Service Manual Buses

Section **5 (59)**

Anti-Lock
Brake System (ABS)

TP 15837/1

VOLVO

Foreword

The specifications given in this service manual are based on data available up to July, 1995.

Reservation is made for changes in specifications introduced after this date.

Contents

Order number: TP 15837/1

Specifications

Control unit

4-channel	Volvo P/N 8141342
6-channel	Volvo P/N 8141345
Operating voltage	max. 30 V
Rated voltage	24 V
Wrong polarity protection	100 V
Min. voltage	18 V

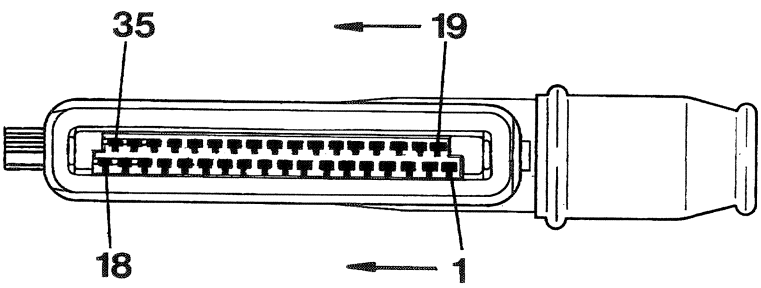
Power consumption with rated voltage

Pin 9 (control unit feed)	max. 300 mA
Pins 8 and 25 (holding current for relay)	80mA/relay
Pin 26 (warning lamp)	10 mA for 2 W bulb
Pins 1 and 9 (valve relay voltage)	closed circuit current max. 20 mA/pin
With ABS-controlled braking	max. 1.6 A/solenoid control valve

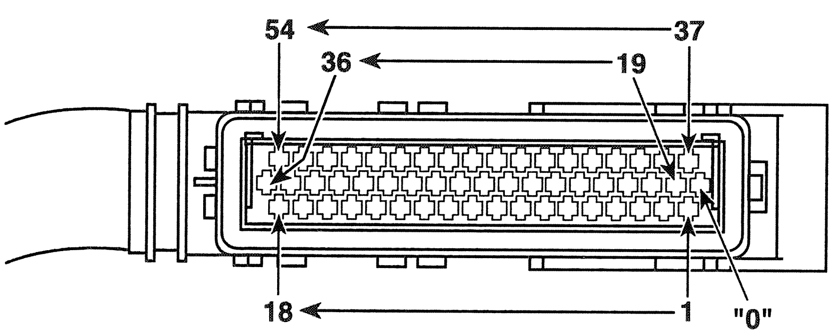
Outputs

Pins on control unit with positive (+) cable	4, 5, 6, 7, 21, 22, 23, 24
Pins on control unit that are negative (–) wired	26, 8, 25, 11, 3

Pin numbering in connectors



4-channel system



6-channel system

Circuit breakers, 8 A	8 A (two)
Relays, qty, 3–6	Volvo P/N 4786690
Circuit board, qty, 1	Volvo P/N 3036092

Pole wheels

Number of teeth	100/Pole wheel
Sensor frequency	7,3–9,7 Hz per km/h

Frequency differences between wheels on same vehicle may not exceed 3%.

Sensors, ABS

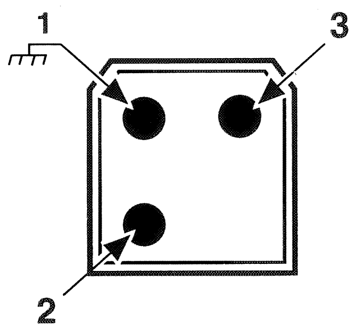
Resistance in coil (late prod.)	$1150\ ^{+100}_{-50}$ ohm
(early prod.)	1750±100 ohm

With 1/2 rev/sec wheel rotation the sensor voltage should be min $\pm$ 0.1 V.

Solenoid control valve, ABS

Volvo P/N	1609241
Working voltage	24 V
Resistance in coil 1	10–22 ohm
Resistance in coil 2	10–22 ohm

Solenoid control valve may be voltage-fed max. 10 secs.



Connectors on solenoid control valve
1. Earth (chassis) connection
2. Coil for venting brake cylinder
3. Coil for shutting-off feed to brake cylinder

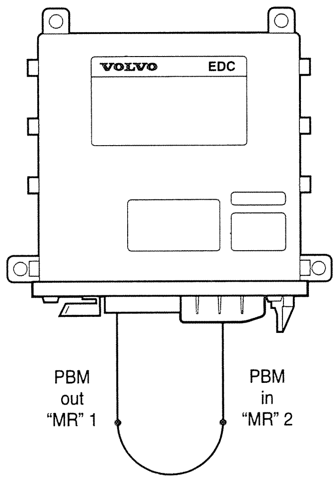
Solenoid valve, ASR

Volvo P/N	9515215
Working voltage	24 V
Resistance in coil	15±5 ohm
Power consumption	1,6 A

No diode on board
The solenoid valve may be voltage-fed max. 10 secs.

Without ASR

When the bus does not have ASR but has an EDC-engine, the PBM-signal in connector "MR" is bridged.



Engine control signal, pin 29, out-signal (only with ASR)

The signal consists of a pulse-band modulated signal from the ABS/ASR control unit. The control unit for the EDC compares the signal with the signal from the accelerator pedal sensor.

PBM-signal frequency	200 Hz
Out-voltage low	<2,5 V
Out-voltage high	>=Ubatt –1 V

When output reduction is required, a 10–90% pulse-band signal is emitted, 10% of which corresponds to low idle.

Normally when output reduction is not required, the pulse-band frequency signal is 90% (fixed value).

The PBM out-signal is emitted to the EDC control unit even if the PBM in-signal is faulty (pin 29).

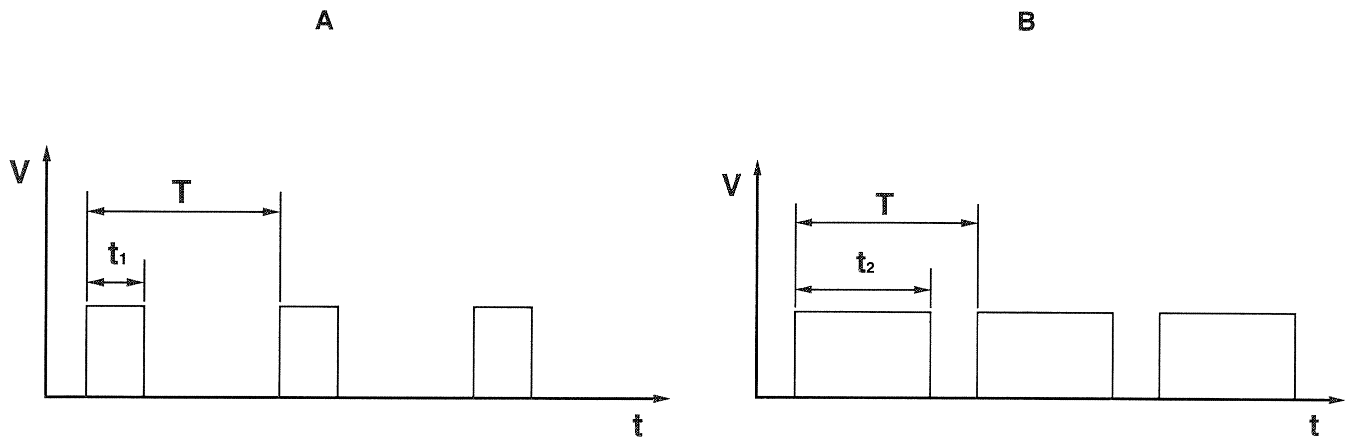
Engine control signal, pin 28, in-signal (only with ASR)

This is a pulse-band modulated signal from the EDC control unit. The signal indicates the throttle position to the ABS/ASR control unit.

PBM-signal frequency	200 Hz
Out-voltage low	<=0,3 x Ubatt
Out-voltage high	>=0,7 x Ubatt
Permitted pulse-band percentage	10–90%, where 10% corresponds to low idle and 40% approx. 1650 rpm.
Fault indicated with pulse-band percentage	<5% or >95%

or if frequency is <110 Hz or >220 Hz
With no or incorrect in-signal to the EDC control unit, an approx. 5% steady PBM-signal goes from the EDC control unit. No power reduction takes place.

Example of a pulse-band modulated signal

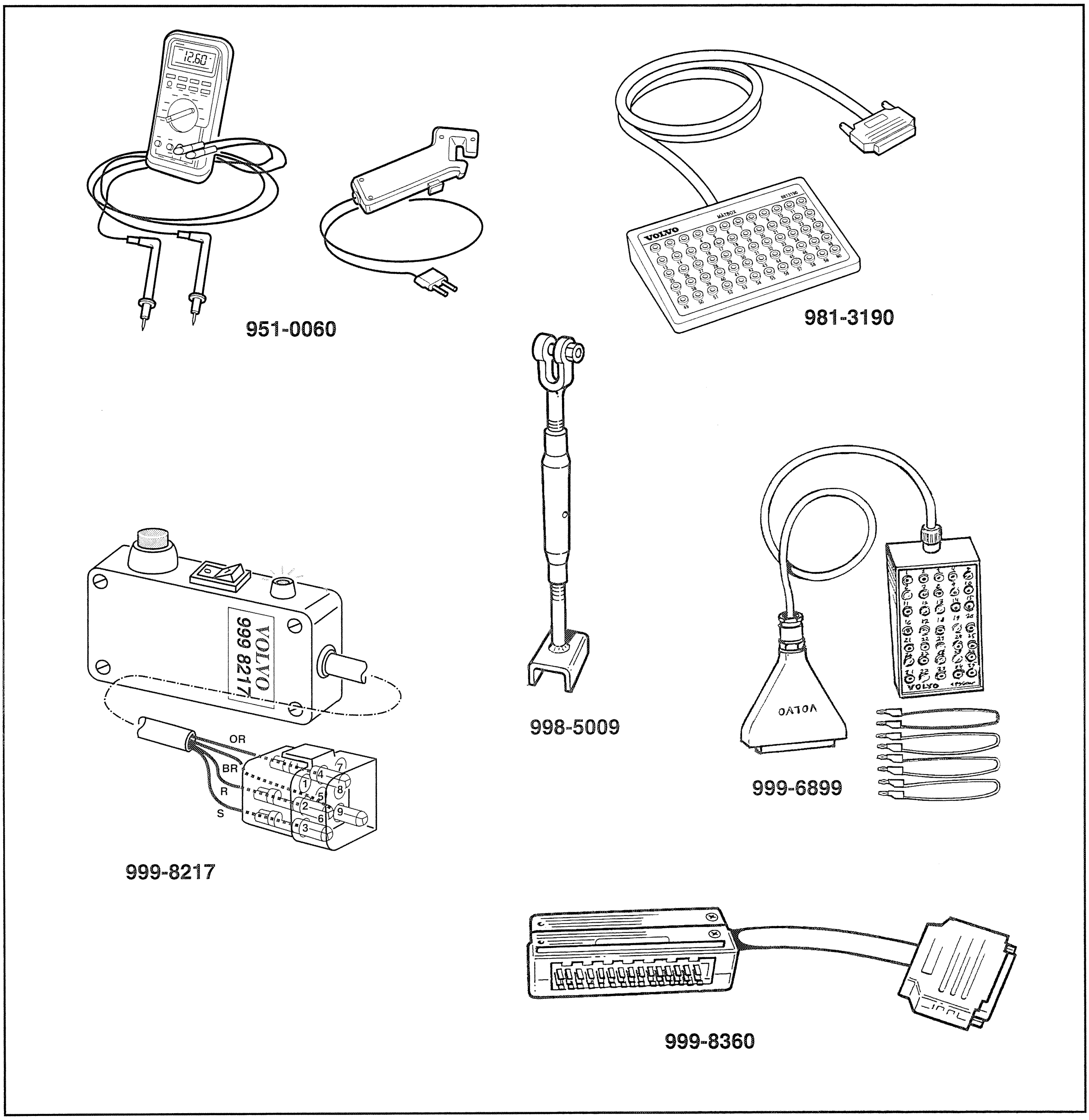


A. Signal with low idle, 220 Hz, 10% pulse-band percentage.
B. Signal at 1650 rpm, 200 Hz, 40% pulse-band percentage.

The pulse-band percentage is estimated as t/T* 100%.

Special Tools

The following special tools are used when testing the ABS/ASR-system. They can be ordered from Volvo Truck Parts AB under their respective article numbers.



951 0060 ***Volvo Digital Multimeter***

981 3190 ***Test box*** with 60-unit connector for 6-channel system

998 5009 ***Pedal support***

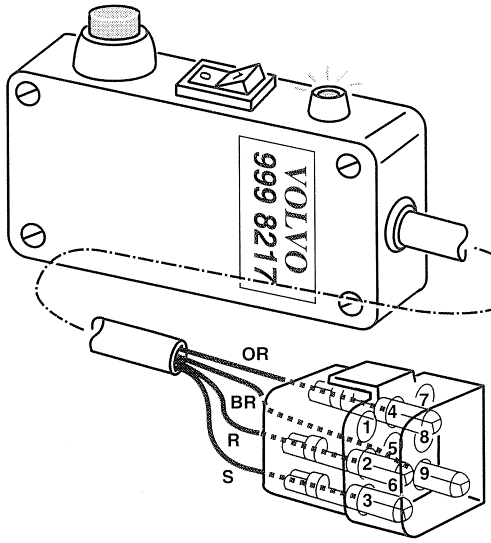
999 6899 ***Test box*** with 60-unit connector for 6-channel system

999 8217 ***Diagnostic tool ABS***

999 8360 ***Adapter*** for 60-unit connector

Diagnostic tool 999 8217

All that is required to be able to use the Volvo Trucks diagnostic tool is just to re-arrange the wiring in the connector on the tool (1) or make an adapter (2) for the tool, if one does not wish to alter the Volvo Trucks type of tool.



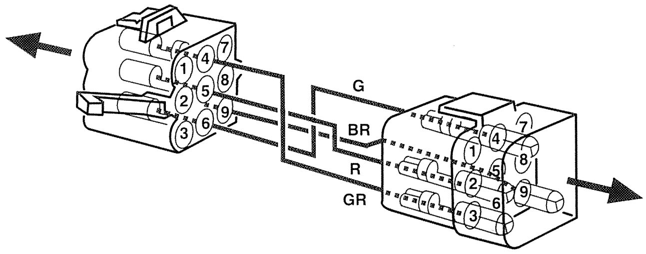
1. **Re-arranging wiring on diagnostic tool's connector**

Pin pos. 4 is moved to pos. 3 (black cable).
Pin pos. 5 is moved to pos. 2 (red cable).
Pin pos. 6 is moved to pos. 4 (orange cable).
Pin pos. 9 is not moved (brown cable).

The Fig. shows the diagnostic tool after re-arranging the wiring.

2. **Adapter**

If you do not wish to alter the diagnostic tool, you can make an adapter like the one in the Fig. below.



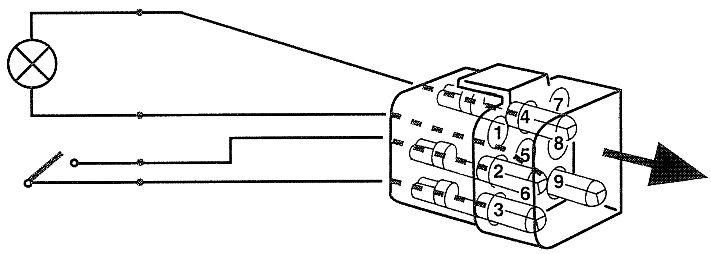
Sleeve insulator P/N 948294
Pin insulator P/N 948295

Sleeves P/N 968018
Pin P/N 968016

Toggle switch with lamp

A simple diagnostic tool as alternative to the above is to use an ordinary switch with lamp and to wire it as outlined below.

