ECAS
in the towing vehicle

System description and installation instructions

2nd Edition

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1. Important instructions and explanations

1.1 Safety instructions and hazard notes

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

When the ignition is switched on, or while diagnosis starts, unexpected movements of the vehicle or a sudden lifting/lowering of the lifting axle 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.

Only **one** ECAS system may be installed in the towing vehicle. It is not allowed to combine ECAS with other air suspension control systems, since the possibility of dangerous interactions cannot be excluded.

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). At least the supply line between the towing vehicle and trailer must be disconnected.
- System components (ECU, sensors, actuators, lines etc.) must never come into contact with welding and ground electrodes.

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

1.2 Range of application

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

To avoid dangerous interaction, combination with other air suspension control systems are not permissible.

Important basic requirements for ECAS operation:

- Compressed air supply must be sufficient.
- Power supply has to be ensured.
- ABS connectors or EBS connectors must be plugged in.

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, remote control units),
- Integration of any appliances by other manufacturers in the system, or
- Implementation of other functions than those described above.

The structure of the ECAS system is specified by a number of circuit diagrams in chapter 9 "System description".

1.3 Explanation of symbols

Potential risks:
Personal injury or material loss

Additional instructions, information, tips

WABCO empirical data, know-how, recommendation

- List

– Action step

↑ refer to (previous section, previous chapter, previous illustration/table)

↓ refer to (paragraph, chapter, illustration/table below)

2. Introduction

Air suspension systems have been used in motor vehicles since the 50s - especially in buses. They greatly contribute to improving ride comfort.

Air suspension systems are now also prevalent in lorries and trailers, particularly in vehicles designed to carry heavy loads. Special design criteria for the wheel suspension have been decisive factors for this development. There can be quite a significant difference, regarding static axle loads on the towing vehicle's rear axle, between unladen and laden condition of the vehicle. These differences can cause problems in vehicles with steel spring suspensions when the are unladen or partially laden. The suspension behaviour deteriorates. In addition, ride comfort plays an important role - just as it does for buses.

The benefits of air-suspension systems as opposed to-steel spring suspension systems
- The entire spring travel is available for balancing dynamic axle load cycles. Static axle load cycles are compensated by means of pressure changes. This results in a gain in height for the vehicle body layout.
- The best possible suspension, regardless of the road condition and the loading condition, improves ride comfort and protects the load. Vehicle rolling noise is not transferred.
- The wheels run evenly on the road surfaces; this improves braking performance and steerability, and considerably extends the life of the vehicle's tyres.
- Accurate load-dependent control of the compressed-air braking system by using the bellows pressure as the control pressure for the brake-power regulator .
- Constant vehicle height is maintained regardless of the static load.
- Controlled raising and lowering processes for loading ramp and container operation.
- Control of lifting axles is possible.
- Individual control of the bellows pressure to compensate lateral forces (e.g. when negotiating bends) is possible.
- Less impact on the road surface.

Disadvantages of air suspension systems as opposed to steel-spring suspension systems
- system incurs more costs,
- axle systems are more complicated due to the use of axle steering and axle stabilisers,
- a larger number of parts due to numerous pneumatic components,
- high loads on control valves due to constant air intake and air exhaust; shorter service life due to greatly alternating loads,

- control of cornering roll.

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

ECAS is the most advanced development along these lines. The use of electronic control units greatly improved the conventional system.

ECAS - Electronically Controlled Air Suspension

(Electronically controlled air suspension system)

ECAS is an electronically controlled air suspension system for vehicles and has a large number of functions. It has been used in towing vehicles since the early 80s.

In mechanically controlled air suspension systems, the device that measures the level also controls the air spring. ECAS, on the other hand, control is taken over by an electronic control unit. It actuates the air spring via solenoid valves using information received from sensors.

In addition to normal level control, the ECU, together with the remote control unit, also controls functions that require a large number of components in the context of conventional air suspension systems. With ECAS, it is possible to implement functions which could not be provided by conventional means.

ECAS generally only operates when the ignition is switched on. Stand-by operation, however, can be activated if an additional battery is installed.

ECAS with CAN bus

The most recent generation of the ECAS systems has CAN bus capability. Here the electronic system are networked by means of a CAN bus and information is transmitted via SAE-CAN identifiers CCVS or TCO1.

The CAN bus (Controller Area Network) is a serial data bus system that was developed to connect electronic control devices in motor vehicles with the aim to reduce cable harnesses and thereby weight. 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.

3.   System functions

The basic purpose of ECAS is to balance any control deviations. Control deviations are caused either by disturbances (such as a change in the load) or by changes in the nominal values (e.g. by way of the remote control unit). These control deviations cause the distance between the vehicle's axle and the vehicle body to change. ECAS balances these control deviations by means of levelling control.

3.1   Operating principle of the ECAS base system

($\downarrow$ Fig. 1)

1. A distance sensor (1) is mounted on the vehicle body and is connected to its axle via a lever system. The distance sensor picks up the distance between the axle and the vehicle body / body. The intervals depend on the vehicle's operating time (driving or loading operation).

2. This measured value is used as the actual value in the control loop and is sent to the electronic control unit (2).

3. The ECU compares this actual value to the nominal value defined in the ECU.

4. In the event of a control deviation, the ECAS solenoid valve (3) receives an actuating signal.

5. Depending on the type of actuating signal received, the ECAS solenoid valve now increases or decreases the air pressure in the supporting bellows (4). The change in pressure in the supporting bellows alters the distance between the axle and the vehicle body.

6. The new distance is also picked up by the distance sensor, and the cycle begins again.

The remote control unit (5) is no longer part of the ECAS base system. It is mentioned because it allows the user to change the desired level directly. Switches or buttons located in the towing vehicle are also frequently used to influence the desired level.

3.2   Basic definitions

3.2.1   Axle types in the towing vehicle

Main axle (driving axle, also driving axle)
A driven axle is referred to as the axle that always remains on the ground and that cannot be steered. Every towing vehicle has a driving axle, which is usually the rear axle. If a vehicle only has air suspension on the driving axle, it is referred to as a vehicle with **partial air suspension**.

Front axle (steering)
As a rule, the front axle on a vehicle is the axle which can be steered. If a vehicle has air suspension on the front and rear axles, it is referred to as a vehicle with **full air suspension**.

Lifting axle
The lifting axle is usually combined with the driving axle to form a multi-axle combination. When the vehicle exceeds a defined axle load on its driving axle, the lifting axle is lowered and can be raised again once the load falls drops below this level.

Trailing axle
The trailing axle is generally also an axle that is combined with the driving axle to form one axle assembly. Typical examples include dummy and steering axles. In contrast to the lifting axle, they cannot be raised; they can only be relieved (load reduction). The advantage compared to a lifting axle is that the mass of the axle is not added to the vehicle body weight. A disadvantage, however, is the increased tyre wear that must be expected.

3.2.2   Air suspension bellows in air suspension systems

Supporting Bellows
Supporting bellows are the commonly known air suspension bellows on the axles. They are responsible for the actual suspension of the vehicle. The supporting bellows on the axles which are in contact with the ground are always filled with a bellows pressure which is

Fig. 1 Basic operation of the ECAS System

Distance Body/Axle

Basic System:

1 Distance sensor

2 Electronic (ECU)

3 ECAS solenoid valve

4 Supporting Bellows

5 Remote Control Unit (optional)

proportional to the respective wheel load while the vehicle is in operation. The supporting bellows of raised axles are either pressureless or a low residual pressure is applied to avoid damage to the bellows. Supporting bellows are found on all the types of axles described above.

Lifting Bellows

Lifting bellows are firmly connected to a lever system of the lifting axle. They raise or lower the lifting axle when the pressure exceeds or falls below a defined limit pressure in the supporting bellows of the axle assembly's main axle. There are also hydraulic systems that may carry out this function.

ECAS is a control system consisting of at least one control loop. A nominal value is specified in a control loop. A sensor is aligned with the system by a calibration process that is performed when the system is taken into operation. This sensor measures the actual value of the system and sends it to an electronic control unit (ECU).

The ECU compares the actual value to the nominal value. It is possible that control deviations occur during this process.

A control deviation denotes that the actual value lies outside a defined reference range.

In the event of a control deviation, the ECU initiates a corrective adjustment to the nominal value in the supporting bellows via an actuator.

Nominal values are:

- specific distances (levels) of the vehicle body above the vehicle axle,
- vehicle conditions that are dependent on the axle load (e. g. traction help, limit pressure for lifting axle control).

There are two ways to transfer a nominal value to the ECU:

- The vehicle manufacturer sets values during initial start-up by means of setting parameters and calibration.
- The system user setting the values via the remote control unit.

Please note that not all the functions described are necessarily available; this depends on system design and configuration. The type of system (number of lifting axles, with or without front axle air suspension) determines whether or not the functions can be implemented.

ECAS can easily be adapted to any vehicle type. Thanks to the modular structure, the system can be put to a wide variety of uses in accordance with customer requirements.

3.3 Controlling the desired level

The desired level is the nominal distance value between the vehicle body and the axle. It is defined by calibration, by setting parameters, or by defining a value using a remote control unit. Adjustment to a desired level is the basic function of ECAS.

A solenoid valve functioning as an actuator is triggered, aligning actual level with desired level by way of ventilating (charging and exhausting) supporting bellows. This occurs if there are:

- Control deviations exceeding a certain tolerance range,
- Modification of the specified value for the desired level.

Unlike conventional air suspension systems, ECAS controls not only the normal level but also any other specified level. Thus, a level set for loading or unloading procedures is assumed to be the desired level and the level is adjusted accordingly.

Distinction between static / dynamic changes in wheel load

By using the speed signal, ECAS differentiates,unlike conventional air suspension systems, between static and dynamic changes in the wheel load. This distinction facilitates the best possible reaction to changes in the wheel load.

Static wheel load changes

The static wheel load changes occur when the vehicle's loading condition changes while it is stationary or moving slowly. This requires the nominal value in the corresponding air suspension bellows to be checked at short intervals and adjusted as required by increasing (charging) or reducing (exhausting) the air pressure. ECAS performs this check once every second. The check interval can be defined in the parameter settings.

Dynamic wheel load changes

Dynamic wheel load changes are mainly caused by uneven road surfaces, cornering, braking and accelerating, and are more likely to occur at high speeds. Dynamic wheel load changes are usually balanced by the compliance behaviour of the supporting bellows. In this case, bellow charging or exhausting would not be desirable because only shut-off bellow have an almost constant compliance character. For this reason, the regulation is checked at greater intervals when the vehicle is moving at higher speeds - usually every 60 seconds. Actual value and nominal value are still compared continuously.

It is possible to avoid unwanted corrections of dynamic wheel load changes during braking: if the ECU receives the brake light signal, no air is charged into or exhausted from the bellows.

Normal level

The system adjusts to normal level (also known as driving level) when the vehicle moves at a higher speed. A maximum of 3 normal levels can be set for ECAS.

3.3.1 Normal level I

Normal level I is the desired level defined by the vehicle manufacturer for optimal normal driving. It is possible to deduce the vehicle's overall height and the vehicle's theoretical centre of gravity from this normal level. It has a special significance as opposed to the other normal levels. Normal level I is described as a basic design parameter for the vehicle.

> **!** Please observe the legally permitted maximum value with regard to overall height.

The vehicle's theoretical centre of gravity is a nominal value for calculation the vehicle's braking action.

– Only the calibration process may be used to communicate the value for normal level I to the system.

– Adjust to normal level I via the driving speed and/or the remote control unit when operating the vehicle.

– Specify the speed value that is to be defined as a switching point for adjusting to this level in the parameter settings.

3.3.2 Normal levels II and III

Both normal levels differ from normal level I. This may be necessary:

• for lowering the body as a means to save fuel,

• for level adjustments aligning the towing vehicle - trailer combination,

• for improving lateral stability at higher speeds.

Speed-dependent lowering the vehicle body is made on the assumption that higher speeds are achieved on sound road surfaces which do not require full use of the bellows suspension travel.

– The value for this normal level is stored in the system as the differential to normal level I in the course of setting the parameters.

Adjustment to this normal level is achieved by one of the following means:

• Switch,

• Remote control unit,

• Driving speed (only normal level II in the case of electronic systems up to and including CAN I).

The chosen normal level remains as the current normal level until another normal level is selected.

– To adjust to the current normal level, briefly press the Normal level button.

– Set the values for the adjustment mode and the switching points for adjustment when setting the parameters.

– Define normal level III as the highest normal level.

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_… .

3.3.3 Memory Level

Two different memory levels can be used for each system. The memory level applies to the overall vehicle. A remote control unit is required for using the memory level function.

Adjusting to memory level is an option when:

• loading or unloading while vehicle is at a standstill or

• moving at a slow speed.

This level provides the option to set a level for the vehicle body that facilitates loading or unloading.
Unlike the unloading level, which is firmly stored in the ECU, the memory level can be defined and changed any time. Once defined, the system will store a memory level until it is changed by the user - even with ignition OFF.

3.4 Height limitation

The ECU automatically aborts any change in the level if the defined value for the upper and lower height limits have been reached. These values can be freely selected. This prevents excessive strain on the rubber buffers and height limit stops (e.g. bellows, arrester cables).

Unloading is detected, and the original desired level is readjusted so that the rebound stops are not strained.

3.5 Lateral stabilisation

For vehicles where an uneven axle load distribution can be expected (e. g. loading on one side), it is possible to set different pressures in the left and right supporting bellows of an axle by means of two control loops.

This is not required for vehicles carrying evenly distributed loads (e. g. road tanks).

3.6 Lift axle control

When the vehicle is stationary, its lifting axle will automatically be lowered or weight shifted to the trailing axle if the permissible axle load of the main axle is exceeded. The corresponding signal reaches the ECU from the pressure sensor (↓ 6.1.3 Pressure sensor) or the pressure switch at the suspension bellows of the main axle. The lifting axle cannot be lowered automatically when the vehicle is in motion, even when pressure peaks occur.

The lifting axle status is maintained when the vehicle is parked and the ignition switched off. This means if a lifting axle has been lifted, it remains lifted.

Pressure sensor system

Apart from automatic lowering, it is also possible to implement automatic lifting of the lifting axle after the vehicle has been unloaded. This is known as 'fully automatic lifting axle operation'.

Pressure switches/-buttons system

The lifting axle is lowered automatically. In this case, the lifting axle must be lifted manually using the ECAS remote control unit or a separate button/switch.

The traction help function can only be used when fully automatic lifting axle operation is activated.

3.7 Normal level shift

It is possible to automatically increase the normal level when the lifting axle is lifted. This procedure increases the clearance of the lifting axle wheels. This applies to the whole of the vehicle.

3.8 Traction help

It is possible to implement a traction help function in 6x2 vehicles given a sufficiently heavy load. By reducing the pressure in the lifting axle supporting bellows and/or raising the lifting axle, the load on the driving axle of the towing vehicle is increased. The objective in doing this is to increase the tractive effort. (↓ Fig. 2)

– The traction help function is activated using a switch contact.

– Activation possible via CAN signal, depending on the parameter setting P3.1: Operation via switch or via CAN message (ASC2).

The traction help mode is split into 5 groups. In this respect, the applicable national legal provisions are met by setting the corresponding parameters accordingly (with/without time speed, load limits, with/without forced interval).

The changes that came with Guideline 97/27/ECC coming into force must be taken into account when setting the parameters.

• **Type "Germany"**
   The traction help can be activated for max. 90 seconds using a button. After these 90 seconds have elapsed, activation of the traction help is blocked for at least 50 seconds. The traction help is automatically deactivated if a specified speed (max. 30 km/h) is exceeded. The tractive force increase is specified, but is not allowed to be more than 30 % above the permissible on the driving axle.

• **Type "EU99"**
   The traction help, once it is activated with the corresponding button, is active for an unlimited period. Once the traction help procedure has been terminated, it can be repeated immediately. The traction help is automatically deactivated if a specified speed (max. 30 km/h) is exceeded. The tractive force
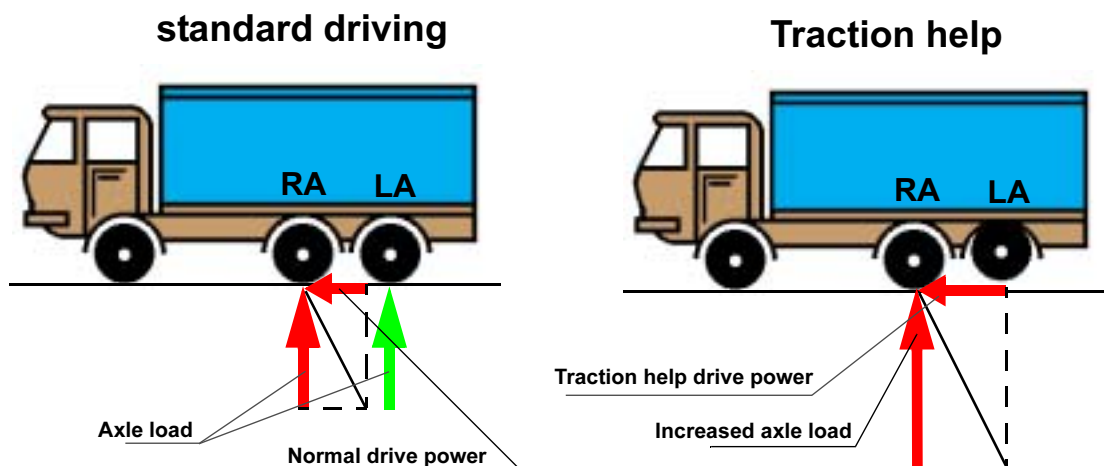
Fig. 2 Axle load and drive power variation with activated traction help

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increase is specified, but is not allowed to be more than 30 % above the permissible axle load.

- **Type "Outside Germany"**
  The traction help type "Outside Germany" is analogous to the traction help type "Germany", except for one difference. The traction help can be posttriggered, i. e. repeatedly requesting the traction help restarts the traction help without a forced intermission.

- **Type "Northern" (via 2-position switch)**
  The traction help function is not limited to a time period and may be activated by a switch. After termination of the traction help procedure, it can be repeated immediately. The traction help is deactivated when the switch is moved back to its initial position (exception: 6x2 vehicles with ECAS-CAN – see 7.9 "Brief description of the ECAS 4x2/6x2 CAN system"). The tractive force increase is specified.

- **Type "manual traction help" or type "Northern" (via 3-position switch/button)**
  The traction help function is not limited to a specific period and is operated using a 3-position switch/button. With this type it is possible to increase and reduce traction continuously. If the switch is in its central position, the set traction is maintained. Traction help is deactivated once the tractive force increase has been completely withdrawn again.

3.9 Overload protection

Overload protection can be implemented by specifying a maximum permitted supporting bellows pressure.

This protection leads to a lowering of the vehicle's vehicle body down to the rubber buffers in the event that the supporting bellow pressure was exceeded by overloading.

– Now you must unload the vehicle until the remaining static axle load requires an air suspension supporting bellows pressure which is below the maximum permitted supporting bellows pressure. When the ignition is switched back on again, ECAS attempts to inflate the bellows and to restore the vehicle body to its normal level.

⚠ Never drive with a lowered vehicle body because vehicle and load may suffer severe damage as a result.

3.10 Tyre Impression Compensation

For vehicles with a particularly large overall height, small wheels are used, as well as very short compression travel when unladen.

As the vehicle is being loaded, however, the suspension travel requirement increases. It is possible to add the tyre deflection, caused by increasing load, to the possible suspension path, while the overall vehicle height remains constant. (↓ Fig. 3)

❗ The legal provisions with regard to vehicle height must be observed.

This control system may be desirable if the overall height of the vehicle body is close to the maximum limit defined by law.

This control is possible with all ECAS systems. It is optional. Basic requirements are the presence of a distance sensor **and** at least one pressure sensor. The desired level is increased. Any changes in load cause the nominal value to be changed.

Prior to implementing this control system, the differences in tyre deflection between the unladen and the fully laden vehicle and for the tyres to be used must be known or must be determined. As a result, the unladen vehicle with

Fig. 3 Effect of tyre impression compensation on the desired level for various vehicle loading conditions

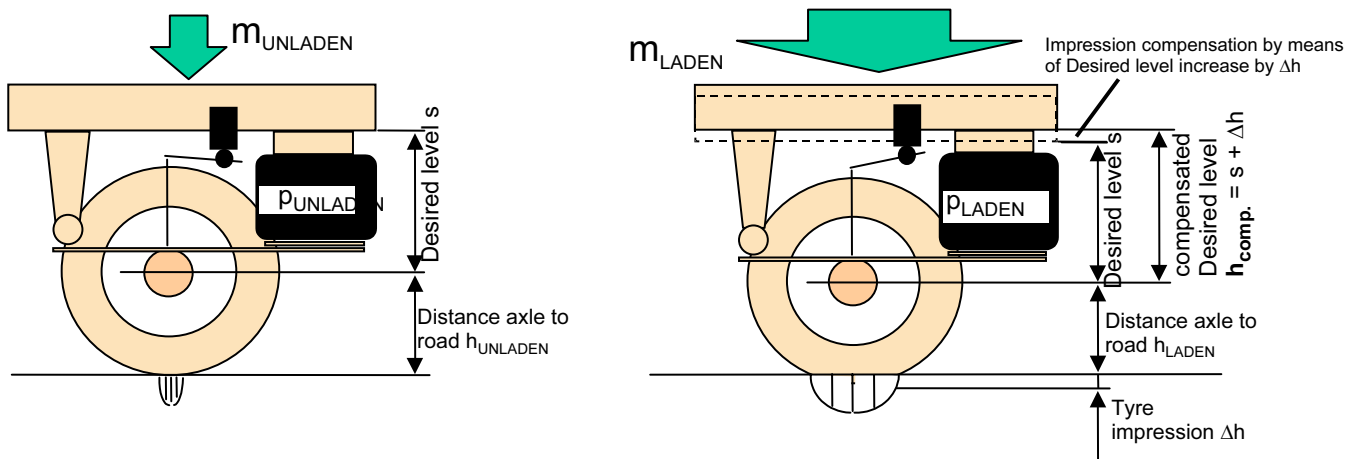supporting bellows pressure $p_{unladen}$ can be assigned a tyre deflection $\Delta h_{0\%}$ and the vehicle with maximum load and supporting bellows pressure $p_{100\%}$ can be assigned a tyre deflection $\Delta h_{100\%}$.

The difference $p_{LADEN} - p_{UNLADEN}$ represents the max. adjustment range within which the normal level is adjusted relative to the load by a value between $\Delta h_{100\%} - \Delta h_{0\%}$.

– The basic values for this control must be programmed into the electronic control unit when the parameters are set.

The ECU then uses them to compute the increase in the nominal value for the driving level.

! If the assignments of basic values does not match the tyres used, unexpected shifts in level may be the result when the vehicle is laden.

The control process is achieved at follows. When the "normal level" nominal value is specified, the system determines the pressure in the support bellows of the main axle. The ECU can then use this determined pressure p, together with the values stored for tyre impression compensation, to compute a nominal value for the normal level which is higher by Δr and to provide this to the system as the new nominal value for the normal level.

Now the same adjustment procedure applies as the one described in chapter 3.1 "Operating principles of the ECAS base system":

1. The distance sensor determines the actual distance between the vehicle body and its axle, and compares this to the new nominal value just computed.

2. In the event of a control deviation, the actuator (solenoid valve) receives an adjustment signal.

3. The pressure in the supporting bellows on the leading axle is increased or decreased accordingly.

4. This causes the distance between the vehicle axle and the vehicle body to change.

Summary

A load-dependent normal level increase can be initiated by means of the following settings:

• Support bellows pressure $p_{Unladen}$ when vehicle condition is unladen

• Supporting bellows pressure $p_{100\%}$ with the vehicle loaded to its maximum level

• Tyre impression difference $\Delta h100\% - \Delta h0\%$ between unladen vehicle and vehicle laden to maximum level.

The tyre impression compensation is not operational when traction help has been activated.

The precise values for the tyre impression compensation are best determined by conducting a test on the vehicle type that is actually going to be used. Apart from tyre impression, the linking kinematics of the axle also has a certain bearing on the tyre impression compensation. The following process is suggested for this:

– park the unladen vehicle on a smooth, level surface with the parking brake **released**.

– define a reference point on the vehicle body above the axle and measure the distance between the reference point and the ground.

– generate the maximum permissible loading condition/ axle load.

– connect a diagnostic tool and determine the distance sensor actual value (WSW_1) on the axle.

– Raising the vehicle body until the distance between reference point and ground is the same as that of the unladen vehicle.

– obtain the new actual distance sensor value WSW_2 on the axle and calculate the distance sensor differential WSW_2-WSW_1.

– the distance sensor differential WSW_2-WSW_1 corresponds to the tyre deflection differential $\Delta h_{100\%} - \Delta h_{0\%}$.

3.11 Control of LSV valve

Towing vehicles with air suspension systems and a conventional braking system have a load-sensing valve fitted which is controlled by the bellows pressure.

In the event of a bellows pressure failure (e.g. bellows are leaking badly or are destroyed), the load-sensing valve would receive unladen vehicle signal in spite of it being fully loaded. As a consequence, underbraking would ensue, and with it excessive stopping distances. ECAS includes a function for detecting such an event and can, should it occur, conduct the supply pressure of the air suspension system to the LSV control port 41/42 and thus to simulate a full-load situation to the load-sensing valve.
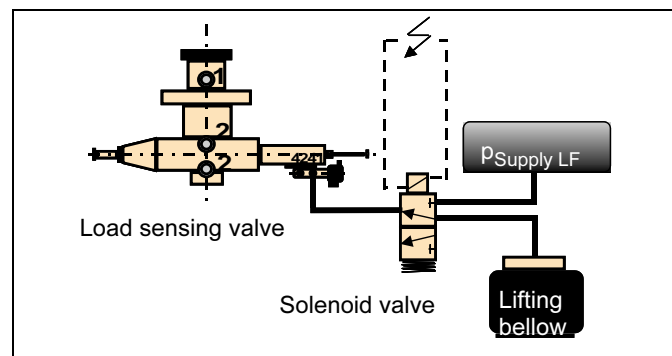
Fig. 4 The circuit for the "LSV" function

3.12 Crane operation

In the case of towing vehicles with mounted cranes, a function referred to as the "crane operation function" may be beneficial. The background to this function is that outriggers are deployed in order to operate mounted cranes. These outriggers raise the vehicle so that the wheels are no longer in contact with the ground. The idea is to prevent the vehicle suspension from being subjected to the force from the crane load. The distance between the axle and the vehicle body increases as the wheels are raised clear of the ground. Normally, ECAS would attempt to reduce this distance by exhausting the bellows. As a result, the supporting bellows would be vented to no purpose, and this may result in damage to the bellows when the vehicle is lowered back to the ground. ECAS detects this situation and stops the bellow air exhaust process before they are completely exhausted.

3.13 Pressure control in vehicles with lifting/trailing axle

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 equalising control

The main feature of this control method is that the pressure in all supporting bellows of the rear axle unit is the same after the lifting axle has been lowered/load transferred to the trailing axle. The driven and lifting/trailing axles' supporting bellows on each side are connected to one another in this arrangement.

Pressure equalising control does not require a lot of components. The pressure value is determined using pressure switches or pressure sensors. (↓ Fig. 5)

Permanently optimised traction control

In a 6x2 towing vehicle with ECAS, it is possible to control the axle load distribution in the rear axle unit so that the driving axle is loaded to 100 % and the lifting/trailing axle absorbs the residual load. This is referred to as ECAS 6x2 DV (DV is a German abbreviation for pressure ratio control).

This type of control may well prove advantageous when operating the vehicle on a smooth or slippery surface. The driving forces which can be transferred to the driving axle are always high, thereby permitting good traction. This method of distributing the axle load reduces tyre wear on the lifting/trailing axle when cornering.

The disadvantage of this configuration lies in the fact that the braking forces which can be applied on the driven and lifting axles may be widely divergent from one another. If you assume that both axles are equipped with the same brake cylinders and the same pressure is applied to both axles, then the load on the brakes will be different.

The complexity of components for optimum traction control is greater than that for pressure equalising control. The bellows pressure is determined by pressure sensors. The number of pressure sensor fitted varies depending on the vehicle manufacturer, ranging from 2 in SCANIA vehicles (1 pressure sensor on the driving axle, the 2nd on the lifting/trailing axle) through to 5 in IVECO vehicles (2 pressure sensors on each side on the driving axle and lifting/trailing axle, and 1 pressure sensor on the lifting bellows). (↓ Fig. 6)

Pressure ratio control
Pressure proportional control is closely related to
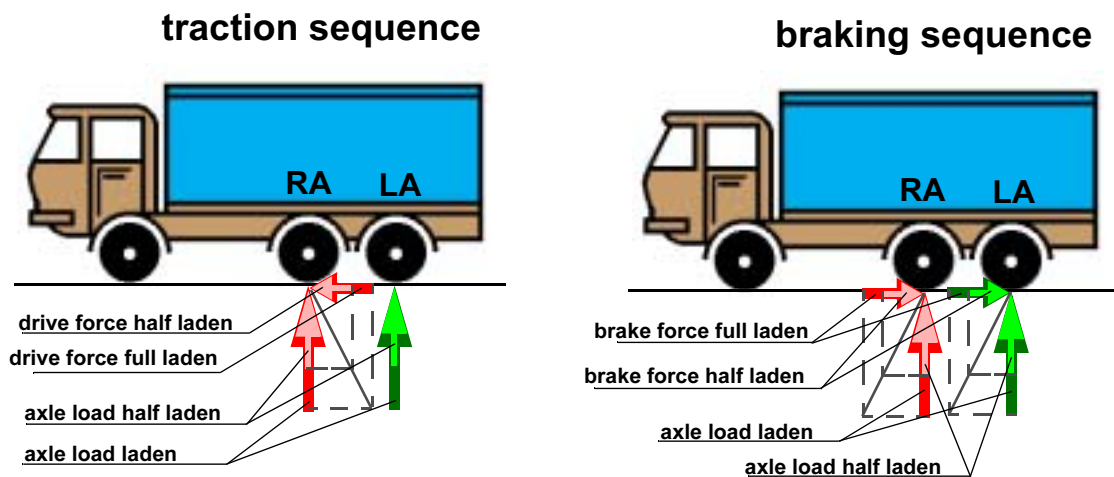
Fig. 5 Axle load and drive power variation with active pressure equalising control

traction sequence

braking sequence

drive force
RA - axle load

LA - axle load half laden
LA - axle load fully laden

RA – brake force
LA – brake force fully laden
LA – brake force half laden
RA - axle load
LA - axle load half laden
LA - axle load fully laden
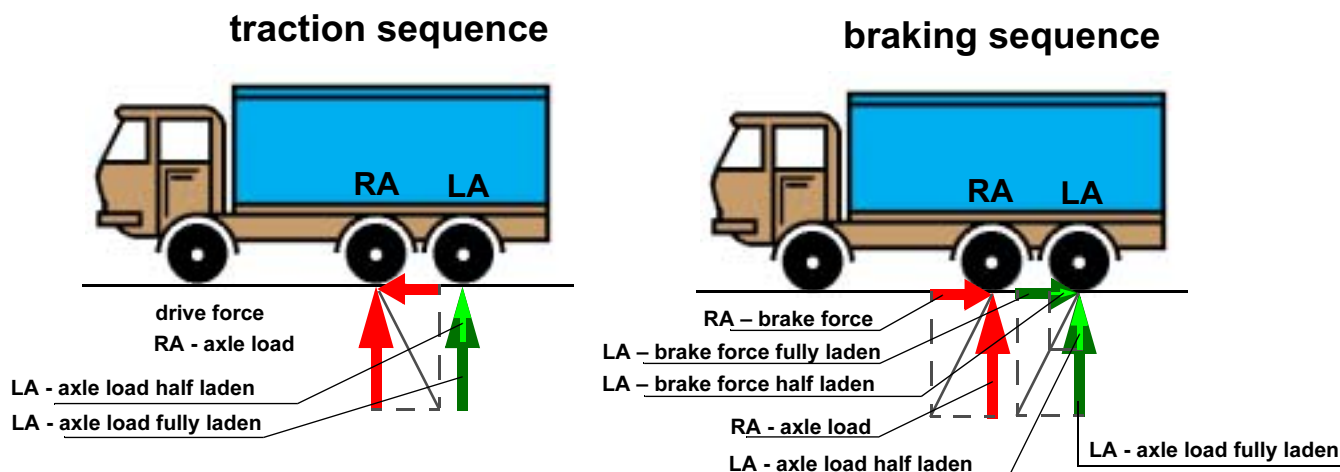
Fig. 6 Axle load and drive force variation with activated traction control

optimum traction control. Either of these two control options can be selected in towing vehicles fitted with ECAS 6x2 DV.

In the case of pressure ratio control, the supporting bellow pressures on the drive and lifting/trailing axles are controlled according to a defined ratio. It is still possible to maintain the drive force at a relatively high level, but brake wear can be distributed more evenly between both axles. This type of control would be suitable for delivery traffic or long-distance haulage, for example.

The complexity of the components for pressure ratio control corresponds to that for optimum traction control. The required control method is selected in the parameter settings. ($\downarrow$ Fig. 7)

The respective boundary conditions determine which of the two latter options will be selected in a system with the corresponding equipment.

3.14 Determining axle load in CAN II electronic systems

By means of the installed pressure sensors, ECAS can determine the axle load and provide this data to the vehicle data bus as a CAN message. This axle load information can be indicated to the driver via the display and/or can be used by other electronic control systems.

The ECU can store up to 4 independent calculation curves (max. 4 axles). Each curve is defined by 3 points of weight/pressure.

The axle load information (mean value from the time interval) is sent to the CAN bus in accordance with the SAE J1939 protocol every 100 ms.

traction sequence

braking sequence

drive force half laden
drive force full laden
axle load half laden
axle load laden
DV

brake force full laden
brake force half laden
axle load laden
axle load half laden
DV
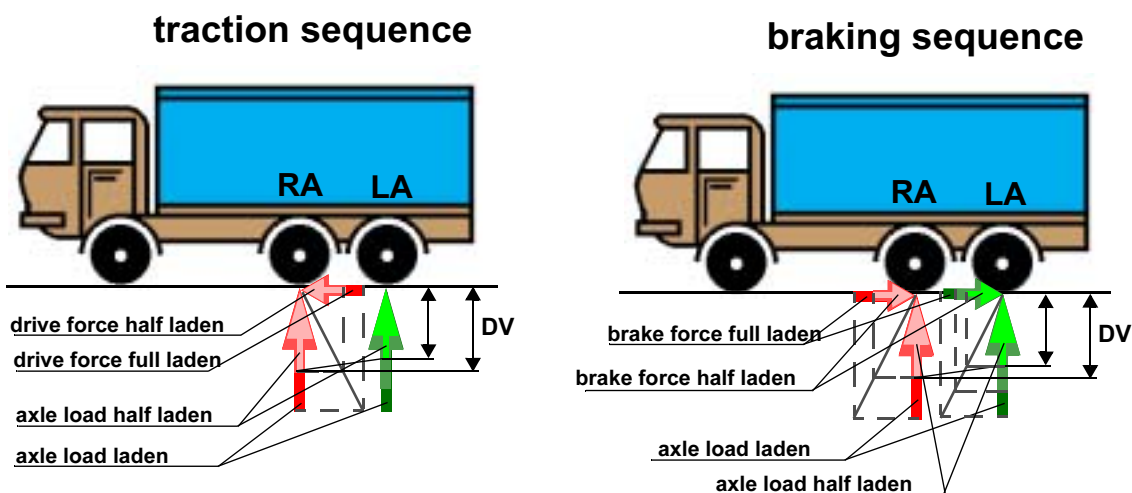
Fig. 7 Axle load and drive power variation with pressure ratio control

WABCO

4. Control algorithm
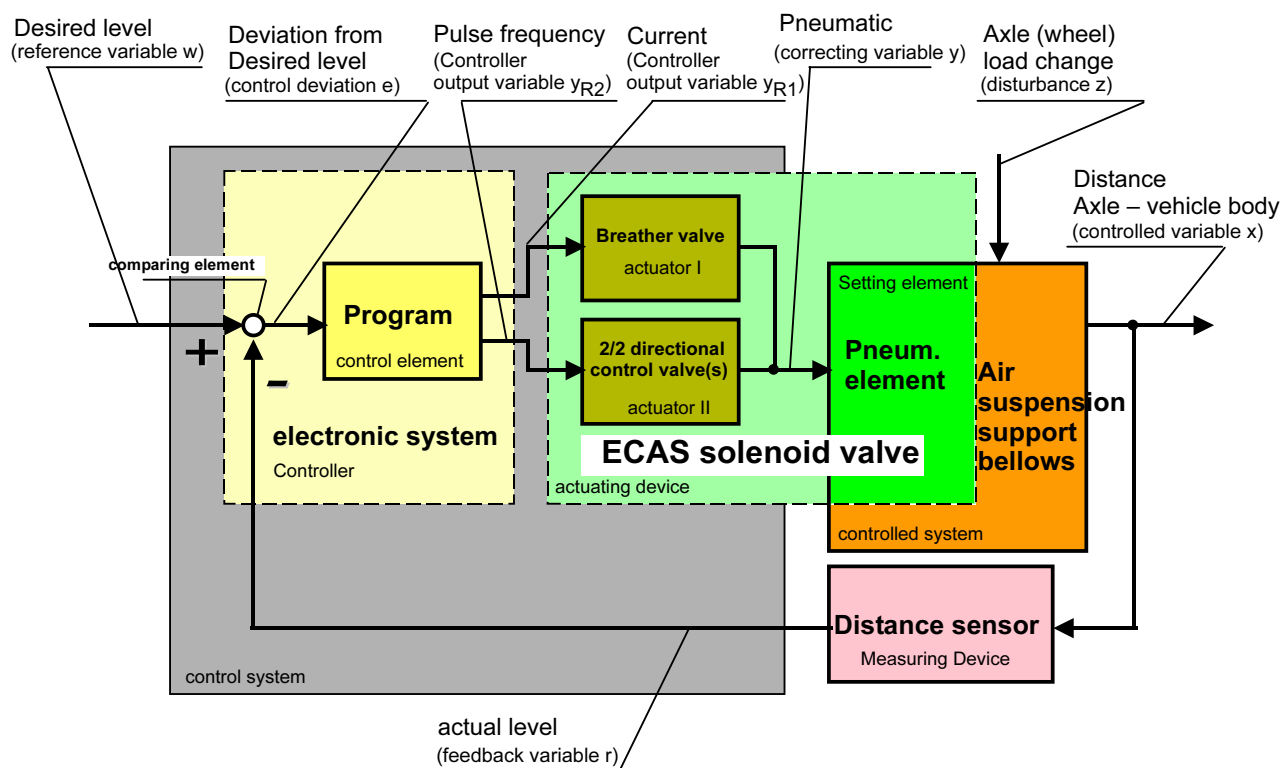
Fig. 8 Action diagram of the single ECAS control circuit

4.1 Control algorithm for levelling control

Levelling control is a function that controls the distance between vehicle body and axle. The levelling control is the basic function of ECAS.

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

In order effectively to describe how ECAS controls the levelling process, the basic physics of the air suspension system are described below.

General Comments on the Physics of ECAS
The basic problem in any control system in the event of a control deviation is to determine the best possible response time. This time describes the period starting with the change of nominal value up to the time when the actual value remains within a defined tolerance range for the nominal value (↓ Fig. 9). Until this is achieved, the control process continues and thus consumes air.

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 small differences in nominal values, is detrimental if the differences in nominal values are great. 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 reservoir pressure input side must be greater than the pressure at the bellows pressure output side.

Oscillation damping and damping force
During the control process, the role of the vibration damper must also be taken into account. Conventional oscillation dampers can be designed for one operating point only. The damping force for the vehicle is designed for the upper loading range. This means that for vehicles which are only partially laden or unladen, the part of the damping force which has to be overcome in the event that the nominal value is changed is disproportionately

high. Variable damping control could improve this. This is available from WABCO under the name of ESAC. ESAC, however, will not be analysed any further at this point.

The further the load is removed from the damper operating point, the greater the effect of the excess damping force.

This issue becomes clear if we look at the way the oscillation damper works. Inside the damper, oil needs to pass from one chamber into another chamber via a small throttling port. The resisting force thus generated is known as damping force. A rapid change in the distance between the vehicle body and the axle also causes this damping force to rise rapidly.

Therefore, it is primarily the change in distance that is responsible for building up the damping force.

At the same time as the distance between the vehicle body and the axle begins to change, damping force reduction is also initiated by the damper oil overflowing through the throttle. The time for this reduction is defined by the design of the damper (e.g. throttle diameter, viscosity of oil...).

Now the damping force 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. Consequently, it is also a force that counteracts levelling control.

This damping force, which varies over time, represents a problem for the control process.

Control process in the case of changes in the nominal value

When the forces of ECAS are balanced, the wheel load acts on the supporting bellows of the axle. Any axle steering transmission ratio must be taken into account in this regard.

The pressure in the supporting bellows multiplied by the effective cross-sectional area of the bellows - and this area **cannot** be computed directly from the diameter of the supporting bellows - counteracts the wheel load. The pressure in the supporting bellows depends only on the wheel load, not the level.

When the level is changed as a result of the change in the nominal value (e.g.by using the remote control unit), the pressure in the bellows is increased or decreased until the actual value for the distance between the vehicle body and the axle corresponds to the new nominal value. This is a dynamic process. The greater the desired change in the nominal value, the greater the acceleration which can be achieved by the control process. The system shows a tendency to oscillate. Overdriving may occur.

This tendency to overshoot occurs especially when the vehicle us unladen. On the one hand, the great pressure difference between the supply pressure and bellows pressure sides within the ECAS solenoid valve causes high flow rates while the bellows are being filled.

On the other hand, the damping force ratio that needs to be overcome is the greatest. The risk of the control loop oscillating is therefore also great. The result is an unnecessarily large number of control cycles within the ECAS solenoid valve, thereby reducing its service life.

If the tolerance range for the nominal value is defined widely enough, undesired oscillations can be prevented. However, this has a negative effect on the repeat accuracy of the control process with identical nominal value definitions.

If, however, a specific dimension should be adhered to, the control process must be changed in such a way that the influx of air is reduced even before the desired level is reached. This would reduce the speed at which the vehicle body is lifted, thereby suppressing the excessive tendency to oscillate or overshoot.

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. This pulsing action briefly interrupts the air stream, thereby achieving a throttling effect which prevents excessive oscillation, i.e. overshooting.

Pulse repetition period and pulse length

The following terms are significant for valve pulsing:

Pulse repetition period

The pulse repetition period is a fixed value which is stored in the ECU as part of the procedure for setting the parameters. The beginning of the pulsing period is assumed to be the actuating pulse for the valve solenoid. The pulse repetition period itself is in this case the period that elapses before the valve solenoid receives the next actuating pulse. (↓ Fig. 9).

Pulse Length

The pulse length describes the length of time for which the valve solenoid receives the actuating pulse. This value is variable and is newly calculated for each pulsing period. The ECU computes the pulse length relative to the existing control deviation, i. e. the difference between the desired level and the actual level.

This type of control is called 'proportional differential control' (or 'PD control' for short). The control process is carried out relative to the degree of control deviation and the rate of control deviation change.

Greater control deviations lead to greater pulse lengths. If the computed pulse length is greater than the entered

pulse repetition period, the valve solenoid is energised continuously. In this case, the change in the control deviation is therefore the greatest.

Because of the large flow cross-sections, readjustment during the lifting process must be slowed down shortly before the new nominal value is reached. The rate at which the control deviation changes is analysed and taken into account for the adjustment in this context. Control deviations changing at high speeds cause the pulse length to be reduced.

Equation for calculating the pulse length when "raising the vehicle body while stationary"

Pulse length $=(|$ control deviation x $K_P|$ - $|$ control deviation rate of change x $K_D|)$

"lowering the vehicle body while stationary"I and when "lifting/lowering when driving":

Pulse length = $(|$ Control deviation x $K_P|$

K_P (proportional coefficient) and K_D (differential coefficient) are important for describing the control cycle and are stored in the ECU as part of the procedure for setting the parameters.

The equation shows:

*   With regard to K_P, great control deviations or high values result in prolonged pulse lengths at equal control deviations.

*   With regard to K_D, on the other hand, extreme control deviation rates or high values while the control deviation rate is the same, reduce the pulse length.

The pulse length is re-computed for each pulse repetition period. A pulse length which exceeds the pulse repetition period causes the solenoid to be energised continuously ('continuous pulse'). The shortest pulse length to be executed is 75 milliseconds (0.075 seconds).

⚠ Shorter pulse times would jeopardize the switching process of the solenoid valve at temperatures below -40 °C .

Determining the proportional and differential coefficients for setting the pulse controller

These factors have to be determined by way of trials on the vehicle. Like the other parameters, they lie within the scope of responsibility of the vehicle manufacturer.

For this reason, the following section is only intended to provide information for checking the control quality of the set control function:

The vehicle is brought to a level which is directly below the nominal value tolerance. If the normal level is reached without any excessive oscillation and without repeated pulsing of the solenoid valve, the setting for the desired level tolerance and the proportional coefficient are acceptable. The larger the K_P value, the faster the pneumatic part of the system performs the control
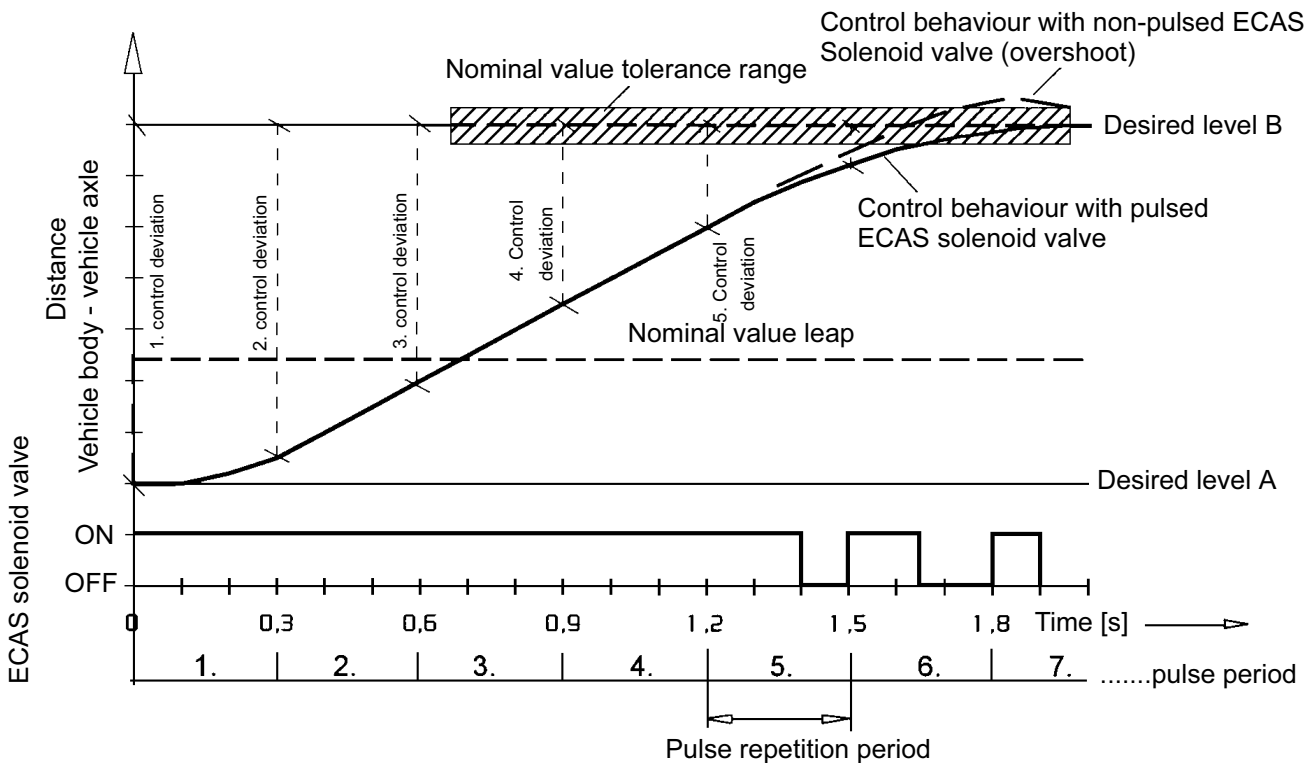
Fig. 9 Example for a control process when the nominal value is changed

function within the limits of what is possible in terms of fluid mechanics. Unnecessarily high K_P values increase the tendency to overshoot.

In order to examine the differential behaviour, the control function is checked using a large nominal value change which has to be compensated for by raising the vehicle body (e.g.bringing the vehicle to its lowest possible level). After the normal level button on the remote control unit has been pressed, the vehicle body should move to its normal level without overshooting and without excessively long pulsing. A single vehicle body overshoot followed by a corrective adjustment to the desired level is still acceptable when the vehicle is empty. The tendency to overshoot can be suppressed by means of a well adjusted differential behaviour. Pulsing of the ECAS solenoid valve begins sooner as the K_D value increases, and thus the lifting process of the vehicle body is slowed down.

It may be the case that the system needs to be manipulated in order to improve the control response because the determined K_P and K_D values do not produce satisfactory control results within the recommended framework. In such a case, the cross section of the air flow in the pneumatic section can be reduced. Usually it is sufficient to fit a throttle in the air line between the solenoid valve and the supporting bellow unit(s) of the axle concerned.

Summary

You can influence the control regarding the distance between the vehicle body and the axle by way of the following settings:

- Pulse repetition period T,
- Nominal value tolerance Δs,
- Proportional coefficient K_P,
- Differential coefficient $K_{D'}$.

