WABCO TRAINING

ABS-Training

Edition October 2003

Price € 26,00

WABCO

Vehicle Control Systems
An American Standard Company

WABCO
Am Lindener Hafen 21
30453 Hannover
Phone 49 / 5 11 / 9 22-0
Fax 49 / 5 11 / 2 10 23 57
www.wabco-auto.com

Wabcodruck 815 000 437 3/10.03

WABCO TRAINING

ABS-Training

TRAINING | WABCO

WABCO

WABCO sets milestones
in commercial vehicle technology

Yesterday

Compressed-air braking systems for commercial vehicles were introduced about 90 years ago. The introduction of the anti-blocking systems represented the first substantial safety function that was electronically controlled. ABS has been developed constantly in recent years and has become the standard in most makes of car on the basis of statutory regulations. Further developments led to anti-spin systems and electronic braking systems (EBS, also known as “brake by wire”), which further improved the safety of commercial vehicles. The same applies to dynamic road-holding systems, which are currently in the phase of being introduced on heavy goods vehicles and on driver-assistance systems.

Today

The WABCO product range covers the following product segments:
– compressed-air purification
– compressed-air disc brakes and actuation cylinders
– brake control systems (ABS, EBS, ESC)
– running gear control systems (ECAS, ESAC)
– gearbox control systems
– electronic-architecture systems
– car air-suspension systems.

WABCO has been regarded for many years now as the global leader in the field of compressed-air regulation systems.

WABCO’s worldwide customers include all the commercial vehicle manufacturers in the field of goods vehicles, buses, and trailers. In addition to this the company also maintains business relationships with many module manufacturers such as those producing axles, gearboxes, and retarders, and also with a large number of car manufacturers.

The company has set itself the goal of extending some of the product segments listed above in order to keep the proverbial “nose ahead” technologically and to provide its customers with the highest quality and functionally most advanced products available.

Tomorrow

More than 700 engineers and technicians, mainly in the European development centres but also in the USA, Brazil, Japan, Korea, and China, are working to maintain and extend this technological lead.
Collaboration with all the leading vehicle manufacturers, universities, industrial associations, component suppliers, and other partners is just as much part of the company's recipe for success as the constant application of the latest development techniques and the company's own test tracks near Hanover and the Arctic Circle.
In addition to team spirit and know-how the WABCO developers, test drivers, engineers, mechanics, software experts and others can contribute an aggregate 10,000 years of shared experience in order to bring more safety onto the roads, day in day out.

The day after tomorrow

ABS, the Anti-Blocking Systems, and EBS, the Electronic Braking Systems, were only the beginning.
The future looks like this: further development and improvement of existing systems, innovative strength and technology for the new millennium. For instance: ACC (Adaptive Cruise Control), which will automatically set the right separation between one lorry and the next; perfection of the running gear control systems such as ESC (Electronic Stability Control for lorries and trailers, computer-assisted (and even satellite-supported) systems that will make the traffic on the roads the day after tomorrow safer and driving easier – and a great deal more besides.
WABCO is taking up this challenge.

Right now.

WABCO is the leading supplier of electronical brake and control systems as well as suspension and drive line systems in commercial vehicles.
Roundabout 5.600 employees in 12 european countries, Brazil, South Corea and Joint ventures in the U.S., Japan, India, South Africa and China make yearly sales of more than 1 billion US $.

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

Founded in the US 136 years ago as Westinghouse Air Brake Company, WABCO was acquired by American Standard in 1968. Headquartered in Brussels, Belgium, the business today employs nearly 6700 people in 30 office and production facilities worldwide. In 2004, WABCO contributed US$ 1.72 billion to American Standard's total sales of US$ 9.50 billion.
Website: www.wabco-auto.com

WABCO

Vehicle Control Systems
An American Standard Company

WABCO TRAINING

ABS / ASR Basic

2

ABS-Training

Anti-lock-Braking-System (ABS) and Anti-Slip-Regulation (ASR)

Edition: Oktober 2002

WABCO

Vehicle Control Systems
An American Standard Company

Function:

The function of the **Anti-lock Braking System (ABS)** - generally, also called Anti-lock Device - is to prevent the locking of vehicle wheels after the service brake has been applied too strongly, especially on slippery lanes.

This is meant to also maintain cornering forces on the braked wheels if the brakes are fully applied, and thus guarantee the driving stability and steering capacity of a vehicle or vehicle combination within the physical possibilities. At the same time, the use of the available frictional connection between the wheels and the lane, and thus the braking time and vehicle delay is optimised.

Why ABS?

Despite the high development level of commercial vehicle brakes, accident-prone situations often arise on slippery lanes when brakes are applied. When the brake is fully or even partially applied on slippery roads, the braking force may not be fully transmitted due to the low friction coefficient between the wheels and the lane. The wheels are over-braked and lock. Locking wheels no longer have any road grip and can almost no longer transmit any cornering forces (steering and tracking forces). This often has dangerous consequences:

- the vehicle becomes uncontrollable
- the vehicle swerves, despite the drive into skid, and side-slips
- the braking time becomes considerably higher
- in trailer trains the trailer breaks away, and in semi-trailers, this results in jack-knifing effect.

Effect of the LSV:

Today, the standard automatic load sensing valves(LSV) alone can often prevent the locking of unloaded vehicle wheels on dry roads. Even on wet lanes, they help the driver to brake effectively and gradually, but they cannot prevent the wheels from locking (no slip monitoring). Moreover, they are ineffective against the driver's overreaction and in case of varying side or axle friction or frictional connection ratios **(μ-split** lanes).

Advantages of ABS:

Only the **Anti-lock Braking System (ABS)**

- guarantees a stable braking behaviour on all lanes
- receives the steering capacity and generally reduces the braking time
- prevents the jack-knifing of vehicle combinations
- reduces wheel wear

ABS limits:

ABS is an efficient safety system. Yet it cannot exceed driving physics limits. Even an ABS-equipped vehicle becomes uncontrollable at too high speed.

ABS is, therefore, not an excuse for inappropriate driving methods or too short safe distance!

Why ASR:

On slippery lanes, increasing the engine output of, especially, an unloaded or partially loaded commercial vehicle (acceleration) results in slightly exceeding the maximum frictional connection on one or all driving wheels and in wheel-spin.

So just like locking wheels during braking, spinning wheels are also a danger for safety while moving, or increasing the speed of the vehicle.

Reason:

1. Spinning wheels transmit as less cornering forces as blocking wheels.

2. They no longer transmit any propulsive thrust either on the lane.

The results are:

- vehicles which come to a standstill or even beak down
- vehicles which are no longer controllable and which jackknife on slopes, or swerve while cornering.

Advantages of ASR:

ASR prevents the driving wheels from spinning and offers the following advantages:

- Propulsion thrust and cornering forces are maintained.
- Stable driving behaviour is guaranteed on slippery lanes while moving, and accelerating the vehicle, as well as during cornering.
- The driver receives a warning signal about skidding conditions via a function indicator light (if available).
- Wheel wear is reduced, and the vehicle's drive train is saved.
- The danger of accident is further reduced.

ASR and ABS:

ASR is a sensible extension of an ABS-controlled braking system. You only need an electronic control unit developed around the ASR function and some additional components for differential brake and engine control to make a complete ABS/ASR control system out of the pure ABS. As a result, ASR only exists in combination with ABS.

Even a differential lock and ASR for off-highway are not impossible, but constitute a sensible supplement.

ASR limits:

The traction capacity of all-wheel commercial vehicles cannot be obtained in a commercial vehicle with only one driving axle, even with an optimum ASR.

	The first prototype was presented to the general public after extensive studies at the 1969 International Automobile Show.
1974:	WABCO and Mercedes-Benz sign a co-operation agreement. The system development and vehicle test are continued through joint team work.
1975:	WABCO starts developing its own electronic control unit based on analogue and integrated signal processing. The co-operation is also extended to other manufacturers.
1980:	Introduction of fully digitalised electronic control units. The main item are micro-computers which are used for the first time in commercial vehicles. Final winter tests in the polar circle in the presence of both the national and foreign experts.
1981:	Release of the WABCO ABS system by Mercedes-Benz, and, soon thereafter, also by other vehicle manufacturers. Beginning of series production of the A version (with 2 and 4 channels).
1986:	Introduction of WABCO-ASR (traction control system) with B generation electronic control unit. Introduction of the 6-channel ABS system.
1989:	Introduction of the modular VARIO-C ABS for trailers (with error storage and ISO diagnosis).
1990:	Introduction of C-generation ABS/ASR in motor vehicles (with error storage, ISO diagnosis and, possibly, additional functions) .
As from October 1991:	EC regulation makes the use of ABS for heavy commercial mandatory.
1994:	Introduction of VARIO COMPACT SYSTEMS (VCS) for trailers and integration of the now mandatory speed limiting system in C-generation motor vehicles.
1996:	Introduction of D-generation ABS for motor vehicles and electronic braking systems (EBS) for motor vehicles.
1998:	Introduction of the EBS also for trailers and, gradually, the obligation to use the ABS also in lighter commercial vehicles.
2000:	Introduction of E-generation ABS in motor vehicles, partly with EBL (Electronic Braking force Limiting) in place of LSV.

Simplified theoretical ABS bases:

The braking force correction value (μ_B):

The braking force correction value (frictional connection) between the wheel and the lane determines the transferable braking forces. It is dependent upon the braking slip between the wheels and the lane, and is influenced by:

- the road and wheel condition
- the wheel or axle load
- the vehicle speed
- the temperature
- the wheel slip angle or the required cornering force.

The cornering stability correction value **(μ_S):**

The maintenance of cornering stability is an important condition for the vehicle's steering capacity. The cornering stability correction value decreases much more quickly than the braking force correction value.

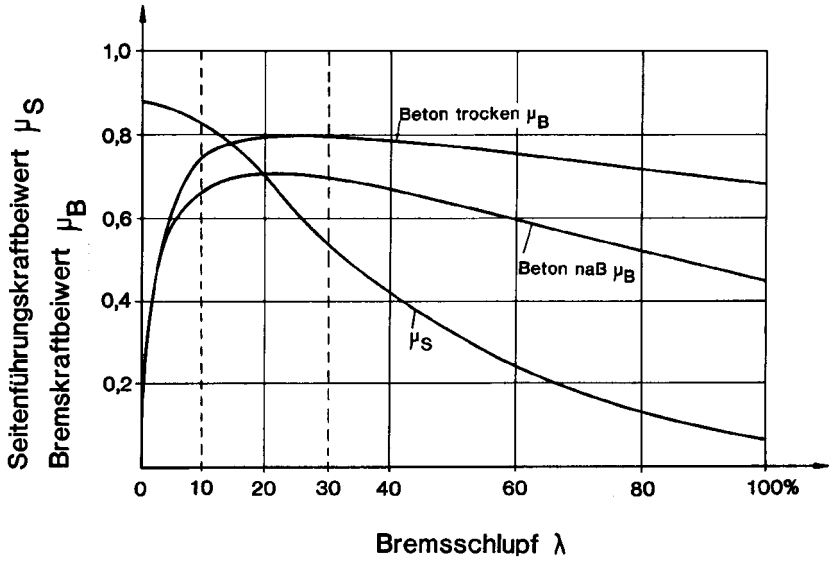
The braking slip (λ):

The braking slip is the percentage ratio of the vehicle speed to the wheel speed. The slip is defined through the equation:

$$\textbf{braking slip } \lambda = \frac{V_F - V_R}{V_F} \cdot 100\ \%.$$

where V_F = vehicle speed
V_R = wheel peripheral speed

Explanation of slip curves (μ_B and μ_S):



The diagram shows the connection between braking force correction value μB, cornering force correction value μS and braking slip λ at different conditions.
So long as the maximum frictional connection is not obtained, the braking force can still be increased in the "stable" area with slip increase. The amount of cornering forces available here is enough to maintain the vehicle control capacity and stability.

If, due to too high braking forces, the unstable area of μ-λ-curve (approximately 30 % to 100 %) is reached, the wheel is overbraked and blocks (100 % slip). The steering capacity is almost completely lost.

To avoid this, the frictional connection is adjusted by the ABS to between 10 % and 30 % slip.

Simplified theoretical ASR bases:

The driving slip (λ_{an}):

Like in braking, the driving power transferred from the wheel to the lane depends on the slip between the wheel and the lane.

The driving slip is the percentage ratio of the wheel speed to the vehicle speed, and is defined through the equation:

$$\lambda_{an} = \frac{V_R - V_F}{V_R} \cdot 100\ (\%)$$

V_R = wheel speed
V_F = vehicle speed

The driving adhesion coefficient (μ_{an}):

The driving adhesion coefficient and, thus, the transferable driving power is dependent upon the same factors as the braking force correction value described above.

The frictional connection in highly spinning wheels (λ_{an} = 100 %) falls considerably below the maximum value. The cornering force correction value also decreases with increasing driving slip is only negligible in slipping wheels.

ASR regulation

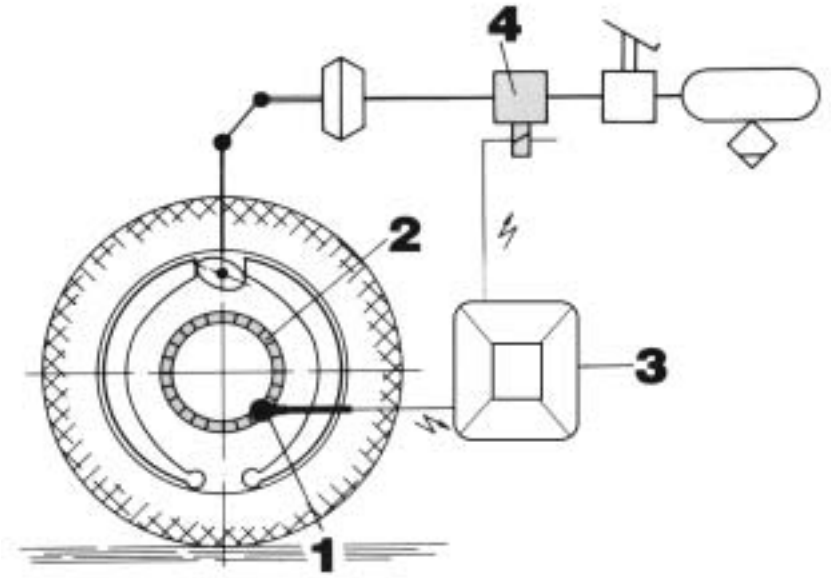
Driving slip regulators only influence the speeding processes if certain wheel-slip or wheel-speed threshold values are exceeded.

Electronically controlled solenoid valves brake the wheel concerned or reduce the engine output until the stable frictional connection range is attained again.

If regulated further, the wheel is maintained at a possibly tight slip range close to the maximum frictional connection.

An ABS control circuit:

Structure:



1 = Sensor, 2 = Pole wheel, 3 = Electronic unit, 4 = Solenoid valve

Operation:

The fixed sensor connected to the axle continuously records each wheel rotation with the help of the pole wheel. The electrical pulses generated in the sensor are transferred to the electronic control unit which determines the wheel speed from it.

At the same time, using a specific method, the electronic control unit determines a reference speed that is not within the range of the measured vehicle speed.

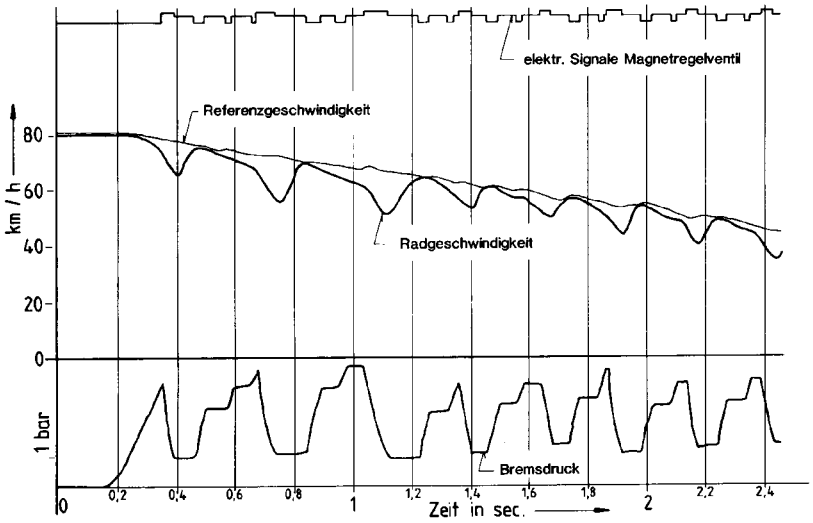
With the help of all this information, the electronic unit continuously calculates the wheel speed values (+b) or the wheel delay values (-b) as well as the braking slip.

If certain slip values are exceeded, the solenoid valve is activated. This limits or even reduces the pressure in the brake cylinder and, thus, maintains the wheel within optimum slip range.

An ABS control cycle:

Example:

The chart concerns **wheel control**. The vehicle's initial speed is 80 km/h.



The control cycles are entered on the abscise based on time. In the ordinate area, the braking pressure is indicated in the lower third, and the reference speed and wheel speed in the middle third. The solenoid valve pulses are in the upper third.

The control process:

The driver actuates the braking system. The braking pressure increases. On the wheel under observation, the wheel speed suddenly decreases much more than the reference speed. Although the wheel is still within the stable range (i.e. between 10 and 30 % braking slip), the electronic control unit starts with the control process.

The ABS solenoid valve and the pressure in the brake cylinder of this wheel quickly fall due to the corresponding control, and the wheel speed starts increasing again.

The electronic control unit sees to the reversal of the solenoid valve, through which the braking pressure is kept constant until the wheel is running again in the stable slip area.

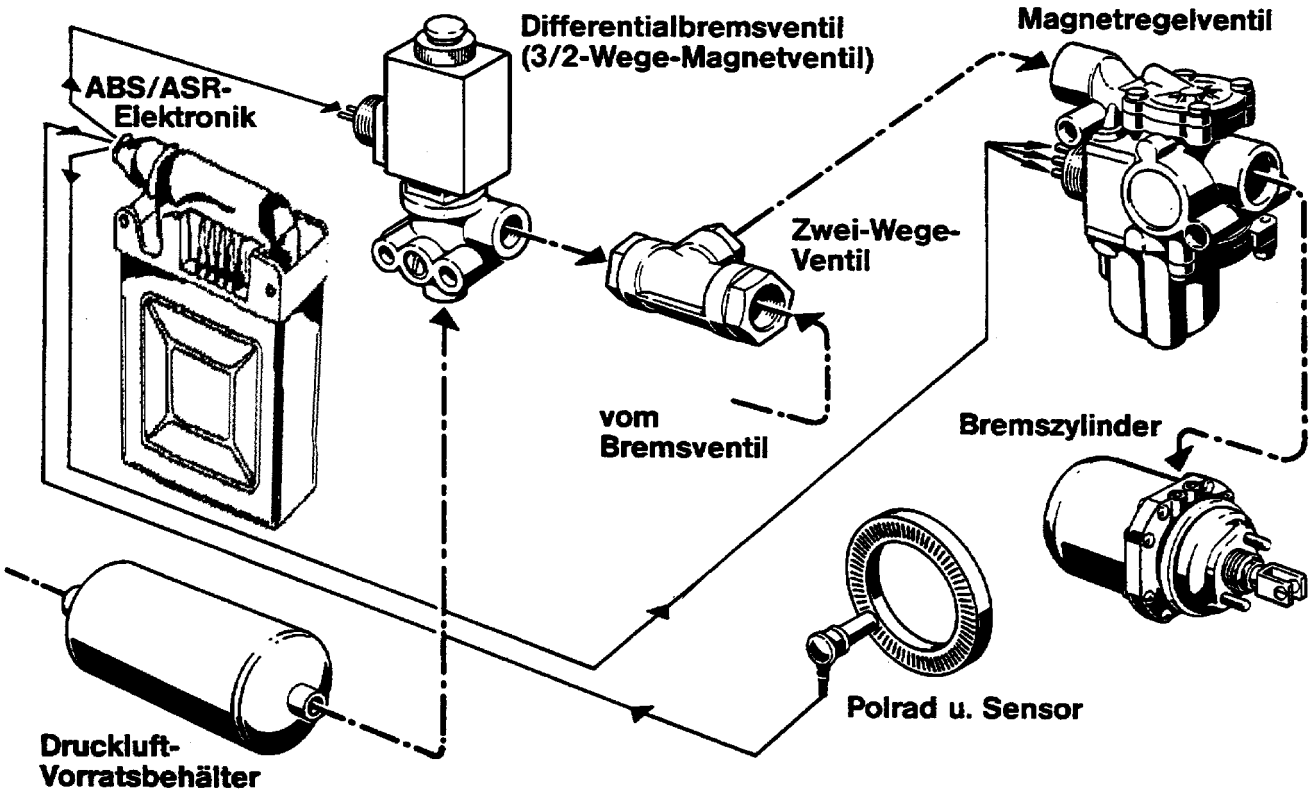
If more braking power can again be transmitted, the braking pressure is increased again via pulses (i.e. pressure level is maintained/increased alternatingly). If in this process the wheel speed falls again remarkably, compared to the reference speed, pressure-maintenance/pressure increase), a new control starts.