Material	**P/N**
Toggle switch with lamp	4803455
Pin insulator	948295
Pin	968016
Cable (black)	954427
One connector	4803454

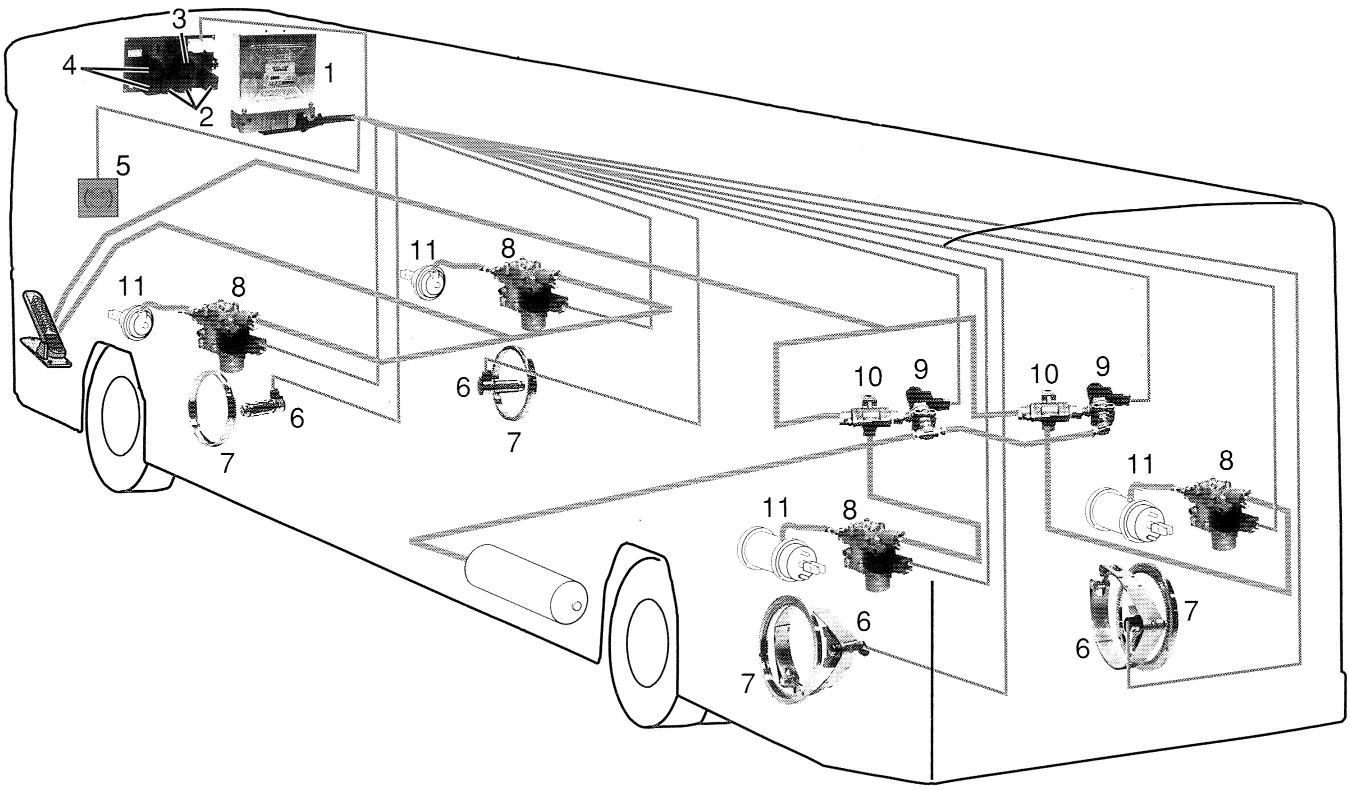


General

This manual covers the ABS/ASR system with the "C-version" control unit. The control unit is wired for ASR (anti-slip regulation), also known as TC (traction control).

The control unit is either of the 4-channel type, which is intended for 2-axle buses and bogie buses; or of the 6-channel type, which is used in artic buses. The "C-version" control unit is introduced into production with effect from January, 1992. The C-version is a development of the B-version. Major differences: the C-version has fault-diagnosis system on board, a fault memory and is wired for ASR connect-up.

The C-version can wholly replace the B-version control unit.



1. **Control unit (9008)**
   Processes in-signals from the sensors and sends out-signals to the solenoid valves.
2. **Relays, voltage feed (three)**
   One relay voltage-feeds the section of the control unit that does the calculations and the analyses. The other two relays voltage-feed the control unit's out-signals to the solenoid valves.
3. **Relay retarder cut-out**
   When the ABS-function starts operating, a relay cuts out the retarder function.
4. **Relay control of automatic transmission (lock-up)**
   When the ABS-function starts operating, a relay breaks the lock-up function and a relay keeps the circuit open until the brake is no longer on.
5. **Indicator lamp**
   An extinguished lamp during a journey indicates that the system is functioning as it should.
6. **Sensors (7057)**
   Mounted next to each wheel. They send speed-dependent impulse signals to the control unit.
7. **Pole wheels**
   Mounted on the hubs. Rotate at same speed as wheels. The pole wheels rotate against the sensors which then generate impulse signals.
8. **Solenoid control valves, ABS (6013)**
   Modulate (control) the pressure out to the brake cylinders.
9. **Solenoid valves, ASR (601)**
   When these valves open, pressurised air goes to the brake cylinders via the ABS-solenoid control valve.
10. **Two-way valve, used together with ASR-solenoid valve**
11. **Brake cylinders**

Why ABS?

The anti-lock brake system, ABS, is a complement to the ordinary brake system.

The function of the ABS-system is to regulate the braking power and so avoid wheel lock during, e.g., panic braking and braking on a slippery road surface. In effect, we get better directional stability and steering compared to a bus that does not have ABS. With ABS, tyre damage also in connection with wheel locking can be avoided. Under normal driving conditions the system remains passive, that is, brakes and brake pressure are not affected by the ABS-system. When wheels lock during braking on a vehicle that does not have ABS, not only does this have a negative effect on the braking capacity, but also and above all on the steering ability. Wheel pairs that lose their grip on a road surface strive to point straight ahead and it becomes almost impossible to steer the bus.

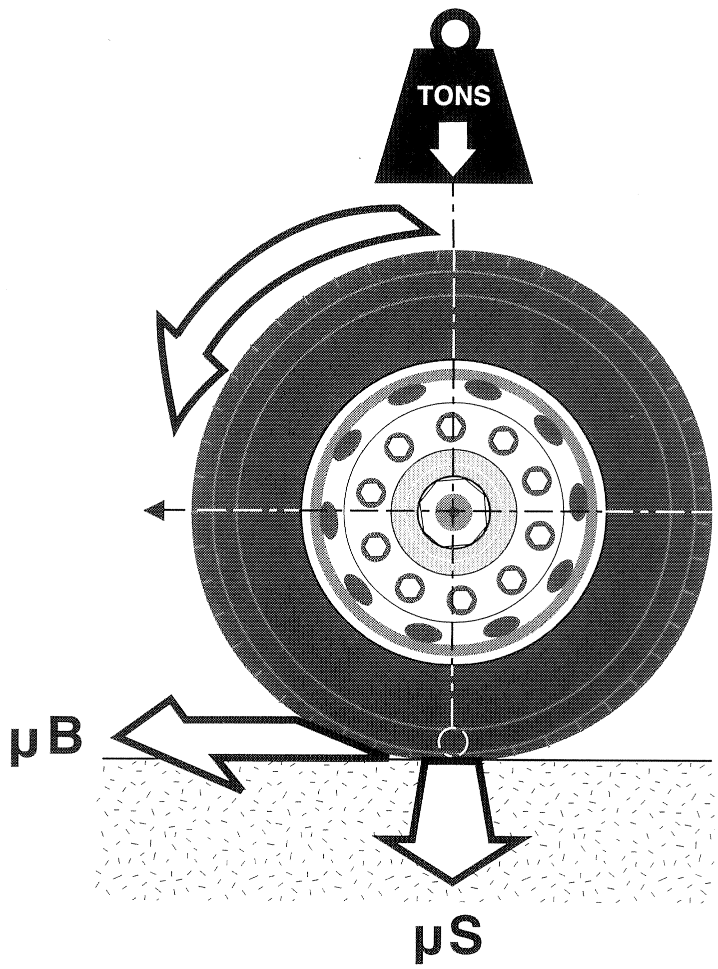
For a proper understanding of the principle behind the ABS-system, it is necessary to study what happens when tyres make contact with the road surface.

Friction

The friction between tyres and the road surface can be divided up into two frictional forces

- Braking force friction (μB)
- Lateral force friction (μS)

Braking force friction comes into play during braking and lateral force friction is utilised for steering and stability. The greater the friction, the better the braking and steerability.

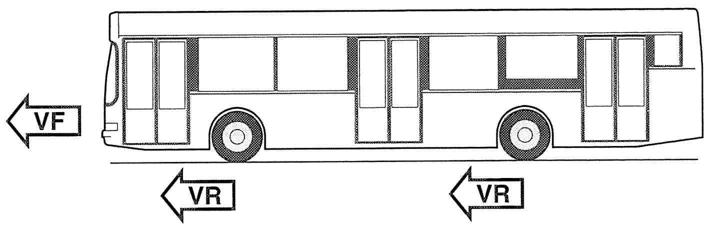


Slip

Whenever a wheel turns, there is always a certain amount of movement between the tyre's contact area and the road surface. When the wheel is braked, slip (λ) takes place in the rolling direction. Slip is calculated according to the following formula:

$\lambda = (VF - VR)/VF \times 100\%$

where
VF = the speed of the vehicle
VR = the peripheral speed of the wheel

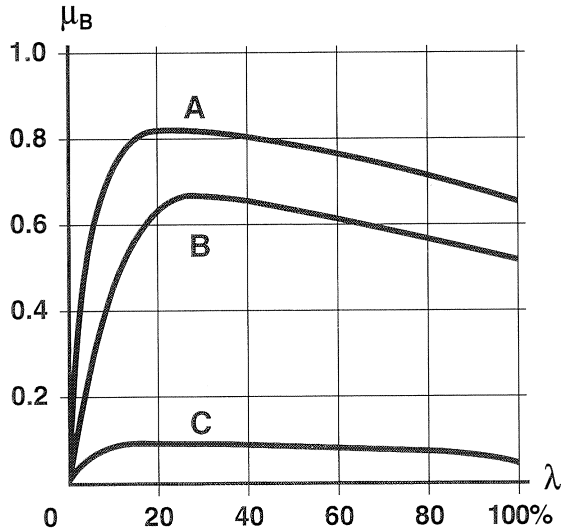


A wheel that rolls completely free without being braked or steered has 0% slip. When the wheel locks, we get 100% slip.

For example: if a bus is running at a speed of 90 km/h at the beginning of powerful braking, the wheel's peripheral speed will reduce much quicker than the bus's. When the bus speed is 80 km/h, perhaps the wheels have a peripheral speed of only 40 km/h. The wheel's slip will then be
= (80–40)/80x100%.
λ = 50%

Relationship between friction and slip

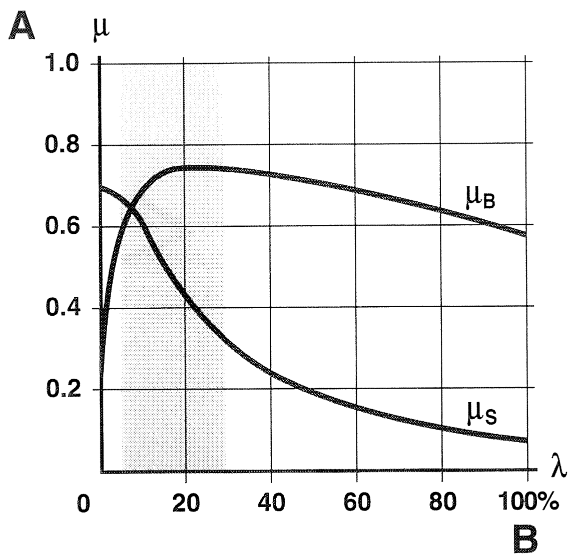
The diagram shows the relationship between the friction coefficient in the wheel rolling direction μB and the wheel slip λ with different road surfaces. There is optimal braking effect with a wheel slip of approx. 5–30%. More powerful braking reduces the friction μB with the wheels finally locking completely at λ = 100%.



A. Dry asphalt
B. Wet asphalt
C. Ice

If you also enter in the diagram the lateral force coefficient μS as a function of the slip λ, we can see that the steerability, that is, the lateral friction, drastically reduces with increased slip. The diagram curves show that, at a slip within approx. 5–20%, you get good braking capacity and also good steerability, which means that stability is maintained.

The ABS-system works within the shaded area. You notice this when an individual wheel loses its grip and starts locking. The braking distance is "pulsed" in such a way that the wheel is all this time kept within the most effective slip range, irrespective of the amount of friction against the road surface.



μB. Friction in the rolling direction
μS. Lateral friction

What happens during a control cycle with ABS

The diagram below outlines the principle during a control cycle involving the most important variables for one wheel: wheel retardation, wheel acceleration, brake pressure and wheel speed. The reference speed is estimated with reference to the speed for all the bus's wheels.

When the brake pressure increases, so also does a wheel's retardation.

At *1* the wheel has reached a retardation level that is impossible to reach for the entire bus. The reference speed and the wheel speed are the same up to this point, after which the wheel speed drops more quickly.

At *2* the wheel has gone below the retardation threshold, –b, and the wheel approaches an unstable position in the μ and λ diagram (slip value too high). A further increase in the brake torque would only increase the wheel's retardation but not the vehicle's. That is why the brake pressure drops rapidly so that the wheel retardation reduces. Brake system inertia will cause the wheel to retard a bit more and thereafter reduce the retardation.

At *3* retardation has reduced and is above the set threshold, –b. Thereafter brake pressure is kept at a constant level for a time-set interval, T1.

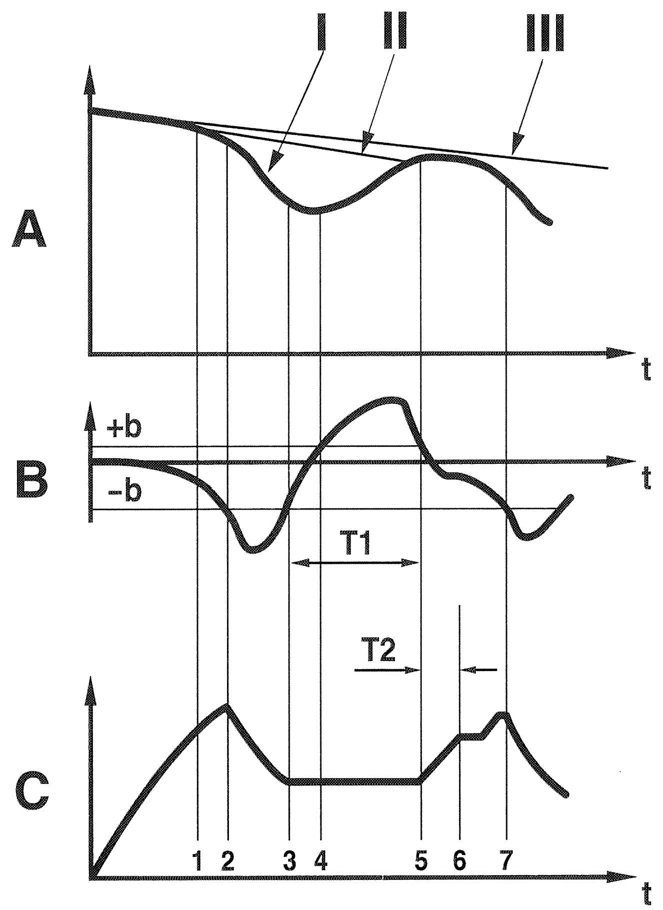
At *4* the wheel's normal acceleration during the interval T1 goes above the acceleration threshold, +b. If the acceleration threshold is not reached within T1, the brake pressure will drop further.