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. This type of control is used in all CAN electronic control units, as well as 4x2/6x2 MAN and 4x2 RVI and DAF. ECAS learns the overshoot behaviour after the very first control process. With regard to subsequent control processes, switch-off already occurs before the desired level is reached. The vehicle body then accurately "swings" into the desired level. ($\downarrow$ Fig. 10)

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).
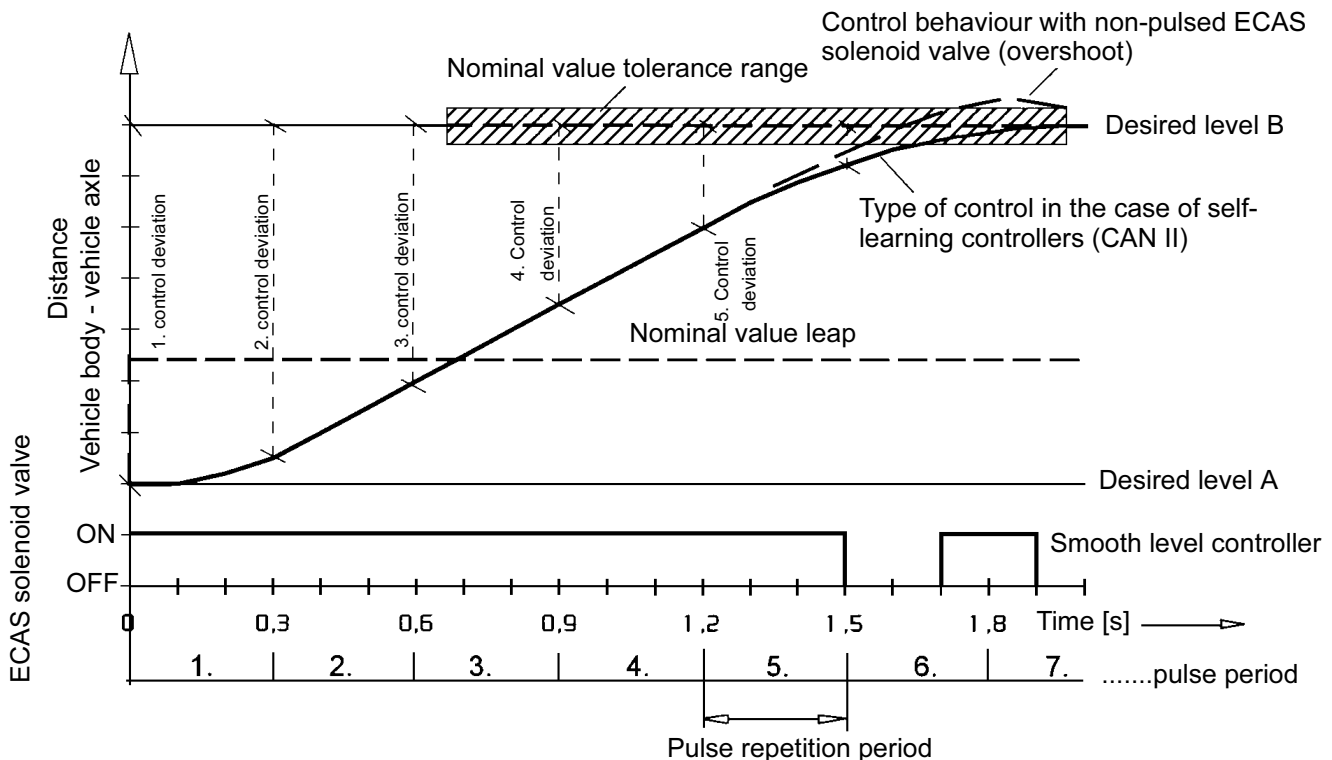
Fig. 10 Example for a control process when the nominal value is changed if self-learning controllers are installed

4.2 Control algorithm for lifting axle control

Vehicles with a lifting axle can be equipped with a lifting axle control facility. This is an optional extra and is not necessarily used in every system.

The lifting axle control adjusts the position of the lifting axle relative to the axle load of the driving axle. For this purpose, ECAS decides whether the lifting axle is on the ground or lifted. Disturbance factors, usually changes in the load, make lifting axle position control necessary. An option for the user to actively modify the reference/nominal value is not provided.

However, a lifting axle which has been raised can always be lowered manually. The lifting axle can also be raised in the partly laden condition, provided this does not result in the max. permitted supporting bellows pressure on the driving axle being exceeded.

The following section always refers to the lifting axle. Essentially, this information can, however, also be applied to the control of a trailing axle.

General information on lifting axle control

Concepts such as "traction help" and "overload protection" also belong to the larger topic "lifting axle control". These will also be covered in this context.

Controlling the position of the lifting axle is based on the pressure in the supporting bellows on the driving axle; this pressure is sensed, depending on the design, by one or more pressure switches or pressure sensors on the supporting bellows. In systems with pressure switches, these switching pressures are predefined. The ECU compares the pressure value picked up by pressure sensors with various nominal values. These nominal values will have been defined already as part of the initial start-up process for the ECU. They determine the following limits:

- Lowering or lifting pressure for the lifting axle
- Maximum permitted traction help pressure
- Maximum permitted load

Thus, every pressure value has a specific condition of the axle assembly assigned to it.

4.2.1 Lifting axle function diagram in vehicles with pressure equalising control (Example: tank lorry)
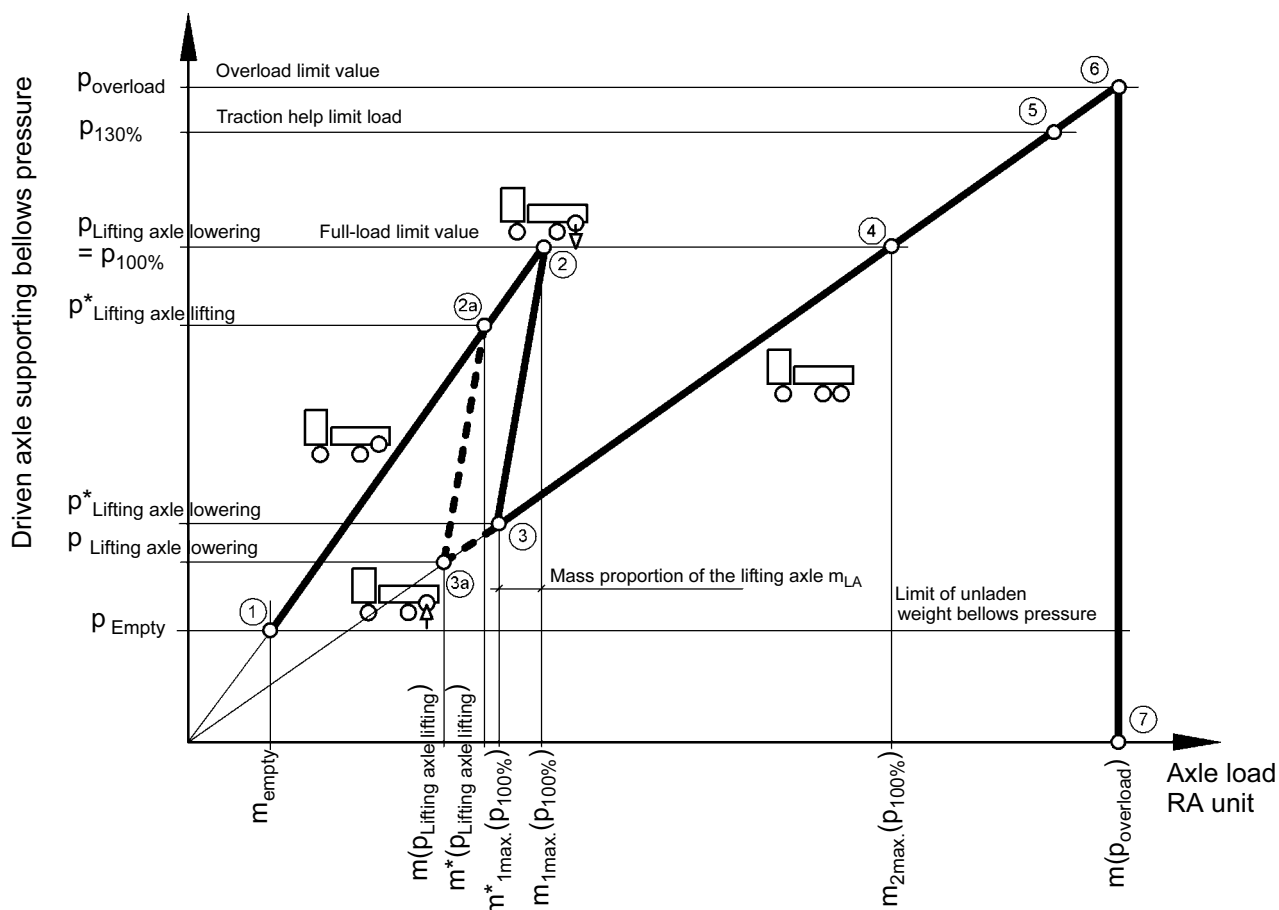
Fig. 11 Lifting axle function diagram in vehicles with pressure equalising control

Figure 11 shows the progress of the support bellows pressure (thick line) in the driving axle in relation to the load on the rear axle combination for a vehicle with pressure compensation control. Neither a pressure ratio nor a traction control has been programmed on the vehicle, i. e. the support bellows of the lifting axle are exposed to the same pressures as those acting on the driving axle.

The line traversed in the process of loading and unloading passes through a number of distinctive points. Some of the pressures in the driving axle's supporting bellows at these points must be specified for the ECAS system in the parameter settings. Other pressures are the result of reactions of the lifting axle and can therefore not be manipulated - such pressures have been marked with an asterisk (*).

! Proper lifting axle control requires a sufficient supply of compressed air and power.

For the purposes of the explanation below, please suppose that a tank lorry is continuously filled with, or drained of, a liquid (↑ Fig. 11).

1. The filling process begins at ①. On the driving axle, the vehicle has an unladen weight $m_{unladen}$. This unladen weight is the combination of:
   • the vehicle body mass
   • and a lifting axle mass proportion m_{LA}.
   The corresponding supporting bellows pressure $p_{Unladen}$ can, for example, be read from the LSV plate.

2. The filling process increases the loading of the vehicle until ② is reached. At this point, the lifting axle is lowered. Let us call the corresponding supporting bellows pressure $p_{Lifting axle lowering}$, this being the lowering pressure for the first lifting axle. It must be made known to electronic control unit via parameter settings. The standard value for this pressure is the permissible nominal value $p_{100\%}$ of the pressure in the supporting bellows when the vehicle is fully laden. This value is also shown on the reference plate for the load-sensing valve.

3. The loads on the rear axle assembly (RA) change when the lifting axle lowers. The load is reduced by the lifting axle mass proportion m_{LA}. The pressure in the supporting bellows of the driving axle also falls because the axle load is distributed to the supporting bellows of the driven and lifting axles. The bellows pressure curve proceeds from ② to ③ after the lifting axle has been lowered. The supporting bellows pressure that now acts on the driving axle $p^*_{Lifting axle lowering}$ cannot be influenced by the user. Determining this pressure, however, is useful for configuration of the lifting axle control.

4. As the tank is filled further, the pressure in the driving axle's supporting bellows again rises to its maximum permissible value ④.

5. The pressure progresses through the maximum permissible pressure for the bellows on the driving axle when traction help is activated, $p_{130\%}$ point ⑤.

6. Finally it reaches a pressure $p_{overload}$⑥ at which overload protection commences.

7. Overload protection can only be activated in systems with pressure sensors (not pressure switches). It means that when this pressure $p_{overload}$ is reached, the supporting bellows of all axles in contact with the ground are exhausted. Under certain circumstances, activation of the overload protection may cause the vehicle body to be lowered down onto the stops ⑦). This is intended to prevent the vehicle being driven with an excessive load on the vehicle body. The pressure value for $p_{overload}$ must be made known to the ECU. The axle manufacturer's data and any legal provisions concerning vehicle load must be observed in this regard.

8. The supporting bellows are only recharged once the axle load drops below the pressure $p_{overload}$ again, as a result of unloading or pressure reduction, for example; when the pressure in the supporting bellows is reduced from the perspective of point ⑥. Switching the ignition OFF and ON is sufficient as a reset to have the last desired level re-established.

9. Continuing with the above example: when more liquid is drained from the tank body, the pressure in the supporting bellows drops below ③ down to ⑶ₐ). At this point, the pressure in the supporting bellows on the main axle is so low that it makes sense to raise the lifting axle. The pressure is referred to as the lifting pressure of the lifting axle $p_{Lifting axle lifting}$. It has to be made known to the ECU as part of the procedure for setting the parameters.

For proper functioning of this feature, the following rules must be observed:
• **Pressure value $p_{Lifting axle lifting}$ < Bellows pressure $p^*_{Lifting axle lowering}$**
• **Lifting pressure $p_{Lifting axle lifting}$ > Pressure $p_{Unladen}$ (at unladen vehicle weight)**

⚠ Non-observance of these rules may result in malfunctions of the lifting axle, e.g. continuous lifting and lowering if the pressure value is greater than the bellows pressure $p^*_{Lifting axle lowering}$.

10. In systems with a semi-automatic lifting axle, the lifting axle can be raised manually should the

pressure drop below the critical pressure $p^*_{\text{Lifting axle lowering}}$.

11. In systems with a fully automatic lifting axle control, the lifting axle is lifted once the lifting pressure has been reached, and only the supporting bellows on the driving axle bear the axle load . The lifting axle mass proportion m_{LA} is now part of the load again. The pressure curve for the supporting bellows runs from ③a to ②a where the resulting pressure in the supporting bellows $p^*_{\text{Lifting axle lifting}}$ cannot be influenced.

12. After the unloading process has been fully completed, the pressure curve for the supporting bellows is again at point ①.

Summary
You can set up the control of a lifting axle, including overload protection, applying the following settings:

- **Lowering pressure of the lifting axle $p_{\text{Lifting axle lowering}}$**
- **Overload protection pressure p_{overload}**
- **Lifting pressure of the lifting axle $p_{\text{Lifting axle lifting}}$**

In addition, the specific boundary conditions for defining the lowering and lifting pressure of the lifting axle must be

taken into consideration in order to establish a successful lifting axle control.

4.2.2 Traction help control

Generally, the traction help facility can be used only if a supporting bellows pressure (↓ Fig. 12) between ③a and ⑥ is determined. That means that the lifting axle must be on the ground. The description follows the requirements of EC Directive 97/27/EC (EC 97/27).

Fig. 12 shows two examples, starting with Ⓐ1 and Ⓑ1, to illustrate the effect of traction help after activation of the different loading conditions.

Example 1
In point Ⓐ1 the supporting bellows of the lifting axle is exhausted. There are pneumatic systems that avoid complete bellow exhaustion - a slight residual pressure is maintained to prevent damage to the bellows. The lifting axle is now raised. A bellows pressure adjusts to a level that lies on the extended line between ① and ② and is referred to as Ⓐ2 . After traction help is deactivated, the pressure in the supporting bellows is again adjusted in accordance with point Ⓐ1 .

The load acting on the driving axle due to the traction help function is limited in accordance with EC 97/27. Unless the axle manufacturer has defined lower values,
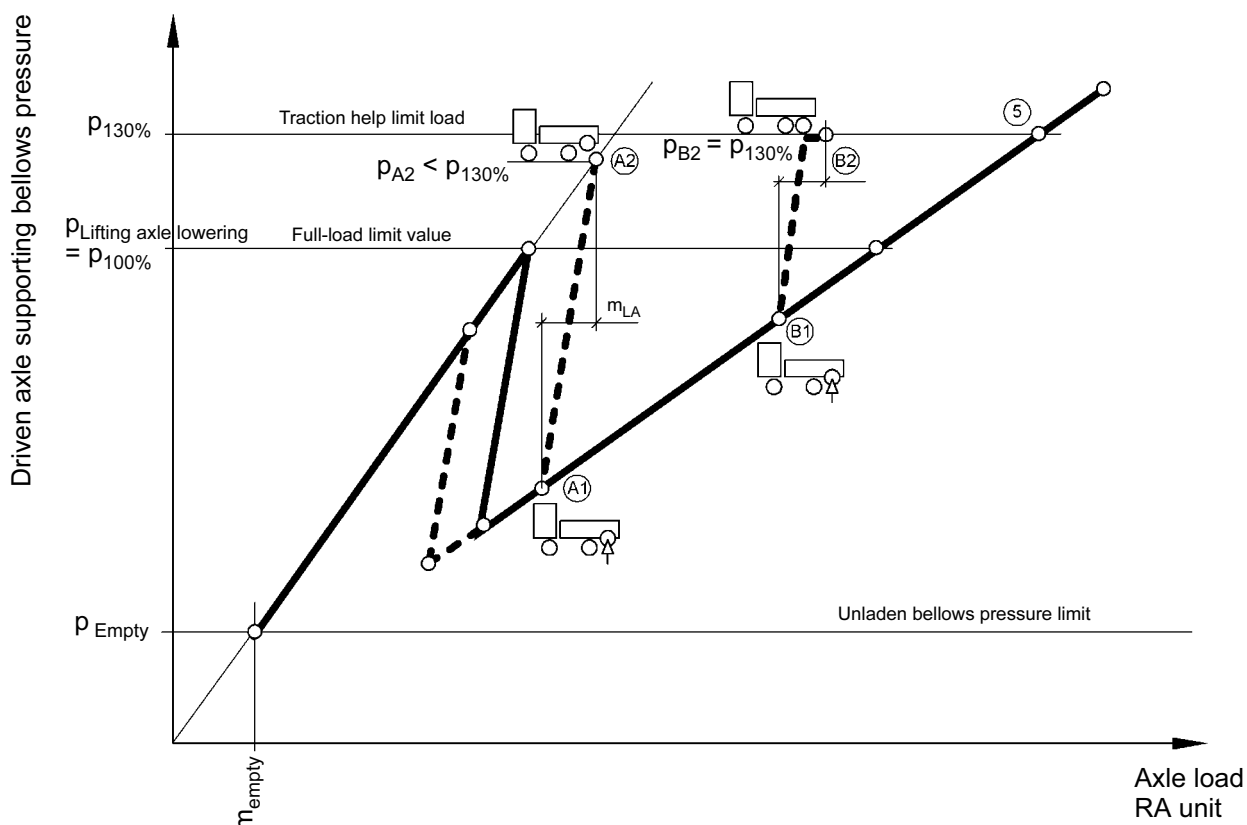
Fig. 12 Traction help function diagram in vehicles with pressure equalising control

the axle load on the driving axle is only allowed to exceed the valid permitted axle load (defined in Germany in section 34 of the Motor Vehicle Construction and Use Regulations (StVZO)) by max. 30 %.

The max. permitted driving axle bellows pressure with traction help activated $p_{130\%}$, i.e. the pressure that complies with these requirements, must be made known to the ECAS electronic control unit via the parameter settings. To be able to adjust to this condition, it is necessary to program into the electronic control unit a nominal value range $\Delta p_{130\%}$ within which traction help limit pressure control takes effect. The following then applies to the control function:

Control range = $p_{130\%} - \Delta p_{130\%}$

The traction help limit pressure is therefore not exceeded when the control system is operating. If traction help and overload protection are provided for in an ECAS system, then the traction help limit pressure $p_{130\%}$ must never exceed the overload pressure $p_{overload}$.

! According to applicable law, traction help may only be effective at speeds below 30 km/h.

Example 2
The second example shows the behaviour when the traction help limit pressure $p_{130\%}$ is reached. Starting at (B1) , the initial step is again exhausting the supporting bellows of the lifting axles. When the traction help limit pressure is reached, the venting of the lifting bellows stops and the pressure in the supporting bellows of the leading axle does not increase any further. (B2) . In this case, the lifting axle remains on the ground. The excess load is taken up by the supporting bellows of the lifting axle. After deactivation of the traction help, the pressure in the support bellows is adjusted in accordance with (B1) again.

To sum up then, the following values have to be made known to the ECU for the traction help facility:

* max. permissible pressure in the driving axle's support bellows when traction help is activated p130% (traction help limit pressure)
* Nominal value range $\Delta p130\%$
* Speed limit for the traction help function

The timings for activation duration and intervals between actuation, as well as the different modes of traction help, can be specified in some systems using a code set on certain pins in the ECAS electronic control unit. In other systems the mode may be freely assignable via ECU parameter settings.

It is possible to set parameters for up to 5 different types of traction help (see chapter 3.8 "Traction help").

The extent two which these types are actually applied depends on the particular ECAS system.

5. System configuration

ECAS is an extremely variable system that can be adapted to meet the requirements of the vehicle with great efficiency. Up to 3 base control loops may be present in the vehicle. In addition, it is possible to control a lifting axle. The selection of the system components to be used is determined by how the vehicle manufacturer expects the system to perform.

To illustrate this further, the following pages show different control circuits for the complete vehicle combination.

For ABS or EBS, the configuration can be determined on the basis of the speed sensors/modulators installed in the system (e. g. 4S/3M); In ECAS, on the other hand, it is the number of basic control circuits for level control which determine the configuration. This number corresponds to the number of distance sensors installed. A system with two distance sensors, for example, is therefore referred to as a 2-point control system.

The specification of the type of control may apply to all sections of the vehicle (as shown here) or to the components of a single axle. A vehicle with full air suspension and 3-point control, for example, consists of

the steered axle with 1-point control and a driving axle with 2-point control.

Generally, the following control types are found in vehicles:

- 1-point control
- 2-point control
- 3-point control

Looked at axle by axle, **1-point control** is found on steered front axles and on rear axles. In vehicles with partial air suspension, the driving axle is sensed by a distance sensor for 1-point control.

2-point control is used in cases where irregular or uneven loading is expected in vehicles with a large tyre tread width, or in vehicles with a high centre of gravity. Even from an overall vehicle perspective, a 2-point control is also evident in vehicles with full air suspension where front and rear axles are equipped with one distance sensor each.

3-point control is only found in vehicles with full air suspension and denotes the combination of 1-point control on the steered front axle and 2-point control on the rear axle.

1-point control
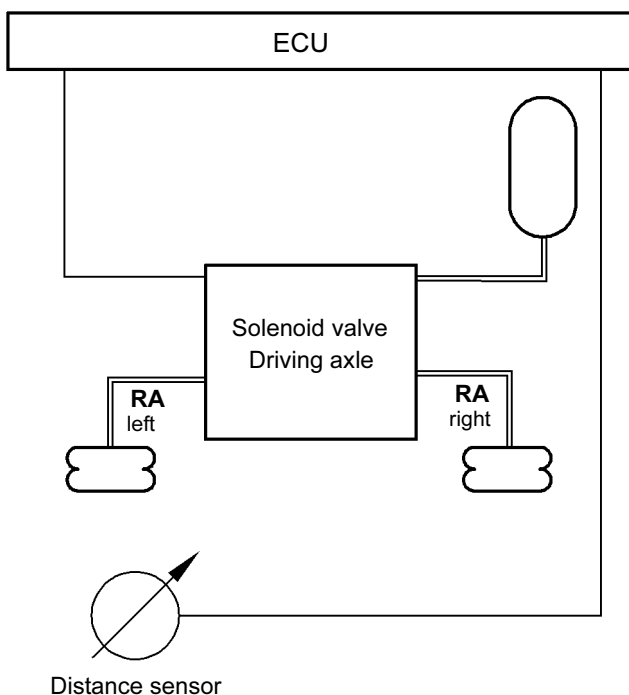
2-point control

Abb. 13 Control for vehicles with partial air suspension
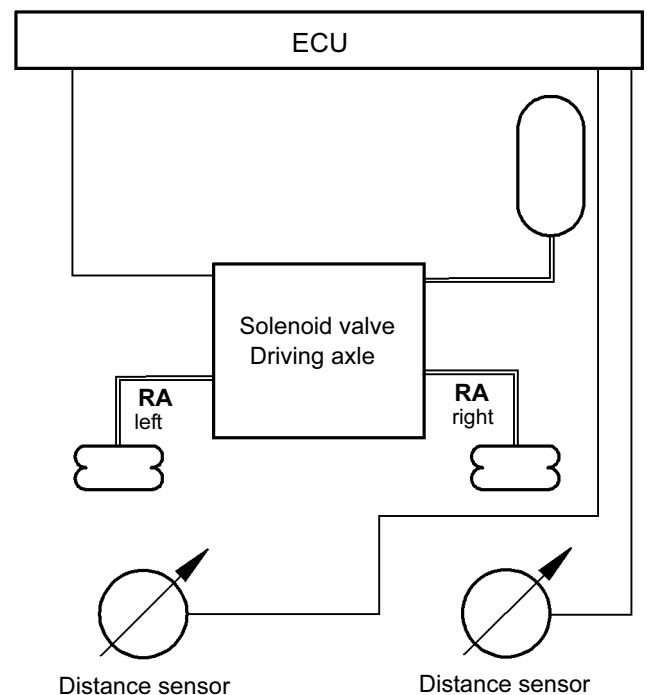
The particular distance sensor configuration can be extended if there is a lifting axle with pressure switches or pressure sensors.

It is sufficient to fit pressure switches that determine the bellows pressure for the automatic lowering of the lifting axle when certain fixed pressure values are reached in the driving axle's support bellows. Pressure switches can also be used to implement a traction help function.

Pressure sensors are used on the driving axle whenever a fully automatic lifting axle, tyre impression compensation, or the overload function is required. If pressure ratio control or optimum traction control is required, then additional pressure sensors have to be fitted to the lifting axle supporting bellows.

2-point control
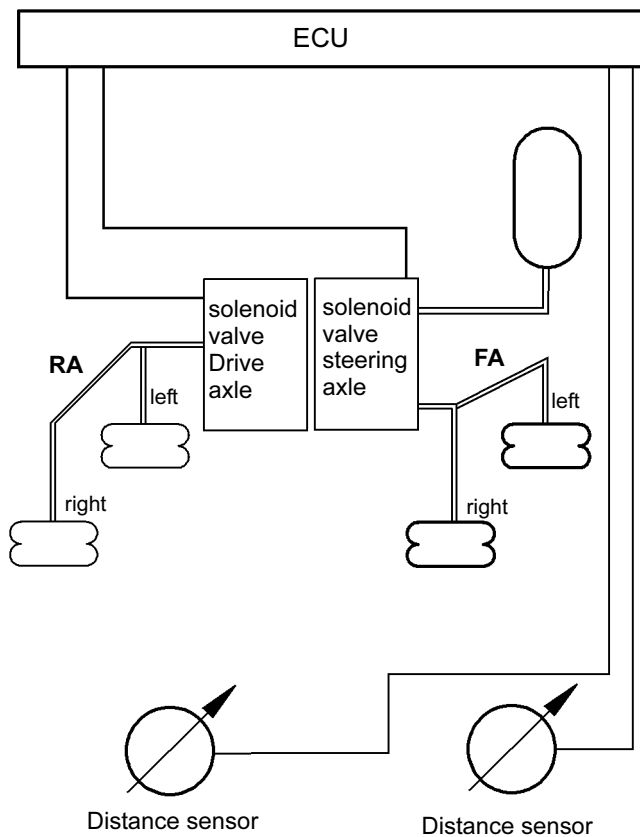
3-point control
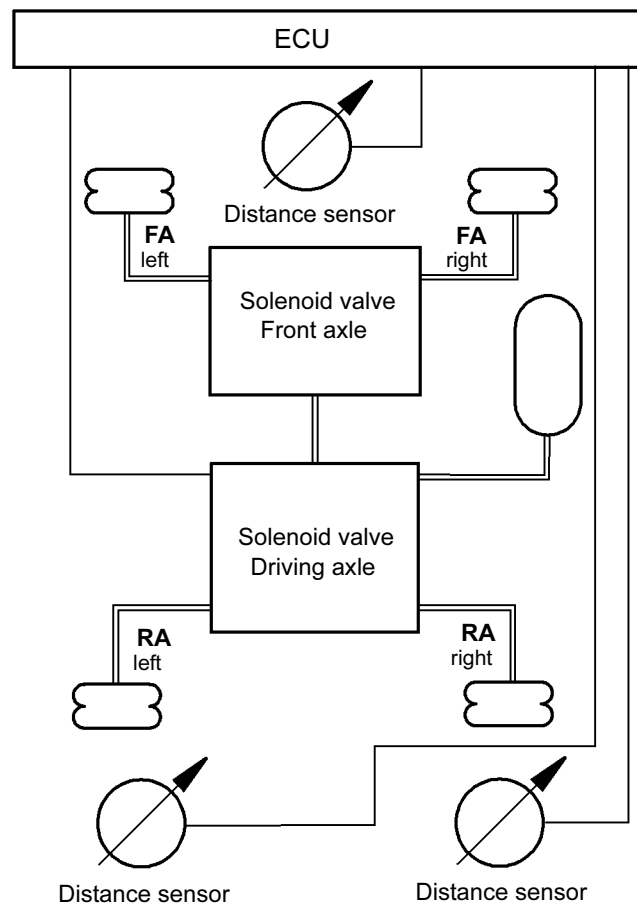
Abb. 14 Control for vehicles with full air suspension

6. Components

Components of an ECAS System

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

The pneumatic components are not dealt with 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. The electrical power supply will be dealt with separately as part of the description of the ECAS electronic electronic system.

6.1 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 switches or pressure sensor(s) are used for controlling additional functions.

6.1.1 Distance sensor

The distance sensor 441 050 0.. 0 is used as an actual value transmitter for continuous detection of changes in height. The inductive measuring principle is used.

A slewing 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.

For the angle-of-rotation sensor 441 050 1.. 0, the change in inductance is generated by the rotary movement of the sensor shaft.

! It is not possible to test the distance sensor function using a voltage meter.
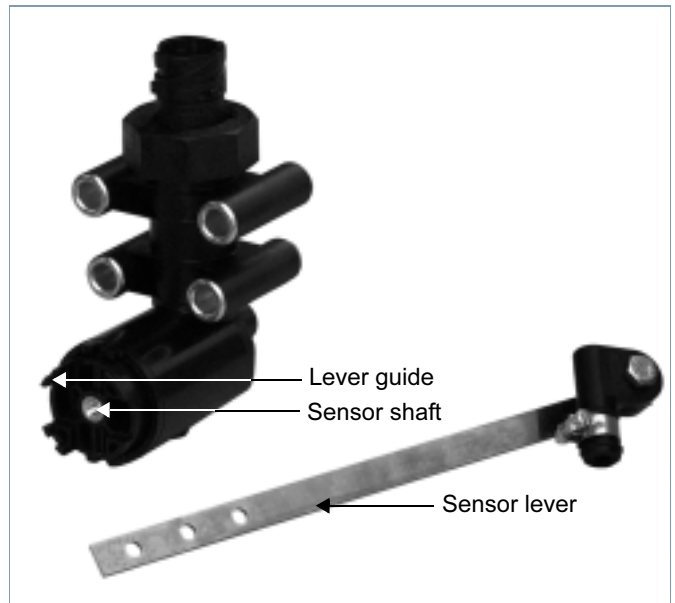
Abb. 15 Distance sensor 441 050 0.. 0 and lever 441 050 718 2
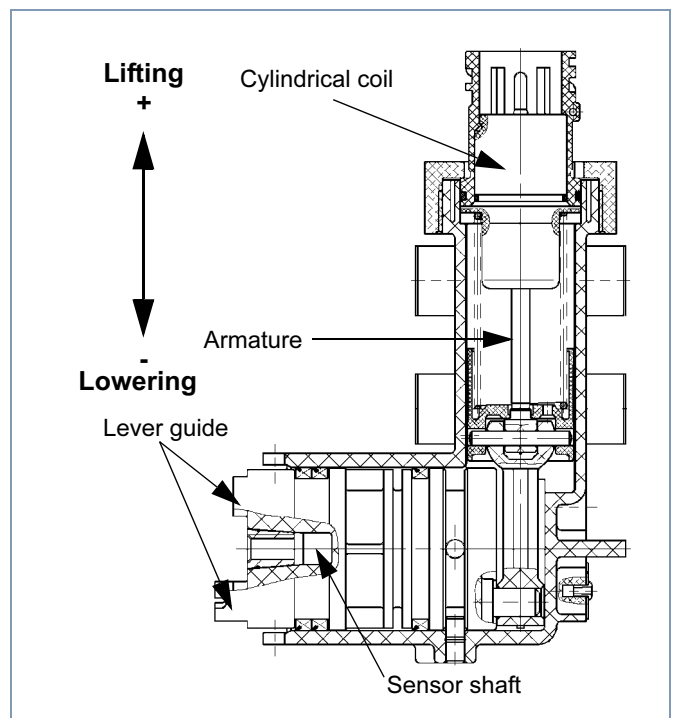
Abb. 16 Sectional view of the distance sensor 441 050 0.. 0

Abb. 17 Angle-of-rotation sensor 441 050 1.. 0
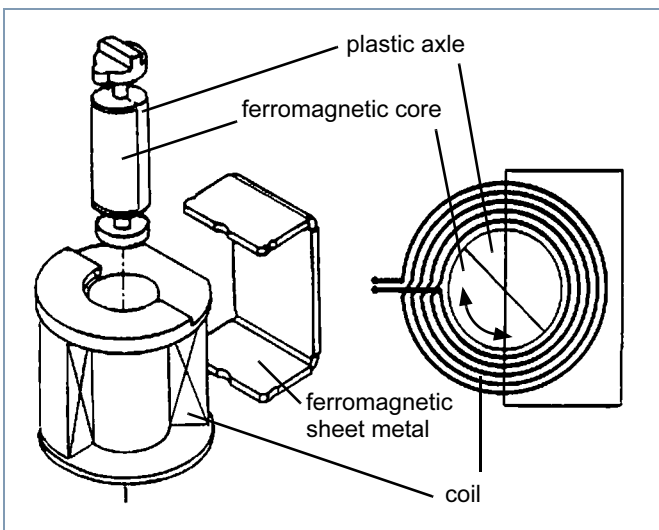
Abb. 18 Diagram of the angle-of-rotation sensor 441 050 1.. 0

If the distance sensor needs to be checked, the resistance can be measured to verify proper function of the coil. The resistance must be approx. 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.

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.

The type of sensors installed must be set in the parameters (optional parameter 2.5).

The ECAS ECU converts the respective sensor value into counts, i.e. into a byte value between 4 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 256 to 65.536).

Installation note

The distance sensor has a measuring range between + 43° and - 40° (initial position 90°, lever is level). Fig. 16 shows the assignment of positive and negative ranges.

The entire deflection range is most efficiently used when the lever is almost horizontal at normal level.

> **!** The maximum deflection of the lever (+/- 50°) may 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 the 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.

The distance sensor only exists in one variant 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.

To facilitate this process, two projections (↑ Fig. 16) functioning as lever guides have been provided on the sensor shaft.

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.

! It is important that the distancesensor 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).

When mounting the distance sensor on the vehicle body, take the sensor's raising and lowering reaction into account:

• Immersion of the cylinder coil in the LIFT direction increases the induction.

• Retraction of the cylinder coil in the LOWER direction reduces the induction.

The acquired measured values can be displayed on suitable diagnostic equipment (PC).

• Raising the vehicle body also increases the displayed values.

• Lowering the vehicle body reduces them.

Distance sensor information for service purposes

Order Number	Design
441 050 006 0	Bayonet; without lever; used by MAN, DAF and as replacement.
441 050 007 0	slim housing; M24x1 thread; used by Renault (cars);
441 050 008 0	M24x1; without lever; used by DC, DAF, MAN, RVI, Scania, other manufacturers (replacement for 441 050 003 0)
441 050 010 0	M27x1; without lever; used by RVI, Neoplan and in trailers
441 050 011 0	Bayonet DIN 72585-A1-2.1-Sn/K2; without lever; used by MAN, IVECO, Scania, DAF and in trailers
441 050 012 0	Bayonet DIN 72585-A1-2.1-Sn/K2; without lever; without temperature compensation; MAN TGA, DC Actros and Atego
441 050 013 0	as for 441 050 012 0, without colour coding on the electrical connection however; used by RVI
441 050 100 0	Angle of rotation sensor; bayonet DIN 72585-A1-2.1-Sn/K2; without temperature compensation; straight lever; used by DAF
441 050 101 0	Angle of rotation sensor; bayonet DIN 72585-A1-2.1-Sn/K2; without temperature compensation; straight lever; used by DAF

Order Number	Design
441 050 120 0	Angle of rotation sensor; bayonet DIN 72585-A1-2.1-Sn/K2; without temperature compensation; cross lever; used by IVECO
441 050 121 0	Angle of rotation sensor; bayonet DIN 72585-A1-2.1-Sn/K2; without temperature compensation; cross lever; used by DC
441 050 122 0	Angle of rotation sensor; bayonet DIN 72585-A1-2.1-Sn/K2; without temperature compensation; cross lever; used by SCANIA Bus
441 050 123 0	Angle of rotation sensor; bayonet DIN 72585-A1-2.1-Sn/K2; without temperature compensation; cross lever; used by MAN

6.1.2 Pressure switch

Abb. 19 Pressure Switch 441 014 … 0

Pressure switches are used to permit simple extended ECAS functions (lifting axle control, traction help) in systems operating according to the pressure equalising principle.

Two pressure sensors, designed as an NCC, sense the support bellows pressure. In unladen condition, the pressure switches are connected to terminal 15 via two corresponding pins on the ECAS electronic control unit.

A pressure switch (with a switching point, for example, of e. g. 11 … 11.5 t) transmits a signal to the ECU when the axle load is above or below the normally permitted level. The lifting or trailing axle is controlled in driving operation on the basis of this information. Dynamic influences on the axle load are ruled out by selecting a certain length of time (e .g. 2 or more seconds) during which the change in switch position must be maintained in order to trigger an axle response.

The 2nd pressure switch (switching point: e. g. 13 t) transmits a signal to the ECU when the permissible axle load with activated traction help is exceeded. Axle load distribution during activated traction help is controlled in accordance with this information.

The advantage of using a normally closed contact is that the lifting axle is always lowered / the load is always transferred to the trailing axle when there is no voltage

(i. e. the ignition is OFF). As a result, overloading can be excluded.

6.1.3   Pressure sensor

Pressure sensors are required in order to use the extended ECAS functions. In the simplest variant, the pressure sensor senses the pressure in one bellows on the driving axle.

This arrangement is selected for the simple control tasks:

- Control of the lifting axle,
- control of traction help, or
- to compensate tyre impression

For complicated control functions, e. g. pressure ratio control, every supporting bellows has a sensor, including the lifting axles.

The pressure is measured by means of extension measuring strips. As the pressure is increased, the resistance at a Wheatstone bridge changes; this change generates a voltage in proportion to the pressure. Depending on the design, the pressure sensor is supplied with 8 … 32 V. The voltage indicating the pressure is transmitted to the ECU via a signal line (sensor cable).

In a pressureless condition (pressure sensor offset), the output is 0.5 V.

The transmittable voltage at the upper limit of the measuring value at a pressure of 10 bar is 4.5 V (pressure sensor type with bayonet connector to DIN 72 585-A1-3.1 - DIN bayonet that is) or 5.5 V (pressure sensor type with bayonet - older version).

! The maximum permitted pressure of 16 bar for these pressure sensors may not be exceeded.

The output of measuring values is digital, i. e. in steps. The acquired measured values can be displayed on suitable diagnostic equipment (PC).

The pressure sensor is connected to a separate connector on the supporting bellows or on a T-piece on the bellows' inlet port.

⚠ The pressure sensor should never be fitted in the compressed air line between the supporting bellows and the ECAS solenoid valve. Measuring errors may be caused by the extreme dynamics of constant charging and venting actions.
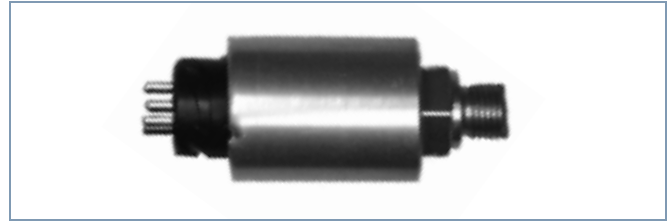
Abb. 20 Pressure sensor 441 040 003 0

The pressure sensor with Schlemmer bayonet connection for the sensor cable. The smallest digital measuring steps are 1/20 bar. 1 1 bar would equal 20 measuring values. This type of pressure sensor is increasingly being replaced by the type described below.

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Abb. 21 Pressure sensor 441 040 0.. 0

The pressure sensor is equipped with a DIN bayonet connection for the sensor cable. The smallest digital measuring steps are 1/16 bar. 1 bar would equal 16 measuring values. This type of pressure sensor is used more and more frequently in vehicle systems (also if EBS is installed) because of its standardised DIN connection and will replace the variant described above.

The same applies to replacing a pressure sensor which with a Schlemmer bayonet connection.

The replacement of the two types of pressure sensors requires some attention. If a replacement becomes necessary, the parameters in the electronic system affecting pressure-related control processes must be modified.

Pressure sensor information for service purposes

Order Number	Design
441 040 003 0	pneum. connection M16x1.5; electr. connection bayonet; 500mV/bar; only replacement DAF and trailers.
441 040 004 0	pneum. connection M16x1.5; electr. connection M27x1; 500mV/bar; only replacement DAF.
441 040 005 0	pneum. connection M16x1.5; O-ring seal; electr. connection M 27x1; 500mV/bar; only replacement RVI.
441 040 013 0	pneum. connection M16x1.5; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; ratio version; used by DC, MAN, DAF, IVECO and trailers; replacement for variant 007

Order Number	Design
441 040 014 0	pneum. connection M16x1.5; bayonet DIN 72585-A1-3.1-Sn/K2; 333mV/bar; 12 bar measuring range; used by IVECO-S2000
441 040 015 0	pneum. connection M16x1.5; Raufoss O-ring seal; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; used by IVECO (from December 2000).
441 040 017 0	pneum. Connection M16x1.5; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; with Gore filter; used by Scania (from January 2001) is replaced by 441 044 105 0
441 040 018 0	pneum. connection M16x1.5; O-ring seal; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; used by RVI.
441 044 001 0	pneum. connection M16x1.5; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; used by DAF, DC, MAN.
441 044 002 0	pneum. connection M16x1.5; Raufoss O-ring seal; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; used by IVECO.
441 044 003 0	pneum. connection M16x1.5; bayonet DIN 72585-A1-3.1-Sn/K2; 333mV/bar; used by Scania Bus.
441 044 105 0	pneum. connection M16x1.5; bayonet DIN 72585-A1-3.1-Sn/K2; 400mV/bar; used by Scania

6.2 Electronic Control Unit (ECU) 446 055 … 0

The ECU is the heart of the ECAS system. The ECAS electronic system is supplied with power via terminal 15 (ignition). In addition, supply via terminal 30 (steady positive voltage) is possible. In this respect, it is decisive which system is used.

The control process for the air suspension is coordinated in the ECAS ECU. That means:

• All incoming signals from the distance sensors are continuously monitored, converted into computer-legible signals (counts or timer ticks) and evaluated.

• In systems with pressure switches fitted, lifting axle control is initiated relative to the pressure switch position.

• If the system configuration includes a pressure sensor, these incoming signals are also continuously monitored, converted into computer-legible signals (counts), and evaluated.

• In correspondence with the parameters settings, and the design of the system, the signals for controlling the nominal values in the air suspension bellows are determined and transmitted to the ECAS solenoid valves.

• All data for which parameters have been set, which have been calibrated, or are otherwise defined (e.g. memory levels), are stored and managed.

• Any messages are recorded, stored and displayed via the signal lamp on the instrument panel if applicable. They can be read out using the appropriate software.

• The electronic control unit stores the parameters which determine how the specific system functions. The vehicle manufacturer specifies the parameters during initial start-up; the parameters are only allowed to be changed with the manufacturer's approval and after a training course has been completed.

• The data exchange with the remote control unit is maintained and certain monitoring functions are performed.

In order to ensure swift control reactions to any changes in actual values, the micro-processor runs through a programme cycle within fractions of 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 (parameter) which are stored in a programmable memory. These parameters affect the computing operation and thus the control reactions of the ECU. They are used to transmit the system configuration and the other preset values concerning the vehicle and functions to the computer programme.

The electronic control unit may be located in a wide range of different positions on or in the vehicle. The majority of vehicle manufacturers prefer to accommodate it in the area of the glove compartment, although electronic control units have already been positioned under the seat (DAF) or in the driver's door (SCANIA).

> For the diagnosis it is important to know the installation position, especially with regard to older generations, so that the diagnostic interface can be inserted between the electronic control unit and the 25 or 35-pin connecting plug.

In newer systems, the electronic control unit can be addressed via a central diagnostic interface.

The large number of different ECAS generations, air suspension systems and rationalisation (i.e. ratio) levels leads to a wide variety of ECAS electronic control units in the towing vehicle sector.

Below is a classification of ECAS electronic systems:

- ECAS 1st generation without pressure sensor
- ECAS 1st generation with pressure sensor
- ECAS 4x2 A
- ECAS 6x2 A
- ECAS 4x2 (Ratio)
- ECAS 4x2 (Ratio) KWP 2000

- ECAS 6x2 (Ratio)
- ECAS 6x2 DV (= **P**ressur**e** ratio control)
- ECAS 4x2/6x2 CAN 1
- ECAS 4x2/6x2 CAN 2
- ECAS + ESAC (with and without CAN)

6.2.1 ECAS 1st generation without pressure sensor

This ECU represents the first generation of ECAS and is used for controlling 4x2 or 6x2 vehicles with partial or full air suspension. The lifting or trailing axle function for 6x2 vehicles can only be controlled using pressure switches in this case.

Abb. 22 ECU 446 055 003 0

An external characteristic feature of an electronic control unit of this type is the aluminium housing into which the printed circuit board with the 35-pin terminal strip is pushed from the back and to which it is then crimped.

This group now only includes the variant 003 (the vehicle manufacturer who uses this ECU is stated in brackets):

- 446 055 003 0 (DAF, Leyland DAF)

This electronic system can be diagnosed using the WABCO diagnostic card 446 300 524 0 (↓ 8. Diagnosis).

6.2.2 ECAS 1st generation with pressure sensor

These are electronic control units also intended for connecting a 35-pin connector. This ECU is used for controlling 6x2 vehicles with partial or full air suspension. Every supporting bellows of the drive and lifting or trailing axle is equipped with a pressure sensor in this variant. As a result, the pressure value for each of these bellows is continuously transmitted to the ECU; the lifting or trailing axle control is therefore implemented as traction control (↑ 3. System functions).

External characteristics as for electronic systems without pressure sensor.

This group includes the following variants:
- 446 055 005 0 (DAF, RVI)
- 446 055 009 0 (DAF)

These electronic systems can be diagnosed using the WABCO diagnostic card 446 300 532 0 (Ø 8. Diagnosis).

! Only listed for information; production has ceased at the beginning of 2004.

6.2.3 ECAS 4x2 A

This ECU is specifically adapted to the requirements of 4x2 vehicles. It represents an advancement over the ECU generation without a pressure sensor. The ECU is more compact and is intended for connecting a 25-pin connector. This ECU is used for controlling 4x2 vehicles with partial or full air suspension.

An external characteristic feature is the aluminium housing into which the printed circuit board with the 25-pin terminal strip is pushed from the connector side and to which it is then crimped.

Abb. 23 ECAS 4x2A

This group includes the following variants:
- 446 055 020 0 (RVI, Scania)
- 446 055 021 0 (MAN)
- 446 055 022 0 (DaimlerChrysler)
- 446 055 023 0 (DaimlerChrysler)
- 446 055 024 0 (DaimlerChrysler)
- 446 055 025 0 (MAN)
- 446 055 026 0 (MAN)
- 446 055 027 0 (RVI, IVECO)
- 446 055 028 0 (Scania)
- 446 055 029 0 (DAF)
- 446 055 030 0 (Nissan Diesel)

These electronic control units can be diagnosed using the WABCO diagnostic card 446 300 520 0 and the PC diagnostic program 446 301 529 0 (↓ 8. Diagnosis).

1	Terminal 15 (5A fuse)		14	Terminal 31 / RCU
2	CLOCK line RCU		15	
3	L-line diagnosis		16	
4	K-line diagnosis		17	
5			18	Distance sensor ground
6	Distance sensor, front		19	Distance sensor, rear left
7	Distance sensor, rear right		20	Directional control valve 2/2 RA right
8	Directional control valve 2/2 RA left		21	Breather valve
9			22	Solenoid valve LSV function
10	Directional control valve 2/2 FA		23	NL I/II-switch (for RCU)
11	DATA line RCU			or
	or			LOWER Vehicle switch
	LIFT vehicle switch		24	Stop-light switch
12	C3/D3 signal (speedometer)		25	Warning lamp, level traction help
13	Fault lamp max. 2 W			

Fig. 24 PIN assignment of the 25-pin ECU for 4x2 vehicles

ECU 446 055 … 0 when servicing

Order Number	Design
446 055 020 0	replaced by 446 055 027
446 055 021 0	depending on system equipment and vehicle manufacturer replaced by 446 055 028; 446 055 026 and 446 055 025
446 055 022 0	replaced by 446 055 024
446 055 023 0	replaced by 446 055 024
446 055 024 0	Successor is 446 055 046
446 055 025 0	replaced by 446 055 301
446 055 026 0	replaced by 446 055 302
446 055 027 0	replaced by 446 055 307; is replaced (only applies to RVI!) by 446 055 303.
446 055 028 0	replaced by 446 055 025
446 055 029 0	Successor is 446 055 311
446 055 030 0	Successor is 446 055 311

! If the ECU is replaced, note that a different diagnostic card may be required for diagnosis.

6.2.4   ECAS 6x2 A

The electronic control systems have been redesigned for this generation and are now equipped with a 35-pin connecting plug. This ECU is used for controlling 6x2 vehicles with partial or full air suspension. Of course it is also possible to control 4x2 vehicles with partial or full air suspension. As a result, vehicle manufacturers have fitted electronic control units of this type to 4x2 and 6x2 vehicles in order to cut down parts expenditure.

The striking feature in vehicles equipped with an ECU of this type is the large number of switches that are connected to the ECU for controlling the system in addition to the remote control unit. The lifting axle is now mainly controlled via pressure switches for instance. One pressure switch operates the automatic lifting axle system and one pressure switch the traction help on the driving axle only; by these means, the lifting or trailing axle control is implemented as pressure equalising control.

An external characteristic feature of this ECU is the plastic housing into which the printed circuit board with the 35-pin terminal strip is pushed from the front and to which it is then screwed using Philips screws.

Abb. 25 ECAS 6x2A

This group includes the following variants:

- 446 055 040 0 (DaimlerChrysler)
- 446 055 041 0 (MAN, Scania)
- 446 055 042 0 (DaimlerChrysler)
- 446 055 044 0 (DAF, RVI)
- 446 055 046 0 (DaimlerChrysler)
- 446 055 047 0 (MAN)
- 446 055 048 0 (Scania)

These electronic control units can be diagnosed using the WABCO diagnostic card 446 300 526 0 and the PC diagnostic program 446 301 529 0 (↓ 8. Diagnosis).).
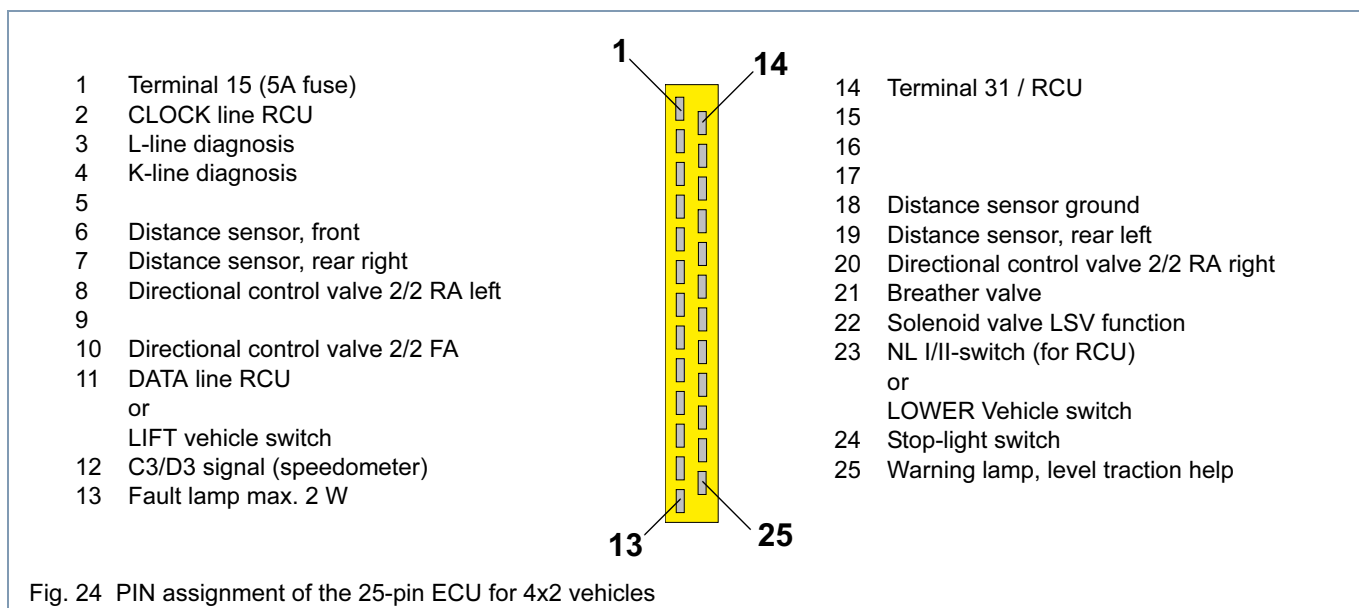
1	Terminal 30 (8A fuse)		19	Coding PIN traction help
2	L-line diagnosis		20	CLOCK line RCU
3			21	DATA line RCU
4	K-line diagnosis		22	C3/D3 signal (speedometer)
5	Pressure switch RA 11t signal		23	NL I/II-switch (with lamp)
	Pressure sensor, support bellows right		24	Lifting axle switch / Unladen drive switch
6	Pressure switch RA 13t signal		25	Distance sensor, rear left
	Pressure sensor, support bellows left		26	Distance sensor, front
7	Stop-light switch		27	Distance sensor ground + terminal 31
8	Distance sensor, rear right		28	
9	Terminal 15 / RCU		29	Solenoid valve LSV function
10			30	Lifting axle lifting / TA Relief
11	Directional control valve 2/2 FA		31	Directional control valve 2/2 RA right
12	Lifting axle lowering / TA Load		32	Ground connection - DISTANCE SENSOR and PRESSURE SENSOR
13	Directional control valve 2/2 RA left		33	Fault lamp max. 10W
14	separate breather valve for LA		34	Warning lamp, level traction help
15	Breather valve		35	LA position lamp (sep. Breather valve for LA)
16	Coding PIN traction help			
17	Traction help switch			
18	Traction help / LA position lamp			

Fig. 26 PIN assignment of the 35-pin ECU for 6x2 vehicles

ECU 446 055 … 0 when servicing

Order Number	Design
446 055 040 0	replaced by 446 055 042, on the other hand, is replaced by 446 055 046.
446 055 041 0	replaced by 446 055 047 (MAN) replaced by 446 055 048 (Scania)
446 055 042 0	replaced by 446 055 046
446 055 044 0	is replaced according to system outfit and vehicle manufacture by 446 055 403 (RVI) or 446 055 405 (DAF)
446 055 046 0	35-pin 2-3 DS, PS
446 055 047 0	replaced by 446 055 404 / 409 (MAN)
446 055 048 0	

! If the ECU is replaced, note that a different diagnostic card may be required for diagnosis.