This process is repeated as long as the pressure on the brake pedal remains too high for this lane condition, or until the vehicle stops. The maximum possible control frequency is 3 to 5 cycles per second.

Differential brake control:

Immediately after the ignition is turned on, and the vehicle started, the electronic control unit monitors the rotation behaviour of all the wheels beyond a wheel speed of approximately 2 km/h.

The driving wheels' speed and acceleration are compared with those of undriven, diagonal front wheels.



Function:

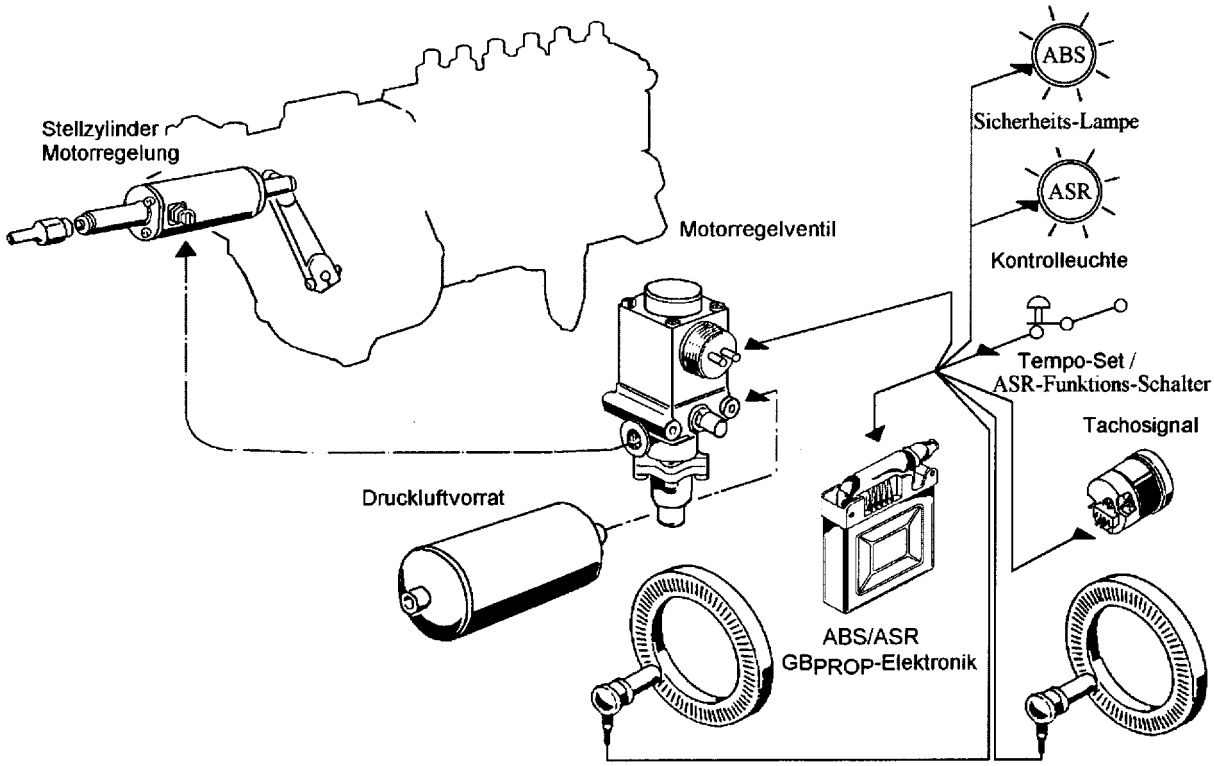
ASR control starts if a specific speed difference or slip threshold is exceeded.

As soon as a driving wheel exceeds the slip threshold during the acceleration process, the electronic control unit activates the corresponding differential brake valve and, thus, the braking pressure in the corresponding service brake cylinder.

The engine driving torque can now support itself on this braked wheel, whereby the driving power on the other wheel increases just like in the differential lock.

Engine control:

As soon as both driving wheels are spinning or the slip on a spinning wheel exceeds a threshold value, the differential brake regulation is switched to engine control, and the engine output is reduced. The differential brake regulation is then only used to synchronise the wheels. Only the engine control function is used at vehicle speed beyond 50 km/h.



Function:

The electronic control unit controls the proportional valve which moves the injection pump's floating lever to idle via the **ASR control cylinder**, even as the driver continues to actuate the driving pedal.

As soon as the wheels are again under the slip threshold due to the engine braking effect, the proportional valve depressurises the control cylinder again. This increases the engine output again to the level chosen by the driver via the accelerator pedal, or until another speed regulation takes place.

Note:

This function can also be used as integrated speed limiting function (**GB_{Prop}**) and meets the statutory specifications on speed limiting devices.

Using differential brake and engine regulation:

In winter, the coefficients of friction on roads often vary. As a result, differential brake regulation and engine regulation complement each other.

On the same lane surface, the regulation takes place, above all, via the reduction of engine speed, and the differential brake regulation limits itself to synchronising the driving wheels.

The differential brake regulation is basically used for the different friction coefficients on each side and pressurises only the brake cylinder of the spinning wheel. The driving torque is thus transferred to the other wheel.

To avoid overheating on the wheel brake, the differential brake threshold value is linearly increased as from 35 km/h so that the slip is regulated more and more through engine speed regulation. No differential regulation is introduced above 50 km/h.

ASR/engine regulation in vehicles with E-Gas:

Electronic engine control is used especially in motor coaches, but also increasingly in other vehicles. The mechanical linkage between the driving pedal and the injection pump is no more applicable, save a short connection between the electric servomotor and pump floating lever.

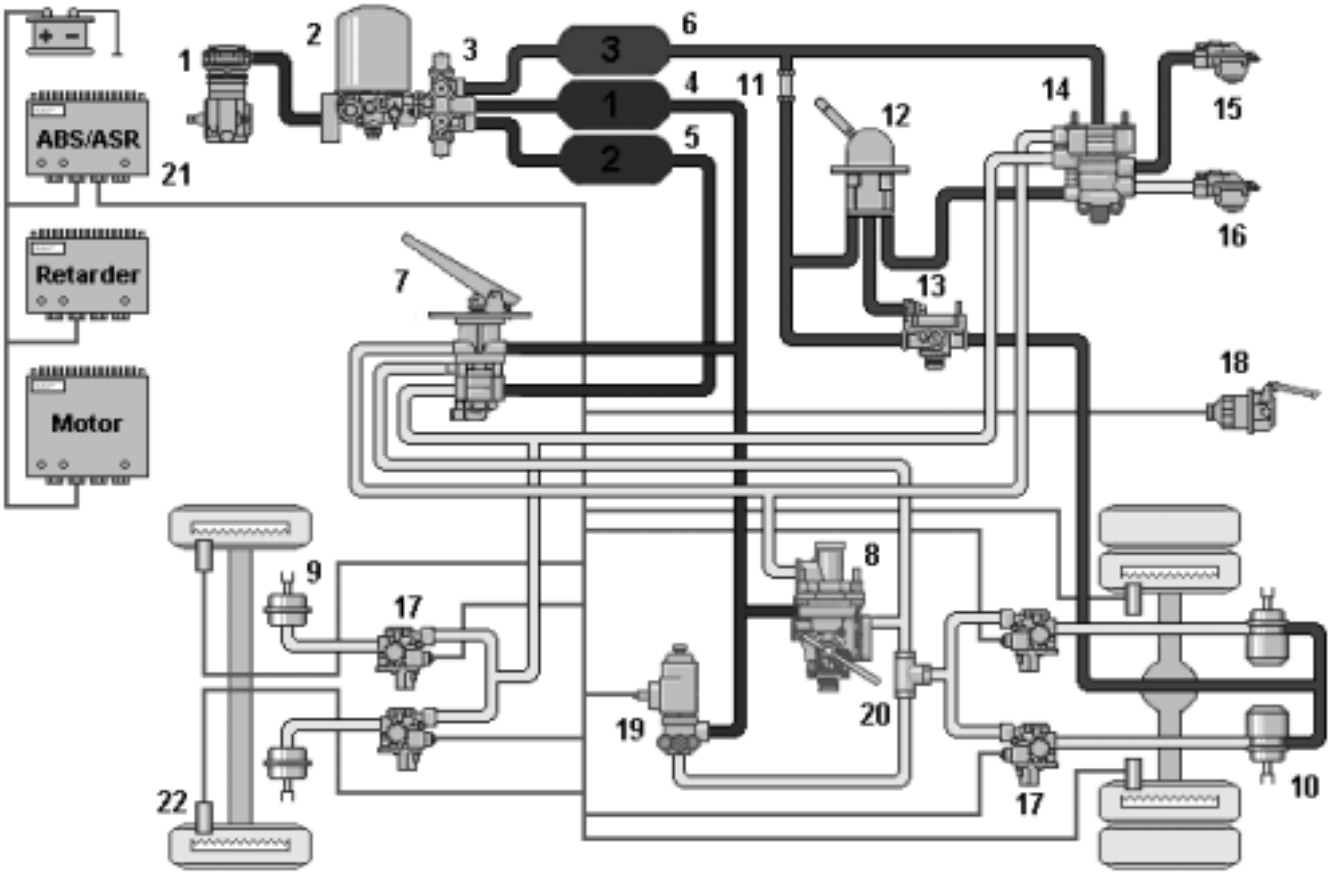
The mechanical linkage is now replaced with an electric set-value indicator on the driving pedal (potentiometer) and a servomotor located close to the injection pump.

The control signal given by the **ABS/ASR electronic control unit** is then transmitted via the digital interface or CAN signal to the E-Gas electronic control unit which in turn transmits the corresponding control commands to the servomotor.

Traction mode und ASR off-highway switch:

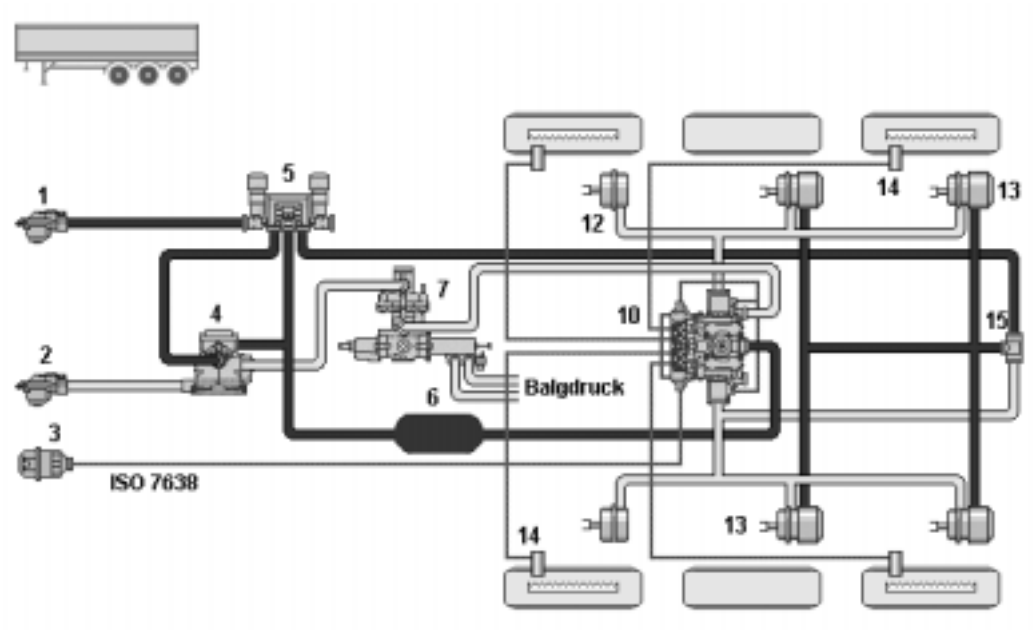
In the presence of much snow or similar conditions, the tensile force can be increased by actuating an optional "ASR off-highway" switch. If this switch is actuated, the electronic control unit changes the conditions (slip thresholds) for ASR control, to allow higher slip conditions. To notify the driver about the possibly reduced stability, the ASR lamp flashes in equal cycles when the switch is actuated.

Structure of an EC compressed air braking system with ABS and ASR in motor vehicles:

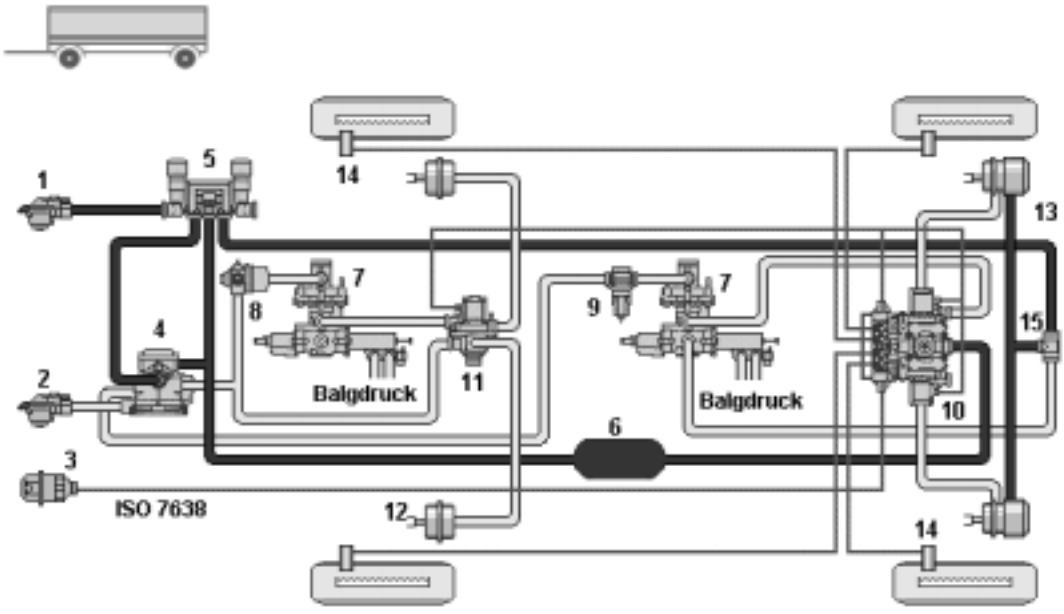


1	Compressor	**12**	Hand brake valve
2	Air dryer with unloader	**13**	Relay valve
3	Four-circuit protection valve	**14**	Trailer control valve
4	Air reservoir for circuit 1	**15**	Coupling head "supply"
5	Air reservoir for circuit 2	**16**	Coupling head "brake"
6	Air reservoir for circuit 3	**17**	ABS solenoid valve
7	Brake valve	**18**	ABS push-in connection
8	LSV	**19**	ASR solenoid valve
9	Brake chamber VA	**20**	Two-way valve
10	Tristop spring brake HA	**21**	ABS/ASR-ECU (D version)
11	Check valve	**22**	ABS sensors

Structure of an EC compressed air braking system with ABS in trailers / semi-trailers:



1	Coupling head "supply"	**9**	Pressure limiting valve
2	Coupling head "brake"	**10**	VCS/ABS ECU with ABS horizontally opposed relay valve
3	ABS push-in connection	**11**	ABS relay valve steering axle
4	Trailer brake valve	**12**	Brake chamber
5	Dual release valve (BBA / FBA)	**13**	Tristop spring brake
6	Air reservoir	**14**	ABS sensor
7	LSV	**15**	Two-way valve
8	Adaptor valve		



Electronic control device 446 003/004 ... 0 in motor vehicles:

Function:

The electronic control device, (also known as **ECU** = Electronic Control Unit) calculates the vehicle and wheel speed as well as wheel delays and accelerations, using sensor signals. If necessary, it controls the solenoid valve to prevent the vehicle wheels from locking.

How it works:

The 4 and 6-channel electronic control units have a dual-circuit structure. Each circuit monitors two (in 6-channel ECU 3) diagonal vehicle wheels and are divided into four functional groups:

A/B-generation ECU:

- Input circuit
- Master circuit
- Safety circuit
- Valve control

Signals generated by the speed sensors are filtered in the **input circuit** and converted to digital information.

C-generation ECU:

The **master circuit** consists of a micro-computer. Control signals are calculated, logically interconnected and transmitted to valve control using a complex program.

The independent **safety circuit** in each circuit basically contains a safety computer and checks the entire ABS device, i.e. the sensors, solenoid control valves, EU and wiring, when the vehicle starts moving and during the drive.

D-generation ECU:

It warns the driver about possible errors, via the warning light and switches off the control of a wheel or of both diagonal wheels and, in certain situations, the entire ABS. The braking remains fully active in this process; only the lock-protection and the ASR are partially or fully deactivated.

In C and D-generation ECUs, detected errors are continuously recorded for diagnosis purposes. The error memory can be read and deleted via the diagnosis connection (in accordance with ISO standards) or via blink code energisation.

D-Basic ECU:

The **valve controls** contain power transistors (power stages) controlled by the signals from the master circuit, and switch the current for control valve actuation.

Variants:

The electronic control units are supplied in **4-channel** (**446 004 ... 0**) and **6-channel variants** (**446 003 0.. 0**) for 24 V- or 12 V vehicle power supply voltage. Moreover, for vehicles with combined braking systems (Air Over Hydraulic or AOH systems), with only one air/hydraulic cylinder on the steering axle, special 4S/3M ECUs are offered, i.e. the front axle is controlled with a single solenoid valve.

The control of unsteered axle(s) is done on an individual basis (**IR**). The steering axle is individually modified and controlled (MIR). On the other hand, modified axle control (**MAR**, see trailer ABS) is used on the steering axle of vehicles with 4S/3M electronic control units.

In earlier **A and B-generations**, the electronic control units were used both in **motor vehicle and trailer ABS.** With the introduction of the **C-generation ABS**, a distinction is made between **motor vehicle ECUs and trailer ECUS** (**VARIO-C** or. **VCS** systems), due to the integrated special functions (example: ASR, GB_{Prop}).

Compatibility:

The B and 4-channel C generation ECUs (35-pin plug) are compatible upwards.

The use of a 54-pinplug was necessary for the 6-channel C generation ECUs. Adapter plugs with 35 to 54-pin plug connection do exist for diagnosis purposes.

The D-generation control units are not compatible downwards since the wiring harness and plug concept (modular structure) have changed.

Installation:

The electronic control unit is installed under protection in the driver's cab. In trailers, the electronic control unit was mounted in a special protective housing on the vehicle chassis.

Checks:

The ECU as well as the connected solenoid valves, sensors and wiring are checked by the integrated safety circuit, with error report.

Any ECU check going beyond this must only be done during a special maintenance check in the manufacturer's workshop.

Note:

Switch off the ignition before removing or installing the electronic control unit, i.e. before removing or installing the electronic plug!

VARIO-C-control unit for trailer ABS 446 105 ... 0:

Structure:

The VARIO-C ABS electronic control device for trailers is based on the same electronic technology development level as the C-version control device for motor vehicles, but was designed for the special trailer conditions.

This includes suitability for installation on vehicle frames, the modular system construction kit structure, with up to 6 sensors and 3 solenoid valves (6S/3M), as well as the recognition of maximum two lifting axles.

How it works:

The VARIO-C electronic control unit has a single-circuit structure and can be divided into four circuits - like the previously described ECUs:

- IInput circuit
- Master circuit
- Safety circuit
- Valve control

It processes signals from **three functional groups with two sensors and one solenoid valve each** the presence of which is detected automatically. Detected errors are also continuously recorded for diagnosis purposes. The error memory can be read and deleted via the diagnosis connection (in accordance with ISO standards) or via blink code energisation.

Variants:

The electronic control units are available for 24 V or 12 V vehicle power supply voltage.

