressure sensor be connected to the connecting line of the air suspension solenoid valve because this could result in incorrect readings during air intake and air exhaust processes.

If air suspension bellows with two threaded ports, as offered by renowned manufacturers of air suspension systems, cannot be used, a special connector must be fitted. This connector can consist of a T-shaped pipe union into which a tube is soldered in the pressure sensor connection; this tube protrudes into the air spring interior and there picks up the "stabilised" bellows pressure.

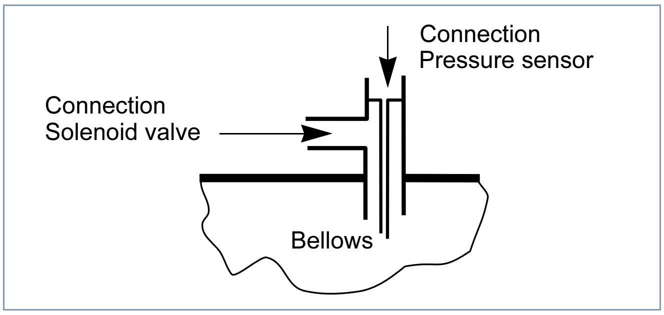


Abb. Sensing the bellows pressure

5.4 ECAS solenoid valve

Special solenoid valve blocks have been developed for the ECAS system. The space and installation time required are kept to a minimum by combining several solenoid valves in one compact block.

Controlled by the electronics as an actuator, the solenoid valves convert the applied voltage into an air intake/ exhaust process, i.e. they increase, lower or maintain the air volume in the air suspension bellows.

Pilot valves are used to achieve a large air throughput. The solenoids initially switch those valves with a small nominal width whose control air is then routed to the piston surfaces of the actual switching valves (NW 10 and/or NW 7).

The solenoid valves are integrated in a modular system: The same housing is equipped with different valve parts and solenoids, depending on the application.

In a solo bus, one axle is usually equipped with two distance sensors, the other with one. The designation 1 distance sensor and 2 distance sensor axles are used for the purpose of distinction since there is no definitive allocation to front or rear axle.

5.4.1 Valve for the axle with two distance sensors

Abb. Solenoid valve 472 900 053 0

This solenoid valve has three solenoids. One solenoid (41) controls a central breather valve (also called a central 3/2 directional control valve), the others control the connection between the two air bellows (2/2 directional control valves) and the central breather valve.

This valve permits the implementation of what is called a 2-point control, in which case distance sensors on both sides of an axle are used for separately controlling the height on either side of the vehicle to keep the body horizontal in spite of uneven load distribution.

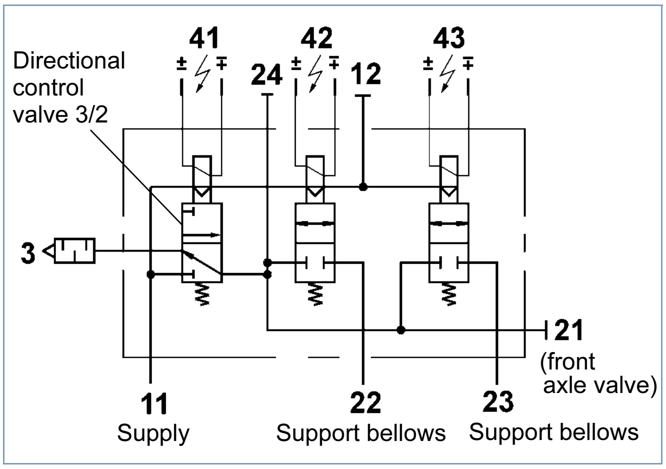


Abb. Circuit diagram of the solenoid valve 472 900 053 0

Design of the valve

Solenoid 41 actuates a pilot valve (1), and the actuating pressure from this valve flows through hole (2) and acts on piston valve (3) of the breather valve. The pilot valve is supplied through connection 11 (supply) and the connecting hole (4).

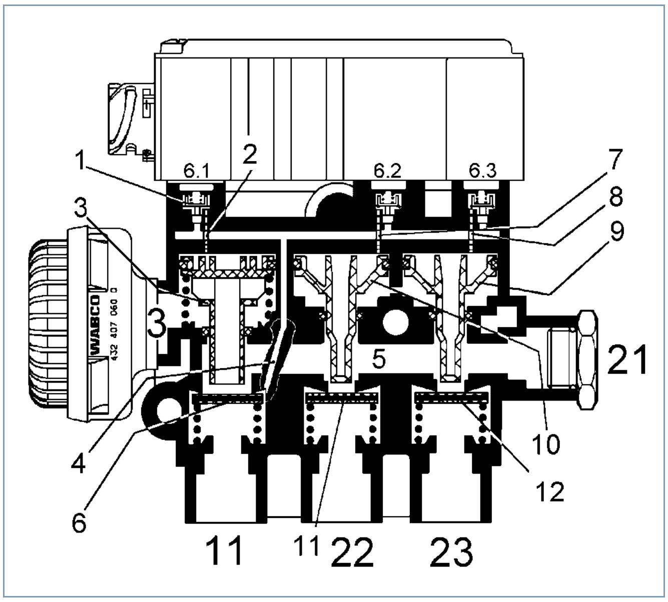


Abb. Sectional view of the solenoid valve 472 900 053 0

This drawing shows the breather valve in its venting position in which air from chamber (5) can flow to connection 3 via the hole of the piston valve (3).

When a current is applied to solenoid 41, the control piston (3) is pushed down, which initially causes the hole of the control piston to be closed by the valve plate (6).

The valve plate is then pushed down from its seat (hence the name seat valve) so that air can flow from the air supply into the chamber (5).

The two other valves connect the air suspension bellows with the chamber (5). Depending on whether solenoid 42 or 43 is energised, air is applied to the control plungers (9) or (10) through holes (7) and (8), thereby opening the valve plates (11) and (12) to connections 22 and 23.

A solenoid valve can be connected to connection 21 for control of the second vehicle axle.

5.4.2 Valve for an axle with one distance sensor

This valve is similar to the valve with two distance sensors, but it contains fewer parts.

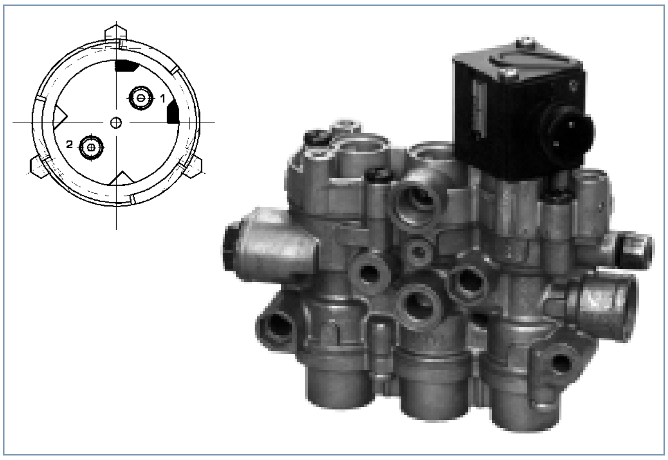


Abb. Front axle valve with DIN bayonet 472 900 058 0

Since connection 14 is connected to connection 21 of the valve described above, no vent valve is required, only a pilot valve (1) is used. The piston valves (3) of both air suspension bellows valves are pressurised via two connecting holes (2) so that each pressurising or venting process is effected evenly for both bellows via chamber (5).

If the solenoid is not energised, the valves are closed, as shown in the illustration. At this time, the only connection between the bellows is the transverse throttle (7) through which any difference in pressures can gradually be compensated.

The valve is connected to the air supply via connection 12. This connection is required to enable the pilot valve to displace the control piston.

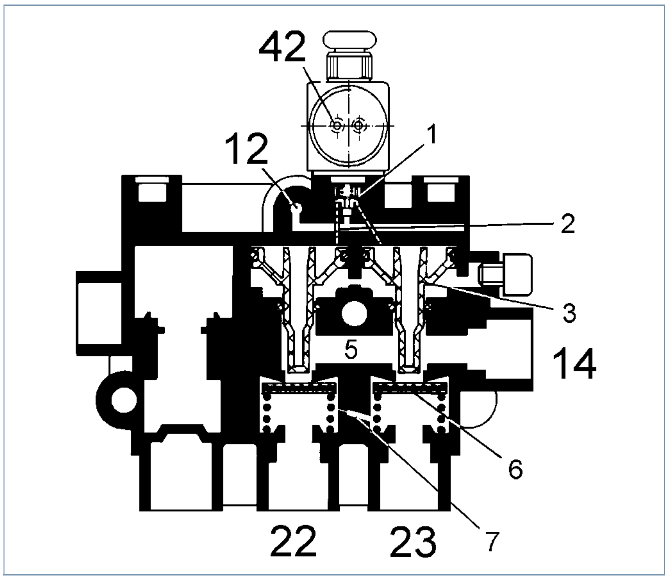


Abb. Sectional view 472 900 058 0

5.4.3 Valve for bus with kneeling

To lower one side, the axle valve must be able to separately control the bellows by means of a distance sensor (1 distance sensor axle), i.e. it requires a pilot valve with a solenoid for each of the directional control valves 2/2 .

The path must also be blocked off by the transverse throttle so that air cannot be exchanged between the bellows during kneeling.

Abb. Solenoid valve 472 900 056 0

The valve shown in the diagram includes both valves described above in a single block, enhanced by the aforementioned functions.

The valve described above for the 2-distance sensor axle is already arranged in the rear valve level. Upstream is the valve for the 1-distance sensor axle; it has a switchable transverse throttle, whose solenoids are located in front of the valve connections, as seen in the illustration.

The schematic diagram shows the two valve levels next to each other.

The left part of the illustration corresponds to the valve for the 2 distance sensor axle. The right part controls the 1 distance sensor axle, whereby both bellows (at connections 26 and 27) are controlled by separate solenoids. The connection via the transverse throttle (1) can be blocked off by the solenoid 63.1.

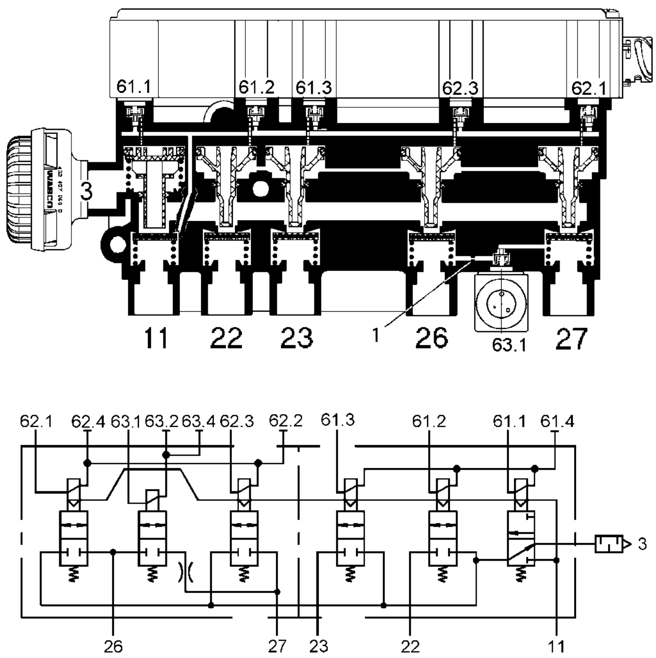


Abb. Section view and circuit diagram 472 900 056 0

5.4.4 Interchangeability of the ECAS solenoid valves

It is possible to distinguish one generation of ECAS solenoid valve from another on the basis of the valve solenoids' design. There are more than 60 variants of the ECAS solenoid valve. The product group 472 900 … 0 comprises the FA, RA valves and RA/LA valves for systems with basic control and pressure ratio control/ traction control. The product group 472 905 … 0 includes the RA/LA valves for pressure equality control.

The solenoid valve generation ECAS III is grouped in the product line 472 880 … 0 and supersedes the ECAS solenoid valves of the product line 472 900 … 0.

Abb. Rear axle valve with DIN bayonet 472 880 030 0

As a general rule, the variants can be categorised into groups sharing the same functions. The main differences between devices in the same group pertain to the electrical and pneumatic interface.

If need be (i.e. repair is required), pipe couplings according to DIN may also be used for devices with specially shaped connection threads (required by special pipe connection systems) should the corresponding pipe couplings not be on hand.

However, problems of greater magnitude arise if the electrical connections to the valve solenoids are configured differently. For example, solenoid control can be implemented as an individual control with a thread or as a valve block control with a connection bayonet. The connection bayonet may vary from one type to another (KOSTAL or DIN bayonet). There can be different contact arrangements even within the same bayonet type, and this may rule out interchangeability. In this case, the only thing to do is to replace the corresponding cable at the same time.

6 Safety concept

6.1 Messages on the display

In order to monitor the function of the system, the ECU regularly checks most of the electrical connections with the individual components and compares the voltage and resistance values with the specified values.

This test is not possible for inputs that are fed into the electronics via the vehicle CAN-BUS, as is the case with the input of the switch for normal level II for example.

In addition, the sensor signals are checked for their plausibility. For example, an unchanged level in spite of air-intake by a bellows is implausible and therefore classified as incorrect.

Detected errors are indicated to the driver by means of a display in the instrument panel.

Abb. Instrument panel with display

Detected errors trigger different responses depending on the type of error. If the electronic unit detects a system fault, a fault message is transmitted on the CAN bus. As a response to a request, an error code is output with a description of the faulty components and the type of fault (e.g. distance sensor 2-distance sensor axle left: interruption). A corresponding fault number can be displayed in the driver's display.

Slight and clearly identifiable faults that do not cause the system to shutdown.
System faults which still permit restricted use of the system (examples):

- Failure of a distance sensor if the same axle has another distance sensor.
- Failure of the CAN-BUS information on the speed signal of the sidewalk detector or the pressure sensor.
- Fault in the WABCO data stored in the ECU.

The error/fault is displayed on the display if applicable and stored in the non-volatile memory of the electronic control unit. The function of the system is maintained to the extent possible; the functionality is restricted however. After the fault has been eliminated, the system returns to normal operation.

Faults that cause a temporary shutdown of the system no longer exist in the new ECAS-CAN electronic units.
This means, limited control is executed even when a plausibility fault is present.

The fault criterion 'plausibility fault' is met once an initiated or active control process fails to respond within a period set in parameter 14. This can be caused by one of the following types of fault:

- The solenoid valve does not pressurise the air suspension bellows.
- The solenoid valve does not exhaust the bellows.
- The solenoid valve remains in an air intake or exhaust position even though the control process has been completed.
- defective compressed air supply
- the air suspension bellows has burst
- blocked or kinked lines.

The electronic unit cannot directly measure a fault since there are no sensors at the inlets and outlets of the solenoid valve; it can only conclude that a fault is present when the feedback from the distance sensors deviates from the plausible response.

6.2 Signal lamp messages

Signal lamps in the instrument panel are used to communicate the messages to the driver in older vehicles without a display in the instrument panel.

The fault lamp lights up (minor error) or flashes depending on what the message conveys.

A second lamp, called warning lamp, indicates to the driver a level that deviates from the normal level.

Both lamps light up for two seconds after the ignition has been turned on to indicate proper function of the lamps to the driver.

	Warning lamp yellow	Fault lamp red
Steady light For two seconds after turning on the ignition (time for the driver to check the lamps).	The nominal level deviates from the normal level. Lifting/Lowering required.	**A minor fault is present** (e.g. no speed signal or the level can only monitored with restrictions. Undervoltage (between 7.5 and 18 volt) **Plausibility fault** (e.g. body is not lifted even though the solenoid is energised)
Flashing The sidewalk detector is activated (warning lamp and fault lamp alternately flash for 1/2 a second.)	Supply pressure too low	**A severe fault is present.** It is not possible to monitor or control the level.
	Sidewalk detector defective (flashing 1/2 second, fault lamp is steadily lit	**The electronic unit is in service mode.**

7 Diagnosis

The ECAS system is maintenance-free. The system monitors itself by means of the fault routines in the ECU program. Further system checks are only required for parts which the ECU itself is unable to check (sensor linkage, signal lamps etc.).

If the ECU detects a fault, this is indicated to the driver (on a display for example), and it is only at this point that the system needs to be tested in the workshop. The most up-to-date means of diagnosis is represented by the PC Diagnosis which has replaced the Diagnostic Controller.

7.1 Diagnosis by means of the PC

To diagnose ECAS you need either

- a PC or a laptop,
- a Diagnostics Interface,
- a connection cable to the vehicle
- the Diagnostic Software "ECAS Bus …"

7.1.1 PC / laptop

WABCO can offer you a laptop that is resistant to impact and dirt, and is therefore suitable for workshop use. It can also be delivered upon request with preinstalled diagnostics software. The "Toughbook" can be procured from WABCO under order number 446 302 040 0.

Abb. "Toughbook" laptop (order number 446 302 040 0)

The Diagnostic Software will also run on all standard PCs with an operating system Microsoft Windows 2000 or higher.

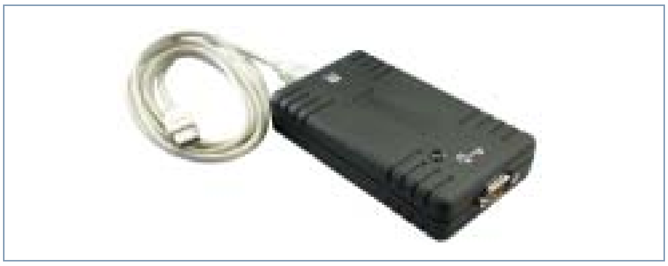
There are no special hardware requirements. The PC should, however, have a free USB port or a free serial port (COM interface 9-pin).

7.1.2 Diagnostic Interface Set

The WABCO Diagnostic-Interface Set with the order number 446 301 021 0 (serial) or 446 301 022 0 (USB) is required for setting up diagnosis of the control unit. The set comprises the interface and a connecting cable to the PC or Laptop.

One of two Diagnostic Interfaces is connected to the vehicle via the central diagnostic socket of the vehicle.

Diagnostic Interface Set (USB) 446 301 022 0



The set includes:

- Diagnostic Interface,
- USB connecting cable to PC/Notebook

Diagnostic Interface Set (serial) 446 301 021 0

As an alternative to the diagnostics interface with a USB connection, WABCO offers a diagnostic interface with serial connection.

7.1.3 Diagnostic Software

There are three ways to obtain the Diagnostic Software for the ECAS system.

USB flash drive version 446 301 XXX 0

Single download 246 301 XXX 0

The XXX value in the order number stands for the currently available language version of the Diagnostic Software:

- 246 301 **861** 0 ECAS bus A
- 246 301 **539** 0 ECAS- bus Citaro
- 246 301 **410** 0 ECAS- bus

Part of a WABCO System Diagnostics subscription

For the diagnosis of multiple WABCO systems, WABCO offers you four different Diagnostic Software subscriptions via the internet. These contain numerous diagnostic programs at a very low price. The most recent version of the programs can be downloaded from the internet at any time ready for immediate use.