6.2.5 ECAS 4x2 Ratio

This ECU is adapted to meet the needs of 4x2 vehicles and represents an advancement over the 4x2 A generation. This ECU is used for controlling 4x2 vehicles with partial or full air suspension.

Its PIN assignment corresponds to the illustrated pin assignment of the ECAS ECU 4x2 A (↑ Fig. 24).

An external characteristic feature of an electronic control unit is the printed circuit board with the 25-pin terminal strip rests on an aluminium plate. The housing top section is made of plastic and is clipped onto the bottom section.

Abb. 27 ECAS 4x2 Ratio

This group includes the following variants:

- 446 055 301 0 (MAN)
- 446 055 302 0 (MAN)
- 446 055 307 0 (IVECO)

These electronic systems can be diagnosed using the WABCO diagnostic card 446 300 881 0 (↓ 8. Diagnosis).

6.2.6 ECAS 4x2 (Ratio) KWP 2000

Is an advancement over the generation 4x2 A. The ECU is still designed for connecting a 25-pin connector. This ECU is used for controlling 4x2 vehicles with partial or full air suspension. It is very similar to the ECAS ECU 4x2 Ratio, the main difference being the diagnostic function in accordance with the "Key Word Protocol 2000" (KWP 2000). Another important difference here is that distance sensors can be connected without temperature compensation.

Its PIN assignment corresponds to the illustrated pin

assignment of the ECAS ECU 4x2 Ratio (↑ Fig. 24). There are the following minor differences between this system and the 4x2 Ratio:

– As an option, PIN 5 can be connected to the positive terminal of a separate battery (was not previously occupied).

– PIN 22 is not assigned (used to be used for the load-sensing valve safety function – a typical MAN function).

– PIN 3 is the flashing code activation lamp for fault determination and for deleting the fault memory without using the Diagnostic Controller (used to be the L-line, but is no longer needed with KWP 2000).

Externally, the electronic control unit is identical to the ECU for ECAS 4x2 (Ratio).

This group includes the following variants:
    - 446 055 303 0 (RVI)
    - 446 055 304 0 (RVI)
    - 446 055 311 0 (DAF)
    - 446 055 312 0 (Leyland)

These electronic control units can be diagnosed using the WABCO diagnostic card 446 300 880 0 and the PC diagnostic program 446 301 524 0 (↓ 8. Diagnosis).

ECU 446 055 … 0 when servicing

Order Number	Design
446 055 303 0	replaces 446 055 027 (only for RVI); is otherwise replaced by 446 055 311
446 055 304 0	does not have any housing attachment lugs, is replaced by 446 055 312
446 055 311 0	Successors for 446 055 029 (DAF)
446 055 312 0	25-pin, 1-3 DS

6.2.7   ECAS 6x2 Ratio

This ECU generation is a revised version of the electronic control units intended for connecting a 35-pin connector.

The same vehicles mentioned in the context of ECAS 6x2 A can be controlled with this ECU.

Different manufacturers implement axle load sensing in different ways, using pressure switches (MAN) or pressure sensors (RVI, DAF) on the driving axle only. Lifting or trailing axle control is thus implemented as pressure equalising control in the same manner as for ECAS 6x2 A (i. e., the pressure level is identical in all the supporting bellows while the lifting or trailing axle is active).

On the whole, the assignment of pins corresponds to the illustrated pin assignment of the ECAS ECU 6x2 A (↑ Fig. 26). There are the following minor differences between this system and 6x2 A:

– A lifting/trailing axle coding function is assigned to PIN 3 (previously unassigned)

– PIN 14 is not used (used to be assigned with the connection for a separate breather valve for the lifting axle, because the function has been taken over by the ECAS solenoid valve).

– PIN 32 is not occupied (used to be an earth connection for the height or pressure sensor).

An external characteristic feature of an electronic control unit of this type is the plastic housing into which the printed circuit board with the 35-pin terminal strip is pushed from the front and screwed on with Philips screws.
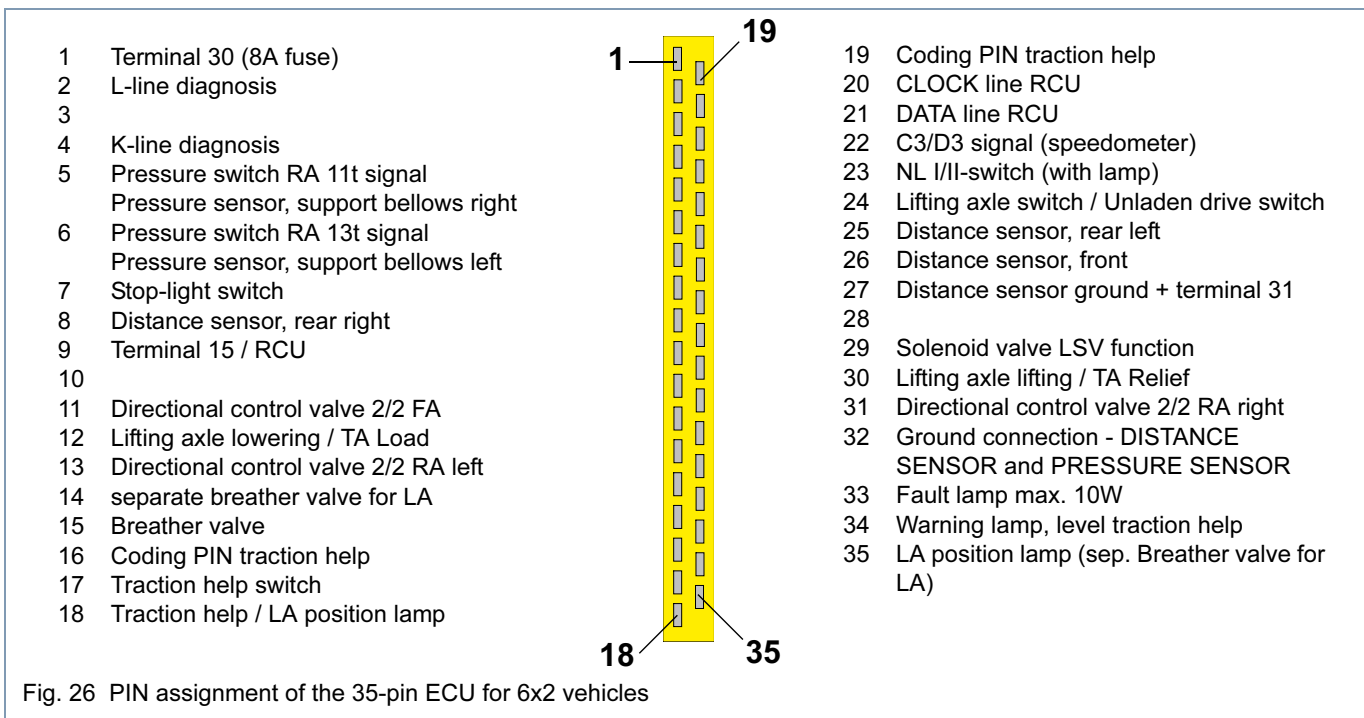
This group includes the following variants:
    - 446 055 403 0 (RVI)
    - 446 055 404 0 (MAN)
    - 446 055 405 0 (DAF)
    - 446 055 409 0 (MAN)

The variant 403/405 can be diagnosed using the WABCO diagnostic card 446 300 526 0 and using the PC diagnostic program 446 301 529 0, the variant 404/409 can be diagnosed with the WABCO diagnostic card 446 300 881 0 (↓ 8. Diagnosis).

6.2.8   ECAS 6x2 DV

This ECU generation has been newly developed. Provided the system is equipped accordingly, this ECU can be used to perform pressure ratio control or a permanent traction control (↑ 3. System functions). The ECU is used for controlling 6x2 vehicles with partial or full air suspension which have a lifting or a trailing axle.

A conspicuous feature of vehicles equipped with this ECU is the large number of switches connected to the ECU in parallel to the remote control unit. The axle load is sensed by pressure sensors on the support bellows of drive and lifting axle. There are systems in which even the lifting bellows is sensed.

The pin assignment of the electronic control unit is significantly different from the pin assignment in the other 6x2 vehicles; it is illustrated below (↓ Fig. 28).

An external characteristic feature of an electronic control unit of this type is the plastic housing into which the printed circuit board with the 35-pin terminal strip is pushed from the front and screwed on with Philips screws.

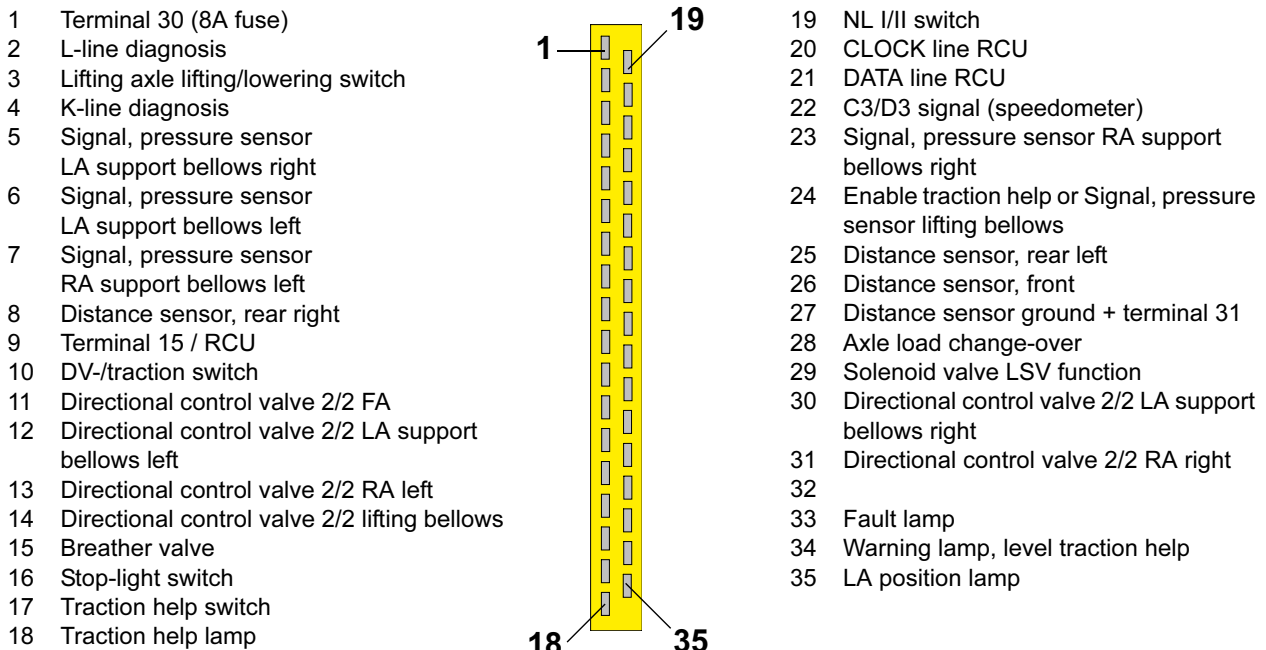|			
1	Terminal 30 (8A fuse)	19	NL I/II switch
2	L-line diagnosis	20	CLOCK line RCU
3	Lifting axle lifting/lowering switch	21	DATA line RCU
4	K-line diagnosis	22	C3/D3 signal (speedometer)
5	Signal, pressure sensor LA support bellows right	23	Signal, pressure sensor RA support bellows right
6	Signal, pressure sensor LA support bellows left	24	Enable traction help or Signal, pressure sensor lifting bellows
7	Signal, pressure sensor RA support bellows left	25	Distance sensor, rear left
8	Distance sensor, rear right	26	Distance sensor, front
9	Terminal 15 / RCU	27	Distance sensor ground + terminal 31
10	DV-/traction switch	28	Axle load change-over
11	Directional control valve 2/2 FA	29	Solenoid valve LSV function
12	Directional control valve 2/2 LA support bellows left	30	Directional control valve 2/2 LA support bellows right
13	Directional control valve 2/2 RA left	31	Directional control valve 2/2 RA right
14	Directional control valve 2/2 lifting bellows	32	
15	Breather valve	33	Fault lamp
16	Stop-light switch	34	Warning lamp, level traction help
17	Traction help switch	35	LA position lamp
18	Traction help lamp		

19 **1** **18** **35**

Fig. 28 PIN assignment of the 35-pin ECU for 6x2 vehicles with pressure ratio control (6x2 DV)

Fig 29 ECAS 6x2 DV

This group includes the following variants:

- 446 055 043 0 (Scania)
- 446 055 049 0 (IVECO)
- 446 055 401 0 (Scania)
- 446 055 402 0 (IVECO)
- 446 055 406 0 (Scania)
- 446 055 407 0 (Nissan Diesel)
- 446 055 408 0 (Mitsubishi)

These electronic control units can be diagnosed using the WABCO diagnostic card 446 300 623 0 and the PC diagnostic program 446 301 529 0 (↓ 8. Diagnosis).

When servicing, it may happen that certain ECUs are no longer available because they have been replaced by an improved variant.

ECU 446 055 … 0 when servicing

Order Number	Design
446 055 043 0	is replaced by 446 055 401
446 055 049 0	is replaced by 446 055 402
446 055 401 0	replaces 446 055 043, is otherwise replaced by 446 055 406
446 055 402 0	35-pin, 2-3 DS, max. 5 PS
446 055 406 0	35-pin, 1-2 DS, max. 3 PS
446 055 407 0	
446 055 408 0	

6.2.9 ECAS 4x2/6x2 24V CAN1

This ECU generation is a new development in electronic control units suitable for use in vehicles equipped with a CAN bus. This ECAS electronic system uses the bus system and transmits information to the interconnected electronic systems of the vehicle.

The information collected in other electronic systems of the vehicle (e. g. speed, brake light, or bellows pressure/ axle load - only in the case of MAN) are used for adjustments.

These electronic control units are diagnosed either using the ECU's own K-line (MAN) or via a central K-line, in which case the ECAS ECU itself only has a CAN interface (DaimlerChrysler).

This ECU is used for controlling 6x2 vehicles with partial or full air suspension. Of course it is also possible to control 4x2 vehicles with partial or full air suspension.

The number and types of switches that can be connected to the ECU was reduced; for this system, only buttons are permitted. Fixed coding of different functions, e. g. traction help coding using pin assignments, is no longer provided. Almost all adjustments of the system by the user are made using the remote control unit.

The axle load is sensed in different ways. Axle load data can be provided to other electronic systems via the CAN bus. Alternatively, pressure sensors are connected to the electronic system and the bellows pressure information collected by these sensors is also made available to other electronic systems in the vehicle. It is now also possible to sense the front axle as well; this was previously not possible.

The pin assignments of the electronic systems has been changed completely. See (↑ Fig. 30) for an illustration.

An external characteristic feature of an electronic control unit of this type is that the electrical connection consists of two 15-pin connectors, or one 15-pin and one 18-pin compact connector, instead of a 25 or 35-pin terminal strip as was previously the case.
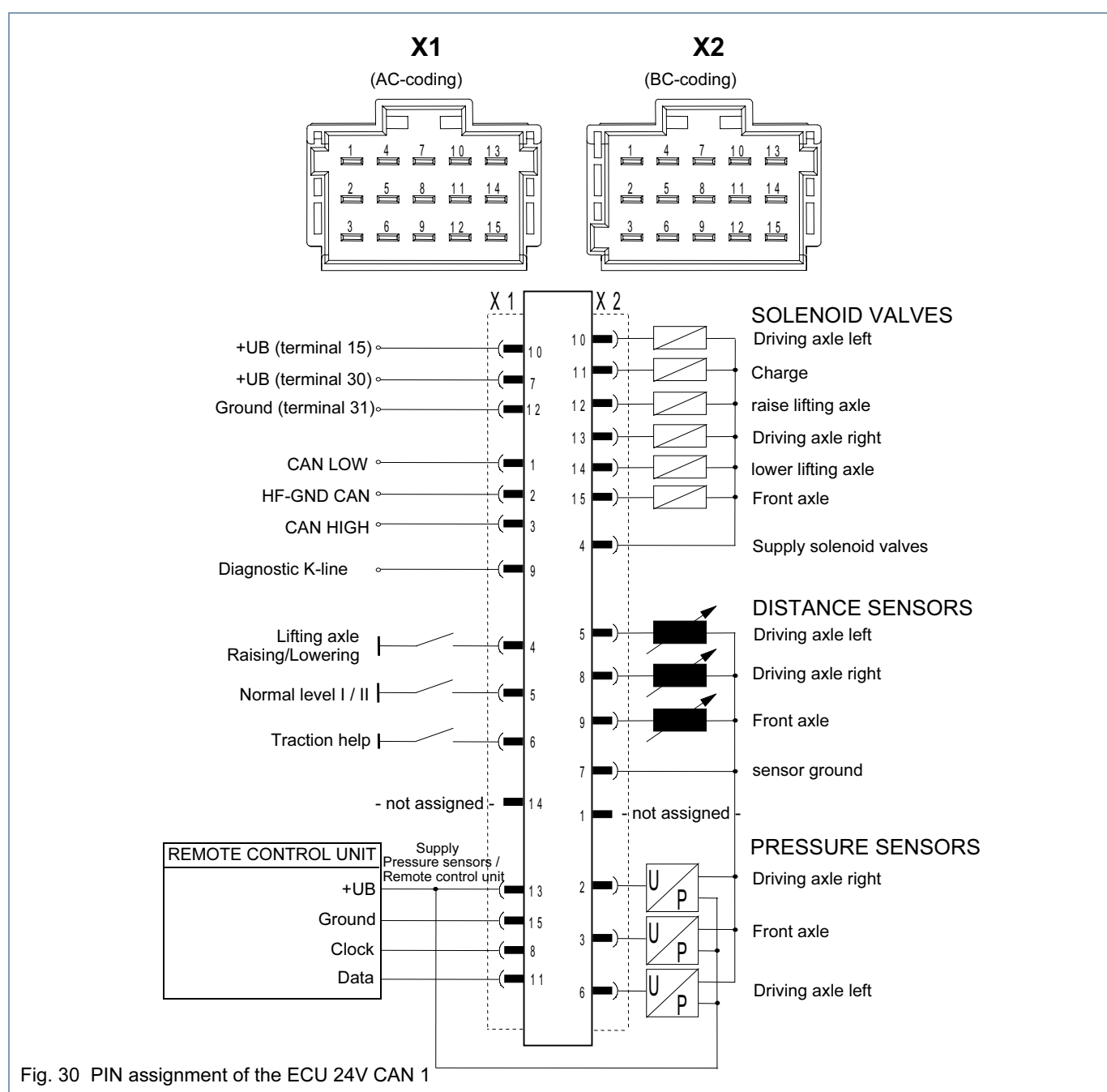

Fig. 30 PIN assignment of the ECU 24V CAN 1

The printed circuit board is pushed into the aluminium housing from the connector side. The cooling ribs on the rear of the housing are also striking features. The latest housings are made of plastic and have 15/18-pin connectors.
.

Abb. 31 ECAS 4x2 CAN and ECAS 6x2 CAN

This group includes the following variants:

- 446 170 001 0 (DaimlerChrysler)
- 446 170 002 0 (DaimlerChrysler)
- 446 170 003 0 (MAN TGA)
- 446 170 004 0 (DaimlerChrysler)
- 446 170 005 0 (DaimlerChrysler)
- 446 170 006 0 (MAN)
- 446 170 021 0 (DaimlerChrysler)
- 446 170 022 0 (DaimlerChrysler)
- 446 170 023 0 (DaimlerChrysler)
- 446 170 024 0 (DaimlerChrysler)
- 446 170 025 0 (DC ACTROS / ATEGO)
- 446 170 026 0 (DC ACTROS / ATEGO)
- 446 170 051 0 (DaimlerChrysler)
- 446 170 052 0 (DaimlerChrysler)
- 446 170 053 0 (MAN TG-A)
- 446 170 054 0 (DaimlerChrysler)
- 446 170 055 0 (DC ACTROS)

The versions of the electronic control units for DaimlerChrysler can be diagnosed using the WABCO diagnostic card 446 300 635 0, while the versions of the electronic control units for MAN can be diagnosed using the WABCO diagnostic card 446 300 893 0 and the PC diagnostic program 446 301 524 0 ↓ 8. Diagnosis).

When servicing, it may happen that certain ECUs are no longer available because they have been replaced by an improved variant.

ECU 446 170 … 0 when servicing

Order Number	Design
446 170 001 0	is replaced by 446 170 004
446 170 002 0	is replaced by 446 170 005
446 170 003 0	18/15-pin, 1-3 DS
446 170 004 0	is replaced by 446 170 023
446 170 005 0	is replaced by 446 170 024
446 170 006 0	

Order Number	Design
446 170 021 0	is replaced by 446 170 023
446 170 022 0	is replaced by 446 170 024
446 170 023 0	is replaced by 446 170 025
446 170 024 0	is replaced by 446 170 026
446 170 025 0	18/15-pin, 3 DS
446 170 026 0	18/15-pin, 2 DS
446 170 051 0	is replaced by 446 170 052
446 170 052 0	is replaced by 446 170 054
446 170 053 0	18/15-pin, 1-3 DS, max. 3 PS
446 170 054 0	is replaced by 446 170 055
446 170 055 0	18/15-pin, 1-3 DS, max. 3 PS

⚠ If the ECU is replaced, note that a different diagnostic card may be required for diagnosis.

The 2nd generation of this group, i.e. CAN 2, is now on the market. This caters for additional vehicle manufacturers. In detail, this group includes the following variants:

- 446 170 201 0 (IVECO)
- 446 170 202 0 (IVECO)
- 446 170 206 0 (Scania)
- 446 170 207 0 (MAN TG-A/TG-1(B)
- 446 170 208 0 (MAN TG-A/TG-1(B)
- 446 170 209 0 (MAN TG-A/TG-1(B)
- 446 170 211 0 (IVECO)
- 446 170 212 0 (IVECO)
- 446 170 213 0 (DAF)
- 446 170 214 0 (DAF)
- 446 170 215 0 (Scania)
- 446 170 216 0 (Scania)

Abb. 32 ECAS 4x2 CAN 2

ECU 446 170 … 0 when servicing

Order Number	Design
446 170 201 0	
446 170 202 0	
446 170 205 0	is replaced by 446 170 215
446 170 206 0	is replaced by 446 170 216

1	Terminal 30 (8A fuse)		19	Coding PIN traction help
2	L-line diagnosis		20	CLOCK line RCU
3	Accelerator pedal sensor		21	DATA line RCU
4	K-line diagnosis		22	C3/D3 signal (speedometer)
5	Signal, pressure sensor RA right		23	NL I/II
6	Signal, pressure sensor RA left		24	Lifting axle switch
7	Brake signal		25	Distance sensor, rear left
8	Distance sensor, rear right		26	Distance sensor, front
9	Pin 15		27	Distance sensor ground + terminal 31
10	Braking pressure switch ESAC		28	external safety relay
11	Directional control valve 2/2 FA		29	Solenoid valve LSV function
12	3/3 directional control valve Lifting axle lowering		30	3/3 directional control valve Lifting axle lifting
13	Directional control valve 2/2 RA left		31	Directional control valve 2/2 RA right
14	ESAC soft		32	ESAC medium
15	Breather valve		33	Fault lamp
16	Coding PIN traction help		34	Warning lamp traction help
17	Traction help switch		35	LA position lamp
18	Traction help lamp			

Fig. 33 PIN assignment of the 35-pin ECU for ECAS/ESAC (446 155 … 0)

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. For this purpose, the PC program 446 301 524 0 is used. No provision is made for use of a Diagnostic-Controller card here.

6.2.10 ECAS/ESAC

This generation of ECUs comprises electronic control units with an integrated ESAC function. Basically, there are 2 different ECU groups:

- 446 155 … 0 (MAN – 3-stage damping)
- 446 171 … 0 (DaimlerChrysler; (MAN - continuously adjustable damping)

In 4x2 vehicles the axle load is also sensed by pressure sensors on all supporting bellows of the driving axle as well as on the front axle. The shock absorbers can be set to three different levels (i. e. soft, medium and hard), or be continuously adjustable. The damper setting that is applied depends on the ECU generation used.

The ESAC functions in these electronic control units will not be dealt with any further at this point since they are not directly linked to the subject matter of this booklet.

ECU 446 155 … 0

These electronic control units can be used to implement a 3-stage damper setting. They are intended for connecting a 35-pin connector. An external characteristic feature of an electronic control unit of this type – as with the electronic control units for 6x2 vehicles – is the plastic housing into which the printed circuit board with the 35-pin terminal strip is pushed from the front and screwed on with Philips screws.

This group has included the following variants so far (the vehicle type using that ECU type is put in brackets):

- 446 155 000 0 (MAN F2000)
- 446 155 001 0 (MAN F2000)

The only differences between the two electronic systems were the traction help parameters and that 446 155 000 was replaced by 446 155 001.

The electronic systems can be diagnosed using the WABCO diagnostic card 446 300 569 0 (Ø 8. Diagnosis).

ECU 446 171 … 0

Electronic control units in this group are used in vehicles with a CAN network (i. e. DaimlerChrysler ACTROS or MAN TGA). They are integrated into the vehicle's CAN bus system and are intended for connecting a 15-pin and an 18-pin connector. This ECU can be used for controlling 4x2 and 6x2 vehicles with full air suspension and a lifting axle. The printed circuit board is pushed into the aluminium housing from the connector side. The cooling ribs on the rear of the housing are also striking features.

This group includes the following variants:

- 446 171 001 0 (DaimlerChrysler ACTROS)
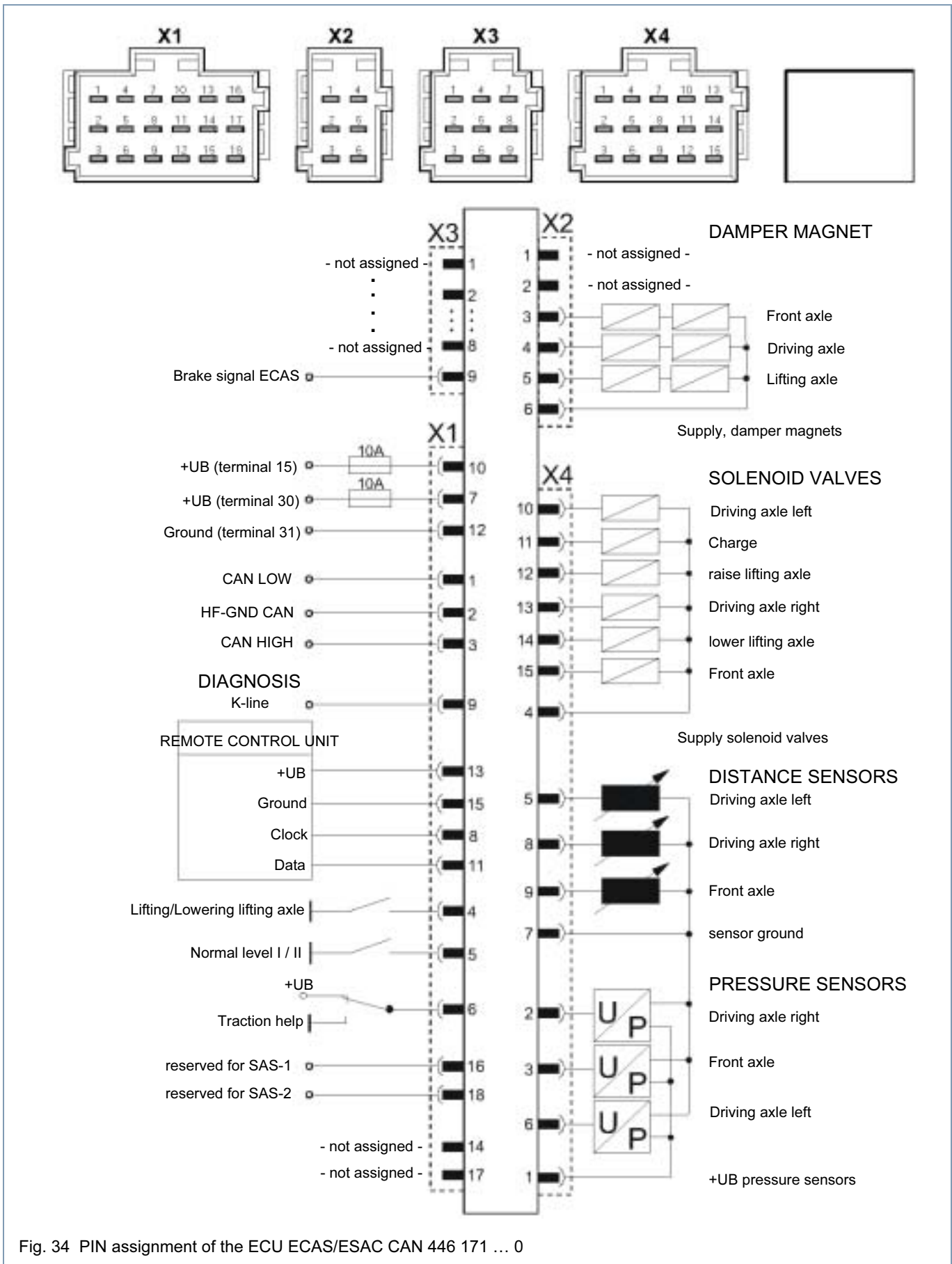- 446 171 002 0 (MAN TGA)

Fig. 34 PIN assignment of the ECU ECAS/ESAC CAN 446 171 … 0

- 446 171 003 0 (DaimlerChrysler ACTROS)
- 446 171 004 0 (DaimlerChrysler AXOR)

The electronic system 446 171 002 is diagnosed using the WABCO diagnostic card 446 300 893 0 and the PC diagnostic program 446 301 524 0. The other ECUs can be diagnosed using the WABCO diagnostic card 446 300 635 0 and the PC diagnosis.

6.3   ECAS solenoid valve

For the purposes of controlling the system, the ECAS solenoid valve is the interface between the electronic output signals from the electronic control unit and the pneumatic actuating signals for the air suspension bellows.

Several individual solenoid valves are combined in a block in the ECAS solenoid valve. This is because the individual solenoid valves cannot generate part-load pressures on the air suspension bellows.

The three functions:
• Pressure build-up
• Pressure retention
• Pressure reduction

are obtained only by combining individual valve functions. Each of these individual solenoid valves represents a unit of an individual solenoid with one or two pneumatic relay valves or control slides.

Abb. 35 ECAS solenoid valve for implementing 2-point control on the driving axle (solenoid block - ECAS - II - solenoid valve)

The electrical control signal for activation of the individual solenoids reaches the individual solenoid to be controlled by means of the electrical connectors on the individual solenoids or solenoid valve blocks. The control signal can only have 2 voltage conditions:

• HIGH (i. e. as a rule, this means 24 V; the solenoid is energised and opens a pneumatic valve seat against the force of a spring).

• LOW (i. e. 0 V; the solenoid is de-energised and the solenoid spring opens the pneumatic valve seat).

The combination of control signals on the individual solenoids ensures that the corresponding pneumatic valves are opened/closed or that the corresponding slides are moved.

Three different types of individual solenoid valves may be used in the ECAS solenoid valve:

• **Directional control valve 3/2** (i. e. 3 pneumatic ports: supply, consumer and vent - and two switching positions - in this case: ON or OFF depending on the solenoid's current supply level). It is used as a breather valve. When the solenoid is de-energised, the air suspension supply is shut off and the downstream consumers are connected to the atmosphere. When the solenoid is energised, the air suspension supply is connected to the downstream consumers.

• **Directional control valve 2/2** (i. e. 2 pneumatic ports: supply and consumer - and two switching positions - in this case: ON or OFF depending on the solenoid's current supply level). It is used as a bellows pressure control valve. When the solenoid is de-energised, the air suspension bellows are blocked off. When the solenoid is energised, the port to the air suspension bellows with the output of the directional control valve 3/2 is connected either to the air suspension supply or to atmospheric pressure.

• **3/3 directional control valve** (i. e. 3 pneumatic ports: supply, consumer and vent - and three switching positions - in this case: TOP, CENTRE and DOWN, depending on the position of the control slide in the valve). It is used for controlling the connection between the trailing axle or lifting axle supporting bellows and the driving axle supporting bellows in vehicles with pressure ratio control. In vehicles with a lifting axle, the pressure in the lifting axle bellows is controlled at the same time as the bellows connection is made.
Two solenoids are used in the 3/3 directional control valve. These solenoids make it possible to apply pressure to one or more control sliders from two sides. By these means, the control slider is brought into the 3 switching positions TOP, BOTTOM, and CENTRE. The solenoids in this valve are only energised for about 5 seconds. A stand-by time is required when the ignition is switched OFF to allow the lifting axle to be lowered or to relieve the trailing axle. As a result, pressure is only applied to the corresponding surface while the control slide is energised. Following this current pulse, the control space in the control slide is vented once again and the control slide is then only held in its position by the pressure of the O-rings.

Depending on the solenoid control of air valves, there are two types of valves:

6.3.1 Spring-returned valve

The pneumatic control system is an indirect control system (↓ Fig. 36) because it comprises a pilot control section and a main control section. The solenoid controlled by the ECU opens a relatively small valve seat, which causes pressure to build up (pilot control).

• In the case of ECAS solenoid valves with a control piston, this pressure opens a plate valve with a large flow cross-section, and the air then flows through this cross-section.

• In the case of ECAS solenoid valves with a control slide, this pressure moves the slide piston into the required position. This causes the pneumatic connections in the ECAS solenoid valve to connected or disconnected from one another.
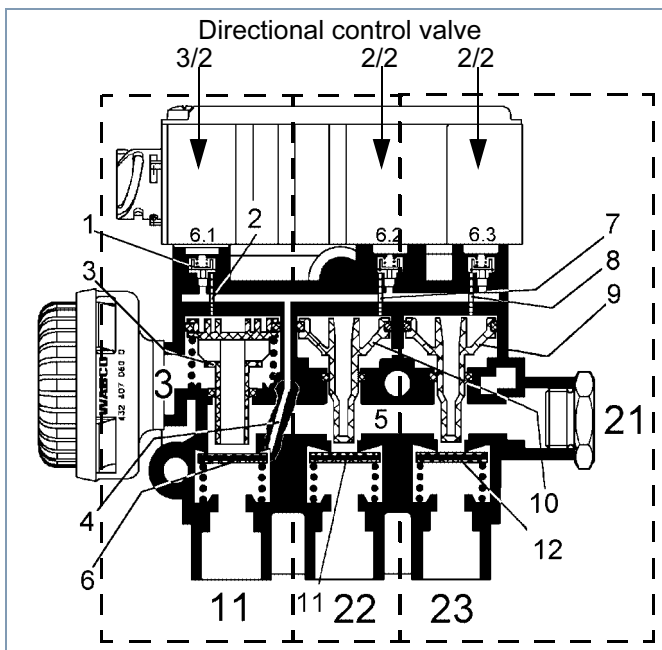

Abb. 36 Cross-section view of an ECAS solenoid valve with spring-returned seat valves for the driving axle (solenoid block ECAS-II solenoid valve)

A directional control valve 3/2 designed as a seat valve functions in according to the following principle:

1. The permanently energised solenoid 6.1 opens a valve seat 1 and allows the supply pressure from channel 4 to the top side of control piston 3 (pilot control) via channel 2.

2. The piston (3) now opens the valve seat (6) against the force of a return spring.

This allows air to flow into the channel (5) and downstream consumers (main control).

When the solenoid is no longer energised:

3. Valve seat (1) is closed, and the top of the control piston (3) is exhausted.

4. The valve spring closes valve seat (6) and, with the help of the piston return spring, returns the control piston (3) to its original position.

5. Channel 5 and any downstream consumers are exhausted by means of the hollow control piston (3).

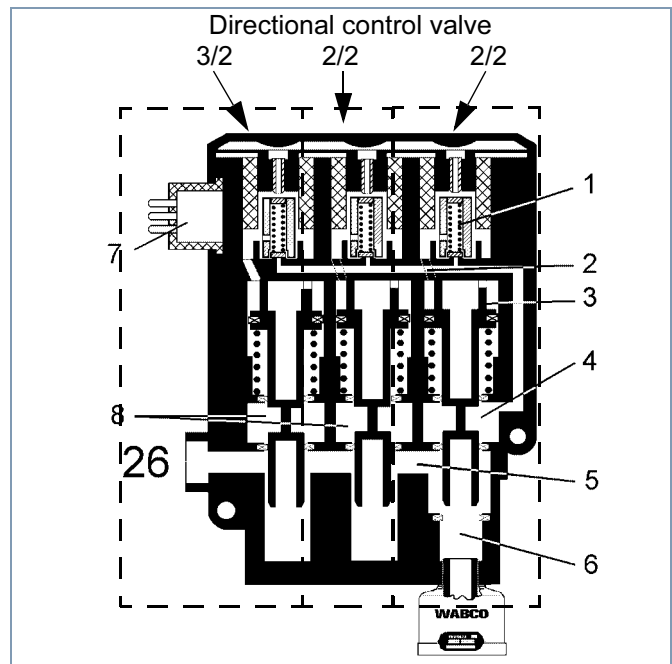Operation of the directional control valves 2/2 follows the same principle.

Abb. 37 Cross-section view of an ECAS solenoid valve with spring-returned sliding valves for the main axle or the main axle section (solenoid block)

In more recent ECAS solenoid valves, the seat valves are progressively being replaced by sliding valves. The spring-returned sliding valve (↑ Fig. 37) works in a similar fashion. The essential difference is that the seat valves have been replaced by slides; these, however, are also controlled by a return spring.

6.3.2 Pulse-controlled slide valve

The pulse-controlled slide valve is a 3/3 directional control valve within the ECAS solenoid valve. It is mainly used to control the lifting axle bellows together with the supporting bellows of the lifting axle. Automatic lifting axle operation can be implemented using pulse-controlled valves. Usually the group of solenoid valve for controlling the lifting bellows are flanged onto the group of solenoid valves for controlling the main axle.
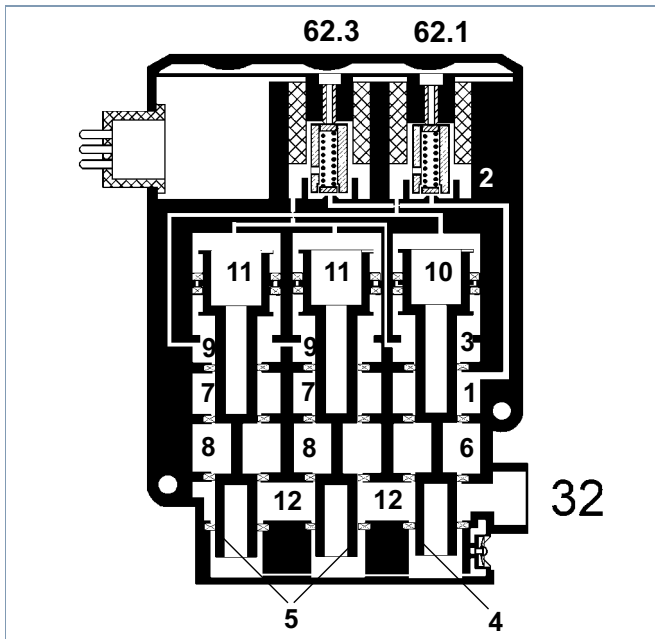
Abb. 38 Cross-section view of an ECAS solenoid valve with pulse-controlled slide valves for the lifting axle portion in the "hold pressure" position

The 3/3 directional control valves (↑ Fig. 38) operate as follows:

1. In annular chamber (1), the supply pressure acts on control solenoid (62.3 'raise' lifting axle) and (62.1 'lower' lifting axle) via channel (2).

2. For raising, control solenoid (62.3) receives a current pulse - hence pulse-controlled - and opens its valve seat.

3. Air is let into the annular chamber (3) at control piston (4) via the system of ducts.

4. This forces the control piston upwards and the annular chamber (1) is connected with the annular chamber (6) at whose outlet the lifting bellows are connected.

5. This causes the lifting bellows to be charged.

6. At the same time, pressure acts on the top of the two control piston (5) as the pressure in chambers (11) is increased, and the control pistons are forced downwards.

7. The annular chambers (8) connected to the supporting bellows of the lifting axle are connected to channel (12) and exhausted via vent (32).

8. These processes cause the lifting axle to be raised.

When there is no longer any current pulse on the solenoid, chambers (3) and (11) are exhausted via the solenoid vent.

The slide positions in the ECAS solenoid valve remain as they are until a subsequent control acts on them.

1. To lower the lifting axle, the solenoid (62.1) receives a current pulse and opens its valve seat.

2. Air is let into the annular chamber (10) at control piston (4) via a system of ducts.

3. This pushes the piston downwards and the annular chamber (6) whose outlet is connected to the lifting bellows is connected to the channel (12) .

4. The lifting axle bellows are therefore vented.

5. At the same time, the annular chambers (7), where the supporting bellows pressure is generated, are connected to the annular chambers (8) to which the support bellows of the lifting axle are connected.

6. The same pressure is therefore applied to the supporting bellows of the main axle and the lifting axle.

7. These processes cause the lifting axle to be lowered.

8. When there is no longer any current pulse on the solenoid, chambers (9) and (10) are exhausted by means of the solenoid vent.

The valve position (↑ Fig. 38) represents a special case and causes the pressure in all bellows to be held. This will occur, for instance, when the pressure in the supporting bellows for the main axle and the lifting axle vary while traction help is active. This means the pressure in the supporting bellows of the main axle is at its maximum and the pressure in the supporting bellows of the lifting axle is lower. This condition is achieved by control solenoids (62.1) and (62.3) being continuously switched on simultaneously.

6.3.3 Distinguishing ECAS solenoid valves

Essentially, there are three groups of ECAS solenoid valves, distinguished according to their application:
• Front axle valve (FA valve)
• Rear axle valve (RA valve)
• Rear axle/lifting axle valve (RA/LA valve)

The outgoing bellows lines should be symmetrical, i. e. they should have identical line lengths and the same line diameter. Take care to assign the electrical and pneumatic connections correctly in accordance with the numbering system.

Front axle valve (FA valve)
The FA valve is located near the front axle and controls the supporting bellows for the front axle. The FA valve usually has only one directional control valve 2/2 for the front axle (steering axle), i.e. it can only perform the opening/blocking function.

The process of ventilation (i.e., increasing and decreasing pressure by venting and exhausting) is controlled by the directional control valve 3/2 of the rear axle valve.
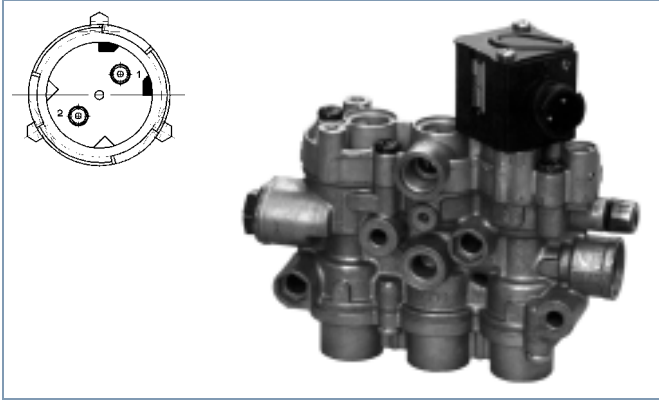

Abb. 39 FA valve with DIN bayonet 472 900 058 0

Rear axle valve (RA valve)

The RA valve is the core valve of an ECAS system without automatic lifting axle operation and is located in the rear axle section. It controls the driving axle support bellows in vehicles with partial or full air suspension but without a lifting or trailing axle. Ventilation of the FA valve (i.e., increasing and decreasing pressure by venting and exhausting) in vehicles with full air suspension is implemented by means of a pneumatic output, this output being closed in vehicles with partial air suspension.

Depending on the type of ECAS system used, the RA valve for controlling the supporting bellows is equipped with the following respectively:

• One directional control valve 2/2 if the axle has a 1-point control

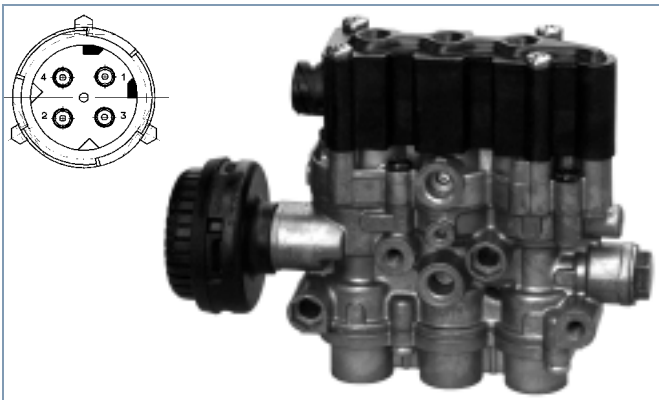• Two directional control valves 2/2 if the axle has a 2-point control

Abb. 40 RA valve with DIN bayonet 472 900 055 0

Rear axle/lifting axle valve (RA/LA valve)

The RA/LA valve is the core valve of a system with automatic lifting axle operation and is located in the rear axle section. It controls the support bellows of the driving axle in vehicles with partial and full air suspension, as well as the lifting bellows and the support bellows of the lifting axle. In systems with pressure ratio control / optimum traction control it is even possible to operate a vehicle with full air suspension (i. e. the supporting bellows on the front axle as well) using one ECAS solenoid valve.
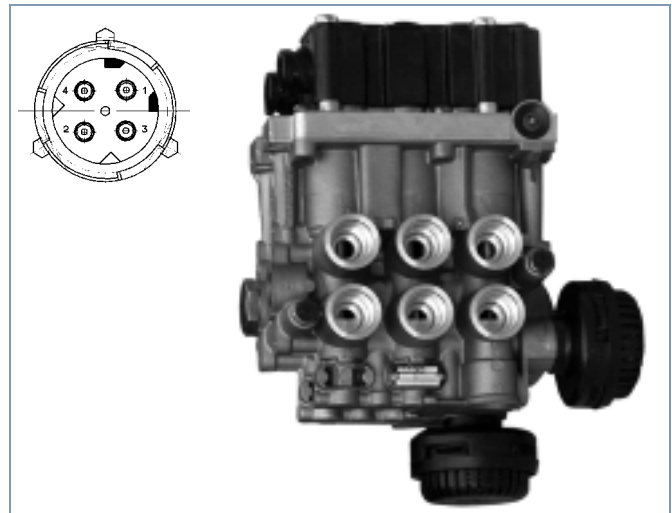

Abb. 41 RA/LA valve with DIN bayonet 472 905 114 0

The valve consists of a rear axle block and a lifting axle block. Its functions is similar to that of the rear axle valve. An additional pneumatic output in the rear axle block enables ventilation of the FA valve. The valves fitted in the lifting axle block depend on whether it is an ECAS system with pressure equalising control or with pressure ratio control/optimum traction control.

There are three 3/3 directional control valves in the lifting axle valve block for ECAS systems with pressure equalising control. These are actuated by two valve solenoids and are responsible for controlling the lifting bellows and the supporting bellows of the lifting axle.

The lifting axle valve block for ECAS systems with pressure ratio control/optimum traction control contains up to three directional control valves 2/2 which are responsible for controlling the lifting bellows and the supporting bellows of the lifting axle.

! Clear assignments can only be made by referring to a circuit diagram (↓ 7. Brief system description).

Whilst the assignment of the electrical connections is not standardised, the following guideline applies to the assignment of pneumatic ports for ECAS in the vehicle:

Port 1

Only in the case of RA/LA valves: Supply pressure from reservoir for downstream consumers.

Port 11
Only in the case of FA valves and RA valves: Supply pressure from reservoir for downstream consumers.

Port 12
Only in the case of FA valves and RA valves: Actuating pressure from reservoir to actuate the control element in the ECAS solenoid valve.

Port 13
Not relevant for operation.

Port 14
Only in the case of FA valves: Supply port from RA valve.

Port 21
• In the case of dedicated RA valves: Output for Port 14 of FA valve.

• In the case of RA/LA valves: Output for (left-hand) supporting bellows of the axle(s) which is (are) on the ground (pressure equalising control only).

Port 22
Output for (right-hand) supporting bellows of the axle(s) which is (are) on the ground.

Port 23
• In the case of dedicated FA or RA valves: Output for (left-hand) supporting bellows of the axle(s) which is (are) on the ground.

• In the case of RA/LA valves: Output to the (left-hand) supporting bellows of the lifting axle for fully automatic lifting axle operation.

Port 24
Output to (right-hand) support bellows of the lifting axle in the case of fully automatic lifting axle operation.

Port 25
Output to lifting bellows on the lifting axle for fully automatic lifting axle operation.

Port 26
• In the case of RA/LA valves: Output to port 14 of the FA valve (pressure equalising control only).

• On buses also output to supporting bellows on the front axle for the 'kneeling' function.

Port 27
• Not relevant for operation.

• On buses also output to supporting bellows on the front axle for the 'kneeling' function.

Port 3
Only on RA valves: Exhausting for downstream consumers.

Port 31
Only in the case of RA/LA valves: Exhausting for downstream consumers in rear axle block.

Port 32
Only in the case of RA/LA valves: Exhausting for downstream consumers in lifting axle block.

6.3.4 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 different types of 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 equalising control.

The new generation of ECAS solenoid valve (ECAS III) was introduced in the year 2000. This solenoid valve generation is grouped in the product group 472 880 … 0 and is meant to replace the ECAS solenoid valves of the product group 472 900 … 0 in future.