Apart from a **Standard ECU** for the respective voltage ranges which can control all possible 2S/1M to 6S/3M systems, there is also **an under-equipped variant** specially designed for semi-trailers, with which only 4S/2M systems and lower can be controlled.

A special ECU (**VARIO-C plus**) can either be used with ABS solenoid relay valves or with ABS solenoid control valves (also with mixed axles).

Checks:

The same instructions as for motor vehicle ECUs apply for the checks.

VARIO Compact ABS (VCS) for trailers (446 108 ... 0 or 400 500 ... 0):

Design:

The VARIO-COMPACT-ABS electronic control device is an upgrade of the proven VARIO-C ABS and is based on the latter's tested system.

VCS is an installation-ready ABS system for trailers, which meets all the legal requirements for category A.

Variants:

In line with the various requirements of vehicle manufacturers, VCS is available as a **compact unit** (control device with integrated and cabled solenoid valves), or in **separated design**, i.e. the electronic control unit and the solenoid valves are fitted separately

400 500 ... 0

Since the device has external plugs and modern cable plug connections, the electronic control unit no longer needs to be opened during installation or diagnosis.

446 108 ... 0

The system range varies from the 2S/2M system for semi-trailers to a 4S/3M system for drawbar trailers or semi-trailers with steering axles.

Operation:

The VCS electronic control unit has a single circuit, with one, two, or three control channels, like the afore-mentioned electronic units, divided into four circuits:
- Input circuit
- Master circuit
- Safety circuit
- Valve control

Detected errors are continuously stored here for diagnosis purposes. The failure memory can be read and deleted using a flashing code stimulation or the ISO diagnostic connection.

Test:

The same instructions described for the electronic control unit apply to the test.

Rod sensor 441 032 ... 0 and Pole wheel:

Function:

Rod sensors and pole wheel sensors record the wheel rotation. The pole wheels for medium-weight and heavy commercial vehicles have 100 teeth. Pole wheels with 80 teeth are also used for wheels with small rolling circumference. Due to the diagonal reference speed development in the electronic control unit, the tooth number and wheel range ratio on the front and rear wheels must be equal but for a few percent.

Operation:

The inductive rod sensor consists mainly of a permanent magnet with a round pole pin, and a coil. The magnetic flux recorded by the sensor coil is changed by the rotation of the pole wheel connected to the wheel hub, thus generating an alternating voltage whose frequency is proportional to the wheel speed.

Variants:

The rod sensor was specially designed for the increasing requirements in commercial vehicles. High thermal stability and vibration resistance guarantee its operational safety, also in extreme cases.

The output voltage of new WABCO sensors were increased at the same wheel velocity, by modifying the internal sensor structure. This way, even with increased air gap, the ABS and ASR drive is still secured at low wheel velocity. The sensor heads are marked with a "**K**", or an "**S**" , or an "**S**". They are system compatible and can be used with old sensors.

Since the introduction of the VARIO-B cabling system, WABCO has been offering sensors with injected sockets which, with special sensor extension cables of different sizes, facilitate, in particular, the equipment of trailers.

Sensor-Einbau:

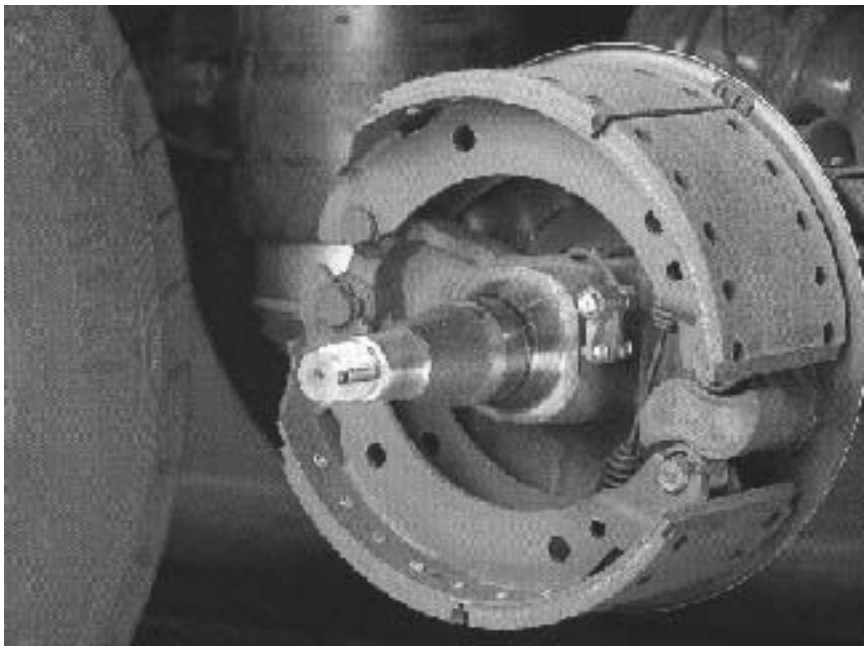
The Sensor is clipped via **clamp bushing 899 760 510 4** (CuBe) or **899 759 815 4** (CrNi) in a hole on the steering knuckle, or in a special sensor bracket.

On the front axle, on a **mounted wheel**, the sensor is hand-pushed into the clamp bushing up to the limiting stop. On the **rear axle** or on **trailer axles**, the sensor is pushed into the clamp bushing up to the limiting stop on dismounted wheel hub, and pushed out so far that the sensor is in contact with the pole edge.

Note:

It is not necessary to set a minimum air gap for the sensor, since it sets itself automatically during the first wheel turns, due to the wheel bearing slackness.

Example of sensor installation on trailer axle

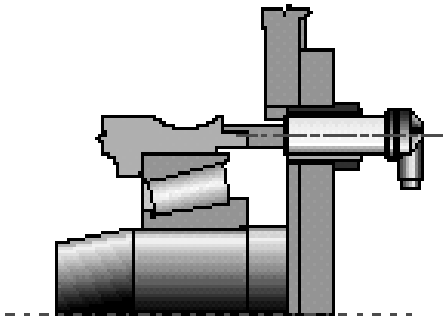


Lubricant:

For adaptations exposed to high dirt accumulation, we recommend that you use clamp bushing and sensor with a thermally stable and splashing water-resistant lubricant, in order to protect the steering knuckle hole against corrosion and dirt accumulation.

We recommend: "**Klueber Staburags NBU 30 PTM**"
1 kg dose order No. 830 502 063 4
8 g tube order No. 830 502 068 4

Maintenance:



In addition to the regular wheel bearing slackness checks, the sensor should be pushed in again till the limiting stop while working on the wheel brake.

To adjust the sensor (in case of too wide air gap), do not use force or inappropriate tools such as pointed or sharp objects, to avoid damaging the sensor cap!

We recommend that you also replace the clamp bushing **while replacing a sensor**.

Test:

PC Diagnostic or Diagnostic Controller can be used to check the sensor coil resistance, the air gap setting and the sensor/wheel co-ordination.

ABS-Magnetventile 472 195 ... 0:

Function:

The function of solenoid control valves is to adapt the brake cylinder pressure during a braking process, regardless of the control signal from the electronic control unit. Moreover, they are used for ASR differential brake regulation on the driving axle.

They allow the three ABS functions:

- Pressure build-up
- Pressure retention
- Pressure release

Variants:

Solenoid valves are available for use with 24 volts and also with 12 V vehicle power supply voltage.

The different variants are due to the port thread form (metric thread, inch thread, stepped hole for Voss connector) and the fastening of the connector pins (Kostal plug adapter, bayonet locking mechanism or snap-on plug). A variant with fording ability is also available for special vehicles.

Operation:

The device consists of a dual solenoid and dual diaphragm part. The very fast solenoid valves merely switch the pressure in the diaphragm's inshot chambers. These latter then control the brake cylinder pressure via the corresponding cross sections.

a. Pressure build-up

Both solenoids (I and II) are not actuated (free position).

Incoming pressure at port (1) opens the inlet diaphragm (4) immediately. Due to the resultant pressurisation of chamber (b), compressed air flows via port (2) to the brake cylinder and to the ring channel (d) above the outlet diaphragm (5). At the same time, compressed air flows through channel (a) via the open valve to chamber (e) below the outlet diaphragm (5). If no control takes place, the solenoid control valve does not reverse. Each pressure increase at port (**1**) is transferred to port (**2**). Reverse is also the case for each pressure decrease.

b. Pressure decrease:

Both solenoid valves (I and II are actuated. Valve (8) is closed, and valve (9) opened by solenoid I (EV). The compressed air building up at port (1) flows through chamber (g) and channel (h) into chamber (k) and closes the inlet diaphragm (4) there.

Solenoid II (AV) closes valve (7) and opens valve (6). The pressure in chamber (e) is thus reduced via the exhaust (3). The output diaphragm (5) opens.

The braking pressure at port (2) is released via chamber (c) and channel (f), at the exhaust (3) into the atmosphere until the solenoid valve is reversed.

c. Pressure retention:

Only solenoid I (EV) is still actuated. Valve (6) is closed, and valve (7) opened when solenoid II (EV) is switched off. This causes the available pressure at port (1) to flow back into chamber (e) and the output diaphragm (5) to close. The solenoid valve also moves to the "pressure retention position".

Maintenance:

A special maintenance operation beyond the statutory tests is not necessary.

Test:

PC Diagnostic or Diagnostic Controller can be used to check the solenoid coil resistance, the inlet and outlet solenoid efficiency and the wheel co-ordination.

ABS solenoid relay valve 472 195 02. 0 or 472 195 04. 0:

Function:

472 195 02. 0

472 195 04. 0

The ABS relay valve is used in trailer ABS VARIO-C. Its function is to control the brake cylinder pressure for ABS control.

It allows the three ABS functions:

- Pressure build-up
- Pressure retention
- Pressure release

When it is not actuated (solenoids are dead), the device works as a relay valve and achieves a faster increase or decrease of the pressure for the brake cylinders.

Variants:

The ABS solenoid valve is available for use with 24 V vehicle power supply voltage (472 195 020 0) or 12 V vehicle power supply voltage (472 195 021 0). Moreover, there is the **flat twin valve** (472 195 04. 0). In it, two ABS relay valves with common ports for control and supply pressure are combined in a compact valve.

Operation:

The pressure delivered via port (**4**) (e.g. 1 bar) flows through the valve solenoids I and II in free position into the upper piston chamber A and pushes piston K downwards. The piston acts on the valve (V), closes the outlet and opens the inlet. The air supply present at port (**1**) flows through Chamber B and port (**2**) to the downstream brake cylinders.

At the same time, pressure builds up in Chamber B which acts on the underside of the piston (K). Since the upper and underside of the piston have the same surface, the inlet of valve V is closed as soon as the pressure in chamber B is equal to the pressure delivered to chamber A. A closed position is reached.

If the control pressure at port (4) falls, piston K is moved upwards by the pressure in chamber B. The outlet opens and the same amount of pressure at port (**2**) escapes via the exhaust (3).

ABS functions:

a. Pressure build-up:

Both solenoids are de-energised.

Control pressure is present at port (**4**).

Gap visible between annular piston and sealing seat.

Air flows from port (**1**) to port (**2**).

b. Pressure retention:

Solenoid I is energised. Armature is attracted. Thus, (despite the increasing control pressure) air supply from port **(4**) to chamber A is interrupted.

Chambers A and B have the same amount of pressure.

The annular piston is seated.

Air can neither flow from (**1**) to (**2**) nor from (**2**) into the atmosphere.

c. Pressure release:

Solenoid II is energised, and the armature attracted. Solenoid I is again in free position.

Control pressure against chamber A closed.

The raised gasket at the bottom of solenoid II clears the air in chamber A through the internal annular piston opening.

This causes piston K to rise, and air escapes from B, port (2) and the connected brake cylinder via the now visible gap on the annular piston.

Maintenance and test:

The same as in the ABS solenoid control valve described above.

Additional components for ASR:

Differential brake valve:

472 1.. ... 0

The solenoid control valves are switched upstream. For control via the electronic control unit, it drives the pressure in the air reservoir, independent of the brake valve, via a two-way valve into the ABS solenoid control valve.

Whereas an individual differential brake valve was required for each driving wheel in the ASR B and C generations, only one valve is required in the D generation. If differential brake adjustment becomes necessary, the device delivers supply pressure to the ABS solenoid valves of both driving wheels. The ABS valve of the wheel that should not be braked is switched to the locking position (pressure stop).

Proportional valve:

472 250 ... 0

The proportional valve is added to the control cylinder and controls, via the pressure allowed to pass through the device, the position of the regulator lever on the injection pump.

The delivered pressure is directly proportional to the (pulse-width modulated (PWM)) solenoid current output by the ABS/ASR electronic control unit for the proportional valve.

The low hysteresis allows a wide range of control cylinder pressures, which allow both very quick and almost stationary adjustment movements of the regulator lever. This device can thus be used not only for ASR engine control, but also to limit speed (GB_{Prop}).

Two-way valve:

434 208 ... 0

The two-way valve is fitted between the differential brake valve and the ABS solenoid control valves. Two-way valves allow the mutual control of the downstream solenoid control valves, both by the service brake and the **ASR control system**.

Further pressurisation and depressurisation of the downstream brake cylinders is done by the respective ABS solenoid valves, in case of **ABS** or **ASR control operation**.

Whereas an individual two-way brake valve was required for each driving wheel in the ASR B and C generations, only one valve is required in the D generation. If differential brake adjustment becomes necessary, the device delivers supply pressure to the ABS solenoid valves of both driving wheels. The ABS valve of the wheel that should not be braked is switched by the ECU to the locking position (pressure stop).

Two-way valve:

534 017 ... 0

To allow mutual pressurisation of the control cylinder on the regulator lever of the engine-shut off and proportional valve, an additional two-way valve with smaller opening areas between the engine-shut off and engine control valve is required.

Variant 534 017 ... 0 is often used here.

Control cylinder for mechanical engine control:

421 44. ... 0

The control cylinder is fitted in the adjustment linkage between the accelerator pedal and injection pump. The control cylinder model and dimensions depend on the engine and injection pump to be regulated.

While controlling proportional valve, the control cylinder switches the injection pump to idle.

Idle stop cylinder

421 444 ... 0

In single-lever injection pumps, an additional idle stop cylinder prevents engine stop during an **ASR-control** or **speed-limiting operation.**

To stop the engine, the control cylinder and the idle stop cylinder must be actuated simultaneously.

The idle stop cylinder is not required in dual–lever pumps, since the engine is stopped here via a second lever that is independent of the **ASR**.

ABS engine-braking or retarder control:

Motor vehicle ABS is designed to control engine braking or a retarder. This takes place through a black/white switch. A solenoid valve is controlled by an electronic control unit signal via a relay. The solenoid valve blocks the compressed air supply of the engine brake cylinder and depressurises the cylinder.

Retarders are controlled accordingly; the afore-mentioned black/white signal switches off the electrical retarder control via a relay.

If the engine braking or retarder is actuated alone, and if a too big slip occurs on one or both rear wheels of the controlled axle, the engine braking system or retarder is deactivated until the locking tendency is remedied. Thereafter, it is automatically reactivated until the locking tendency reoccurs again or the driver switches it off.

If the engine brake and the service brake are actuated at the same time, the service brake pressure and the engine brake are adjusted in case of locking tendency.

Differential lock switching in all-wheel drawbars with ABS:

If the driver actuates the (longitudinal) differential lock for the transfer gear-box between the front and rear axle(s), normally when ABS control is used, the longitudinal lock opens automatically and remains open until the end of the braking operation.

ABS switching for off-highway use (A and B version):

The normal ABS function is optimised for road conditions. To ensure the shortest possible braking time also for difficult off-highway use on construction sites or in the military field, a cut-off function is today being provided in drawbars for the ABS below a speed of 15 km/h.

For this, the driver has to actuate an "off-highway ABS" switch, and the ABS warning light **comes** on as soon as the cut-off becomes effective below 15 km/h and the wheels can be locked.

C version off-highway ABS:

Alternatively, as from C-version ABS, a special "off-highway ABS logic is offered which provides the normal ABS function at a higher speed, but allows higher wheel slip below 40 km/h and the wheels to lock below 15 km/h .

This way, higher delay values can be produced, and yet limited stability and steering capacity maintained off-highway through the occasional wheel "dig in".

The ABS warning light flashes to warn the driver, when the corresponding "off-highway ABS" switch is actuated. For more recent vehicles, legislation requires an **automatic return to the "highway logic"** after the ignition has been switched off and on.

Safety circuit, recognition and measures in case of component errors:

Safety circuit:

When the ignition is turned on, or the engine started, the safety circuit controls the solenoid valve shortly and also checks the other essential ABS components and electronic parts.

If all ABS components are faultless, and if sufficiently high alternating voltages are generated when all sensors are started, the warning light activated when the ignition was turned on goes off at approximately **7 km/h**. In more recent vehicles this light goes off about **2 seconds** after ignition on, if the device has been recognised as not faulty and if there was no fault during the last drive.

Monitoring while the vehicle is in motion:

In addition to the passive monitoring of control-signal and solenoid-control plausibility, the active monitoring of essential components like solenoids, sensors and feed lines is done cyclically during the drive (braked or nit braked).

The internal electronic components also monitor each other mutually during the drive.

System reactions in case of error:

In case of error in the ABS system, the warning light goes on to warn the driver about this.

The safety circuit switches the regulation in such a way that unacceptable braking safety influence is avoided and at least the normal braking effect is guaranteed.

In keeping with the different system designs, the dual-circuit 4 or 6-channel systems and the single-circuit VARIO-C or VSC trailer systems partly react differently in terms of the remaining ABS effect in case of individual component errors.

If any fault is detected, the warning light goes on and remains on at least as long as the fault is present. In case of loose contact, the warning light comes on until the vehicle stops and when the vehicle starts moving again, if the fault reoccurs.

In the electronic control unit of C and D generation, additional error storage takes place in a non-volatile electronic memory.

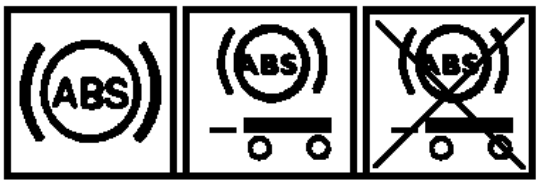
Mechanical fault:

Some possible mechanical faults in the control valves, especially those that result in leakage and loss or pressure, may not be detected by the ABS safety circuit. Like similar errors in other braking systems, they can only be detected by the driver or during regular braking system checks.

ABS/ASR control lights:

A motor vehicle is usually equipped with three ABS control lights for function recognition and active system monitoring:

- ABS **warning light** for motor vehicles **Example:**
- ABS w**arning light** for trailers
- ABS **warning light** for driver information (not mandatory)



As a rule, an additional **ASR light** is used in ASR-equipped motor vehicles.

Warning lights (formerly known as safety lights):

a. Warning light for motor vehicles:

It comes on after the ignition has been turned on and goes off if no error is detected by the ABS safety circuit after about 2 seconds, or if the vehicle speed exceeds approximately 7 km/h.

b. Warning light for trailers:

It comes on after the ignition has been switched on, if a trailer is coupled on, and the ABS push-in connection connected. It also goes off (just like the warning light for motor vehicles) after approximately two seconds, or if the vehicle speed exceeds 7 km/h and no error occurs.

Both warning lights also remain dark if the vehicle stops, for instance, before a traffic light.

The anti-lock braking system is ready for operation after the ABS warning lights have gone off. However, ABS control only starts if one or more wheels tend to lock during a braking process.

Important note:

The driver has to check that the warning light goes off while setting the vehicle in motion! If a warning light does not go off when the vehicle speed exceeds 7 km/h or comes on during the drive, this means that there is an ABS system error.

Caution!

Drive carefully when the warning light comes on! The vehicle's braking behaviour may change.

Have the error corrected as quickly as possible in an authorised expert workshop.

Information light:

The information light indicates to the driver whether a trailer with or without ABS has been coupled. It comes on if a trailer without ABS is coupled, or if the ABS connector for trailer ABS is not connected, after ignition on or when the brakes are applied (depending on the vehicle manufacturer's configuration).

The information light **does not** come on if the coupled trailer has an ABS or is driven without a trailer.

The information light is not mandatory!

ASR light:

As a rule, ASR-equipped vehicles have an additional control light: the **ASR light**: This light indicates ASR activities to the driver and thus also gives him warning signals about skidding conditions.

As a test, the ASR light comes on shortly when the ignition is switched on for about **1 second**.