The means of graphic representation provided by the PC make diagnosis clear and structured. Thanks to detailed repair information and circuit diagrams with measured values, successful diagnosis and repair is made easy and fast.

The Diagnostic Software may be may be used by any user for the purpose of diagnosis. If parameters need to be changed or a calibration needs to be carried out, authorisation (PIN) is required. This PIN is obtained by completing corresponding training at the WABCO Academy. More information on WABCO Academy training courses, visit www.wabco-auto.com.

7.1.4 Important Diagnostic Software menus

Main menu

Once the Diagnostic Software has started successfully, you are in the main menu of the Diagnostic Software.

Successful communication with the ECAS ECU is indicated in the status line at the bottom right margin of the window: A green lamp symbol lights up and the corresponding connection of the cable to the Diagnostic Interface is indicated. The toolbar buttons are also active.

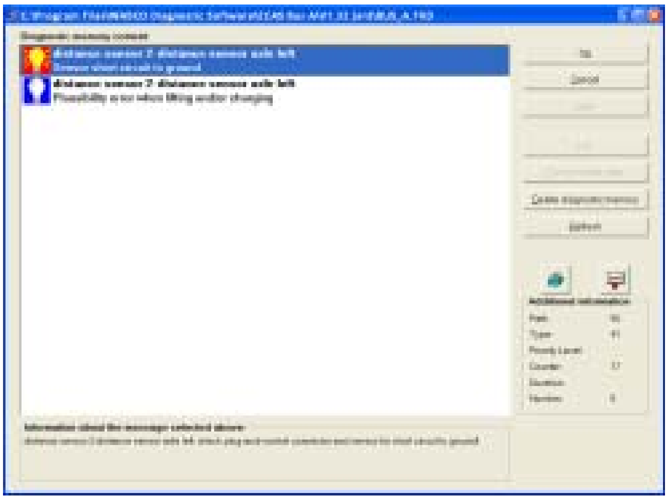
The ECU data, current messages, the configuration and the current measured values are displayed in the corresponding fields of the main menu.

! When the Diagnostic Software is not connected to the ECAS-ECU:

– Click the second button in the toolbar "Start diagnosis".

The option "Establish diagnostic connection when starting" can be activated in the "Options" menu, menu item "Settings", tab "Program options".

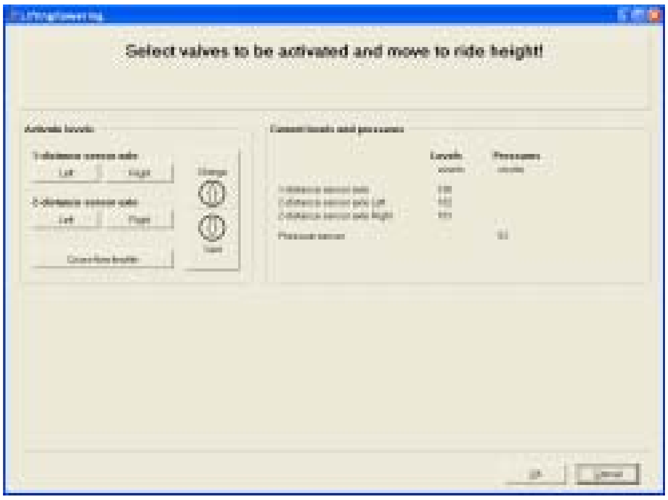
Messages (diagnostic memory)



In the messages menu, the messages stored in the diagnostic memory are displayed. Current messages are marked by a red symbol.

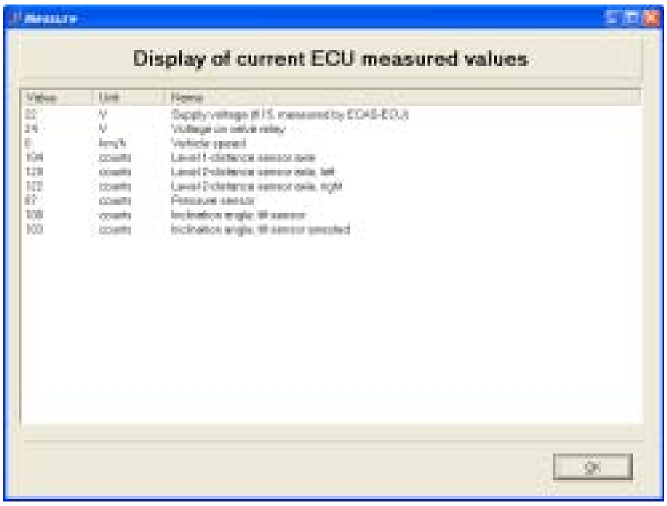
The messages in the diagnostic memory can be printed as a protocol, stored and deleted on the PC, and it is possible to call further information on the messages.

Control (Lift / Lower)



The "Control" menu is used to select the air suspension bellows of the axles and to initiate air intake or exhaust for these bellows. The actual level and pressure values are displayed during this process.

Measured values



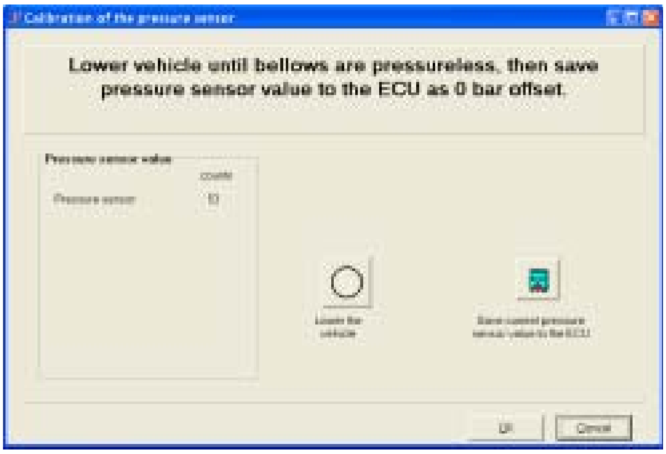
The "Measured values" menu displays the currently measured values of the ECU, such as voltage, levels, pressures and tilt angle.

Calibrate the distance sensors

The menu item "Calibrate the distance sensors" is called from the "System" menu.

Please refer to the chapter "Calibration" for further information on calibrating the distance sensors.

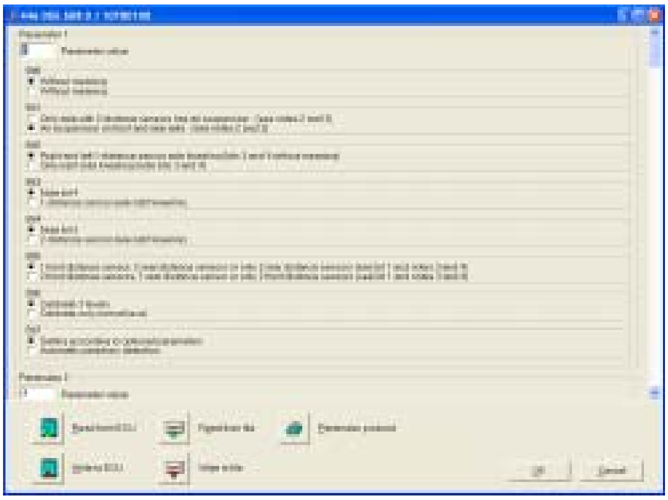
Calibrate the pressure sensors



The menu item "Calibrate the pressure sensors" is called from the "System" menu.

Please refer to the chapter "Calibration" for further information on calibrating the pressure sensors.

Setting parameters



The menu item "Setting parameters" is called from the "System" menu.

Please refer to the chapter "Setting parameters" for further information on setting parameters.

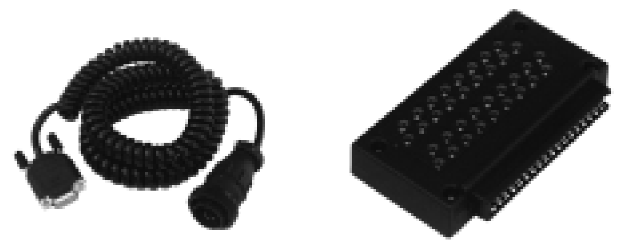
7.2 Connecting the diagnostics

Connection adapter

35-pin 446 300 327 0

25-pin 446 300 317 0
only for 4×2 vehicles

Diagnostic cable, adapter plug



Diagnostic cable
894 604 303 2

Adapter plug
446 300 31X 0

Vehicle with central diagnostic socket in accordance with ISO 9141

The diagnostic socket must match the pin assignment in accordance with ISO 9141 illustrated below. To start diagnosis, plug the connecting cable into the ISO socket of the vehicle.

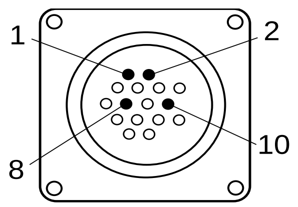


Abb. Assignments of the diagnostic socket

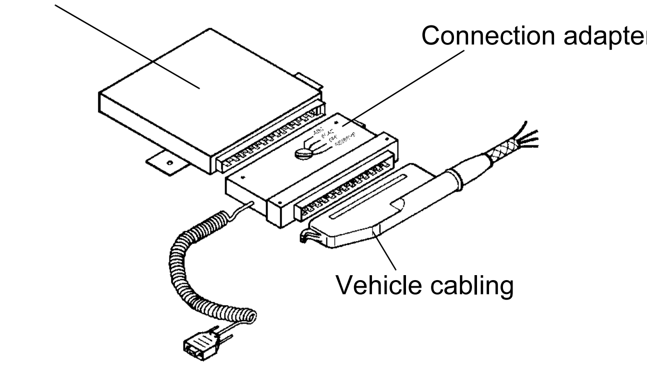
1 Battery Plus terminal - terminal 30
2 Battery Minus terminal - terminal 31
8 Diagnostic K-line
10 Diagnostic L-line

Vehicle without central diagnostic socket in accordance with ISO 9141

If the vehicle is not equipped with an ISO 9141 diagnostic socket, the diagnostics can be connected using a connection adapter (accessory).

– Connect the 9-pin connector of the connecting cable or the connection adapter to the Diagnostic Interface. This provides both the diagnostic connection and the electrical power supply.

The connection adapter is connected between vehicle cabling and the electronic unit while the ignition is switched off.



! After the diagnosis has been completed, the connection adapter must be removed again!

Pin assignment of the DB-9 connector "Diagnostic Input":

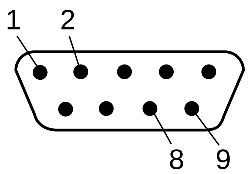


Abb. Assignments of the diagnostic socket

1 Battery Plus (terminal 30)
2 Battery Minus - (terminal 31)
8 Diagnostic K-line
9 Diagnostic L-line

7.3 Diagnosis with the WABCO Diagnostic Controller

Diagnosis by means of the Diagnostic Controller has been replaced by the PC Diagnosis and can not be used for the diagnosis of ECAS systems with CAN.

This Diagnostic Controller is not only used for the start-up procedure but can also be used for locating faults, for actuating solenoid valves, lamp testing, checking test values and measured values, manipulating the control unit's data, and for functional testing.

Diagnostic Controller with program card

Diagnostic Controller 446 300 320 0 | Program card 446 300 894 0

7.3.1 Menu Program card 446 300 894 0

Certain menu items can only be activated if the PIN was entered under the menu item 4 "Special functions" beforehand. This PIN is obtained by completing corresponding training at the WABCO Academy.

- 1 Diagnosis — Front section / Rear section
  - 1 Fault finding
  - 2 Control
    - 1 Lift/Lower
    - 2 Air intake valve
    - 3 Lamp test
    - 4 Throttle test*
    - 5 Kneeling function
  - 3 Test and measured values
    - 1 Distance sensor values
    - 2 Pressure sensor value*
    - 3 Speed
    - 4 Switch positions
    - 5 Operating voltages
  - 4 Control device data
    - 1 Parameters**
    - 2 WABCO data
    - 3 Overshoot data
    - 4 Print
      - 1 Print faults
      - 2 Print parameters
    - 5 Transfer parameters
      - 1 Control unit ->Controller
      - 2 Controller ->Control unit ***
  - 5 Functional test
  - 6 Calibration
    - 1 Calibrate distance sensor
    - 2 Display distance sensor data
    - 3 Calibrate pressure sensor*
    - 4 Display pressure sensor data*
    - 5 Enter data***
    - 6 Transfer data
      - 1 Control unit ->Controller
      - 2 Controller ->Control unit ***
- 2 Multimeter
  - 1 Direct voltage
  - 2 Alternating voltage
  - 3 Resistance
- 3 Options
  - 1 Help text
  - 2 Version
  - 3 testable ECUs
  - 4 Measured value acquisition
- 4 Special functions

* if installed/depends on parameter settings
** The parameters can only be edited after entering the PIN
*** only possible after entering the PIN

8 Setting parameters

The electronic units are supplied with standard parameter sets. These standard parameters in the electronic control unit must be adapted to the respective vehicle. During servicing, it may be necessary to change certain parameters - and may also be requested by the by the vehicle owner.

However, only trained personnel may set parameters in the electronic control unit. If the parameters are to be changed using the WABCO Diagnostic Software, authorisation (PIN 1) is required. This PIN is obtained by completing corresponding training at the WABCO Academy.

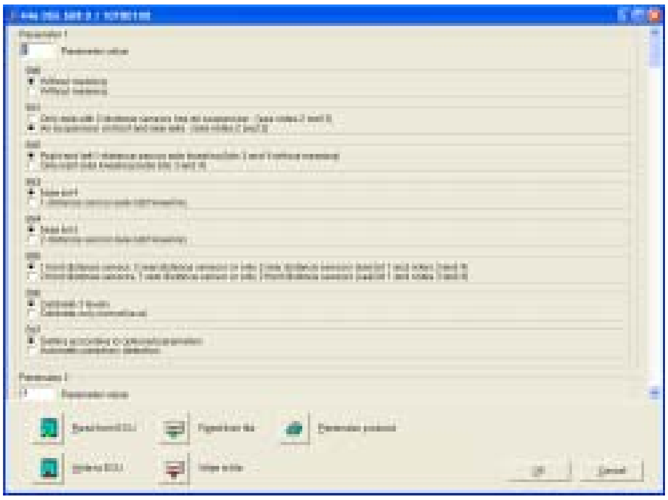


Abb. Menu "Parameters" of the Diagnostic Software

Parameters are set using the Diagnostic Software. In this step, parameter sets can, for example:

- be read in, displayed, and stored from an existing ECU.
- be written into an ECU.
- be manually created, modified, and transferred to the ECU.

– Prior to setting parameters, save the parameter set stored in the ECU to the PC.

This provides a back-up copy which can be used to restore the previous set of parameters in the electronic control unit at any time. This is particularly important if existing sets of parameters are to be modified.

! Parameter changes require the approval of the vehicle manufacturer.

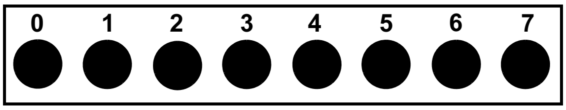
8.1 Option parameters

Option parameters are parameters in which 8 bits (also referred to as "option bits") can be respectively set or not set. These are options that are precisely defined by means of YES or NO, or by means of "1" or "0" in terms of computer language. Option parameters are non-dimensional.

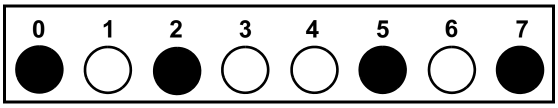
One byte comprises 8 bits, i.e. 8 option parameters. They are uniquely represented as a number between 0 and 255. The binary system of numbers is the basis for this representation.

Model representation of numbers 255 and 165 in digitalised form (example)

Eight option parameters make one value parameter.



$$2^0 + 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^6 + 2^7$$
$$1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 = 255$$



$$2^0 + 0 + 2^2 + 0 + 0 + 2^5 + 0 + 2^7$$
$$1 + 0 + 4 + 0 + 0 + 32 + 0 + 128 = 165$$

One byte can be imagined as follows: Eight lamps are installed on a strip with terminals 0 to 7, symbolically representing 8 bits. If one lamp is on, this equals the number "2 raised to the power of the terminal number". For example: The lamp on terminal 3 is on. This corresponds to $2^3 = 8$. If the lamp is off, this is equal to the figure 0. There are a total of 256 different combinations for illuminating the lamps.

Since an option bit can only be described by means of the condition YES or NO (lamp ON or OFF), 8 option parameters can be said to represent one value parameter. Adding up the values of these 8 option bits produces a number between 0 and 255, by means of which the parameter is uniquely described.

Option parameters represent details regarding functional scope and desired operating mode of the system. These are, for example:

- Distance sensor calibration of the system, configuration detection
- calibration procedure to perform, plausibility checking procedure, switch configuration
- presence of a pressure sensor, traction help configuration
- presence of an LSV solenoid valve, type of normal level selection, etc.

8.2 Value parameters

Value parameters are numerical values defining the nominal, limit, and tolerance values of the system. These values are numbers between 0 and 255. They are proportional values for actual quantities such as: distance, pressure, time, speed.

8.2.1 Counts

Counts are count values of the ECU. Binary numbers form the basis of these counts. The counts range from 0 to 255.

When the parameters – i.e. the nominal values for control – are being set, they are set as counts. To allow the ECU to compare nominal values and actual values, the actual values also need to be provided as counts.

The values picked up by the sensors are based on distances or pressures. They are transmitted to the ECU as voltages or current pulses. The ECU then converts these signals into digital values, the so-called counts (digitisation of the signals). The band width of the voltages and pulse times within the measuring range is divided into equal parts for this purpose. The maximum possible measuring range is divided into 256 steps.

The smaller these steps are, the:

- more accurate are the measured values provided for computation.
- smaller the band width of the measuring range that can be covered.

The greater these steps are, the:

- less accurate are the measured values provided for computation.
- wider the band width of the measuring range that can be covered.

The above information must be taken into account when choosing the lever length for the distance sensor.

8.2.2 Timer ticks

In more recent ECAS electronic systems, 8-bit processing has been changed to 16-bit processing. This opens a wider range of data processing options and thus a much higher resolution for calculating measured values.

The electrical signal transmitted by the distance sensors is now converted into timer ticks by the ECU. The values range from 0 to 65.535.

It is important to observe the difference between the counts of older ECAS electronic systems and the timer ticks when performing calibration.