At *5* the acceleration has gone below the threshold value and the brake pressure increases rapidly in a time interval, T2, and this steps up the control cycle. Time T2 is pre-set for the first control cycle but after that it is calculated for each cycle.

After the first rapid pressure increase (at 5), the pressure gradually rises via pulses for pressure holding and pressure increasing (at 6). These pulses continue until the retardation limit value is again reached (–b) in point *7* and the brake pressure again drops, that is, a new control cycle has begun.

The control cycle shown in the Fig. applies to a road surface with high friction coefficiency. The control curves will differ with other friction coefficiencies.

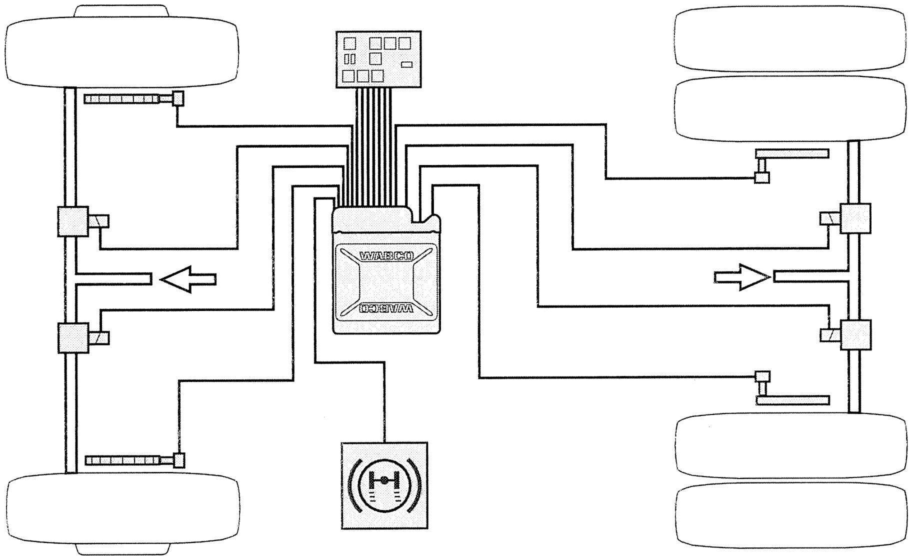
Nor are the threshold values for the wheel acceleration and the wheel retardation constant but depend on a number of parameters. The number of cycles per second can go up to 3–5/sec.



A. Speed
B. Wheel acceleration
C. Pressure in brake cylinder

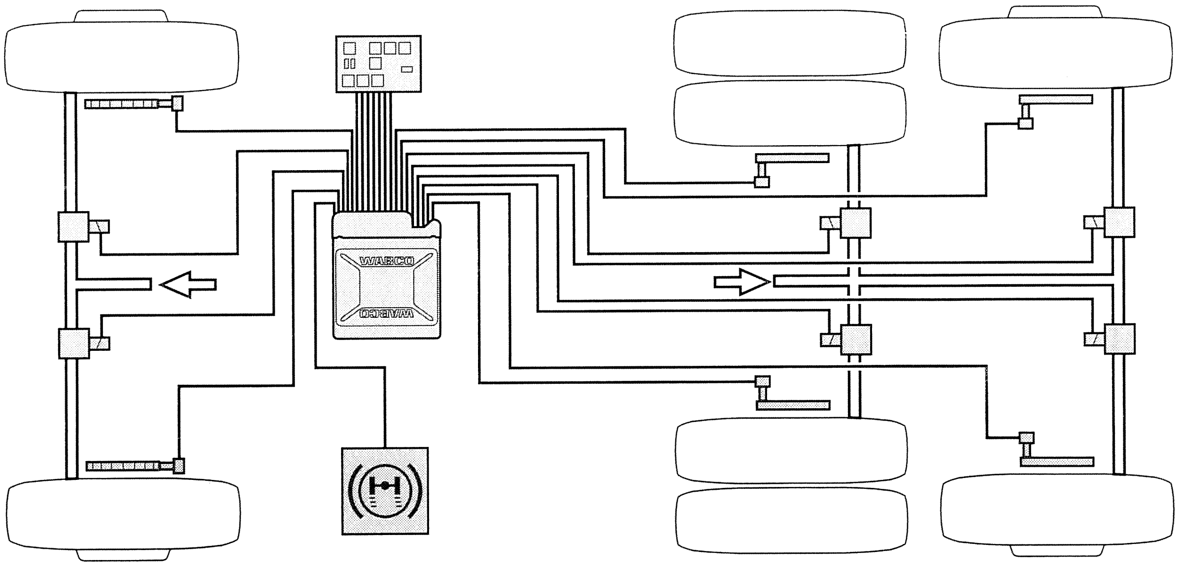
I. Wheel speed
II. Reference speed
III. Bus's speed

Structure of the ABS-system



4-channel system (2-axle and bogie buses)

⇦ = brake pressure



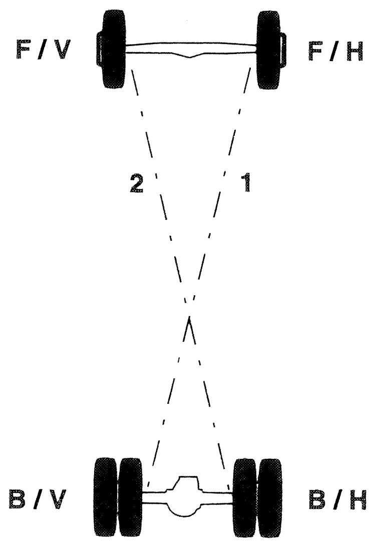
6-channel system (artic bus)

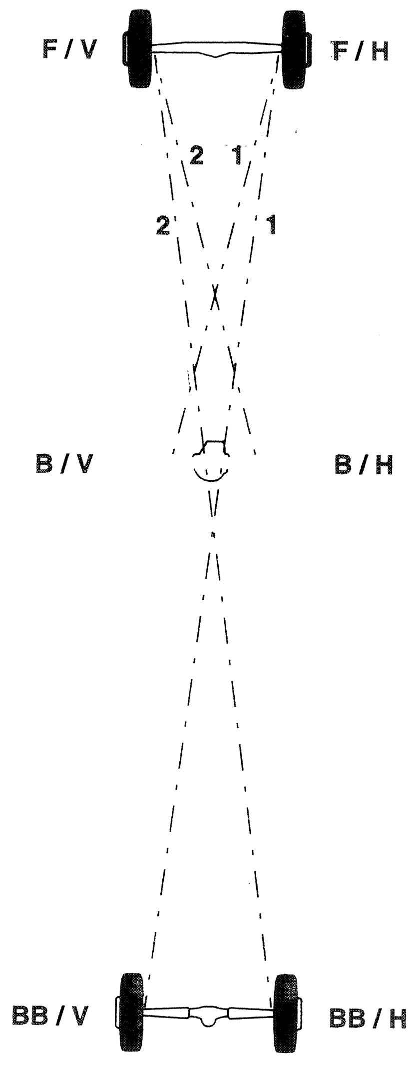
Brake circuitry

The ABS/ASR control unit compares the diagonal impulse signals from the sensors between the front and rear wheels. The sensor signals inputted into the control unit for the 4-channel system are in two groups; one group formed by the sensors on the right front wheel and left rear wheel, diagonal 1; and the other group formed by the sensors on the left front wheel and right rear wheel, diagonal 2.

The signals in the 6-channel control unit are grouped so that the sensor on the right front wheel together with the sensor on the left intermediate wheel and the sensor on the left rear wheel form one group, diagonal 1. The other group is formed by the sensors on the left front wheel, right intermediate wheel and the right rear wheel, diagonal 2. Should a fault develop in one of the circuits, the faulty circuit is partly or wholly shut down but the circuit will still function as a brake circuit now without the help of ABS. An indicator lamp on the instrument panel lights with circuit failure.

1. Diagonal 1
2. Diagonal 2
F/R: Front/right
F/V: Front/left
B/H: Rear/right
B/V: Rear/left
BB/H: Artic/right
BB/V: Artic/left





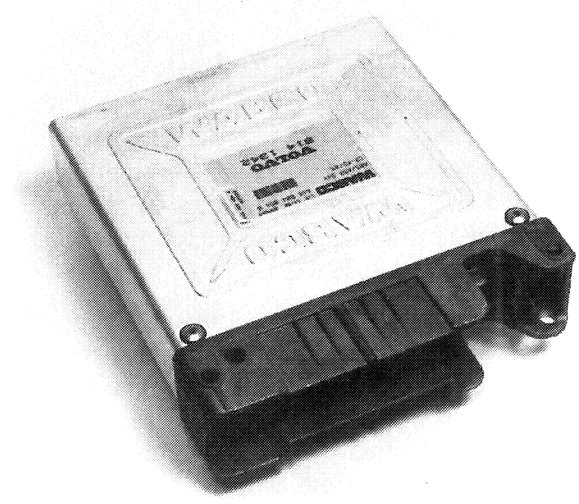
Control unit

The control unit contains electronic components. These form two diagonal circuits, where each diagonal circuit (1 and 2) can be divided up into function blocks. A diagonal circuit has the following function blocks:

- In-signal circuit
- Signal calculation circuit (main processor)
- De-coding circuit
- Drive circuit for controlling solenoid control valves
- Fault analysis function

The in-signal circuit

The in-signal circuit filters and transforms the inductive frequency-based sensor signals to 5 V digital in-signals to the signal-calculation circuit.



Control unit

The signal-calculation circuit

The signal-calculation circuit consists of a 16-bit micro-processor, programmed for evaluating and interpreting the digital in-signals of the wheels' speeds. When one or more wheels tend to lock (or spin with ASR-function), this immediately determines the solenoid control valve and relay that is to be activated or de-activated. All signals from the signal-calculation circuit are transmitted digitally to the de-coding circuit.

The de-coding circuit

The de-coding circuit responds to the digital signals from the signal-calculation circuit and divides them up into different control signals that are sent on to the drive circuit for controlling the solenoid control valves.

Drive circuit for controlling solenoid control valves

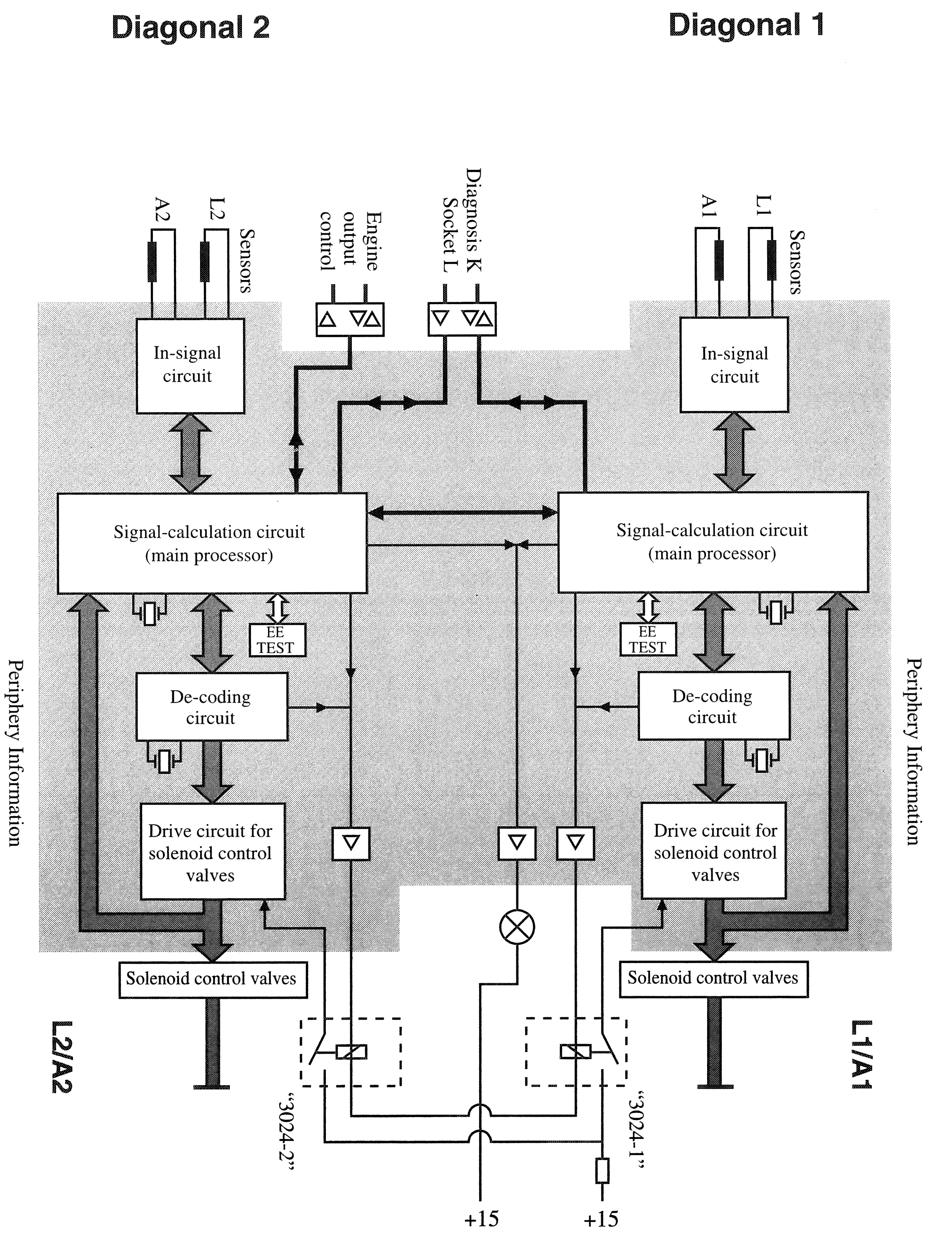
This circuit contains power transistors that are controlled by the in-signals from the de-coding circuit. The boosted out-signals from the power transistors control the solenoid control valves for brake release and brake application.

The drive circuit is voltage-fed via an external relay.

The fault-analysis function

The system carries out a fault analysis by doing different checks between the blocks in the diagram. All signals are checked primarily via the signal-calculation circuit and the de-coding circuit. Among the analyses made here are: reasonability analyses, signal-calculation analyses, signal time analyses, RAM/ROM checks, impedance checks. EEPROM checks, check of voltage feed to solenoid control valves, etc.

A fault is registered and stored in the EEPROM memory. This is then read-off via fault codes. See section "Fault tracing".



Block diagram, control unit

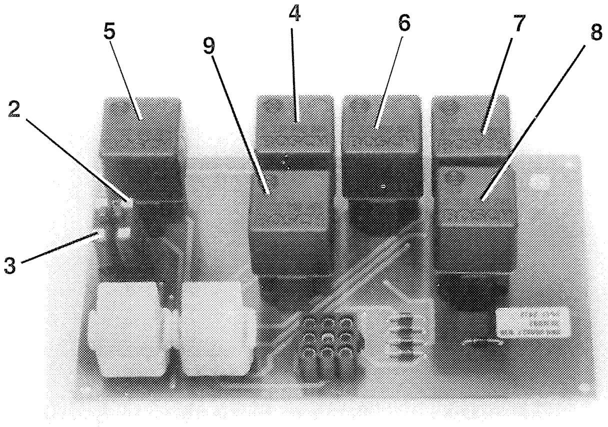
Relay, voltage feed

The ABS/ASR control unit is voltage-fed via fuse "15" when the feed starter switch or starter key is turned to the drive/start position. Pin 9 on the control unit is then + fed to activate the control unit.

When the control unit is activated by voltage via pin 9, it checks the system (test-cycle). If the system is without fault, the control unit earths pins 8, 25 and 26. When these pins are earthed, this closes relays 3025, 3024-1 and 3204-2.