Abb. 41 RA valve with DIN bayonet 472 880 030 0

As a general rule, it is possible to subdivide the various versions into groups with the same function. The main differences between devices in the same group concern the electrical and pneumatic interface.

Devices with specially shaped connection threads - these being required by special pipe connection systems - do not represent a particular problem should the corresponding pipe couplings not be on hand. If need be (i.e. repair is required), pipe couplings according to DIN may still be used.

However, problems of a different 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.

The following tables present a brief list of the most important ECAS solenoid valves with equivalent functions and provide some information about interchangeability.
The following applies to the designation of the electrical connection (E-conn.) as a DIN bayonet:

Connector   DIN 72 585-A1-4.1-Sn/K1 (example)

A1= = fixed connector (A) with coding strip assignment 1 in the connector plug (4 different arrangements are possible).

4.1 = DIN coding of the contact assignment (here: 4 contacts assigned according to variant 1).

Sn = tin-plated contacts.

K1 = Duty class (K2 can be subjected to higher loads than K1).

The following applies to the pneumatic connections (P-conn.):

JED-152 = Threaded holes for metric connection thread according to DIN.

JED-388 = Threaded holes for VOSS plug-in connection system (can be used for pipe unions according to DIN).

The following table first displays the symbol diagram for the various groups, followed by a brief description. Some variants can only be distinguished by the presence/absence of a silencer (GD).
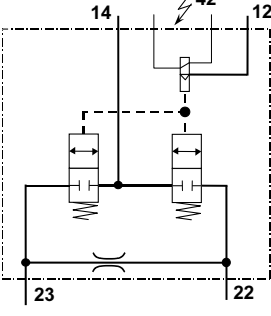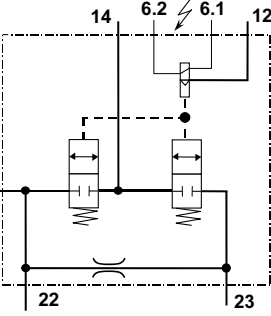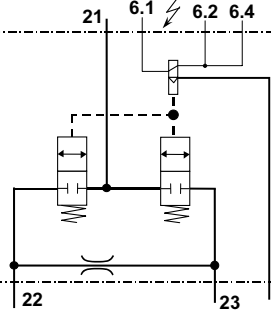
This and the following groups deal with solenoid valves which are used for ECAS basic control on the rear (or driven) axle.

The first group listed in the table consists of **RA valves for 1-point control** (1 distance sensor). These valves have a throttle (diameter 0.6 mm) between the pneumatic outputs to the left and right side of the bellows.

Table 1: Solenoid valve

Symbol diagram	Order Number	E-connection	P-connection	Comment
	472 900 030 0	2 individual solenoids M27x1	VOSS connection M22x1.5	Linchpins of the individual solenoid connections turned at 90° towards one another; with silencer
	472 900 032 0	2 individual solenoids M27x1	M 22x1.5	Linchpins of the individual solenoid connections turned at 90° towards one another; without silencer
	472 900 033 0	2 individual solenoids M27x1	M 22x1.5 (JED-388)connections with access from top	Linchpins of the individual solenoid connections turned at 90° towards one another; with silencer
	472 900 034 0	2 individual solenoids M27x1	M 22x1.5 (JED-388)	Linchpins of the individual solenoid connections pointing in the same direction; without silencer
	472 900 055 0	2 solenoids 1x bayonet DIN 72585-A1-4.2-Sn/K1	M 22x1.5 (JED-388)	
	472 900 061 0	2 solenoids 1x bayonet DIN 72585-A1-3.1-Sn/K1	M 22x1.5 (JED-388)	Special solenoid seal for SCANIA; with silencer (6.3 not assigned)
	472 900 065 0	2 solenoids 1x bayonet DIN 72585-A1-4.2-Sn/K1	M 22x1.5 (JED-152)	IVECO; with silencer
	472 880 030 0	2 solenoids 1x bayonet DIN 72585-A1-4.2-Sn/K1	M 22x1.5 (JED-388)	**ECAS III** with silencer; replaces 472 900 055 0
	472 880 031 0	2 solenoids 1x bayonet DIN 72585-A1-3.2-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** special solenoid seal for SCANIA; with silencer replaces 472 900 061 0 (6.3 not assigned)

Symbol diagram	Order Number	E-connection	P-connection	Comment
RA valves for 2-point control (2 distance sensors) These valves enable the pneumatic outputs to the air suspension bellows to be controlled separately. **Variants:**				

Symbol diagram	Order Number	E-connection	P-connection	Comment
	472 900 000 0	3 individual solenoids M27x1	VOSS connection M22x1.5	Replaced by variant 001; with silencer
	472 900 001 0	3 individual solenoids M27x1	VOSS connection M22x1.5	Linchpins of the individual solenoid connections left, front, and right; replacement for variant 000; with silencer
	472 900 002 0	3 individual solenoids M27x1	M 22x1.5 (DIN thread)	Individual solenoid connections as in variant 001; with silencer
	472 900 006 0	3 individual solenoids M27x1	M 22x1.5 (DIN thread)	Linchpins of the individual solenoid connections 2x front and right; replaced by variant 012; w/o silencer
	472 900 008 0	3 individual solenoids M27x1	M 22x1.5 (JED-388)	Individual solenoid connections as in variant 001; P-connections with access from top; with silencer
	472 900 009 0	3 individual solenoids M27x1	M 22x1.5 (JED-388)	Linchpins of the solenoid connections 2x rear and right; without silencer
	472 900 012 0	3 individual solenoids M27x1	M 22x1.5 (DIN thread)	Individual solenoid connections as in variant 006; replacement for variant 006; w/o silencer
	472 900 014 0	3 individual solenoids M27x1	M 22x1.5 (JED-388)	Individual solenoid connections as in variant 001; P-connections with access from top; without silencer
	472 900 053 0	1x bayonet DIN 72585-A1-4.1-Sn/K1	M 22x1.5 (JED-388)	with silencer
	472 900 060 0	1x bayonet DIN 72585-A1-4.1-Sn/K2	M 22x1.5 (JED-388)	Port 21 open; with silencer
	472 900 062 0	1x bayonet DIN 72585-A1-4.1-Sn/K1	M 22x1.5 (JED-388)	special solenoid seal for SCANIA; without silencer
	472 900 063 0	1x bayonet DIN 72585-A1-4.1-Sn/K1	M 22x1.5 (JED-152)	with silencer
	472 900 073 0	1x bayonet DIN 72585-A1-4.1-Sn/K1	M 22x1.5 (JED-388)	12V supply voltage: with silencer
	472 880 000 0	1x bayonet DIN 72585-A1-4.1-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** Port 21 open; with silencer supersedes 472 880 060 0
	472 880 001 0	1x bayonet DIN 72585-A1-4.1-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** with silencer; supersedes 472 880 053 0
	472 880 002 0	1x bayonet DIN 72585-A1-4.1-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** special solenoid seal for SCANIA; with silencer;
	472 880 070 0	1x bayonet DIN 72585-A1-4.1-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** 12V voltage supply; with silencer; supersedes 472 880 073 0

	Solenoid valves for basic ECAS control on the front axle. **Group 1: FA valves for 1-point control (1 distance sensor)** These valves have a throttle (diameter 0.6 mm) between the pneumatic outputs to the left and right side of the bellows. These valves are ventilated (vented and exhausted) via the RA valve connected upstream; this means it is necessary to connect a separate supply line for the pilot control, port 12 (as of ECAS III, port 11). **Variants:**			
Symbol diagram	**Order Number**	**E-connection**	**P-connection**	**Comment**
	472 900 020 0	1 individual solenoid M27x1	VOSS connection 3x M22x1.5 1x M16x1.5	additional port 13 next to port 14 (closed)
	472 900 021 0	1 individual solenoid M27x1	VOSS connection 3x M22x1.5 1x M16x1.5	
	472 900 022 0	1 individual solenoid M27x1	3x M22x1.5 1x M16x1.5 (DIN thread)	
	472 900 054 0	1x bayonet DIN 72585-A1-3.6-Sn/K1	3x M22x1.5 1x M16x1.5 (JED-388)	
	472 900 064 0	1x bayonet DIN 72585-A1-3.6-Sn/K1	3x M22x1.5 1x M16x1.5 (JED-152)	
	472 900 074 0	1x bayonet DIN 72585-A1-3.6-Sn/K1	3x M22x1.5 1x M16x1.5 (JED-388)	Solenoid turned by 90° when compared to 054
	472 900 058 0	1x bayonet DIN 72585-A1-2.1-Sn/K2	3x M22x1.5 1x M16x1.5 (JED-388)	Special model: if required, to be replaced by 472 880 021 0, in which case port 25 can be picked off from port 22 (T-piece); note the difference in thread size!
	472 880 020 0	1x bayonet DIN 72585-A1-3.6-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** phases out 472 900 054 0
	472 880 021 0	1x bayonet DIN 72585-A1-2.1-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** phases out 472 900 058 0 (6.4 not assigned)
	472 880 024 0	1x bayonet DIN 72585-A1-3.6-Sn/K2	M 22x1.5 (JED-388)	**ECAS III**

Symbol diagram

Solenoid valves for basic ECAS control on the front axle.
Group 2: FA valves used in buses.
Apart from the function as a front axle valve, this valve group has an additional directional control valve 2/2 for the kneeling function.

Variants:

Order Number	E-connection	P-connection	Comment
472 900 066 0	1x bayonet DIN 72585-A1-3.6-Sn/K1 1x bayonet DIN 72585-A1-4.1-Sn/K1	3x M22x1.5 1x M16x1.5 (JED-388)	Replaced by 472 880 061 0
472 900 076 0	1x bayonet DIN 72585-A1-3.2-Sn/K1 1x bayonet DIN 72585-A1-4.1-Sn/K1	3x M22x1.5 1x M16x1.5 (JED-388)	12V supply voltage; replaced by 472 880 071 0
472 880 061 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	4x M22x1.5 (JED-388)	**ECAS III** supersedes 472 900 066 0; note changed pneumatic ports; with silencer
472 880 071 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	4x M22x1.5 (JED-388)	**ECAS III** 12V supply voltage; supersedes 472 900 066 0; note the modified pneumatic ports

Symbol diagram

FA valve for use in buses. As well as the directional control valve 2/2 for kneeling, these valves also have an independently functioning breather valve.

Order Number	E-connection	P-connection	Comment
472 880 062 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	4x M22x1.5 (JED-388)	**ECAS III** SCANIA design; venting function integrated in the valve; with silencer
472 880 064 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	4x M22x1.5 (JED-388)	**ECAS III** Ventilation function (venting and exhausting) integrated in the valve; with silencer

Solenoid valves used for the traction control / pressure equalising control in complete vehicles or for multi-axle combinations.	

Symbol diagram	

FA/RA valves for 1-point control / 2-point control (3 distance sensors).
These valves have a throttle (diameter 0.6 mm) between the pneumatic outputs to the left and right side of the bellows. They are used in 4x2 vehicles. The advantage is that a single valve can be used to coordinate the bellows control for a vehicle with full air suspension.

Variants:

Order Number	E-connection	P-connection	Comment
472 900 052 0	4 individual solenoids M27x1	5x M22x1.5 (JED-388)	for information only, no longer available
472 900 057 0	1x bayonet DIN 72585-A1-3.6-Sn/K1 1x bayonet DIN 72585-A1-4.1-Sn/K1	5x M22x1.5 (JED-388)	replaced by 472 880 050 0; with silencer
472 900 067 0	1x bayonet DIN 72585-A1-3.6-Sn/K1 1x bayonet DIN 72585-A1-4.1-Sn/K1	5x 1/2-14 NPTF DRYSEAL	replaced by 472 880 051 0; with silencer
472 880 050 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	5x M22x1.5 (JED-388)	**ECAS III** supersedes 472 900 057 0; with silencer
472 880 051 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	5x 1/2-14 NPTF DRYSEAL	**ECAS III** supersedes 472 900 067 0; with silencer
472 880 052 0	1x bayonet DIN 72585-A1-3.6-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	5x 1/2-14 NPTF DRYSEAL	**ECAS III** SCANIA design; RA + FA/LA; with silencer

Symbol diagram	

RA/LA (or RA/TA) valve for 1-point control (1 distance).
There is one output on the lifting axle block for the lifting bellows and one output for the support bellows of the lifting axle.

| Order Number	E-connection	P-connection	Comment
472 900 113 0	2x bayonet DIN 72585-A1-4.1-Sn/K1	5x M22x1.5 (JED-388)	RA/TA valve (rear axle / trailing axle valve)

Symbol diagram

RA/LA (or RA/TA) valve for 2-point control
(2 distance sensors).
There are two pneumatic outputs on the valve block for the supporting bellows of the lifting/ trailing axle.

Variants:

Order Number	E-connection	P-connection	Comment
472 900 102 0	5 individual solenoids M27x1	VOSS connection 5x M22x1.5	Replaced by 472 900 105 0
472 900 103 0	5 individual solenoids M27x1	5x M22x1.5 (DIN thread)	electrical connections 41 to 43 (also refer to page 43); with silencer
472 900 105 0	5 individual solenoids M27x1	5x M22x1.5 (JED-388)	Replacement for 472 900 102 0; electrical connections 41 to 43; P-connections with access from top; with silencer
472 900 110 0	1x bayonet DIN 72585-A1-4.1-Sn/K1 1x bayonet DIN 72585-A1-4.2-Sn/K1	5x M22x1.5 (JED-388)	RA/TA valve; Replacement for 472 900 105 0; with silencer
472 900 112 0	1x bayonet DIN 72585-A1-4.1-Sn/K1 1x bayonet DIN 72585-A1-3.1-Sn/K1	5x M22x1.5 (JED-388)	RA/LA valve; without silencer changed connector coding on the electrical connection 62.3
472 880 100 0	1x bayonet DIN 72585-A2-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	5x M22x1.5 (JED-388)	**ECAS III** RA/TA valve; supersedes 472 900 110 0; but changed connector coding on the electrical connections; with silencer
472 880 101 0	1x bayonet DIN 72585-A1-4.1-Sn/K1 1x bayonet DIN 72585-A1-3.1-Sn/K1	5x M22x1.5 (JED-388)	**ECAS III** RA/LA valve; supersedes 472 900 112 0; without silencer

Symbol diagram

RA/LA valves for 2-point control
(2 distance sensors).
There is one output on the lifting axle block for the lifting bellows and two outputs for the supporting bellows of the lifting axle.

Variants:

Order Number	E-connection	P-connection	Comment
472 900 101 0	6 individual solenoids M27x1	VOSS connection 6x M22x1.5	Replaced by 472 900 111 0
472 900 104 0	6 individual solenoids M27x1	6x M22x1.5 (JED-388)	electrical connections 41 to 43 (also refer to page 43); P-connection with access from top; with silencer
472 900 111 0	1x bayonet DIN 72585-A1-4.1-Sn/K1 1x bayonet DIN 72585-A1-4.2-Sn/K1	6x M22x1.5 (JED-152)	Replacement for 472 900 101 0

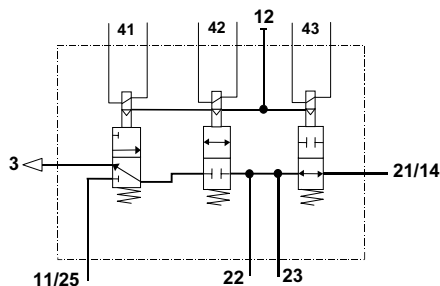| Order Number	E-connection	P-connection	Comment
472 900 114 0	2x bayonet DIN 72585-A1-4.1-Sn/K1	6x M22x1.5 (JED-388)	Replacement for 472 900 104 0; with silencer
472 880 103 0	1x bayonet DIN 72585-A2-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	6x M22x1.5 (JED-388)	**ECAS III** supersedes 472 900 114 0; with silencer
472 880 104 0	1x bayonet DIN 72585-A2-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.1-Sn/K2	6x M22x1.5 (JED-388)	**ECAS III** with silencer
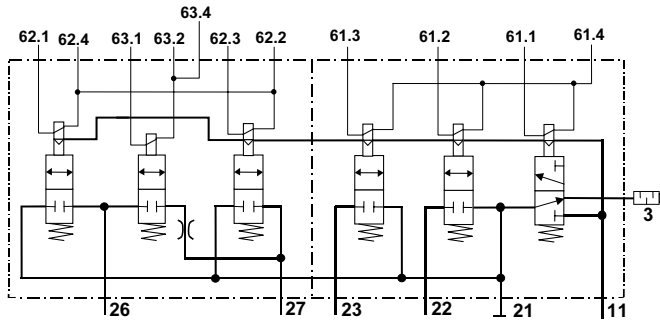
Symbol diagram	
	FA/RA valves for 3-point control (3 distance sensors). Special form for buses - these valves have a throttle (diameter 1 mm) between the pneumatic outputs to the left and right side of the bellows. Special feature: Valve solenoid, required for the kneeling function, in FA section. **Variants:**

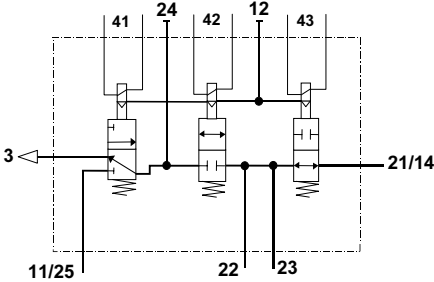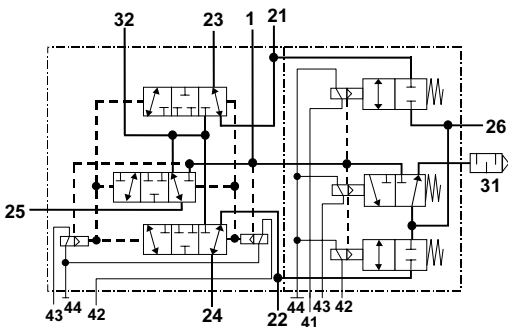| Order Number	E-connection	P-connection	Comment
472 900 050 0	6 individual solenoids M27x1	M 22x1.5 (DIN thread)	electrical connections 41 to 43 (also refer to page 43); with silencer
472 900 051 0	6 individual solenoids M27x1	M 22x1.5 (DIN thread)	for information only, no longer availableelectrical connections 41 to 43 (also refer to page 43); P-connection with access from top; with silencer
472 900 056 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2 1x bayonet DIN 72585-A1-3.6-Sn/K2	M 22x1.5 (JED-388)	with silencer
472 900 059 0	6 individual solenoids M27x1	M 22x1.5 (JED-388)	electrical connections 41 to 43 (also refer to page 43); P-connection with access from top; without silencer
472 900 068 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2 1x bayonet DIN 72585-A1-3.6-Sn/K2	M 22x1.5 (JED-388)	12V design: with silencer
472 880 060 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2 1x bayonet DIN 72585-A1-3.6-Sn/K2	M 22x1.5 (JED-388)	**ECAS III** supersedes 472 900 056 0; with silencer

Symbol diagram	
	ECAS solenoid valvesthat perform special control functions. Special feature: directional control valve 2/2 upstream of port 21/14; the valve is open when de-energised.

Order Number	E-connection	P-connection	Comment
472 900 013 0	3 individual solenoids M27x1	M22x1.5/M16x1.5 (DIN thread)	w/o silencer

Symbol diagram

ECAS solenoid group with added port 24/13. They do not play any role as far as use in the vehicle is concerned, although they are encountered in the CTU (conformity measuring instrument for the ECE-R13) as a pneumatic actuator.

Variants:

Order Number	E-connection	P-connection	Comment
472 900 005 0	3 individual solenoids M27x1	M22x1.5/M16x1.5 (DIN thread)	replaced by 472 900 007 0; without silencer
472 900 007 0	3 individual solenoids M27x1	M22x1.5/M16x1.5 (DIN thread)	Replacement for 472 900 005 0; may also replace 472 900 013 0; without silencer

	Solenoid valves used for pressure equalising control.	

Symbol diagram

RA/LA (or RA/TA) valve for 2-point control (2 distance sensors).
The bellows pressure on the left-hand and right-hand side of the vehicle can be controlled separately.

Variants:

Order Number	E-connection	P-connection	Comment
472 905 105 0	2x KOSTAL bayonet	M 22x1.5 (JED-388)	replaced by 472 905 107 0; with 1x silencer (old version)
472 905 107 0	2x KOSTAL bayonet	M 22x1.5 (JED-388)	Replacement for 472 905 105 0; replaced by 472 905 111 0; with 1x silencer (old version)
472 905 111 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	M 22x1.5 (JED-388)	Replacement for 472 905 107 0; with 1x silencer
472 905 112 0	2x KOSTAL bayonet	M 22x1.5 (JED-152)	Replacement for 472 905 108 0; with 1x; fording ability
472 905 118 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	M 22x1.5 (JED-388)	SCANIA design; bus, 6x2; with 2x silencers

Symbol diagram

RA/LA (or RA/TA) valve for 2-point control (2 distance sensors).
The bellows pressure on the left-hand and right-hand side of the vehicle can be controlled separately.
Special feature: Lifting axle is lifted/lowered inversely (i. e. opposite). Replacing the following valves with the previously mentioned valves is not permissible.

Variants:

Order Number	E-connection	P-connection	Comment
472 905 110 0	2 solenoid blocks M27x1	M 22x1.5 (JED-152)	replaced by 472 905 116 0; housing identified by a blue paint dot on the cover; 1 silencer
472 905 116 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	M 22x1.5 (JED-388)	Replacement for 472 905 110 0; housing identified by a blue paint dot on the cover; with 1x silencer.

Symbol diagram

RA/LA (or RA/TA) valves for 1-point control (1 distance sensor).
These valves have a throttle (diameter 0.6 mm) between the pneumatic outputs to the left and right side of the bellows. The bellows pressure on the left-hand and right-hand side of the vehicle cannot be controlled separately.

Variants:

Order Number	E-connection	P-connection	Comment
472 905 109 0	2x KOSTAL bayonet	M 22x1.5 (JED-388)	replaced by 472 905 114 0; with 2x silencers
472 905 114 0	1x bayonet DIN 72585-A1-4.1-Sn/K2 1x bayonet DIN 72585-A1-4.2-Sn/K2	M 22x1.5 (JED-388)	Replacement for 472 905 109 0; with 2x silencers
	Solenoid valves with special tasks for particular users.		

Symbol diagram

FA/RA valves for 1-point control / 1-point control with integrated lifting bellows control (2 distance sensors).
Such a valve can carry out all the ECAS functions in a 6x2 vehicle with full air suspension and a lifting axle. There is one output available in each case for the front, rear and lifting axle supporting bellows. The lifting bellows has a separate output on the valve and does not have constrained control.

Order Number	E-connection	P-connection	Comment
472 905 070 0	2 solenoid blocks M27x1	M22x1.5 (JED-388) 1X (JED-152)	w/o silencer

WABCO

		RA valve for 1-point control (1 distance sensor)		
Symbol diagram	Order Number	E-connection	P-connection	Comment
	472 905 010 0	1x KOSTAL bayonet	1/2-14 DRYSEAL NPTF	12 V design: with silencer

		RA/TA valve for 1-point control (1 distance sensor)		
Symbol diagram	Order Number	E-connection	P-connection	Comment
	472 905 060 0	1x KOSTAL bayonet	1/2-14 DRYSEAL NPTF	12 V design: with silencer

6.4 The remote control unit

Using the remote-control, you have the following options:
- to change the desired level,
- to adjust the position of the lifting axle,
- to activate traction help,
- to preselect the desired normal level.

The ride height can be adjusted only while at a standstill or moving no faster than a limit speed v_{OPER}.
– The ECU is informed of this limit speed when you set the parameters.

Ideally, the remote control unit should be accommodated in a housing. The remote control unit is linked to the ECU using a flexible 4-core helix cable and a socket on the vehicle.

The 4-core cable is assigned as follows:
- Terminal 15 for the voltage supply
- Terminal 31
- CLOCK line (also: pulse line)
- Data line (also: data line)

Fig. 42 shows the remote control unit 446 056 117 0 for a vehicle with full air suspension and a lifting axle. The functions of this RCU are:
- Adjusting to normal level.

- Lowering and raising of the vehicle body simultaneously above all axles; separately above the front or rear axle, or multi-axle combination, and, if the system is designed accordingly, separately on the axle's right and left side.
- Raising and lowering the lifting axle and thereby switching off or on any fully automatic lifting axle operation, and reducing or increasing the load on the trailing axle.
- Storing up to two preference (i.e. memory) levels and adjusting these levels by briefly pushing the appropriate button.
- Setting the vehicle to STAND-BY operation during which the power supply for ECAS is provided by terminal 30.
- pressing the STOP button will cancel any lifting and lowering processes immediately.

Systems with less comprehensive configurations will not react to button commands that are not consistent with the actual system. For example: selection of a front axle in a vehicle with partial air suspension, because these vehicles do not have a front axle with air suspension. With a remote control unit for vehicles with full air suspension, on the other hand, it is perfectly possible to operate a vehicle with partial air suspension.

Layout of the remote control unit
The top row of the operating panel contains three indicator lamps. They indicate which axle has been preselected for an adjustment.

preselect button 'front axle' or left side of the vehicle if right/left control is available

Memory level 2 button M 2

Memory level 1 button M 1

LIFT button

LOWER button

Indicator lamp Front axle

Indicator lamp Rear axle

Indicator lamp Lifting axle

Preselect button 'rear axle' or right side of the vehicle if right/left control is available

Preselect button 'lifting axle'

Normal level button

Stop button

Abb. 42 Remote control unit 446 056 117 0 and its components

The second row of the control panel contains three preselect buttons: front axle (left side of vehicle), rear axle (right side of vehicle), lifting axle. Each of these buttons is located below the corresponding indicator lamp.

– Press the desired preselect button.

The corresponding lamp will light up, indicating that it is now possible to perform an action on the preselected axle.

– Press the same preselect button again.

The corresponding indicator lamp goes out, indicating that input mode for the remote control unit has been terminated.

! It is no longer possible to make changes using the remote control unit.

Desired level changes relating to the entire vehicle are desired:
– Press and hold the preselect buttons 'front axle' and 'rear axle'.

Both indicator lamps (for the front and the rear axle) must light up to indicate that the axles are ready for actuation.

! Generally, any input using the remote control unit is initiated by preselecting the desired axle(s) and ends by cancelling the input mode.

Lifting and lowering the vehicle body

– Press and hold the LIFT or LOWER button.

A modified desired level for the vehicle body section located above the preselected axles is preset for the ECU. The vehicle body now immediately adjusts its distance to the vehicle axle for as long as the button is pressed and held.

– Release the button or press the STOP button.

The procedure for changing the nominal value is terminated. The nominal value detected the moment that the button was released is used as the new nominal value, and levels are adjusted accordingly.

Lifting and lowering the lifting axle

– Press the preselect button 'lifting axle' and then briefly tap the LIFT or LOWER button.

The lifting axle is raised or lowered, or the trailing axle is loaded or relieved. Lifting or loading action is only possible if the defined permitted maximum pressure in the main axle's support bellows is not exceeded. Lowering the lifting axle, or relieving the trailing axle, triggers deactivation of automatic lifting/trailing axle operation.

Deactivation of automatic lifting/trailing axle operation

The automatic lifting/trailing axle operation can be switched off, provided that at least one lifting/trailing axle was automatically lifted/relieved owing to a light load.

– Press the LOWER button.

Deactivating automatic lifting axle operation means that the previously (automatically) raised lifting axle is lowered, or that load is placed on the previously relieved trailing axle.

Switching on automatic lifting/trailing axle operation

– Press the preselect button 'lifting axle' and then press the LIFT button.

– by switching the ignition on and off.

Normal levels
A brief tap on the 'normal level' button is sufficient for adjustment to the current normal level. In some systems there is no need to deactivate the axle preselection as this is done automatically.

Memory levels
A specific ride height setting is frequently required during loading or unloading operation.

You have the option to save this level and to apply it as often as required, simply by pressing a button.

– Press the STOP button and simultaneously press either the M1 or the M2 button.

This saves an existing desired level as a memory (or 'preferential') level.

The stored values are not lost when the ignition is switched off. These values apply to the entire vehicle, so you only need to preselect an axle and retrieve the setting.

– Tap the corresponding button M1 or M2.

The vehicle body is immediately adjusted to the stored level.

Stop

– Press the STOP button.

All levelling control processes are stopped immediately, and the present level is recognised as the desired level.

⚠ The Stop function is designed, above all, to permit cancelling any level changes currently under way (memory, driving level) should you consider continuation of the process hazardous.

In some systems, pressing the STOP button is obligatory to terminate the LIFT and LOWER functions.

– Switch off ignition while you press and hold the STOP button.

The vehicle is in STAND-BY mode.

Speed dependency
The "Raising and lowering of the vehicle body" and "Memory level" functions can be used only when the vehicle is either stationary or has not exceeded a preselected speed v_{OPER}. Any control processes which were started below that speed will be completed even at greater speed.

Pressing several buttons simultaneously
If several buttons are pressed simultaneously and these do not represent a plausible combination, no command will be accepted when a targeted level change is initiated. The STOP function is executed.

Disconnecting the remote control unit
– Disengage the remote control unit.

The STOP function is triggered immediately.

Using several remote control units
A second remote control unit (on the loading platform, for example, or outside the vehicle) may be provided for controlling ECAS.

To ensure that only one of these remote control units communicates with the electronic system, a selection switch must be installed on the DATA line leading to the ECU for selecting one of the two remote control units. This also applies if more than two remote control units are used.

⚠ Do not connect two concurrent remote control units to the ECU in parallel. Such a procedure is impermissible and will cause malfunctions.

Priority
The remote control unit has a high priority within the system. If the unloading level function has been activated and a LIFT/LOWER command is also entered via the remote control unit, it is the command from the remote control unit will be executed.

In the event that the LIFT/LOWER function fails, the vehicle body can still be adjusted to a reasonable level as a makeshift solution for the vehicle to be driven to the workshop.

– ECAS needs to be aware of the existence of a remote control unit. For this reason, the remote control unit must be connected to the ECU before the system can be put into operation.

Service issues for remote control units
Depending on the system configuration, there are approximately 60 different remote control unit variants available. These differ with regard to development stage, functional range, connector layout, and vehicle manufacturer's logo. This wide variety, however, can be

reduced to a few basic variants. Should the unit need to be replaced, the procedure is therefore straightforward.

Remote control unit	Replacement
446 056 000 0, 446 056 007 0, 446 056 011 0, 446 056 014 0, 446 056 016 0, 446 056 017 0, 446 056 018 0, 446 056 021 0, 446 056 024 0, 446 056 027 0, 446 056 028 0, 446 056 029 0, 446 056 032 0, 446 056 035 0, 446 056 116 0, 446 056 124 0, 446 056 127 0, 446 056 128 0, 446 056 129 0, 446 056 132 0, 446 056 135 0, 446 056 136 0, 446 056 137 0, 446 056 140 0, 446 056 141 0, 446 056 142 0, 446 056 143 0	**446 056 117 0** **446 056 202 0**
446 056 002 0, 446 056 005 0, 446 056 009 0	**446 056 102 0**
446 056 012 0, 446 056 013 0	**446 056 113 0**
446 056 015 0	**446 056 115 0**
446 056 019 0, 446 056 020 0, 446 056 119 0	**446 056 120 0**
446 056 008 0, 446 056 025 0	**446 056 125 0**
446 056 030 0	**446 056 130 0**
446 056 033 0, 446 056 034 0, 446 056 133 0	**446 056 134 0**
446 056 138 0	**446 056 139 0**
446 056 026 0, 446 056 031 0, 446 056 126 0, 446 056 131 0	**446 056 146 0**

6.4.1 Remote control unit for vehicle combination 446 056 25 . 0

The remote control unit for the vehicle combination is used for manual levelling control, as well as lifting axle control, for vehicles equipped with ECAS. These units also include ECUs with integrated ECAS functionality, such as TCE system for example.

- With this device it is possible to control the level of the towing vehicle and trailer vehicle body, provided that the ECAS systems in the vehicle sections support this function.

- The device can be installed in any vehicle type. Drawbar trailer as well as semitrailer vehicles/units are supported.

- The remote control unit may be used equally in conjunction with the ECAS system of the trailer and/or the towing vehicle.

The user thus has the option to control the level of the entire vehicle using only a single operating device that is easily managed and robust.

Separate axle preselection buttons are provided for targeted selection of all vehicle axles, or groups of axles, in any combination. Selected axles are indicated by a corresponding indicator lamp. Easily understood symbols and colours for special buttons facilitate intuitive operation.

A tough, flexible four-core helix cable, which is securely fixed on the device, is used to establish a connection to the ECU. A mounting bracket is available under the WABCO no. 446 056 010 4. It is recommended that the device is placed back into the holder if it is not used.

Abb. 43 Remote control unit 446 056 250 0

Button assignment (for functions refer to 6.4)

1 Indicator lamp, front axle towing vehicle
2 Indicator lamp, rear axle towing vehicle
3 Indicator lamp, front axle trailer
4 Indicator lamp, rear axle trailer
5 Preselect button, lifting axle trailer
6 Preselect button, lifting axle towing vehicle
7 Normal level button
8 Stop button STOP
9 LOWER button
10 Memory level 2 - button M 2
11 Preselect button, rear axle towing vehicle
12 Preselect button, rear axle trailer
13 LIFT button
14 Memory level 1 - button M 1
15 Preselect button, towing vehicle
16 Preselect button, front axle trailer

7. Brief description of the individual systems

7.1 ECAS 1st generation without pressure sensor Sample circuit diagram: 841 801 208 0

This system is used for automatic levelling control in 4x2 and 6x2 commercial vehicles with air-sprung axles. Up to 3 distance sensors continuously sense the actual level, i. e. the distance between the vehicle body and the axle. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded.

It is possible to connect a remote control unit or an operating switch. Complete bellow evacuation can be avoided using a pressure limiting valve. The following functions can be implemented using switches or buttons:

- Forced lowering of the lifting axle with switch

- Activation of the traction help with button

- Normal level selection with switch to choose between 2 parameterised normal levels.

There are 2 lamps in the instrument panel for monitoring the system:

1. The fault lamp indicates faults in the system.

2. The warning lamp indicates situations in which ECAS is not in normal mode (e. g. vehicle body not at normal level or traction help active), but is operating without any faults. Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.

The control function is suppressed for a certain time after the brake is released – ECAS detects the opening of the brake lamp switch. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

An "LSV Output" on the ECU, an output that is energised during normal operation, triggers a solenoid valve after the ECU has detected the lowering of the vehicle body body below a specified level as a failure of the bellows
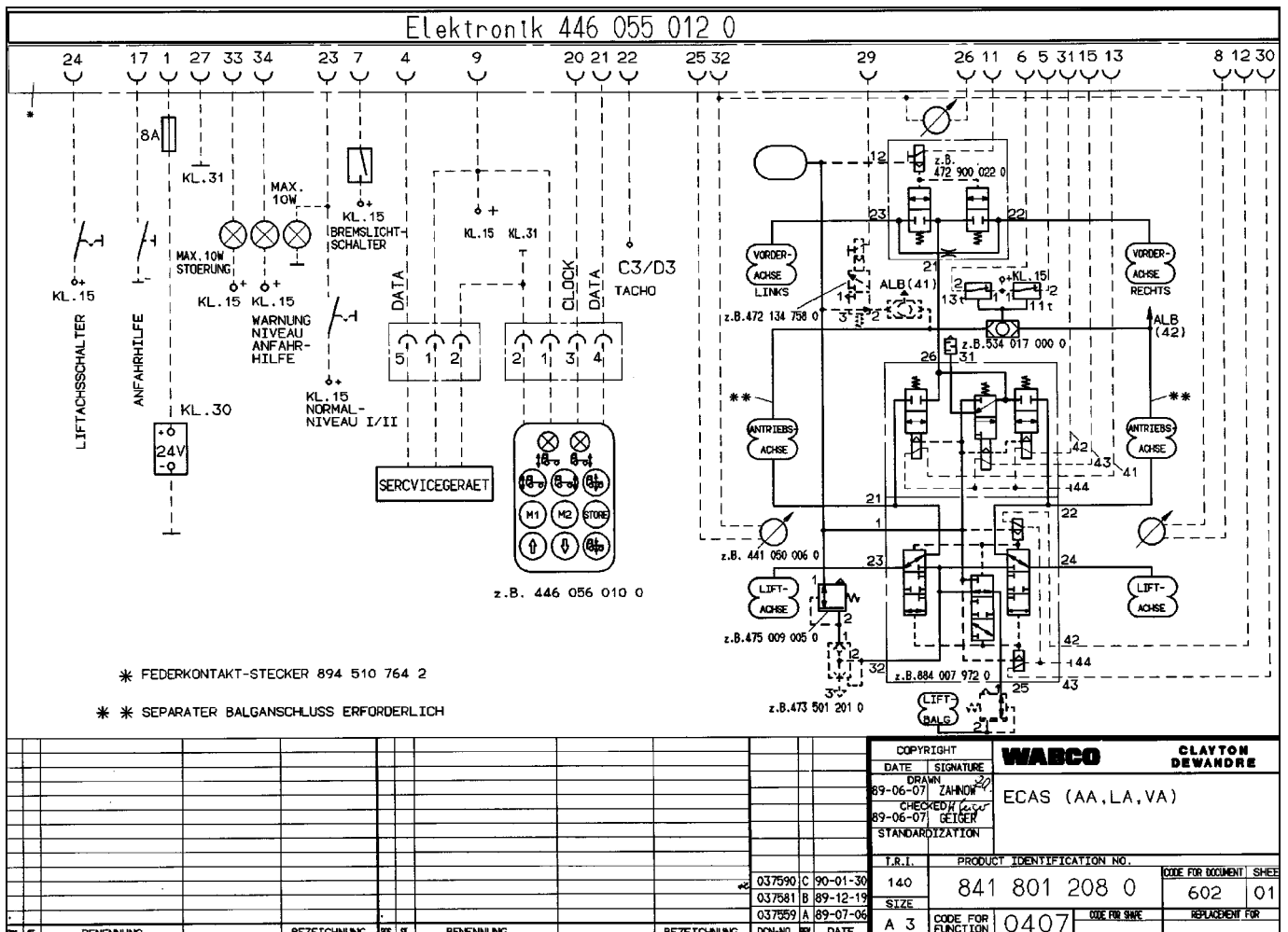

Fig. 44 ECAS 1st generation without pressure sensor

pressure information to reach the LSV controller (port 41/42). As a result, it is the air-suspension supply pressure, and not the bellows pressure, that reaches the inputs 41/42 of the LSV controller as a control signal. The controller interprets this signal as an indication that the vehicle is fully laden. This, in turn, is designed to prevent the vehicle from underbraking.

In 6x2 vehicles, the bellows pressure can be monitored by 2 pressure switches if required (Switching threshold: 13 t or 11 t, for example). The lifting axle can only be raised when the 11 t switch is closed. It would also be lowered again if this switch were to open during the lifting procedure. Activation of the traction help only results in the lifting axle being raised for a sustained period if the 13 t switch does not open. A desired level increase can be set in the parameters for activated traction help or while the lifting axle is raised. Speeds set in the parameters define limits for traction help activation and automatic deactivation. The duration of the traction help, and the interval between activations of the traction help, can be set in the parameters in line with the relevant provisions.

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.

7.2 ECAS 1st generation with pressure sensor Sample circuit diagram: 841 801 242 0

This system is primarily used for automatic level control in 6x2 commercial vehicles with air-suspended axles, although it can also be used in 4x2 vehicles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded.

It is possible to connect a remote control unit. The traction help function can be implemented with a button or a switch.

There are 2 lamps in the instrument panel for monitoring the system: (↑ 7.1 generation without pressure sensor)
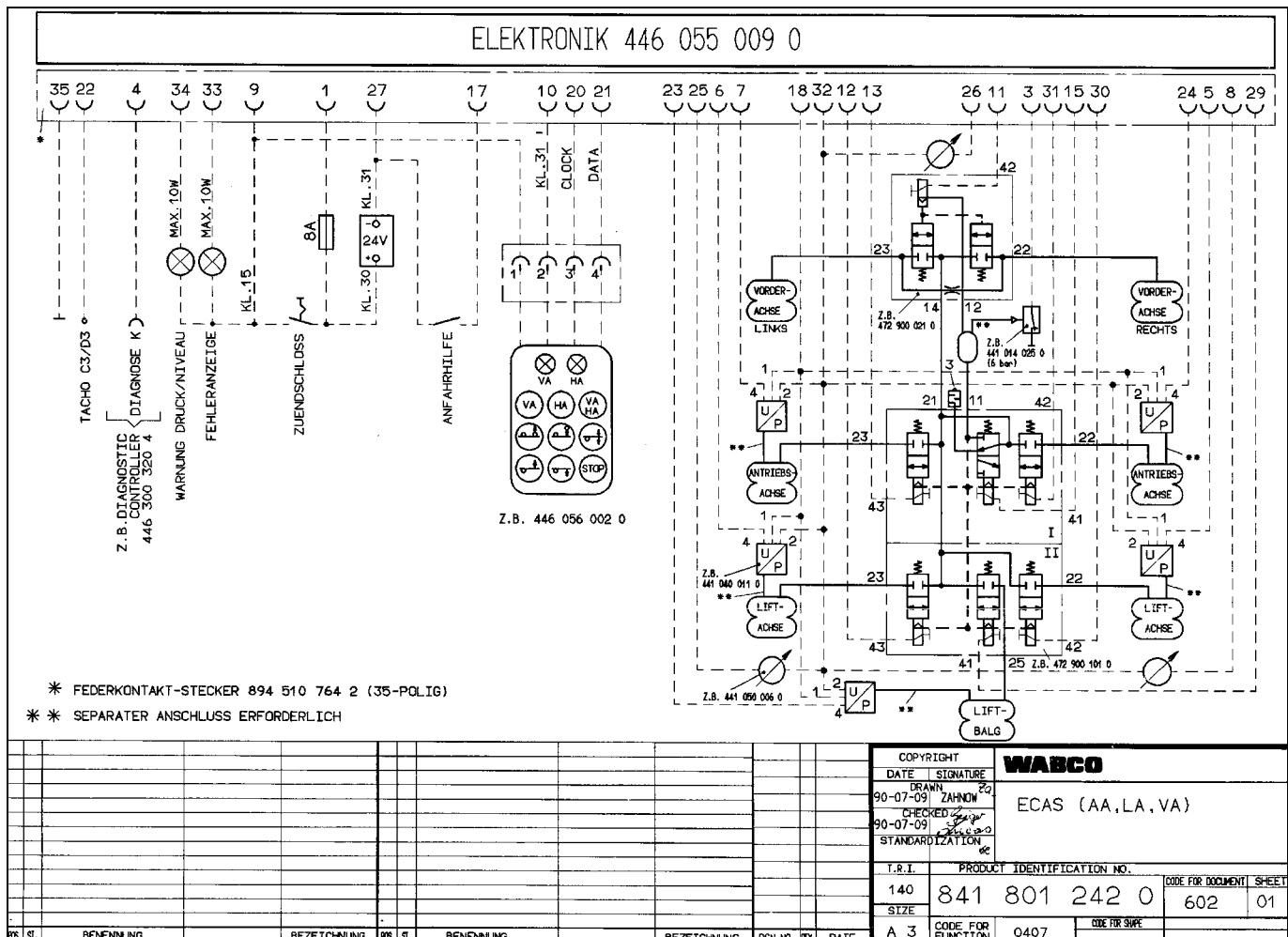

Fig. 45: ECAS 1st generation with pressure controller

The system operates with various control strategies - depending on the respective speed:

- At v > 0 km/h, ECAS categorises level changes as dynamic changes (driving) and only corrects the nominal value if the distance sensor values persistently remain outside the permissible range for a 60 second period.

- At v = 0 km/h, ECAS categorises level changes as static (stationary) and corrects the nominal value if the distance sensor values sensed within a parameterised, and very brief, period (1s for example), persistently remain outside the permissible range .

- For up to 3 seconds after the transition from v >0 km/h to v = 0 km/h (end of driving), ECAS still categorises level changes as dynamic (dynamic run-on).

- 7 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.

A level referred to as "reference level" was introduced to number of systems (with electronic control unit 446 055 009 0) in this group. It forms the basis for all other parameterised levels and is a parameterised differential value below the calibrated normal level I. The ECU calculates the reference level value subsequent to calibration. It must be greater than 5 counts in order to avoid fault messages.

The "Safe level above buffer" can be set in the parameters. It has been introduced to avoid complete evacuation of the supporting bellows when the vehicle body is lowered. This level represents the smallest possible distance differential to the reference level; it should always be above the bottom stops and to must be possible to adjust to this level using the remote control unit. During lowering of the vehicle body, the ECAS solenoid valve stops evacuation if the electronic control unit detects that the vehicle body is below this level and that the distance no longer changes over a period 6 times the pulse repetition period (also referred to in some systems as "measuring time").

The upper level is set in the parameters as a differential from the reference level. The sum total of both values is not allowed to exceed 254.

In some versions, it is possible to change between 2 normal levels in relation to a speed threshold that can be set in the parameters. Both normal levels are set in the parameters as a level differential relative to the reference level. The level is adjusted to normal level II at speeds below the parameterised threshold speed; the level is adjusted to normal level I at speeds above the threshold speed.

The control process is suppressed for a certain time after the brake is released. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

In 6x2 vehicles, the pressures between the driving axle and the non-driving axle (e. g.lifting axle) are adjusted in the case of optimum traction (ECU 446 055 009) or in the case of a parameterised pressure ratio (ECU 446 055 009), depending on the system version. For this, it is necessary to sense the supporting bellows of the driving axle and the non-driven rear axle using pressure sensors.

It is possible to activate a traction help. Because the supporting bellows are sensed by pressure sensors, the traction help is implemented as an infinitely variable load shift from the non-driven rear axle to the driving axle for as long as the traction help button is pressed down. The type of traction help, as well as the corresponding benchmark data (e. g. max. permitted driving axle load; limit speed before traction help takes effect, etc.) are set in the parameters.

Tyre impression compensation is possible if pressure sensors are installed (ECU variant 446 055 009).

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory. In order for the desired level to be stored correctly, the electronic control unit has to remain energised for longer than 6.6 seconds after the ignition is switched off. If this cannot be ensured, the actual levels which were set before the supply voltage was interrupted are taken as new desired levels after the ignition is switched on.

7.3 ECAS 4x2A
Sample circuit diagrams: 841 801 390 0 / 841 801 214 0 / 841 801 490 0

This system is used for automatic levelling control in 4x2 commercial vehicles with air-suspended axles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded.

The control characteristics of the desired level controller must be set in the parameters. To do this, a proportional and a differential coefficient for the front and rear axles are programmed into the electronic control unit via the parameter settings. The control behaviour of the system during desired level control is determined on the basis of these coefficients.

It is possible to connect a remote control unit or an operating switch.

There are 2 lamps in the instrument panel for monitoring the system:

1. The fault lamp indicates faults in the system. In this case, minor faults, plausibility errors, or undervoltage faults 7.5 … 18 V are indicated by a steady light while severe faults and "System in diagnostic mode" are indicated by a flashing light (flashing frequency: approx.1 Hz). frequency approx.1 Hz).

2. The warning lamp indicates situations in which ECAS is not in normal mode (e. g. vehicle body outside normal level, minor plausibility errors, or conducting manual calibration), but is operating without any faults. Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.

The system operates with various control strategies relative to a limit speed set in the parameters:

- At speeds faster than this speed parameter, ECAS categorises level changes as dynamic changes (driving operation) and only corrects the nominal value if the distance sensor values remain outside the permitted nominal value range set in the parameters persistently for a 60 second period.

- Below this limit speed, ECAS categorises level changes as static (stationary) and corrects the nominal value if the distance sensor values determined within a very short period (e. g. 1 s), which can be defined in the parameter settings, remain persistently outside the permitted range.

- For up to 3 seconds after the transition from v >0 km/h to v = 0 km/h (end of driving), ECAS still categorises level changes as dynamic (dynamic run-on).

- 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.

Specific parameter settings (only ECU 446 055 027; i. e. RVI, IVECO, DAF) permit a control mode whereby a greater vehicle body tilt is permitted above the axle in favour of a uniform bellows pressure distribution in vehicles with 2 distance sensors on the driving axle. After failing to adjust to the desired level twice within the
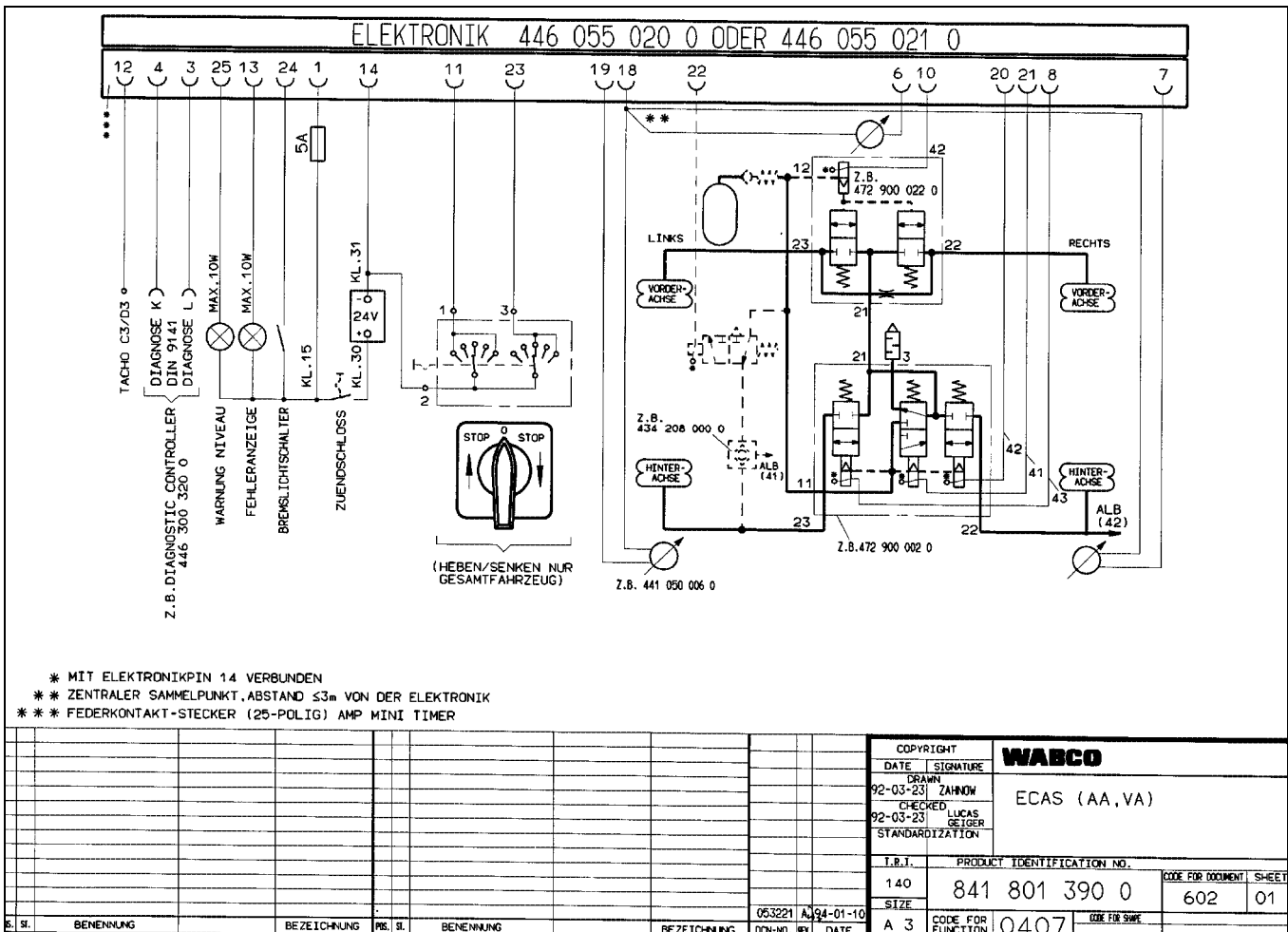

Fig. 46: ECAS 4x2A; circuit diagram 841 801 390 0

permissible tolerance range, ECAS detects an uneven loading condition in the course of lifting the vehicle body and adjusts the left side of the vehicle correctly to the desired level. It briefly (300 ms) pressurises the supporting bellows of the vehicle side that is in the higher position to balance the bellows pressures of the driving axle.