The ASR light comes on while the vehicle is in motion
- if ASR control is present (skidding conditions warning for the driver)
- in case of integrated speed limiting GB_{Prop}, if the "2^{nd} limit speed" set by the driver is attained when the ASR/tempo-set switch is actuated.
- if the electronic control unit detects ASR/GB_{Prop} error (example: interruption of the electrical line to the proportional valve).

The **ASR light flashes** in the same manner if the ASR switch, or in case of integrated GB_{Prop}, the ASR/tempo-set switch is in the "ASR off-highway" position for slip bump increase.

Moreover, in motor vehicles with C or D version ABS control system **the ASR light can be used to issue a blink code for diagnosis purposes**, if the relevant push-button is pressed.

When is an exhaustive ABS check necessary?

ABS system check with diagnosis tools becomes necessary if the ABS warning light fails to go off when the vehicle is set in motion, or if it comes on during the drive.

ABS diagnosis possibilities

ISO diagnosis with Diagnostic Controller:

The ABS electronic control units, as from C generation for motor vehicles and VARIO-C generations for trailers, have an integrated error memory and a diagnostic interface in accordance with **ISO standard 9141**.

With the WABCO **Diagnostic Controller**, errors stored using this interface can be viewed by type and rate of occurrence, displayed in clear text, and also deleted. The Diagnostic Controller is not only meant for use with WABCO ABS, but also with other WABCO electronic systems. Each program is provided via individual **program cards**. They lead the tester through the test process with any need for further test instructions.

ISO diagnosis via PC and diagnostic interface:

WABCO is also offering the **PC Diagnostic**, parallel to the well-known Diagnostic Controller. For C and D version ABS in motor vehicles, and for VCS ABS in trailers and other WABCO electronic system, the corresponding **Diagnostic Software** does exist for this.

Together with the **Diagnostic Interface,** the software offers an extensive and comfortable diagnosis.

ISO diagnosis with Compact tester

The error memory is easy to read using the inexpensive compact testers for motor vehicle ABS (C and D generation) or for trailer ABS (VARIO C and VCS).

Depending on the system, special functions (example: system christening, functional test, reading of the integrated VCS mileage indicator, etc) are also possible.

WABCO Blink Code:

The blink code provided in the C and D electronic control units represents a limited but helpful and inexpensive diagnosis possibility.

A blink code can be energised by connecting a special diagnosis line (L line) with ground. The ASR light serves as indicator for motor vehicle ABS/ASR, while the warning light serves as indicator for trailer ABS. The person performing the check can determine whether the system is in order, or the type of error detected, using the flashed pulse sequence and a blink code list.

WABCO TRAINING

ABS-Training

ABS wiring diagram

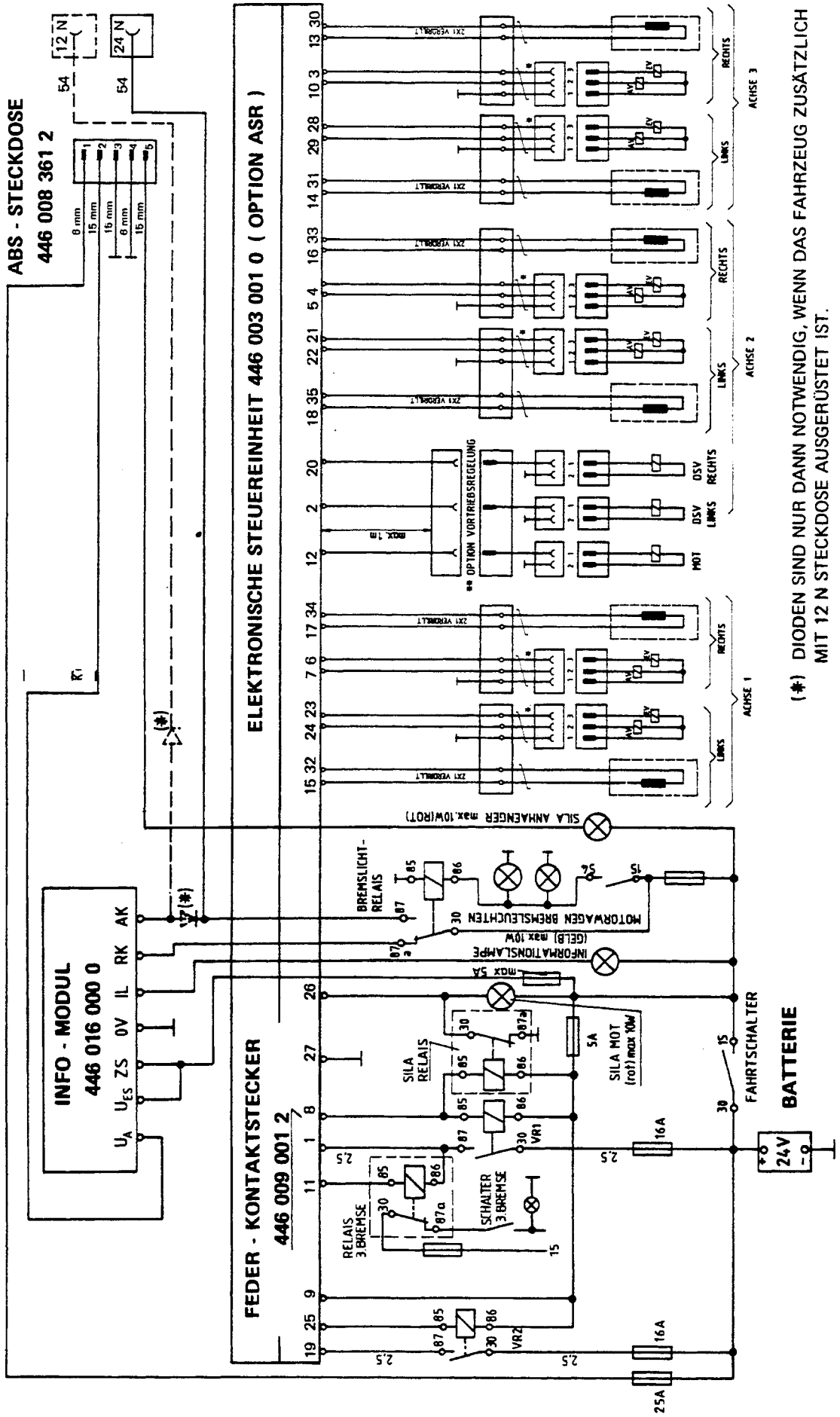
3

Wiring- diagram ABS and ASR

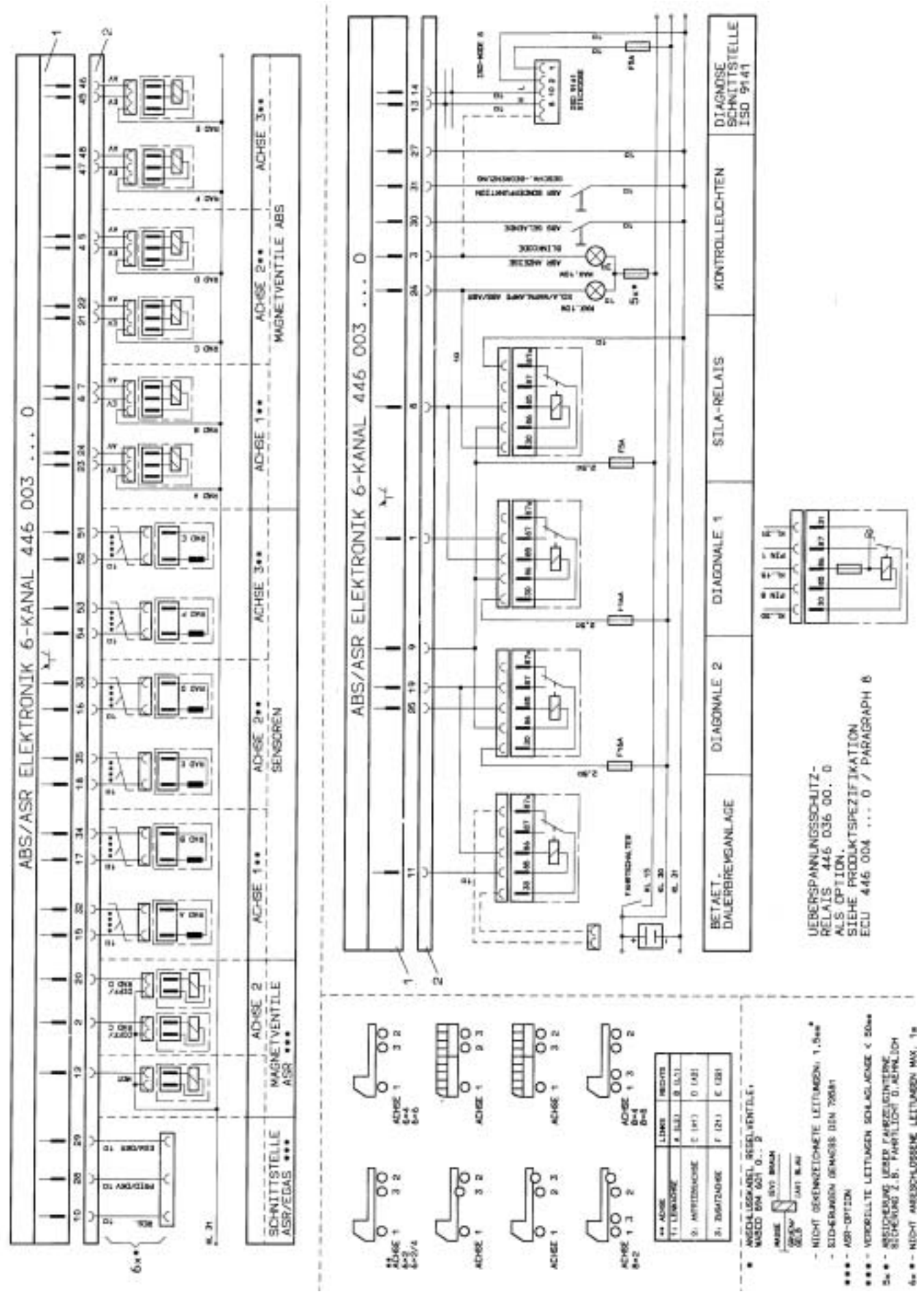
Editon: Oktober 2002

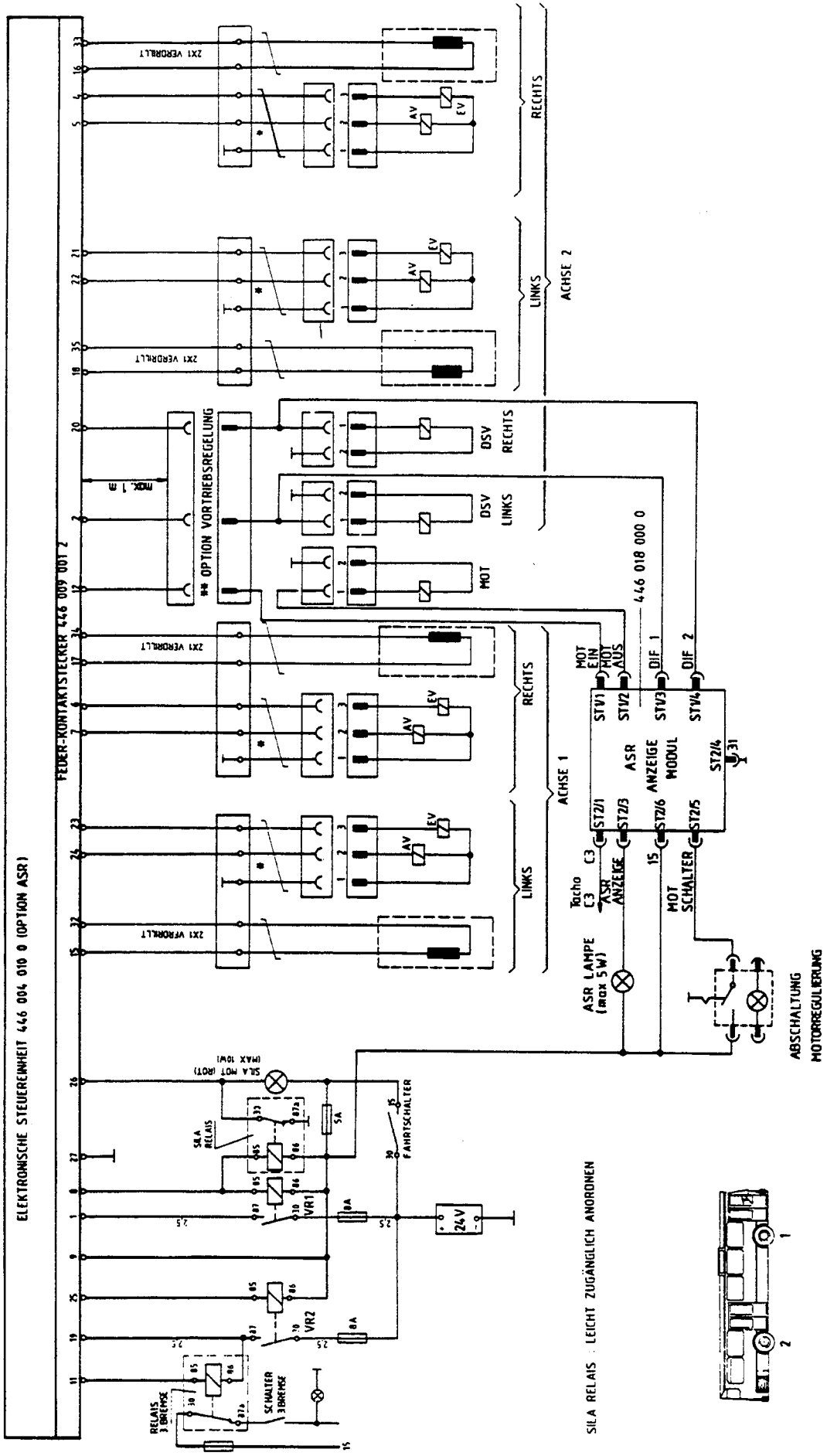
WABCO

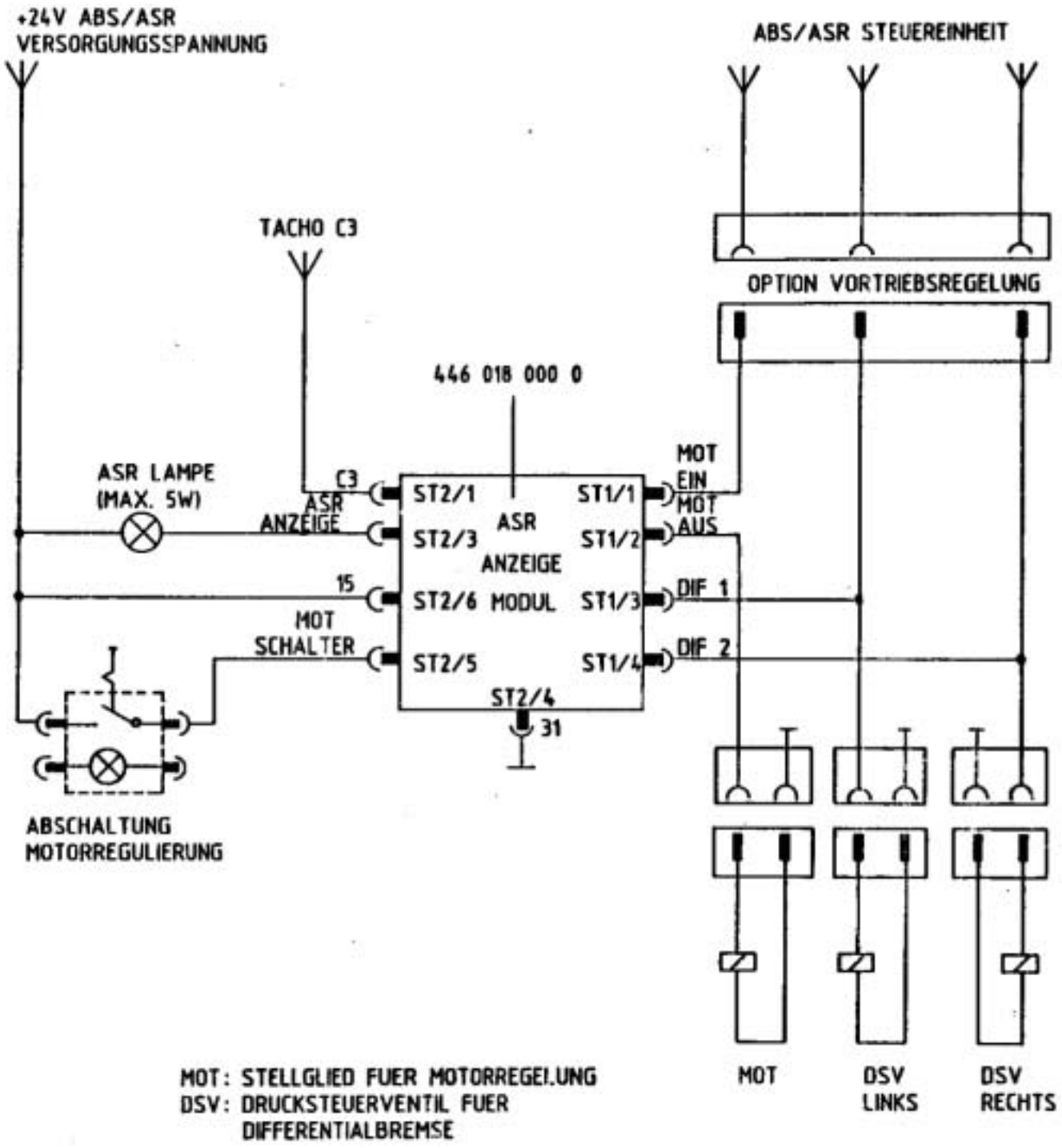
Vehicle Control Systems
An American Standard Company