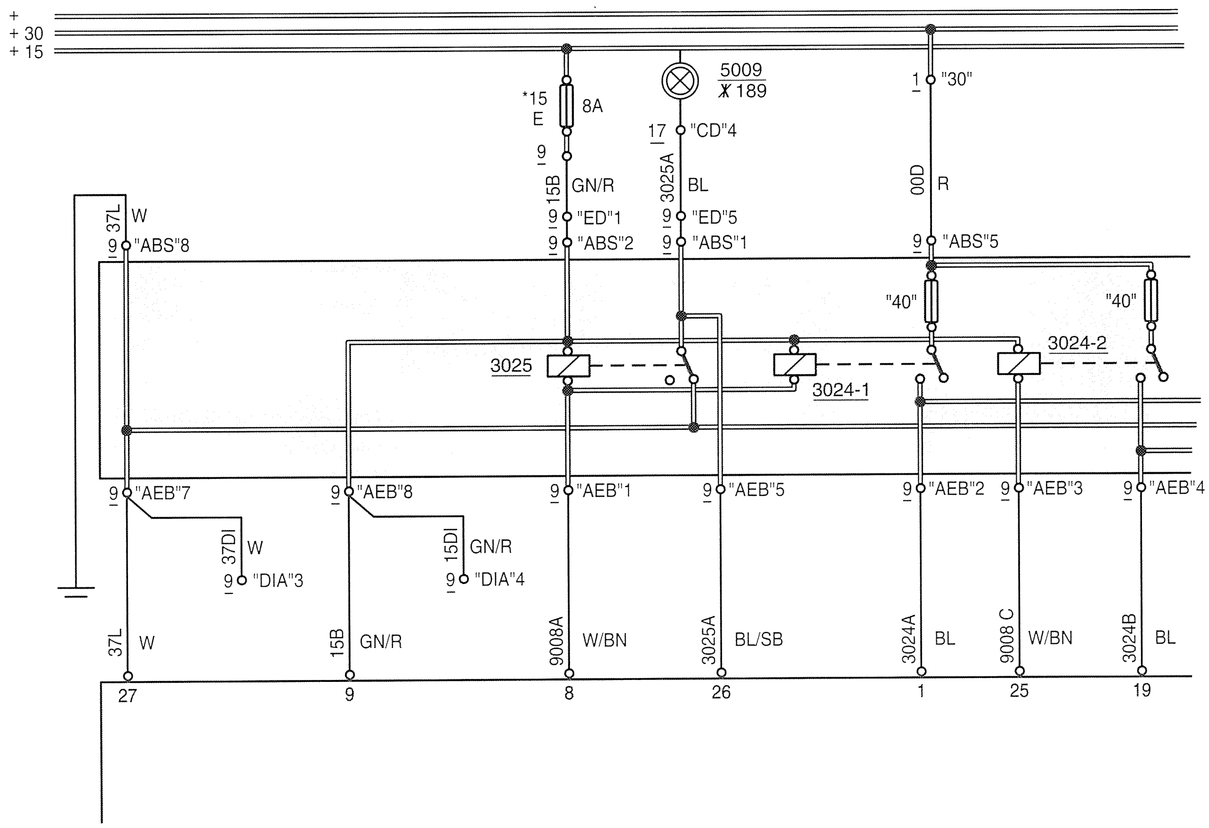
When relays 3024-1 and 3024-2 are activated (closed), voltage is fed to control unit pins 1 and 19 via fuses "40" and "41".

Pins 1 and 19 voltage-feed diagonal 1 and diagonal 2, that is, they supply the solenoid valves with voltage when these are to be activated.



Relay circuit board

1.	"15"	Fuse 8 A placed in electrical centre
2.	"40"	Fuse 8 A
3.	"41"	Fuse 8 A
4.	"3024-1" diagonal 1	Relay, ABS
5.	"3024-2" diagonal 2	Relay, ABS
6.	"3025"	Relay, indicator lamp
7.	"3044"	Relay, hold circuit
8.	"3045"	Relay, lock-up
9.	"3046"	Relay, retarder



Other relays

Where automatic transmissions are concerned, an activated ABS/ASR system is guarded against interference from other components by cut-out of the retarder and the lock-up function (direct coupling). The engine brake, so-called "exhaust brake", is not affected by the ABS system. On the other hand, however, the VEB-brake is affected by the ABS/ASR system.

Retarder operation

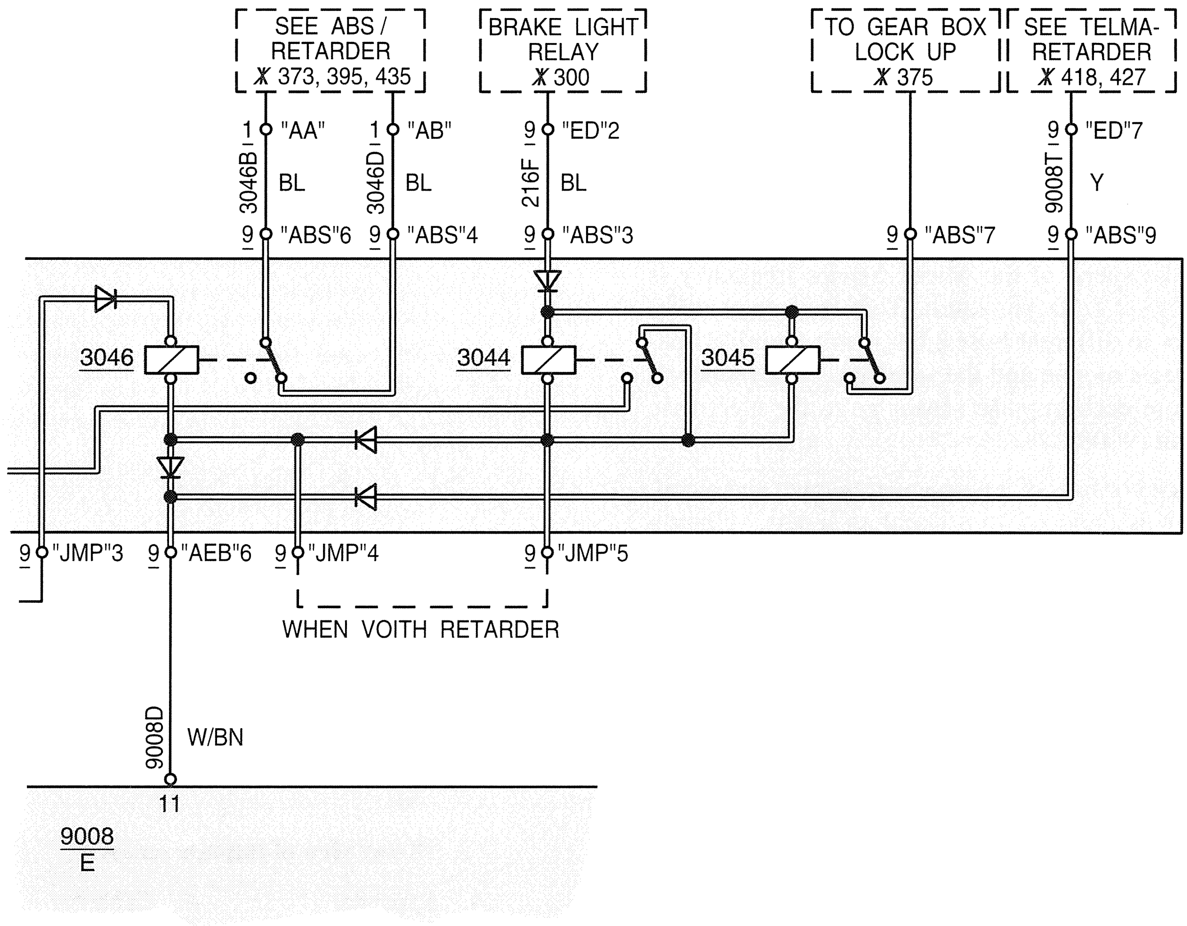
The retarder disengages when the ABS-function engages. The electric wiring will depend on the retarder type. The electric retarder (Telma) disconnects when the signal on control unit pin 11 earths (–). The retarder's control unit is wired to the relay circuit board via connector "ABS" 9.

The hydraulic (Voith) retarder disengages via a relay (3046). Disengagement begins when pin 11 earths (–). An extra cable on the relay board, between "JMP" 4 and "JMP" 5, will activate relay 3046 even after pin 11 is not earthed (–). This is done with the help of relay 3044, which keeps the retarder disengaged until the brake indicator light goes out, that is, when the brake pedal is released. This retarder is wired to the relay circuit board via connectors "ABS" 6 and "ABS" 4.

For a retarder built into the ZF-automatic transmission, retarder disengagement is via relay (3046) when pin 11 earths (–). The built-in retarder is wired to the relay circuit board via connectors "ABS" 6 and "ABS" 4.

Lock-up function (automatic transmission)

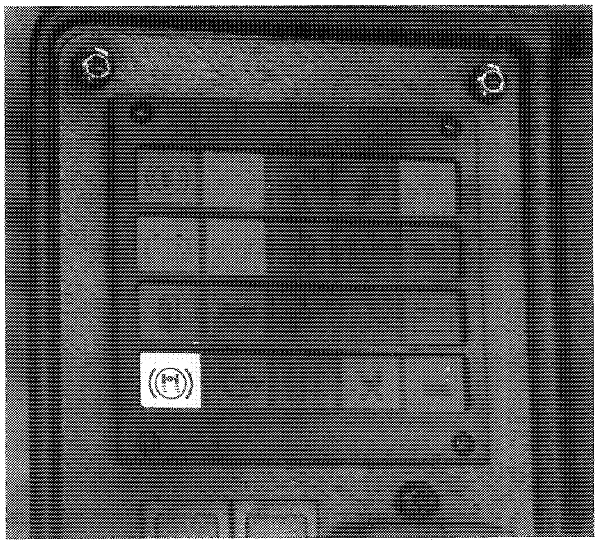
The lock-up function disengages via relay 3045, which closes when pin 11 earths (–). The transmission's control unit then gets a positive signal from the relay circuit board via connector "ABS" 7. Relay 3044, which is also closed, keeps relay 3045 closed until the brake light goes out, that is, when the brake pedal is released.



Indicator lamp

The ABS/ASR system automatically does a self-function check each time the bus is started. If the system is without fault, its indicator lamp lights when the feed starter switch/starter key is turned to the drive position. At the same time as the indicator lamp lights, the system's control unit sends an electric impulse to all the solenoid control valves, which go into stand-by operation. (This can be heard from outside the bus.) When the ABS/ASR system has done a self-function check and found that the system is without fault and the bus has reached a speed of approx. 7 km/h, the control unit breaks the earthing on pin 26. The ABS/ASR system's indicator lamp goes out. If the lamp doesn't go out or lights again during driving, this indicates a fault in the ABS/ASR system. In which case, see further "Fault tracing".

If the lamp lights, the bus can still be driven, but the ABS/ASR system may not wholly or partly function. Normal braking in the faulty circuit, however, will not be affected; the brake circuit will still function as an ordinary brake circuit during braking.



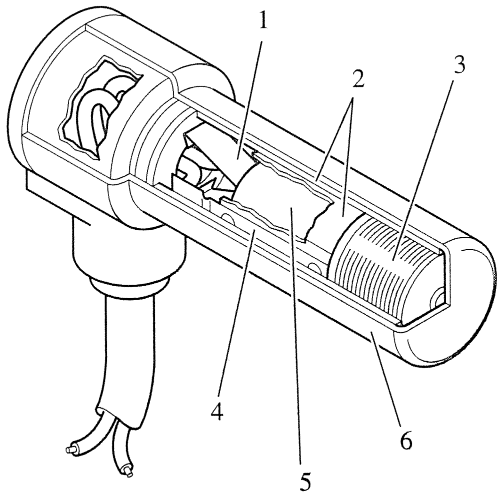
ABS/ASR system indicator lamp

Impulse sensors

The anti-lock brake system works with inductive speed sensors (7057), which are mounted next to each wheel. At each wheel hub there is also a pole wheel, which rotates at the same speed as the vehicle's wheel. The impulse sensors are placed opposite the teeth of the pole wheel. A rotating pole wheel generates alternating current which the sensors induce at a frequency proportional to the speed of the wheel. Sensor frequency is between 7.3–9.7 Hz per km/h. This frequency tolerance caters to different buses, but is not permitted between wheels on one and the same bus. The inductive signals from each impulse sensor go to the electronic control unit (9008).

Each sensor consists of a permanent magnet and a coil. The sensor is clamped to a stainless holder. When a sensor or hub with pole wheel has been removed, the distance between the sensor and pole wheel must be set when re-installing. This is done by pressing the sensor under finger pressure (never tap in the sensor) as far as possible in against the pole wheel. The sensor adjusts itself out if there is play in the wheel bearing.

Since the sensor is magnetic, it must always be thoroughly cleaned before being re-installed.



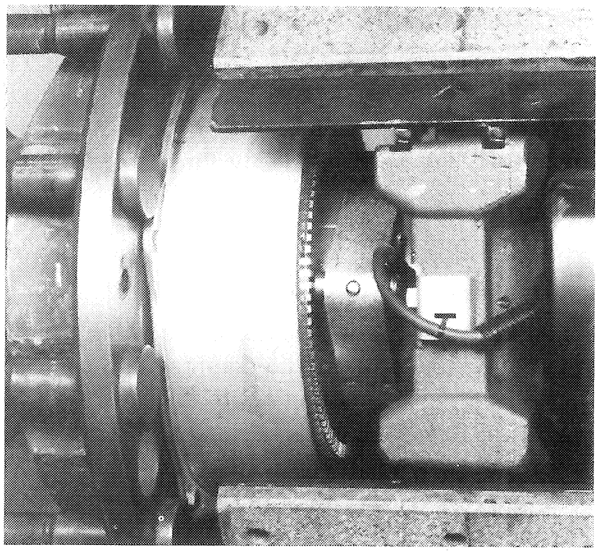
X-ray view of impulse sensor

1. Expander
2. Insulation
3. Coil
4. Cable bar
5. Magnet
6. Metal sleeve

Pole wheels

At each wheel of the vehicle there is a pole wheel that rotates at the same speed as the vehicle's wheel. The pole wheel consists of a cast iron ring with milled out teeth. On the front axle the pole wheel is pressed onto a milled shoulder on the hub, and on the rear axle it is bolted to the hub. The pole wheel has 100 teeth. It is the number of teeth that gives the frequency for sensors' output signals.

Hubs with pole wheels must be handled carefully to prevent damage to the teeth. A damaged or defective pole wheel sends wrongs signals to the control unit, which then shuts off the ABS function for the circuit in question. With pole wheel replacement, press the pole wheel on so far that it lies against the bottom surface on the hub's milled seat. Max. permitted warp on a fitted pole wheel is 0.3 mm. When the brake drum is removed, the pole wheel must always be cleaned with a soft cloth or brush and suitable cleaner.



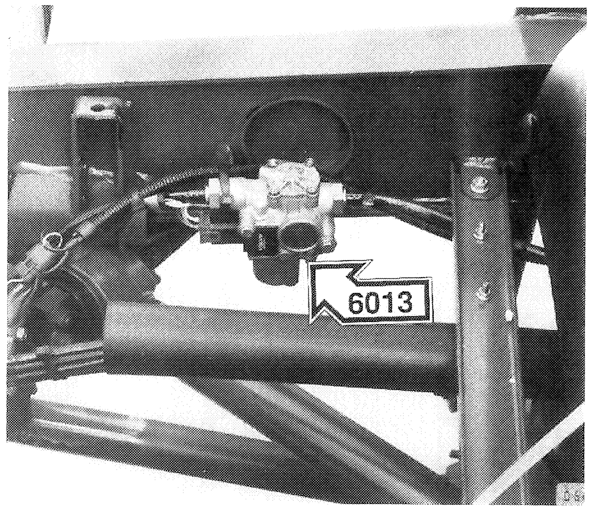
Solenoid control valves, ABS

The electronic control unit compares the impulse signals between the wheels and if one or several of the wheels tend to lock, the control unit emits control signals to the solenoid control valves. Mounted in a bracket next to the brake cylinders these solenoid control valves regulate the brake pressure for the wheels showing a tendency to lock themselves. Throughout all this time, the electronics in the control unit are comparing the signals coming from the impulse sensors, that is, the speeds of the vehicle's wheels, and judge when and how much the solenoid control valves should pulse the brake pressure to the wheel in question.