The control function is suppressed after the brake is applied – ECAS detects this by the presence of U_{BATT} at pin 24 of the ECU. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

Adjustment in response to failure of the LSV signal can be performed via a solenoid valve if parameters have been set accordingly. (not in the case of ECU 446 055 024 and 446 055 027)

Level changes between the two normal levels (NL I and NL II), however, are possible, as well as level adjustments to any level between upper and lower level. The NL I is made known to the electronic system during

start-up of the system, NL II can be parameterised and is entered as a differential value to the lower level. They can be created in the following manner:

- actuating the normal level (NL) I/III switch, effects a change between the two levels. In order to set NL II, ECU pin 23 is connected to earth and this connection is interrupted to return to NL I. Pressing the NL button on the control unit moves the vehicle body to the normal level in accordance with the position of the NL I/II switch.

- The vehicle body moves to the normal level (if it is not already there) if a speed limit set in the parameters is exceeded; given appropriate parameter settings, it is possible to change between a set NL I and NL II by exceeding another speed limit and then decelerating to below a second, somewhat slower, speed limit.

- it is possible to move to any level by pressing the LIFT or LOWER button on the remote control unit. It depends on the particular system whether the lifting/lowering function is activated by briefly tapping the corresponding switch on the remote control and not to be deactivated until the STOP button is pressed (ECU
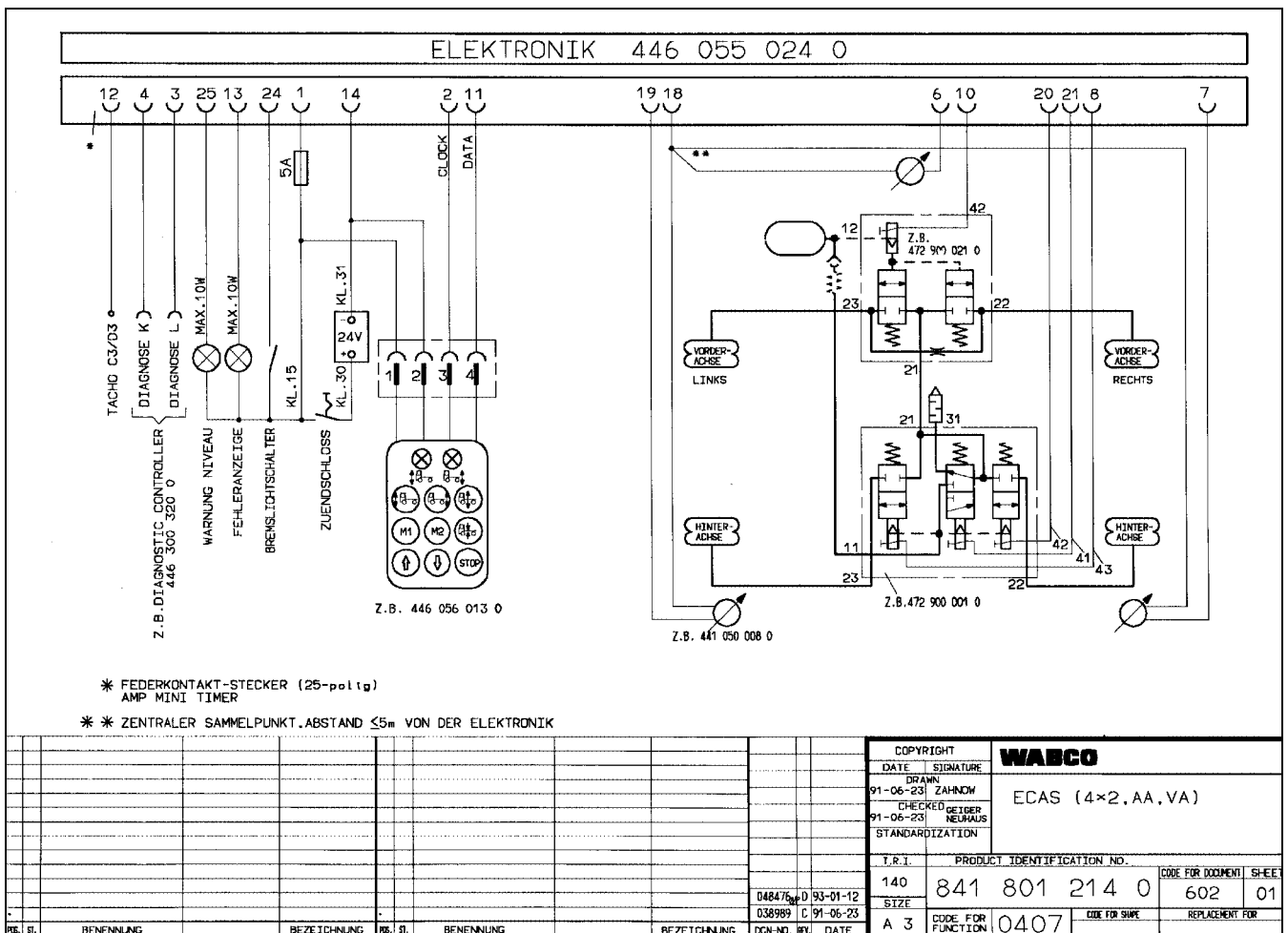

Fig. 47: ECAS 4x2A; circuit diagram 841 801 214 0

446 055 024; i. e. DC vehicles) **or** whether the lifting/ lowering function only remains active for as long as the corresponding button on the remote control unit is pressed (all other variants).

- LIFT and LOWER functions can also be performed by actuating a coded operating switch within the system instead of the remote control unit.

If the system is not fitted with either a remote control unit or an operating switch, jumpering pins 2 and 11 on the electronic control unit causes ECAS to adjust to the normal level as soon as the ignition is switched on.

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.

A measured value output can be organised during normal ECAS operation by setting the parameters accordingly (not for ECU 446 055 024).

The individual operating values are:

1. Actual level on the left of the rear axle
2. Actual level on the right of the rear axle
3. Actual level on the front axle
4. Desired level on the left of the rear axle
5. Desired level on the front axle
6. Speed
7. Controller status (only ECU variant 027) otherwise without significance
8. Status of remote control unit / operating switch:

1	= Preselection, front axle
2	= Preselection, rear axle
4	= STOP
8	= Normal level
16	= Memory I
32	= Memory II
64	= Lift
128	= Lower

This measured value output mode is only permitted for service operation; the system must be returned to normal mode at the end of measured value output.
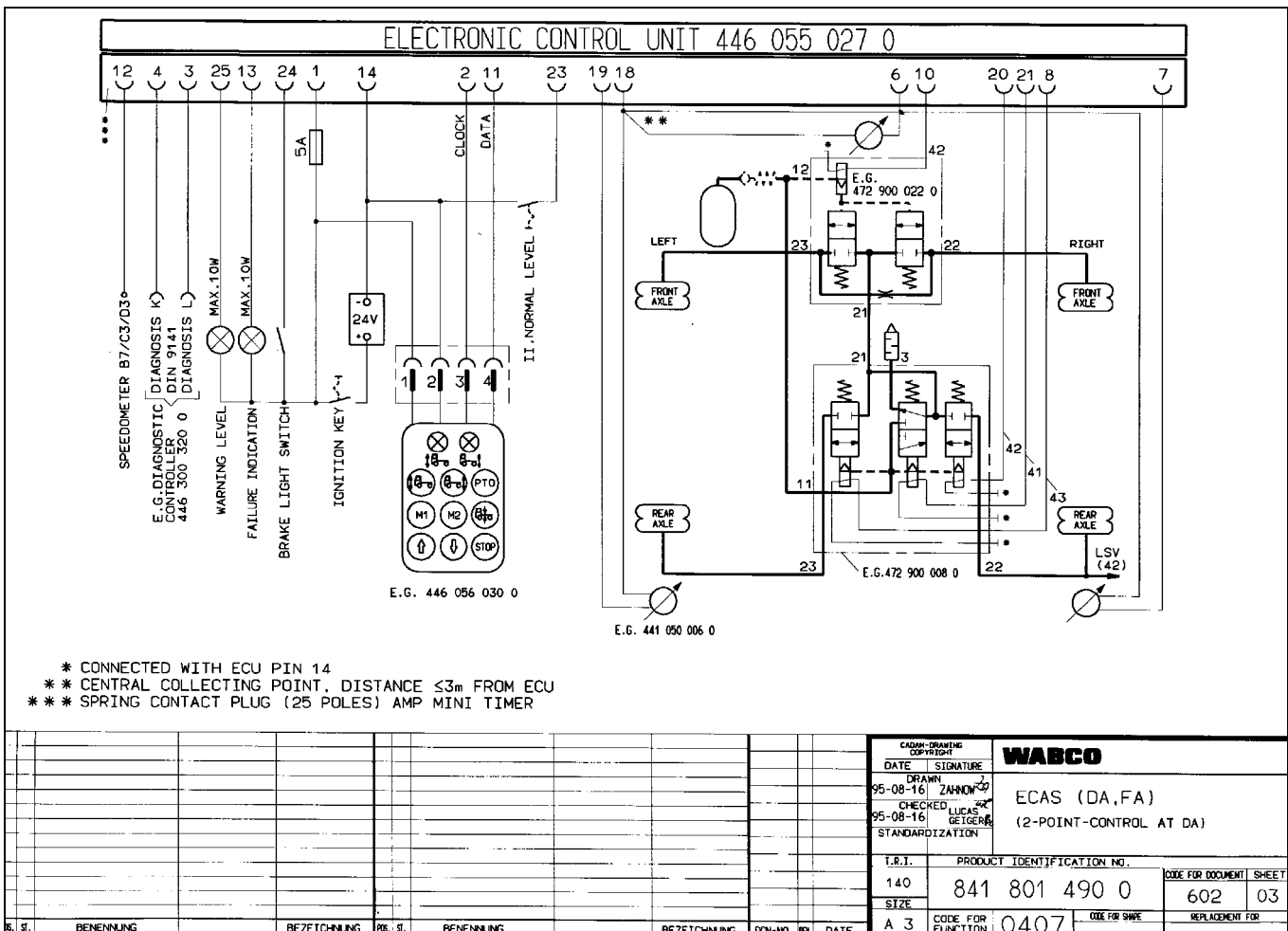

Fig. 48: ECAS 4x2A; circuit diagram 841 801 490 0

7.4 ECAS 6x2A
Sample circuit diagrams: 841 801 353 0 / 841 801 268 0 / 841 801 379 0

This system is primarily used for automatic level control in 6x2 commercial vehicles (4x2 commercial vehicles are possible) with air-suspended axles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded. A supporting bellows limit pressure of the driving axle is signalled to the electronic control unit by the position of pressure switches. This is the limit pressure which, if exceeded, causes a lifting axle to be lowered or load transferred to a trailing axle.

The control characteristics of the desired level controller must be set in the parameters. To do this, a proportional and a differential coefficient for the front and rear axles are programmed into the electronic control unit via the parameter settings. The control behaviour of the system during desired level control is determined on the basis of these coefficients.

It is possible to connect a remote control unit.

There are up to 5 lamps in the instrument panel for monitoring the system:

- The fault lamp (also known as "malfunction indication lamp") indicates faults in the system. In this case, minor faults, plausibility errors, or undervoltage faults 7.5 … 18 V are indicated by a steady light while severe faults and "System in diagnostic mode" are indicated by a flashing light (flashing frequency: approx. 1 Hz).

- The level warning lamp indicates situations in which ECAS is not in normal mode (e. g. vehicle body outside normal level, minor plausibility errors, or conducting manual calibration), but is operating without any faults.

- The traction help indication shows whether the traction help is activated.

- The lifting axle position lamp (also: unladen/lifting axle lamp) lights up when the lifting axle is raised or the load is transferred from the trailing axle (TA relief).
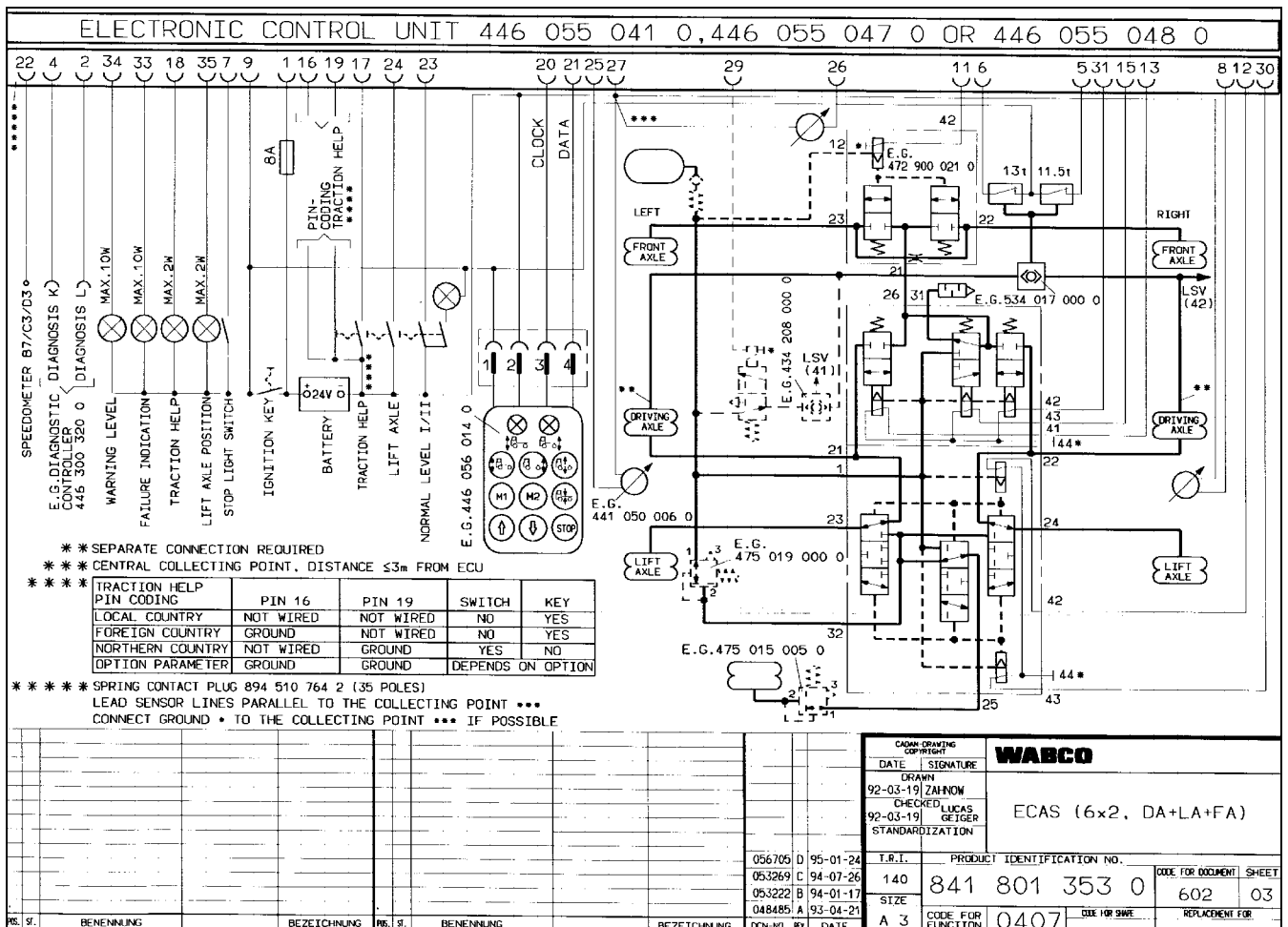

Fig. 49: ECAS 6x2A; circuit diagram 841 801 353 0

- The normal level lamp indicates whether normal level (NL) II was preselected for the vehicle.

Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.

The system operates with various control strategies - depending on the respective speed:

- If the speed exceeds a specified limit value, ECAS categorises level changes as dynamic changes (driving operation) and only corrects the nominal value if the distance sensor values persistently remain outside the permitted nominal value range set in the parameters for a 60 second period.

- If the speed remains below the defined limit value, ECAS categorises level changes as static (stationary) and corrects the nominal value if the distance sensor values determined within a very short period (e. g. 1 s), which can be defined in the parameter settings, remain persistently outside the permitted range.

- Up to 3 seconds after the speed falls below the speed limit value, ECAS still categorises level changes as dynamic (dynamic run-on).

- 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.

After brake actuation, ECAS detects this actuation by the presence of U_{BATT} on pin 7 of the electronic control unit. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

Adjustment in response to failure of the LSV signal can be performed via a solenoid valve if parameters have been set accordingly.

Level changes between the two normal levels (NLI and NLII), however, are possible, as well as level adjustments to any level between upper and lower level. They can be created in the following manner:

- actuating the normal level (NL) I/II switch will cause a switchover between the two levels. In order to set NL II, ECU pin 23 is connected to ground and this connection is interrupted for a reset NL I. Pressing the NL button on the control unit moves the vehicle body to the normal level in accordance with the position of
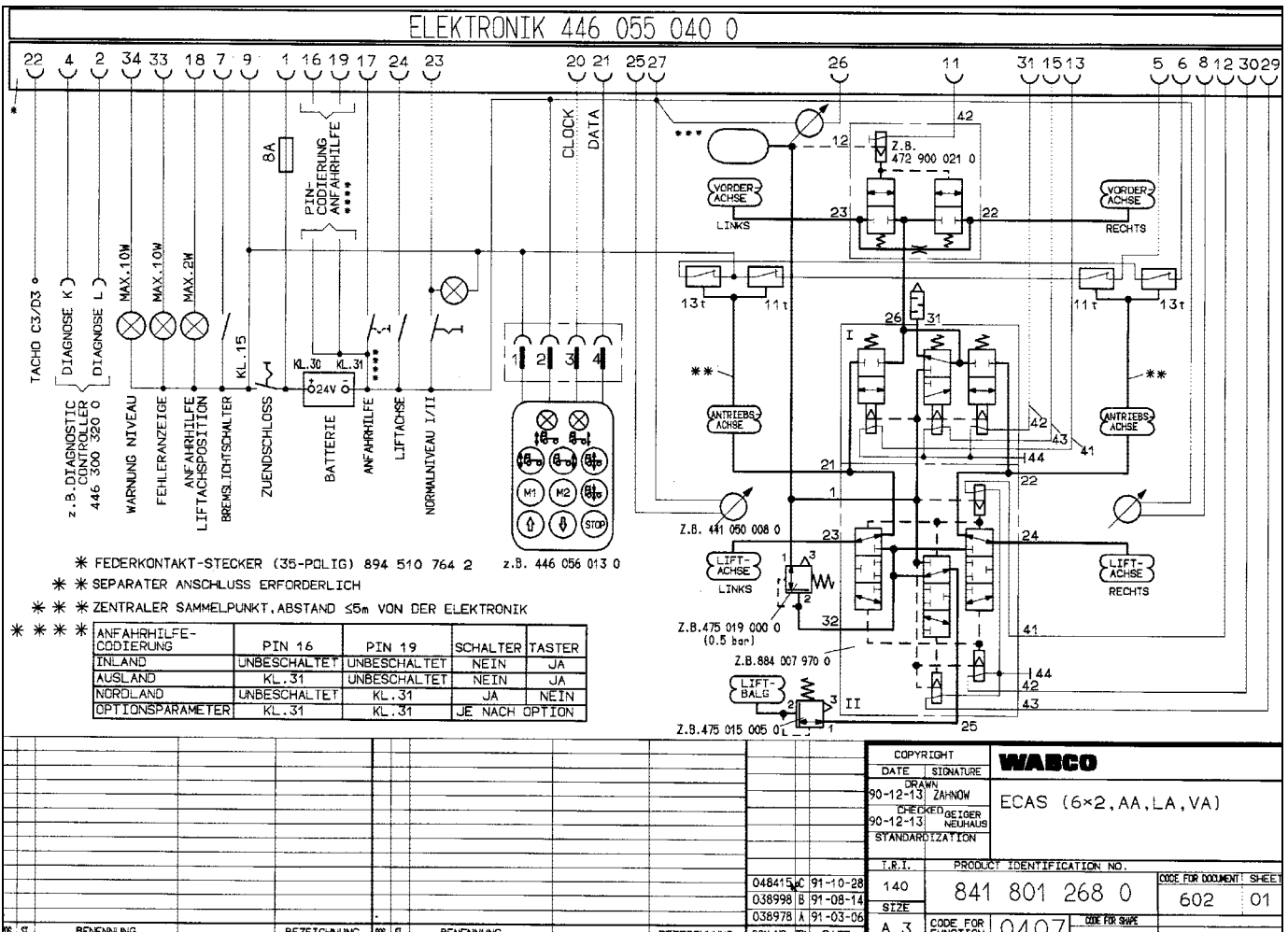

Fig. 50: ECAS 6x2A; circuit diagram 841 801 268 0

the NL I/II switch. Traction help must not be active during this procedure.

- The vehicle body moves to the normal level (if it is not already there) if a speed limit set in the parameters is exceeded; given appropriate parameter settings, it is possible to change between a set NL I and NL II by exceeding another speed limit and then decelerating to below a second, somewhat slower, speed limit.

- it is possible to move to any level by pressing the LIFT or LOWER button on the remote control unit.

If the system is not fitted with a remote control unit, jumpering pins 20 and 21 on the electronic control unit causes ECAS to adjust to normal level as soon as the ignition is switched on.

Apart from the basic ECAS function (adjusting the distance vehicle body - axle), ECAS also performs control of the lifting/trailing axle LOAD and RELIEF function. It is possible to organise manual lifting/trailing axle control or fully automatic lifting/trailing axle control. When discussing functions regarding "lifting axle" in the remaining document, these explanations will also include, as far as possible, trailing axle functions.

The lifting axle switching point on the driving axle can be obtained using up to 2 pressure switches or pressure sensors. If there is one pressure switch or one pressure sensor on the driving axle, the higher of the supporting bellows pressures is determined by means of a 2/2 proportional relay valve. Two pressure switches on the driving axle are connected in series, so that the switch to open first will transmit the signal to the ECU. When there are two pressure sensors on the driving axle, the supporting bellows pressure values measured on the left and right-hand side are averaged in the ECU. because only the driving axle is sensed, control is only possible according to the "pressure equalising control" principle.

Pressure switch:
The switching point of the lifting/trailing axle normally lies within range 11 t … 11.5 t. It is determined by a pressure switch connected to pin 5. If the pressure switch is defective, the lifting/trailing axle is lowered or load is transferred onto the trailing axle.

Pressure sensor:
The switching point of the lifting/trailing axle is set in the parameters. It is determined by a pressure sensor connected to pin 5/6. If the pressure sensor is defective, the lifting axle is lowered or the load is transferred onto the trailing axle.

However, separate switches for controlling the lifting axle can also be provided on the instrument panel. Depending on the parameter settings, it is possible to use 3 different switch variants for controlling the lifting axle:

1. **Lifting axle or Unladen switch:**
   Ground switched to pin 24 of the ECU.
   open switch = Lifting axle LOWERING
   closed switch = Lifting axle LIFTING.

2. **Lifting axle or Unladen button:**
   switched to pin24 of the ECU.
   Button open = No activation
   Button switched to ground = Lift lifting axle
   Button switched to U_{BATT} = Lower lifting axle.

3. **Combination switch for lifting axle control and traction help:** Lifting axle control switched to pin24 / traction help switched to pin17 of the ECU.
   Pin 24 and pin 17 open = LOWER lifting axle
   Pin 24 closed and pin 17 open = LIFT lifting axle

The following applies to the switches: ECAS only responds to switching actions performed when the ignition is ON.

The lifting bellows themselves are predominantly controlled positively, i.e. the ECAS solenoid valve simultaneously performs the functions "Lifting axle lifting" (pressurise lifting bellows, ECU pin 30 = U_{BATT}) or "Lifting axle lowering" (exhaust lifting bellows, ECU pin 12 = U_{BATT}) via internal pneumatic connections.

In vehicles with ECU 446 055 048 (Scania), separate lifting bellows control can be implemented, provided the corresponding parameters have been set. In order to do this, it is necessary to have the corresponding ECAS solenoid valve with a 3rd pilot solenoid for the lifting bellows, which is switched to U_{BATT} via ECU pin 14 if required. The periods for which a current is applied to the ECAS solenoid valve depend on which mechanism is used for lifting the lifting axle.

An important point in this regard is the configuration of the traction help. The required type of traction help can be defined, on the one hand, via the hardware by means of the switching combination on pins 16 and 19 of the ECU (i. e. pin switched to earth or not) and, on the other hand, via the software by setting the parameters. Pins 16 and 19 must be connected to ground if the traction help type is to be set in the parameters. The traction help itself is then activated by switching ECU pin 17 to earth.

The traction help limit on the driving axle can be determined using up to 2 pressure switches or pressure sensors. The signal is obtained in the same way as the signal for the lifting axle switching point.

Pressure switch:
The limit for the traction help is normally approx. 13 t. The limit is obtained by a pressure switch connected to pin 6. The axle load on the driving axle is exceeded by gradually relieving the load on the lifting axle. This process continues until the traction help pressure switch

is triggered, after which the bellows pressure in the supporting bellows is maintained.

Pressure sensor:

The limit for the traction help is set in the parameters. It is determined by the pressure sensor connected to pin 5/6. If the pressure sensor is defective, the lifting axle is lowered or the load is transferred onto the trailing axle.

"Traction help with overload" can be organised by using pressure sensors. This means that when the driving axle is still subjected to a load below the permissible axle load but has exceeded the switching point for the lifting axle control (e. g. switching point for lifting axle control = 75 % of the permissible axle load), the limit for traction help is increased by this pressure differential.

When the traction help is activated – irrespective of the current desired level – the desired level is always increased by the value set in the "Desired level increase when traction help activated" parameter.

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.

A measured value output can be organised during normal ECAS operation by setting the parameters accordingly.

The individual operating values are:
1. Actual level on the left of the rear axle
2. Actual level on the right of the rear axle
3. Actual level on the front axle
4. Desired level on the left of the rear axle
5. Desired level on the front axle
6. Status of the 13 t switch or averaged pressure on the driving axle
7. Speed or offset tyre impression compensation
8. Status of remote control unit: / or speed:
    - 1 = Preselection, front axle
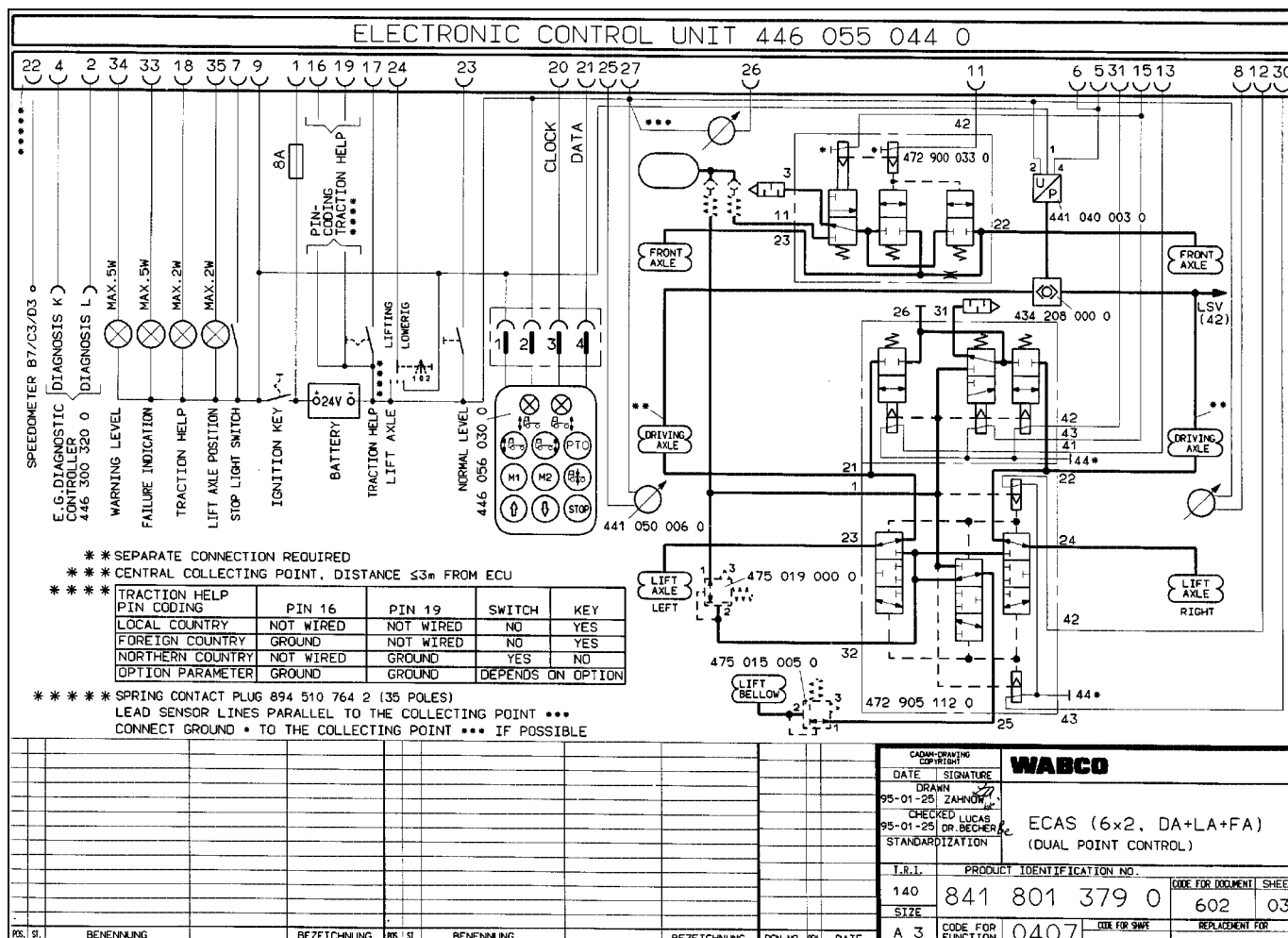   - 2 = Preselection, rear axle
    - 4 = STOP

Fig. 51: ECAS 6x2A; circuit diagram 841 801 379 0

8 = Normal level

16 = Memory I

32 = Memory II

64 = Lift

128 = Lower

The measured values output on the individual channels depend on which electronic control unit is used.

This measured value output mode is only permitted for service operation; the system must be returned to normal mode at the end of measured value output.

7.5 ECAS 4x2 Ratio
Sample circuit diagrams: 841 801 641 0 / 841 801 635 0

This system is used for automatic levelling control in 4x2 commercial vehicles with air-suspended axles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded. The pin assignment is almost identical to the ECAS 4x2A version; this Ratio variant represents a further development of that version.

It is no longer necessary to set parameters for the characteristics of the desired level controller. The system is self-learning, i. e. there is no longer any need to enter the proportional and differential coefficients.

It is possible to connect a remote control unit or an operating switch.

There are 2 lamps in the instrument panel for monitoring the system:

1. The fault lamp indicates faults in the system. In this case, minor faults, plausibility errors, or undervoltage faults 7.5 … 18V are indicated by a steady light while severe faults and "System in diagnostic mode" are indicated by a flashing light (flashing frequency: approx. 1 Hz).

2. The warning lamp indicates situations in which ECAS is not in normal operating mode (e.g. vehicle body not at normal level or traction help active, minor errors or plausibility errors, or manual calibration is performed), but is operating without any faults. Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.
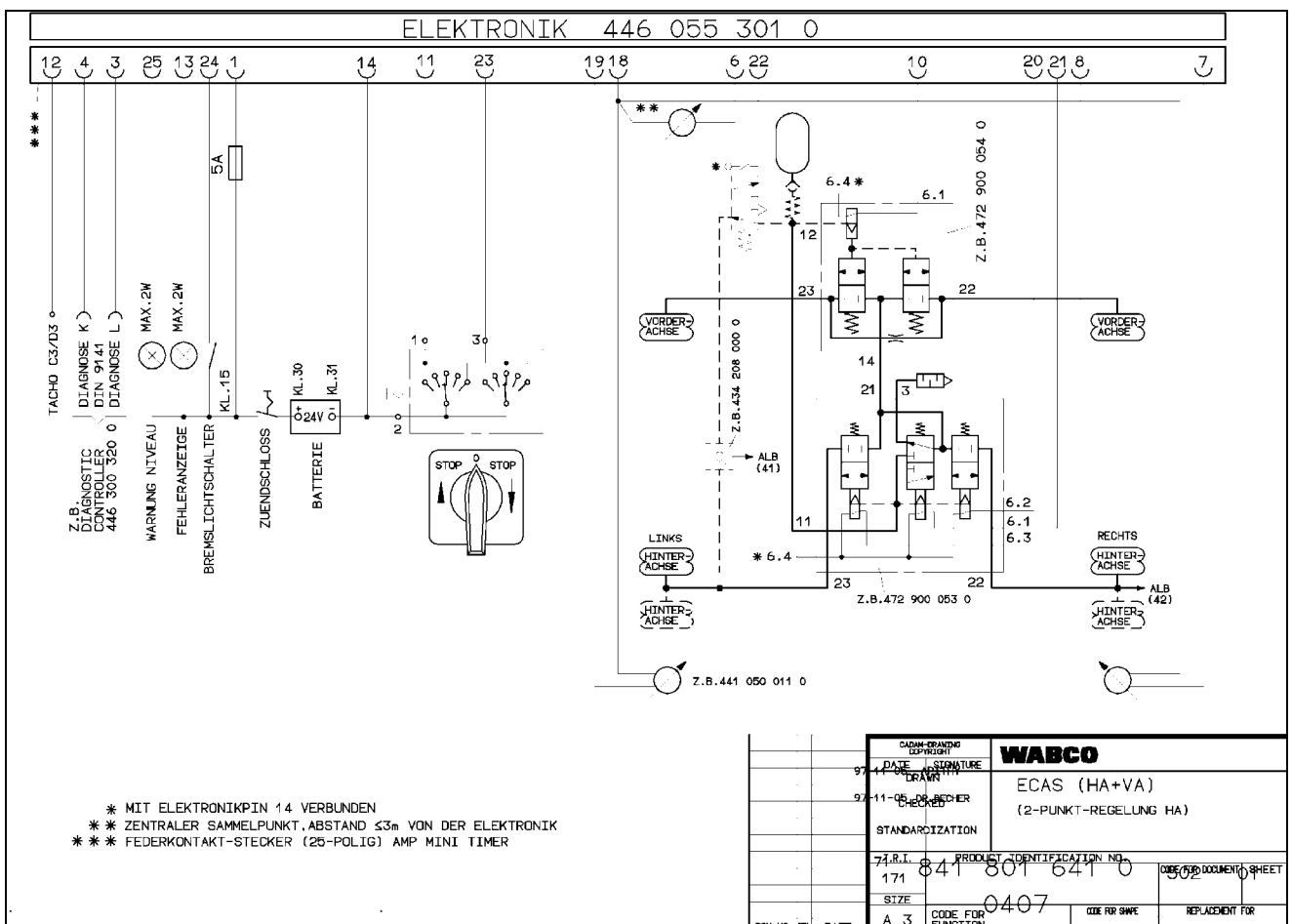

Fig. 52: ECAS 4x2 Ratio; circuit diagram 841 801 641 0

This system also operates with various control strategies - depending on the respective speed:
(↑ 7.4 ECAS 6x2A)

After brake actuation, ECAS detects this actuation by the presence of U_{BATT} on pin 24 of the electronic control unit. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

Adjustment in response to failure of the LSV signal can be performed via a solenoid valve if parameters have been set accordingly.

Level changes between the two normal levels (NL I and NL II), however, are possible, as well as level adjustments to any level between upper and lower level. They can be created in the following manner:

• actuating the NL I/II switch will alternate between the two levels. In order to set NL II, ECU pin 23 is connected to ground and this connection is interrupted for a reset NL I. Pressing the NL button on the control unit moves the vehicle body to the normal level in accordance with the position of the NL I/II switch.

• The vehicle body moves to the normal level (if it is not already there) if a speed limit set in the parameters is exceeded; given appropriate parameter settings, it is possible to change between a set NL I and NL II by exceeding another speed limit and then decelerating to below a second, somewhat slower, speed limit.

• it is possible to move to any level by pressing the LIFT or LOWER button on the remote control unit.

• LIFT and LOWER functions can also be performed by actuating a coded operating switch within the system instead of the remote control unit.

If the system is not fitted with either a remote control unit or an operating switch, jumpering pins 2 and 11 on the electronic control unit causes ECAS to adjust to the normal level as soon as the ignition is switched on.

The special "Crane operation" function can be set in the parameters for these electronic control units.

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.
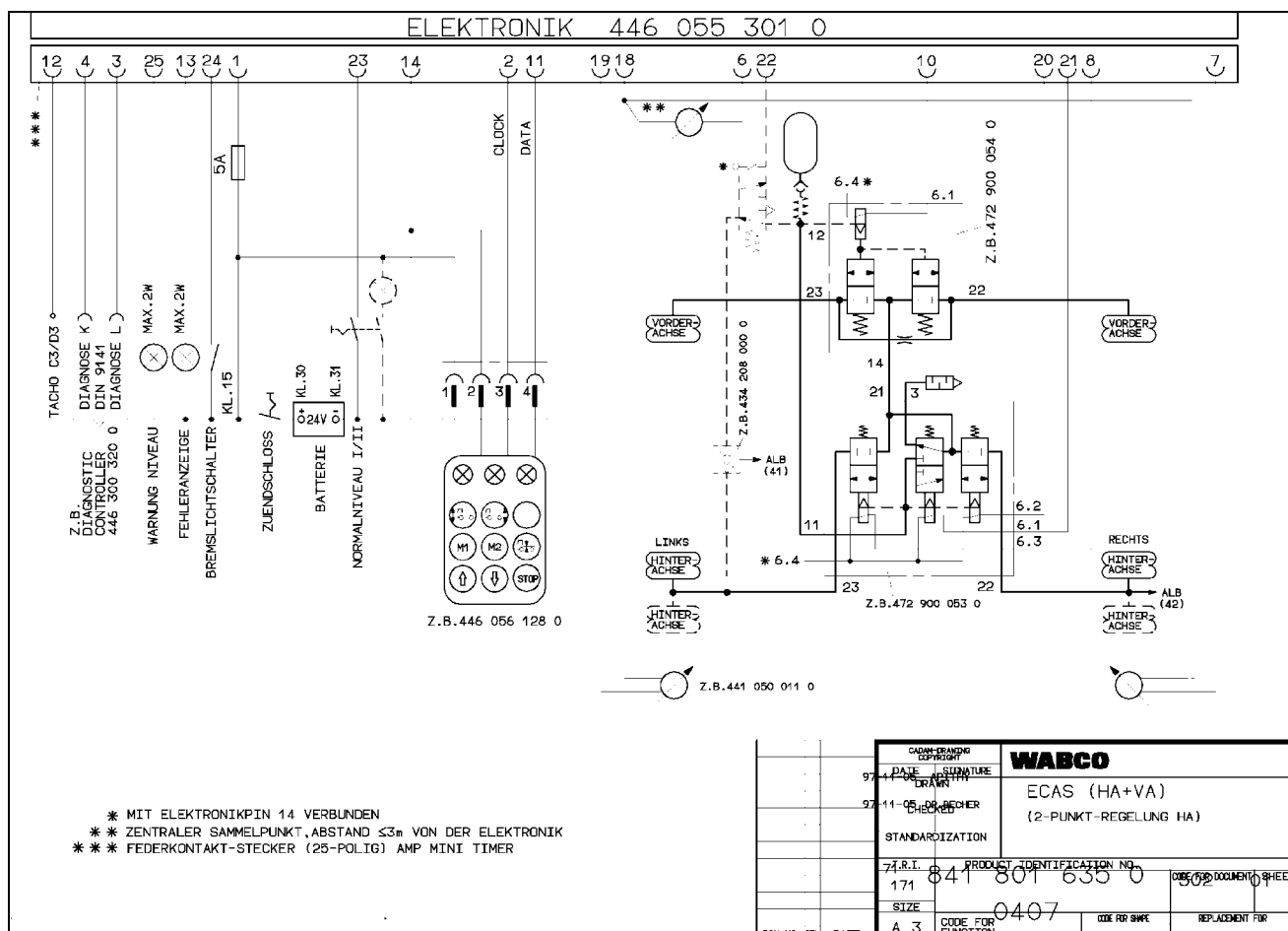

Fig. 53: ECAS 4x2 Ratio; circuit diagram 841 801 635 0

A measured value output can be organised during normal ECAS operation by setting the parameters accordingly. The individual operating values are:

1 Actual level on the front axle
2 Actual level on the left of the rear axle
3 Actual level on the right of the rear axle
4 Desired level on the front axle
5 Desired level on the left of the rear axle
6 Controller status at front
7 Controller status at rear left
8 Controller status at rear right

This measured value output mode is only permitted for service operation; the system must be returned to normal mode at the end of measured value output.

7.6 ECAS 4x2 KWP 2000
Sample circuit diagrams: 841 801 647 0 / 841 801 663 0

This system is used for automatic levelling control in 4x2 commercial vehicles with air-suspended axles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded. The pin assignment is based on the ECAS 4x2A version. This Ratio variant is a further development of that version.

The electronic control unit contains a diagnostic interface according to ISO/WD 14 230 ("Keyword Protocol 2000") which distinguishes it from previous 4x2 electronic control units that have a diagnostic interface according to DIN ISO 9141. As a result, it is possible to dispense with the L-line, and the data transfer rate is also a little higher.

It is no longer necessary to set parameters for the characteristics of the desired level controller. The system is self-learning, i. e. there is no longer any need to enter the proportional and differential coefficients. The teach-in process only takes place under certain boundary conditions and involves optimising specified theoretical control processes. It is based on the lifting and lowering speeds of the vehicle body, which are determined individually on each distance sensor. The characteristic curves obtained during the teach-in process are stored in the ECU when the ignition is switched off.
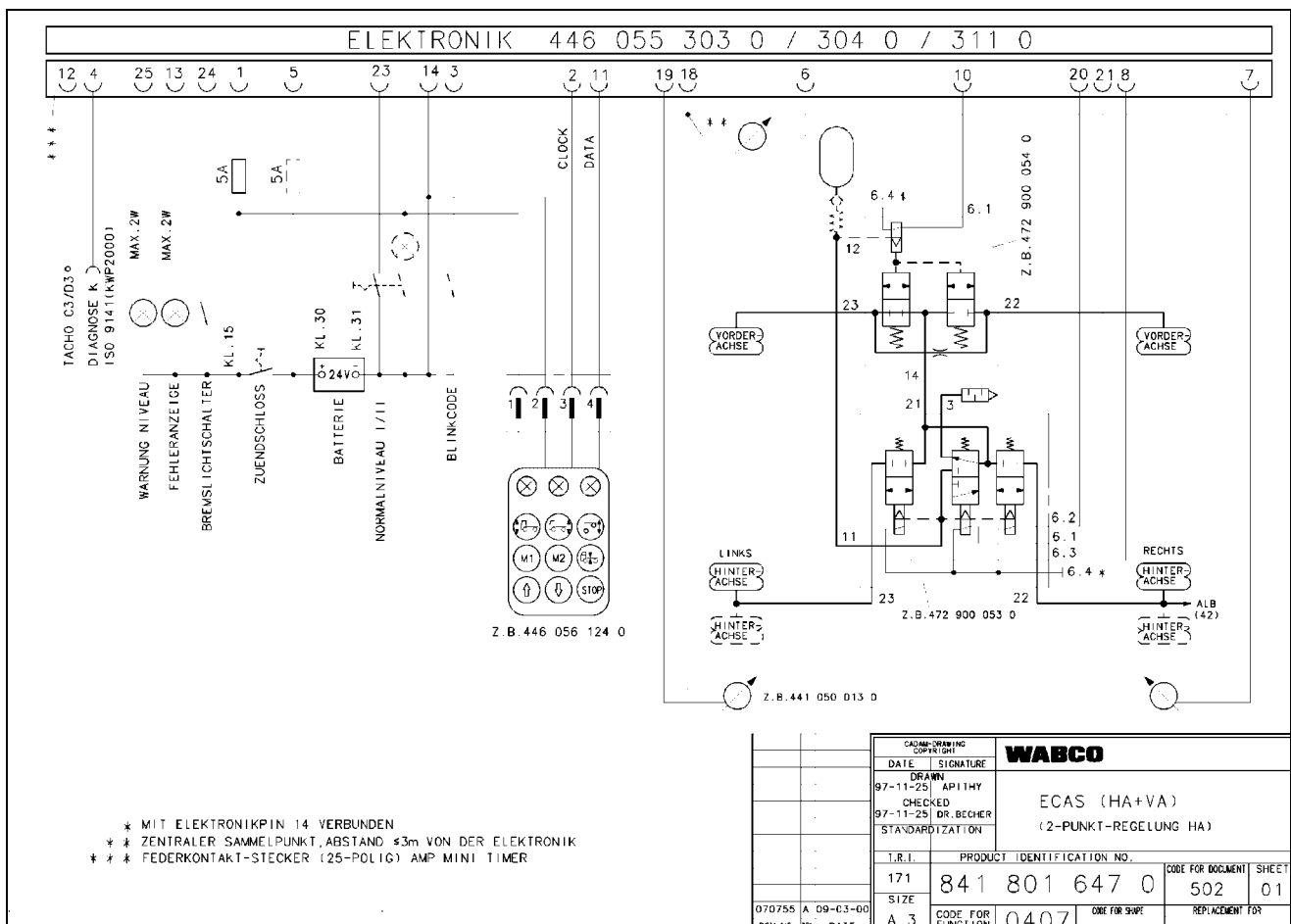

Fig. 54: ECAS 4x2 KWP 2000; circuit diagram 841 801 647 0

It is possible to connect a remote control unit or an operating switch.

There are 2 lamps in the instrument panel for monitoring the system: (↑ 7.5 ECAS 4x2 Ratio)

The system operates with various control strategies relative to a limit speed set in the parameters:

• At speeds faster than this limit speed, ECAS categorises level changes as dynamic changes (driving operation) and only corrects the nominal value if the distance sensor values remain outside the permitted nominal value value range set in the parameters persistently for a 60 second period.

• Below the limit speed, ECAS categorises level changes as static (stationary) and corrects the nominal value if the distance sensor values determined within a very short period (e. g. 1 s), which can be defined in the parameter settings, remain persistently outside the permitted range.

• For up to 3 seconds after the transition from v > 0 km/h to v = 0 km/h (end of driving), ECAS still categorises level changes as dynamic ones (dynamic run-on).

• 7 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.

• Specific parameter settings permit a control mode whereby a greater vehicle body tilt is permitted above the axle in favour of a uniform bellows pressure distribution in vehicles with 2 distance sensors on the driving axle. After two unsuccessful attempts at adjusting to the desired level within the permissible tolerance range, ECAS detects an uneven loading condition during the process of lifting the vehicle body. It adjusts the left side of the vehicle to the correct desired level and briefly (300 ms) pressurises the supporting bellows of the vehicle side that is in the higher position to balance the bellows pressures of the driving axle.

• After brake actuation, ECAS detects this actuation by the presence of U_{BATT} on pin 24 of the electronic control unit. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

• Adjustment in response to failure of the LSV signal can be performed via a solenoid valve if parameters have been set accordingly.
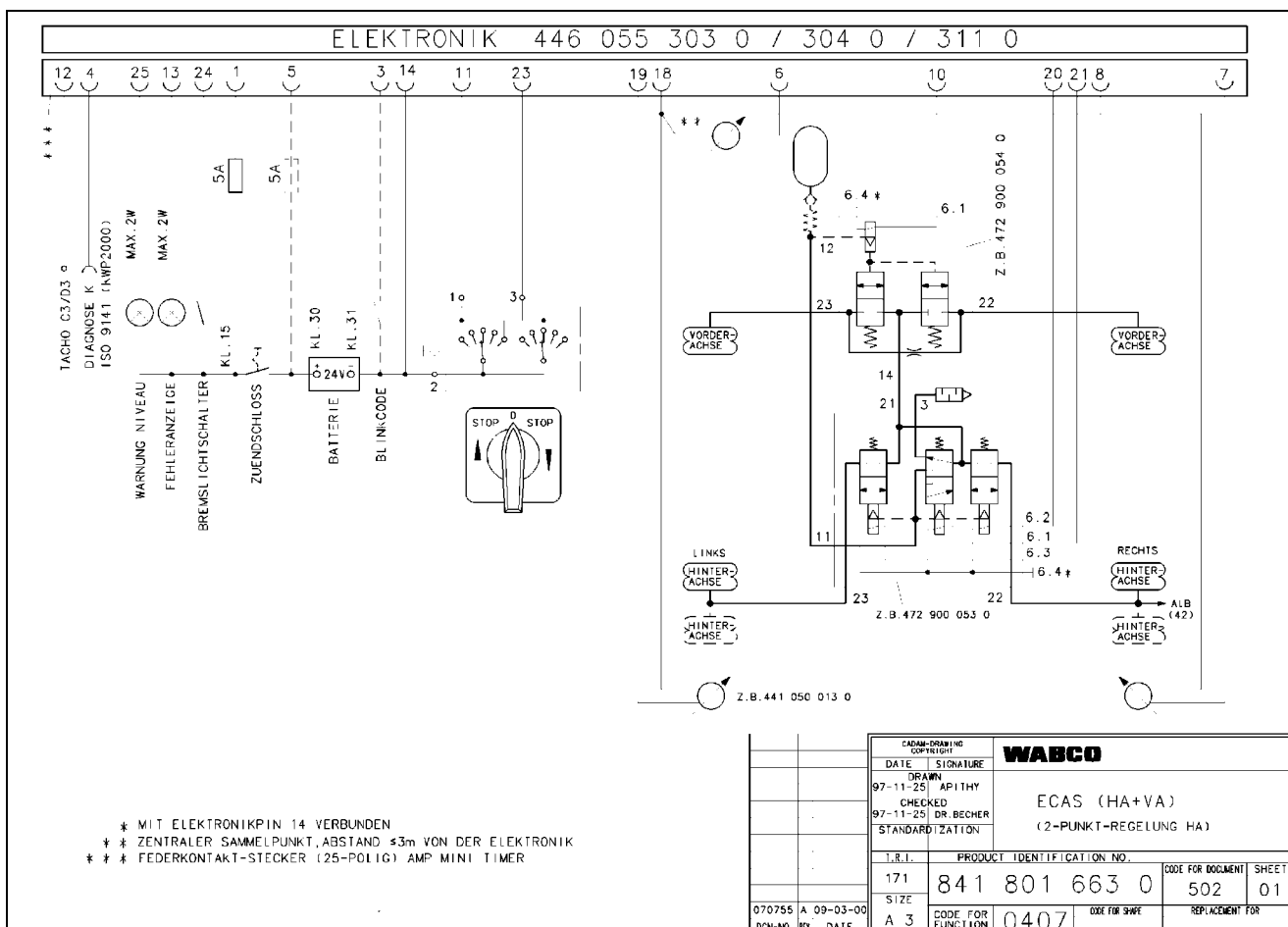

Fig. 55: ECAS 4x2 KWP 2000; circuit diagram 841 801 663 0

Level changes between NLI and NLII, as well as level adjustments to any level between upper and lower level are generated in the same manner as described to 4x3 Ratio (↑ 7.5).