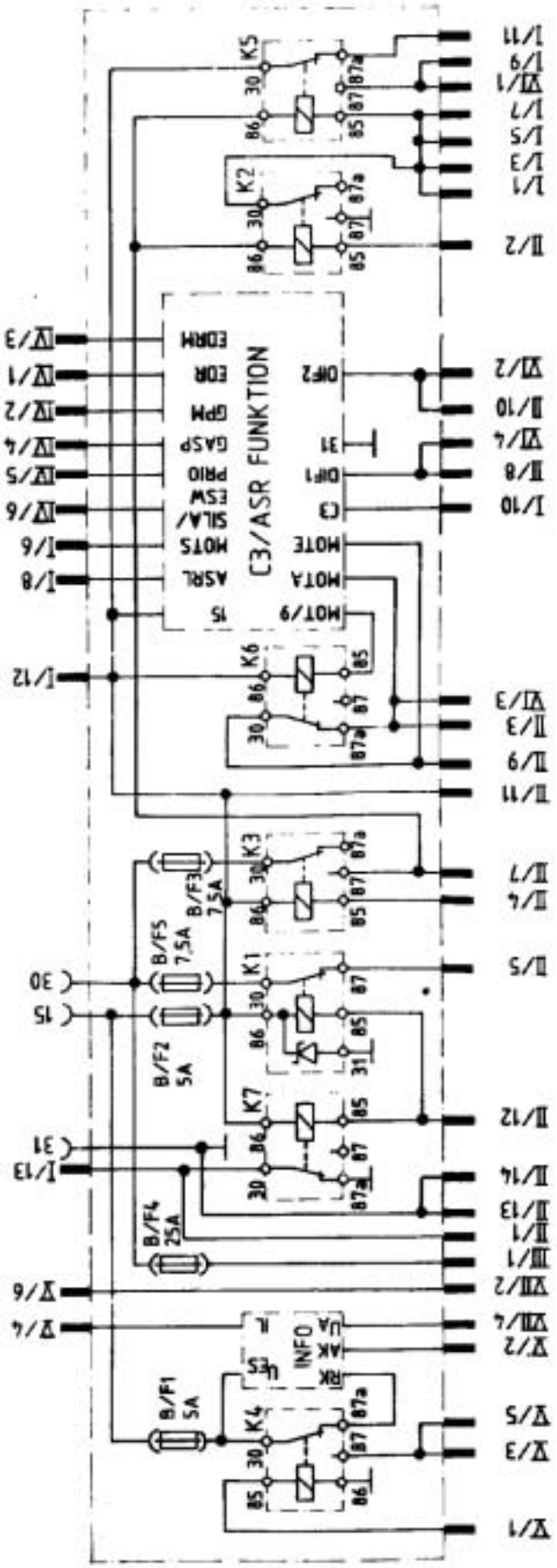


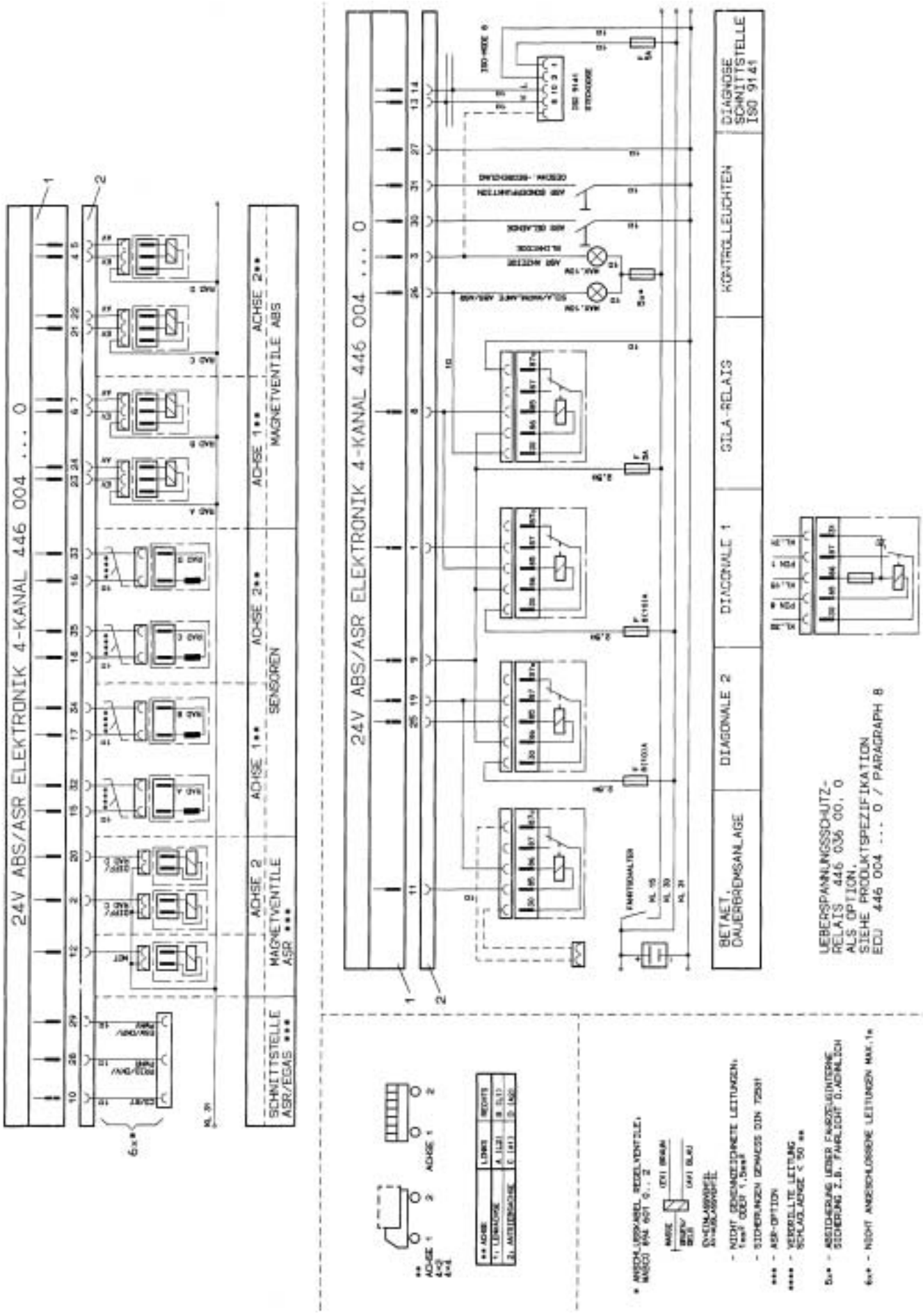
(*) DIODEN SIND NUR DANN NOTWENDIG, WENN DAS FAHRZEUG ZUSÄTZLICH MIT 12 N STECKDOSE AUSGERÜSTET IST.


ABS/ASR ELEKTRONIK 6-KANAL 446 003 ... 0
ACHSE 1**
ACHSE 2**
ACHSE 3**
SENSOREN
MAGNETVENTILE ABS
SCHNITTSTELLE ASR/EGAS ***
MAGNETVENTILE ASR ***
ABS/ASR ELEKTRONIK 6-KANAL 446 003 ... 0
DIAGNOSE SCHNITTSTELLE ISO 9141
KONTROLLEUCHTEN
SILA-RELAIS
DIAGONALE 1
DIAGONALE 2
BETRIEB, DAUERBREMSANLAGE
UEBERSPANNUNGSSCHUTZ-RELAIS 446 036 00. 0 ALS OPTION. SIEHE PRODUKTSPEZIFIKATION ECU 446 004 ... 0 / PARAGRAPH 6


ELEKTRONISCHE STEUEREINHEIT 446 004 010 0 (OPTION ASR)
FEDER-KONTAKTSTECKER 446 009 001 2
** OPTION VORTRIEBSREGELUNG
2X1 VERDRILLT
RECHTS
LINKS
ACHSE 2
ACHSE 1
DSV
MOT
AV
EV
446 018 000 0
MOT EIN
MOT AUS
DIF 1
DIF 2
ST1/1
ST1/2
ST1/3
ST1/4
ST2/1
ST2/3
ST2/6
ST2/5
ST2/4
ASR ANZEIGE MODUL
Tacho C3
ASR ANZEIGE C3
MOT SCHALTER
ASR LAMPE (max 5 W)
ABSCHALTUNG MOTORREGULIERUNG
SILA MOT (ROT) (MAX 10W)
SILA RELAIS
FAHRTSCHALTER
VR1
VR2
5A
8A
24V
RELAIS 3.BREMSE
SCHALTER 3.BREMSE
SILA RELAIS : LEICHT ZUGÄNGLICH ANORDNEN


+24V ABS/ASR
VERSORGUNGSSPANNUNG
ABS/ASR STEUEREINHEIT
TACHO C3
OPTION VORTRIEBSREGELUNG
446 018 000 0
ASR LAMPE
(MAX. 5W)
C3
ASR
ANZEIGE
ST2/1
ST2/3
ST2/6
ST2/5
ST2/4
ASR
ANZEIGE
MODUL
ST1/1
ST1/2
ST1/3
ST1/4
MOT
EIN
MOT
AUS
DIF 1
DIF 2
15
MOT
SCHALTER
31
ABSCHALTUNG
MOTORREGULIERUNG
MOT: STELLGLIED FUER MOTORREGELUNG
DSV: DRUCKSTEUERVENTIL FUER
DIFFERENTIALBREMSE
MOT
DSV
LINKS
DSV
RECHTS

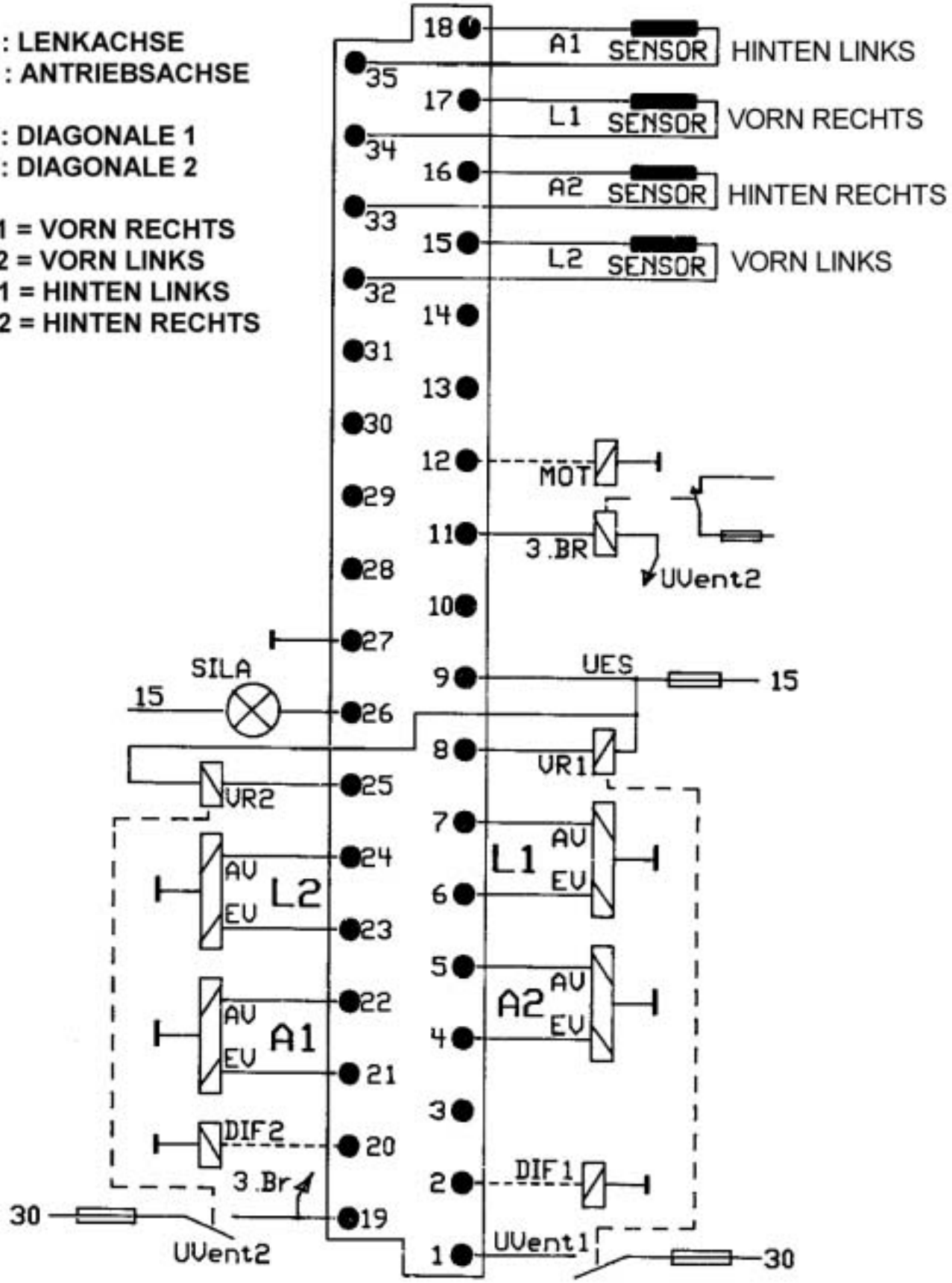

C3/ASR FUNKTION
EDRM
EDR
GPM
GASP
PRIO
TSW
SILA
MOTS
ASRL
15
MOTE
MOTA
MOT/9
DIF2
31
DIF1
C3
K1
K2
K3
K4
K5
K6
K7
B/F1 5A
B/F2 5A
B/F3 7,5A
B/F4 25A
B/F5 7,5A
INFO
30
15
31

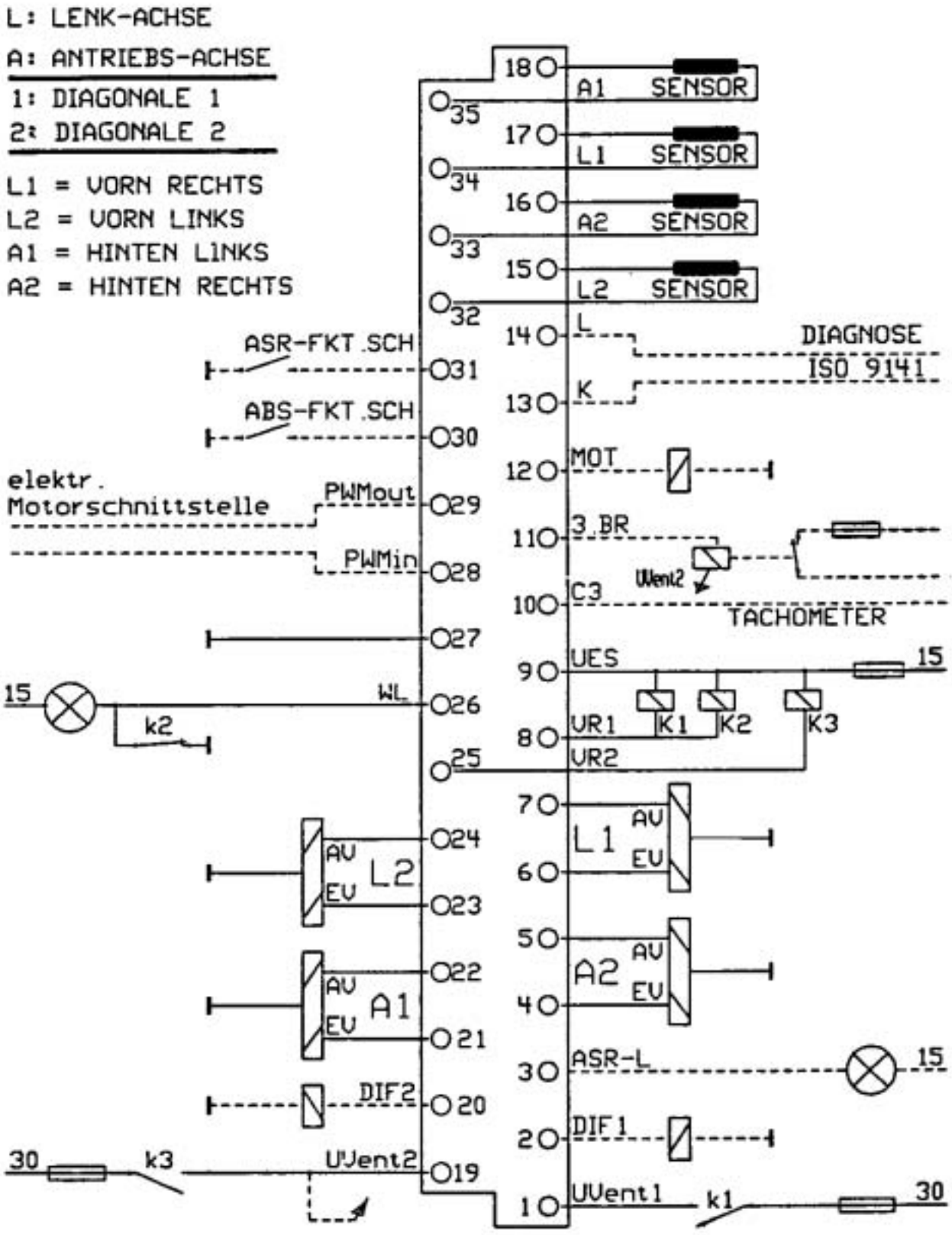

24V ABS/ASR ELEKTRONIK 4-KANAL 446 004 ... 0
24V ABS/ASR ELEKTRONIK 4-KANAL 446 004 ... 0
SCHNITTSTELLE ASR/EGAS ***
ACHSE 2
ACHSE 1**
ACHSE 2**
MAGNETVENTILE ASR ***
SENSOREN
MAGNETVENTILE ABS
DIAGNOSE SCHNITTSTELLE ISO 9141
KONTROLLEUCHTEN
SILA-RELAIS
DIAGONALE 1
DIAGONALE 2
BETAET, DAUERBREMSANLAGE
UEBERSPANNUNGSSCHUTZ-RELAIS 446 036 00. 0 ALS OPTION, SIEHE PRODUKTSPEZIFIKATION EDU 446 004 ... 0 / PARAGRAPH 8
ACHSE 1
ACHSE 2
LINKS
RECHTS
1) LENKACHSE
2) ANTRIEBSACHSE
- ASR-OPTION
- VERDRILLTE LEITUNG
- SICHERUNGEN GEMASS DIN 72551
- ABSICHERUNG LEBER FAHRZEUGINTERNE SICHERUNG Z.B. FAHRLICHT O.AEHNLICH
- NICHT ANGESCHLOSSENE LEITUNGEN MAX. 1A