8.3 Parameters of the ECU 446 055 055 0

8.3.1 Option parameters

Enter the total of the decimal numbers

No.	Meaning	Deci mal
0	ECAS unit address if several units are on the address (data) bus	
1	Bit 0 **0** without significance **1** without significance	0 1
	Bit 1 **0** only axle with 2 distance sensors is air-suspended **1** Front and rear axle air-suspended 2) 3)	0 2
	Bit 2 **0** right and left 1-distance sensor axle kneeling (bits 3 and 4 without significance) **1** only right side kneeling (note bits 3 and 4!)	0 4
	Bit 3 **0** note bit 4! **1** 1-distance sensor axle right kneeling	0 8
	Bit 4 **0** note bit 3! **1** 2-distance sensor axle right kneeling	0 16
	Bit 5 **0** 1 distance sensor on front axle, 2 distance sensors on rear axle 1) 3) **1** 2 distance sensors on front axle, 1 distance sensor on rear axle (also note bit 1)	0 32
	Bit 6 **0** 3 calibration levels **1** only calibrate normal level	0 64
	Bit 7 **0** Setting according to option parameters **1** automatic periphery detection	0 128
2	Bit 0 **0** Door enabling pin 11 –> high impedance state **1** Door enabling pin 11 –> + UB	0 1
	Bit 1 **0** without significance **1** without significance	0 2
	Bit 2 **0** without pressure sensor 2) 4) **1** with pressure sensor	0 4
	Bit 3 **0** automatic / manual kneeling by means of switch on pin 21 **1** automatic kneeling pin 21, Manual kneeling pin 23	0 8
	Bit 4 **0** valve monitoring on pin 11 at V > 7 km/h **1** no valve monitoring on pin 11	0 16
	Bit 5 **0** valve monitoring on pin 29 at V > 7 km/h **1** no valve monitoring on pin 29	0 32
	Bit 6 **0** with valve monitoring **1** without valve monitoring	0 64
	Bit 7 **0** without measured value output **1** with measured value output	0 128

No.	Meaning	Deci mal
3	Bit 0 **0** without main flow throttle **1** with main flow throttle [2]	0 1
	Bit 1 **0** without transverse throttling **1** with transverse throttling [2]	0 2
	Bit 2 **0** automatic kneeling regardless of door position **1** automatic kneeling, taking door position into account	0 4
	Bit 3 **0** Control of sides that are not kneeled during kneeling **1** no control of sides that are not kneeled during kneeling	0 8
	Bit 4 **0** no level control with brake applied **1** level control permissible with brake applied when door is open	0 16
	Bit 5 **0** without door enabling output pin 11 **1** with door enabling output pin 11 [2]	0 32
	Bit 6 **0** without starting lock output pin 29 **1** with starting lock output pin 29 [2]	0 64
	Bit 7 **0** door opened at 0 V on pin 5 **1** door opened at + UB on pin 5	0 128
4	Bit 0 **0** without fault monitoring of sidewalk detector **1** with fault monitoring of sidewalk detector	0 1
	Bit 1 **0** sidewalk detector as break contact **1** Sidewalk detector as make contact OR without sidewalk detector (set bit 0 to "0"!)	0 2
	Bit 2 **0** transverse throttling function at V = 0 km/h and at V > 0 km/h **1** Transverse throttling function only at V = 0 km/h	0 4
	Bit 3 **0** with standby for the pins: 11, 18, 29, 32, 35 **1** without standby for the pins: 11, 18, 29, 32, 35 [5]	0 8
	Bit 4 **0** without significance **1** without significance	0 16
	Bit 5 **0** without significance **1** without significance	0 32
	Bit 6 **0** without significance **1** without significance	0 64
	Bit 7 **0** Without significance **1** without significance	0 128

1) Operation is not possible with only one distance sensor.

2) With automatic periphery detection, the bit is set accordingly.

3) If this bit is changed, the ECAS distance sensors must be recalibrated.

4) After changing this bit from "0" to "1", the pressure sensor must be recalibrated.

5) PIN 11: Door enabling
PIN 18: Transverse throttling
PIN 29: Starting lock
PIN 32: Kneeling lamp
PIN 35: Main flow throttle

8.3.2 Value parameters

No.	Meaning	Unit
Levels		
5	Normal level 2, 1-distance sensor axle Input: Normal level 2 – lower calibration level	Counts
6	without significance	
7	Normal level 2, 2-distance sensor axle Input: Normal level 2 – lower calibration level	Counts
8	Limit of plausibility fault recognition when lowering 1-distance sensor axle [1]	Counts
9	without significance	
10	Limit of plausibility fault recognition when lowering 2-distance sensor axle [1]	Counts
11	Tolerance for nominal level of the 1-distance sensor axle (> = 3)	Counts
12	without significance	
13	Tolerance for nominal level of the 2-distance sensor axle (> = 3)	Counts
14	permissible right/left deviation in nominal levels (> = 3)	Counts
15	Permissible right/left deviation outside the nominal levels	Counts
16	permissible front/rear deviation outside the nominal levels	Counts
17	without significance	
18	Difference (nominal level - actual level), when difference smaller than, equal, the main flow throttle switches to small cross-section [2]	Counts
19	Difference (normal level 1 - actual level), when difference is exceeded, starting lock is only active during kneeling	Counts
20	Difference (normal level 1 - actual level), when difference is exceeded (front and rear axle), door may be enabled during kneeling	Counts
21	Difference (normal level 1 – kneeling level) by which the 1-distance sensor axle may be lowered during kneeling	Counts
22	without significance	
23	Difference (normal level 1 – kneeling level) by which the 2-distance sensor axle may be lowered during kneeling	Counts
24	Kneeling offset: This is the value by which the 1-distance sensor and 2-distance sensor axle is reversed when the pushbutton is released in the event of manual kneeling (when actual level > kneeling level + 2 × tolerance)	
Speeds		
25	Vehicle speed up to which targeted height changes can be made (must be < = parameter 26, otherwise limited to parameter 26!)	km/h
26	Road speed at which, when exceeded, the normal level is automatically activated (must be> = Parameter 25 **and** > 0 km/h!)	km/h
27	Road speed at which, when exceeded, the old nominal level is set again (must be < parameter 26 , otherwise limited to parameter 26!)	km/h

No.	Meaning	Unit
Control		
28	Control delay when stationary	250 ms
29	Pulse repetition period T	25 ms
30	Buffer recognition time	250 ms
31	Pulse divider	----
32	Proportional coefficient Kpv for desired-level controller 1-distance sensor axle	1/3 counts
33	without significance	
34	Differential coefficient Kph for desired-level controller 2-distance sensor axle	1/3 counts
35	Differential coefficient Kdv for nominal level controller 1-distance sensor axle	1/3 counts
36	without significance	
37	Proportional coefficient Kdh for desired-level controller 2-distance sensor axle	1/3 counts
Times		
38	Delay for plausibility fault recognition	10 sec
39	Standby time (only downward adjustments are permitted, ECAS "OFF")	10 sec
40	Delayed activation of control delay when driving	10 sec
Pressures		
41	Minimum pressure at which, when exceeded, the tyre impression compensation becomes effective	1/20 bar
42	Maximum pressure at which the tyre impression is compensated with the maximum offset	1/20 bar
43	Maximum offset for compensating the tyre impression	1/20 bar
Control delay		
44	Control delay when driving	250 ms

1) Units and tens digits indicate the distance in counts.
Hundreds digit = 0 : Buffer region = lower end position ... lower end position + distance
Hundreds digit = 1 : Buffer region = 0...lower end position + distance

2) Units and tens digits indicate the difference in counts.
Hundreds digit = 0 : Lift from kneeling level to normal level with an appropriate the main flow throttle cross section.
Hundreds digit = 1 : Lift from kneeling level to normal level only with a large main flow throttle cross section. In all other cases, control/lift/lower with the corresponding main flow throttle cross section, taking into account the programmed difference.

8.3.3 Description of the parameters

Parameter 0

Parameter 0 sets the device address that the Diagnostic Controller uses to communicate with the ECU. By default, the address 16 is set for the electronic unit of the bus. However, if two electronic control units are connected to the Diagnostic Controller - as is the case with articulated buses for example - the address 17 is predefined in this parameter for the electronic control unit in the rear section. This allows differentiated diagnosis with the Diagnostic Controller for the desired electronic control unit.

Parameter 1

Bit 0: Is set to "0". The setting "1" is without significance.

Bit 1: Air suspension on front and rear axle
If the bus has air-suspended front and rear axles which are to be controlled with ECAS, then this bit must be set to "1". If only one axle is to be controlled, as in the rear section for example, "0" is entered. This one axle must have two distance sensors.

Bit 2: Kneeling of the axle with one distance sensor
It is possible to choose between kneeling of an entire axle (left and right), kneeling of a complete side of the vehicle, or kneeling of only one side of an axle.

If only one axle is to lowered left and right, the only axle that can be selected in this case is the axle with only one distance sensor (i.e most likely the front axle). Bit 2 must be set to "0".

If the vehicle is to be kneeled to the right, bit 2 is set to "1". As a result, the setting according to bits 3 and 4 becomes valid.

Bit 3 and bit 4: Kneeling of the right side
Depending on the settings for bits 3 and 4, the following types of kneeling are possible at the axle with one distance sensor (1-distance sensor axle, usually the front axle) and at the axle with two distance sensors (2-distance sensor axle, usually the rear axle):

	Bit 3	Bit 4
Kneeling only of the 1-distance sensor axle right	1	0
Kneeling only of the 2-distance sensor axle right	0	1
Kneeling right both axles	0 1	0 1

Buses with doors on the left side of the vehicle
In general, only right-side kneeling is referred to here since most vehicles are designed for right-hand traffic. ECAS can, of course, be brought to kneel on the left-hand side:as well. This is achieved by a simple workaround: the distance sensors and the solenoid valves are simply connected to the respectively opposite

side. Here the distance sensor of the left side of the vehicle, for example, is not connected to pin 25 (distance sensor 2-distance sensor axle left) but to pin 8 (distance sensor 2-distance sensor axle right); the right sensor is correspondingly connected to pin 25. The same procedure is used for the solenoid valves on the two axles.

Bit 5: Distance sensor arrangement
To ensure the correct assignment of distance sensors to solenoid valve, the position of the distance sensors must be communicated to the electronic control unit by means of bit 5:

If the 2-distance sensor axle is the rear axle and the 1-distance sensor axle is the front axle, bit 5 must be set to "0" and if it is the other way round, it must be set to "1".

If only one axle (with two distance sensors) is controlled, bit 5 must specify the position of this axle: "0" for rear and "1" for front.

Bit 6: Number of calibration levels
If the value "0“ is entered here, the ECU expects three level positions during the calibration process: normal level 1, the highest and the lowest nominal level.

If the value "1“ is set, only the normal level is calibrated. Before calibrating this level alone however, the two other levels must be entered as count values via the Diagnostic Controller.

Bit 7: Automatic periphery detection
If bit 7 = "1", the ECU checks the electrical connections prior to calibration and uses this information to determine which system configuration is being used.

The parameters describing the configurations are automatically set accordingly.

If bit 7 = "0" is set, options apply in accordance with specifications of the entered parameter set.

Parameter 2

Bit 0: Output Enable door
According to German law, no door must be open at the start of kneeling. To meet this requirement, the door control is locked via pin 11 of the ECAS ECU during kneeling and lowering / lifting and subsequently enabled again.

According to the setting of bit 0, enabling occurs either by energising pin 11 (switch from currentless to +Ub – bit 0 = "1") or by terminating the current supply (switch of +Ub to currentless – bit 0 = "0"). The pin can be loaded with currents not exceeding 500 mA.

In the ECU ... 050 0, enabling the door only occurs by switching +Ub to currentless, a different setting is not possible. Bit 0 is without function in this variant should be set to "0".

Bit 1: Without function
Setting this bit does not affect the function. However, the value "0" should be entered for clarity.

Bit 2: System with pressure sensor
If the system has a pressure sensor, in order to perform tyre impression compensation for example, bit 2 should be set to "1", otherwise it should be set to "0".

The ECU 446 055 050 0 is not designed for the connection of a pressure sensor. The setting of bit 2 is therefore insignificant. The value "0" should be set, however, to maintain a clear structure of the parameter set.

Bit 3: Manual / Automatic kneeling
The kneeling process can be initiated either a briefly pressing the button (automatic) or by keeping the button pressed until the lowering process is complete (manual).

The difference between these two types of kneeling is a safety criterion: With manual kneeling, the driver only needs to release the kneeling button (pin 23) to cancel the lowering process if he sees any danger.

To cancel the lowering process during automatic kneeling, the stop button must be pressed or the safety contact-strip ("sidewalk detector") underneath the entrance must be triggered.

To allow the driver to choose between these two types of kneeling, the following options are available for bit 3:

Bit 3 = "0". A switch connected to pin 21 is used to select automatic or manual kneeling. A pushbutton on pin 23 executes the preselected kneeling process.

Of course it is also possible to implement a cable bridge on pin 21 so that a permanently preselected is executed.

Bit 3 = "1". It is possible, for example, to install two pushbuttons in the instrument panel: The button for automatic kneeling is connected to pin 21 and the button for executing manual kneeling is connected to pin 23.

Bit 4: Valve monitoring on pin 11
If bit 4 is set to "0", the connection to the valve or relay connected to pin 11 for enabling the door, is monitored for interruption and short circuit to ground or +Ub. The general valve monitoring must also be activated however (bit 6 = "0").

If bit 4 = "1", this output is not monitored, so there is also no fault memory entry in the event of an interruption - caused by an emergency switch for example.

Bit 5: Valve monitoring on pin 29
If bit 5 is set to "0", the connection to the valve or relay connected to pin 29 for the starting lock, is monitored for interruption and short circuit to ground or +Ub. The general valve monitoring must also be activated however (bit 6 = "0").

If bit 5 = "1", this output is not monitored, so there is also no fault memory entry in the event of an interruption - caused by an emergency switch for example.

With ECU ... 051 0, these outputs are only monitored at speeds above 7 km/h to avoid faults due to the effect of external circuits when stationary.

Bit 6: Monitoring of the solenoid valves

If bit 6 is set to "0", the connected solenoid valves for controlling the air suspension bellows, as well as the valves, configured by bit 4 and 5, for control of the door enabling function and the starting lock are monitored for interruption, short circuit to ground and short circuit to +Ub.

If bit 6 = "1“ is set, the solenoid valves are not monitored and therefore there there is also no entry into the fault memory in the event of a fault.

Bit 7: Measured value output

If bit 7 = "1“ is set, ECU constantly transmits eight measured values, calculated on the basis of the sensor values, to the ECU. The measuring points are defined according to the following assignment:

1 actual value distance sensor 2-distance sensor axle left

2 actual value distance sensor 2-distance sensor axle right

3 actual value distance sensor 1-distance sensor axle

4 actual value pressure sensor

5 nominal value Level 2-distance sensor axle left

6 nominal value Level 2-distance sensor axle right

7 nominal value Level 1-distance sensor axle

8 current vehicle speed

The measured values 1 to 7 are output as counts, the speed is output in km/h.

The values for the nominal level are output according to the tyre impression compensation settings. If a nominal value "Normal level 1" has been preselected and the vehicle is laden, a higher than calibrated value is output when a tyre impression compensation has been defined.

If the system does not have one of the measurement points (point 3 for example in systems with only one controlled axle), the value "0" or "255" is output.

The measured value output must only be applied during the definition of parameters. Since the electronic unit is constantly transmitting data, it is otherwise impossible to start diagnostic operation with the diagnostic program card 446 300 528 2.

To complete the parameter settings, bit 7 must be set to "0".

Parameter 3

Bit 0: Control of a main flow throttle

To prevent overshooting the nominal level during level control processes, provision is made for control of a main flow throttle as an addition measure to adjusting the control parameters described in section "the control algorithm".

This main flow throttle, which is connected between the air-intake valve and the directional control valves 2/2 of the individual air suspension bellows, can be switched from a free position (large cross section) to a throttle position (e.g. ø 2) by a solenoid.

If bit 0 is set to "1", the throttle position is activated at a proximity to the nominal level defined by parameter 17, so that level change can only take slowly beyond this point.

If a main flow throttle is not to be used, bit 0 must be set to "0".

Bit 1: Switchable transverse throttle on the 1-distance sensor axle.

At an axle with only one distance sensor, the two bellows must always be interconnected by at least one transverse throttle. This ensures a slower pressure equalisation between the bellows even when the solenoid valves are closed, and so prevents the vehicle from tilting due to different pressures.

If the bus is to kneel on one side, the pressure on this side must be lowered. Pressure equalisation between the bellows must be prevented at this moment, it must be possible to block the transverse throttle by means of a solenoid valve for the duration of the kneeling.

With bit 1 = "1", a transverse throttle is defined on pin 18 of the ECU. In this case, pin 18 is never switched currentless while a kneeling function is active; in the alternative case, +Ub is applied to pin 18.

If a transverse current flow throttle is not installed, bit 1 must be set to "0“.

Bit 2: Door status during kneeling

According to German law, the door must not be open at the start of a kneeling process.

The status of the door is queried via a signal input of the ECU (pin 5), provided bit 2 = "1" is set. In this case, an automatically started kneeling or a lift/lower command is not executed when the door is open.

This function can be deactivated for buses operating in other countries: if bit 2 = "0" is set, automatic kneeling can be initiated even the door is open. If manual kneeling is required regardless of the door being open, this can be achieved by simple means: Parameter 3, bit 7 is set to "0" and the switching input for the door status, pin 5, is not connected.

Bit 3: Control of left side during kneeling
Depending on the control point of the left distance sensor and the force output by the axle stabiliser, kneeling produces a different level on the left side of the vehicle even though the quantity of air in the left bellows was not changed.

Bit 3 can only be used to define whether the level attained on the left side of the vehicle after a kneeling process should be maintained for the duration that the vehicle is in a kneeling position.

If bit 3 = "0“ is set, control occurs on the left side while the vehicle is in a kneeling position.

If bit 3 = "1“ is set, the left side is only controlled (adjustment only if required) after the right side has been lifted into normal level.

The same applies to the second axle if axle by axle kneeling is carried out.

Bit 4: Level control with applied brake
ECAS does not normally execute control while the brakes are applied since the level change caused by the braking obviously does not have to be readjusted:

The shift in axle loads during braking causes only a brief lowering of the vehicle and the old level is restored on its own accord the next moment. However, if air was fed into the front bellows at the moment the vehicle pitches, it would need to be vented again later.

This is not the case at the bus stop: Here the vehicle is prevented from rolling away by the brakes, but the change in load (passengers getting on or off) may necessitate level adjustment.

To take this circumstance into account, it is possible to perform a level adjustment when the brake if applied, provided the door is also open. In this case bit 4 must be set to "1".

If bit 4 = "0", then no adjustment is made as long as the brakes are applied.

Bit 5: Output Enable door
The door enabling function was already described for the setting of parameter 2, bit 4.

Bit 5 = "1" permits use of the door enabling function on pin 11. If the output is not connected, bit 5 must be set to "0".

Bit 6: Output starting lock
The starting lock function was already described for parameter 2, bit 5.

Bit 6 = "1" permits use of the starting lock function on pin 29. If the output is not connected, bit 6 must be set to "0".

Bit 7: Input Door status
Analogous to the description for parameter 3, bit 2, the execution of automatic kneeling as well as the execution of lifting and lowering processes can be made to depend on the door position.