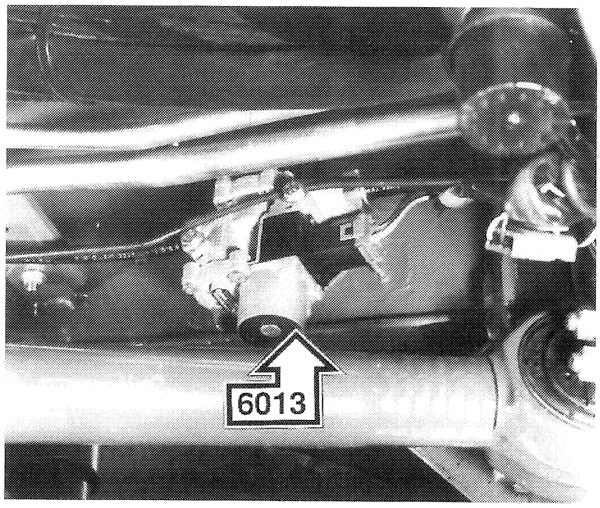
The solenoid control valves for the ABS are all of the same type. They contain two double valves, which are controlled electrically with the help of two electromagnets, and two, pressurised air-controlled diaphragm valves.

No particular maintenance is required for the solenoid control valves. They are replaced complete as a unit whenever faulty.

Each time the feed switch/starter key is turned to the drive position, the control unit's pins 1 and 19 get +feed and the control unit emits an activation voltage impulse to the solenoid valves which do a working cycle. This is done in order to ensure the solenoid valves are functioning properly and do not bind.



6013 (B10B) Solenoid control valve ABS



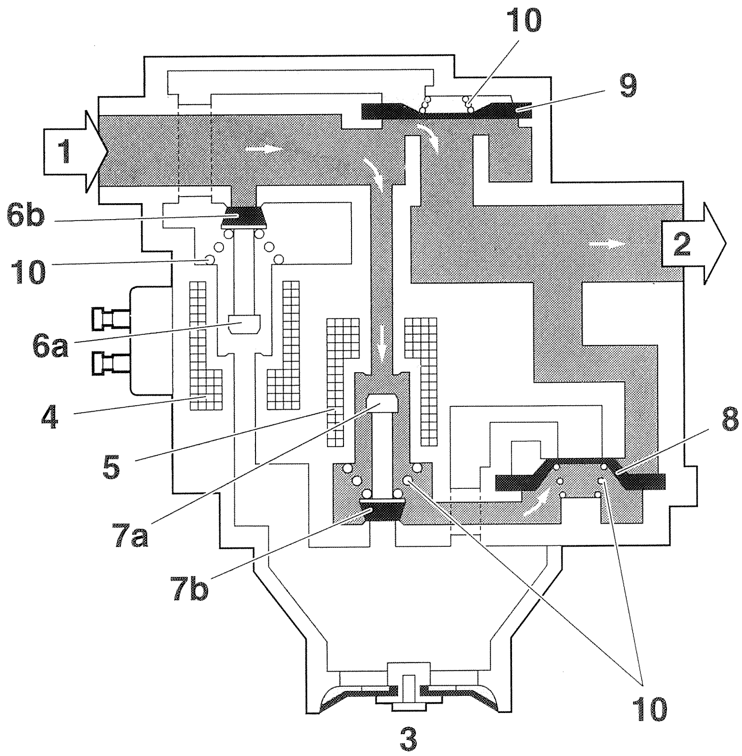
6013 (B12) Solenoid control valve ABS

Function, solenoid control valve ABS

The air passage from the inlet (1) to the outlet (2) can be closed by the diaphragm (9). The diaphragm (8) can close/open the venting (3). The working cycle of a solenoid valve can be divided into three stages, see below.

Pressure rise

The brake pressure from the footbrake valve comes in through the inlet (1), lifts the diaphragm (9) and continues on through the outlet (2) to the brake cylinder, to apply the wheel brake. At the same time, brake pressure goes through the valve (7a) to the space under the diaphragm (8), to keep the vent (3) closed.

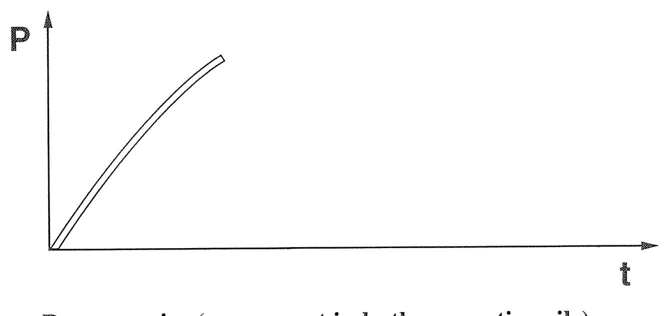


1. Inlet (from brake valve)
2. Outlet (to brake cylinder)
3. Vent
4. Magnetic coil
5. Magnetic coil

6a and 6b. Double valve, which controls diaphragm 9

7a and 7b. Double valve, which controls diaphragm 8

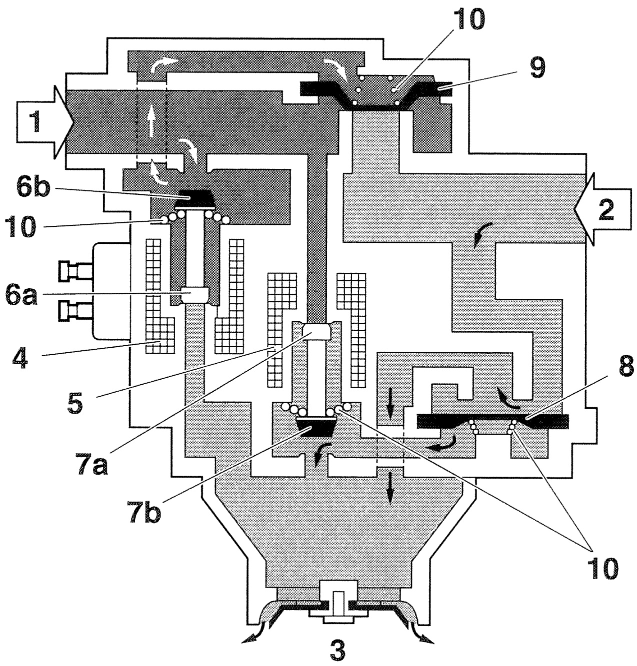
8. Diaphragm, venting
9. Diaphragm, inlet pressure
10. Spring

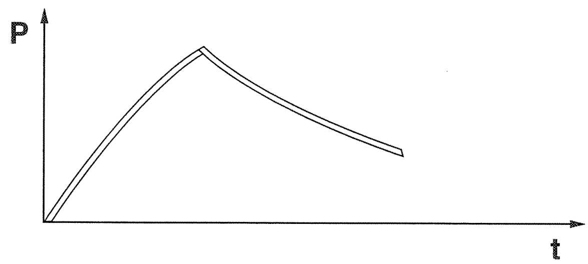


Pressure rise (no current in both magnetic coils)

Pressure decrease

If a wheel is about to lock, both magnetic coils are energised from the control unit. Valve (6b) opens to allow pressurised air into the space above the diaphragm (9), which closes to prevent further increase in the braking pressure. Valve (6a) shuts off the passage to the vent (3). Valve (7a) closes to prevent pressurised air from reaching the space under the diaphragm (8). Valve (7b) opens to vent the space under the diaphragm (8). This opens the diaphragm and the brake cylinder is vented via the valve vent (3). Brake pressure drops and so also the braking power.

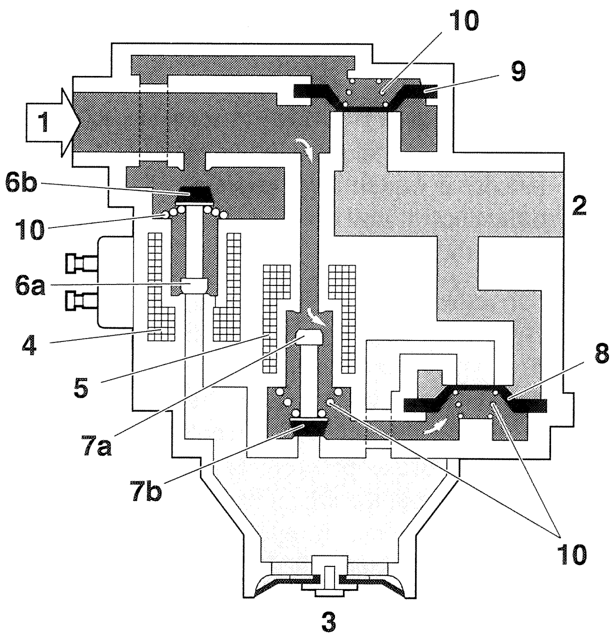


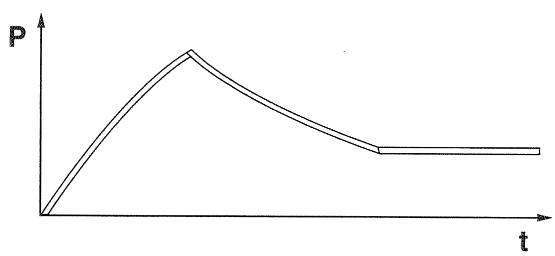


Pressure drop (both magnetic coils are energised)

Pressure hold

When the pressure in the brake cylinder reduces, the speed of the vehicle's wheel increases and at a certain speed the control unit cuts out the current to the magnetic coil (5). Valve (7a) opens and valve (7b) closes. Pressurised air then flows into the space under the diaphragm (8), which closes the passage to the vent (3). This creates a constant pressure in the outlet (2) and in the brake cylinder for a brief moment. Thereafter current to the solenoid (4) is broken and brake pressure again rises. A new cycle has begun. A working cycle is very fast, up to 5 times per second.





Pressure hold (solenoid 4 is energised)

ASR-function (optional)

ASR, anti-spin regulation. Without ASR function, the drive wheel which has the least grip (friction) on a slippery road surface would start spinning.

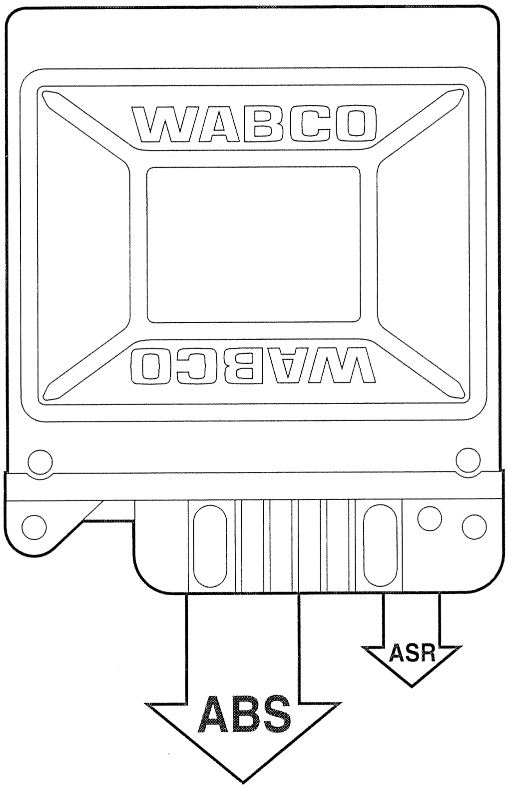
If the control unit receives information that the speed of a driving wheel is too high in relation to the other wheel and to the vehicle's speed (the wheel spins), the ASR is activated (the control unit receives speed signals via the ABS-system's impulse sensors).

The ASR system activates when the speed difference exceeds 5 km/h.

The ASR function can influence drive wheel rotation in two ways:

- Braking power control
- Engine output control

When the ASR function activates, the lock-up function disengages (applies to automatic transmissions).



Braking power control

The ASR system uses two pneumatic solenoid valves, one for braking the right drive wheel and one for braking the left drive wheel. The solenoid valves are connected to the control unit via pin 2 for the left side and via pin 20 for the right side.

When a drive wheel starts spinning, the control unit sends a signal to the ASR solenoid valve for this drive wheel. The valve opens and pressurised air flows through the two-way valve and then through the ABS solenoid control valve to the brake cylinder, which applies the brake. Brake pressure is modulated via the ABS valve to prevent the wheel from locking itself fully. When the difference in speed between the drive wheels is less than 4 km/h, the braking stops.

The extra braking torque on the spinning wheel makes it possible to transfer a corresponding higher drive torque to the other drive wheel (differential braking effect).

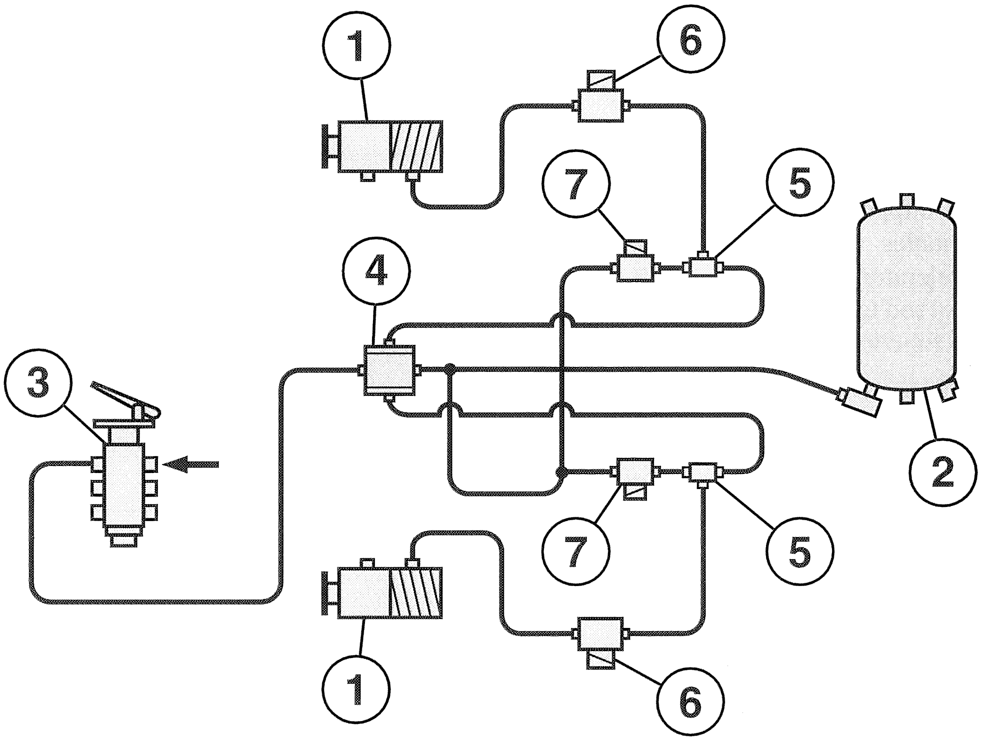
To prevent the brake system from overheating, the braking power control function can only be activated in speeds of up to 35 km/h, if one of the drive wheels is spinning. At higher speeds, the ASR function is regulated via engine output control.

Engine power control

Engine power control activates if the control unit registers that both drive wheels have a tendency to spin. If one drive wheel starts spinning much more than the other, engine power control is also activated to back-up the braking control.

Thereafter the drive wheels rotate within a range that guarantees optimal traction and good lateral stability for the road surface in question.

The electronic engine control's interface in the control unit is adapted for communication with EDC (Electronic Diesel Control)-engines. Pins 28 and 29 are wired to the EDC control unit for engine control. Signals consist of an out-signal from the ABS/ASR control unit, pin 29, that sends information to the EDC control unit when power control is needed. The other is an in-signal from the EDC control unit to the ABS/ ASR control unit, which provides information about the power needed. Both signals are pulse-band modulated (PBM).