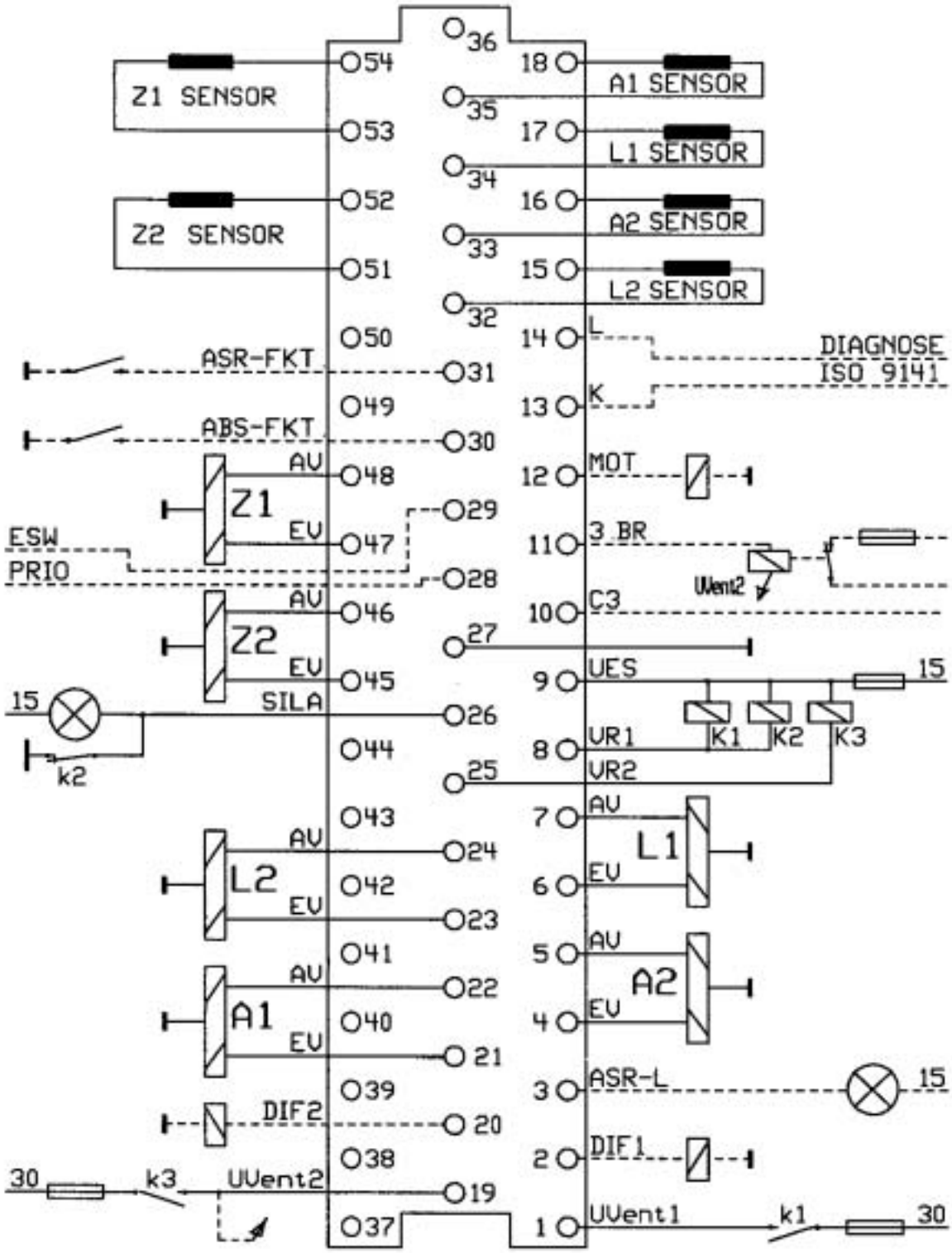
L : LENKACHSE
A : ANTRIEBSACHSE

1 : DIAGONALE 1
2 : DIAGONALE 2

L1 = VORN RECHTS
L2 = VORN LINKS
A1 = HINTEN LINKS
A2 = HINTEN RECHTS

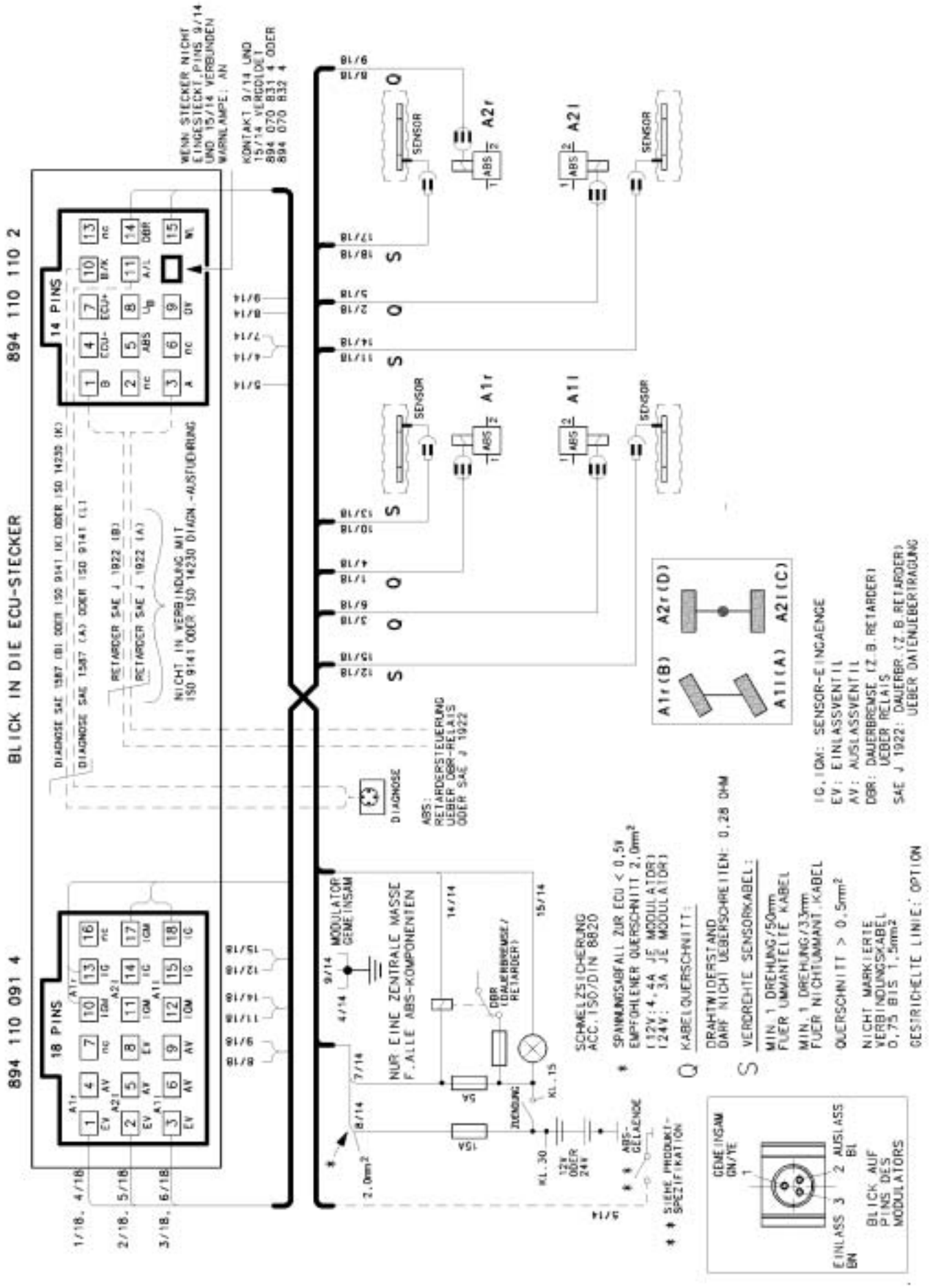


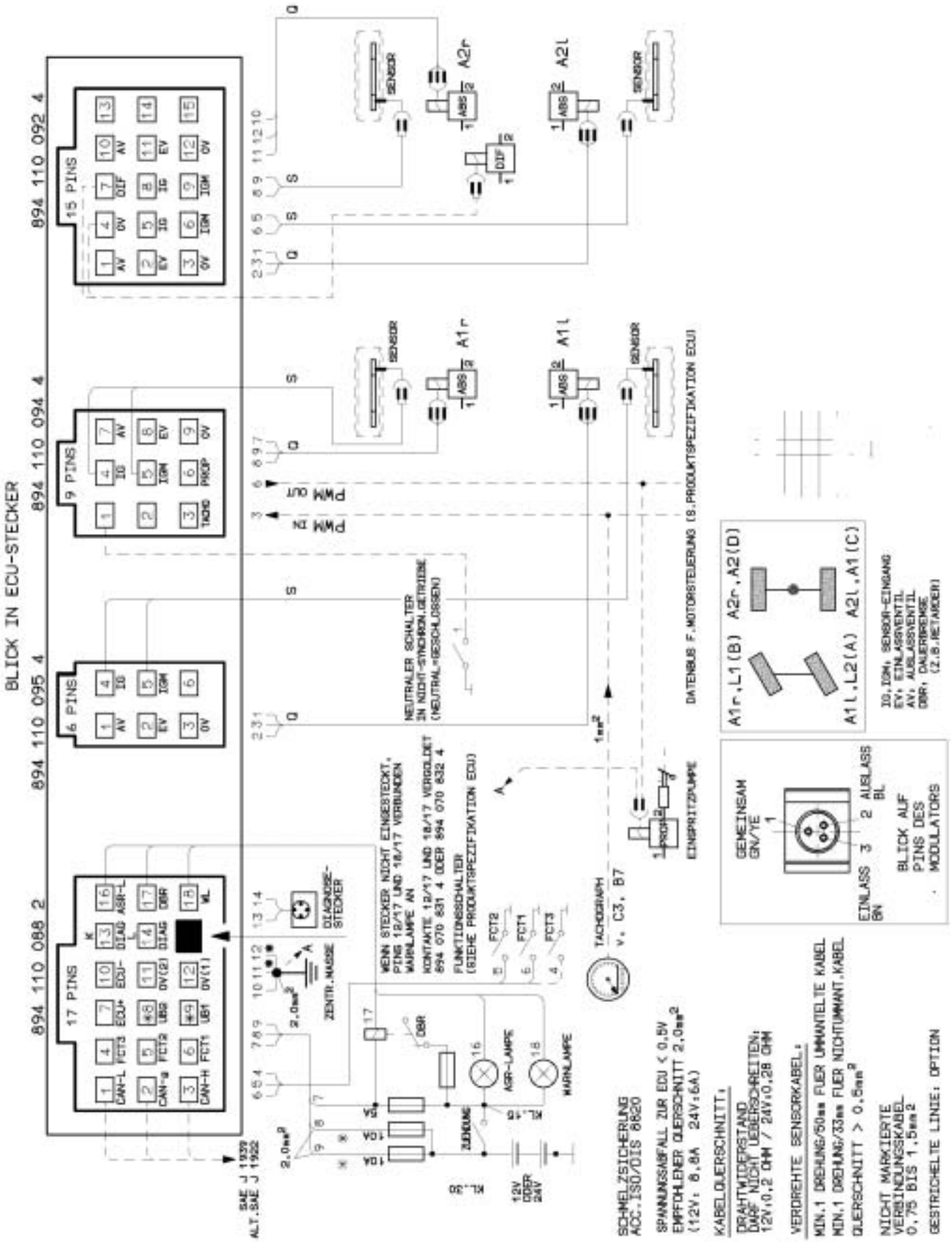

L: LENK-ACHSE
A: ANTRIEBS-ACHSE
1: DIAGONALE 1
2: DIAGONALE 2
L1 = VORN RECHTS
L2 = VORN LINKS
A1 = HINTEN LINKS
A2 = HINTEN RECHTS
18
A1 SENSOR
35
17
L1 SENSOR
34
16
A2 SENSOR
33
15
L2 SENSOR
32
14
L
DIAGNOSE
ISO 9141
ASR-FKT.SCH
31
13
K
ABS-FKT.SCH
30
12
MOT
elektr.
Motorschnittstelle
PWMout
29
11
3.BR
PWMin
28
UVent2
10
C3
TACHOMETER
27
9
UES
15
15
WL
26
k2
8
VR1
K1
K2
K3
25
VR2
7
L1
AV
EV
24
6
L2
AV
EV
23
5
A2
AV
EV
22
4
A1
AV
EV
21
3
ASR-L
15
DIF2
20
2
DIF1
30
k3
UVent2
19
1
UVent1
k1
30
K1,K2,K3 : KFZ-Relais
---- : Option
: zentraler Massepunkt

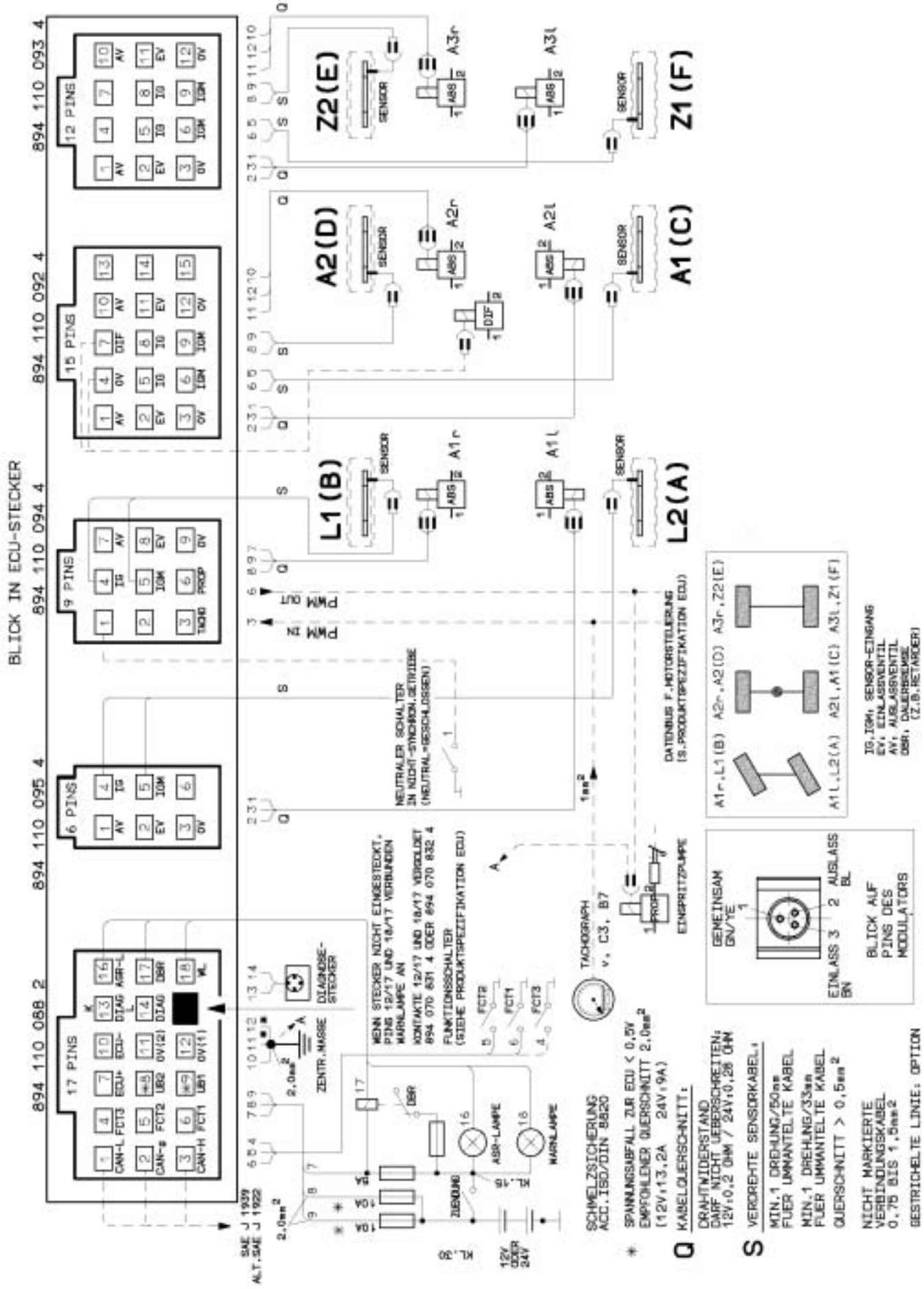


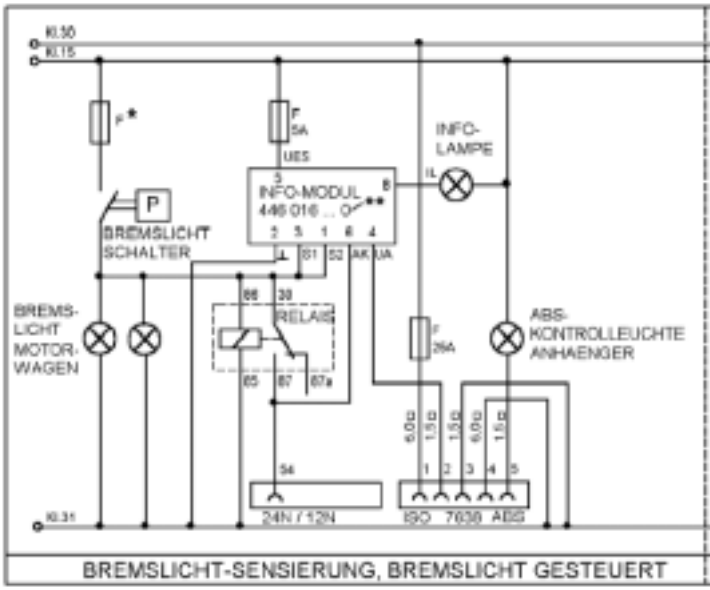
L1 = LENK-ACHSE RECHTS
L2 = LENK-ACHSE LINKS
A1 = ANTRIEBS-ACHSE LINKS
A2 = ANTRIEBS-ACHSE RECHTS
Z1 = ZUSATZ-ACHSE LINKS
Z2 = ZUSATZ-ACHSE RECHTS

ESW,PRIO : elektr. Motorschnittstelle
K1,K2,K3 : KFZ-Relais
---- : Option
⊥ : zentaler Massepunkt

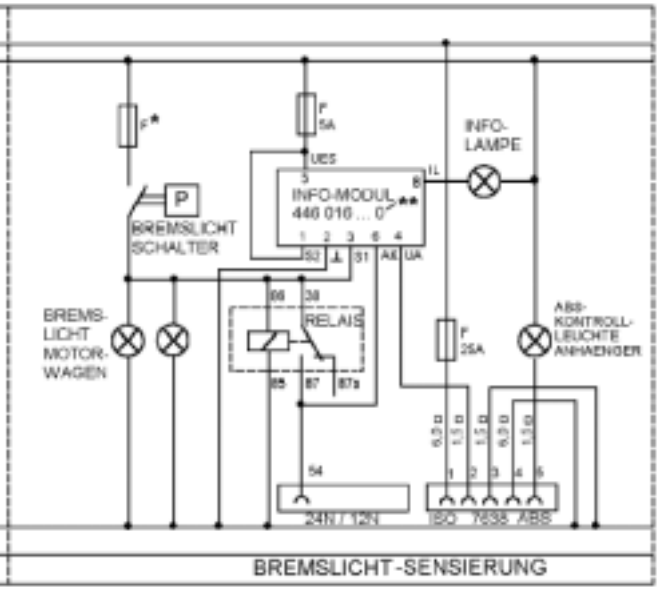

894 110 110 2
894 110 091 4
BLICK IN DIE ECU-STECKER
14 PINS
18 PINS
WENN STECKER NICHT EINGESTECKT, PINS 9/14 UND 15/14 VERBUNDEN WARNLAMPE: AN
KONTAKT 9/14 UND 15/14 VERGOLDET 894 070 831 4 ODER 894 070 832 4
DIAGNOSE SAE J 1587 (B) ODER ISO 9141 (K) ODER ISO 14230 (K)
DIAGNOSE SAE J 1587 (A) ODER ISO 9141 (L)
RETARDER SAE J 1922 (B)
RETARDER SAE J 1922 (A)
NICHT IN VERBINDUNG MIT ISO 9141 ODER ISO 14230 DIAGN.-AUSFUEHRUNG
SENSOR
A2r
A2l
A1r
A1l
A1r(B) A2r(D)
A1l(A) A2l(C)
DIAGNOSE
ABS: RETARDERSTEUERUNG UEBER DBR-RELAIS ODER SAE J 1922
MODULATOR GEMEINSAM
NUR EINE ZENTRALE MASSE F. ALLE ABS-KOMPONENTEN
SCHMELZSICHERUNG ACC. ISO/DIN 8820
DBR (DAUERBREMSE/ RETARDER)
ZUENDUNG
KL. 30
KL. 15
12V ODER 24V
ABS-GELAENDE
SIEHE PRODUKT-SPEZIFIKATION
KABELQUERSCHNITT:
DRAHTWIDERSTAND DARF NICHT UEBERSCHREITEN: 0,28 OHM
VERGROESSERTE SENSORKABEL:
MIN. 1 DREHUNG/50mm FUER UMMANTELTE KABEL
MIN. 1 DREHUNG/33mm FUER NICHTUMMANT. KABEL
QUERSCHNITT > 0,5mm²
NICHT MARKIERTE VERBINDUNGSKABEL 0,75 BIS 1,5mm²
GESTRICHELTE LINIE: OPTION
IG, IGM: SENSOR-EINGAENGE
EV: EINLASSVENTIL
AV: AUSLASSVENTIL
DBR: DAUERBREMSE (Z.B. RETARDER) UEBER RELAIS
SAE J 1922: DAUERBR. (Z.B. RETARDER) UEBER DATENUEBERTRAGUNG
GEMEINSAM GN/YE
EINLASS 3 BN
2 AUSLASS BL
BLICK AUF PINS DES MODULATORS


BLICK IN ECU-STECKER
894 110 088 2
894 110 095 4
894 110 094 4
894 110 092 4
17 PINS
6 PINS
9 PINS
15 PINS
SAE J 1939
ALT.SAE J 1922
DIAGNOSE-STECKER
ZENTR.MASSE
WENN STECKER NICHT EINGESTECKT, PINS 12/17 UND 18/17 VERBUNDEN WARNLAMPE AN
KONTAKTE 12/17 UND 18/17 VERGOLDET 894 070 831 4 ODER 894 070 832 4
FUNKTIONSSCHALTER (SIEHE PRODUKTSPEZIFIKATION ECU)
NEUTRALER SCHALTER IN NICHT-SYNCHRON.GETRIEBE (NEUTRAL=GESCHLOSSEN)
TACHOSIGNAL v. C3, B7
EINSPRITZPUMPE
DATENBUS F.MOTORSTEUERUNG (S.PRODUKTSPEZIFIKATION ECU)
SENSOR
ABS
DIF
A1r
A1l
A2r
A2l
ZUNDUNG
ASR-LAMPE
WARNLAMPE
12V ODER 24V
SCHMELZSICHERUNG ACC.ISO/DIS 8820
+ SPANNUNGSABFALL ZUR ECU < 0,5V EMPFOHLENER QUERSCHNITT 2,0mm² (12V: 8,8A 24V:6A)
Q KABELQUERSCHNITT:
DRAHTWIDERSTAND DARF NICHT UEBERSCHREITEN: 12V:0,2 OHM / 24V:0,28 OHM
S VERDREHTE SENSORKABEL:
MIN.1 DREHUNG/50mm FUER UMMANTELTE KABEL
MIN.1 DREHUNG/33mm FUER NICHTUMMANT.KABEL
QUERSCHNITT > 0,5mm²
NICHT MARKIERTE VERBINDUNGSKABEL 0,75 BIS 1,5mm²
GESTRICHELTE LINIE: OPTION
A1r,L1(B) A2r,A2(D)
A1l,L2(A) A2l,A1(C)
GEMEINSAM GN/YE
EINLASS GN
AUSLASS BL
BLICK AUF PINS DES MODULATORS
IG,IGN; SENSOR-EINGANG
EV; EINLASSVENTIL
AV; AUSLASSVENTIL
DBR; DAUERBREMSE (2.B.RETARDER)