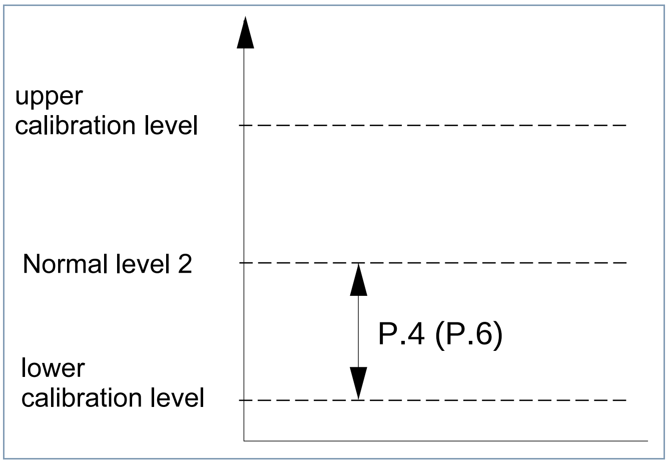
Information on whether a door is open or closed is queried via the signal input pin 5.

In this respect it is optional whether the 'open' status of a door is defined by pin 5 being connected to ground (bit 7 = "0") or by being connected to +Ub (bit 7 = "1"). A closed door is indicated by the respectively other potential or by the pin being potential-free (for ECU 050 0, an additional resistor may be required).

Parameter 4

Height of normal level 2 of the 1-distance sensor axle (counts).
The second normal level, to be set via a switching contact, is entered as a differential (distance) to the lower calibration level.

The P.4 setting is illustrated by the following figure:



Parameter 5

Parameter 5 is without function and is set to zero.

Parameter 6

Height of normal level II of the 2-distance sensor axle (counts). The setting is made analogous to P.4 for the 2-distance sensor axle.

Parameter 7

Plausibility limit at the 1-distance sensor axle (counts). P.7 acts differently depending on the lowest permissible level determined:

- Lower height limit (lowest level) is the rubber buffer
- P.7 is selected greater than 100. The value to be entered is determined by the elasticity of the rubber buffer; an empty vehicle does not compress the rubber buffer as much as a laden vehicle. If the vehicle was calibrated when it was laden, the unladen vehicle will not be able to reach this lowest level,

despite complete exhaust of the bellows and a plausibility error is signalled accordingly.

- The ECU identifies the "rubber buffer“ and terminates the exhaust process when the level drops below the set level (end level + P.7- 100) and there is no further height change during the time specified by P.29 (buffer detection time). This prevents complete exhaust of the bellows. The level reached is stored as the new nominal level.

Recommended setting: If the vehicle was calibrated unladen, a value between 110 and 125 should be parameterised so that no plausibility fault is detected even when the vehicle is tilted, only making contact with the buffer on one side. If the vehicle was calibrated when laden, a value between 120 and 135 is sensible.

- The lowest level is above the rubber buffer
- If the lower height limit is above the rubber buffer, this is communicated by value for P.7 that is below 100. In this case the bus can only be lowered to the calibrated lower level.
- In the event that the body still makes contact with the buffer above this level due to an uneven road surface, the following applies: The exhaust process is terminated as soon as the level drops below the set level (calibration level + P.7) **and** there is no further height change during the time specified by P.29 (buffer detection time). As plausibility problems are generally only possible when the vehicle is severely tilted, we recommend setting the value between 5 and 20, depending on the distance between the calibration level and the buffer.

When, during a lowering process, no downward distance change (at least 1 count) is observed **above** the limit formed by P.7 and stop level within 30 seconds, the ECU detects a plausibility fault.

Especially in buses with right-side kneeling it must be taken into account that the axle stabiliser may prevent adequate lowering. When kneeling level = buffer stop is parameterised without contact being made with the buffer, the ECU detects a plausibility fault.

The distance sensor of the 2-distance sensor axle - a sensor that is not directly attached at the wheel - will also fail to output the lowest level during side kneeling even though the buffer stop has been reached. While axle and body are in parallel when the bus is calibrated on the buffer, they are at an angle during kneeling. If the distance sensor is fitted nearer the middle of the axle, the sensor value during kneeling lies somewhere between the normal level and the lowest level.

Here the only remedy is an increased plausibility limit or the selection of a higher kneeling level that can be read out by the measured value output.

Parameter 8

Parameter 8 is without function and is set to zero.

Parameter 9

Plausibility limit on the 2-distance sensor axle (counts) Analogous P.7 for the 2-distance sensor axle.

Parameter 10

Tolerance of the nominal level at the 1-distance sensor axle (counts). The setting for this parameter together with the proportional and differential coefficients determines the system's adjusting quality at the front axle. See chapter "Control Algorithm".

Parameter 11

Parameter 11 is without function and is set to zero.

Parameter 12

Tolerance of the nominal level at the 2-distance sensor axle (counts). Corresponds to parameter 10 for the 2-distance sensor axle

Parameter 13

Permissible right/left deviation in the nominal level (counts). This parameter acts at the 2-distance sensor axle. It specifies the permissible body tilt e.g. under laterally uneven load distribution.

Values greater than 2 × P.12 are not reasonable and are automatically limited to 2 × P.12 by the ECU.

Parameter 14

Permissible deviation right/left for lifting/lowering process (counts). Unlike P.13, it is not the control process in the range near the nominal level which is being specified but the process during greater level changes. On a vehicle with a greater load on one side, the side which has less weight on it will be raised more rapidly than the other (or the side with the greater load will be lowered more rapidly), thus causing a unintentional inclination as the level is being changed. By pulsing the corresponding bellows, a more even lifting/lowering process is achieved.

The pulse length is determined by the pulse divider (P.30).

Parameter 15

Permissible deviation front/rear for lifting/lowering process (counts).
The level control of the vehicle with tow air-suspended axles should generally be implemented in such a way that the body front and rear reach the new nominal level more or less at the same time. The axle with the shorter path to the new level is lifted/lowered more slowly by means of corresponding air-intake / air-exhaust pulses. Parameter 15 is used to specify the extent to which control is to match an ideally even level change of the two axles.

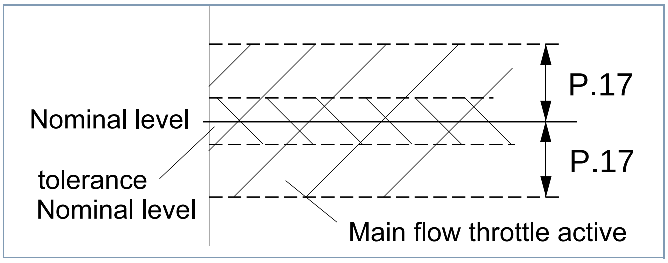
A very low tolerance is therefore not desirable since this will this cause constant pulsing of the solenoid valves during the control process.

Parameter 16

Parameter 16 is without function and is set to zero.

Parameter 17

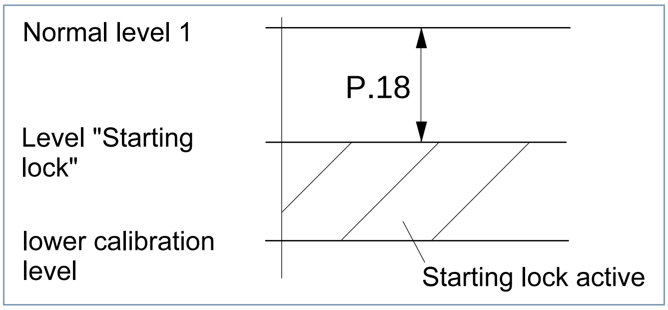
Distance to nominal level for activation of the main flow throttle (counts).
If the system is equipped with a main flow throttle (also see parameter 3, bit 0), it can be used to reduce the air flow as the body approaches the required nominal level thereby decelerating movement beyond this point. This measure can help to prevent overshooting beyond the nominal level and so to avoid the need for corrective control. P.17 specifies at which distance to the nominal level throttling should occur, regardless of whether it is a lifting or lowering movement (should be > 2 × tolerance).



Parameter 18

Level for switching on the starting lock (counts).
After the vehicle has been lowered by means of kneeling, the starting lock is activated as soon as the level drops below normal level. As soon as the level specified in P.18 is exceeded after kneeling, the starting lock is disabled again.

This level is set as a differential to normal level 1 (calibration level) (> 2x tolerance):



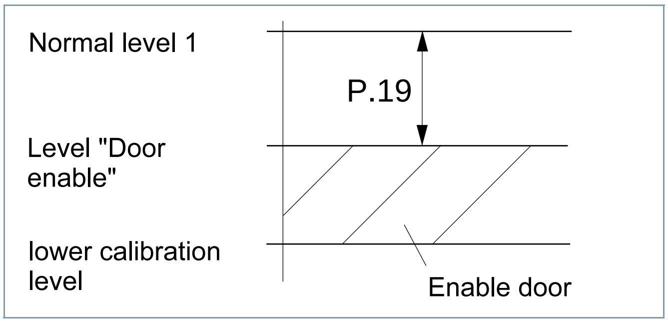
Parameter 19

Level for switching on the door enabling function (counts). In principle, the door is enabled at every level. It is only disabled temporarily during level changes.

To save time during kneeling, it is permissible according to German law to open the door even before the kneeling level is reached, provided the door is not opened by more than 80% upon reaching the kneeling level.

It is therefore only possible to set a level below which it is permitted to enable the door "prematurely" during automatic or manual kneeling.

This level is set relative to normal level 1:



Parameter 20

Kneeling level 1-distance sensor axle (counts). This parameter is used to define for the 1-distance sensor axle the level to which the vehicle is lowered during automatic kneeling.

During manual kneeling, the driver must keep the pushbutton pressed until at least this level (more precisely: kneeling level + 2 x nominal level tolerance) is reached, otherwise lowering is cancelled. Provided this is set via P. 23, the vehicle may even need to be lifted again after such an event.

With ECU ... 051 0, the signal lamp "Kneeling level reached" lights up once this level (+ 2 × tolerance) is reached.

Analogous to parameters 18 and 19, this level is set relative to normal level 1.

Parameter 21

Parameter 21 is without function and is set to zero.

Parameter 22

Kneeling level 2-distance sensor axle (counts). Analogous to P.20 for the 2-distance sensor axle.

Parameter 23

Reversing after kneeling is cancelled (counts)
If the pushbutton is released during manual kneeling before the kneeling level is reached, the lowering movement is immediately cancelled, followed by an upwards movement up to a height specified by P. 23. A reverse process beyond normal level 1 is only carried out up to normal level 2.

Parameter 24

Road speed up to which the raising/lowering commands are accepted (km/h). This parameter can be used to set the road speed up to which specific level changes can be initiated by the driver.

The maximum speed up to which the driver can change the ride height is the speed specified in parameter 25.

The maximum speed up to which kneeling can be requested is fixed at 5 km/h.

Parameter 25

Automatic normal level (km/h)
For safety reasons, it may be required driving at higher speeds is only possible at the normal levels. P.25 is used to set a speed threshold above which the level is automatically adjusted to the preselected normal level.

The value for P.25 must be greater than the value of P.24 and greater than 0 km/h!

Parameter 26

Automatic return to the old nominal level (km/h)
Generally, it is not desirable that a return to the previous (prior to exceeding the speed threshold P.25) nominal level is initiated at speeds directly below the speed specified by P.25. In this case, constant adjustments would occur at speeds in the region of this threshold (e.g driving in a line of traffic).

It makes more sense to define a second limit speed at some distance to P.25; return to the old nominal level is then controlled below this second speed.

The second speed threshold is freely definable, but is imperative that it is below the value for P.25.

If the level should not return to the old nominal level and the normal level should remain current instead, P.26 is set to zero.

Parameter 27

Control delay when stationary (in 250 ms)
A sensible value for control delay when stationary is generally considered to be one second (4 counts). This control delay allows for a stabilising phase after each adjustment, providing time for the final level position to be reached before another (corrective) adjustment is initiated.

Parameter 28

Pulse repetition period (25 ms)
The function of the pulse repetition period is described in chapter "The control algorithm". A sensible value for P.28 is 300 ms. Accordingly, 12 counts must be entered.

Parameter 29

Buffer recognition time (in 250 ms).
The buffer recognition time should be < 30 sec (< 120 counts) in order to prevent plausibility faults.

See parameter 7.

Parameter 30

Pulse divider (counts)
See P.14. Describes the time fraction of a cycle for the length of which the faster moving vehicle side is pulsed. Pulse times below 75 ms are not executed.

If the value "255" is entered, the solenoid valve on the faster moving vehicle side is closed until the body is once again within the permitted tolerance in accordance with P.14.

Parameter 31

Proportional coefficient Kp for the 1-distance sensor axle (1/3 counts)
Settings for the level controller are described in chapter "The control algorithm".

Parameter 32

P.32 is without function and is set to zero.

Parameter 33

Proportional coefficient Kp for the 2-distance sensor axle (1/3 counts)
Settings for the level controller are described in chapter "The control algorithm".

Parameter 34

Differential coefficient Kd for the 1-distance sensor axle (1/3 counts)
Settings for the level controller are described in chapter "The control algorithm".

Parameter 35

P.35 is without function and is set to zero.

Parameter 36

Differential coefficient Kd for the 2-distance sensor axle (1/3 counts)
Settings for the level controller are described in chapter "The control algorithm".

Parameter 37

Delay of the plausibility fault recognition (in 10 sec)
If ECAS is to carry out a level adjustment immediately after the engine is started, a plausibility fault may occur due to insufficient supply pressure. This can be delayed via P.37 until the compressor has conveyed sufficient air for correct function.

Before this delay period has expired, the right-hand kneeling is terminated by simultaneous adjustment of the left and right side. Although this hardly ever occurs in practice, rolling movements or extreme overshooting may make it noticeable during a test that includes the kneeling function (frequent switching on and off of the ignition).

Parameter 38

Standby period after ignition switched off (10 sec)
A situation could arise where the engine is switched off (having reached its destination) before all passengers have got off the bus.

As the ECAS only works when the ignition is switched on, the level will rise as there is no corrective control.

P. 38 can be used to set a standby period within which ECAS responds to an increase in level and vents the bellows.

Adjustments other than venting are not carried out despite P.38 being set.

Parameter 39

Delay of control in accordance with driving (in 1s)
As soon as the ECU detects a driving speed of the vehicle, a control delay of 60 sec comes into effect to prevent adjustments to uneven road surfaces.

This may be a disadvantage under certain circumstances when starting off from a bus stop:

- when, due to an uneven surface of the bus bay, the vehicle was tilted before starting to drive off and secured against rolling by the service brake being applied, thus preventing a level adjustment while the vehicle was stationary,
- when the input "Brake" is used to intentionally prevent a level adjustment while the door is open to avoid the danger of tripping over the moving edge of the entrance.

in each of the cases above, the bus could have an unfavourable level when starting to drive and this would not be corrected for another 60 seconds.

After leaving the bus stop (start of drive), a single additional level correction is performed once the vehicle is on an even surface and the time specified in P.39 has elapsed. The control delay for the condition "drive" is only reactivated after this adjustment.

Remark: When using this parameter, it must be taken into account that the vehicle may be entering a corner while the adjustment takes place and that the cornering roll will be corrected in this case.

The following parameters are without function in the ECU ... 050 0 because this electronic control unit does not have a tyre impression compensation. The value for the following parameters must therefore be set to zero.

Parameter 40

Pressure value at which, when exceeded, the tyre impression is compensated (in 1/20 bar)
An especially short compression travel of the air spring may be required for buses with particularly high superstructures so that they still comply with the legal provisions regarding maximum vehicle height.

This may cause the body to bottom onto the buffers when the vehicle is heavily laden or the road surface is extremely uneven.

When the vehicle is heavily laden, the tyre impression is also greater however, reducing the overall vehicle height.

A pressure sensor, in combination with the ECU 446 055 051/052/054/055 0, can be used to determine the degree of loading. The distance between axle and body can be increased when load is added, resulting in a longer compression path while the vehicle height remains constant.

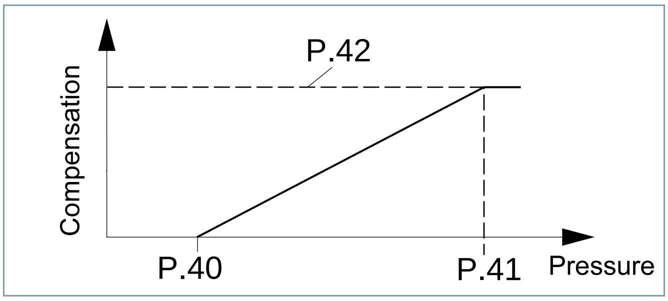
P. 40 is used to set the pressure value above which the compensation should become effective. This is generally the value that is present in the supporting bellows when the vehicle is unladen.

Parameter 41

Pressure for maximum compensation (in 1/20bar)
P.41 describes the pressure in the support bellows at which the greatest tyre impression occurs that should be compensated. Generally, this will be the bellows pressure when the vehicle is fully laden.

Parameter 42

Maximum offset used for compensating the tyre impression (in counts)
Here the normal level offset compensating increased tyre pressure due to increased load is entered. The offset is linearly dependent on the load, i.e the nominal value offset occurs evenly between the lower pressure value in accordance with P.40 (Offset = 0) and loading in accordance with P.41 (Offset = max. value = P.42).



8.4 Sample parameters for ECU CAN I

8.4.1 Option parameters

Enter the total of the decimal numbers

No.	Meaning	Decimal
0	ECAS unit address if several units are on the address (data) bus	
1	Bit 0 **0** rear section **1** Solo bus or front section	0 1
	Bit 1 **0** no kneeling on the 1-distance sensor axle [1) 2)] **1** kneeling on the 1-distance sensor axle	0 2
	Bit 2 **0** no kneeling on the 2-distance sensor axle **1** kneeling on the 2-distance sensor axle	0 4
	Bit 3 **0** one-sided kneeling right on the 1-distance sensor axle **1** two-sided kneeling on the 1-distance sensor axle	0 8
	Bit 4 **0** one-sided kneeling right on the 2-distancesensor axle **1** two-sided kneeling on the 2-distancesensor axle	0 16
	Bit 5 **0** without separate pressure switch for air suspension supply pressure **1** with separate pressure switch for air suspension supply pressure	0 32
	Bit 6 **0** 3 calibration levels **1** only calibrate normal level	0 64
	Bit 7 **0** without pressure sensor for tyre impression compensation [3)] **1** with pressure sensor for tyre impression compensation	0 128
2	Bit 0 **0** without switchable transverse lock **1** with switchable transverse lock	0 1
	Bit 1 **0** vehicle in kneeling position Correction to the current level on the unkneeled side **1** Vehicle in kneeling position: No correction to the current level on the unkneeled side	0 2
	Bit 2 **0** Suppression of automatic level control when brake is applied regardless of door position **1** Suppression of automatic level control when brake is applied only while door is closed	0 4
	Bit 3 **0** Transverse lock only in the case of side kneeling **1** Transverse lock function in the case of side kneeling and at V > 0 km/h	0 8
	Bit 4 **0** Reference level for normal level 2 parameter settings is the lower calibration position **1** Reference level for normal level 2 parameter settings is the lower calibration position	0 16
	Bit 5 **0** no transverse lock function during standby time after ignition is switched off **1** Transverse lock active during standby time after ignition is switched off	0 32
	Bit 6 **0** "Gentle" control function permissible with door open **1** suppress automatic level control if at least one door is open	0 64
	Bit 7 **0** Nominal levels during kneeling are preset by parameters 22 and 23 **1** Lower down to buffer on the side to be kneeled during kneeling	0 128
3	Bit 0 **0** without sidewalk detector **1** with sidewalk detector on ECU plug X1/6	0 1
	Bit 1 **0** without fault monitoring of sidewalk detector **1** with fault monitoring of sidewalk detector	0 2
	Bit 2 **0** sidewalk detector as break contact **1** sidewalk detector as make contact	0 4
	Bit 3 **0** Disregard door position during kneeling **1** Take door position into account during kneeling. Kneeling and at V > 0 km/h	0 8
	Bit 4 **0** not connected	
	Bit 5 **0** not connected	
	Bit 6 **0** not connected	
	Bit 7 **0** not connected	

No.	Meaning	Decimal
4	Bit 0 **0** without measured value output **1** with measured value output	0 1
	Bit 1 **0** with valve monitoring **1** without valve monitoring	0 2
	Bit 2 **0** Emergency operation only via info "Lift" or "Lower" **1** Emergency operation via info "normal level“ (-> raising) or "kneeling“ (-> lowering)	0 4
	Bit 3 **0** Do not change the tyre impression compensation offset during a control process **1** Recalculate the tyre impression compensation offset during a control process	0 8
	Bit 4 **0** not connected	
	Bit 5 **0** not connected	
	Bit 6 **0** not connected	
	Bit 7 **0** not connected	

1) Operation is not possible with only one distance sensor.