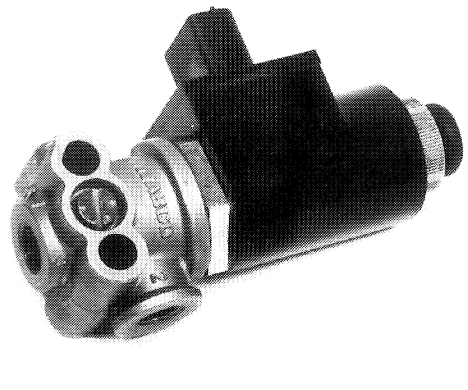


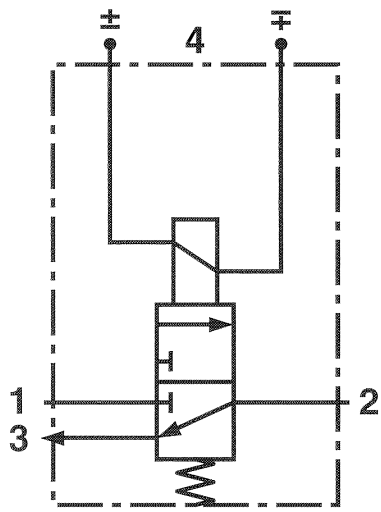
General layout of the ASR system (braking power control)

1. Brake cylinder, drive axle
2. Air tank, rear brake circuit
3. Footbrake valve
4. Relay valve (or load-sensing valve)
5. Two-way valve
6. ABS solenoid control valve (6013)
7. ASR solenoid valve (601)

Solenoid valve, ASR function

The ASR solenoid valve has only two positions; activated or non-activated. When there is no voltage across the connection pins, no pressure is allowed through.



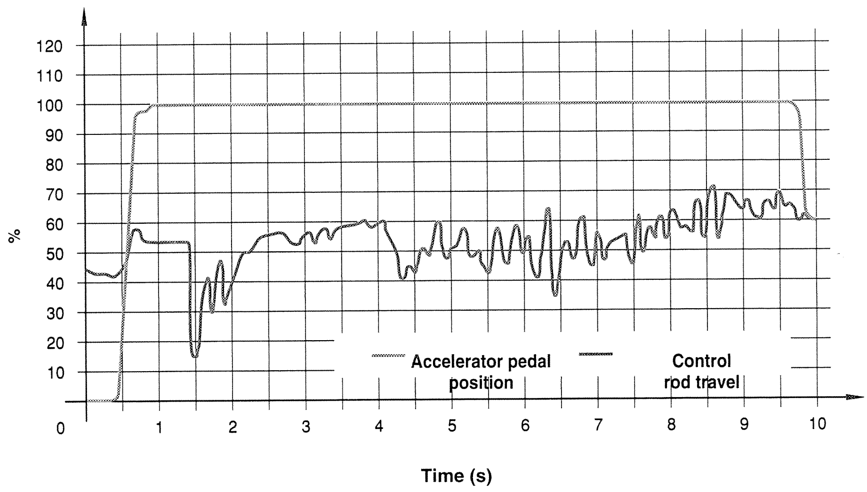


General layout of the ASR solenoid valve. The illustration shows the solenoid valve non-activated.

1. Inlet
2. Outlet
3. Draining
4. Electrical connection

ASR-control cycle

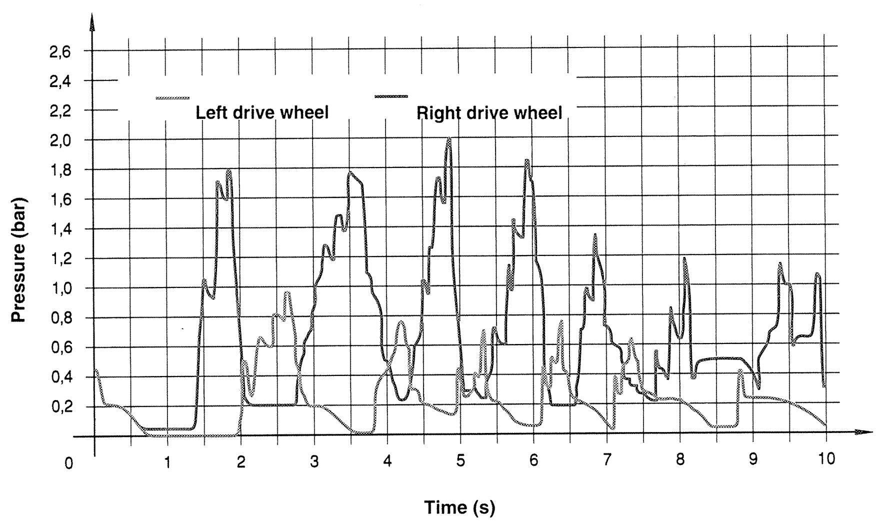
The adjacent diagrams show the principle of how the ASR function works when starting on a slippery surface (ice). Inputted variables are speed, brake pressure, accelerator pedal position and the control rod travel in the injection pump as a function of time.



Throttling

Throttling

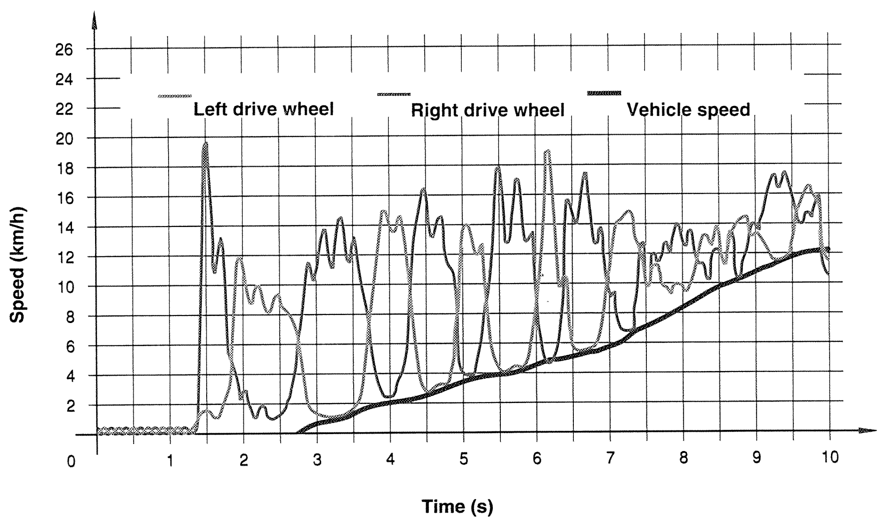
The diagram shows what happens when the bus starts from stationary on an icy road. If the driver depresses the accelerator pedal fully, the control unit registers that one or both the drive wheels are spinning and reduces the control rod travel (throttling) in the injection pump. (The bus has automatic transmission and the diagram shows driving in first speed.) Compared to full throttle, control is generally reduced to half.



Brake pressure

Brake pressure

When the control unit registers that one of the drive wheels is spinning, it tries to transfer the drive torque to the wheel with the best grip (friction) by supplying air to the brake cylinder for the wheel that is spinning most. The diagram shows how the control unit shifts drive torque between right and left side all the while there is low friction between the drive wheels and the road surface.



Speed

Speed

The diagram shows the speed for the left and right drive wheels and also the overall speed for the bus. From it we can see that it is the right drive wheel that first starts to spin.

Fault tracing

- Fault memory and diagnosis with the help of blink codes
- Fault codes table
- Complementary text for fault codes table
- Fault tracing with multimeter

Diagnosis with the help of blink codes

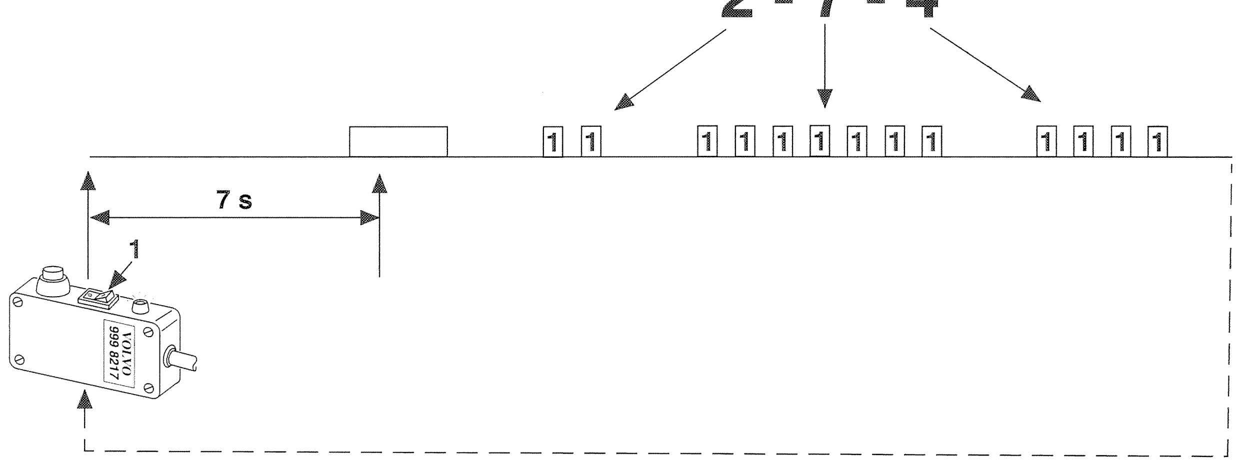
The control unit for the anti-lock brake system has a built-in fault memory, if the control unit's P/N is 8141342, 3944519 or 8141345. The fault memory is read-off via blink codes with the help of a diagnostic tool. Either Volvo Trucks' diagnostic tool 9998217 is used for buses after modification to or supplementation of the adapter. Or another alternative is to use an ordinary toggle-type switch with a lamp. See separate description under Special Tools.

Connecting up the diagnostic tool

Plug the diagnostic tool into the control unit's test socket, marked "DIA", which is near the control unit. Next turn the engine feed switch/starter key to the drive position. Depress the switch on the diagnostic tool (the Volvo Trucks' tool – the square switch in position 1), until lengthy blinking indicates that the fault code sequence has started. One fault code sequence is shown at a time, that is, if there is more than one fault, the fault for the first fault code sequence must first be put right and erased before reading-off the next fault code sequence.

Fault code sequences

Those parts of the system about which the fault codes provide information are the sensors (7057), the solenoid valves (6013), the relay (3024) and the control unit (9008).



Example of fault code sequence

The blinks from the fault diagnostic tool gives us the fault codes. Each fault code sequence starts with a long blinking that indicates fault coding has started. This is followed by the actual fault code, which is always comprised of three digits, e.g., 2, 7, 1.

Short blinks indicate a digit in the fault code. For example, two blinks refer to digit 2, seven blinks refer to digit 7, and so on. Between each digit in a code there is a pause of 2.5 seconds. The first of the three digits in a fault code tells us the type of control unit, 4- or 6-channel type. A "one" stands for the 6-channel system and a "two" for the 4-channel system. The other digits refer to the fault code in question.

Erasing fault codes

With erasure all fault codes with no faults remaining disappear. Fault codes are erased in the following way:

- Set the diagnostic tool's square switch to the "0" position.
- Wait until the fault code blinking has stopped.
- The fault code has now been erased.

N.B. To erase fault codes when using a toggle switch and lamp, disconnect the tool or set the switch to "0".

Fault codes table

Tabled in the following pages are the various fault codes in numerical order together with the component in question, the wheel in question, the probable fault and a letter reference for the measure described after the list (p. 26).

Control unit type	Fault code sequence 1	Fault code sequence 2	Component	Diagonal	Wheel	Fault	Ref.	Remedy action. Remarks
-2	-0	-0	-	-	-	No fault registered		
-2	-6	-6	Relay 3024-1	1	-	Low-V relay can't close	A	Low-V on pin 1 or 9
-2	-6	-7	Relay 3024-2	2	-	Low-V relay can't close	A	Low-V on pin 9 or 19
-2	-6	-8	Sensor (front axle)	1	F/R	No impulse sgnl from wheel	B	
-2	-6	-9	Sensor (front axle)	2	F/L	No impulse sgnl from wheel	B	
-2	-6	-10	Sensor (front axle)	1	F/R	Incorrect impedance	C	Cable damage/short circuit
-2	-6	-11	Sensor (front axle)	2	F/L	Incorrect impedance	C	Cable damage/short circuit
-2	-6	-12	Sensor (front axle)	1	F/R	Speed sgnl from wheel absurd	D	
-2	-6	-13	Sensor (front axle)	2	F/L	Speed sgnl from wheel absurd	D	
-2	-7	-0	Sensor (drive axle)	1	R/L	Speed sgnl from wheel absurd	B	
-2	-7	-1	Sensor (drive axle)	2	R/R	Speed sgnl from wheel absurd	B	
-2	-7	-2	Sensor (drive axle)	1	R/L	Incorrect impedance	C	Cable damage/short circuit
-2	-7	-3	Sensor (drive axle)	2	R/R	Incorrect impedance	C	Cable damage/short circuit
-2	-7	-4	Sensor (drive axle)	1	R/L	Speed sgnl from wheel absurd	D	
-2	-7	-5	Sensor (drive axle)	2	R/R	Speed sgnl from wheel absurd	D	
-1	-7	-8	Sensor (art. bus axle)	1	R/L	No impulse sgnl from wheel	B	
-1	-7	-9	Sensor (art. bus axle)	2	R/R	No impulse sgnl from wheel	B	
-1	-7	-10	Sensor (art. bus axle)	1	R/L	Incorrect impedance	C	Cable damage/short circuit
-1	-7	-11	Sensor (art. bus axle)	2	R/R	Incorrect impedance	C	Cable damage/short circuit
-1	-7	-12	Sensor (art. bus axle)	1	R/L	Speed sgnl from wheel absurd	D	
-1	-7	-13	Sensor (art. bus axle)	2	R/R	Speed sgnl from wheel absurd	D	
-2	-8	-0	Control unit	1	-	Fault in control unit	H	
-2	-8	-1	Control unit	2	-	Fault in control unit	H	
-2	-8	-2	ASR-contr. sgl transm.	1	-	Cable damaged	E	Pin 12 on control unit
-2	-8	-3	Signal to EDC-	2	-	Contact with other +/–cable	F/G	Pin 29 on control unit
-2	-8	-4	ASR-contr. sgl transm.	1		Short-circuit to earth	F	Pin 12 on control unit
-2	-8	-5	Signal from EDC-	2	-	Wrong sgnl, contact with +cable	G	Pin 28 on control unit
-2	-8	-7	Signal from EDC-	2	-	Contact with +/– cable or damaged cable	F/G	Pin 28 on control unit
-2	-8	-9	Signal from EDC-	2	-	Contact with +cable or wrong sgnl	G	Pin 28 on control unit
-2	-8	-10	ABS-sol. valve	1	F/R	Short-circuit to earth	F	Pin 6 on control unit
-2	-8	-11	ABS-sol. valve	2	F/L	Short-circuit to earth	F	Pin 23 on control unit
-2	-8	-12	ABS-sol. valve	1	F/R	Damaged cable	E	Pin 6 on control unit
-2	-8	-13	ABS-sol. valve	2	F/L	Damaged cable	E	Pin 23 on control unit
-2	-8	-14	ABS-sol. valve	1	F/R	Short-circuit to earth	F	Pin 7 on control unit
-2	-8	-15	ABS-sol. valve	2	F/L	Short-circuit to earth	F	Pin 24 on control unit

Fault code table (cont.)