If the system is not fitted with either a remote control unit or an operating switch, jumpering pins 2 and 11 on the electronic control unit causes ECAS to adjust to the normal level as soon as the ignition is switched on.

The special "Crane operation" function can be set in the parameters for these electronic control units.

Three types of distance sensor can be used as sensing elements for the distance between the axle and the vehicle body:

- Distance sensors without temperature compensation.
- Distance sensors with temperature compensation.
- Angle-of-rotation sensors.

However, only one type may be installed in a particular vehicle e, i .e. mixed installation is not permissible. Make sure the installed type of distance sensor matches the parameter settings.

The bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.

A measured value output can be organised during normal ECAS operation by setting the parameters accordingly. The individual operating values are:

1. Actual level on the front axle.
2. Actual level on the left of the rear axle.
3. Actual level on the right of the rear axle.
4. Desired level on the front axle.
5. Desired level on the left of the rear axle.
6. Right/left deviation.
7. Valve status.
8. Driving speed.

This measured value output mode is only permitted for service operation; the system must be returned to normal mode at the end of measured value output.

7.7 ECAS 6x2 Ratio
Sample circuit diagram: 841 801 681 0

This system is primarily used for automatic level control in 6x2 commercial vehicles (4x2 vehicles are possible) with air-suspended axles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded. A supporting bellows limit pressure of the driving axle is signalled to the electronic control unit by the position of pressure switches. This is the limit pressure which, if exceeded, causes a lifting axle to be lowered or load transferred to a trailing axle.

The control characteristics of the desired level controller no longer have to be set in the parameters. The system is self-learning, i.e. there is no longer any need to enter the proportional and differential coefficients. The teach-in process only takes place under certain boundary conditions and involves optimising specified theoretical control processes. It is based on the lifting and lowering speeds of the superstructure which are determined individually on each distance sensor. The characteristic curves obtained during the teach-in process are stored in the ECU when the ignition is switched off. It is possible to connect a remote control unit.

There are up to 5 lamps in the instrument panel for monitoring the system. They must come on and remain lit for 2 seconds as a check when the ignition is switched ON. Then they work in normal mode, which means:

- The fault lamp indicates faults in the system. In this case, minor faults, plausibility errors, or undervoltage faults 7.5 … 18 V are indicated by a steady light while severe faults and "System in diagnostic mode" are indicated by a flashing light (flashing frequency: approx.1 Hz).

- The level warning lamp indicates situations in which ECAS is not in normal mode (e. g. vehicle body outside normal level, minor plausibility errors, or conducting manual calibration), but is operating without any faults.

- The traction help indication shows whether the traction help is activated.

- The lifting axle position lamp (also: unladen/lifting axle lamp) indicates whether the lifting axle is raised or the load is transferred from the trailing axle (TA relief).

- The normal level lamp indicates whether normal level (NL) II is preselected for the vehicle.

Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.

The system operates with various control strategies relative to a limit speed set in the parameters:

- At speeds faster than this speed, ECAS categorises level changes as dynamic changes (driving) and only corrects the nominal value if the distance sensor values persistently remain outside the permitted nominal value range set in the parameters for a 60 second period.

- Below the limit speed, ECAS categorises level changes as static (stationary) and corrects the nominal value if the distance sensor values

determined within a very short period (e. g. 1 s), which can be defined in the parameter settings, remain persistently outside the permitted range.

- For up to 3 seconds after the transition from v > 0 km/h to v = 0 km/h (end of driving), ECAS still categorises level changes as dynamic ones (dynamic run-on).

- 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.

- After brake actuation, ECAS detects this actuation by the presence of U_{BATT} on pin 7 of the electronic control unit. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

Adjustment in response to failure of the LSV signal can be performed via a solenoid valve if parameters have been set accordingly.

Level changes between NLI and NLII, as well as level determination of the lifting axle switching point, are generated in the same manner as described for **ECAS 6x2A (↑ 7.4).**

The lifting bellows themselves are predominantly controlled positively, i.e. the ECAS solenoid valve simultaneously performs the functions "Lifting axle lifting" (pressurise lifting bellows, ECU pin 30 = U_{BATT}) or "Lifting axle lowering" (exhaust lifting bellows, ECU pin 12 = U_{BATT}) via internal pneumatic connections.

An important point in this regard is the configuration of the traction help. The required type of traction help can be defined, on the one hand, via the hardware by means of the switching combination on pins 16 and 19 of the ECU (i. e. pin switched to earth or not switched) and, on the other hand, via the software by setting the parameters. Pins 16 and 19 must be connected to earth if the traction help type is to be set in the parameters. The traction help itself is then activated by switching ECU pin 17 to earth.

The traction help switching point on the driving axle can be determined using up to two pressure switches or
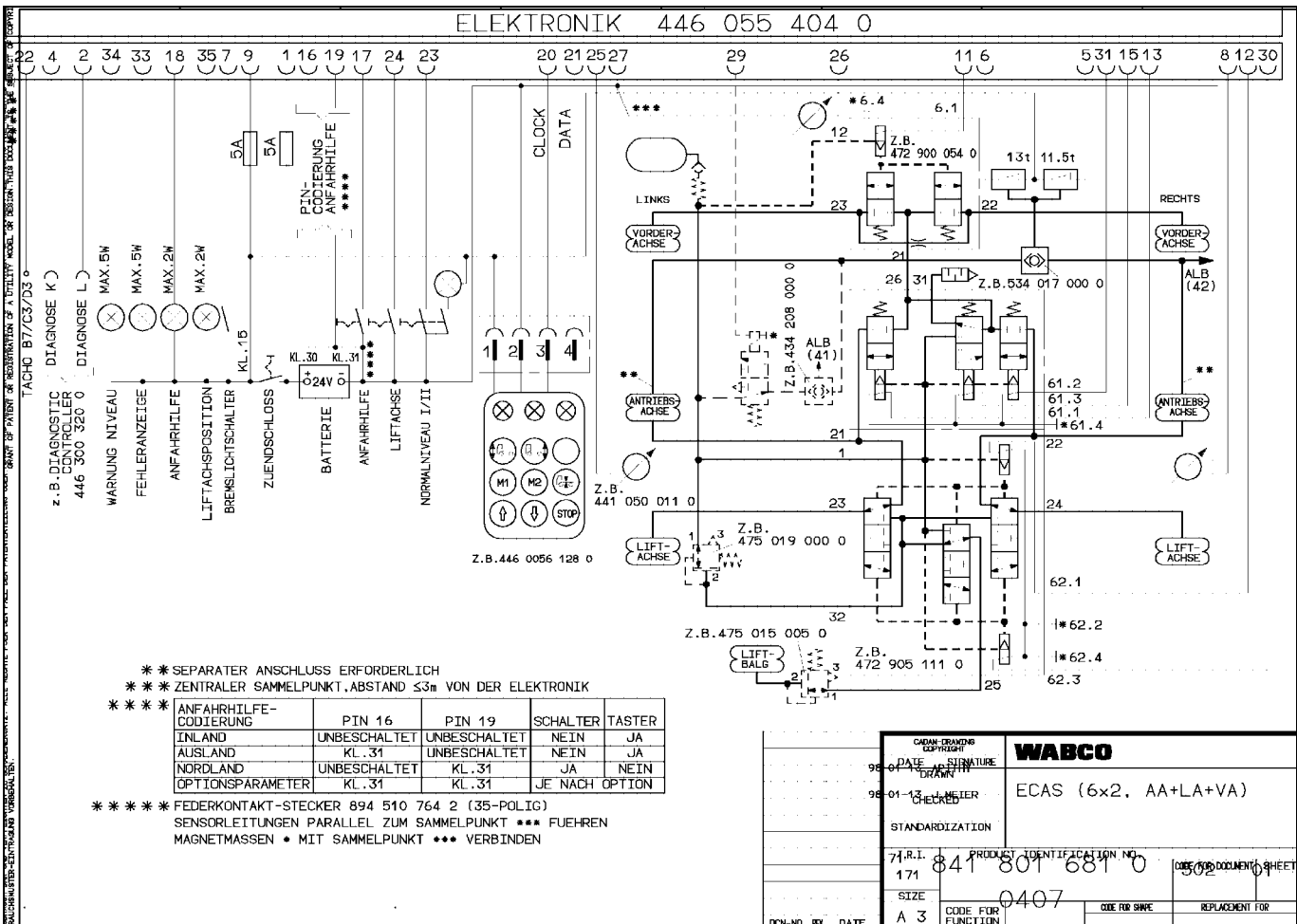

Fig. 56: ECAS 6x2 Ratio; circuit diagram 841 801 681 0

pressure sensors. The signal is obtained in the same way as the signal for the lifting axle switching point.

Pressure switch:
The limit for the traction help is normally approx. 13 t. It is determined by the pressure sensor connected to pin 6. The axle load on the driving axle is exceeded by gradually relieving the load on the lifting axle. This process continues until the traction help pressure switch is triggered, after which the bellows pressure in the supporting bellows is maintained.

Pressure sensor:
The limit for the traction help is set in the parameters. It is determined by the pressure sensor connected to pin 5/6. If the pressure sensor is defective, the lifting/trailing axle is lowered or loaded. A "traction help for overload" can be organised using pressure sensors (e. g. 446 055 405 for DAF). This means that when the driving axle is still subjected to a load below the permissible axle load but has exceeded the switching point for the lifting axle control (e. g. switching point for lifting axle control = 75 % of the permissible axle load), the limit for traction help is increased by this pressure differential.

Desired level increase with activated traction help.
The desired level is always increased by the value set in the parameters when traction help is activated, irrespective of the current desired level.

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.

A measured value output can be organised during normal ECAS operation by setting the parameters accordingly. It is then possible to view individual operating values.

For ECU variants 404 and 409, these are:
1. Actual level on the front axle.
2. Actual level on the left of the rear axle.
3. Actual level on the right of the rear axle.
4. Desired level on the front axle.
5. Desired level on the left of the rear axle.
6. Controller status at front.
7. Controller status at rear left.
8. Controller status at rear right.

For ECU variants 405, these are:
1. Actual level on the left of the rear axle.
2. Actual level on the right of the rear axle.
3. Actual level on the front axle.
4. Desired level on the left of the rear axle.

5. Desired level on the front axle.
6. averaged pressure on the driving axle.
7. Offset tyre impression compensation at rear.
8. Speed.

This measured value output mode is only permitted for service mode. After measured value output has been completed, operation must be set to normal mode .

7.8 ECAS 6x2DV
Sample circuit diagrams: 841 800 423 0 / 841 801 487 0 / 841 801 295 0

This system is primarily used for automatic level control in 6x2 commercial vehicles (4x2 vehicles are possible) with air-suspended axles. Up to 3 distance sensors continuously sense the actual level, i. e. the distance between the vehicle body and the axle. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded. A supporting bellows limit pressure of the driving axle is specified for the electronic control unit. This is the limit pressure which, if exceeded, causes a lifting axle to be lowered or load transferred to a trailing axle. The actual pressure of the supporting bellows is continuously monitored via pressure sensors. In order to implement pressure proportional control or traction control, all supporting bellows pressures – and in some cases even the lifting bellows pressure – are sensed by pressure sensors fitted in the vehicle.

The control characteristics of the desired level controller must be set in the parameters. To do this, a proportional and a differential coefficient for the front and rear axles are programmed into the electronic control unit via the parameter settings. The control behaviour of the system during desired level control is determined on the basis of these coefficients.

It is possible to connect a remote control unit.

There are up to 4 lamps in the instrument panel for monitoring the system.

• The fault lamp indicates faults in the system. In this case, minor faults, plausibility errors, or undervoltage faults 7.5 … 18 V are indicated by a steady light while severe faults and "System in diagnostic mode" are indicated by a flashing light (flashing frequency: approx.1 Hz).

• The level warning lamp displays situations in which ECAS is not in normal operational mode but operates fault-free. For example,vehicle body outside normal level, minor errors or plausibility errors, or performing manual calibration.

- The traction help indication shows whether the traction help is activated.
- The lifting axle position lamp (unladen/lifting axle lamp) indicates whether the lifting axle is lifted or the load is transferred from the trailing axle (TA relief).

Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.

The system operates with various control strategies for levelling control depending on a speed set in the parameters:

- At speeds above this limit speed, ECAS categorises level changes as dynamic changes (driving operation). It only corrects the nominal value if the distance sensor values remain outside the permitted nominal value range set in the parameters persistently for a 60 second period.
- At speeds below this limit speed, ECAS categorises level changes as static changes (stationary). It only corrects the nominal value if the distance sensor values determined within a very short period (e. g. 1 s), defined in the parameter settings, remain persistently outside the permitted range.

- Up to 3 seconds after the end of the drive, ECAS still categorises level changes as dynamic (dynamic run-on).
- 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.
- The control function is suppressed after the brake is applied – ECAS detects this by the presence of U_{BATT} at pin 16 of the ECU. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.

Adjustment in response to failure of the LSV signal can be performed via a solenoid valve if parameters have been set accordingly.

The special function "Release parking brake on the front axle" can also be set in the parameters. The background is that ECAS activity can lead to distortions in vehicles in which the parking brake acts on the front axle. For this reason, a switching signal U_{BATT} is output on pin 29 of the electronic control unit when manual LIFT and LOWER
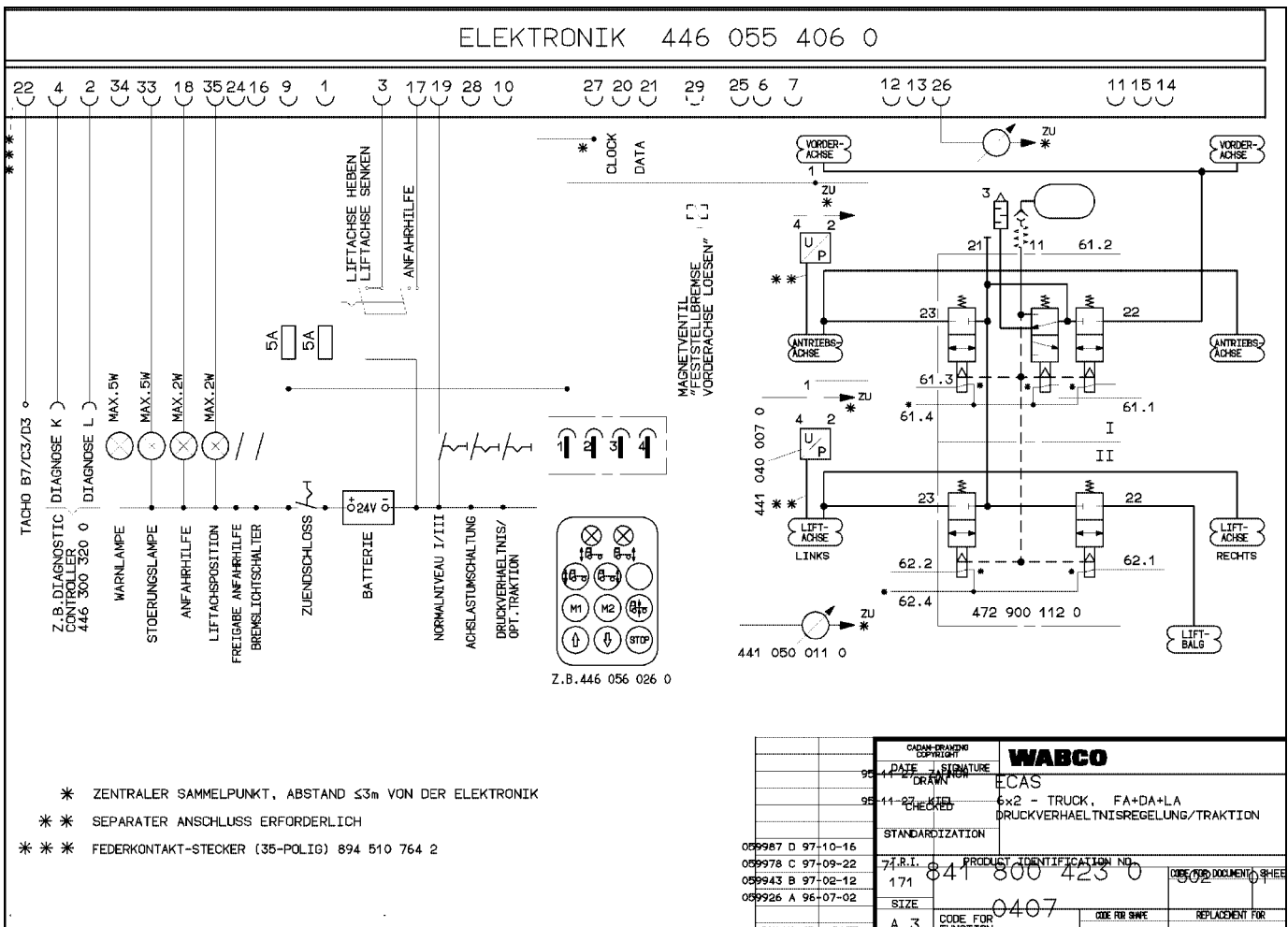

Fig. 57: ECAS 6x2 DV; circuit diagram 841 800 423 0

procedures are triggered while the vehicle is stationary. This signal can be used to reverse a solenoid valve in the line to the front axle parking brake, causing the brake to be released.

Parameters can be set for level changes between up to 3 normal levels (NL). The NL I is made known to the ECU during initial start-up of the system, NL II and NL III can be parameterised and are entered as the differential value to NL I. But any level between the upper and lower level is also possible. They can be created in the following manner:

- Actuating the normal level I/III switch will alternate between the two levels. In order to set NL II, ECU pin 19 is connected to ground and this connection is interrupted for a reset NL I. Pressing the NL button on the control unit moves the vehicle body to the normal level in accordance with the position of the NL I/III switch. Instead of using the remote control unit, it is also possible to set the selected normal level using a "Normal" operating switch on pin 21 by switching to earth. Whether a remote control unit or an operating switch will be used must be defined in the parameter settings. – Traction help must not be active while the normal level is being set.

- if a parameterised limit speed is exceeded, the vehicle body is adjusted to the preselected normal level I or III (unless it is already at that level). By exceeding another limit speed and subsequently dropping below a second, slightly lower limit speed, it is possible, provided the corresponding parameters have been set, to change between a set NL I and NL II. Parameters are set with regard to whether the speed-dependent change between NL I and NL II, or the switch-dependent change between NL I and NL III, has priority.

- it is possible to move to any level by pressing the LIFT or LOWER button on the remote control unit.

- if a "Normal" operating switch is used, the LIFT function is triggered when pin 21 is open and pin 10 is switched to ground; the LOWER function is triggered when pin 21 and pin 10 are switched to ground.

If the system is not fitted with a remote control unit, jumpering pins 20 and 21 on the electronic control unit causes ECAS to adjust to normal level as soon as the ignition is switched on.
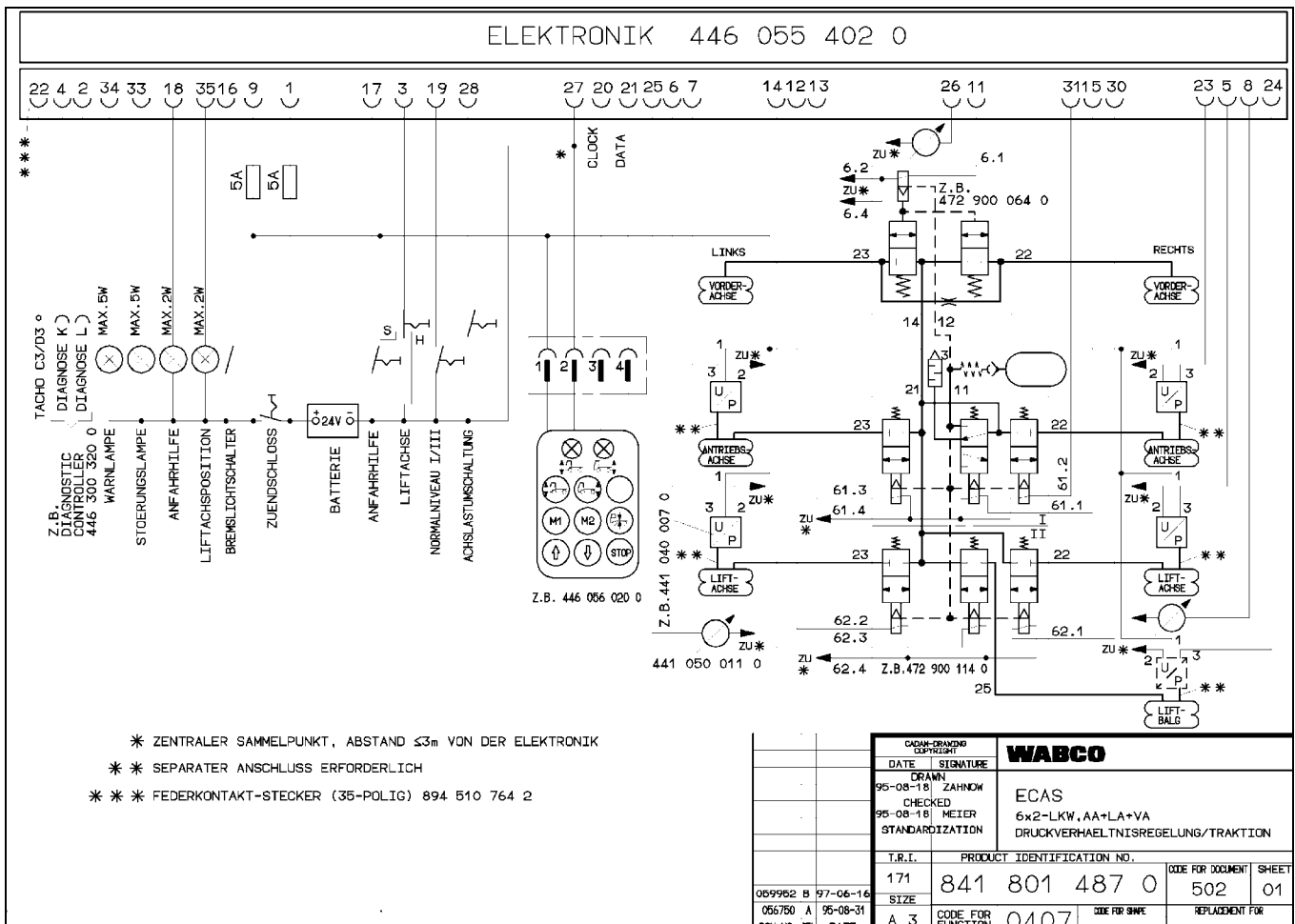

Fig. 58: ECAS 6x2 DV; circuit diagram 841 801 487 0

Apart from the basic ECAS function (adjusting the distance vehicle body - axle), ECAS also performs control of the lifting/trailing axle LOAD and RELIEF function. It is possible to organise manual lifting/trailing axle control or fully automatic lifting/trailing axle control.

By connecting an axle load switch to pin 28 of the ECU, it is possible to select which mode applies: "Normal axle load" mode (switch open) or "Increase axle load" (switch closed). Thereby it is possible, for example, to open the switch when a carriageway axle load limit is encountered during "Optimum traction control" mode, in which the driving axle operates under maximum load, causing the load distribution between the driven and lifting axles to change in such a way as to comply with the limited axle load requirements.

Up to two pressure sensors on the driving axle bellows may be used to determine the switching point of the lifting axle. It depends on whether the supporting bellows are controlled jointly by one ECAS solenoid valve outputs, or are controlled separately by two ECAS solenoid valve outputs. Additionally, the supporting bellows of the lifting axle are sensed. There are also systems in which the lifting bellows has been equipped with a pressure sensor.

The fact that not only the driving axle supporting bellows, but also the supporting bellows of the lifting axle, are equipped with sensors means that it is possible to select between "pressure ratio control" [in German abbreviated as DV control] principle and the "optimum traction control" principle. It depends on the parameter settings which principle is applied. With regard to the control principle, it also depends on the position of the "pressure proportional control/traction control" selector switch by means of which pin 10 of the electronic control unit is switched to ground. When the selector switch is open, the control principle set in the parameters is used. When the selector switch is closed, the opposite control principle is used.

The switching point of the lifting/trailing axle is set in the parameters. The switching point is measured in systems with a pressure sensor on the driving axle connected to pin 7 of the ECU. In systems with two pressure sensors connected to pin 7 and pin 23, it is calculated by averaging the values. If the pressure sensor fails
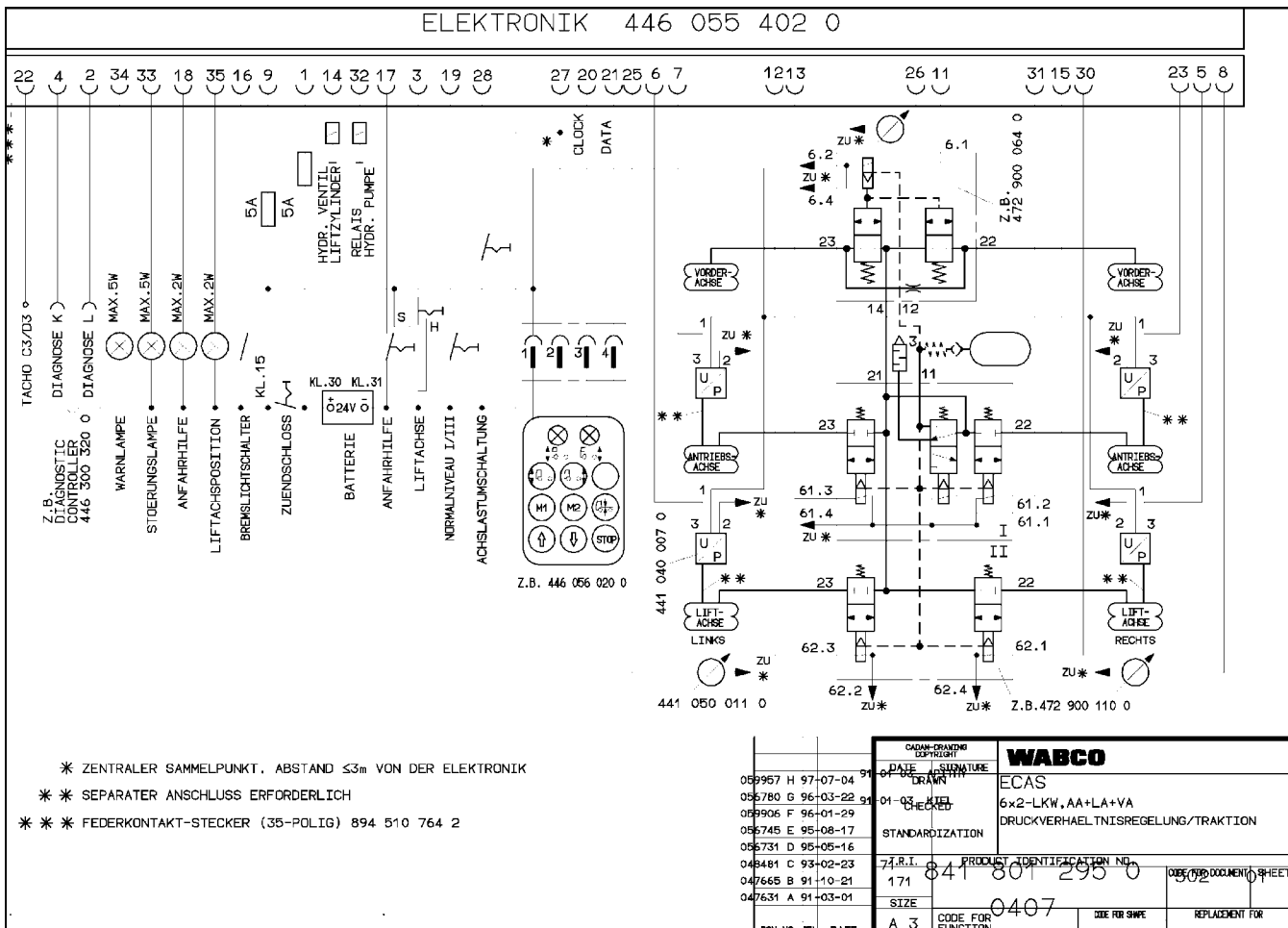

Fig. 59: ECAS 6x2 DV with hydraulic lifting axle device; circuit diagram 841 801 295 0

completely, the lifting axle is lowered or the load is transferred onto the trailing axle.

However, separate switches for controlling the lifting axle can also be provided on the instrument panel. Depending on the parameter settings, it is possible to use the following different switch variants for controlling the lifting axle:

1. 2-stage "Lifting axle" switch:
    Ground switched to pin 3 of the ECU.
    open switch = "Lifting axle lowering"
    closed switch = "Lifting axle lifting"
    ECAS only responds to switching actions performed when the ignition is ON.

2. (3-position) "Lifting axle" button:
    switched to pin 3 of the ECU.
    Button open = "No activation"
    Button switched to ground = "Lifting axle lifting"
    Button switched to U_{BATT} = "Lifting axle lowering"
    The closing time of the button must be at least 0.1 seconds.

The lifting bellows themselves are separately controlled, i.e. the lifting bellows solenoid of the ECAS solenoid valve is switched by pin 14 of the electronic control unit.

The LIFT and LOWER procedures of the lifting axle themselves differ according to whether the lifting bellows is sensed or not. Especially with regard to the LIFTING procedure, the electronic control unit has to perform pressure calculations in advance. The result of these calculations is a criterion for correct implementation. The boundary conditions required for this calculation need to be set in the parameters – just as the type of lifting axle lifting device needs to be parameterised.

Apart from controlling a lifting axle using lifting bellows, there is also the option of controlling hydraulic lifting axle lifting devices. In this case, the control signal is output at electronic control unit pins 14 and 32.

–   Lifting axle lifting = Pin 14 open/Pin 32 to U_{BATT}

–   Lifting axle lowering = Pin 32 open/Pin 14 to U_{BATT}

An important point in this regard is the configuration of the traction help. The required traction help type can now only be defined by the software applying parameter settings. Traction help is activated by switching ECU pin 17 to ground. A traction help enable function can also be installed in some systems as an additional function. This is a contact that switches electronic control unit pin 24 to U_{BATT}. Traction help can only be activated when the contact is closed.

The signal for the traction help is determined in the same manner as the signal for the lifting axle switching point. The limit for the traction help is set in the parameters. It is obtained by the pressure sensor connected to pin 7. Apart from the known traction help types:

•   Germany
•   EC
•   Northern…

… it is also possible to organise a manual traction help in vehicles with ECAS 6x2 DV. In this case, the driver can manually increase or decrease the pressure in the driving axle bellows (increase subject to the specified maximum pressure limit). Lifting is actuated by the traction help button and continues for as long as the button switches electronic control unit pin 17 to ground. Lowering is actuated by the lifting axle switch and continues for as long as the switch on electronic control unit pin 3 is open. If the corresponding parameters have been set, the last manually set traction help can be recalled when the traction help button is pressed for less than 2 seconds (memory function).

When the traction help is activated, irrespective of the current desired level, the desired level is always increased by the value set in the "Desired level increase when traction help activated" parameter.

It is possible to set the parameters for stand-by mode. This mode is activated if the ignition is switched OFF whilst the STOP button of the remote control unit is being pressed. It causes adjustment to the last level before ignition OFF (assuming adequate pressure and voltage is available).

A bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory.

A measured value output can be organised during normal ECAS operation by changing the parameters. In this way, it is possible to view individual operating values:

1. Actual level (left – only ECU variant 402) on the rear axle.

2. no function or actual level on the right of the rear axle (only ECU variant 402).

3. Actual level on the front axle.

4. Desired level (left – only ECU variant 402) on the rear axle.

5. Desired level on the front axle.

6. Driving axle pressure.

7. Lifting axle pressure.

8. Speed.

The measured values output on the individual channels depend on which electronic control unit is used.

This measured value output mode is only permitted for service operation; the system must be returned to normal mode at the end of measured value output.

7.9 ECAS 4x2/6x2 CAN (1st and 2nd generation) Sample circuit diagrams: 841 801 694 0, 841 801 545 0 (CAN I) / 841 801 909 0 (CAN II)

This system is primarily used for automatic levelling control in 6x2 and 4x2 commercial vehicles with air-suspended axles. Up to 3 distance sensors continuously sense the actual level. Deviations from the desired level are corrected by the control system when a specified tolerance range is exceeded. A supporting bellows limit pressure of the driving axle is specified for the ECU. This is the limit pressure which, if exceeded, causes a lifting axle to be lowered or load transferred to a trailing axle. The actual pressure of the supporting bellows is continuously monitored via pressure sensors. The ECAS electronic control unit is connected to the overall architecture of electronic systems in the vehicle by means of a CAN bus. On the one hand, this means it receives and uses CAN messages to ensure functional safety, and, on the other hand, that it sends out CAN messages which could be relevant to other electronic systems or which are used for display purposes. The basic control loop comprising the distance sensor/electronic control unit/solenoid valve is retained. The previously connected switches and lamps, however, have been simplified considerably – the required information is now shown on a display.

Setting parameters for the control characteristics of the desired level controller is no longer required. The system is self-learning, i. e. there is no longer any need to enter the proportional and differential coefficients. The teach-in process only takes place under certain boundary conditions and involves optimising specified theoretical control processes. It is based on the lifting and lowering speeds of the vehicle body, which are determined individually on each distance sensor. The characteristic curves obtained during the teach-in process are stored in the ECU when the ignition is switched off.
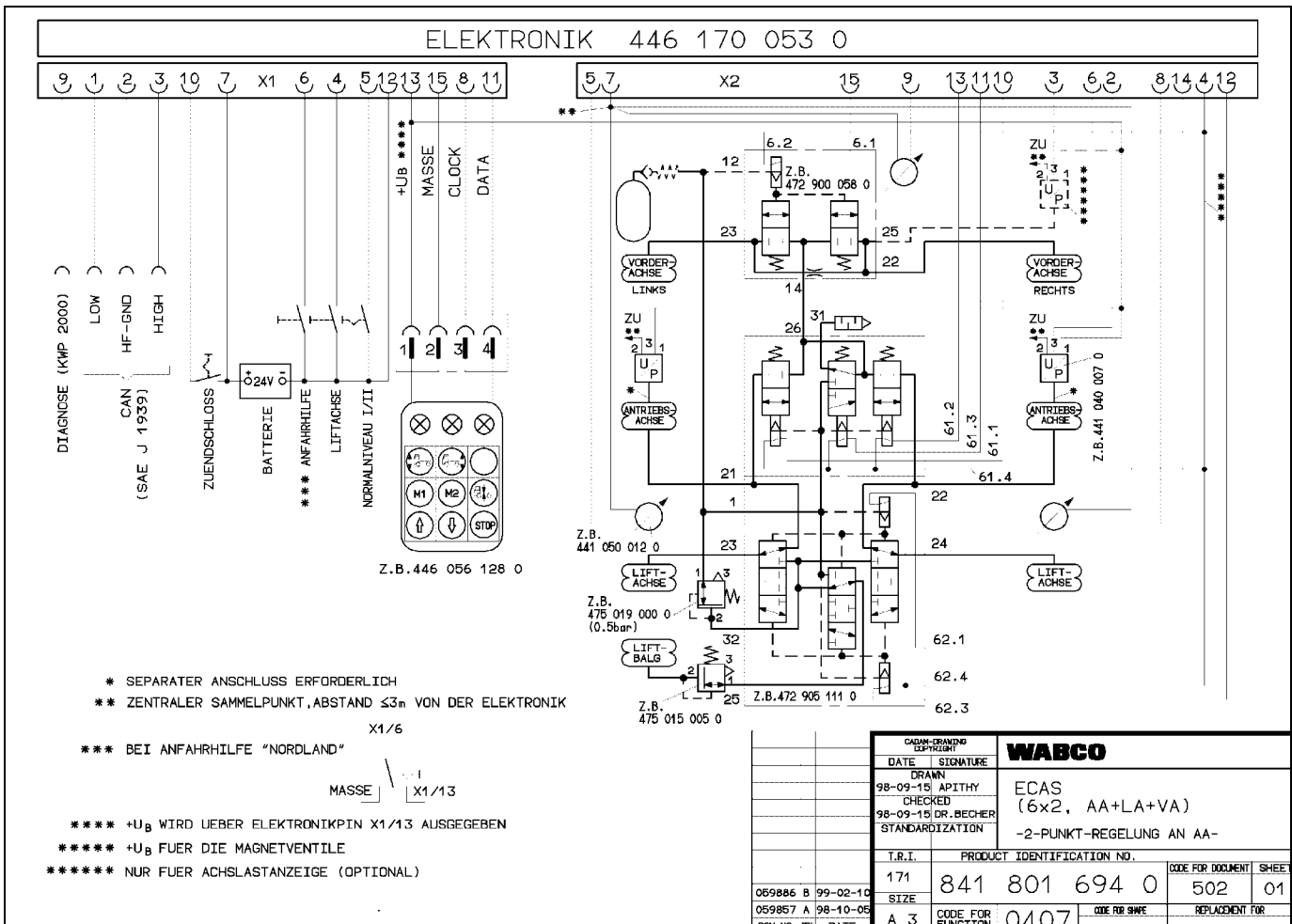

Fig. 60: ECAS 6x2 CAN (Diagnosis KWP2000); circuit diagram 841 801 694 0

It is possible to connect a remote control unit. The system is not monitored by lamps; instead, the necessary warnings are indicated via CAN messages.

In the event of faults being present in the system, fault messages are output in a CAN message. Fault messages contain information on:

…the faulty component

… the fault type, location and quantity

…fault severity (normal or minor)

…fault lamp to trigger ("RED" or "YELLOW")

The normal level lamp indicates whether the vehicle is at normal level (NL) I or II.

Vehicle parameters, actual values, faults, and other information are stored in the electronic control unit.

The system operates with various control strategies for levelling control depending on a speed set in the parameters:

• At speeds faster than this limit speed, ECAS categorises level changes as dynamic changes (driving operation) and only corrects the nominal value if the distance sensor values remain outside the permitted nominal value range set in the parameters persistently for a parameterised period (e. g. 60 seconds).

• Below the limit speed, ECAS categorises level changes as static (stationary) and corrects the nominal value if the distance sensor values determined within a very short period (e. g. 1 s), which can be defined in the parameter settings, remain persistently outside the permitted range.

• 7 7 seconds after the start of the drive, ECAS checks whether a nominal value differential set in the parameters regarding the desired level at the start of a drive was exceeded. If this was the case, it corrects the desired level accordingly.

• The control function is suppressed if the brake is applied. ECAS detects such an actuation by receiving the corresponding CAN message. This makes allowance for the dynamic axle load changes during braking and avoids unnecessary adjustments.
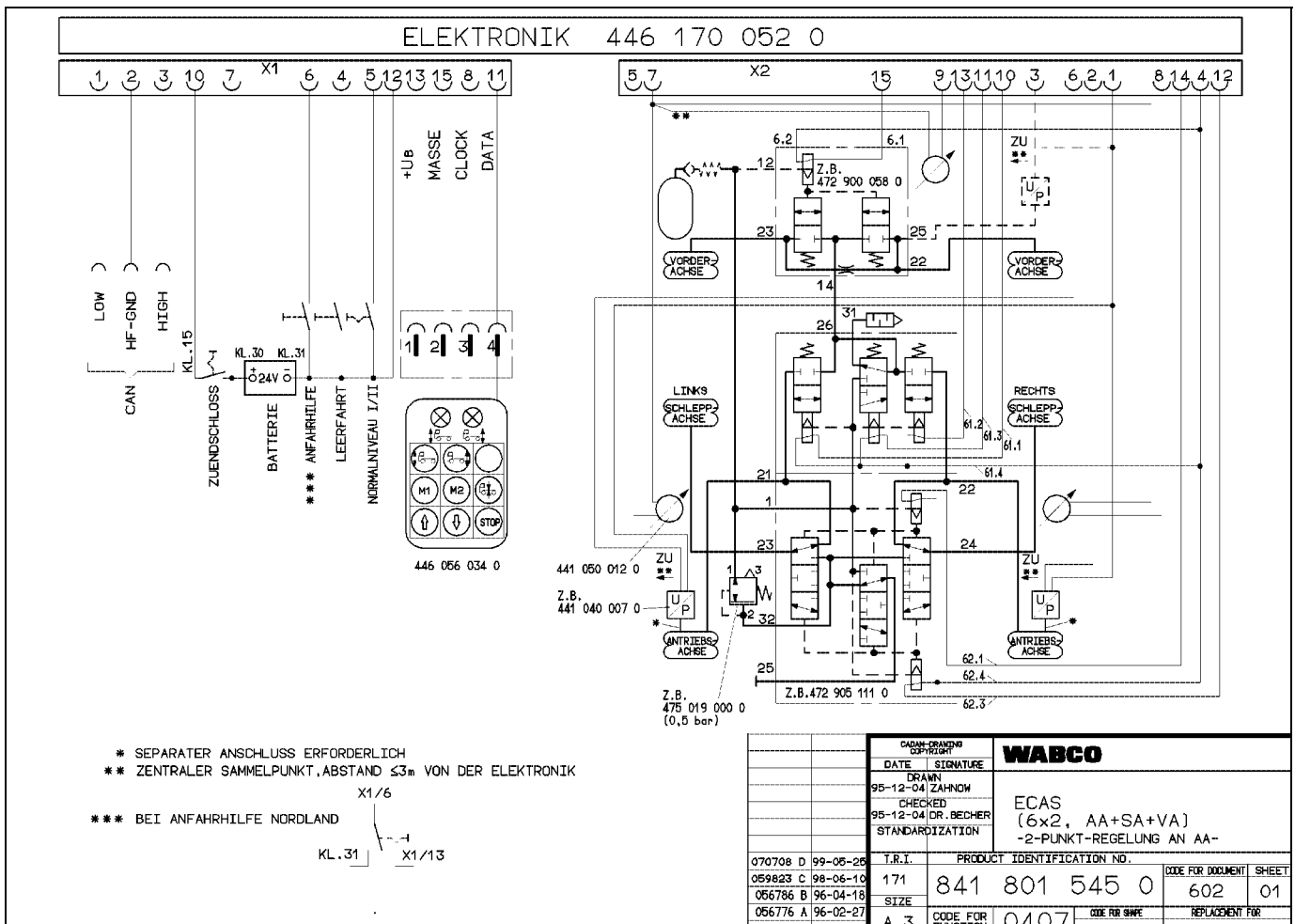

Fig. 61: ECAS 6x2 CAN (diagnosis via CAN); circuit diagram 841 801 545 0

Level changes between the two normal levels (NL), however, are possible, as well as level adjustments to any level between upper and lower level. The NL I is made known to the ECU during initial start-up of the system; NL II can be parameterised and is entered either as a differential value to the lower level or as a differential value to NL I (input value = NL II - NL I or lower level + 125). Level changes can be effected in the following manner:

- actuating the normal level(NL) I/II switch will cause a switchover between the two levels. In order to set NL II, ECU pin X1/5 is switched to ground and this connection is interrupted for a return to NL I.

- The vehicle body moves to the normal level (if it is not already there) if a speed limit set in the parameters is exceeded; given appropriate parameter settings, it is possible to change between a set NL I and NL II by exceeding another speed limit and then decelerating to below a second, somewhat slower, speed limit.

- it is possible to move to any level by pressing the LIFT or LOWER button on the remote control unit.

- by requesting a CAN message for a level change. Requests for a level change via CAN have priority over the remote control unit.

If there is no remote control unit installed in the system, ECAS adjusts to normal level immediately after the ignition is switched on.

It is possible to adjust to an unloading level (UL) if the vehicle is at a standstill. This unloading level is programmed into the electronic unit when the parameters are set; it is entered as a differential from NL I.

(Input value = UL - NL I + 125)

ECAS transmits information on the selected NL in a CAN message.

For these electronic control units it is possible to parameterise the special "Crane operation" function.

Three types of sensor can be used as sensing elements for the distance between the axle and the vehicle body:

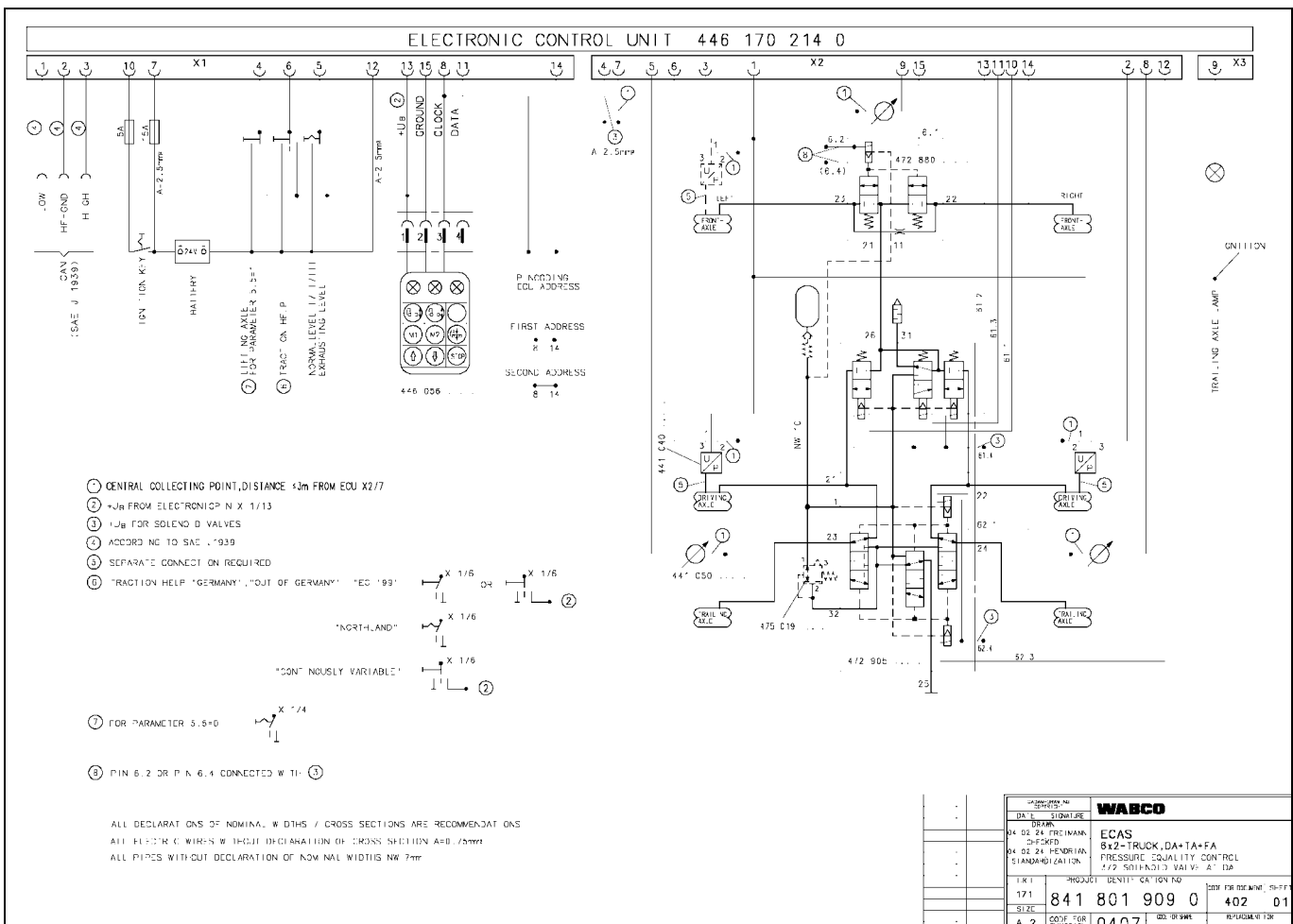- Distance sensors without temperature compensation.

Fig. 62: ECAS 6x2 CAN II (diagnosis via CAN); circuit diagram 841 801 909 0

– Distance sensors with temperature compensation.

– Angle-of-rotation sensors.

However, only one type may be installed in a particular vehicle, i .e. mixed installation is not permissible. Make sure the installed type of distance sensor matches the parameter settings.

Apart from the basic ECAS function (adjusting the distance vehicle body - axle), ECAS also performs control of the lifting/trailing axle LOAD and RELIEF function. It is possible to organise manual lifting/trailing axle control or fully automatic lifting/trailing axle control.

The switching point of the lifting/trailing axle is set in the parameters. The lifting axle switching point can either be determined by up to 2 pressure sensors on the driving axle supporting bellows or the ECAS electronic control unit uses the information about the driving axle load provided in a CAN message from the EBS. The principle to be used must be set in the parameters.

The lifting axle itself is controlled according to the principle of pressure equalising control.

If pressure sensors are used, the switching point is measured on the driving axle by one pressure sensor respectively connected to pin X2/6 and pin X2/2. If the pressure sensor is defective, the lifting axle is lowered or the load is transferred onto the trailing axle.

Depending on the parameter settings, it is possible to use the following actuation variants for controlling the lifting axle:

• via CAN message
• via button

The lifting axle position can be changed if the corresponding CAN message is sent to the electronic control unit requesting control of the lifting axle.

However, a separate button can also be provided on the instrument panel for controlling the lifting axle. This is a lifting axle button by means of which pin X1/4 on the ECU is switched to ground. Pressing the button sends a switching pulse to the ECU, causing a change in the lifting axle position, provided permissible boundary conditions exist. Lifting axle control only responds to switching actions performed when the ignition is ON.

The lifting bellows themselves are under controlled positively, i. e. the ECAS solenoid valve simultaneously performs the functions "Lifting axle lifting"/"Pressurise lifting bellows" functions (ECU pin X2/12 = GND) or "Lifting axle lowering"/"Exhaust lifting bellows" (ECU pin X2/14 = GND) via internal pneumatic connections.

An important point in this regard is the configuration of the traction help. The required traction help type is defined by setting parameters in the software. Traction help is activated by switching ECU pin X1/6 to ground.

The signal is obtained in the same way as the signal for the lifting axle switching point. The limit for the traction help is set in the parameters. It is determined by the pressure sensors connected to pins X2/2 and X2/6.

In CAN II electronic systems, parameters are set for the times (period and forced pause) and the remote control unit (switches or buttons). The ECU uses this information to generate the corresponding traction help type. Up to 5 different types of traction help are possible:

• Germany
• EU99
• Outside Germany
• Northern
• manual traction help

When the parameters have been set for the NORTHERN traction help, the driver can manually increase or decrease the pressure in the driving axle bellows, the increase being subject to the specified maximum pressure limit. Increases are performed using a 3-position latched switch.

Starting the traction help can be triggered by a variety of means:

• By pressing a button in the case of type "Germany" (German road traffic regulations), "Outside Germany" and "EU 99" (optional parameter 3.1 = 1 and 7.1 = 0)

• By actuating a 2-position switch in the case of type "Northern" (optional parameter 3.1 = 1 and 7.1 = 0).

• By actuating a 3-position button in the case of type "Germany" (German road traffic regulations), "Outside Germany", "EU 99", and "infinitely variable load transfer" (optional parameter 3.1 = 1 and 7.1 = 1).