2) If this bit is changed, the ECAS distance sensors must be recalibrated.

3) After changing this bit from "0" to "1", the pressure sensor must be recalibrated.

8.4.2 Value parameters

No.	Meaning	Unit
5	Differential normal level 2 on the 1-distance sensor axle (input depends on parameter 2, bit 4)	Counts
6	Differential normal level 2 on the 2-distance sensor axle (input depends on parameter 2, bit 4)	Counts
7	Tolerance for nominal level at the 1-distance sensor axle (must be greater than or equal to 3 counts)	Counts
8	Tolerance for nominal level at the 2-distance sensor axle (must be greater than or equal to 3 counts)	Counts
9	permissible right / left deviation at nominal level on the 2-distance sensor axle (must be greater than or equal to 3 counts)	Counts
10	permissible right / left deviation outside the nominal level on the 2-distancesensor axle (must be greater than or equal to 3 counts)	Counts
11	permissible front/rear deviation outside the nominal levels	Counts
12	Plausibility check limit during lowering at the 1-distance sensor axle	Counts
13	Plausibility check limit during lowering at the 2-distance sensor axle	Counts
14	Period for plausibility check	Counts
15	Delay of plausibility check after "Ignition ON“	10 sec

No.	Meaning	Unit
16	Standby time after "Ignition OFF" -> only downward control is permissible (then ECAS-ECU "OFF")	min
17	V_{limit} Vehicle speed up to which selective height changes can be carried out via the Lift/Lower button (must not be > parameter 18!)	km/h
18	V_{Norm} Vehicle speed at which, when exceeded, automatic adjustment to the normal level occurs (must be > 0, may not be < parameter 17!)	km/h
19	Control delay when stationary	250 ms
20	Control delay when driving	sec
21	Buffer recognition time (should be < parameter 14!)	250 min
22	Differential (normal level 1 – kneeling level) by which the 1-distance sensor axle can be lowered during kneeling	Counts
23	Differential (normal level 1 – kneeling level) by which the 2-distance sensor axle can be lowered during kneeling	Counts
24	Kneeling offset: When the pushbutton is released during manual kneeling, the level is adjusted in the opposite direction by this value (when actual value > kneeling value + 2 × nominal level tolerance)	Counts
25	Differential [normal level 1 - actual level] at which, when exceeded the starting lock is active (only during kneeling)	Counts
26	Pressure at which, when exceeded, the tyre impression compensation at the 1 distance sensor axle becomes active.	1/20 bar
27	Pressure at which the tyre impression compensated by the maximum value at the 1-distance sensor axle	1/20 bar
28	Maximum value by which the tyre impression is compensated at the 1-distance sensor axle	Counts
29	Pressure at which, when exceeded, the tyre impression compensation at the 2 distance sensor axle becomes active.	1/20 bar
30	Pressure at which the tyre impression compensated by the maximum value at the 2-distance sensor axle	1/20 bar
31	Maximum value by which the tyre impression is compensated at the 2-distance sensor axle	Counts
32	Differential [nominal level - actual level], at which, when the door is open, the limitation for the lifting / lowering speed sets in	Counts
33	maximum lifting/lowering speed when the door is open	Counts/ 600 ms
34	Switch-off time of the PWM signal for valve control when the door is open	25 ms
35	PWM periodic time of the PWM signal for valve control when the door is open	25 ms
36	maximum duration of the pulsing control	25 ms

No.	Meaning	Unit
37	Limit value of lateral acceleration at which, when exceeded, cornering is detected (no automatic level corrections when cornering)	0,1 m/s^2
38	Delay for plausibility fault detection	10 sec
39 … 46	unassigned	

8.4.3 Description of the parameters

Parameter 0

Parameter 0 defines the device address that is used to communicate with the electronic control unit.

Parameter 1

Bit 0: Air suspension on front and rear axle
If the bus has air-suspended front and rear axles that are to be controlled by ECAS, then this bit must be set to "1". If only one axle is to be controlled, in the rear section for example, "0“ is entered. This axle must have two distance sensors.

It is possible to choose between kneeling of an entire axle (left and right), kneeling of a complete side of the vehicle, or kneeling of only one side of an axle.

If an axle is to be lowered on the left and the right, bit 3 and 4 must be set to "1“. If the vehicle is to be kneeled on the right side, bits 3 and 4 are set to "0“. In this regard, it is important to take bit 1 and 2 into account.

Bit 1: Kneeling of the axle with one distance sensor

Bit 2: Kneeling of the axle with two distance sensors

Bit 3 and bit 4: Kneeling of the right side
Depending on the settings for bits 3 and 4, the following types of kneeling are possible at the axle with one distance sensor (1-distance sensor axle, usually the front axle) and at the axle with two distance sensors (2-distance sensor axle, usually the rear axle):

	Bit 1	Bit 2	Bit 3	Bit 4
Kneeling only of the 1 distance sensor right	1	0	0	1
Kneeling only of the 2 distance sensors	0	1	0	0
Kneeling right both axles	1	1	0	0

Buses with doors on the left side of the vehicle
In general, only right-side kneeling is referred to here since most vehicles are designed for right-hand traffic. ECAS can, of course, be brought to kneel on the left-hand side:as well. This is achieved by a simple workaround: the distance sensors and the solenoid valves are simply connected to the respectively opposite side. The distance sensor of the left vehicle side, for example, is not connected to pin X2/5 (distance sensor 2 distance sensors left) but to pin X2/8 (distance sensor 2-distance sensor axle right); the right sensor is accordingly connected to pinX2/5. The procedure is identical for the solenoid valves on the two axles.

Bit 5: Presence of a separate pressure switch

Bit 6: Number of calibration levels
If the value "0" is entered here, the ECU expects three level positions during the calibration process: normal level 1, the highest and the lowest nominal level.

If the value "1" is set, only the normal level is calibrated. Before calibrating this level alone however, the two other levels must be entered as count values via the Diagnostic Controller.

Bit 7: Installation of a pressure switch for tyre impression compensation.

Optional parameter 2

Bit 0: Switchable transverse lock
At an axle with only one distance sensor, the two bellows must always be interconnected by at least one transverse throttle. This ensures a slower pressure equalisation between the bellows even when the solenoid valves are closed, and so prevents the vehicle from tilting due to different pressures.

If the bus is to kneel on one side, the pressure on this side must be lowered. Pressure equalisation between the bellows must be prevented at this moment, it must be possible to block the transverse throttle by means of a solenoid valve for the duration of the kneeling.

If bit 1 = "1", a transverse throttle is set on pin X2/14 of the ECU. As long as a kneeling function is active, pin X2/14 is switched currentless in this case; if the other case applies, +Ub is applied to pin X2/14.

If a transverse current flow restrictor is not installed, bit 1 must be set to "0".

Bit 1: Adjustment of the left side during kneeling
Depending on the control point of the left distance sensor and the force output by the axle stabiliser, kneeling produces a different level on the left side of the vehicle even though the quantity of air in the left bellows was not changed.

Bit 1 can now be used to define whether the level change resulting on the left side of the vehicle during lowering is to be compensated.

If bit 1 = "0" is set, the adjustment takes place immediately. If bit 1 = "1" is set, control of the left side, should this be required, will not occur, until the right side has been raised to the normal level.

The same applies to the second axle if axle by axle kneeling is carried out.

Bit 2: Level control with applied brake
ECAS does not normally execute control while the brakes are applied since the level change caused by the braking obviously does not have to be readjusted:

The shift in axle loads during braking causes only a brief lowering of the vehicle and the old level is restored on its own accord the next moment. However, if air was fed into the front bellows at the moment the vehicle pitches, it would need to be vented again later.

This is not the case at the bus stop: Even though the vehicle is secured against rolling, level control may still be required due changes in load (passengers getting on or off).

To take this circumstance into account, it is possible to perform a level adjustment while the brake is applied, provided the door is also open. In this case, bit 2 must be set to "1".

If bit 2 = "0“, then no adjustment is made while the brake is applied.

Bit 3: Transverse lock function
The transverse lock function can either be switched on only during side kneeling (Bit 3 = 0) or during side kneeling **and** at a speed of > 0 km/h (bit 3 = 1).

Bit 4: Reference level for normal level 2
The normal levels 1 front/rear are saved in the electronic unit when the system is put into service. Parameters 5 and 6 are used by the electronic unit to calculate the normal levels 2 front/rear. Depending on the setting for optional parameter 2, bit 4, there are two possible entries for parameters 5 and 6:

a) Parameters 5 and 6 are interpreted as a differential to the determined lower front/rear stop levels that were determined and saved to the electronic control unit (if optional parameter 2, bit 4 = 0).

Example for option parameter 2, bit 4 = 0:

Normal level 1	100 counts
lower stop level :	35 counts
Normal level 2	80 counts

The following must be entered for parameters 5 and 6 respectively:
80 - 35 = 45 counts.

b) The parameters 5 and 6 are interpreted as the distance from normal level 1 (if optional parameter 2, bit 4 = 1). In this regard, normal level 2 can be above or below normal level 1:

Hundreds digit = 0 ->
Normal level 2 = Normal level I + parameter 5/6
Hundreds digit = 1 ->
Normal level 2 = Normal level 1l – (Units and tens digit of parameter 5/6)

1. Example for option parameter 2, bit 4 = 1:
Normal level 1 100 counts
Normal level 2 80 counts

The following must be entered for parameters 5 and 6 respectively: 120 counts.

2. Example for option parameter 2, bit 4 = 1:
Normal level 1 100 counts
Normal level 2 115 counts

The following must be entered for parameters 5 and 6 respectively: 15 counts.

To ensure that a level change at normal level 1 or 2 can definitely occur, the parameters 5 and 6 must be selected so that the resulting level differentials between normal level 1 and normal level 2 are greater than 2 x parameter 7 or 8 (tolerance in nominal level front/rear.

Bit 5: Transverse lock function during the standby period
If bit 5 is set to "0", the transverse lock function is deactivated during the standby time after the ignition is switched off.

If Bit 5 = "1", the transverse lock function is activated during standby after the ignition is switched off.

Bit 6: Automatic level adjustments
In the event that a level adjustment is imperative due to a change in load (passengers getting on or off) even though the brake is applied to secure the vehicle against rolling at a bus stop, provision can be made for an adjustment to be executed despite the brake being applied, provided the door is also open at the same time. In this case, bit 6 must be set to "0". A "gentle adjustment“ is made.

If bit 4 = "1", no adjustment takes place while a door is open.

Bit 7: Nominal level during kneeling
If bit 7 is set to "0", the nominal levels for kneeling are adjusted by ECAS according to the settings for parameters 22 and 23.

If this bit is set to "1", the side to be kneeled is lowered down to the buffer.

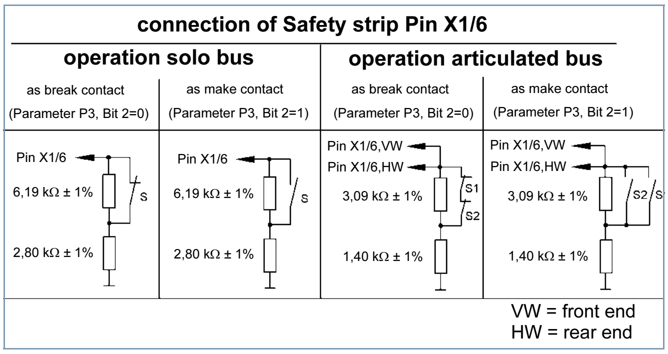
Option parameter 3

Bit 0: Sidewalk detector
If bit 0 = "0", no sidewalk detector is installed to monitor the area below the first step (step edge - kerb) during kneeling.

Bit 0 = "1" means that a sidewalk detector is connected to PIN X1/6.

Bit 1: Fault monitoring of the sidewalk detector
By setting bit 1= "0", fault monitoring of the sidewalk detector is cancelled.

Bit 1 = "1" results in fault monitoring of the sidewalk detector. For this purpose, the sidewalk detector must be connected to resistors.



Bit 2: Sidewalk detector as make or break contact

With bit 2 = "0", ECAS expects a sidewalk detector that acts as a break contact.

Bit 2 = "1" means: The sidewalk detector is a "normally open contact".

Bit 3: door position

The settings of bit 3 are used to take the door position (door open) into account for enabling the kneeling function via the vehicle CAN-BUS or, if the bit is set to "0", the door position is ignored.

Option parameter 4

Bit 0: Measured value output

If bit 0 = "1"is set, the ECU, during normal operation, will transmit continuously measured values derived from sensor values . The measured values are specified in accordance with the chapter "Diagnosis" (1.9).

The ECAS sends the measured value output via the CAN data bus to the FPS. It is then possible to display the measured values on the driver's display or for the Diagnostic Controller to query them via the K-line.

The measured value output should only be used while the parameters are being set - otherwise problems may occur on the data bus.

Bit 1: Valve monitoring

If bit 1 is set to "0", all the connected solenoid valves are monitored for interruption, short circuit to ground and short circuit to $+U_B$.

If bit 1 = "1" is set, the solenoid valves are not monitored and no entry is made into the fault memory should a fault occur.

Bit 2: Emergency operation

Bit 2 = "0" signifies that an emergency function is still possible using an installed Lift / Lower switch when ECAS has stopped operation due to a "severe" fault.

Bit 2 = "1" permits the aforementioned function via a driver-operated switch (must be installed) for Normal level (raising) and Kneeling (lowering).

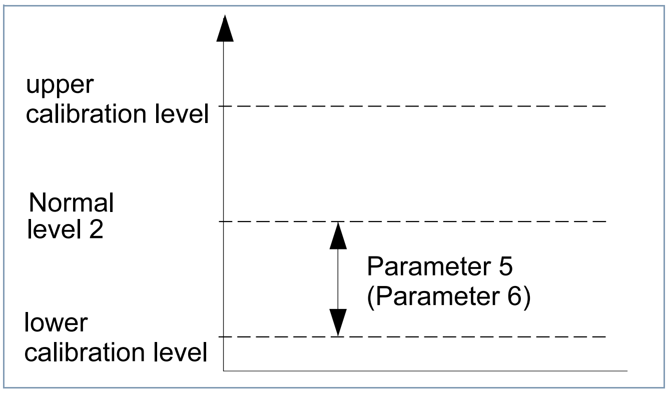
Bit 3: Tyre impression compensation offset

This parameter can be used to define whether the tyre impression compensation is recalculated **during** an ECAS control process.

Bit 4 – 7: Not connected

Parameter 5

Height normal level 2 of the 1-distance sensor axle (counts). The second normal level is entered as a differential (distance) to the lower calibration level.



Parameter 6

Height of normal level 2 of the 2-distance sensor axle (counts). Settings as for parameter 5 for the 2 distance sensors.

Please take options parameter 2 bit 4 into account for P5 and P6!

Parameter 7

Tolerance of the nominal level at the 1-distance sensor axle (counts)
The setting of this parameter determines, together with the proportional and differential coefficients, the control performance of the system at the front axle, see chapter "The control algorithm".

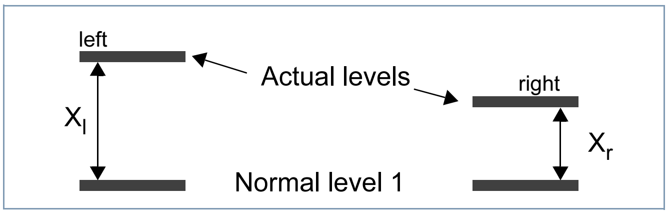
Parameter 8

Tolerance of the nominal level at the 2-distance sensor axle (counts)
Corresponds to parameter 7 for the 2-distance sensor axle.

Parameter 9

Permissible right/left deviation in nominal level (counts)
This parameter acts on the 2 distance sensor axle. It specifies the permissible body tilt, in the event of laterally uneven load distribution for example.

An identical distance to normal level 1 is selected as reference point for uniform raising/lowering right/left, taking into account the permissible deviation (parameter 10).



Parameter 10

Tolerance of the nominal level at the 1-distance sensor axle (counts). The setting of this parameter determines, together with the proportional and differential coefficients, the control performance of the system at the front axle, see chapter "The control algorithm".

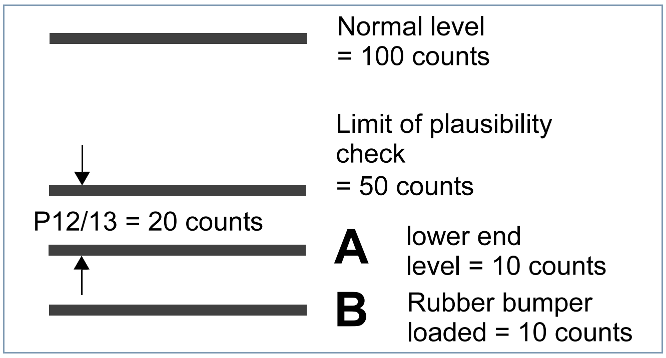
Parameter 11

Tolerance of the nominal level at the 2-distance sensor axle (counts). Corresponds to parameter 10 for the 2-distance sensor axle

Parameter 12

Tolerance at the 1-distance sensor axle (counts). Parameter 12 has a different effect depending what is defined as the lowest permissible level:

- Lower height limit (lowest level) is the rubber buffer
- Parameter 12 is set greater than 100. The value to be entered is determined by the elasticity of the rubber buffer; an empty vehicle does not compress the rubber buffer as much as a laden vehicle. If the vehicle was calibrated when it was laden, the unladen vehicle will not be able to reach this lowest level, even though the bellows have been completely vented, and will signal a corresponding plausibility fault.
- The ECU identifies the "rubber buffer“ and terminates the exhaust process as soon as the level drops below the set level (lower end level + P.12 - 100) **and** there is no further height change over the time specified by parameter 14 (buffer recognition time). This prevents complete exhaust of the bellows. The level reached is stored as the new nominal level.