Control unit type	Fault code sequence	Fault code sequence	Component	Dia-go-nal	Wheel	Fault	Ref.	Remedy action. Remarks
-2	-9	-0	ABS-sol. valve	1	F/R	Damaged cable	E	Pin 7 on control unit
-2	-9	-1	ABS-sol. valve	2	F/L	Damaged cable	E	Pin 24 on control unit
-2	-9	-2	ABS-sol. valve	1	R/L	Short-circuit to earth	F	Pin 21 on control unit
-2	-9	-3	ABS-sol. valve	2	R/R	Short-circuit to earth	F	Pin 4 on control unit
-2	-9	-4	ABS-sol. valve	1	R/L	Damaged cable	E	Pin 21 on control unit
-2	-9	-5	ABS-sol. valve	2	R/R	Damaged cable	E	Pin 4 on control unit
-2	-9	-6	ABS-sol. valve	1	R/L	Short-circuit to earth	F	Pin 22 on control unit
-2	-9	-7	ABS-sol. valve	2	R/R	Short-circuit to earth	F	Pin 5 on control unit
-2	-9	-8	ABS-sol. valve	1	R/L	Damaged cable	E	Pin 22 on control unit
-2	-9	-9	ABS-sol. valve	2	R/R	Damaged cable	E	Pin 5 on control unit
-1	-9	-10	ABS-sol.v. art. axle	1	R/L	Short-circuit to earth	F	Pin 47 on control unit
-1	-9	-11	ABS-sol.v. art. axle	2	R/R	Short-circuit to earth	F	Pin 45 on control unit
-1	-9	-12	ABS-sol.v. art. axle	1	R/L	Damaged cable	E	Pin 47 on control unit
-1	-9	-13	ABS-sol.v. art. axle	2	R/R	Damaged cable	E	Pin 45 on control unit
-1	-9	-14	ABS-sol.v. art. axle	1	R/L	Short-circuit to earth	F	Pin 48 on control unit
-1	-9	-15	ABS-sol.v. art. axle	2	R/R	Short-circuit to earth	F	Pin 46 on control unit
-1	-10	-0	ABS-sol.v. art. axle	1	R/L	Cable failure	E	Pin 48 on control unit
-1	-10	-1	ABS-sol.v. art. axle	2	R/R	Cable failure	E	Pin 46 on control unit
-2	-10	-2	ASR-sol. valve	1	R/L	Short-circuit to earth		
-2	-10	-3	ASR-sol. valve	2	R/R	Short-circuit to earth		
-2	-10	-4	ASR-sol. valve	1	R/L	Damaged cable	E	Pin 2 on control unit
-2	-10	-5	ASR-sol. valve	2	R/R	Damaged cable	E	Pin 20 on control unit
-2	-10	-7	Relay 3044,3045,3046	2	-	Contact with + cable	G	Pin 11 on control unit
-2	-10	-8	Signal to transm.	1	-	Exceeded activ. time, ASR	K	Pin 12 on control unit
-2	-10	-9	Signal to transm.	2	-	Exceeded activ. time, ASR	K	
-2	-11	-12	ABS-sol. valve	1	F/R	Contact with +cable	L	
-2	-11	-13	ABS-sol. valve	2	F/L	Contact with +cable	L	
-2	-11	-14	ABS-sol. valve	1	R/L	Contact with +cable	L	
-2	-11	-15	ABS-sol. valve	2	R/R	Contact with +cable	L	
-2	-12	-0	ABS-sol.v. art. axle	1	R/L	Contact with +cable	L	
-2	-12	-1	ABS-sol.v. art. axle	2	R/R	Contact with +cable	L	
-2	-12	-2	ASR-sol. valve	1	R/L	Contact with +cable	L	
-2	-12	-3	ASR-sol. valve	2	R/R	Contact with +cable	L	
-2	-12	-4	ASR-sol. valve	1	-	Contact with +cable	L	Pin 12 on control unit
-2	-12	-7	Relay 3044,3045,3046	2	-	Short-circuit to earth	F	Pin 11 on control unit
-2	-12	-8	ABS-sol. valve	1	F/R	Contact with +cable	G	
-2	-12	-9	ABS-sol. valve	2	F/L	Contact with +cable	G	
-2	-12	-10	ABS-sol. valve	1	R/L	Contact with +cable	G	
-2	-12	-11	ABS-sol. valve	2	R/R	Contact with +cable	G	
-1	-12	-12	ABS-sol.v. art. axle	1	R/L	Contact with +cable	G	
-1	-12	-13	ABS-sol.v. art. axle	2	R/R	Contact with +cable	G	
-2	-12	-14	ASR-sol. valve	1	R/L	Contact with +cable	G	
-2	-12	-15	ASR-sol. valve	2	R/R	Contact with +cable	G	
-2	-13	-0	ASR-sol. valve	1	-	Contact with +cable	G	Pin 12 on control unit
-2	-13	-4	Relay 3024-1	1	-	Relay doesn't open	M	
-2	-13	-5	Relay 3024-2	2	-	Relay doesn't open	M	
-2	-13	-6	Control unit	1	-	Fault in control unit	H	
-2	-13	-7	Control unit	2	-	Fault in control unit	H	
-2	-13	-8	Control unit	1	-	Overvoltage	N	
-2	-13	-9	Control unit	2	-	Overvoltage	N	
-2	-13	-10	Control unit	1	-	Fault in control unit	H	
-2	-13	-11	Control unit	2	-	Fault in control unit	H	
-2	-13	-12	Control unit	1	-	Fault in control unit	H	
-2	-13	-13	Control unit	2	-	Fault in control unit	H	
-2	-13	-14	Control unit	1	-	Fault in control unit	H	
-2	-13	-15	Control unit	2	-	Fault in control unit	H	
-2	-14	-0	Control unit	1	-	Fault in control unit	H	
-2	-14	-1	Control unit	2	-	Fault in control unit	H	
-2	-14	-2	Control unit	1	-	Fault in control unit	H	
-2	-14	-3	Control unit	2	-	Fault in control unit	H	
-2	-14	-4	Control unit	1	-	Fault in control unit	H	
-2	-14	-5	Control unit	2	-	Fault in control unit	H	
-2	-14	-6	ABS-sol. valve	1	-	Exceeded activ. time, ABS	K	
-2	-14	-7	ABS-sol. valve	2	-	Exceeded activ. time, ABS	K	
-2	-14	-8	ASR-sol. valve	1	R/L	Exceeded activ. time, ABS	K	
-2	-14	-9	ASR-sol. valve	2	R/R	Exceeded activ. time, ABS	K	
-2	-14	-10	Control unit	1	-	Fault in control unit	H	
-2	-14	-11	Control unit	2	-	Fault in control unit	H	
-2	-14	-12	Control unit	1	-	Fault in control unit	H	
-2	-14	-13	Control unit	2	-	Fault in control unit	H	
-2	-14	-14	Control unit	1	-	Fault in control unit	H	
-2	-14	-15	Control unit	2	-	Fault in control unit	H	

Complementary text to Fault Code Table

Action

The following short-cut information should help in quickly localising a fault. The actual fault-tracing is then done with a multimeter.

Reference	Fault	Check
A	*Voltage drop. Voltage measured on pins 1, 9 or 19 is too low. (Relay not activated.)*	Check cables and voltage feed. Relay or fuse may be faulty.
B	*No wheel speed signal (el. failure).*	Check sensor cables and connections for loose contact or short-circuiting. Check pole wheels and sensors for damage, check also air columns, for loose bearings, sensor positions and voltage from sensors.
C	*Incorrect impedance (el. failure or short-circuit).*	Failure, loose contacts or short-circuiting. Check cables and sensor.
D	*Improbable wheel speed signal.*	Measure the voltage from the sensor and compare this with the correct voltage. The air column between sensor and pole wheel may be too large. (Check for possible bearing looseness.) Check to make sure pole wheel mounting is not warped, and that the bus's tyres are of the correct size. Max. difference in size between front and rear tyres: 5%.
E	*Cable failure.*	Cable between the control unit and the component temporarily or permanently broken.
F	*Short-circuit to earth.*	Control unit's out-signals temporarily or permanently short-circuiting to earth.
G	*Contact with +cable (incorrect impulse).*	Control unit's outlet or the connected component has a temporary overload to another interfering cable.
H	*Fault in control unit.*	Replace control unit.
K	*ABS/ASR function activated for lengthy time, e.g., with wheel locking. (Can happen when driving on rolling country road.)*	Permanent prohibited wheel locking on the drive axle (that is, longer than 60 seconds). Check to make sure the throttle-deduct function is working. Also check that the correct wheel is fitted (max. 5% difference in size) and that the pole wheel has the correct number of teeth.
L	*Contact with + cable (spark-over).*	The prohibited voltage on the component in question is causing solenoid valve malfunction. Check for spark-over at the connectors and cables between the control unit and sensors/solenoid valves also between the control unit and the relay circuitry board.
M	*Relay doesn't open.*	Since the relay has not cut-out, pin 1 or 19 should have voltage. Check the relay. Check that pin 25 has not been mixed-up with pin 8.
N	*Overvoltage.*	The voltage feed is higher than 32 V for more than 5 seconds. Check the alternator and the battery.

* *Differences in tyre size.* The maximum difference in wheel tyres on the same axle is 2%. This applies to new tyres. The percentage makes allowance for coming differences in wear between front and rear tyres. The maximum percentage difference is in the region of 3% higher, that is, approx. 5%. If the difference is greater, the wheels/circuit will disconnect and the fault indicator lamp for the ABS-system will light.

Fault tracing with multimeter

Special tools:
951 0060 *Multimeter*
999 6899 *Test box, 35-unit (for 4-channel control unit)*
981 3190 *Test box, 60-unit (for 6-channel control unit)*
999 8360 *Adapter for 60-unit test box*
999 5009 *Pedal support*

Fault tracing with multimeter is a complement to fault code read-off. It can be done in several ways. As a general rule, however, the fault codes should always be first read-off and, if this doesn't succeed, try tracing the fault with the help of a multimeter.

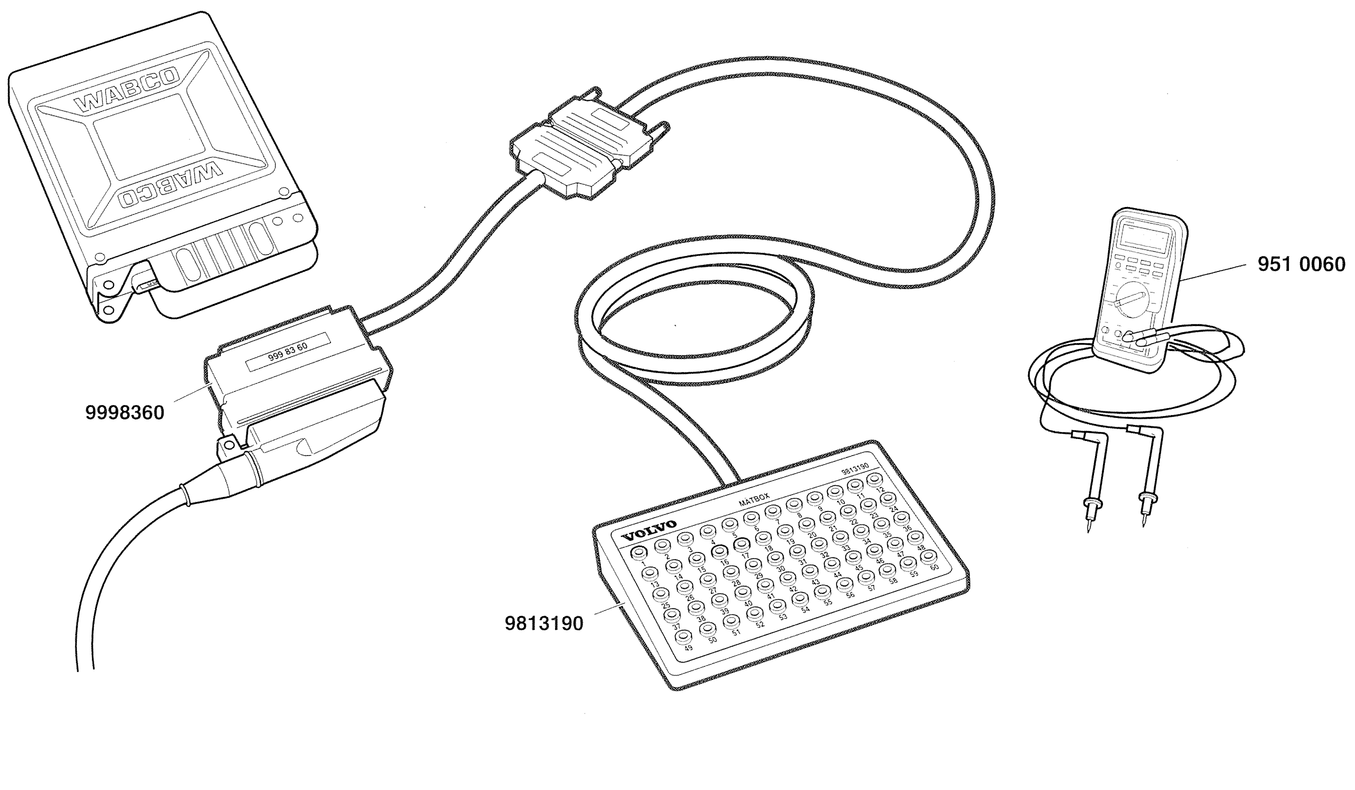
Before fault tracing

Check that:

- The fuses are intact
- The ABS/ASR indicator is intact (starter key/feed switch in drive position).

Important with regard to adapter

Adapter 999 8360 can be connected to the ABS system in two ways. (No pin predominates.) Risk of short-circuiting! Only one way is correct, see illustration below.



Connecting-up test box:

- Turn starter key/feed switch to neutral position.
- Unplug the 35-unit/55-unit connector from the control unit and connect the test box to the cable harness's connector.

Measurements come under the 4-channel and 6-channel headings when testing the 6-channel ABS. If no distinction is made between 4-channel and 6-channel ABS, then the measurements apply to both systems.

1. Checking control unit earthing

Pin 27 earths the control unit (9008). The test involves checking that the pin has contact with the bus's framework.

- **Turn the feed switch/starter key to the neutral position.**

Measuring points	Measuring range	Should value	Connect-up
27 – framework	Buzzer	Even buzzer tone	Connect (–) on the multimeter to reliable earthing point.

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2. Checking solenoid control valve resistance

Measure the resistance in both coils in the solenoid control valve. (1 coil for venting, 1 coil for closing.)

- **Turn the feed switch/starter key to the neutral position.**

Measuring points		Measuring range	Should	Checked solenoid control valve
Coil	**Coil**	**Ω**	**value Ω**	
Venting	**Closing**			
4-channels'	**4-channels'**			
27-7	27-6		10–23	Right front
27-24	27-23		10–23	Left front
27-22	27-21		10–23	Left rear
27-5	27-4		10–23	Right rear
6-channels'	**6-channels'**			
27-48	27-47		10–22	Left, artic section
27-46	27-45		10–22	Right, artic section

Only buses with ASR

3. Checking ASR-solenoid valve resistance

Measure the resistance in solenoid valve coil.

- **Turn the feed switch/starter key to the neutral position.**

Measuring points	Measuring range Ω	Should value Ω	Checked solenoid valve
27-2		15±5	Left drive
27-20		15±5	Right drive

4. Checking resistance in impulse sensors

Measure the resistance across the sensor and its cables.

Check to make sure the sensors are properly connected up to the 35-unit connector by disconnecting the connection when measuring the resistance on the cable nearest the sensor. The multimeter should then indicate "1" = cable failure.

0 = Short-circuiting
1 = Cable failure

- **Turn the feed switch/starter key to the neutral position.**

Measuring points 4-channels'	Measuring range k Ω	Should value	Check sensors
17–34		1.00–1.99 k Ω	Right front
15–32		1.00–1.99 k Ω	Left front
18–35		1.00–1.99 k Ω	Left rear
16–33		1.00–1.99 k Ω	Right rear
6-channels'			
53–54		1.00–1.99 k Ω	Left artic section
51–52		1.00–1.99 k Ω	Right artic section

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5. Checking impulse sensor circuit for short-circuiting

For this check connect the multimeter to earth (27) and one of the cables in the sensor circuit.