• By requesting "Traction help (load transfer)" via SAE-CAN identifier ASC2_…, byte 3, bit 1…4, (optional parameter 3.1 = 0).

When the traction help is operating, the electronic system sends corresponding information ("Traction help – load transfer", "Traction help – load reduce", "Load fixing") in the SAE-CAN-identifier ASC1_…, byte 4, bit 5…8.

When the traction help is activated – irrespective of the current desired level – the desired level is always increased by the value set in the "Desired level increase when traction help activated" parameter.

The crane operation function can be set in the parameters.

The load-sensing valve controller cannot function correctly if the vehicle body is lowered onto the buffers while driving, because no load information is available. The electronic control unit detects this and outputs a CAN signal so the brake system also detects this situation.

It is possible to set the parameters for stand-by operation. It is activated with ignition OFF (PIN X1/10 of the ECU de-energised) and STOP button of the remote control unit pressed. It causes adjustment to the last level before ignition OFF, assuming adequate pressure and voltage is available.

There are electronic control units which contain a diagnostic interface according to ISO/WD 14 230 ("Keyword Protocol 2000"). Other electronic control units can only communicated via the IES CAN bus; diagnosis is performed from a central interface.

During parameter settings, the K-line or the CAN data bus can be used for output, via CAN messages, of the following information to be displayed on a suitable diagnostic instrument:

"Measured value output …"

… Actual and desired levels of all distance sensors

… Solenoid valve settings

… Characteristic values for levelling control

… Driving speed

… Status of the remote control unit

… Pressure sensor values

… Ignition (ON/OFF)

…Standby operation active

… detected faults

The bi-directional serial port permits diagnosis, functional tests, system calibration, parameter setting, and reading out the diagnostic memory. After exiting the diagnosis, it is necessary to switch the ignition OFF and then ON again.

ECAS/ESAC systems will not be described at this at this point because there are no new functions for the ECAS part of theses systems. Contact the vehicle manufacturer or WABCO for advice in the event of any problems.

8. System start-up and diagnosis

8.1 General

The set values stored in the electronic control unit – referred to as the parameters – are already already designed to match the vehicle. When the system is serviced, however, it may be desirable or even necessary to alter certain parameters.

Only trained personnel may change the parameters however. If WABCO test equipment is to be used for setting the parameters, this is only possible by entering a code number (also referred to as the PIN or personal identification number). Trained persons are then in a position to change the parameters because the PIN permits access to the corresponding program parts of the diagnostic equipment.

After an ECAS electronic control unit has been replaced, the system must be put into service by calibrating it. **Calibrating** sensors means that the sensors are brought into relation with the electronic system – they are "introduced to the electronic control unit". This is necessary to allow the measured values picked up by the sensors to be transmitted and processed. If a remote control unit is to be used for the ECAS system, it must be connected to the system during the calibration process.

Calibration of the sensors is required for new systems, after replacing sensors, and after replacing the electronic control unit. The sensors are calibrated using diagnostic equipment.

Initial start-up of the ECAS system requires the use of diagnostic equipment. It should be mentioned that the extent of available parameter settings and calibration options varies widely from one vehicle manufacturer to another. Some vehicle manufacturers make reference to our diagnostic equipment when changes to the parameter settings are requested. Others do not allow any access to the parameter and calibration values.

The diagnosis is carried out using a PC or notebook that is connected to the vehicle electronics. WABCO diagnostics software must be installed on the notebook. The software is available in different languages and for different ECAS system versions. You will find up-to-date information on the Internet **(www.wabco-auto.com)** via the "Download" menu. All available language versions of the WABCO diagnostic program are shown on the diagnostics software subscription pages.

The diagnostic memory and current measuring data can be obtained using the diagnostic program. In the event of a malfunction, the fault is described.

The connection to the diagnostic PC requires a Diagnostic Interface; here it is possible to use either the serial or the USB version.

Diagnostic Interface

446 301 022 0 (USB)   446 301 021 0 (serial)

Abb. 63

Start-up of ECAS 1st Generation can also be carried out using the WABCO Diagnostic Controller (DC) with associated hard- and software. The following accessories are required for this:

Connection adapter

35-pin 446 300 327 0   25-pin 446 300 317 0
                             only for 4x2 vehicles

Abb. 64

Diagnostic cable, multimeter cable, adapter plug

Diagnostic cable   Multimeter cable   Adapter plug
894 604 303 2   894 604 30. 2   446 300 31. 0

Abb. 65

and the corresponding program card. (↑ Brochure "Test Equipment Overview" 815 010 037 3)

This diagnostic device is of course 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.

The software uses a menu structure for the Diagnostic Controller card and the PC program and and designed in according to a similar structure. Beyond the principle functions, the PC program also includes features such as system illustrations in colour, help files, information on the diagnostic program, on the ECAS system, on setting the parameters, on the calibration procedure, and on locating any errors or faults for the user convenience.

8.2 Diagnostic card overview

Apart from the manufacturers' own diagnostic systems, diagnostic cards or a PC diagnosis are available for all ECAS towing vehicle systems. In conjunctions with the specified diagnostic hardware, these can be used for detecting faults, reading out data from the electronic control unit, setting the parameters of the electronic control unit, and calibrating distance and pressure sensors.

It should be mentioned that the diagnostic card is used less and less frequently. On the one hand, an increasing emphasis is being placed on PC-based diagnosis and, on the other hand, it will become increasingly difficult to accommodate the data required by the new ECAS systems on the chip of the diagnostic card. Table 3 is thus for information only so a complete overview is provided.

Table 3: Diagnostic cards

System	for ECU	Diagnostic Card
without pressure sensor	446 055 00 . 0 / 446 055 01 . 0	446 300 524 0
4 x 2 A	446 055 02 . 0	446 300 520 0
4 x 2 Ratio	446 055 301 0 / 446 055 302 0	446 300 881 0
4 x 2 KMP	446 055 303 0 / 446 055 304 0 / 446 055 311 0 / 446 055 312 0	446 300 880 0
with pressure sensor	446 055 00 . 0	446 300 532 0
6 x 2 A	446 055 04 . 0	446 300 526 0
6 x 2 Ratio	446 055 403 0 / 446 055 405 0 446 055 404 0	446 300 526 0 446 300 881 0
6 x 2 DV	446 055 043 0 / 446 055 049 0	446 300 623 0
6 x 2 DV Ratio	446 055 401 0/ 446 055 402 0 / 446 055 406 0 / 446 055 407 0 446 055 408 0	446 300 623 0
4 x 2 / 6 x 2 24V CAN (for DC ACTROS)	446 170 001 0 / 446 170 002 0 / 446 170 004 0 / 446 170 005 0 446 170 021 0 / 446 170 022 0 / 446 170 023 0 / 446 170 024 0 446 170 051 0 / 446 170 054 0	446 300 635 0
4 x 2 / 6 x 2 24V CAN (for MAN NFG)	446 170 003 0 / 446 170 006 0 / 446 170 053 0	446 300 893 0

8.3 Diagnostic Software

The ECAS system is maintenance-free. The system monitors itself by means of the fault routines in the ECU program. No further system checks are required, apart from inspecting those parts of the system which the ECU is unable to check. (sensor linkage, signal lamp, etc.).

If the ECU detects a fault, the signal lamp will flash; it is only then that the system needs to be checked in the workshop.

The diagnostic device used most frequently is the PC diagnosis. Because it offers a number of convenient functions, starting from a clearer program organisation and structure down to permanent accessibility to the latest diagnostic software on the Internet, it has superseded the Diagnostic Controller to a large extent.

Both types of diagnostic device indicate, in plain text, faults, the frequency of their occurrence, and their current status. In addition, the PC software offers help functions for eliminating faults and on for the general description of the system and its components. The required configurations have already been presented in section 8.1 "General Information".

8.3.1 Diagnosis using the Diagnostic Controller

Diagnosis by means of the Diagnostic Controller has been largely replaced by PC diagnosis, and should be considered as a second option for diagnosis with regard to ECAS (with the exception of ECAS 1st generation). It is menu-driven, i.e., it requires no special know-how. The menu item "Fault finding" should be used for the actual

fault finding. A number of menu items in this regard can only be activated if the PIN was previously entered in menu item 4 "Special functions". All faults are shown in plain text and the fault memory can be printed out on a printer which is connected to the Diagnostic Controller.

8.3.2 Diagnosis with the PC

The diagnosis via PC, however, is the more comfortable method and has therefore replaced the DC diagnosis. All faults are shown in plain text, and additional information is provided on faults and system. The diagnostic memory contents and a vehicle data log can be printed out on a connected printer for the purpose of documentation. The diagnostic program is controlled via the command bar or via buttons and icons.

The program structure closely follows that of the program card in order to make it easier for former users of other diagnostic equipment to handle the diagnostic program. For actual fault finding, the item. "Fault finding" should be selected from the menu.

The PC program is available on disk or can be downloaded from the Internet. One advantage of downloading diagnostic programs from the Internet, and this advantage should not be underestimated, is that it is no longer required to obtain updates as is the case with disks and program cards.

As part of an annual subscription, the latest versions of all available WABCO PC diagnostic programs can be downloaded from the Internet. For ECAS, these are currently the following programs:

ECAS- Bus A 246 301 851 0
ECAS- 4 x 2 S2000246 301 860 0
ECAS- CAN 2246 301 866 0
ECAS- (ENR) Actros246 301 521 0
ECAS- Bus Citaro246 301 523 0
ECAS- Truck KWP K246 301 524 0
ECAS- Truck JED 677246 301 529 0
ECAS- Bus   246 301 558 0

Within the diagnostic program it is possible to access 3 program levels, which, when access is required, must be activated with a PIN (i. e. personal identification number).

1. Diagnosis and reading out the parameter set can be performed immediately with this program.

2. The right to change the calibration can be obtained by taking part in an ECAS information course (1 day)

or following appropriate training given by someone authorised or recognised by the WABCO Customer Service Department (trainer, field service employee, etc. – the WABCO Customer Service Department can provide an up-to-date list of correspondingly authorised persons). Once the trained person has been registered with the WABCO Customer Service Department, he or she can obtain a PIN (personal identification number) for your program. This enables access to the options for use listed under point 1, as well as the option to calibrate distance and pressure sensors.

3. The right to set parameters can be obtained by taking part in an ECAS training course (min. 2 days) or following appropriate training given by someone authorised or recognised by the WABCO Customer Service Department (this may very well include training given by another vehicle manufacturer). Once the trained person has been registered with the WABCO Customer Service Department, he or she can obtain a PIN for your program. This enables access to the options for use listed under point 2, as well as the option to change parameters in the electronic control unit.

Since July 2005, WABCO offers the option to obtain PINs via the Internet. Having completed a system training course, you can use the licence letter you received during training to log in via the Internet and retrieve the PIN.

When a PIN is requested via the Internet, the Internet application requires a subscriber's's login. The login indicates to WABCO whether the requester, whom WABCO recognise by means of the licensing date he or she enters, belongs to the company and is the owner of the subscription.

Abb. 66 PIN request via the Internet

9. Setting parameters

The electronic control units are supplied with parameters already set. The only thing that is required for initial start-up is the calibration of the electronic system. In order to understand ECAS, however, it is important to know and evaluate the various parameters.

9.1 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.

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

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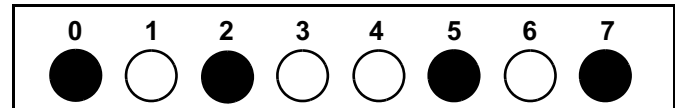
9.2 Value parameters

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 physical dimensions such as: distance, pressure, time, speed.

Eight option parameters make one value parameter.
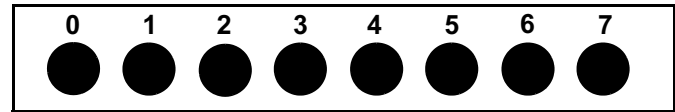
$$2^0 + 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^6 + 2^7 =$$

$$1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 = 255$$

$$2^0 + 0 + 2^2 + 0 + 0 + 2^5 + 0 + 2^7$$

$$1 + 0 + 4 + 0 + 0 + 32 + 0 + 128 = 165$$

Abb. 67 Model representation of numbers 255 and 165 in digitalised form (example)

One byte can be imagined as follows:

Eight lamps are placed on a strip with terminals 0 to 7, symbolically representing 8 bits. If one lamp is on, this corresponds to the number "2 raised to the power of the terminal number".

For example:
The lamp on terminal 3 is on. This equals $2^3 = 8$.

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 only needs to 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.

The parameters can be set using the appropriate software.

In this step, parameter sets can, for example:
- be read in, displayed, and stored in a PC from an existing ECU;
- be written into an ECU from a PC;
- be manually created, modified, and stored in the PC, i.e., transferred to an 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.

WABCO

Parameter changes require the approval of the vehicle manufacturer.

9.2.1 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 bigger 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, for example, when choosing the lever length for the distance sensor.
($\uparrow$ 6.1.1 Distance sensor - instruction for installation)

9.2.2 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 256 to 65.536.

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

9.3 Explanation of the parameters

This section explains the significance of the parameters. The large number of different parameter sets, which also have different structures, makes it almost impossible to explain every single parameter. Many parameters – especially option parameters – do not need an extensive explanation. In many cases , they are simple YES/NO queries by means of which the system structure is defined.

> **!** The parameters explained here do not form part of a specific electronic control unit; rather, this explanation is intended to provide a general overview of all parameters occurring in ECAS electronic control units.

Depending on the electronic control unit used, it may very well be that parameters with the same function have a different parameter number or bit number. As a result, the parameters are not numbered here; instead, the text is divided up into topics. Refer to the diagnostic device or the documentation for the assignment of parameter numbers in a specific electronic control unit; alternatively, you can ask the vehicle manufacturer or WABCO.

It is also possible that parameters with the same function differ slightly in terms of the wording used to represent them. This point is referred to in the explanation of the parameters.

These are the parameter sets that form the basis for the parameters below:

> 446 055 046 0 (6x2 A – MB)
> 446 055 405 0 (6x2 Ratio – DAF)
> 446 055 406 0 (6x2 DV – Scania)
> 446 170 053 0 (4x2/6x2 CAN I – MAN)

These cover the majority of parameters to be described (these parameters are also found in other electronic control units).

The explanation is divided into three headings:

> 1. Device address parameter
> 2. Option parameter
> 3. Value parameter

9.3.1 Device address parameter

Parameter 0 sets the device address which allows the diagnostic device to address the electronic control unit.

The standard address for towing vehicle ECAS electronic control units is "16".

Exceptions are only permissible if, for example, there is more than one ECU installed in a vehicle and these ECUs share a common diagnosis interface. Consequently, the separate ECAS electronic control unit in a bus dolly may have the ISO address "17" should the ECAS electronic control unit in the main vehicle already have the address "16".

Vehicles with 1st generation ECAS (i. e. ECAS with/without pressure sensor) may have different addresses (e.g. ECU 446 005 003 0 for DAF = address 85). If in doubt, contact the vehicle manufacturer or the WABCO Customer Service Department.

Vehicles with CAN-enabled electronic control units do not have a device address because in this case a slightly different method is used for accessing the diagnostic information.

9.3.2 Option parameters

As described above, an option parameter is made up of up to 8 option bits respectively. The option named first corresponds to bit status "0" and the second to bit status "1".

Option bits 4x2 (also 6x2)
Remote control unit or operating switch

This specifies to the electronic control unit whether manual intervention in the system (e.g. LIFT or LOWER command) is accomplished by using operating switches or the remote control unit. The functions of the remote control unit or the operating switch are tested in the diagnostic functions "Activation – Measured Values – Remote Control Unit".

Bit = 0:   ECAS system with remote control unit

Bit = 1:   ECAS system with operating switch

Remote control unit

This specifies to the electronic control unit whether a remote control unit is connected or not, since it is unable to detect this on its own:

Bit = 0:   ECAS system with remote control unit

Bit = 1:   ECAS system without remote control unit

Positive control of the lifting bellows valve
or separate lifting bellows control

In the majority of ECAS system with a lifting axle, the lifting bellows are controlled positively. Positive control is used in the case of pulse-controlled ECAS solenoid valves (↑ 8.3). The ECAS solenoid valve is made in such a way that the functions of pressurising the lifting axle bellows/depressurising the lifting axle supporting bellows (= lifting axle lifting) and depressurising the lifting axle bellows/pressurising the lifting axle supporting bellows (= lifting axle lowering) are internally coupled.

There are ECAS systems in which the lifting axle supporting bellows and the lifting bellows are each controlled by a separate solenoid valve. In this case, separate control of the lifting bellows valve must be assigned to the electronic control unit.

Bit = 0:   Positive control

Bit = 1:   separate control

air suspension only on rear axle or air suspension on rear and front axles)

For vehicles with full air suspension, rear axle(s), front axle(s), and a separate lifting axle function can be controlled independently from one another. In vehicles with partial air suspension, it is possible to control rear axle(s) and a separate lifting axle function – front axle components are not accepted and trigger a fault message.

Bit = 0:   Vehicle with full air suspension

Bit = 1:   Vehicle with partial air suspension

6x2 vehicle or 4x2 vehicle

This parameter is used for defining the vehicle configuration, in particular for electronic control units used in 4x2 and 6x2 vehicles.

Bit = 0:   6x2 vehicle

Bit = 1:   4x2 vehicle

Vehicle with lifting/trailing axle or vehicle without lifting/trailing axle (6x2- or 6x4-vehicle)

Electronic control units in vehicles with the drive formula 6xn can be used in vehicles with a lifting/trailing axle (6x2), as well as in vehicles without a lifting/trailing axle (6x4).

The corresponding system configuration must be made known to the electronic control unit so it can decide whether components specific to the lifting/trailing axle are not connected or defective.

For 4x2 vehicles, without lifting/trailing axle is of course always applicable in this context.

Bit = 0:   Lifting axle or trailing axle vehicle

Bit = 1:   Vehicle without lifting/trailing axle

In conjunction with the previous option bit (i.e. if bit = 0), lifting axle vehicle or trailing vehicle

The difference between a lifting axle and a trailing axle is that the trailing axle can only have the load transferred from it, whereas the lifting axle can also be lifted and lowered. (↑ 3.2 Fundamental definitions).

The appropriate system configuration must be made known to the electronic control unit so it can decide whether components specific to the lifting/trailing axle (e. g. ECAS solenoid valve with lifting axle function) are not connected or are defective (e. g. cable discontinuity).

Bit = 0:   Lifting axle vehicle

Bit = 1:   Trailing axle vehicle or vehicle without additional axle (i.e. 4x2 vehicle)

2 distance sensors on the rear axle or 1 distance sensor on the rear axle

This parameter informs the electronic control unit whether the vehicle body above the rear axle is controlled on a per side or per axle basis.

If side-to-side control is implemented, the system expects 2-point control (i.e. 2 control loops) on the rear axle for controlling the height of the vehicle body. With two distance sensors, and an ECAS solenoid valve equipped with two directional control valves 2/2, the level can be kept in parallel to the axle even though the load on either side of the vehicle may vary. However, note that in this case the wheel loads on the axle may differ widely from one another and the axle will then be subject to distortion.

For control on a per axle basis, the system expects 1-point control (1 control loop) on the rear axle. At the distance sensor, which is usually located at the centre of the axle, the supporting bellows are actuated by an ECAS solenoid valve with a 2/2 directional control valve 2/2 valve. A transverse throttle between the two pneumatic outlets of the directional control valve 2/2 permits the pressure of the supporting bellows on both sides of the vehicle to be balanced slowly. This avoids axle distortion. However, a one-sided load can have the unwanted effect tilting the vehicle body.

Bit = 0:   2 distance sensors on the rear axle

Bit = 1:   1 distance sensor on the rear axle

In conjunction with the previous option bit (Bit = 1) distance sensor rear left or rear right

In vehicles in which there is only 1 distance sensor on the driving axle, there are 2 possible ways of connecting this distance sensor to the electronic control unit. It can either be assigned to the electronic control unit slot "distance sensor on rear axle left" or "Distance sensor on rear axle right". Make sure the directional control valve 2/2 of the corresponding ECAS solenoid valve is assigned to the same side of the vehicle. The electronic control unit must be informed that the control circuit has been defined in this way.

Bit = 0:   Control loop for the left-hand side of the vehicle is active

Bit = 1:   Control loop for the right-hand side of the vehicle is active

Without measured value output or with measured value output

When measured value output is active, the ECU that is not CAN-enabled continuously transmits eight measured values calculated from the sensor values during regular operation. The transmitted values can be displayed during PC diagnosis. The assignment of measuring points depends on the electronic control unit used. The output of measured values displays the ACTUAL and NOMINAL values of the distance sensors, current speed information, pressure sensor values, offset values for tyre impression compensation, controller status, etc. Ask the vehicle manufacturer or WABCO to find out which measured values are output in the electronic control unit in question.

The measured values are output in counts. The value 0 or 255 is output if a measuring point is missing.

The measured value output must only be used for diagnostic purposes. Since the ECU continuously transmits data, diagnosis is not possible without a PIN. If the Diagnostic Controller is being used and initialisation is done using the service card, a message which reads "Data received on K-line, please re-initialise" will be displayed.

Bit = 0:   Normal mode

Bit = 1:   Diagnostic mode

> **! ATTENTION! To complete the process of setting the parameters, bit 7 must be set to "0"; otherwise fault finding will not be possible without a PIN.**

Calibrate three calibration levels or one normal level

The standard value to be entered here is ZERO. For the calibration process, the ECU expects adjustment to three different levels. Taking normal level I as the starting point, the level must then be moved to the upper and the lower level and respectively calibrated.

If the upper/lower levels are known, and for exceptional cases, this bit can be set to 1. Prior to the calibration

process, the upper/lower levels must be made known to the ECAS electronic control unit as count numbers. During the calibration process, only normal level I is initiated and calibrated.

Bit = 0: Calibration of the normal level, the upper level, and the lower levels is required (standard)

Bit = 1: Calibration of the normal level is required

Setting according to option parameters or automatic periphery detection

If this bit is set to 0, the electronic control unit must be informed of the entire system configuration in the option parameters.

If this bit is set to 1, the ECU checks the electrical connections prior to calibration and deduces the applied system configuration from this information. Accordingly, the parameters of the system configuration description are then set automatically if a parameter is changed and/or in the event of a recalibration. The advantage being that the configuration requires less thought. However, there is the disadvantage that a component failure is not always detected as such because every time the ignition is switched ON, the existing sensors are used for drawing a conclusion on what the configuration is.

Even though the bit has been set to "1", parameter settings are still required. For example, the ECU cannot detect whether a pressure switch has been connected, how traction help is meant to operate, etc.

Without LSV valve or with LSV valve

This is used to define whether the system has a directional valve 3/2 for controlling the LSV bellows control connection. If this bit is set to 0, no safety function is provided for the LSV controller. If this bit is set to 1, a separate directional control solenoid valve 3/2 is energised as long as the system is working properly and the level is above the buffers. In the event of a malfunction, the vehicle level is lowered below the distance sensor value. If the electronic control unit detects this behaviour, the solenoid valve is deenergised and sends the full supply pressure to control connection 41 or 42 of the LSV controller.

Indicate plausibility warning via warning lamp, switch off valves or valves remain activated

Plausibility errors are distance sensor reactions that, over a specific period of time, do not match the electronic control unit's expectations. After a certain period of time, the electronic control unit checks the way ECAS reacts to any commands given. For example, after a command to

LIFT has been given, the electronic control unit expects a rising number of distance sensor value counts.

The LIFT command does not necessarily come from the remote control unit; it may have been triggered, for example, automatically because the limit speed for moving the vehicle body into normal level from a lower level was exceeded.

If the distance sensor values remain constant, or if they fall, the ECU considers this to be implausible and detects what is referred to as a plausibility error. The electronic control unit also detects a plausibility error if the count values are not reduced after a certain period of time has elapsed since the LOWER command was received. As a consequence of such an implausible response, the warning lamp is switched on, indicating a **plausibility warning** to the driver, i. e. that a plausibility error has occurred.

Standard for this bit is 0. Plausibility errors are detected when they occur, written into the diagnostic memory of the ECU, the warning lamp is switched on, and the ECAS solenoid valves are switched off. The ACTUAL levels in effect at this point are taken as new desired levels and applied accordingly.

Example: The intention is to lift a vehicle body from 60 counts to the normal level range (taking tolerances into account) at 75 to 85 counts. After the time limit subsequent to command input has elapsed, the ECU still detects a desired level of 60 counts . This means 60 counts is taken as the new desired level and is applied accordingly. Consequently, subsequent distance changes of vehicle body above the axle due to changes in loading conditions would be adjusted to 60 counts.

If this bit is set to 1, any plausibility errors are written into the diagnostic memory of the electronic control unit, the warning lamp is switched on, and (in contrast to the variant with bit = "0") the ECAS solenoid valves remain energised (!) in order to raise the vehicle body to the desired level. The valve activation time must be taken into account here.

Without crane operation or with crane operation

Bit = 0: is the standard setting.

Bit = 1: is the preferred setting for vehicles with cranes in order to prevent complete depressurisation of the supporting bellows during crane operation (↑ 3.12 "Crane operation"). This function only operates at v = 0 km/h.

When crane operation is started, the vehicle's outriggers raise the vehicle body so the axles are suspended above the ground. In this case, the distance between the vehicle body and the axles will be large. ECAS would then unsuccessfully attempt to re-establish the previous

desired level by exhausting the supporting bellows (LOWER command). When this bit is set, ECAS detects crane operation after a certain specified time period and cancels exhausting the bellow.

This function can also be used for vehicles that are hoisted onto a ferry for example. Here, it may be desirable to avoid completely exhausting the supporting bellows to prevent damage to the bellows when the vehicle is lowered back down.

Increased vehicle inclination to reduce bellows pressure differences permissible or not permissible

When ECAS moves the vehicle body to a desired level, its foremost aim is to adjust to this level until all distance sensor deliver distance signals within the tolerance range of the desired level. In vehicles with 2 distance sensors on the driving axle, uneven loading over the driving axle may lead to great pressure differences in the supporting bellows as a result of this control strategy. The consequence would be insufficient grip utilisation (ASR intervention).

In order to improve the utilisation of available tractive force, a greater vehicle inclination is permitted over the driving axle with a simultaneous gain in grip utilisation on the road surface. After the second attempt to bring both distance sensors to within the permitted nominal value range, the current misalignment is accepted if the distance sensor on the left-hand side of the vehicle is within the permitted nominal value tolerance range (irrespective of where the right-hand side distance sensor is located). The control process is stopped at this point. Following this, the higher side – the side with the lower supporting bellows pressure – is additionally pressurised for 0.3 seconds in order to reduce further the pressure difference between the right-hand and left-hand supporting bellows.

This control function only takes place if the vehicle is driving. The original calibration values of the distance sensors are unaffected by this control process, i. e. during the next control process ECAS will initially attempt to align the vehicle body horizontally.

Bit = 0:   permits a greater vehicle inclination.

Bit = 1:   does not permit a greater vehicle inclination.

Without terminal 30 supply on pin 5 or with terminal 30 supply on pin 5

This bit defines the electrical power supply for the electronic system. Normally, ECAS only functions when the ignition (terminal 15) is switched ON. However, it is also possible to organise stand-by operation during which ECAS maintains a desired level despite the fact that the ignition has been switched off. To do this, the

electronic control unit (in this case, via pin 5) must be powered from terminal 30 ("steady positive voltage"). The electronic control unit must be informed of this situation. If pin 5 does not get power from terminal 30 although this has been defined, this situation is indicated to the driver by the fault lamp lighting up with a steady light. ECAS basic functions continue to be ensured; stand-by operation is no longer possible however.

Bit = 0: No ECU power supply via terminal 30.

Bit = 1: ECU power supply via terminal 30 is possible, stand-by operation can be organised.

Distance sensor selection

Some electronic control units permit connection of different distance sensor types (↑ also 6.1.1 "Distance sensor"):
• Distance sensor without temperature compensation
• Distance sensor with internal temperature compensation
• Angle-of-rotation sensor

Only distance sensors of one type are allowed to be connected to the ECU.

Distance sensor selection involves setting or not setting bits to inform the electronic control unit which type of distance sensor is present in the system. By means of a defined bit coding scheme, the ECU is aware of which distance sensor type is being used .

With fault monitoring of the connected sensor type or without fault monitoring

This option bit is closely related to the previously described bit. Here, it is possible to decide whether the electronic control unit should check what type of distance sensor is connected. If this bit is set for fault monitoring, the electronic control unit indicates a distance sensor that does not match the code setting and detects a severe fault.

9.3.2.1   Option bits 6x2 (additional)

It is quite possible for option bits used in 4x2 vehicles to be used in 6x2 vehicles as well. If they have been described in section 8.5.2.1 "Option bits 4x2", they will not be explained again in this section. Typical option bits which are exclusively seen in 6x2 vehicles are related to the topics of lifting axle/trailing axle control, traction help, tyre impression compensation, etc.

Not applicable or lifting/trailing axle control using pressure switches

If the bit is set to 0, a fully automatic lifting axle control can be implemented. This setting allows automatic lowering

of the lifting axle, or increasing the load on the trailing axle, when a defined maximum pressure in the supporting bellows is reached and lifting of the lifting axle, or reducing the load on the trailing axle, when the pressure in the supporting bellows falls below a defined minimum value. This requires a pressure sensor to be fitted in order to control the lifting axle. This bit must also be set to 0 in vehicles without a lifting axle.

Bit = 1: absolutely requires the connection of pressure switches for controlling the lifting axle.

Traction help "Germany" or traction help "Outside Germany" (also: Traction help Domestic or traction help Abroad)

As well as defining the type of traction help via the pin assignments on the ECU, it is also possible to define the type of traction help by setting parameters. The option bits only determine the traction help type, the precise definition of the traction help parameters is performed in a later section of the parameter set.

Bit = 0: sets the traction help in accordance with the criteria of the German Motor Vehicle Construction and Use Regulations (StVZO). This means that – in addition to the requirements relating to permitted load and limit speed – there is a mandatory pause (minimum duration: 50 seconds) following an activation time (maximum permitted value: 5090 seconds).

Bit = 1: sets a traction help type in which a time limit is possible but is no longer mandatory. The traction help is essentially only limited by load and speed.

A button is generally used for activating of the traction help types described here.

Regarding 6x2 DV vehicles, there may be a second switch input provided - referred to as the Traction help enable - in vehicles which have a lifting axle that is not sensed with regard to pressure. In this case, the switch must be actuated when the traction help is activated.

Traction help Northern

This option bit is closely related to the option bit described previously.

Bit = 0: activates the traction help as described in the explanatory text for the previous option bit.

Bit = 1: activates a traction help type that operates without limits that can be set in the parameters. Activation and deactivation is controlled by the driver using a switch.

Pulse-controlled lifting axle raising device or Permanently energised lifting axle raising device

Some electronic control units have a separate pin for raising the lifting axle. This option bit defines the output signal.

Bit = 0: the lifting axle raising device receives, over a period of about 5 seconds, a control pulse (e. g. ECAS solenoid valve with slide-controlled lifting axle unit).

Bit = 1: the lifting axle raising device is permanently energised (e. g. separate lifting axle raising valve).

Manual lifting/trailing axle control using switch or using a 3-position switch

System intervention into the lifting/trailing axle control using switches is a widespread feature in ECAS systems in the towing vehicle. There are various actuation variants for manual lifting/trailing axle control.

Bit = 0: the lifting axle is controlled with a 2-position switch that signals the command for lifting or lowering the lifting axle to the ECU depending on the respective switch position. In this case, the electronic control unit responds solely to changes in the switch setting, not to changes in the load or the ignition being switched ON/OFF.

Bit = 1: which means the lifting axle is controlled with a spring-returned 3-position button that is in a neutral position when not actuated. Depending on the position of the button, a command pulse is sent to the ECU to raise or lower the lifting axle. The button then automatically returns to the neutral position.

Combination switch for lifting/trailing axle control and traction help

This option bit is closely related to the option bit described previously.

Bit = 0: activates manual lifting/trailing axle control, which has already been explained in the explanatory text for the previous option bit.

Bit = 1: which means the lifting axle is controlled by means of a combination switch. This switch combines the functions of a switch for manual lifting/trailing axle control (↑ Option bits, bit = 0) and a spring-returned traction help switch.

2. normal level via switch/button or 2nd normal level via limit speed

The level can be adjusted to normal level II by using either a switch/button or in relation to speed.

Bit = 0: which means normal level II is initiated by means of a switch/button input.

Bit = 1: assumes that normal level I will be applied as the nominal value. If a specified speed is exceeded, the ECU applies normal level II as the new nominal value during driving. If the speed drops below another specified speed, which must be slower than the one mentioned above, normal level I is once again taken as the nominal value and applied accordingly.

2. Normal level via switch or 2nd normal level via 3-position switch

This option bit is closely related to the previously described option bit and takes effect when the previously described bit = 0.

Bit = 0: expects the connection of a switch; in this case, the level is adjusted to normal level in accordance with the switch position.

Bit = 1: expects a 3-position switch to be connected, in which case the normal level is applied in accordance with the previously selected normal level. The 3-position switch is in a neutral position when not actuated.

Permanently activate fault lamp on minor faults or briefly activate fault lamp in the event of minor faults

ECAS acknowledges minor faults (faults which permit ECAS to operate with restrictions without shutting down the system) by the fault lamp lighting up with a steady light.

Bit = 0: the fault lamp comes on permanently if a minor fault occurs.

Bit = 1: the fault lamp comes on if a minor fault occurs; the lamp remains on for only a few seconds and then goes out. This function is selected so the driver is not irritated by a permanently lit fault lamp.

Manual lifting/trailing axle control or fully automatic lifting/trailing axle control

If bit = 0: it is possible to perform a manual (also semi-automatic) lifting axle control. In this case, ECAS can be equipped with pressure switches or pressure sensors to detect the axle load. A limit pressure is specified for the system i. e., the switch point of the pressure switch or limit parameters for the pressure sensor) below which it is possible for the driver to use a switch or the remote control unit to raise and lower the lifting axle or transfer the load onto/off the trailing axle within a specified limit speed. The lifting axle is automatically lowered or the load transferred onto the trailing axle if the set supporting bellows pressure on the driving axle is exceeded. Traction help cannot be organised in this mode.

If bit = 1 is set, fully automatic lifting/trailing axle control is preselected. This setting allows automatic lowering of the lifting axle/increasing the weight on the trailing axle when a defined maximum pressure in the supporting bellows on the driving axle is reached, and raising of the lifting axle/reducing the weight on the trailing axle when the pressure in the supporting bellows falls below a defined minimum value. A pressure sensor in the system is essential in this case. Traction help can only be organised if fully automatic lifting/trailing axle control was selected. Provided the maximum supporting bellows pressure (which, if exceeded, causes the lifting axle to be lowered automatically or the load to be automatically transferred to the trailing axle) has not yet been exceeded, the fully automatic function can be switched OFF using the "Lower lifting axle/Load trailing axle" command and switched back ON again using the "Raise lifting axle/Relieve trailing axle" command.

STOP button without effect on lifting axle movement or STOP button reverses lifting axle movement

Bit = 0: the STOP button on the remote control unit interrupts all control processes regarding level adjustment. The STOP button does not normally have any effect on ongoing control processes of the lifting/trailing axle.

Bit = 1: it is possible to intervene in an ongoing lifting/trailing axle control function provided that no speed is detected and that this function does not lead to overloads. By pressing the STOP button within 5 seconds of a lifting/trailing axle movement initiation, this movement can be reversed.

Pressure sensors with an output voltage of 4.5 V at 10 bar or pressure sensors with an output voltage of 5.5 V at 10 bar

There are different generations of pressure sensor, the major difference between them being their digital resolution (↑ 6.1.3 "Pressure sensor"). Although the pressure parameters are entered as count values in the following parameters if required, this distinction is still made. The reason is that the pressure values are output to diagnostic tools (Diagnostic Controller or PC) as real pressure values. It is necessary to state the ECU

resolution for conversion of the count values used for output of pressures as real pressure values.

Bit = 0: for pressure sensors which, at 10 bar, have a voltage output of 5.5 volt to the signal line. 1 count then corresponds to 1/20 bar (= 0.05 bar). Pressure sensors with this resolution have Schlemmer (KOSTAL) bayonet connections.

Bit = 1: for pressure sensors which, at 10 bar, have a voltage output of 4,5 volt to the signal line. 1 count then corresponds to 1/16 bar (= 0.0625 bar). Pressure sensors with this resolution have DIN bayonet connections and are the current standard version which is also used in EBS systems.

4x2 vehicle without pressure sensors or 4x2 vehicles with pressure sensors (tyre impression compensation)

In vehicles without a lifting axle, it may be desirable to use tyre impression compensation. In this case, pressure sensors are connected to the electronic control unit. The ECU connections for controlling the lifting/trailing axle are not assigned/wired in this case. This parameter prevents faults being detected without reason (e. g. interruption of the directional control valve 2/2 for the lifting axle).

Bit = 0: means that no tyre impression compensation is desired for the vehicle.

Bit = 1: means that tyre impression compensation is possible – parameters for the required benchmark data are set later.

9.3.2.2   Option bits 6x2 DV (additional)

For 6x2 vehicles (i.e. 6x2 vehicles with pressure ratio control), some option bits are used which are very specific to pressure ratio/traction control. Next to these, there are still option bits as used in 4x2 and 6x2 vehicles; these will not be explained again at this point. Typical option bits used exclusively in 6x2DV vehicles, concern topics such as of pressure ratio control, traction control, bellow sensors, etc.

Lifting axle without pressure sensing in the air bellows. Hydraulic lifting device. Trailing axle or lifting axle with pressure sensing elements in air bellows

This informs the system whether the system includes a trailing or a lifting axle. Furthermore, ECAS is informed how raising/lowering of the lifting axle should be organised. On the basis of this definition, ECAS activates one of the three modes for lifting or lowering the lifting axle:

- Lifting axle with pressure sensing in the lifting bellows
- Lifting axle without pressure sensing in the lifting bellows
- Hydraulic lifting axle device

The statements made here and in the two following option bits permit a definitive assignment.

Bit = 0: means this system either has a lifting axle without a pressure sensor, or a lifting axle with a hydraulic lifting axle device, or a trailing axle.

Bit = 1: means this system has lifting bellows with a pressure sensor.

Lifting axle with pressure sensing in the air bellows. Lifting axle without pressure sensing in the air bellows. Trailing axle or hydraulic lifting device

This option bit is closely related to the previous and next option bits.

Bit = 0: means this system either has a trailing axle or a lifting axle with or without a pressure sensor.

Bit = 1: means this system has a hydraulic lifting device.

Lifting axle with pressure sensing in the air bellows. Hydraulic lifting device. Trailing axle or lifting axle with pressure sensing in the air bellows

This option bit is closely related to the two previous option bits.

Bit = 0: means this system either has a lifting axle with a pressure sensor, or a lifting axle with a hydraulic lifting axle device, or a trailing axle.

Bit = 1: means this system has lifting bellows without a pressure sensor.

Manual traction help

This option bit is closely related to the option bit for defining the traction help type described in section 8.5.2.2 "Option Bits 6x2 (additional)".

Manual traction help is a special type of traction help which can only be implemented in 6x2 DV vehicles because in this case the supporting bellows of the driving axle and the lifting axle are equipped with pressure sensors. The supporting bellows pressure on the driving axle can be infinitely varied, in contrast to the traction help types described above which always have a fixed maximum permitted limit pressure setting on the driving axle – when the lifting axle is not completely raised or does not have the complete load transferred off it – and the remaining load is carried by the lifting axle. A traction

help button and a lifting axle switch (LIFT/LOWER lifting axle) are required in order to perform manual traction help control. The traction help is activated using the traction help button. The load on the driving axle is increased in this case by pressing the traction help button again. Reduction is effected by bringing the lifting axle switch into the position "Lifting axle LOWERING". In order to stop the change in position, the traction help button must be released and the lifting axle switch must be in the neutral position.

Another parameter can be used to define whether the pressures set manually here for the traction help should be saved and for possible retrieval when the traction help is next used.

Bit = 0: activates the traction help as described in the explanatory text for the previous option bits. Traction help type Germany, Outside Germany, or Northern.

Bit = 1: activates the manual traction help.

Do not raise lifting axle while traction help is active or lift lifting axle while traction help is active

Normally, ECAS attempts to raise the lifting axle when the traction help is activated, provided the upper load limit on the driving axle is not exceeded. It may be a good idea, in vehicles used on construction sites for example, to leave the lifting axle on the ground at all times when traction help is activated (in order to improve traction) since this gives the vehicle greater stability.

Bit = 0: the lifting axle is lifted when traction help is activated, subject to the load limit (standard).

Bit = 1: the lifting axle remains on the ground when traction help is activated.

3. Normal level via switch has priority over 2nd normal level via limit speed.
2nd normal level via switch has priority over 3rd normal level via switch

It is possible to control other levels either via speed (normal level II) or via switch (normal level III).

In this configuration, normal level II is exclusively controlled via speed and normal level III (alternating with normal level I) via a switch. It is assumed that the level will be adjusted to normal level I at speeds below a specified speed limit. If this specified speed is exceeded, the electronic control unit adjusts to normal level II as the new nominal value during driving operation. If the speed drops below another specified speed, which must be slower than the one mentioned above, normal level I is

once again taken as the nominal value and applied accordingly. The switch can also be used to determine whether normal level I or III will be adopted as the desired level and applied accordingly. These two functions can lead to the following conflicting situations:

– the switch is in the "Control normal level III" position and the vehicle exceeds the limit speed at which ECAS should control normal level II

– the vehicle is moving with a speed at which ECAS adjusts the level to normal level II as the desired level, and the driver moves the switch to the "Normal level III" position.

In order to resolve this conflict, the electronic control unit is informed which desired level control should be given priority.

Bit = 0: if the switch is in the "Normal level III" position or it is moved to this position, the level is always adjusted to normal level III regardless of the speed at which the vehicle is moving. If the switch is in the "Normal level I" position, the level is adjusted to either normal level I or II, depending on the speed at which the vehicle is travelling.

Bit = 1: if the vehicle exceeds the speed at which the level should be adjusted to normal level II, the level is always adjusted to normal level II regardless of the switch position. If the vehicle speed drops below the speed at which the level should be adjusted back to normal level I, the level is adjusted to either normal level I or III, depending on the switch position.

Start of traction help via actuated switch to ground and an actuated switch to $+U_B$

Normally, the traction help is activated when a switch/button is connected to ground. 6x2 DV vehicles without sensors on the lifting bellows represent an exception to this rule (vehicles with a trailing axle, without lifting bellows sensing elements, or with a hydraulic lifting axle raising device). In these vehicles, a switch (enable switch for traction help) is connected to $+U_B$ on the ECU pin for the signal line of the lifting bellows pressure sensor. This switch must be closed in addition to the traction help button before the traction help can be activated.

Bit = 0: activates traction help only by means of the traction help button / switch (normal situation).

Bit = 1: means the traction help enable switch must be actuated first, before traction help can be activated via the traction help button/switch.

**Enabling traction help without second switching input or
via second switching input**

Some systems have an additional traction help enable function switched on ECU pin 24. (↑ System description 6x2 DV)

Bit = 0:   means there is no traction help enabling function

Bit = 1:   means there is a switchable traction help enable function on U_{BATT}

Traction control or pressure ratio control

In 6x2 DV vehicles, the bellows pressure control on the driving axle can function as traction control or pressure ratio control. A pressure ratio/traction switch, which is connected to ground, can be used to select which of the two control concepts should be in effect. This option bit determines which of the two control concepts is in effect when the switch is open. If the switch is closed, the other control concept takes effect.

Bit = 0:   means traction control is operational when the pressure ratio/traction switch is open.

Bit = 1:   means pressure ration control is operational when the pressure ratio/traction switch is open.

Without LSV valve / without valve Release parking on the front axle when lifting/lowering, or with corresponding valves

This parameter defines whether a switch signal that triggers a solenoid valve should be output on electronic control unit pin 29 in specific circumstances. In this case, electronic control unit pin 29 is assigned a double function. On the one hand, the "Release parking brake on the front axle when raising/lowering" function is supported,"With LSV" function on the other hand.

Bit = 0:   means no switch signal U_{BATT} is output on electronic control unit pin 29.

Bit = 1:   means a switch signal U_{BATT} is output on electronic control unit pin 29.

**Valve with multifunction "Release parking brake front axle when lifting/lowering", or
valve with multifunction "LSV"**

The parameter is closely related to the previous parameter.

This parameter defines the assignment of ECU pin 29 with a double function. Depending on which bit has been set, the described function is covered by the pin

connected to U_{BATT}. (↑ 7.8 "System description 6x2 DV")

The "Release parking brake on the front axle when raising/lowering" function is activated when the lift or lower button on the remote control unit is pressed. It is of interest in vehicles in which the parking brake also acts on the front axle. In this case, a solenoid valve in the front axle parking brake circuit is controlled in order to release the parking brake on the front axle. This avoids any frame distortion due to the raising or lower procedure and thus the associated incorrect performance of the lifting / lowering function.

The "With LSV solenoid valve" function mentioned here causes a solenoid valve to be activated for securing the "laden" information on LSV controller.

Bit = 0:   means the Release parking brake on the front axle when raising/lowering function is supported.

Bit = 1:   means the the function With LSV valve is supported.

Switch off the valve with "Release parking brake on the front axle when raising/lowering" function at the end of lifting or lowering using the STOP button, or switch off the valve with "Release parking brake on the front axle when raising/lowering" function using the STOP button.

This parameter is closely related to the previous parameter and describes how the release function of the parking brake is deactivated again.

Bit = 0:   means the release function is automatically switched off at the end of the lifting or lowering procedure.

Bit = 1:   means the STOP button on the remote control unit must be pressed in order to terminate the release function – only then would the front axle be braked again.

Without memory function for axle loads in the case of manual traction help, or with memory functions

This option bit is closely related to the option bit for manual traction help described above.

With manual traction help, the traction help button and the "RAISE/LOWER lifting axle" lifting axle switch is used for setting an individual pressure ratio between the supporting bellows on the driving axle and the lifting axle. With this option bit, it is possible to decide whether it should be possible to recall this pressure ratio indefinitely via the traction help switch when traction help is activated (press the button for < 2 seconds).

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Bit = 0: means that a recall of the individual pressure ratio last set between the supporting bellows on the driven and the lifting axles in the event of manual traction help function is desired.

Bit = 1: means that a recall of the individual pressure ratio last set between the supporting bellows on the driven and the lifting axles in the event of manual traction help function is not desired.

Automatic, load-dependent lowering of the lifting axle, or No automatic, load-dependent lowering of the lifting axle

Bit = 0: a fully automatic lifting axle control can be implemented. This setting allows automatic lowering of the lifting axle, or increasing the load on the trailing axle, when a defined maximum pressure in the supporting bellows is reached and lifting of the lifting axle, or reducing the load on the trailing axle, when the pressure in the supporting bellows falls below a defined minimum value.

Bit = 1: deactivates the fully automatic lifting axle control and only permits the lifting axle to be controlled using switches or the remote control unit.

9.3.2.3   Option bits 4x2/6x2 CAN (additional)

In 4x2/6x2 CAN vehicles (i. e. vehicles with control via the CAN bus), certain option bits with functions designed specifically for systems with CAN data bus connection are used. Next to these, option bits as used in 4x2-/6x2 vehicles, as well as 6x2 DV vehicles are also present; these will not be explained again at this point. Typical option bits which are exclusively seen in 4x2/6x2 CAN vehicles relate to the topics of intervention via CAN messages, load information via pressure sensor or as CAN message, various fault and measured value outputs via CAN data bus, etc.

Functions according to FFR_1 and remote control unit, or Functions only via buttons/switches/remote control unit

This defines how the user is allowed to intervene in the system. In this case, FFR_1 is the name of the CAN message containing the action commands for ECAS (e.g. lifting, lowering, etc.)

Bit = 0: means the user can intervene in the system by means of a CAN message or by means of the remote control unit.

Bit = 1: means that the user has the option, as was the case in older systems, to intervene in the system by means of buttons, switches, or the remote

control unit. Access via the CAN message FFR_1 is not permitted.

4x2/6x4 vehicle without overload lowering, or with overload lowering

This defines whether an overload shall be detected in 4x2/6x4 vehicles (i.e., vehicles without a lifting or trailing axle), causing the vehicle body to be lowered onto the buffers.

Bit = 0: means that no lowering onto the buffers is initiated when an overload is detected.

Bit = 1: means that lowering onto the buffers is initiated when an overload is detected. The driving axle must be equipped with pressure sensors in order for this function to be used. The ECAS electronic control unit obtain information regarding the loading condition via the CAN data bus, or from a pressure sensor directly connected to the electronic control unit.

Front axle with pressure sensor, or without pressure sensor

Sensing the front axle is required if axle load data acquisition, via pressure sensors, for the overall vehicle has been set. In the case of this setting, ECAS expects a load on the pressure sensor port for the front axle.

Bit = 0: means the front axle is equipped with a pressure sensor.

Bit = 1: means that the front axle is not sensed with regard to pressure.

Trailing axle or leading axle

This bit must be viewed in relation to the Lifting axle/ Trailing axle option bit and describes the position of the axle in more detail. It is only relevant in 6x2 vehicles.

Bit = 0: means the lifting/trailing axle is located downstream of the driving axle.

Bit = 1: means the lifting/trailing axle is located upstream of the driving axle.

Reference level for normal level II - normal level I, or reference level for normal level II - lower calibration position"

The normal level II (NL II) is always entered as a differential value. This determines whether NL II should be entered as a differential from normal level I or from the lower calibration level (also: lower level or lowest level).

Bit = 0: means normal level II is entered as a differential relative to normal level I.

Bit = 1: means normal level II is entered as a differential relative to the lowest level I.

ECAS with pressure sensors, or load info from EBS

This defines the origin of the loading condition information. It defines whether the electronic control unit obtains the information via hardware (pressure sensors connected to the electronic control unit) or via software (CAN message from the EBS electronic control unit).

Bit = 0: means that the electronic control unit obtains the information from pressure sensors.

Bit = 1: means the load condition information is transmitted from the EBS electronic control unit to the ECAS ECU.

Without measured value output via ID 889/890/891 or with measured value output

Measured values can be output in the identifiers (CAN message) 889/890/891 during normal ECAS operation and they can be displayed if a suitable diagnostic device is available. The CAN message DM4, which contains information about current and non-current faults and other information, cannot be sent in the measured value output status however.

The measured value output mode should be reset if it is no longer required.

Bit = 0: means normal mode

Bit = 1: means measured value output mode is set

With reception of identifier ECAM1, or without reception

Identifier ECAM1 transmits information about the supply pressure in the air suspension system to the ECAS ECU. In conjunction with the information about the engine speed (identifier EEC1), the electronic control unit is able to detect that there is a leak within a defined supply pressure range of the air suspension system if a lifting control function was not completed within a specified time.

Bit = 0: means leakage detection is possible

Bit = 1: means leakage detection is not possible

With plausibility error fault warning in DM1, or without fault warning

Plausibility errors are faults detected by the ECAS ECU when distance sensor reactions do not match the signalled commands. If the "Lift vehicle body" command is signalled, for example, then the electronic control unit checks, after a specified time, whether the count values received from the distance sensor are increasing. If they remain the same (e. g. insufficient supply pressure in the system), or indeed drop (e. g. distance sensor lever has overturned), then the electronic control unit identifies this as implausible behaviour.

This detected fault would be indicated in identifier DM1, provided it is enabled in this option bit. The fault would also be stored in the diagnostic memory in this case.

Bit = 0: means plausibility error warning is possible.