Recommended setting: If the vehicle was calibrated unladen, a value between 110 and 125 should be parameterised so that no plausibility fault is detected even when the vehicle is tilted and only makes contact with the buffer on one side. If the vehicle was calibrated when laden, a value between 120 and 135 is sensible.

- The lowest level is above the rubber buffer
- If the lower height limit is above the rubber buffer, this is communicated by means of a value less than 100 for parameter 12. In this case, the bus can only be lowered down to the calibrated lower level.
- In the event that the body still makes contact with the buffer above this level due to an uneven road surface, the following applies: The exhaust process is terminated as soon as the level drops below the set level (calibration level + parameter 12) **and** there is no further height change during the time specified by parameter 21 (buffer recognition time). As plausibility problems are generally only possible when the vehicle is severely tilted, we recommend a setting between 5 and 20, depending on the distance between the calibration level and the buffer.

Especially in buses with right-side kneeling it must be taken into account that the axle stabiliser may prevent adequate lowering. When kneeling level = buffer stop is parameterised without contact being made with the buffer, the ECU detects a plausibility fault.

The distance sensor of the 2-distance sensor axle - a sensor that is not directly attached at the wheel - will also fail to output the lowest level during side kneeling even though the buffer stop has been reached. While axle and body are in parallel when the bus is calibrated on the buffer, they are at an angle during kneeling. If the distance sensor is fitted nearer the middle of the axle, the sensor value during kneeling lies somewhere between the normal level and the lowest level.

Here the only remedy is an increased plausibility limit or the selection of a higher kneeling level that can be read out by the measured value output.

Parameter 13

Tolerance at the 2-distance sensor axle (counts) Corresponds to parameter 12 for the 2-distance sensor axle.

Parameter 14

The electronics is unable to directly detect all the possible errors. Therefore, a plausibility check is used to monitor the vehicle's behaviour.

If the adjusting procedure to be performed is not started or continued within a period that can be set with parameter 14, implausible behaviour is detected. The system reacts as follows:

a) Engine running -> the current adjustment is continued and the level lamps are activated in accordance with the actual level.

b) Engine is at a standstill and at least one brake reservoir pressure is less than 9.5 bar -> the current adjustment is cancelled and the nominal level is retained. The level lamps are activated according to the actual level.

If both brake reservoir pressures are larger than 9.5 bar once more or the engine starts up again, the adjustment is continued.

The system detects whether the engine is running or not via the vehicle's CAN-BUS (engine speed) and also uses it to detect the brake reservoir pressures (circuit 1 and circuit 2).

Parameter 15

Delay of the plausibility fault recognition (in 10 sec)
If ECAS is to carry out a level adjustment immediately after the engine is started, a plausibility fault may occur due to insufficient supply pressure. This can be delayed via parameter 15 until the compressor has conveyed sufficient air for correct function.

Before this delay period has expired, the right-hand kneeling is terminated by simultaneous adjustment of the left and right side. This hardly ever occurs in practice, however it can be noticeable during a test with the kneeling function (frequent switching on and off of the ignition) due to rolling movements.

Parameter 16

Standby period after ignition is switched off (min)
A situation could arise where the engine is switched off (having reached its destination) before all passengers have got off the bus. As the ECAS only works when the ignition is switched on, the level will rise as there is no corrective control.

Parameter 16 can be used to set a standby period within which ECAS responds to an increase in level and vents the bellows. Adjustments other than venting are not carried out despite parameter 16 being set.

A transverse throttle function in standby mode is only available if bit 5 = "1" is set in option parameter 2.

Parameter 17

Road speed up to which the raising/lowering commands are accepted (km/h).
This parameter can be used to set the road speed up to which specific level changes can be initiated by the driver.

The maximum speed up to which the driver can change the ride height is the speed specified in parameter 18. The maximum speed up to which kneeling can be requested is fixed at 5 km/h.

Parameter 18

Automatic normal level (km/h)
For safety reasons, it may be required driving at higher speeds is only possible at the normal levels. Parameter 18 can be used to set a speed limit above which the level is automatically adjusted to the preselected normal level.

The value for parameter 18 must be greater than the value of parameter 17 and greater than 0 km/h!

Parameter 19

Control delay when stationary (in 250 ms)
A sensible value for control delay when stationary is generally considered to be one second (4 counts). This control delay allows for a stabilising phase after each adjustment, providing time for the final level position to be reached before another (corrective) adjustment is initiated.

Parameter 20

During dynamic level changes, i.e. at v > 0 km/h, the height is only corrected if the distance sensor signals differ continuously from the nominal level including tolerances (parameters 7, 8, 9) for a period defined in parameter 20 (control delay when driving, e.g. 60 sec). Each distance sensor is dealt with separately. If the level of a distance sensor is permanently outside the tolerance window after the valve has been switched off, a corrective adjustment is made at the corresponding distance sensor. Further level corrections do not take place until the period preselected with parameter 20 has expired. By selecting an appropriate value for parameter 20, the air consumption is kept to a minimum and an adjustment due to dynamic body movements is avoided as far as possible.

Parameter 21

Buffer recognition time (in 250 ms).
The buffer recognition time should be < 30 sec (< 120 counts) in order to prevent plausibility faults, see parameter 14.

Parameter 22

Kneeling level 1-distance sensor axle (counts)
This parameter is used to define the level for the 1-distance sensor axle up to which the vehicle lowers during automatic kneeling.

During manual kneeling, the driver must keep the pushbutton pressed until at least this level (more precisely: Kneeling level + 2 x nominal level tolerance) has been reached, otherwise the lowering process is cancelled. Provided this is set via parameter 24, the vehicle may even need to be lifted again after such an event.
A corresponding indication can appear in the driver's display.

Parameter 23

Kneeling level 2-distance sensor axle (counts)
Corresponds to parameter 22 for the 2-distance sensor axle.

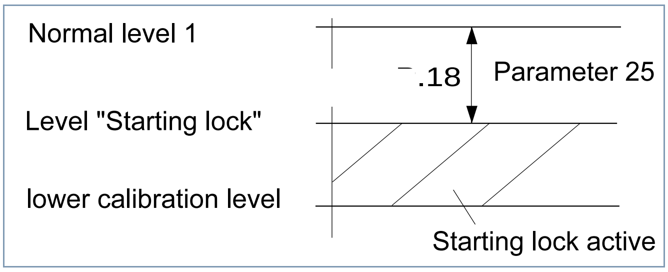
Parameter 24

Reversing after kneeling has been cancelled (counts)
If the pushbutton is released during manual kneeling before the kneeling level is reached, the lowering movement is immediately cancelled, followed by an upwards movement through the height specified by parameter 24. A reverse process beyond normal level 1 is only carried out up to normal level 1.

Parameter 25

Level for switching on the starting lock (counts)
After the vehicle has been lowered by means of kneeling, the starting lock is activated via the CAN-BUS once the level drops below normal level. The starting lock is disabled again after kneeling has been completed and the level specified by parameter 25 is exceeded.

This level is set as a differential to normal level 1 (calibration level) (> 2x tolerance):



Description of functions for parameters 26 – 31
Tyre impression compensation (only for bit 7 = 1 of optional parameter 1)

The electronic control unit can only adjust the level between the vehicle body and the vehicle axle on the basis of height information obtained from the distance sensors. As the number of passenger increases, the total weight of the vehicle also increases and with it the tyre impression. This may reduce the ground clearance of the vehicle too much. On the other hand, it may also cause the legally permitted maximum vehicle height to be exceeded when the vehicle is empty and the tyres are only slightly impressed. The entrance level - important for buses - varies relative to the load status.

In order to compensate varying tyre impressions, it is possible to correct the required nominal level by a pressure-dependent level adjustment relative to the bellows pressure, thereby maintaining a constant distance between road and body. For this purpose, a **pressure sensor is connected to a bellows via a separate air connection** (preferably on a kneeling side so that a constant entrance height is guaranteed even if the load differs).

Six parameters are available for the tyre impression compensation:

Parameter 26

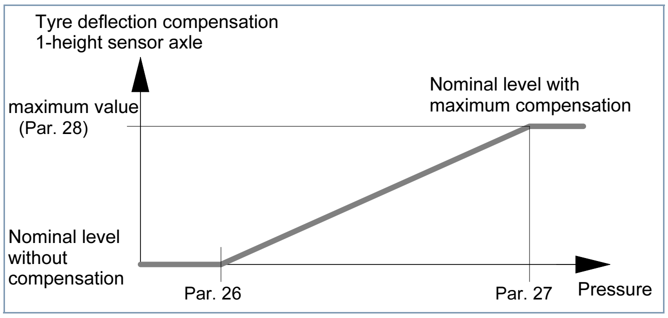
"Pressure at which, when exceeded, the tyre impression compensation at the 1 height sensor axle becomes effective“. This value usually corresponds to the bellows pressure at the 1-distance sensor axle when the vehicle is unladen.

Parameter 27

"Pressure at which the tyre impression is compensated with the maximum value on the 1-distance sensor axle". This value usually corresponds to the bellows pressure at the 1-distance sensor axle when the vehicle fully loaded.

Parameter 28

Maximum value for compensating the tyre impression on the 1-distance sensor axle". This value generally corresponds to the differential laden vehicle / unladen vehicle tyre impression at the 1-distance sensor axle . Between these extreme values, the tyre impression compensation changes linearly with the load:



Parameters 29 - 31 also apply (as described above) for the 2-distance sensor axle.
Further properties of the tyre impression compensation:

- It is performed at every level.
- During an adjustment, the tyre impression compensation is constantly updated, even when the brakes are applied.
- The pressure sensor value is filtered to a large extent.
- The tyre impression compensation is only updated at v = 0 km/h. This value is retained for the remainder of the drive.
- The upper height limits are not exceeded by the tyre deflection compensation.

Parameters 32 – 36

Limitation of the raising/lowering speed while the door is open.
If parameters 32 to 36 are selected accordingly, the raising and lowering speed with the door open can be limited. Level corrections, required as passengers get

on/off the bus for example, can therefore be carried out much more smoothly, almost unnoticed by passengers.

Within a parameterisable tolerance range around the nominal level (parameter 32), the raising and lowering speed of the body is limited to an equally parameterisable maximum value (parameter 33). In order to adequately take into account the system's dead time, the valves are controlled by pulses for a period that can be set in the parameters, as soon as the current level enters the tolerance range or a level correction starts within the tolerance range. The result is a "soft" start of the control process. Pulse pause and period time of the PWM signal can be by parameters 34 and 35. Parameter 36 determines the max period of the pulsing valve activation.

Parameter 37

During detected cornering, automatic level correction is discontinued or is not started. This prevents undesired adjustment of dynamically occurring rolling angles during cornering.

Parameter 37 can be used to specify lateral acceleration, above which automatic level correction is not carried out. The lateral acceleration is computed from the speed of the front wheels that is transmitted by the EBS.

If parameter 37 = 0, this function is switched off, i.e. the level is adjusted to nominal level regardless of the lateral acceleration.

Parameters 38 – 46

Parameters 38 - 46 have no function and are set to zero.

Remark:
Where parameters do not have any meaning, e.g. in vehicles without air suspension on the front axle, the value 0 should be entered for more clarity, provided this is permitted. From parameter 38 upwards, the value zero must be entered for each of the parameters because otherwise the diagnostic unit may calculate an incorrect parameter checksum.

8.5 Examples of parameters for the ECU CAN II 400 070 042 0

8.5.1 Option parameters

Enter the total of the decimal numbers

No.	Meaning	Deci mal
1	Bit 0 **1** must be entered	1
	Bit 1 **0** vehicle with lifting/trailing axle **1** vehicle without lifting/trailing axle	0 2
	Bit 2…7 without significance	
2	Bit 0 **0** Air suspension only on rear axle(s) [1] **1** Air suspension on front and rear axle(s) [1]	0 1
	Bit 1 **0** two distance sensors on rear axle(s) [1] **1** one distance sensor on rear axle(s) [1]	0 2
	Bit 2 **0** distance sensor rear left [1] **1** distance sensor rear right (nur only permissible when parameter 3 bit 0 = 0) [1]	0 4
	Bit 3 **0** one distance sensor on front axle[1] **1** two distance sensor on front axle [1]	0 8
	Bit 4 **0** must be entered	0
	Bit 5 **0** piston type sensor without temperature compensation [1] [2] **1** angle of rotation sensor[1] [2]	0 32
	Bit 6…7 **0** must be entered	0
3	Bit 0…3 **0** must be entered	0
	Bit 4 Selection of ECU address **0** always electronic unit at the front **1** bin pin coding	 0 16
	Bit 5 Pressure sensors on driving axle (only when parameter 2, bit 1 = 0 and (parameter 1, bit 1 = 1 or parameter 5, bit 4 = 1)) **0** two pressure sensors on driving axle **1** one pressure sensor on driving axle	 0 32
	Bit 6 position of the pressure sensor on driving axle (only when parameter 3, bit 5 = 1) **0** pressure sensor on left side **1** pressure sensor on right side	 0 64
	Bit 7 without significance	
4	Bit 0 pressure sensor 4×2 vehicle **0** without pressure sensor **1** with pressure sensor	 0 1
	Bit 1 **0** without pressure sensor on front axle **1** with pressure sensor on front axle	0 2
	Bit 2…7 without significance	

1) After this bit is changed, the distance sensors must be recalibrated.

2) After these parameters are changed, the relation of vehicle height to distance sensor value must be newly determined.

No.	Meaning	Decimal
5	Bit 0 Vehicle with lifting/trailing axle (only when parameter 1, bit 1 = 0) **0** with lifting axle (only when parameter 5, bit 4 = 1) **1** with trailing axle	0 1
	Bit 1 Pressure sensors on lifting/trailing axle **0** two pressure sensors/solenoid valves **1** one pressure sensor / solenoid valve	0 2
	Bit 2…3 **0** must be entered	0
	Bit 4 **0** pressure equality control in accordance with parameter 6, bit 1 **1** Pressure equality control	0 16
	Bit 5 without significance	
	Bit 6…7 **0** must be entered	0
6	Bit 0 automatic lowering of lifting axle in the case of overload on the driving axle **0** activated **1** not activated	0 1
	Bit 1 axle load distribution (only when parameter 5, bit 4 = 0) **0** traction control **1** pressure ratio control	0 2
	Bit 2…7 without significance	
7	Bit 0 traction help type **0** type "EU ‘99" (parameter 42.4 must be set to 255) or type "Germany" **1** manual traction help	0 1
	Bit 1 manual traction help **0** Nordic **1** infinitely variable load transfer	0 2
	Bit 2 **0** must be entered	0
	Bit 3 immediate adjustment to permissible traction help bellows pressure **0** without immediate adjustment **1** with immediate adjustment	0 8
	Bit 4 **0** must be entered	0
	Bit 5…7 without significance	

No.	Meaning	Decimal
8	Bit 0 lower vehicle on front axle **0** down to calibrated low level **1** down onto rubber buffer	0 1
	Bit 1 lower vehicle on rear axle **0** down to calibrated low level **1** down onto rubber buffer	0 2
	Bit 2 activation standby mode **0** only through request Stop (ASC2_...) or request Normal level (ASC2_...) **1** automatically by ignition being switched off	0 4
	Bit 3 send SAE-CAN identifier during standby mode **0** activated **1** not activated	0 8
	Bit 4 **0** must be entered	0
	Bit 5 Additional level function **0** normal level 3 **1** exhausted bellows	0 32
	Bit 6 without significance	
	Bit 7 **0** smooth level controller not activated **1** smooth level controller activated	0 128
9	Bit 0 Reference level for normal level 2 **0** normal level 1 **1** calibrated low level	0 1
	Bit 1 Reference level for normal level 3 **0** normal level 1 **1** calibrated low level	0 2
	Bit 2 Activation normal level 3 **0** through ASC2_... **1** through speed	0 4
	Bit 3 Implausible behaviour of the vehicle level controller **0** maintain nominal levels **1** new nominal levels = measured actual levels	0 8
	Bit 4 Automatic activation of the normal level after ignition is switched on **0** not activated **1** activated	0 16
	Bit 5 Tyre impression compensation **0** not activated **1** activated	0 32
	Bit 6 Residual pressure maintenance when bellows are exhausted **0** not activated **1** activated	0 64
	Bit 7 **0** must be entered	0
10	Bit 0…1 **0** must be entered	0
	Bit 2 Axle load information upon SAE-CAN identifier Vehicle Weight **0** not activated **1** activated	0 4
	Bit 3…7 without significance	

No.		Meaning	Decimal
11	Bit 0	Fault detection of the valve outputs **0** without measured value output **1** with measured value output	 0 1
	Bit 1	without significance	
	Bit 2	**0** component check activated **1** component check not activated	0 4
	Bit 3…7	without significance	
12	Bit 0	measured value output in identifiers Measured Values 1, 2, 3 **0** not activated **1** activated	 0 1
	Bit 1…7	without significance	
13 … 16	Bit 0…7	without significance	