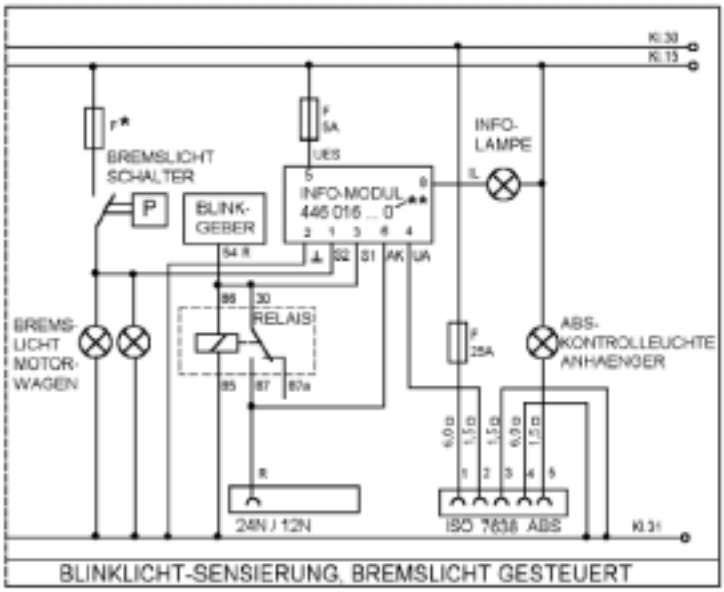

BLICK IN ECU-STECKER
894 110 088 2
894 110 095 4
894 110 094 4
894 110 092 4
894 110 093 4
17 PINS
6 PINS
9 PINS
15 PINS
12 PINS
L1 (B)
L2 (A)
A2 (D)
A1 (C)
Z2 (E)
Z1 (F)
SENSOR
ABS
DIF
PROP
PWM OUT
PWM IN
DIAGNOSE-STECKER
ZENTR.MASSE
ASR-LAMPE
WARNLAMPE
DSR
ZUENDUNG
12V ODER 24V
SCHMELZSICHERUNG ACC.ISO/DIN 8820
TACHOGRAPH
EINSPRITZPUMPE
NEUTRALER SCHALTER IN NICHT-SYNCHRON.GETRIEBE (NEUTRAL=GESCHLOSSEN)
FUNKTIONSSCHALTER (SIEHE PRODUKTSPEZIFIKATION ECU)
DATENBUS F.MOTORSTEUERUNG (S.PRODUKTSPEZIFIKATION ECU)
A1r,L1(B) A2r,A2(D) A3r,Z2(E)
A1l,L2(A) A2l,A1(C) A3l,Z1(F)
GEMEINSAM GN/TE
EINLASS 3 BN
2 AUSLASS BL
BLICK AUF PINS DES MODULATORS
IG,IGM: SENSOR-EINGANG
EV: EINLASSVENTIL
AV: AUSLASSVENTIL
DBR: DAUERBREMSE (Z.B.RETARDER)
Q KABELQUERSCHNITT:
DRAHTWIDERSTAND DARF NICHT UEBERSCHREITEN: 12V:0,2 OHM / 24V:0,28 OHM
S VERDREHTE SENSORKABEL:
MIN.1 DREHUNG/50mm FUER UMMANTELTE KABEL
MIN.1 DREHUNG/33mm FUER UMMANTELTE KABEL
QUERSCHNITT > 0,5mm²
NICHT MARKIERTE VERBINDUNGSKABEL 0,75 BIS 1,5mm²
GESTRICHELTE LINIE: OPTION
SPANNUNGSABFALL ZUR ECU < 0,5V EMPFOHLENER QUERSCHNITT 2,0mm² (12V:13,2A 24V:9A)
WENN STECKER NICHT EINGESTECKT, PINS 12/17 UND 18/17 VERBINDEN WARNLAMPE AN
KONTAKTE 12/17 UND 18/17 VERGOLDET 894 070 831 4 ODER 894 070 832 4



BREMSLICHT-SENSIERUNG, BREMSLICHT GESTEUERT



BREMSLICHT-SENSIERUNG

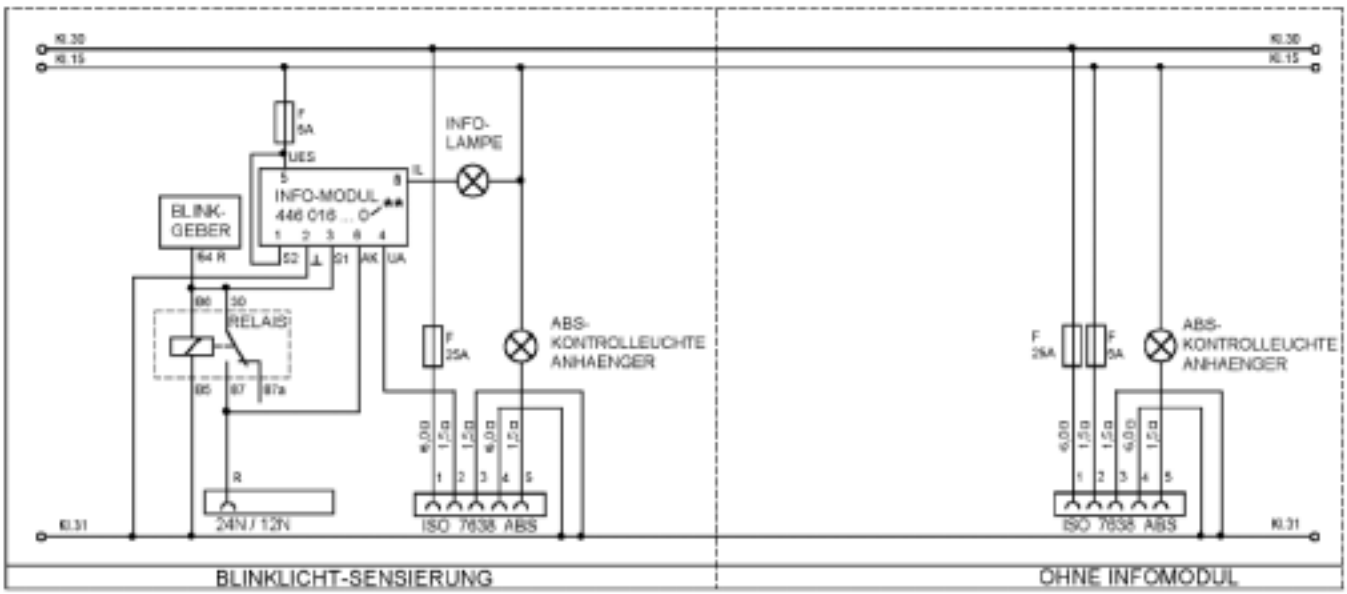


BLINKLICHT-SENSIERUNG, BREMSLICHT GESTEUERT

Nicht gekennzeichnete Leitungen:
Kabelquerschnitt 0,75 mm □

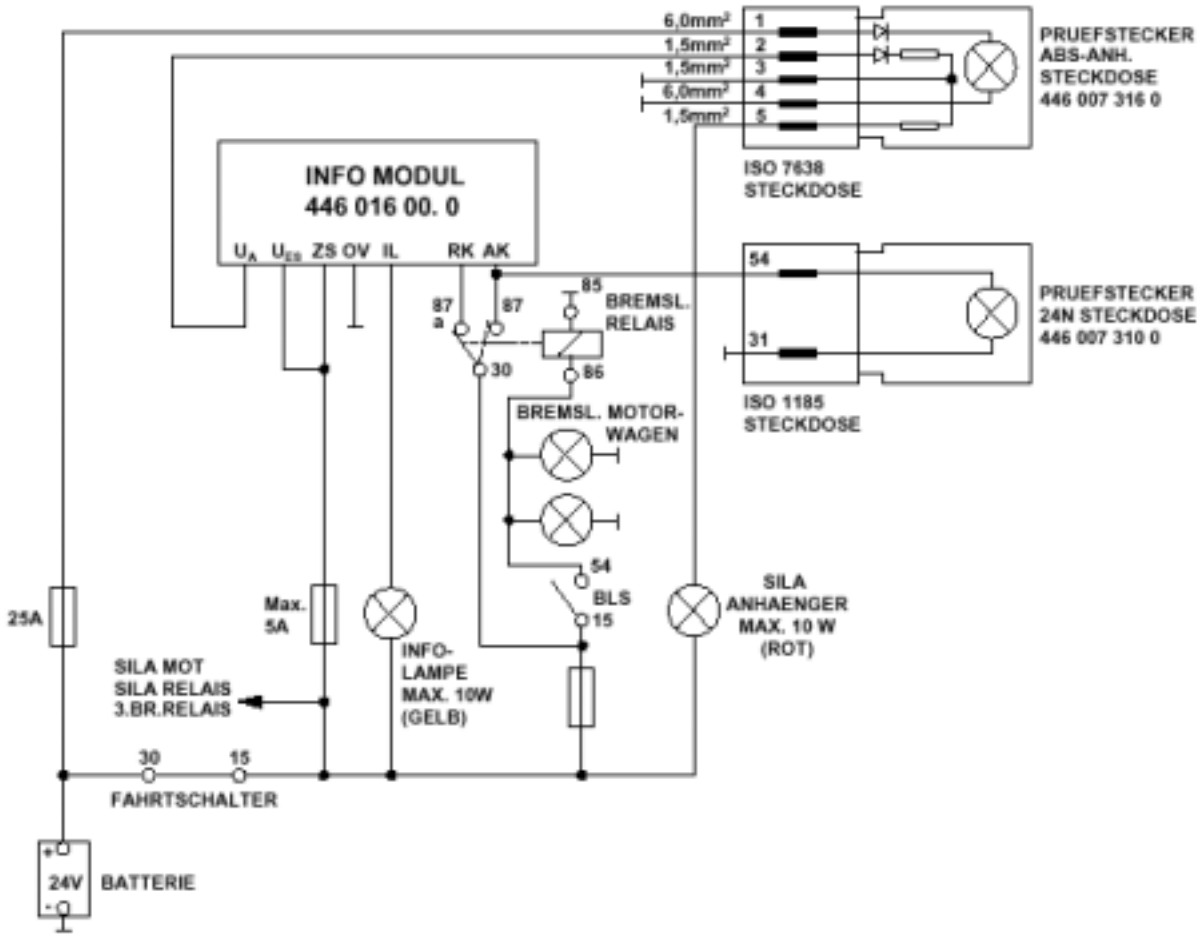
* Sicherungen und Lampen Fahrzeughersteller spezifisch nach DIN 72 581

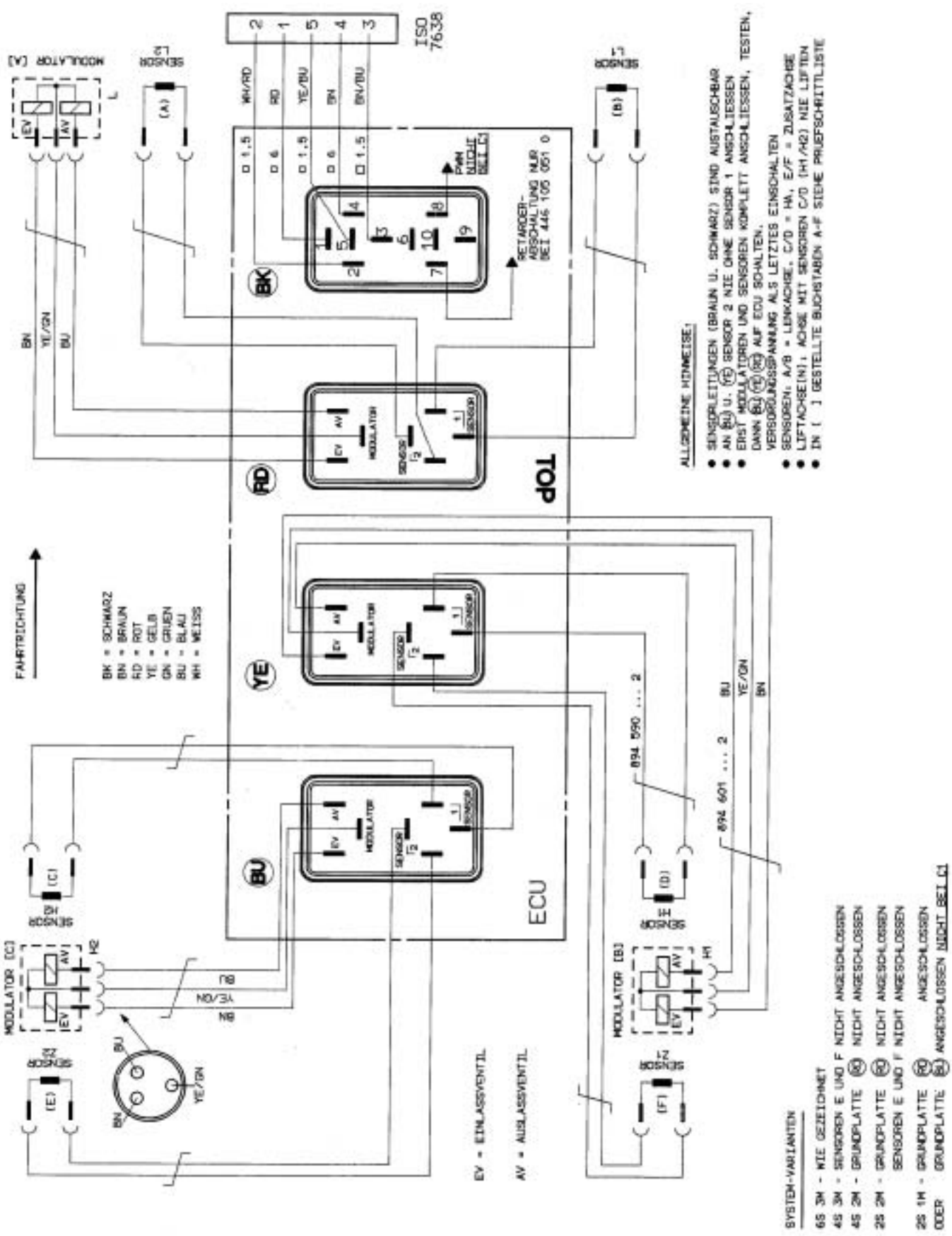
** 446 016 002 0 / 24 V oder
446 016 003 0 / 12 V



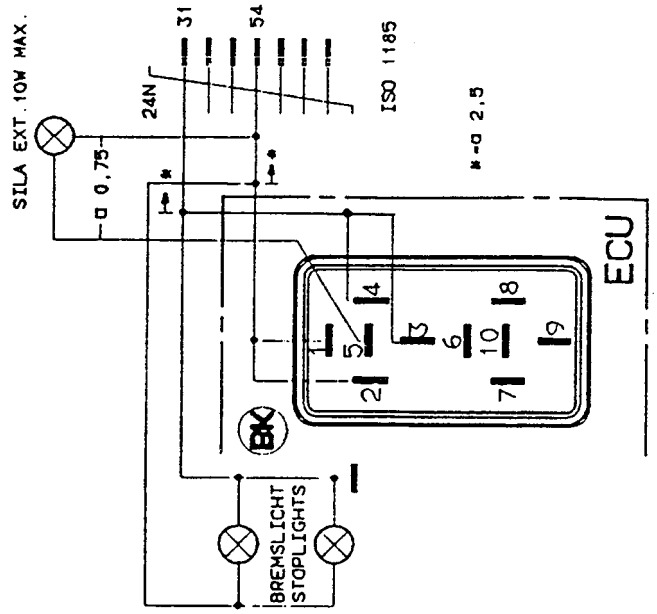
BLINKLICHT-SENSIERUNG

OHNE INFOMODUL

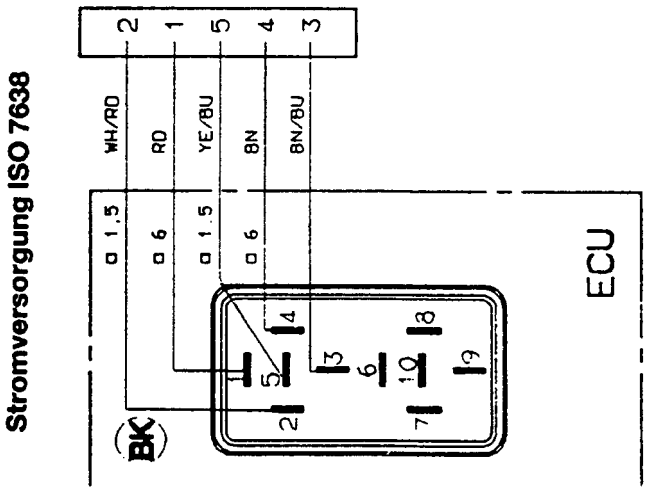

6,0mm²
1,5mm²
1,5mm²
6,0mm²
1,5mm²
1
2
3
4
5
PRUEFSTECKER
ABS-ANH.
STECKDOSE
446 007 316 0
ISO 7638
STECKDOSE
INFO MODUL
446 016 00. 0
UA UES ZS OV IL RK AK
54
31
PRUEFSTECKER
24N STECKDOSE
446 007 310 0
ISO 1185
STECKDOSE
85
87
a
87
BREMSL.
RELAIS
30
86
BREMSL. MOTOR-
WAGEN
54
BLS
15
25A
Max.
5A
INFO-
LAMPE
MAX. 10W
(GELB)
SILA
ANHAENGER
MAX. 10 W
(ROT)
SILA MOT
SILA RELAIS
3.BR.RELAIS
30
15
FAHRTSCHALTER
24V
BATTERIE


ISO 7638
MODULATOR (A)
SENSOR (A)
SENSOR (B)
WH/RD
RD
YE/BU
BN
BK/BU
1.5
6
1.5
6
1.5
PWM NICHT BEI C1
RETARDER-ABSCHALTUNG NUR BEI 446 105 051 0
BK
RD
YE
BU
TOP
ECU
BN
YE/GN
BU
FAHRTRICHTUNG
BK = SCHWARZ
BN = BRAUN
RD = ROT
YE = GELB
GN = GRUEN
BU = BLAU
WH = WEISS
MODULATOR (C)
SENSOR (C)
SENSOR (D)
MODULATOR (B)
SENSOR (E)
SENSOR (F)
894 590 ... 2
894 601 ... 2
EV = EINLASSVENTIL
AV = AUSLASSVENTIL
ALLGEMEINE HINWEISE:
• SENSORLEITUNGEN (BRAUN U. SCHWARZ) SIND AUSTAUSCHBAR
• AN (BU) U. (YE) SENSOR 2 NIE OHNE SENSOR 1 ANSCHLIESSEN
• ERST MODULATOREN UND SENSOREN KOMPLETT ANSCHLIESSEN, TESTEN, DANN (BU) (YE) (RD) AUF ECU SCHALTEN.
VERSORGUNGSSPANNUNG AUS LETZTES EINSCHALTEN
• SENSOREN: A/B = LENKACHSE, C/D = HA, E/F = ZUSATZACHSE
• LIFTACHSE(N): ACHSE MIT SENSOREN C/D (H1/H2) NIE LIFTEN
• IN [ ] GESTELLTE BUCHSTABEN A-F SIEHE PRUEFSCHRITTLISTE
SYSTEM-VARIANTEN
6S 3M - NIE GEZEICHNET
4S 3M - SENSOREN E UND F NICHT ANGESCHLOSSEN
4S 2M - GRUNDPLATTE (M) NICHT ANGESCHLOSSEN
2S 2M - GRUNDPLATTE (M) NICHT ANGESCHLOSSEN
SENSOREN E UND F NICHT ANGESCHLOSSEN
2S 1M - GRUNDPLATTE (M) ANGESCHLOSSEN
ODER GRUNDPLATTE (BU) ANGESCHLOSSEN NICHT BEI C1

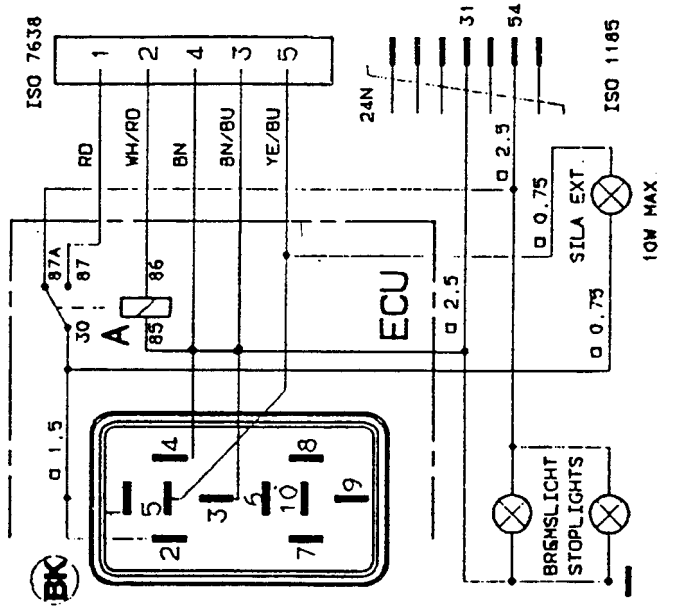
Stromversorgung nur mit Bremslicht



Stromversorgung ISO 7638



Stromversorgung ISO 7638 und Bremslicht



Wiring- diagram ABS Vario Compact

ALLGEMEIN:
GENERAL:

UEBERSICHT;
SURVEY OF DESIGNATIONS:

MODULATOR A = L
MODULATOR B = H1
MODULATOR C = H2

SENSOR c = H2
SENSOR d = H1
* SENSOR e = Z2/L2
* SENSOR f = Z1/L1

WL= WARNLAMPE
WARNING LIGHT

GROUND= MASSE
VALVES= VENTILE

* DURCH STECKEN DES KABELS AM MODUL. A(L) -4S/3M- WERDEN DIE SENSORSIGNALE VON e+f ZUR MAR-REGELG. DIESER ACHSE HERANGEZOGEN.