Bit = 1: means no plausibility error warning is possible and the fault is not stored in the diagnostic memory.

All the most important option parameters have now been discussed. An exact description of the parameters is only possible if the part number of the electronic control unit is known. Only then is it possible to describe accurately the effect the parameters have in the specific system.

9.3.3 Value parameters

The most important value parameters are described in the following section. Whereas the option parameters describe a qualitative condition, the value parameters specify the quantitative value of a setting. For example, the type of traction help is defined as an option parameter, while setting this traction help type is done in the value parameters.

The formulation of parameters with the same function may vary in different electronic control units. This situation is taken into consideration by alternative formulations being listed in brackets after the parameter names.

One section is devoted to explaining parameters that can be set separately on the front and rear axle.

Difference between normal level I and normal level II front or rear

This parameter describes the level which takes effect on the front or driving axle when the NL II switch is actuated or the normal level button on the remote control unit is pressed when NL II is selected on the NL II switch.

If the level meant to be higher than NL I, a value between 0 and 99 counts is entered. This value is then added to the value for normal level I.

The parameter must be set greater than 100 if the level is meant to be lower. The value above 100 is then

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subtracted from the normal level I to give the new nominal value. Input is made in counts.

Difference between normal level II and (offset = -125) normal level I / Lower calibration level front or rear (for vehicles with 1 st generation ECAS 4x2/6x2 CAN)

A few special aspects have to be considered in vehicles with 1 st generation ECAS 4x2/6x2 CAN.

The entry is made taking into account of an offset of 125 counts. This significantly alters the philosophy for entering values. The input value (IV) is calculated as the difference between the normal level II (NL II) and the reference level (RL, i. e. normal level I or the lower level) plus the offset 125:

$$\text{Input value} = \text{NL II} - \text{RN} + 125$$

Therefore, if NL II is meant to be above the reference level, the value <125 must be entered. If NL II is meant to be below the reference level, the value to be entered must be >125.

Example 1: A NL II is meant to be 10 cts. above the NL I:

RN = NL I = 100 cts.
NL II = 100 - 10 = 90 cts.
IV = 90 - 100 + 125 = 115 cts.
Input parameter: 115 counts

Example 2: A NLII is meant to be 10 cts. below the NL I:

RN = NL I = 100 cts.
NL II = 100 + 10 = 110 cts.
IV = 110 - 100 + 125 = 135 cts.
Input parameter: 135 counts

Entering ZERO would thus give a NL II that is 125 counts below the reference level.

Limit for detecting plausibility errors on the front axle or on the rear axle

This parameter defines a value for the distance sensor which, when exceeded while the vehicle body is being lowered, will not cause the electronic control to detect a plausibility error. Depending on the definition of the lowest permissible level, the function of the parameter varies:

Case A: The rubber buffer is meant to be the lower height limit (lowest possible limit).

In order to ensure the vehicle remains stable, it may be desirable to define the rubber buffers as the absolute lowest possible level to which the vehicle body can be lowered. If it is assumed that the calibration (including the lower level) is performed when the vehicle is unladen, it must also be ensured that the lowest possible level to which even the fully laden vehicle may be lowered is represented by the buffers. Due to the greater dead weight, this desired lower level for the fully laden vehicle would be below the lower level calibrated when the vehicle was in unladen condition.

The parameter to select for input is greater than 100. Because the input value is greater than 100, the electronic control unit detects case A, "Rubber buffer". It uses the input value to calculate a limit value (input value minus 100) which is internally added to the calibrated lower level. While the vehicle body is positioned within the determined range, plausibility fault recognition is suppressed.

The main criterion for cancelling bellows venting is the electronic control unit no longer detecting a change in height within a parameterised time period. This means it is possible to move to levels below the calibrated lower level.

The level thus reached is then assumed to be the new desired level.

Recommendation: If calibration is done on the unladen vehicle, a value between 110 and 125 should be chosen for this parameter to ensure that no plausibility error is detected even when the vehicle is in a tilting position and thus resting on the buffers on one side only. If calibration is done on the laden vehicle, a value between 120 and 135 is reasonable.

Case B: Lower height limit is above the rubber buffer.

In order to avoid abrasion of the rubber buffer in the supporting bellows, thereby causing wear debris to spread in the air lines, it may be desirable to prevent lowering of the vehicle body onto the rubber buffers.

The parameter to select for input is less than 100. Because the input value is less than 100, the electronic control unit detects case B, "Limit above the rubber buffer". The input value represents a limit value which is internally added to the calibrated lower level. While the vehicle body is positioned within the determined range, plausibility fault recognition is suppressed analogous to case A.

The main criteria for cancelling bellow venting is the vehicle body having reached the lower level.

The level thus reached is then assumed to be the new desired level.

Permissible desired level tolerance on the front axle or the rear axle

The tolerance value to be entered describes the permissible value by which the vehicle body may move above or below each desired level to be controlled on the front and rear axle. The tolerance range, within which a nominal value is considered as having been set, is therefore twice the entered value.

This parameter setting also determines, together with the proportional and differential coefficients or the self-taught control characteristics, the control quality of the system on the rear axle. (↑ 4.1 Control algorithm for levelling control)

Input is made in counts. The entered value must be greater than 2 … 3 counts (depending on the system).

Permissible right/left deviation at desired level

This parameter only takes effect in systems with two distance sensors at the rear axle. It indicates the permissible inclination of the body when the load distribution is biased towards one side. Input is made in counts.

Permissible right/left deviation when lifting/lowering

This parameter only relates to axles with two distance sensors. In contrast to the aforementioned parameters, the control procedure is specified during substantial level changes (lifting/lowering). 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 heavier load will be lowered more rapidly), thus causing a dangerous inclination as the level is being changed.

More even lifting is achieved by reducing the pressurisation of the less loaded bellows (pressure pulsing). More even lowering is achieved by reducing venting of the more loaded bellows (pressure pulsing).

Permissible front/rear deviation when lifting/lowering

When the level of the fully air-suspended vehicle changes, the body is supposed to reach the new desired level simultaneously at the front and the rear. That section of the body above the axle which has the shorter path to the new desired value is lifted/lowered at a correspondingly slower rate.

This parameter determines the permissible path differential between the distance sensors at front and rear for the control process to occur.

Minor deviations cause constant pulsing of the solenoid valves during the control process and should therefore be avoided. Input is made in counts.

Permissible level increase 7 s after starting a drive or when the unloading level function is activated

If required, desired level control occurs at certain time intervals while driving (interval length = control delay when stationary - default setting: 6060 seconds or freely adjustable parameter). It may well be that the vehicle is still being unloaded when it starts moving. In this case, the distance between the vehicle body and the axle increases and is therefore above the desired level. In the worst case, an adjustment did not occur until 60 s later.

This parameter contains the permissible value by which the vehicle body distance above the axle may exceed the desired level. 7 7 seconds after the vehicle starts moving, ECAS checks whether the distance "desired level + permissible value for exceeding desired level" has been exceeded on **all** distance sensors in the system. If this condition is detected, the level is immediately adjusted to the desired level.

The parameter should not be ZERO, otherwise an adjustment would be triggered each time the value is exceed even by a minimal value as soon as 7 s have elapsed after starting the drive. Input is made in counts.

Vehicle speed up to which targeted height changes are possible

The parameter describes the speed limit up to which "lifting/lowering" or "M1/M2" commands from the remote control unit are accepted. If this speed is exceeded, the desired level set via the remote control unit is retained and can no longer be changed via the remote control unit .

Control to the last preselected normal level occurs in the parameter "Vehicle speed above which the normal level is activated automatically" (explained below). The value for the parameter "Vehicle speed up to which the targeted height changes are possible" must be smaller than the parameter "Vehicle speed above which the normal level is activated automatically".

Control delay when stationary

The parameter defines a period for which the distance sensor signals must have been persistently outside the permissible desired level tolerance range to trigger a readjustment.

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Pulse repetition period T

In systems where control characteristics must be entered, this parameter defines the length of a pulsing period for desired level control.

The standard setting is a pulse repetition period of 12 counts (= 300 ms). Input values are in steps of 25 ms per count. Input is made in counts.

The pulse period is the interval between two actuating pulses to the directional control valves 2/2 inside the ECAS solenoid valve. The actuation period of the directional control valves 2/2 is determined by the ECU on the basis of the control parameter deviation and the speed at which the control parameter deviation changes. If the computed actuation period is equal to, or greater than, the entered pulse repetition period, the directional control valves 2/2 are energised continuously. A detailed description is found in chapter 5.1.

Buffer recognition time

The parameter is closely related to the parameter "Plausibility check when lowering at the front or rear". It defines the time in which the ECU should recognise the lower stop (rubber buffer).

If no change in distance is detected within this time following output of the command "lower vehicle body", and the body distance above the axle is at a level corresponding to the setting in the parameter "Plausibility check when lowering at the front or rear", pulsing of the ECAS solenoid valve is stopped.

Pulse divider

In conjunction with the parameters "Permitted deviation right/left outside the desired levels" and "Permitted deviation front/rear outside the desired levels", this parameter specifies the portion of a period during which the faster moving body side during the raising/lowering process is switched off or only pulse-pressurised.

Pulse times below 75 ms are not executed.

If the value "255" is entered, the solenoid valve on the faster moving side is closed until the vehicle body has returned to within the permissible tolerance.

Proportional coefficient K_{PV} or K_{PH} for desired level control at the front (also: on the front axle) or at the rear (also: on the rear axle)

The proportional coefficient K_P is a basic value for ECAS control of nominal values. It is used to compute the pulse length during levelling control. The pulse length to be computed is proportional to the existing desired level

deviation. Thus, a proportionality factor – the proportional coefficient K_P – must be provided to the ECU so that it can compute the pulse length.

The proportional coefficient K_P is dependent on the system configuration and must be determined by trials and then defined more precisely. This the vehicle manufacturer's responsibility and is usually not required for servicing. It is determined as follows:

1. Set parameters "Permitted deviation right/left in the desired levels", "Permitted deviation right/left outside the desired levels" and "Permitted deviation front/rear outside the desired levels" to "255"
   Set parameter "Pulse repetition period T" to 👍 12
   Set parameter "Tolerance of desired level front / rear" to 👍 3 … 5 or possibly up to 7

2. Determine a (starting) value for K_P according to the formula:
   KP = (Parameter "Pulse repetition period" - 2) / (Parameter "Tolerance for desired level at front" or "… rear" - 1)

3. Determine the parameter to be entered according to the formula:
   Parameter to enter = K_P x 3 (round off the result to a whole number)
   (Note: With this value, the slowest raising rate and the smallest desired level deviation to be controlled would just cause the ECAS solenoid valve to be energised continuously.)

4. Calibrate the vehicle

5. Move vehicle to a level below the nominal value tolerance for the current normal level, followed by the "normal level" command (via remote control unit).
   Check: Does the vehicle body move to the normal level without excessive oscillation (overshooting) and without the solenoid valve pulsing?

6. Result:
   YES: K_P is OK and does not need to be changed
   Body overshoots; reduce the K_D value
   (increase desired level tolerance if necessary)
   Solenoid valves pulsing: Increase the K_P value

7. Continue as described under 5. after making any necessary corrections.

If you cannot find a compromise setting, i. e. the tendency of the vehicle body to overshoot cannot be overcome within a reasonable nominal value tolerance range by altering the K_D value setting, then the recommended course of action is to optimise the cross-section (e. g.

narrowing) of the pneumatic lines between solenoid valve and supporting bellows (smaller line cross-section or throttle).

IMPORTANT: The value is entered in thirds of counts.

In vehicles with self-learning control function, this and the following parameter no longer have to be determined and entered.

Differential coefficient K_{PV} or K_{PH} for desired level control
or on the rear axle)

The differential coefficient K_D is one of the basic values for ECAS nominal value control. The period of time in which the ECAS valve solenoid is energised while the vehicle body is being raised can be shortened as a ratio of the speed at which the control deviation is being changed. This serves to slow down the lifting process in the event of major deviations in the desired levels, and so to prevent overshooting. In order to shorten this pulse length, the electronic control unit has to be provided with a factor – the differential coefficient K_D.

The differential coefficient K_D is dependent on the system configuration and has to be determined by trials and must then be defined more precisely. This the vehicle manufacturer's responsibility and is usually not required for servicing. It is determined as follows:

1. Determine a starting value according to the formula:
   K_D **= Proportional coefficient K_P x 2**

2. Bring the vehicle into a major nominal value deviation below the normal level, followed by the "normal level" command (via remote control unit).
   Check: Does the vehicle body move to the normal level without overshooting and without the solenoid valve pulsing?

3. Result:
   YES: K_D is OK and does not need to be changed
   Vehicle body overshoots: Increase the K_D value (note that K_D should not exceed 4 x K_P)

4. Continue as described under 2. after making any necessary corrections.

The value is entered as the pulse repetition period per thirds of counts.

Normal level III to normal level I on the front axle or on the rear axle

This parameter is used in vehicles with a third driving level (e. g. 6x2 DV) and parameter 24 describes the

normal level III on the front or rear axle. The entry is made in counts.

If normal level II is to be higher than normal level I, a value between 0 and 99 counts is entered. The value entered is then added to normal level I.

If normal level III is meant to be lower than normal level I then parameter 24 must be specified as greater than 100. Normal level III is then calculated as: Normal level I - Parameter + 100.

Vehicle speed which, when exceeded, automatically triggers adjustment to normal level II.

This and the following parameter are closely related and are set in vehicles which have a speed-dependent control setting from normal level I to normal level II and back again. This function must be activated in the corresponding option parameter.

If the speed set in this parameter is exceeded, the electronic control unit sets normal level II automatically as the nominal value during driving. The entry is made in km/h.

Vehicle speed which, when exceeded, automatically triggers adjustment to normal level I.

This parameter is closely related to the one described previously and specifies a speed at which, if the vehicle's speed falls below that speed, normal level I is set.

This function must be activated in the corresponding option parameter. The parameter is the inverse function of the parameter described above and must be set lower than the parameter described above. The entry is made in km/h.

Control delay when driving

This parameter is used in vehicles with ECAS 4x2/6x2 CAN. The time interval at which the desired level is controlled while the vehicle is in motion can be set by this parameter. It is set to 60 s in electronic control units in which this value cannot be set in the parameters.
The entry is made in seconds.

Permitted (mean) pressure on the driving axle at which the lifting axle is lowered or the weight on the trailing axle increased.

This parameter is an important parameter for 6x2 vehicles with pressure equalising control.

It describes the lowering pressure in the supporting bellows on the leading axle. When this pressure is exceeded, automatic lifting axle control becomes effective. As a consequence, the lifting axle is lowered

and thus the axle load distributed across the main and lifting axle.

The specified pressure must not lead to the permitted axle load on the main axle being exceeded. This permitted axle load is specified by the axle manufacturer. After the lifting axle has been lowered, the pressure in the supporting bellows falls below the specified value!

Section 4.2 provides more detailed information. Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

In vehicles with a CAN enabled electronic control unit, it may occur that the permissible pressure on the driving axle with activated traction help is made known to the electronic control unit via calibration.

Permissible (mean) pressure on the driving axle at which the lifting axle/trailing axle relief is possible

This parameter is an important parameter for 6x2 vehicles with pressure ratio control and is closely related to the previous parameter.

It specifies the pressure at which the lifting axle is lifted automatically. The axle load is distributed between the main axle and the lifting axle. The pressure in the supporting bellows of the axle in contact with the ground drops in accordance with the new axle load distribution after the lifting axle has been lowered.

The pressure value to be set in the parameters must be less than the previous parameter. Strictly speaking, it must be even less than the supporting bellows pressure established after lowering of the lifting axle in order to avoid constant lowering and raising of the lifting axle.

Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

Mean load on driving axle up to which relief of lifting axle/tag axle is still possible.
or mean pressure

This parameter occurs in vehicles with CAN electronic control units and serves the same function as the previously described parameter for conventional ECAS electronic control units.

This parameter merely takes account of the situation that the information about the load status of the vehicle can be sent, in accordance with the setting in the option

parameters, to the ECAS electronic control unit by means of a connected pressure sensor or via the CAN line as axle load information. In vehicles with EBS, for example, information about the loading condition is output via the axle load information.

The description of the parameter corresponds to the description of the previous parameter.

Permissible mean overload pressure on the driving axle

The parameter describes the pressure level in the supporting bellows of the main axle which may never be exceeded because this would involve the risk of overloading the axle or the air suspension bellows. If the pressure sensor measures a higher value than the value described here, any further increase in the pressure is prevented, and the vehicle body is lowered onto the buffers.

When this happens, reducing the axle load (unloading) and switching the ignition off and on again will induce a return to normal operating conditions.

If the system includes a pressure sensor, the parameter may never be set to 0 because this would cause ECAS to lower the vehicle until it rests on the buffers. If this function, referred to as overload protection is not required, the value should be set to 255.

Section 4.1 provides more detailed information. Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

Permissible mean overload pressure (overload) on the driving axle

This parameter is found in vehicles with CAN electronic control units and serves the same function as the previously described parameter for conventional ECAS electronic control units.

In this parameter it is merely taken into consideration that the information about the loading condition of the vehicle can be sent to the ECAS electronic control unit, in accordance with the setting in the option parameters, via a connected pressure sensor or via the CAN line as part of the axle load information. In vehicles with EBS, for example, information about the loading condition is output via the axle load information.

The description of the parameter corresponds to the description of the previous parameter.

Vehicle speed up to which manual lifting/trailing axle control is possible

This parameter limits the speed up to which the lifting/ trailing axle can be controlled manually. The entry is made in km/h.

Level increase with activated traction help

The parameter specifies the value for increasing the normal level when traction help is activated. This provides more clearance for the wheels of the lifting axle when traction help is activated.

Duration of traction help, type Germany

The parameter defines for how long traction help may be active. German Motor Vehicle Construction and Use Regulations (StVZO) permit the traction help function to be effective for 90 seconds. The entry is made in steps of 5 seconds. Input is made in counts.

– Set parameter to 👆 18 counts.

When EC Directive 97/27/EC comes into force, the time limit for the traction help will no longer apply.

Duration of traction help type Outside Germany (also: …type "EC" or …type "EU 99")

The parameter defines for how long traction help is activated. This parameter is set in accordance with national legislation. The entry is made in steps of 5 seconds. Input is made in counts. Entering the value 255 deactivates the time limit for this type of traction help.

When EC Directive 97/27/EC comes into force, the time limit for the traction help will no longer apply.

Forced pause of traction help

This parameter is closely related to the parameter Duration of traction help type Germany and specifies how long the interval is between the end of a traction help cycle and reactivation of the traction help. This parameter is set according to the German Motor Vehicle Construction and Use Regulations (StVZO), which is at present 50s. The entry is made in steps of 5 seconds. Input is made in counts.

– Set parameter to 👆 10 counts.

Driving speed up to which traction help can be activated

This parameter is not subject to statutory provisions. It restricts the speed up to which the traction help can be activated.
The entry is made in km/h.

Driving speed at which traction help is switched off automatically

As soon as the EU regulation 97/27/EC comes into force, this 30 km/h speed limit may not be exceeded. The entry is made in km/h.

Permissible mean pressure on the driving axle during traction help

This parameter defines the average pressure permitted in the supporting bellows of the driving axle that may not be exceeded when traction help is active. As a rule – unless the axle manufacturer specifies a lower maximum load – 130 % of the bellows pressure at maximum permitted vehicle loading is set here.

Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

If the pressure set here were to be exceeded when the lifting axle is fully raised, the lifting axle would stay on the ground. The pressure in the supporting bellows for the main axle is controlled so that it does not exceed the value set by this parameter. This means that the maximum possible load is applied to the driving axle. Any excess load is absorbed by the partially exhausted supporting bellows of the lifting axle – the axle load is being distributed.

When EC Guideline 97/27/EC comes into force, this means that in the member states of the EU the axle load may not be exceeded by more than 30 %, provided the value stipulated by the manufacturer for this purpose is not exceeded.

In vehicles with a CAN enabled electronic control unit, it may be that the permitted pressure on the driving axle with activated traction help is made known to the electronic control unit via calibration.

Safety margin relative to the calibrated permissible pressure on the driving axle in the event that a pressure sensor fails

This parameter takes effect in vehicles with a CAN electronic control unit in which the permissible pressure on the driving axle made known to the electronic control unit via pressure sensor calibration. This parameter is not relevant if the axle load information is transmitted via the data line.

For lifting axle control, 2 pressure sensors on the driving axle determine the load and transmit this information to the electronic control unit. Should a pressure sensor now fail, there is a risk that an uneven load above the driving axle on the side of the failed pressure sensor will cause

an overload situation. For this reason, a safety differential is entered, and the permitted value specified to the electronic control unit for the pressure on the driving axle is reduced by this safety differential if a pressure sensor failure is detected.

This parameter only takes effect during normal operation.

Safety differential to the calibrated permissible pressure on the driving axle during traction help when a pressure sensor fails

This parameter takes effect in vehicles with a CAN electronic control unit in which the permitted pressure on the driving axle is made known to the electronic control unit via pressure sensor calibration. It is not relevant if the axle load information is transferred via the data line.

For lifting axle control with traction help activated, 2 pressure sensors on the driving axle determine the load which is sent to the electronic control unit – as already described in the previous parameter. If a pressure sensor were to fail, there would be a risk of uneven load above the driving axle on the side of the failed pressure sensor causing an overload situation. For this reason, a safety differential is entered, and the permissible value specified to the electronic control unit for the pressure on the driving axle is reduced by this safety differential when a pressure sensor failure is detected.

Whereas the parameter described previously applies in normal operation, this parameter is only takes effect when traction help is active.

Pressure hysteresis

While traction help control is active, the distribution of the axle load across the lifting axle and the driving axle causes the pressure in the driving axle's supporting bellows to rise. The pressure in the supporting bellows of the driving axle is maintained within a defined tolerance range below the set maximum permissible supporting bellows pressure on the driving axle.

Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

Pressure hysteresis, driving axle or loading hysteresis, driving axle

This parameter occurs in vehicles with CAN electronic control units and serves the same function as the previously described parameter for conventional ECAS electronic control units.

In this parameter it is merely taken into consideration that the information about the loading condition of the vehicle can be sent to the ECAS electronic control unit, in accordance with the setting in the option parameters, via a connected pressure sensor or via the CAN line as part of the axle load information. In vehicles with EBS, for example, information about the loading condition is output via the axle load information.

The description of the parameter corresponds to the description of the previous parameter.

Normal level increase with raised lifting axle

The parameter specifies the value for increasing the normal level when the lifting axle is raised. This provides more clearance for the wheels of the lifting axle. This effect is also called normal level shift. The value set here must be observed during calibration.

Normal level increase with traction help

The parameter specifies the value for increasing the normal level when the lifting axle is raised and traction help is activated. This achieves improved clearance for the wheels of the lifting axle during traction help control. This effect is also called normal level shift during traction help.

Offset for increasing the calibrated top stop level at the front or rear

The upper desired level for front or rear can be set above the calibrated upper level by entering a distance differential. The background is that, after calibration of three calibration levels, the vehicle body can no longer be moved to the upper level in normal mode. An internal safety function for protecting the mechanical stops prevents the vehicle body from moving beyond within a few counts (often 3 counts) of the calibrated upper level when moving to the upper level. In order to utilise the last reserves of height or to form a rigid block of the vehicle body against the axles, it is possible to enter a distance differential here whereby the vehicle body can be lifted beyond the upper level that can be attained in normal mode. Input is made in counts.

Setting this parameter (i. e. parameter greater than ZERO was entered) when the dimensions of the mechanical stops are not sufficient may cause problems:

– When, during the unloading procedure, the vehicle body is at its uppermost desired level (i. e. nominal value + nominal value tolerance), flexure in the structure may prevent lowering of the vehicle body when the ECAS solenoid valve is vented, so that this desired level can no longer be exited.

– If the parameter value is set higher, it may be possible that the resulting upper level (e. g. by keeping the LIFT button pressed on the remote control unit) can no longer be reached. The supporting bellows

pressure can rise up to the supply pressure of the air suspension. After the period for the plausibility error check has elapsed, a plausibility error is entered in the electronic control unit.

Plausibility errors are distance sensor responses to the air intake or air exhaust actions specified for the ECAS solenoid valve in the event that they do not match the expectations of the electronic control unit. The ECU checks the way ECAS reacts to any commands given. For example, after a command to LIFT has been given, the ECU expects a rising number of distance sensor value counts. If the distance sensor values remain unchanged, or if they even fall, the ECU considers this to be implausible and detects a so-called plausibility error. In spite of the electronic system working properly, in some cases, especially after a long period at a standstill, a lifting commend cannot be executed because there is a shortage of compressed air in the air suspension system. To prevent a fault being recorded due to this shortage, the air suspension system is given enough time to build up sufficient operating pressure to execute the lift command.

Plausibility error check delay

This parameter specifies a time period after the ignition is switched ON during which the electronic control unit does not check the system for plausibility errors.

Vehicle speed above which the normal level is activated automatically

This parameter defines a speed above which the level is automatically adjusted to the current normal level. The normal level which is taken as the current normal level depends on the position of the normal level switch or the setting of the speed-dependent normal level control.

This parameter is important in vehicles with a remote control unit because, when the ignition is switched ON, the level is only automatically adjusted to normal level if the normal level button is pressed on the remote control unit or, in vehicles without a remote control unit, the CLOCK and DATA lines are jumpered on the electronic control unit.

The entry is made in km/h. If the value 255 is entered, the function is deactivated.

Time period for checking plausibility errors

The parameter defines a time period in which the electronic control unit expects a command to be executed or continued. If a given command is not followed by any response, the ECU detects implausible behaviour.

Input is made in steps of 0.3 s. Input is made in counts.

Standby time (STAND-BY)

Input of the duration for which stand-by operation is desired. Input is made in counts.

Limit speed for manual lifting/trailing axle control

This parameter defines a speed limit up to which the lifting axle can still be manually controlled. Lowering the lifting axle at higher speeds would cause tyre damage due to the high ground contact load. Input is made in counts.

Mean pressure on the driving axle at which tyre impression compensation begins

This parameter specifies the supporting bellows pressure in the driving axle at which tyre deformation compensation starts.

Preferably, the supporting bellows pressure for the unladen vehicle should be selected. Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

Mean pressure on the driving axle at which at which tyre impression compensation ends

This parameter specifies the supporting bellows pressure in the driving axle at which tyre deformation compensation ends.

Preferably, the supporting bellows pressure for the fully laden vehicle should be selected. Input is provided in steps, depending on the type of pressure sensor used, of 1/16 (standard value) or 1/20 bar per count. Input is made in counts.

Maximum value with which tyre impression is compensated on the driven or front axle.

The parameter is used to define the amount by which a tyre is compressed, i.e. impressed, between the load conditions as defined by the two aforementioned parameters.

This value should be determined by trials performed on the vehicle. The value established then applies only to the tyre used with the applicable axle steering kinematics. If tyres other than the ones from the test are used with this parameter setting, unintentional changes in the normal level may result, causing the permissible height of the vehicle to be exceeded. Input is made in counts.

Time period for air exhaust without Distance change during crane operation

This specifies the time during which no more distance sensor changes take place when the vehicle is being lowered while the ECAS solenoid valve continues to exhaust air. When this time has elapsed, the electronic control unit recognises crane operation. Input is made in counts.

Difference loading level to normal level I (for vehicles with ECAS 4x2/6x2 CAN of the 1st generation)

In vehicles with ECAS 4x2/6x2 CAN, it is possible to set a loading level in the parameters which can be activated by a message request. Activation using the remote control unit is not possible. This loading level can only be activated when the vehicle is stationary and causes the vehicle body to move to the level set in the parameters here as a difference from the normal level I, where it is then maintained by the control system, so that a supporting position can be adopted in the event of unloading (e. g. increased tilt of a tank container for better unloading).

The entry is made taking account of an offset of 125 counts. This significantly alters the philosophy for entering values. The input value (IV) is calculated as the difference between the required loading level (LL) and the normal level I (NL I) plus the offset 125:

$$\text{Input value} = LL - NL\ I + 125$$

Therefore, if LL is meant to be above the reference level, the value <125 must be entered. If loading level is meant to be below the reference level, the value to be entered must be >125.

Example 1: A LL is meant to be 10 cts. above the NL I:

NL I = 100cts.
LL = 100 - 10 = 90 cts.
IV = 90 - 100 + 125 = 115 cts.
Input parameter: 115 counts

Example 2: A LL is meant to be 10 cts. below the NL I:

NL I = 100 cts.
LL = 100 + 10 = 110 cts.
IV = 110 - 100 + 125 = 135 cts.
Input parameter: 135 counts

As a result, entering ZERO would produce a LL of 125 counts below the normal level I.

The loading level can be set separately for each distance sensor (i. e. front, rear left and rear right).

This concludes the explanation of the parameters. This list contains a large number of possible parameters, but nevertheless no claims are made regarding completeness.

Contact the vehicle manufacturer or WABCO if you have any general questions.

ATTENTION!
The specific parameter values are the responsibility of the vehicle manufacturer in question and any changes to the parameters always requires the a request on the part of the user and the approval of the vehicle manufacturer (not WABCO).

10. Calibration

As part of the commissioning procedure on a new vehicle, the sensors have to be calibrated after the parameters have been set. The distance and pressure sensors which are part of the system have to be **introduced** to the electronic control unit. This means that they must be given a reference value in relation to the electronic control unit.

The calibration process has to be repeated every time the electronic control unit is to work with a new sensor. This is the case when:

- A sensor is replaced
- The electronic control unit is replaced

Depending on the sensor to be calibrated, one distinguishes between:

- Distance sensor calibration
- Pressure sensor calibration

As a rule, a calibration PIN (personal identification number) is required for calibration. This may be the system PIN which is also used for making changes to parameters, or else it is possible to request a calibration PIN from WABCO if required.

10.1 Distance sensor calibration

The process of calibrating the distance sensor aligns the sensor with the electronic control unit. As a rule, the vehicle body is 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 assigned to the electronic control unit. The distance sensor values are specified in "counts".

Correct calibration requires the following preparatory work to be carried out with due care:

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

– Make sure that the distance sensor has been properly installed and that its lever can move freely across the whole of the lifting/lowering range.

– If the vehicle has two distance sensors on one axle, the bellows on both sides are connected to each other by means of a test hose (balancing the pressure to spread the load evenly across the axle).

– Determine the distance between the vehicle body and the axle for each distance sensor, at least in normal level I.

If the electronic control unit is to be replaced and you do not know the calibration data for the vehicle, you can read out the calibration data for the distance sensors of the former electronic control unit. If this is no longer possible, the following assumptions can be used as a workaround:

- The distance sensor will be aligned horizontally at normal level I.
- The level is driven to the upper and lower level until the vehicle body can no longer be raised or lowered.

The distance sensor is calibrated using the PC. To do this, call up the "Calibrate Distance Sensors" menu item on the diagnostic tool. This menu item offers interactive calibration which is briefly explained at this point.

10.1.1 Distance sensor calibration with the PC

To calibrate 3 calibration levels, move to each level to be calibrated in the following sequence: Normal level I, upper level, and lower level. Do this use the PC.

a) First, the vehicle is taken to the determined normal level I (for the front axle and the rear axle in each case). Then the calibration process is initiated (actual levels are now stored as normal levels).

b) Move the vehicle to the level of the upper stop. Re-initiate the calibration process. (Actual levels to which the vehicle body is moved are stored as upper stop levels.) To protect the stops, the ECU will automatically reduce the value for the upper stop level by 3 counts.

c) Move the vehicle to the level of the lower stop. Re-initiate the calibration process. (Actual levels are stored as lower stop levels.)

Note: It is not possible to change the level via the remote control unit when calibrating with the PC. In order for the ECU to recognise the remote control unit, it has to be connected to the system during the calibration process.

After the individual calibration phases have been completed, the PC will check the fault memory and indicate whether calibration was carried out correctly or not.

For a successful completion of the calibration, the following principles for the distance sensor values DSV must be observed: The individual numerical values may fluctuate – a guideline should be given here:

– The entered distance sensor values must be greater than 4 counts and less than 250 counts.

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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 desired level tolerance (ΔDSV) set in the parameters. The front/rear assignment of the distance sensor depends on its slot in the control unit.

DSV $_{OL}$ > DSW$_{NL}$ + 3counts + 3x ΔDSV

– The lower level (LL) must be less than the normal level (NL) less twice the desired level tolerance ΔDSV .

DSV $_{LL}$ < DSV $_{LL}$ - 2x ΔDSV

A **second possibility** is to calibrate normal level I only. The upper and lower levels are entered in the electronic control unit manually using the diagnostic tool prior to calibration. 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.

At the same time, this function can be used to make some manipulations. In vehicles in which no offset from the upper level is possible, this function makes it possible to bypass the protective function for reducing the load on the stops in the upper level. It is also possible to enter a low value for the lower level in order to ensure that the vehicle body does actually come to rest on the rubber buffers.

For this procedure, the calibration guidelines also have to be observed. On the basis of the rear left and rear right normal level, the calibration values for the "upper/lower level rear" can be defined as follows:

1. Calculate the differences between the "upper level rear left" – "normal level rear left" and "upper level rear right" – "normal level rear right".

DSV$_{OL-left}$ - DSV$_{NL-left}$ = ΔDSV$_{left}$

DSV$_{OL-right}$ - DSV$_{NL-right}$ = ΔDSV$_{right}$

2. Add the smaller difference to the expected calibration value "normal level rear left" to obtain the calibration value to be entered for the "upper level rear".

Selection of ΔDSV$_{OL}$:

ΔDSV$_{right}$ > ΔDSV$_{left}$ ➔ ΔDSV$_{UL}$ = ΔDSV$_{left}$

or

ΔDSV$_{left}$ > ΔDSV$_{right}$ ➔ ΔDSV$_{UL}$ = ΔDSV$_{right}$

Calibration input value IV$_{UL}$:

DSV$_{NL\ left}$ + ΔDSV$_{UL}$ = IV$_{UL}$

3. Calculate the differences between the "normal level rear left" – "lower level rear left" and "normal level rear right" – "lower level rear right".

DSV$_{LL\ left}$ - DSV$_{NL\ left}$ = ΔDSV$_{left}$

DSW$_{LL\ right}$ - DSV$_{NL\ right}$ = ΔDSV$_{right}$

4. Subtract the smaller difference from the expected calibration value "normal level rear left" to obtain the calibration value to be entered for the "lower level rear".

Selection of ΔDSV$_{LL}$:

ΔDSV$_{right}$ > ΔDSV$_{left}$ ➔ ΔDSV$_{LL}$ = ΔDSV$_{left}$

or

ΔDSV$_{left}$ > ΔDSV$_{right}$ ➔ ΔDSV$_{UN}$ = ΔDSV$_{right}$

Calibration input value IV$_{LL}$:

DSV$_{NL\ left}$ - ΔDSV$_{UL}$ = IV$_{UL}$

The data thus computed are stored via the PC prior to actual calibration. The calibration process is then initiated as follows:

– Take vehicle to its normal level.

– By initiating the calibration process, this level is recognised as the normal level.

After the individual calibration phases are completed, the PC will check the fault memory and indicate whether calibration completed correctly or incorrectly.

The **third option** for making the calibration values known to the electronic control unit is to enter the distance sensor values directly. This can only be done with a PIN. To do this, the distance sensor values have to be known.

In theory, calibration can also be done without a DC/PC. However, this should be done in emergencies only because it involves a complex procedure which has to be followed scrupulously. For further information, please contact the WABCO Customer Service Department.

Note: 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.

10.2 Pressure sensor calibration

The process of pressure-sensor calibration aligns the pressure sensor with the ECU. The pressure sensor values are given in counts.

Pressure sensor calibration is necessary in up to 3 cases:

1. Pressure sensor calibration for calibrating to atmospheric pressure.

2. Pressure sensor calibration for defining the permitted bellows pressure on the driving axle in normal operation.

3. Pressure sensor calibration for defining the permissible bellows pressure on the driving axle with traction help activated.

10.2.1 Pressure sensor calibration for calibrating to atmospheric pressure

Calibrating the pressure sensor for atmospheric pressure calibration is by far the most frequently required pressure sensor calibration. This type of calibration is referred to in general when pressure sensor calibration is discussed.

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. To ensure this, it is safest to unscrew the pressure sensor from the bellows and to measure the ambient.

Calibration of the pressure sensor can be done via the PC. To do this, call up the "Calibrate Pressure Sensor" menu item of the diagnostic software.

10.2.2 Pressure sensor calibration for defining the permissible bellows pressure on the driving axle in normal operation.

Calibration of the pressure sensor for defining the permitted bellows pressure on the driving axle during normal operation is a calibration procedure which is required in vehicles with CAN electronic control units.

The supporting bellows pressures on the driving axle at which the lifting axle is lowered/the load is transferred from the trailing axle are in this case not specified to the electronic control unit by parameter settings, but instead using this calibration process. To generate the required bellows pressures, the corresponding pressure must be created in the supporting bellows by loading the vehicle accordingly, or else the pressure sensor must be unscrewed and a pressure simulated using a precision control valve.

The supporting bellows pressure is made known to the electronic control unit in this condition; this being the pressure which, if exceeded, leads to the lifting axle being lowered/the trailing axle being raised.

10.2.3 Pressure sensor calibration for defining the permissible bellows pressure on the driving axle with traction help activated.

Calibration of the pressure sensor for defining the permissible bellows pressure on the driving axle when traction help is activated is a calibration procedure which is required in vehicles with CAN electronic control units.

The supporting bellows pressures on the driving axle which are not allowed to be exceeded when traction help is activated are in this case not specified to the electronic control unit by parameter settings, but instead using this calibration process. To generate the required bellows pressures, the corresponding pressure must be created in the supporting bellows by loading the vehicle accordingly, or else the pressure sensor must be unscrewed and a pressure simulated using a precision control valve.

The supporting bellows pressure is made known to the electronic control unit in this condition; this being the pressure which is set when traction help is activated and is not exceeded.

When the parameters have been set and the calibration process has been completed, initial start-up has been completed. After exiting from the diagnosis program (it might be advisable to read out the fault memory again first!), the vehicle is ready for operation.

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11. Safety Concept

In order to check the functioning of ECAS, the ECU:

- testing the electrical connections to the individual components for the various control processes,
- Compares the voltages and resistance values to the nominal values,
- checking the sensor signals for plausibility.

Faults which occur are written into a diagnostic memory and (if they are currently present) can be displayed using a fault lamp or on a display.

Indication of fault responses by lamps

In ECAS systems without CAN data transmission, up to 4 lamps can be fitted in order to provide information about special operating conditions as well as faults. Every time the ignition is switched on, the lamps will come on for a few seconds as a function check.

The following different lamps are used:

1. **Warning lamp (4x2 and 6x2 vehicles):** indicates whether the system is outside normal control mode. (In some versions, the warning lamp may indicate minor faults or a plausibility warning.)

2. **Fault lamp (4x2 and 6x2 vehicles):** indicates whether there is a fault active in the system. In this case, a flashing light (severe fault) takes precedence over a steady light (minor fault).

3. **Lifting axle lamp (only 6x2 vehicles):** displays whether the lifting axle is raised.

4. **Traction help lamp (only 6x2 vehicles):** indicates whether the traction help is active.

Various meanings of warning lamp ON

- functional test of the warning lamp after the ignition has been switched on
- at least one measured actual level is not at the current normal level after ignition ON and lamp test
- the distance between the vehicle body and the axle is not at the normal level
- level change command has been issued
- normal level shift "lifting axle" (increased distance between the vehicle body and axle when the lifting axle is raised) in progress (6x2 vehicles)
- normal level shift "traction help" (= increased distance between the vehicle body and axle when the traction help is activated) in progress (6x2 vehicles)
- a minor fault is present (in some versions)

- a plausibility warning is being displayed (in some versions).

The fault lamp displays faults in the ECAS system and, depending on the severity of the fault, may either display a steady light (minor fault) or flash (severe fault). If a fault occurs, this will not only cause the signal lamp to light up or flash, but also triggers the following reactions depending on the severity and type of the fault:

- If the fault is **minor** or if the voltage supply is insufficient (voltage between 5 and 18 volts): no further reaction.
- In case of **plausibility errors:** temporary and also partial shut-down of the system is possible.
- If the error is **severe**: The system is switched off.

The severity and characteristics of a error are described as follows:

11.1 Minor faults which do not cause a shut-down of the system

The following faults are referred to as "minor faults". The system can still operate with restrictions, meaning that the vehicle does not have to be taken out of service immediately:

- Failure of a distance sensor if the same axle has another distance sensor.
- Failure of one or both pressure sensors.
- Error in the data stored in the ECU.

The system responds as follows in the event of minor errors

- The fault lamp lights up.
- The fault is stored in the non-volatile memory of the ECU.

Minor errors permit a limited function of the ECAS system. After the error has been corrected, the system returns to normal operation.

11.2 Plausibility errors causing the system to be switched off temporarily

There are no pressure sensors connected to the inlet and outlet ports of ECAS solenoid valves, which means faults in the pneumatic system can only be detected indirectly. To do this, the reaction of the vehicle body is evaluated on the basis of the distance sensor values being sent to the electronic control unit. In the event of a LIFT vehicle body, for example, command is sent to the vehicle body

then the distance sensor values must increase after a certain length of time. If the distance sensor values are different from the expected response, the electronic control unit signals a plausibility error, which means the reaction of the vehicle body deduced from the distance sensor values is not plausible.

Malfunctions which can cause a plausibility error to be reported:

• The ECAS solenoid valve is failing to pressurise or evacuate the supporting bellows.
• The ECAS solenoid valve remains in its air intake or exhaust position although the control process has been completed.
• Lines blocked or kinked, insufficient supply pressure.
• Leakage in the supporting bellows.

Reactions of the system in the event of plausibility errors:

• The fault lamp lights up.
• The fault is stored in the non-volatile memory of the ECU.
• The current control process and levelling control are aborted.

Solving temporary error in operation or error which merely seems to exist:

– Switching the ignition off and on again.

or

– pushing any button on the remote control unit.

If the error does not re-occur, the system is operating as usual. The fault will, however, continue to be stored in the electronic control unit until it is deleted.

Severe faults causing the system to be switched off permanently.

11.3 Severe faults

Severe error cause the system to be switched off permanently. They are divided into two categories.

Category I

ECAS can no longer execute any functions.

Category I includes the following faults:

• A fault has been detected in the program of the ECU (ROM module),
• a storage cell in the ECU's main memory (RAM) is defective,

• a valve relay is interrupted (no contact from Terminal 30) or has a short circuit/ an external voltage at the valve-outlet port.

Category II

Emergency operation is possible via the remote control unit. Axle preselection will definitely be working. Lifting/ Lowering of the vehicle body is possible by pressing the LIFT/LOWER button on the remote control unit, provided there is compressed air available for lifting/lowering.

Category II includes the following faults:

• Parameter error: The checksum of the parameter values has changed or the parameters have not been set in the ECU.
• Calibration error:
    • The calibrated sensor values are outside their permissible tolerance.,
    • the calibration data memory is defective (check total has changed),
    • no calibration has been performed yet.
• Interruption or short circuit on a solenoid valve or in a cable leading to the solenoid valve (ECAS or load-sensing solenoid valve).
• Failure of all distance sensors on one axle.
• Standard value for distance sensor evaluation circuit or its checksum is incorrect or does not exist.
• WABCO-specific data are faulty.

System reactions to severe faults:

• The fault lamp flashes.
• The fault is stored in the non-volatile memory of the ECU.
• automatic shutdown of the entire system.

⚠ If errors of category I and II prove impossible to eliminate, the ECU must be replaced.

After eliminating the fault, the system can be taken back into operation by switching the ignition OFF/ON.

The fault will, however, continue to be stored in the electronic control unit until it is deleted.

Output of fault responses via CAN message

In ECAS systems with CAN data transfer, information relating to level warnings and fault messages are sent as CAN messages and displayed using suitable display equipment. Outputting detected faults in CAN messages makes it possible to treat the information in a very detailed way. However, a detailed explanation is beyond the scope of this document. The detailed fault resolution

make partial function shut-downs possible while maintaining basic functions.

Reaction of the system in the event of intermittent contact

If an error is temporary, e. g. caused by intermittent contact, it will be displayed, or the system switched off, only as long as the error prevails. The type of error is irrelevant. However, the error will always be stored in the error memory so it can be localised in subsequent repairs. The error will, however, continue to be stored in the ECU until it is deleted.

Errors not detected by the ECU:

- **A burnt filament of the signal lamp**

! It is up to the driver to check that the lamps are working when the ignition is switched on.

- **Malfunction of the remote control unit**

The remote control unit does not transmit signals continuously and it may also be disconnected at times. The ECU cannot check the function of the remote control unit. Usually, a malfunctioning remote control unit does

not represent much of a hazard because the person using it will notice immediately that there is an error.

- **Bent linkage of a distance sensor**

Is not detected by the electronic control unit but may result in an inaccurate normal level, or in an inclined vehicle.

- **Failure of a pressure switch or an error of the pressure sensor within a permissible range**

Valid measured values are still being transmitted. The error causes that the permissible axle load might be exceeded.

Faults of this type can only be found if the system is closely inspected.

– The vehicle may have to be re-calibrated after the fault has been eliminated.

⚠ Do not load or unload the vehicle when the warning lamp is flashing to display a fault or when the system is switched off! This is because there will be no response to any changes in level.

11.4   Fault search table

Table 4 provides an overview of possible faults, representative of those reported by customers.

Fault indication	Effect of fault	Possible cause of fault	Suggested remedy
ECAS fault lamp is flashing, ECAS is inactive, LIFT/LOWER function ("emergency function") possible with remote control unit.	ECAS not working, emergency function maintained.	ECU detects a severe fault of Category II (↑ 11. Safety concept).	Read out the ECAS-ECU fault memory; replace ECU if necessary (↑ 11. Safety concept) or eliminate fault
ECAS traction help lamp on after error is eliminated, vehicle adjusts to normal level I.	ECAS traction help lamp on, traction help active.	Traction help activated (no fault - ↑ 11. Safety concept). or ECU pin traction help received unwanted ground contact.	Traction help switches off automatically or check cabling and traction help button or switch.
ECAS lifting axle lamp on after fault elimination, Vehicle adjusts into normal level I	ECAS lifting axle lamp on, lifting axle remains lowered in unladen condition.	Lifting axle lowering activated (no fault - ↑ 11. Safety concept) or ECU pin "Lifting axle lowering" receives unwanted contact.	Lift lifting axle or check cabling and lifting axle switch.
ECAS warning lamp does not go off after ignition ON.	possible vehicle inclination	vehicle not at normal level	Use remote control unit to bring vehicle to normal level (↑ 6.4 Remote control unit) or drive vehicle faster than parameterised speed at which vehicle moves to normal level.
ECAS warning lamp not working after ignition ON, or ECAS signal lamp but ECAS fully operable.	ECAS lamp does not provide any information (i. e. does not light up at all).	Warning lamp or warning lamp feed line defective.	Repair warning lamp or warning lamp feed line.

Fault indication	Effect of fault	Possible cause of fault	Suggested remedy
ECAS warning lamp on; starts to flash after a while.	ECU does not carry out level changes.	Plausibility error.	Charge compressed air reservoir; check distance sensor for plausible reaction (distance sensor values rising when raising, falling when lowering); delay plausibility fault recognition further; extend plausibility fault recognition limits.
Normal level is increased while lifting axle is being raised.	Vehicle is slightly above normal level.	No fault; normal level increase according to permitted desired level increase when lifting axle raised.	Adjustment of corresponding parameter required if legal maximum heights are exceeded.
No switch-over from normal level I to normal level II when vehicle is unladen and axle is lifted.	Normal level II cannot be set.	Normal level II is higher than normal level I by same distance as lifting axle normal level shift; no fault.	Alter corresponding parameters if necessary.
Lifting axle cannot be raised by remote control unit.	Lifting axle stays on the ground.	Vehicle load too heavy - no error or defective remote control unit or defective pressure switch/ pressure sensor or wrong parameter setting for lifting axle control.	Unload vehicle or fit a new remote control unit or fit a new pressure switch/pressure sensor or change parameter setting.
Vehicle body above rear axle is being raised or lowered continuously.	Continuous control, continuous change of normal level.	Directional control valves 2/2 of RA valve block remain open. Sensor leap. ECU defective.	Replace solenoid valve block. Check/replace distance sensor, replace ECU.
Continuous actuation of ECAS solenoid valves when in motion.	Unchecked raising and lowering of vehicle body while vehicle is moving.	no speed information or incorrect parameter setting of basic function (nominal value tolerances; control parameter $K_P + K_D$)	ECAS solenoid valve leaking or check wiring ABS/EBS-ECAS or check wiring ABS/EBS-ECAS or alter parameter settings.
Traction help and lifting axle function cannot be activated.	Lifting axle stays on the ground.	Load does not permit activation or pressure sensor defective or no pressure sensor signal via K-line (EBS).	Check load – no fault or replace pressure sensor. check EBS system, check K-line.
Lifting axle cannot be lowered.	Lifting axle remains raised.	Remote-control unit defective or pressure sensor defective or no pressure sensor signals via CAN line. No supply pressure.	Replace remote control unit or replace pressure sensor. Check the CAN line. Check pressure.
If two distance sensor installed on driving axle, vehicle body tilted.	Vehicle body inclination.	Sensor linkage bent or uneven surface - no fault. Stabiliser distorted. Rubber on linkage has slipped.	Straighten distance sensor linkage or check nominal value tolerance set in parameters between 2 distance sensors on driving axle and alter if necessary recalibrate vehicle. Tighten rubber.
If 1 distance sensor is installed on the driving axle, vehicle body tilted and different supporting bellows pressures.	Vehicle body inclination.	Transverse throttle in ECAS solenoid valve (one distance sensor) or stabiliser distorted.	Replace ECAS solenoid valve or re-calibrate the vehicle. Check stabiliser.
Remote control unit is not accepted by ECAS after parameter setting.	No lifting/lowering possible with remote control unit.	Remote-control unit not connected to ECAS during calibration.	Re-calibrate vehicle while remote control unit is connected.
Fault search cannot be started with PC although ECAS-ECU is functioning.	No fault search possible via PC.	Wrong ISO address setting or diagnostic line/socket defective or measuring value output switched on.	Set ISO address to 18 or repair diagnostic line or switch off measured value output.

Fault indication	Effect of fault	Possible cause of fault	Suggested remedy
Desired level cannot be changed by remote control unit.	No change in desired level.	No axle preselected on remote control unit or ignition OFFor if several remote control units: Changeover switch is in wrong position or remote control unit is defective.	Preselect axle or ignition ON or put changeover switch into correct position or replace remote control unit.
No reaction of ECAS solenoid valves while loading/unloading.	No levelling control.	ECAS deactivated or control day at standstill set too high or nominal value tolerances too great.	Switch on ECAS - select STAND-BY function (↑ 6.4 Remote Control Unit) or reduce control delay at standstill or correct excessive nominal value tolerances.
Neither parameter settings nor calibration possible for ECAS-ECU.	ECAS-ECU does not respond.	ECU defective. Water in the ECU.	Replace ECU. Eliminate the cause for water penetration.
Lifting axle is swinging (lifting/lowering).	Lifting axle does not remain in assigned position.	Parameter configuration not ideal. Pressure sensor/cable defective.	Increase difference between parameters (pressure difference). Check, replace as necessary.
Lifting axle is in "laden" condition.	Lifting axle remains lifted although full load is assumed.	No error, as the load does not achieve the pressure applicable to the maximum axle load.	Improved customer information service. Lower the corresponding parameter.