8.5.2 Value parameters

No.	Meaning	Unit
Level control		
20.1	Tolerance for nominal level front axle	0.1 mm
20.2	Tolerance for nominal level rear axle	0.1 mm
21.1	Permissible right/left deviation of nominal levels.	0.1 mm
21.2	Permissible right/left deviation outside the nominal levels	0.1 mm
21.3	permissible front/rear deviation outside the nominal levels	0.1 mm
21.4	permissible level increase 7 sec after starting	0.1 mm
21.5	permissible front/rear deviation front axle > rear axle in the case of manual lifting lowering of an axle	0.1 mm
21.6	permissible front/rear deviation front axle < rear axle in the case of manual lifting lowering of an axle	0.1 mm
22.1	Control delay when stationary	250 ms
22.2	Control delay for lifting adjustments when status is "driving"	sec
22.3	Control delay for lowering adjustments when status is "driving"	sec
22.4	Buffer recognition time (should be < parameter 35.1)	250 ms
22.5	Vehicle speed up to which targeted height changes can be made.(must be < parameter 29.1)	km/h
23.1	Road speed up to which "Control delay when stationary" (parameter 22.1) is valid	km/h
Normal levels		
24.1	Level changes for normal level 1 on the front axle dependent on vehicle speed v_2 (offset = –32000)	0.1 mm
24.2	Level changes for normal level 1 on the rear axle dependent on vehicle speed v_2 (offset = –32000)	0.1 mm
25.1	Vehicle speed v_1 at which the level is automatically adjusted to normal level 1 when the vehicle is in normal level 1 ± parameter 24.1/24.2	km/h
25.2	Vehicle speed v_2 at which the level is automatically adjusted to normal level 1 ± parameter 24.1/24.2 when the vehicle is in normal level 1	km/h
25.3	Duration for which the vehicle speed must be the higher value of v_1 or v_2 to adjust the level to normal level 1 + parameter 24.1/24.2 or normal level 1.	sec
26.1	Differential normal level 2 front to (offset = –32000) – normal level 1 (parameter 9.0 = 0) – lower calibrated low level (parameter 9.0 = 1)	0.1 mm
26.2	Differential normal level 2 front to (offset = –32000) – normal level 1 (parameter 9.0 = 0) – lower calibrated low level (parameter 9.0 = 1)	0.1 mm
27.1	Differential normal level 3 front to (offset = –32000) – normal level 1 (parameter 9.1 = 0) – lower calibrated low level (parameter 9.1 = 1)	0.1 mm
27.2	Differential normal level 3 front to (offset = –32000) – normal level 1 (parameter 9.1 = 0) – lower calibrated low level (parameter 9.1 = 1)	0.1 mm
28.1	Vehicle speed at which, when exceeded, the level is automatically adjusted to normal level 3 if the vehicle is in normal level 1 (only when parameter 9.2 = 1)	km/h
28.2	Vehicle speed at which, when the speed drops below this speed, the level is automatically adjusted to the corresponding normal level 1 or 2 (only when parameter 9.2 = 1, parameter 28.2 must be < parameter 28.1)	km/h
29.1	Vehicle speed at which, when the speed drops below this level, the level is automatically adjusted to the corresponding normal level 1, 2 or 3	km/h
upper levels		
30.1	Offset to the upper nominal level increase on the front axle	0.1 mm
30.2	Offset to the upper nominal level increase on the rear axle	0.1 mm
Customer levels		
31.1	without significance	
31.2	Differential of customer level front axle to normal level 1 (offset = –32000)	0.1 mm
31.3	Differential of customer level rear axle to normal level 1 (offset = –32000)	0.1 mm
31.4	Differential of customer level rear axle right to normal level 1 (offset = –32000)	0.1 mm

No.	Meaning	Unit
Standby		
32.1	increased tolerance in standby-mode (front/ rear, only effective if the value is > 0)	0.1 mm
33.1	Control delay in standby-mode	sec
33.2	Standby period after the ignition is switched off (terminal 15) hours (0 ... 254)	hrs.
33.3	Standby period after the ignition is switched off (terminal 15) minutes (0 ... 59)	min
Plausibility:		
34.1	Limit for plausibility test at front when lowering	0.1 mm
34.2	Limit for plausibility test at rear when lowering.	0.1 mm
35.1	Period for plausibility check	sec
35.2	Delay for plausibility test after "ignition on" (terminal 15)	10 sec
Pressure check		
36.1	Residual pressure in the lifting axle / trailing axle bellows and the driving axle bellows	0.1 kPa
36.2	Pressure hysteresis	0.1 kPa
36.3	permissible average overload pressure on the driving axle	0.1 kPa
37.1	Pressure ratio between driving axle and lifting axle / trailing axle, normal axle load (value≤ 255)	0,01
37.2	Pressure ratio between driving axle and lifting axle / trailing axle, increased axle load (value≤ 255)	0,01
38.1	permissible pressure ratio deviation	0.1 kPa
Lifting axle/trailing axle		
39.1	without significance	
39.2	without significance	
40.1	Height increase normal level 1, 2, 3 with lifted lifting axle / relieved trailing axle	0.1 mm
41.1	Vehicle speed up to which manual lifting/trailing axle control is possible (value≤ 255)	km/h
Traction help		
42.1	only in the case of traction help: Portion of the load/pressure limit at which the decision to lift or lower the lifting axle is taken (value ≤ 255)	%
42.2	Driving speed up to which traction help can be switched on (value≤ 255)	km/h
42.3	Driving speed at which traction help is automatically switched off again (value ≤ 255)	km/h
42.4	Duration of traction help (new EU directive: set parameter to 255)	5 sec
42.5	Forced pause after traction help	5 sec
43.1	Level increase with activated traction help	0.1 mm
43.2	temporary level increase while the driving axle pressure is adjusted to the permissible level during traction help	0.1 mm

No.	Meaning	Unit
Pressure changes lifting axle		
44.1	Pressure increase in the driving axle bellows by means of lifting the lifting axle with 0 kPa in the pressure bellows of the lifting axle prior to lifting	0.1 kPa
44.2	Pressure increase in the driving axle bellows by means of lifting the lifting axle with 300 kPa in the pressure bellows of the lifting axle prior to lifting	0.1 kPa
Tyre impression compensation		
45.1	Mean pressure on the driving axle at which tyre impression compensation begins	0.1 kPa
45.2	Mean pressure on the driving axle at which the tyre impression is compensated with the maximum value	0.1 kPa
45.3	Maximum value with which the tyre impression on the driving axle is compensated	0.1 mm
45.4	Mean pressure on the front axle at which tyre impression compensation begins	0.1 kPa
45.5	Mean pressure on the front axle at which the tyre impression is compensated with the maximum value	0.1 kPa
45.6	Maximum value with which the tyre impression on the front axle is compensated	0.1 mm
Critical levels		
46.1	Upper limit of the critical level on the front axle relative to normal level 1(offset = –32000)	0.1 mm
46.2	Lower limit of the critical level on the front axle relative to normal level 1 (offset = –32000)	0.1 mm
46.3	Upper limit of the critical level on the rear axle relative to normal level 1(offset = –32000)	0.1 mm
46.4	Lower limit of the critical level on the rear axle relative to normal level 1 (offset = –32000)	0.1 mm
Supply pressure request		
APR	requested supply pressure when lifting lifting/ trailing axle and during traction help control processes	0.1 kPa

8.5.3 Option parameter bus

Enter the total of the decimal numbers

No.	Meaning	Decimal
1	Bit 0 Control of the side that is not kneeled **0** The side that is not kneeled is not adjusted **1** The side that is not kneeled is adjusted	0 1
	Bit 1 Door monitoring for kneeling **0** door status is monitored **1** door status is ignored	0 2
	Bit 2 Door status during manual kneeling **0** only permitted with closed doors **1** also permitted with doors open	0 4
	Bit 3 additional processes during kneeling **0** not possible **1** possible	0 8
	Bit 4 Stop when normal level 1 is reached **0** not activated **1** activated	0 16
	Bit 5 Adjusting back to normal level 1 when the last door is closed during kneeling **0** not activated **1** activated	0 32
	Bit 6 Automatic level correction during braking **0** no correction during braking action **1** correction only when door is open	0 64
	Bit 7 Automatic level correction with door open **0** not activated **1** activated	0 128

No.	Meaning	Decimal
2	Bit 0 CAN requirement with ASC2_... and ASC6_... for an articulated bus **0** identical messages for front and rear section **1** different messages	0 1
	Bit 1 Transverse throttle active (pressure compensation right / left) **0** always when driving **1** in accordance with bus par. 2.5 and 2.6	0 2
	Bit 2 manual height changes **0** possible when supply pressure sufficient OR engine running **1** possible when supply pressure sufficient AND engine running	0 4
	Bit 3 automatic traction help in the event of an active anti-slip control process **0** not activated **1** activated	0 8
	Bit 4 Suppression of automatic level correction when engine is at standstill **0** not activated **1** activated	0 16
	Bit 5 Activate transverse throttle when driving prior to automatic level correction **0** not activated **1** activated	0 32
	Bit 6 Activate transverse throttle when there is little lateral acceleration **0** not activated **1** activated	0 64
	Bit 7 Suppression of automatic level corrections when there is intense lateral acceleration **0** not activated **1** activated	0 128
3	Bit 0 Switchable transverse throttle **0** not installed **1** installed	0 1
	Bit 1 **0** must be entered	0
	Bit 2 Take joint angle between front section and rear section into account for kneeling **0** ignore angle **1** take angle into account	0 4
	Bit 3 Supply pressure information **0** via SAE-CAN message ECAM **1** via pressure switch	0 8
	Bit 4 **0** sidewalk detector as make contact **1** sidewalk detector installed as break contact	0 16
	Bit 5 Valve configuration on the front axle **0** with separate lifting / lowering valve **1** without separate lifting / lowering valve	0 32
	Bit 6 Reception of the SAE-CAN message door control **0** not activated **1** activated	0 64
	Bit 7 Sidewalk detector **0** not installed **1** installed	0 128

No.	Meaning	Decimal
4	Bit 0 **0** anti-tilt function not activated **1** anti-tilt function activated	0 1
	Bit 1 anti-tilt function detection **0** Lateral acceleration sensor **1** software algorithm	0 2
	Bit 2 lowering after detection of anti-tilt function **0** without monitoring right / left deviation **1** with monitoring of right / left deviation	0 4
	Bit 3…7 without significance	
5	Bit 0 Adjustment to normal level when speed in parameter 22.5 is reached, provided no predefined nominal level is active **0** not activated **1** activated	0 1
	Bit 1 no control process when ramp is extended **0** not activated **1** activated	0 2
	Bit 2…7 without significance	

8.5.4 Value parameter bus

No.	Meaning	Unit
Level control		
6	Maximum permissible joint angle between front section and rear section for kneeling	1 °
7	Speed threshold up to which starting lock during kneeling is transmitted	1 km/h
8	Reversing path in the event of kneeling as portion of the distance from kneeling level to normal level 1	1 %
9	Kneeling level limit as portion of the distance from kneeling level to normal level 1	1 %
10 A.1	Value 0 must be entered	
10 A.2	without significance	
10 B.1 … B.3	without significance	

No.	Meaning	Unit
Anti-tilt function		
11.1	Angle at which the anti-tilt function is activated	0,5 °
11.2	Angle at which the anti-tilt function is deactivated	0,5 °
11.3	Buffer recognition time during an active anti-tilt function process	250 ms
11.4	Speed up to which an ant-tilt function process can be started	1 km/h
11.5	Delay time for starting the anti-tilt function	1 sec
12.1	Deviation from nominal level at which the anti-tilt function is activated, level above nominal level	0.1 mm
12.2	Deviation from nominal level at which the anti-tilt function is activated, level below nominal level	0.1 mm
12.3	Right / Left deviation at which the anti-tilt function is terminated	0.1 mm
Acceleration limit for activation of the transverse throttle		
13	Acceleration up to which activation of the transverse throttle is possible	0,01 m/s^2
Customer levels		
14.1	Delay time for starting the automatic traction help	250 ms
14.2	Delay time for terminating the automatic traction help	250 ms

A detailed description of the parameters is not included here because during servicing all parameters are meant to be transferred to ensure that the characteristics are also transferred.

When an ECU is replaced, the parameters are read out and transferred using the Diagnostic Software. You will find the buttons "Read out parameters" and "Transfer parameters" under the "System" menu in the menu item "ECU replacement".

Many parameters have a similar meaning to those of the ECU without CAN and ECU CAN I.

9 Calibration

When commissioning the new system, the sensors need to calibrated after all parameters have been set. The sensors are calibrated using the Diagnostic Software. There are two types of calibration: the calibration of distance sensors and the calibration of pressure sensors.

The calibration process must also be carried out when the electronic unit needs to communicate with a newly installed sensor. This is the case when a sensor or the electronic unit is replaced.

Authorisation (PIN) is generally required for calibration. This may be the PIN that is used to for changing parameters or calibration PIN 2, which is granted after having been accordingly instructed by WABCO sales representatives.

9.1 Distance sensor calibration

The process of calibrating the distance sensor aligns the sensor with the electronic control unit. The vehicle body is here moved to normal level I, to the upper and lower level (stops beyond which movement is not possible when raising and lowering), and the respective level is then saved to the electronic control unit. The distance sensor values are specified in counts or timer ticks.

9.1.1 Preparing the distance sensor calibration

– Place vehicle on a surface which is horizontal and even.

– Use brake wedges to secure the vehicle against rolling and release both the parking brake and the halt brake.

– Ensure that the vehicle has a sufficient supply of compressed air and sufficient voltage supply.

– Make sure that the distance sensor was properly installed and that its lever moves freely over the entire raising/lowering range.

9.1.2 Carrying out the distance sensor calibration

The distance sensors are calibrated using the Diagnostic Software. There various calibration options. These depend on the selected parameter settings:

- Calibrate 3 levels
- Only calibrate normal level
- Direct input of the distance sensor values

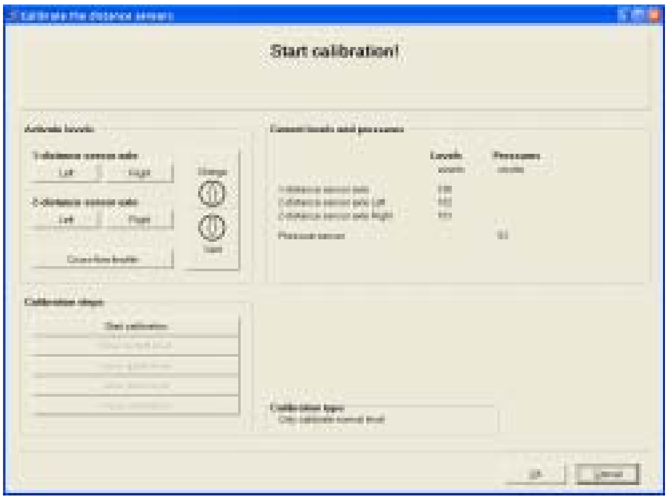


Abb. Menu "Calibrate the distance sensors" in the Diagnostic Software

Calibrate 3 levels

The 3 levels must be calibrated, and the body moved to the corresponding level, adhering to the following sequence: Normal level 1, upper level and lower level.

– Select the menu item "Calibrate the distance sensors" in the Diagnostic Software and click "Start calibration".
You are then prompted to enter the PIN.

– Use the "Left" or "Right" buttons to select the respective vehicle page.

– Click "Air-intake" or "Exhaust" and move the vehicle to the normal level 1 specified by the vehicle manufacturer.

– Fix the distance sensor in centre position and adjust the linkage of the distance sensor, if necessary.

– Click "Save normal level".
This saves the actual levels to which the body was moved as normal levels.

– Click "Air-intake" and move the body to the upper stop level.

! Charge the air-suspension bellows only until the upper stop level is reached. Further air-intake results in an excessive pressure increase and may cause damage.

– Press "Save upper level".
This saves the actual levels to which the body was moved as upper stop levels. To protect the stops, the ECU will automatically reduce the value for the upper stop level by 7 counts.

– Click "Exhaust" and move the body to the lower stop level.

– Ensure that the pressure in the air suspension bellows has been completely relieved. Use a pressure gauge for this purpose.

– Press the button "Save lower level".
This saves the actual levels to which the body was moved as lower stop levels.

After the individual calibration phases have been completed, the Diagnostic Software will check the fault memory and display whether calibration was performed correctly.

Only calibrate normal level

This type of calibration is a good idea if the positions of the upper and lower stops are known and it is only necessary to calibrate the distance sensor to the normal level. The values for the upper and the lower level are entered manually into the Diagnostic Software.

– Select the menu item "Calibrate the distance sensors" in the Diagnostic Software.

– Use the "Left" or "Right" buttons to select the respective vehicle page.

– Click "Air-intake" or "Exhaust" and move the vehicle to the normal level 1 specified by the vehicle manufacturer.

– Fix the distance sensor in centre position and adjust the linkage of the distance sensor, if necessary.

– Click the button "Start calibration".
You are then prompted to enter the PIN.

– Enter the count or timer tick values for the upper and lower level in the corresponding fields.

– Click "Save normal level".
This saves the values for the normal level 1 to which the body was moved and the values entered for the upper and the lower level.

Direct input of the distance sensor values

With this type of calibration, all distance sensor values are entered into the Diagnostic Software. To be able to do so, the distance sensor values must be known.

9.1.3 Notes on the distance sensor calibration

For a successful performance of the calibration, the following principles for the distance sensor values DSV must be observed: Because the numerical values may vary from case to case, they only serve as a guideline:

- The entered distance sensor values (DSW) must be greater than 4 counts and less than 250 counts.
4 counts < DSV < 250 counts
- The upper level (UL) must be larger than the total of the normal level (NL) plus 3 counts and 3 times the nominal level tolerance (∆DSV) set in the parameters. The front/rear assignment of the distance sensor depends on its slot in the control unit.
$\mathbf{DSV_{UL} > DSV_{NL} + 3\ counts + 3 \times \Delta DSV}$
- The lower level (LL) must be less than the normal level (NL) less twice the nominal level tolerance ∆DSV .
$\mathbf{DSV_{LL} < DSV_{NL} - 2 \times \Delta DSV}$

! Increasing the normal level when the lifting axle is raised and compensating for tyre impression have to be taken into account when calibrating sensors.

If values are entered for these parameters, it may be that calibration will not lead to the desired result. If a vehicle is now calibrated with a raised lifting axle and a bellows pressure just under the lifting axle lowering pressure, and the normal level command is issued at the end of diagnosis, then the normal level increases (offsets) relative to the calibrated normal level are added to the loading condition accordingly and may lead to problems with regard to the overall vehicle height.

9.2 Pressure sensor calibration

The process of pressure-sensor calibration aligns the pressure sensor with the ECU and is necessary for the equalisation with atmospheric pressure. The pressure sensor values are given in counts.

Pressure-sensor calibration is in fact an offset allocation. At ambient pressure, the pressure sensor transmits a certain signal to the control unit which, depending on the type of sensor used, is somewhere around 16 and 20 counts. This value has a pressure of 0 bar assigned to it.

Proper calibration requires that the supporting bellow on which the pressure sensor is located are pressureless.

– Connect a pressure gauge to ensure that the air suspension bellows are pressureless or remove the pressure sensor from the air suspension bellows.

The pressure sensor is calibrated via the menu item "Calibrate pressure sensor" in the Diagnostic Software.