* CONNECTING THE CABLE TO MODULATOR A(L) -4S/3M- THE SENSOR SIGNALS OF e+f ARE USED FOR MAR-CONTROL.

ZUORDNUNG:

1. REGELKANAELE

SIEHE UEBERSICHT SYSTEMBEISPIELE GUTACHTEN "VARIO C" ODER "VARIO COMPACT"

2. FARBEN

WICHTIG IST; FUER JEDE FAHRZEUGSEITE DIESELBE FARBE ZU WAEHLEN. DAMIT IST IMMER DIE RICHTIGE PNEUMATISCHE UND ELEKTRONISCHE ZUORDNUNG GEWAEHRLEISTET.

(BEISPIELE SIEHE UNTEN)

YE IN FAHRTRICHTUNG RECHTS GILT AUCH FUER VCS.

ALLOCATION:

1. CONTROL CHANNELS

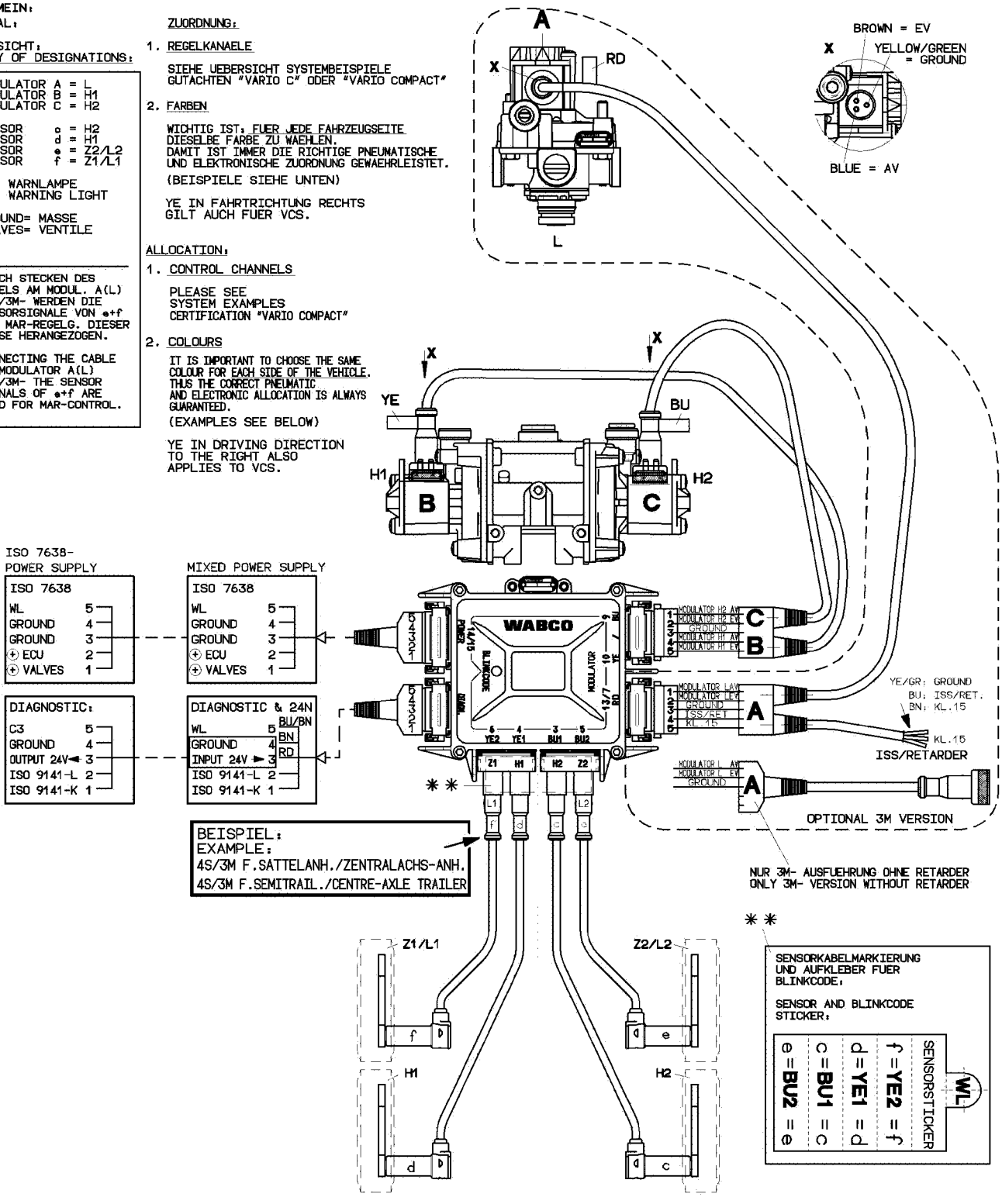
PLEASE SEE SYSTEM EXAMPLES CERTIFICATION "VARIO COMPACT"

2. COLOURS

IT IS IMPORTANT TO CHOOSE THE SAME COLOUR FOR EACH SIDE OF THE VEHICLE. THUS THE CORRECT PNEUMATIC AND ELECTRONIC ALLOCATION IS ALWAYS GUARANTEED.

(EXAMPLES SEE BELOW)

YE IN DRIVING DIRECTION TO THE RIGHT ALSO APPLIES TO VCS.



BEISPIELE:
EXAMPLES :

MODULATOREN:
YE ≙ H1 ≙ B
BU ≙ H2 ≙ C

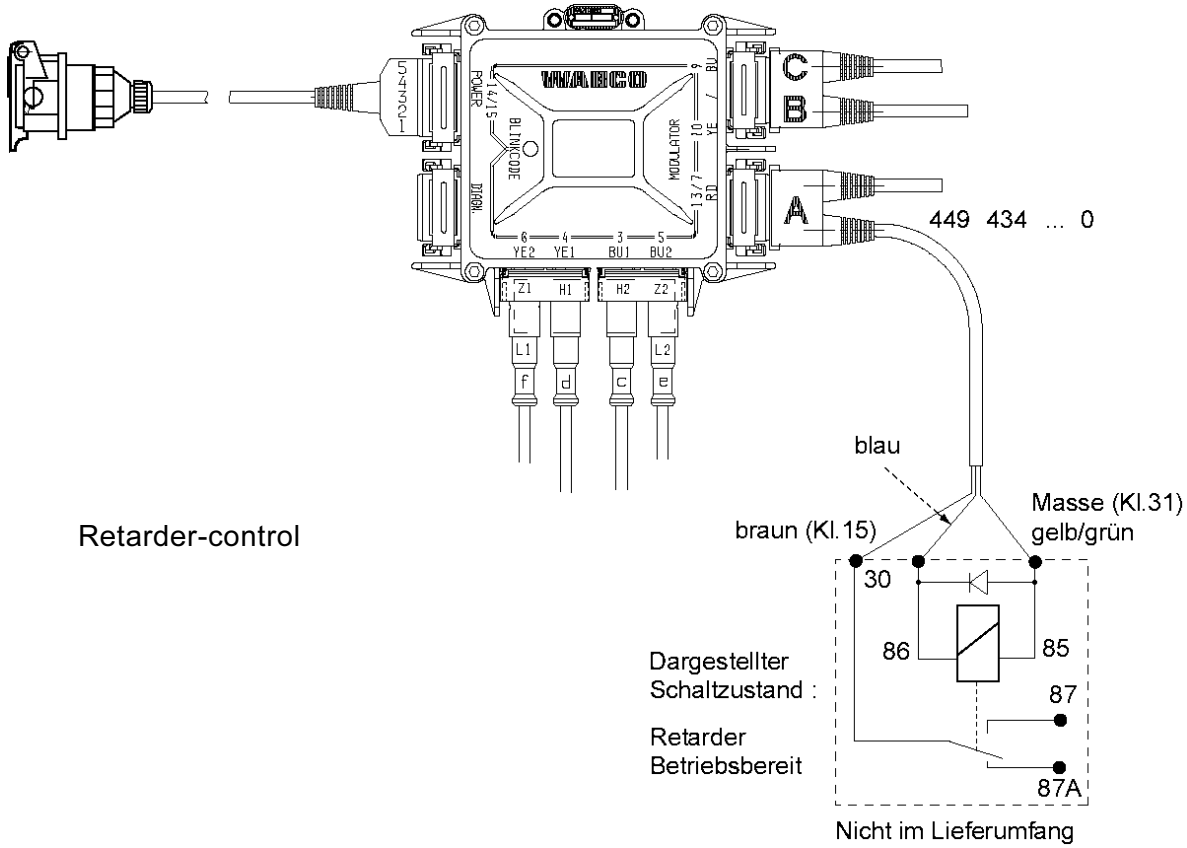
FAHRZEUGTYP	YE1	
2S/2M	d H1 H1 H2 c H2	BU1

MODULATOREN:
YE ≙ H1 ≙ B
BU ≙ H2 ≙ C

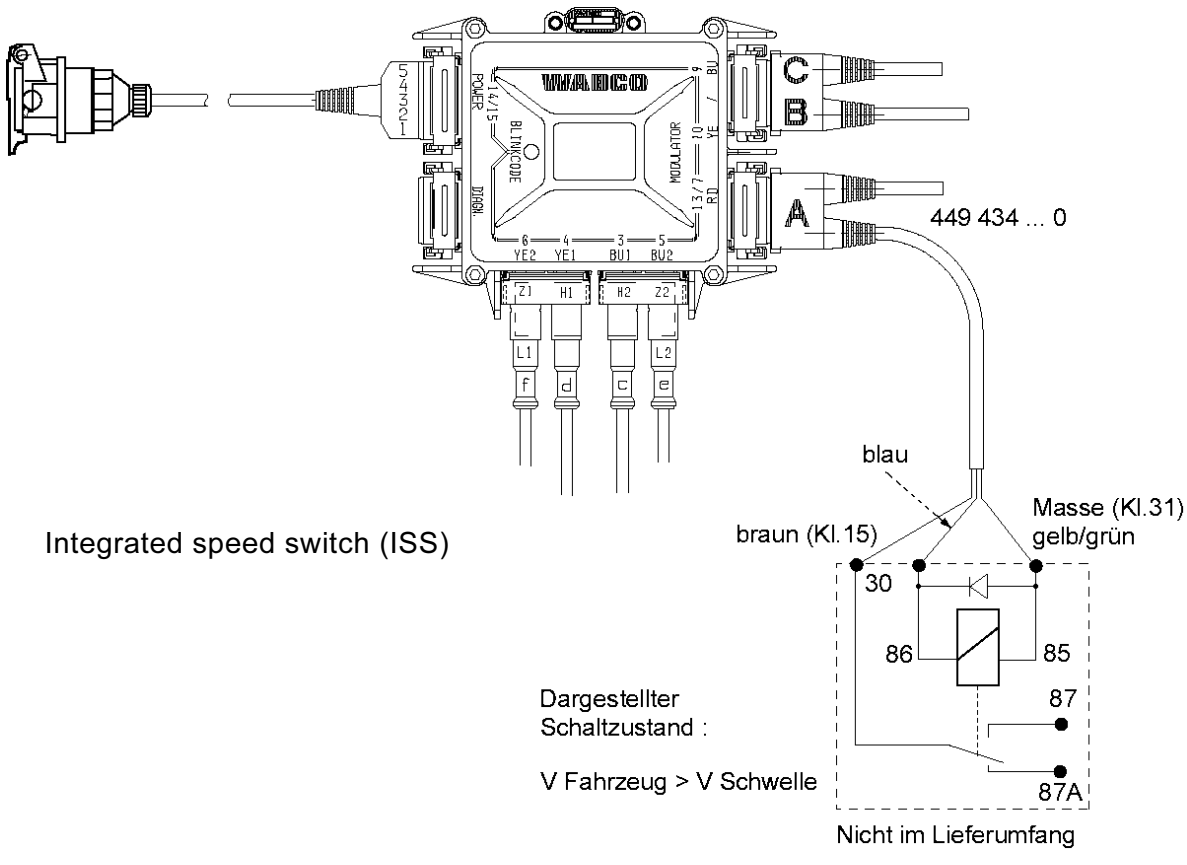
FAHRZEUGTYP	YE1	YE2
4S/2M	d H1 H1 H2 c H2	Z1 f Z2 e BU1 BU2

MODULATOREN:
RD ≙ L ≙ A
YE ≙ H1 ≙ B
BU ≙ H2 ≙ C

FAHRZEUGTYP	YE2	YE1
4S/3M	f L1 H1 H1 L H2 e L2 H2	d c BU2 BU1



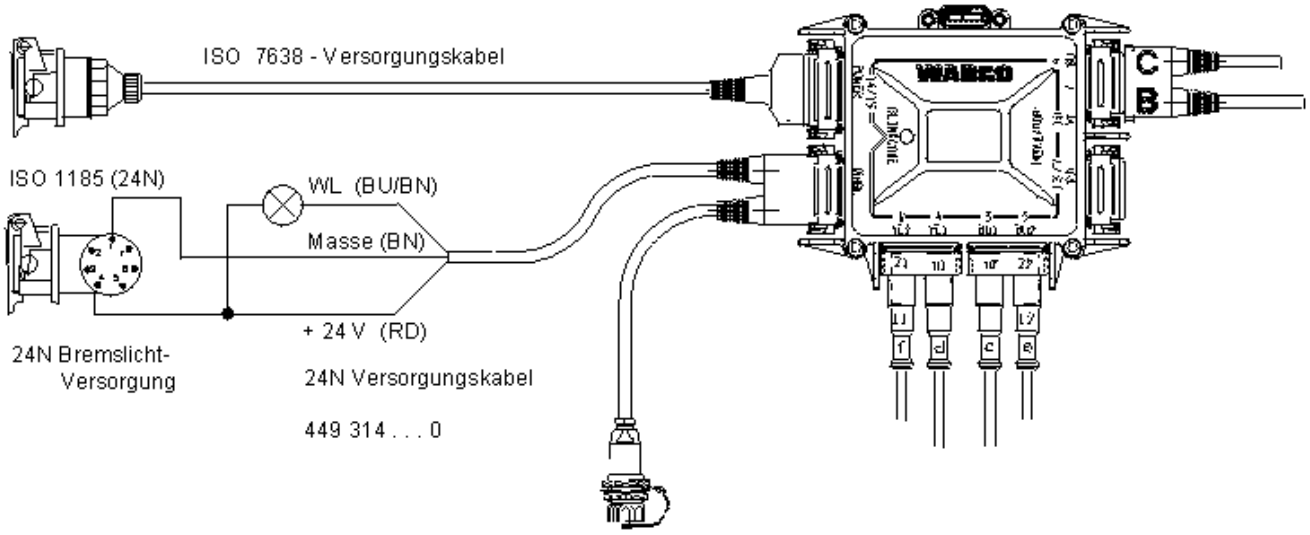
Retarder-control



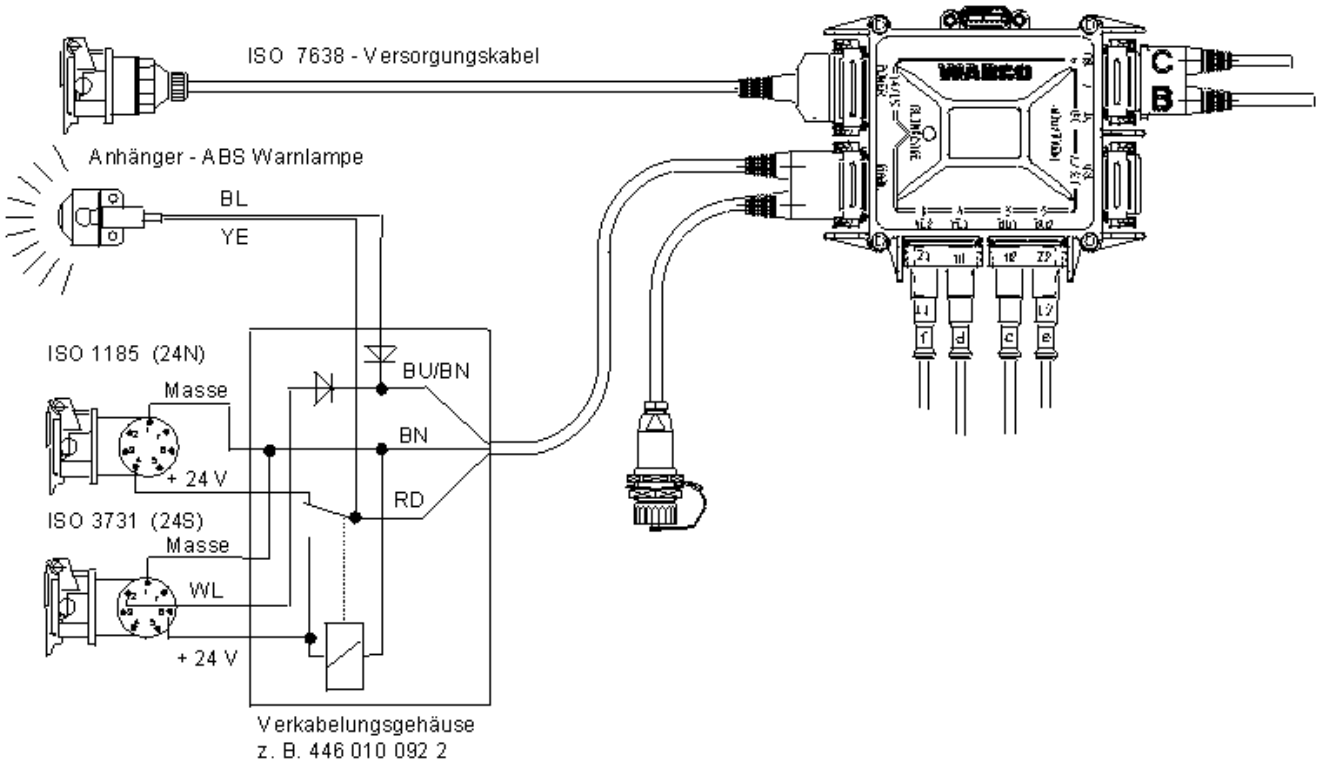
Integrated speed switch (ISS)

Power supply

ISO 7638 + 24N (Stop light)



Power supply
ISO 7638 + 24N + 24S



WABCO TRAINING

ABS-Training

Blink code truck C-Generation

4

Brochure **815 010 074 3**

Blinkcode
for Goods Vehicles
and Buses
ABS/ASR “C”-Generation

WABCO

TRAINING

ABS-Training

ABS / ASR
D-Generation

5

Brochure **815 010 001 3**

Anti-Lock Brake Systems (ABS-D)

for Commercial Vehicles

WABCO

TRAINING

ABS-Training

Trailer ABS
VARIO-C-System

6

Brochure **815 000 163 3**

VARIO-C

EMC - Certification
e1 021106

System Description
Installation
Components

Brochure **815 000 140 3**

TÜV -
Official Test Report

Results of certification tests
carried out by the
TÜV organisation in
accordance with regulations
70/320/EWG and ECE-R 13

WABCO TRAINING

ABS-Training

Trailer ABS VCS (Vario-Compact-System)

7

Brochure **815 010 006 3**

Vario Compact ABS

EMC - Certification
e1 021058

System Documentation
Installation
Components

Brochure **815 010 008 3**

Vario Compact System 2nd Generation

System Overview

WABCO

TRAINING

ABS-Training

Diagnosis Tools and Test Equipment Diagnostic Software Diagnostic Subscription

8

Brochure **815 010 037 3**

Diagnosis Tools and Test Equipment

General Information
Testing and Adapter Tools
Test Equipment per System