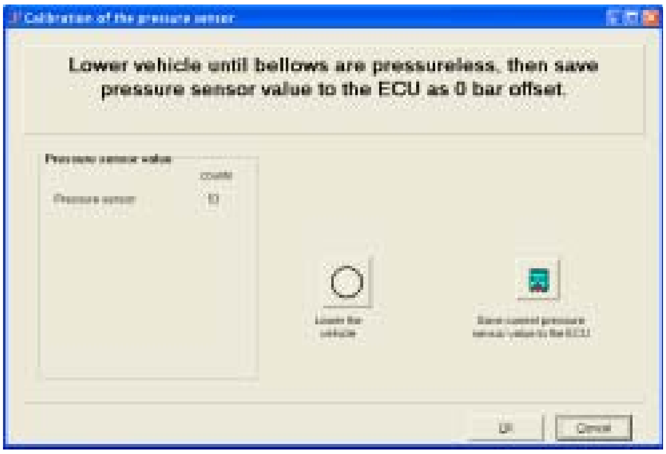
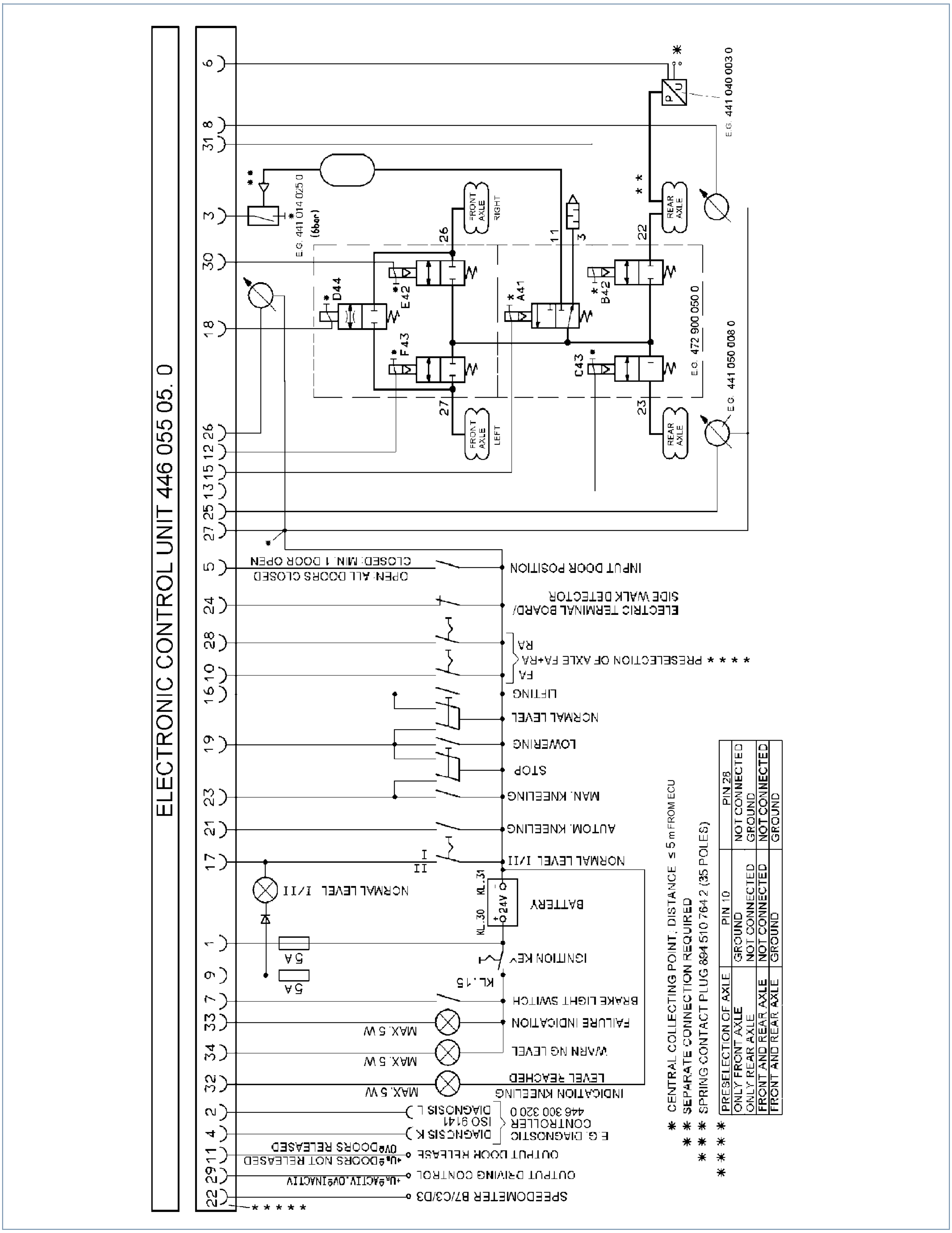
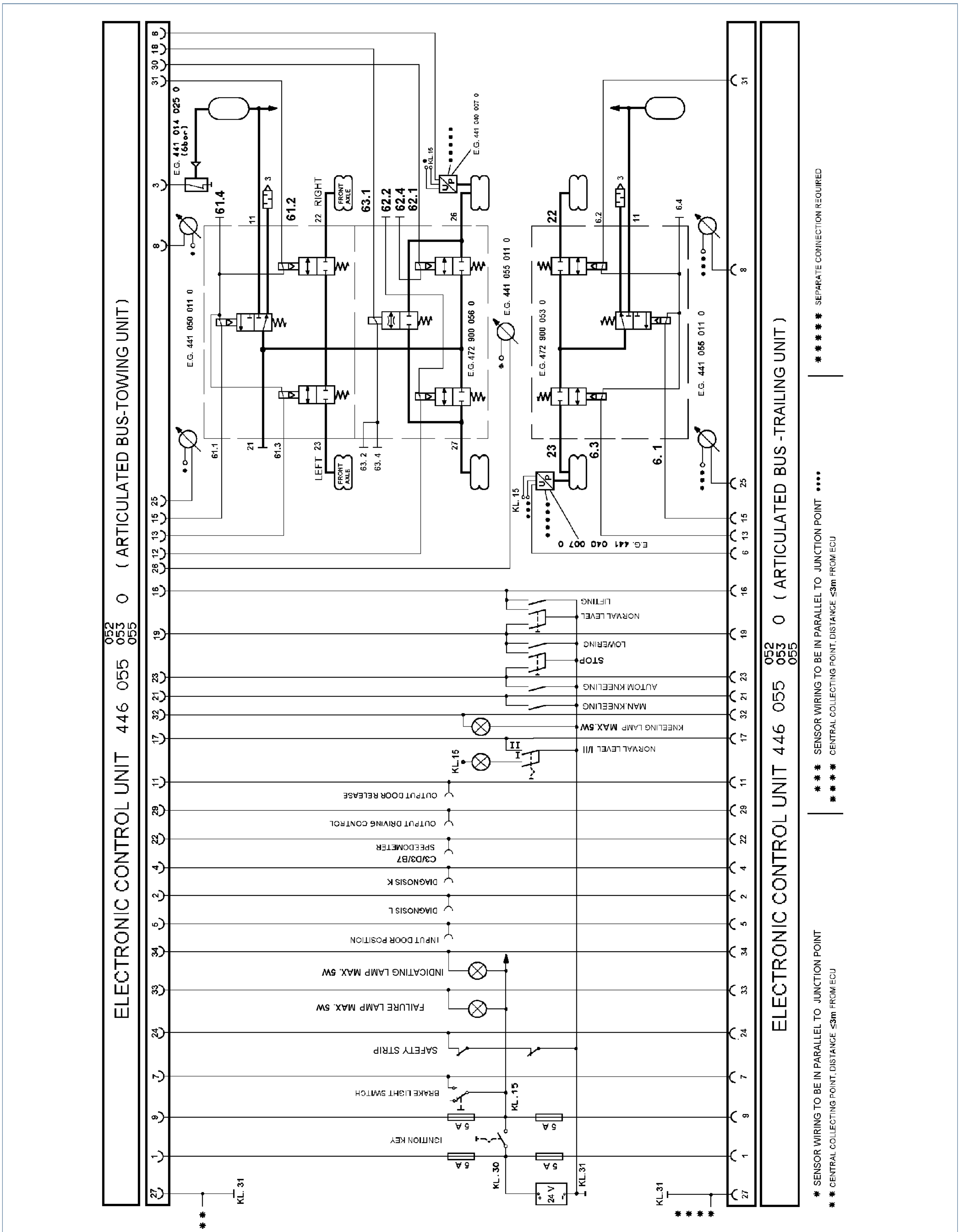


Abb. Menu "Calibrate the pressure sensor" in the Diagnostic Software

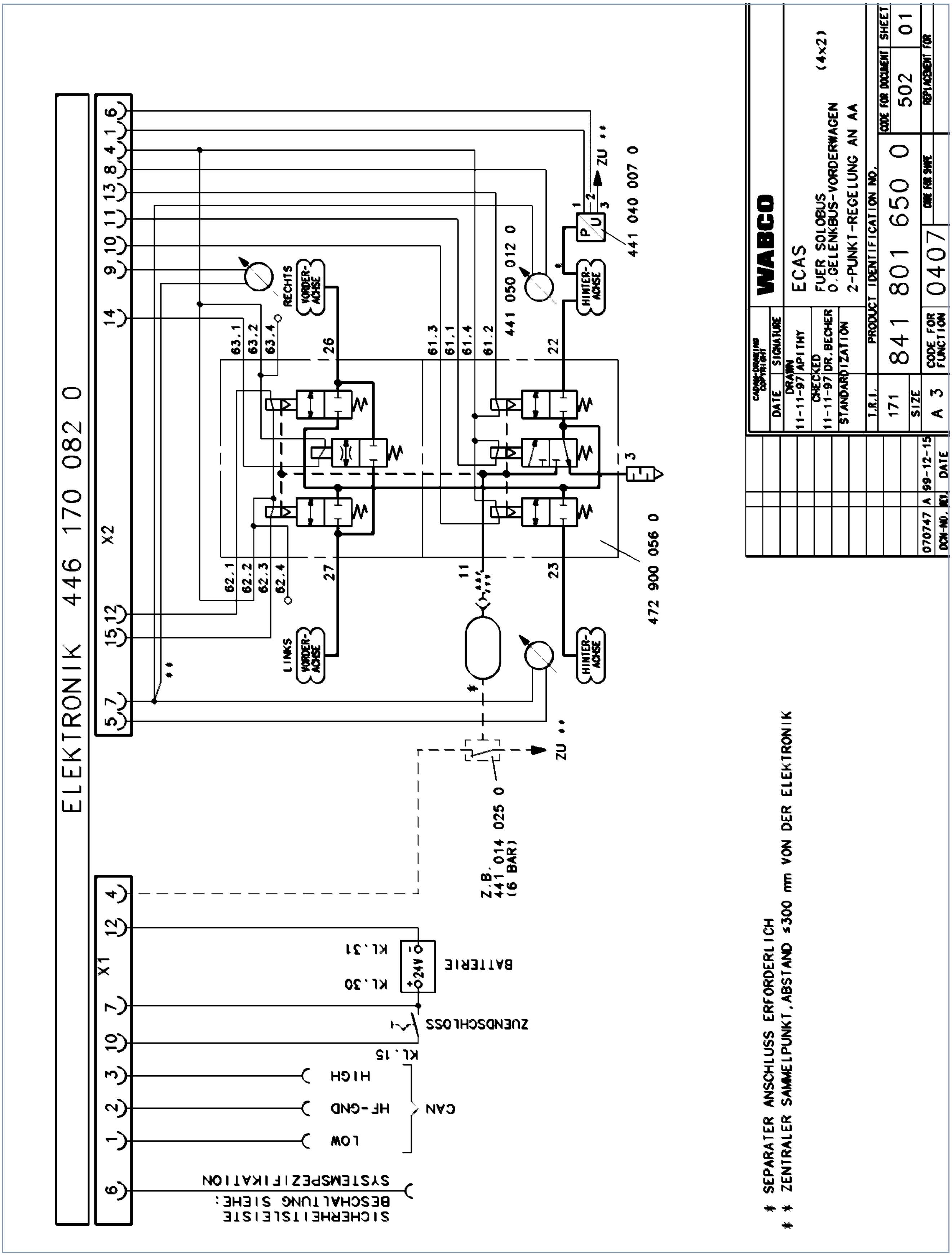
10.1 Circuit diagram solo bus



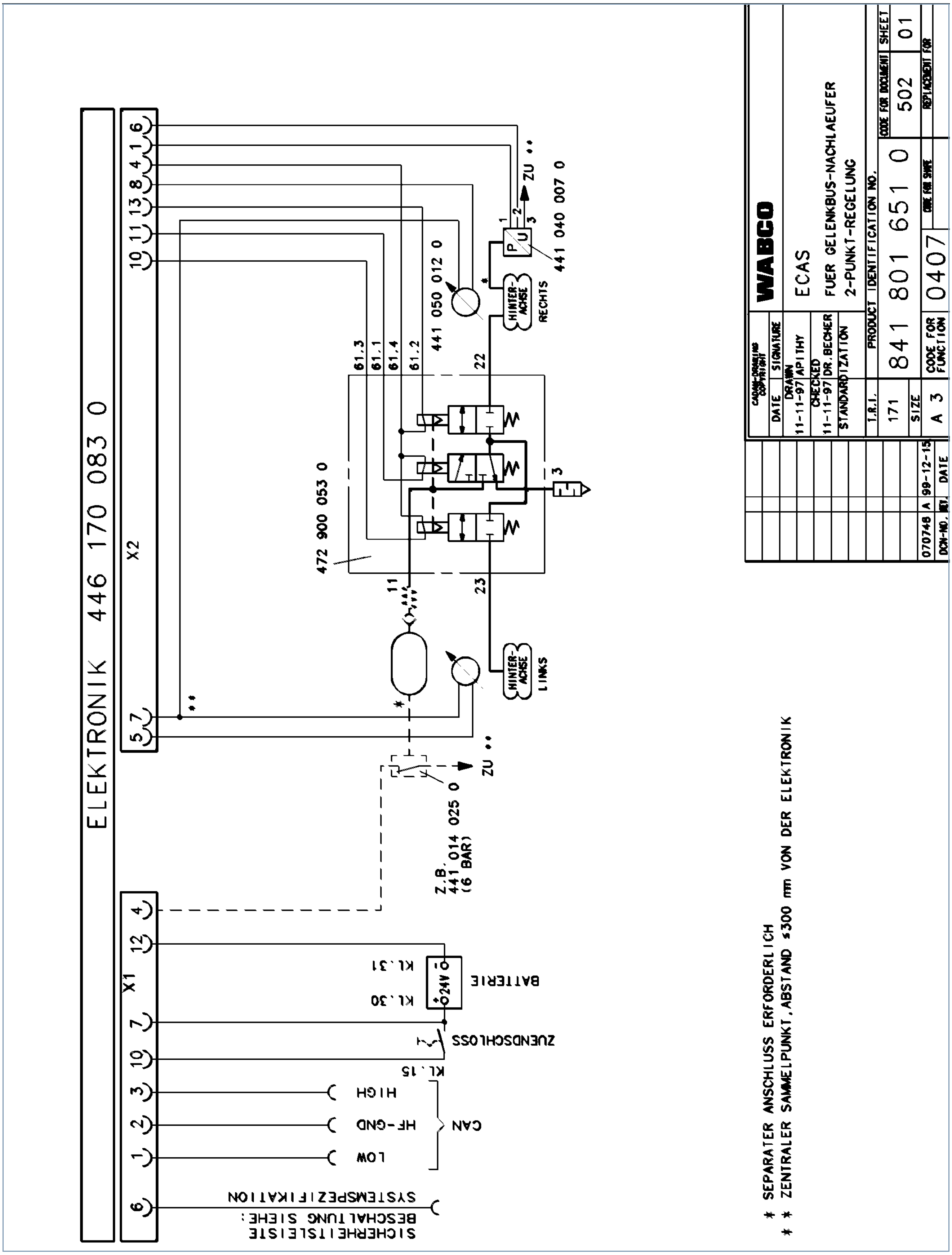
10.2 Circuit diagram articulated bus



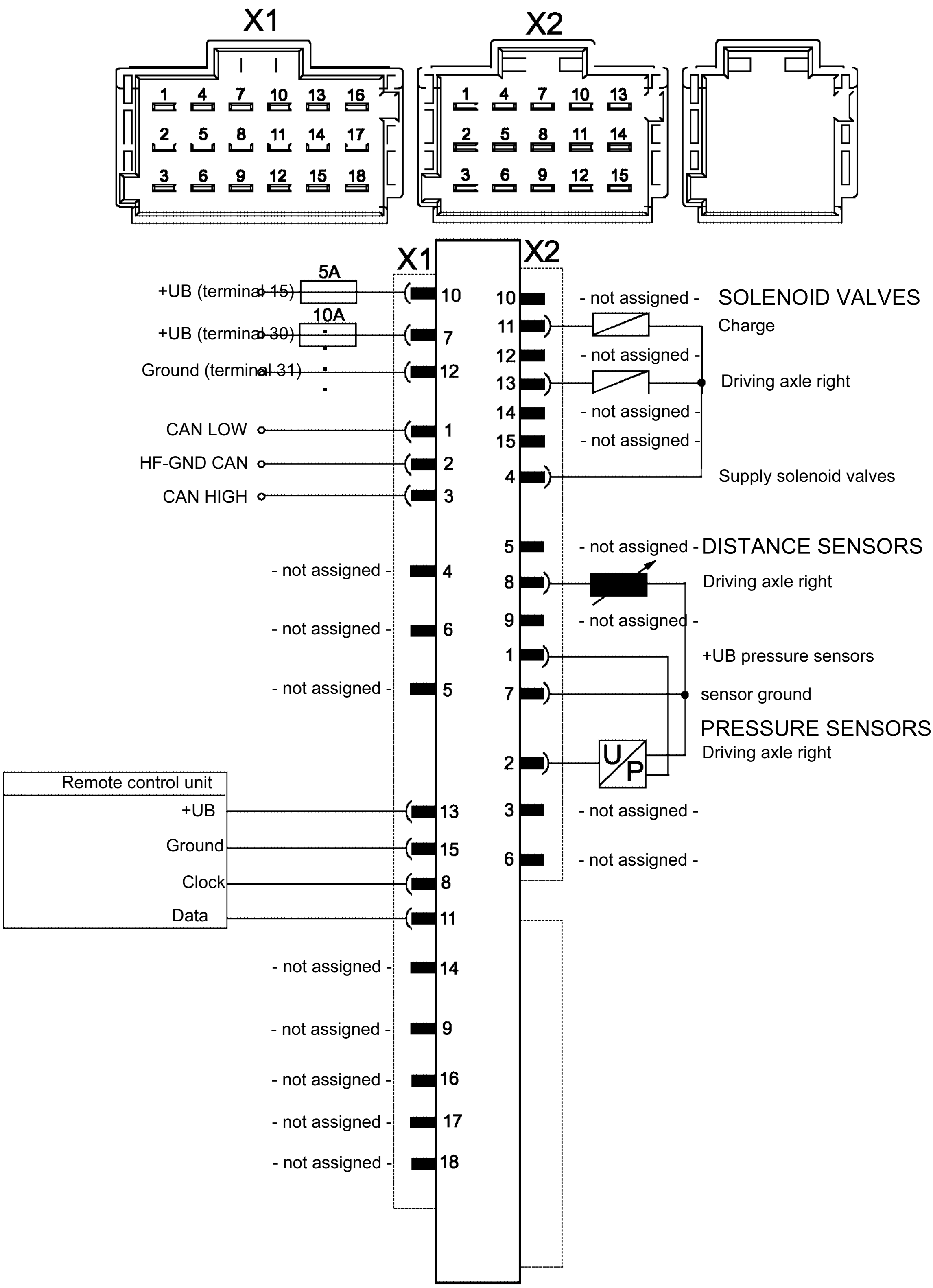
10.3 Circuit diagram solo bus



10.4 Circuit diagram articulated bus



10.5 Pin assignment ECU 446 170 209 0 / 4 × 2 CAN II



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