1. If the sensor circuit is intact, the multimeter will indicate 0 = no current.
2. If one of the cables is shorting to the sensor, the multimeter will register >0, that is, the same as the sensor's resistance depending on which of the sensor cables is shorting.

- **Turn the feed switch/starter key to the neutral position.**

Measuring points 4-channels'	Measuring range Ω	Should value	Checked sensor circuit
17–27		"0"	Right front
15–27		"0"	Left front
18–27		"0"	Left rear
16–27		"0"	Right rear
6-channels'			
53–27		"0"	Left artic section
51–27		"0"	Right artic section

6. Checking relay 3024-1 and relay 3024-2 and their cables

The relays provide the control unit with the current that is passed on to the solenoid control valves. They activate as soon as the feed switch/starter key is turned to the drive position.

- **Remove relay 3025.**
- **Turn the feed switch/starter key to the drive position.**

Measuring points	Measuring range	Should value	Comments
27–8	V	20–28 V	Relay 3024-1 is not activated
27–25		20–28 V	Relay 3024-2 is not activated
27–1		0 V	
27–19		0 V	

Connect a cable between 8 and 27 on the test box.

27–1		20–28 V	Relay 3024-1 is activated

Transfer the cable and connect between 25 and 27.

27–19		20–28 V	Relay 3024-2 is activated

Fit relay 3025

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7. Checking relay 3025

When relay 3025 is activated, the indicator lamp (5009) goes out, and there is cut-out to earthing.

N.B:! The indicator lamp can also be activated by the control unit (9008).

- **Remove relay 3024-1.**
- **Turn the feed switch/starter key to the drive position, the bus's fault indicator lamp (5009) should light.**

Measuring points	Measuring range	Should value	Comments
27–8	V	20–28 V	Relay 3025-1 is not activated
27–26		0 V	

Connect a cable between 8 and 27. The indicator lamp should go out.

27–26		20–28 V	Relay 3025-1 is activated

- **Fit relay 3024-1**

8. Checking relay 3045 (breaks lock-up function in automatic transmission)

- **Remove relays 3046 and 3044.**
- **Turn the feed switch/starter key to the drive position.**
- **Keep the brake pedal depressed. (Check that the brake air tanks maintain a pressure of min. 4 bars.)**

Measuring points	Measuring range	Should value	Comments
27–11	V	20–28 V	Relä 3045 is not activated

Connect a cable between 11 and 27 on the test box. Relay 3045 should now "click".

---

9. Checking relay 3046 (for disengaging retarder in automatic transmission and for Voith retarder)

- **Turn the feed switch/starter key to the drive position.**

Measuring points	Measuring range	Should value	Comments
27–11	V	0 V	Relay 3045 is not activated

Connect a cable between 25 and 27 on the test box.

Measuring points	Measuring range	Should value	Comments
27–11	V	20–28 V	Relay 3046 is not activated

Connect a cable between 11 and 17 on the test box. Relay 3046 should now "click".

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10. Checking relay 3044 (holding circuit for disengaging lock-up)

- **Remove relays 3046 and 3045.**
- **Turn the feed switch/starter key to the drive position.**
- **Keep the brake pedal depressed.**

Measuring points	Measuring range	Should value	Comments
27–11	V	20–28 V	Relay 3044 is not activated

Connect a cable between 11 and 27 on the test box.

The relay should be in the activated position after the cable between 11 and 27 has been removed. It becomes inactive when the brake pedal is released.

11. Checking distance between sensor and pole wheel

The distance between the sensor and the pole wheel should be 0–0.5 mm. Zero is the best distance. Greater than 0.5 mm and the sensor out-voltage will be too low. If the voltage does not exceed 0.1 V, press the sensor in towards the pole wheel.

N.B.! Press in the sensor and brush clean the pole wheel as often as possible, e.g., when changing brake linings.

Measuring the voltage from the sensor

1. Lift **one** wheel at a time and rotate it by hand. Approx. 1/2 rev/sec (gear in neutral). The wheel should rotate with as smooth a speed a possible.
2. Throughout the wheel's entire rotation the voltage should exceed 0.1 V. Bear in mind that this value is a minimum value. Therefore, press in those sensors that lie nearer to 0.1 V. If the voltage does not exceed 0.1 V, the brake drum must be removed and the sensor and pole wheel checked. A pole wheel with burr, bevel tips, dirt, etc., can impair sensor signalling.
3. If the measurements taken at one wheel differ substantially, note the Min. and the Max. values. If the Max. value is more than double the Min. value, carry out Check No. 12 (see below).

N.B.! Alternating current (AC) measuring.

Measuring points 4-channels'	Measuring range mV (AC)	Should value	Checked sensors
17–34		Greater than 0.1 V	Right front
15–32		Greater than 0.1 V	Left front
18–35		Greater than 0.1 V	Left rear
16–33		Greater than 0.1 V	Right rear
6-channels'			
54–53		Greater than 0.1 V	Left artic section
52–51		Greater than 0.1 V	Right artic section

12. Checking pole wheels and wheel bearings

A warped pole wheel or loose wheel bearing can impair ABS function. A warped pole wheel alters the distance between the sensor and pole wheel during a rotation. When this distance to the sensor is at its greatest, the sensor signal can be so weak that the ABS registers that a wheel has locked itself. The ABS system shuts down with this type of fault and the system's fault indicator lamp (5009) lights.

1. The wheel must rotate at **even** speed. One way to rotate the wheel at even speed is to drive the vehicle on a straight stretch of a road while measuring. A suitable rotational speed is approx. 1/4 rev per second.
2. Measure during several wheel rotations and note the Max. and the Min. values. A double Min. value should be greater than the Max. value.
3. If a fault is discovered, remove the brake drum. With a feeler gauge blade measure the distance between the sensor and the pole wheel. Permitted change in the rear air column is 0.3 mm and 0.4 mm for the front.

Measuring points 4-channels'	Measuring range mV (AC)	Should value	Checked wheels
17–34		*	Right front
15–32		*	Left front
18–35		*	Left rear
16–33		*	Right rear
6-channels'			
54–53		*	Left artic section
52–51		*	Right artic section

* Should value: Double Min. value should be greater than the Max. value.

Remarks

Burr, bevel tips on pole wheel

A pole wheel with burr or bevel tips can impair sensor signalling to the control unit. This in turn would affect to a certain extent brake pressure to a wheel that is tending to lock itself. If the speed is high enough, above 80–85 km/h, the ABS will shut down the faulty wheel/circuit and the ABS system fault indicator lamp will light.

The same type of fault system can arise if the gaps between the pole wheel teeth are filled with dirt.

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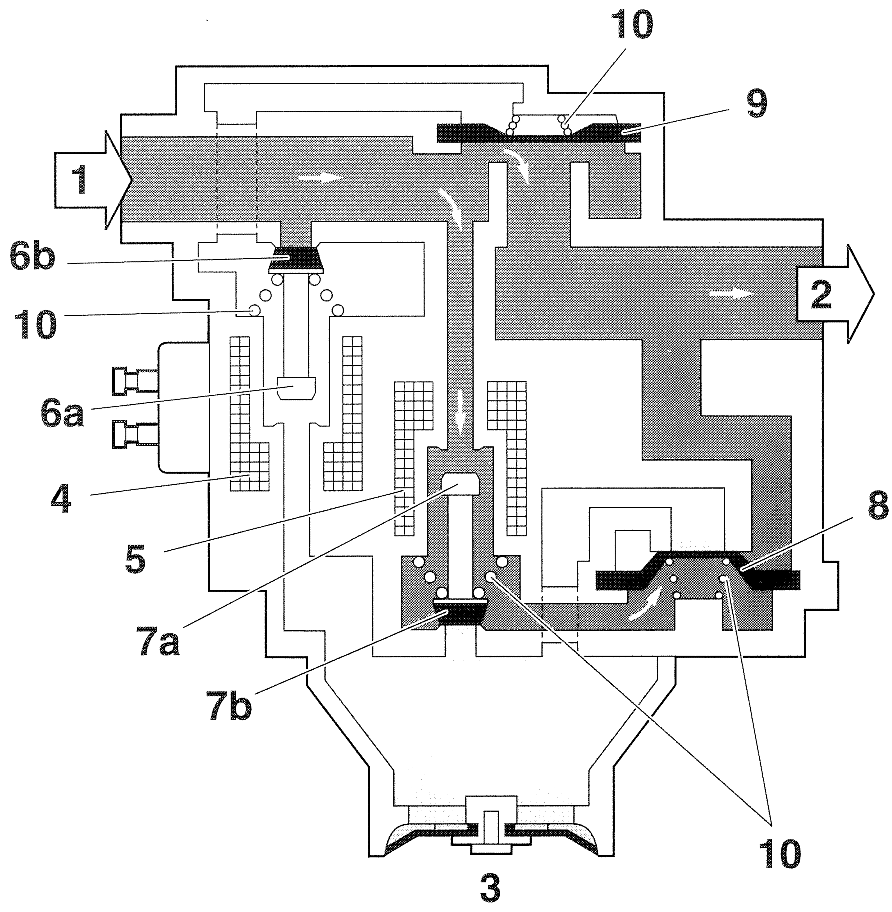
13. Checking solenoid control valves (6013)

- Check to make sure the cables to the coils are not mixed-up.
- Check the solenoid control valve's diaphragm.
- Check the solenoid control valve's magnetic coils.

1. Inlet
2. Outlet
3. Vent
4. Magnetic coil for valve 6
5. Magnetic coil for valve 7

6a. and 6b. Double valve, inlet pressure
7a. and 7b. Double valve, venting

8. Diaphragm, venting
9. Diaphragm, inlet pressure
10. Spring



The venting circuit, testing

1. The service brake should be on for this test. It is important that the brake is on before power is applied. The parking brake, however, must not be on for the test.
   N.B.! To prevent the bus from rolling, suitably chock the wheels.
2. When current is switched on, the solenoid control valve should vent, and when it is switched off, venting should stop entirely. Check to make sure the correct solenoid control valve is vented.
   N.B.! When the respective magnetic coil is connected up, current must not be on for longer than max. 10 seconds on each occasion.
3. The purpose of the test is to check the function of the solenoid control valve pos. 5 and the diaphragm pos. 8. (See previous page.)
4. If the brake cylinder rods do not move during the venting, this indicates that the compressed-air lines to the solenoid control valve have been incorrectly fitted (mixed-up).

- **Turn the feed switch/starter key to the drive position.**
- **Connect a cable between 8 and 27, to activate relay 3024-1 so that contact 1 in the test box is in circuit.**

Procedure	**Comments**
4-channels'	
Apply the footbrake and connect up a cable between...	
1–7 (max. 10 secs.)	Solenoid valve right front vents and the brake cylinder rod moves.
1–24 (max. 10 secs.)	Left front vents and the brake cylinder rod moves.
1–22 (max. 10 secs.)	Left rear vents and the brake cylinder rod moves.
1–5 (max. 10 secs.)	Right rear vents and the brake cylinder rod moves.
6-channels'	
Apply the footbrake and connect up a cable between...	
1–48 (max. 10 secs.)	Left, axle 3 vents and the brake cylinder rod moves.
1–46 (max. 10 secs.)	Right, axle 3 vents and the brake cylinder rod moves.

Inlet circuit, testing

1. Connect a cable between 8 and 27. A click should be heard when the valve (pos. 6 on the illustration, page 33) moves in the solenoid control valve. The cable may be in circuit for max. 10 seconds at a time.
2. Depress the brake pedal. Pressure in the brake cylinder must not increase, that is, the brake cylinder rod must not move. If it moves, then this indicates that the diaphragm (pos. 9) in the solenoid control valve is damaged. In which case, replace the solenoid control valve.
3. Remove the cable. Depress the brake pedal. The brake cylinder rod should move – brakes apply.

- **Turn the feed switch/starter key to the drive position.**
- **Connect a cable between 8 and 27, to activate relay 3024-1 so that contact 1 in the test box is in circuit.**

Measuring points	Comments
When the respective magnetic coil is connected up, current mustnot be on for longer than max. 10 seconds on each occasion.	
4-channels'	
Connect up a cable between...	
1–23 (max. 10 secs.)	A click is heard from the solenoid control valve, left front.
Depress the brake pedal.	The brake cylinder, front, must not be activated.
Remove the cable 1–23.	
Depress the brake pedal.	The brake cylinder, front, must be activated.
Continue as above but connect the cable between...	
1–21 (max. 10 secs.)	A click is heard from the valve, left rear.
1–4 (max. 10 secs.)	A click is heard from the valve, right rear.
1–6 (max. 10 secs.)	A click is heard from the valve, right front.
6-kanals	
1–47 (max. 10 secs.)	A click is heard from the valve, artic section left.
1–45 (max. 10 secs.)	A click is heard from the valve, artic section right.

14. Checking solenoid valves, ASR (601)

- **Check to make sure the cables to the solenoid valves are not mixed-up. Check the function of the solenoid valves.**

1. The service brakes and the parking brake should not be on during the test.
   N.B.! To prevent the bus from rolling, suitably chock the wheels.
2. When current is switched on to the solenoid valve, it should open to let air through to the brake cylinder. When the current is switched off, the brake cylinder should vent the air. Make sure the correct solenoid valve opens.
   On each occasion the current must not be switched on for longer than max. 10 seconds.
3. Turn the feed switch/starter key to the drive position.
4. Connect a cable between 8 and 27. This activates relay 3024-1 so that contact 1 in the test box is in circuit.

Measuring points	**Comments**
Connect a cable between 1 and 2 (max. 10 seconds)	Solenoid valve left rear opens to let through air. The brake cylinder rod moves.
Connect a cable between 1 and 2 (max. 10 seconds)	Solenoid valve right rear opens to let through air. The brake cylinder rod moves.

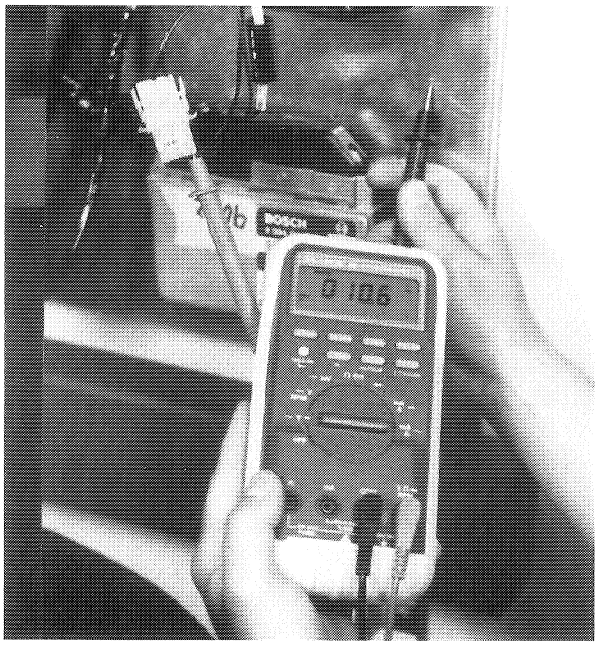
15. Checking pulse-band modulated signals to/from ABS/ASR control unit (only buses with ASR)

This test is to ensure that the in/out PBM-signals are within the tolerance range. See “Specifications”.

The test cannot be carried out when the 35-unit or the 60-unit test box is connected-up since both in/out-signals must go to the ABS/ASR control unit in order to be able to measure the correct value. Therefore, the test must be done when the connector is plugged into the control unit. The most suitable way to measure is via a connector, e.g., connector “MR” or “ASR”.

- **Start the engine.**

Measuring points	Measuring range	Should value	Comments
“MR” 1-earth	%-pulse band	10% (200 Hz)	At low idle
“MR” 1-earth	%-pulse band	40% (200 Hz)	At approx. 1650 r/min
“MR” 2-earth	%-pulse band	90% (200 Hz)	Irrespective of the speed, constant



ABS-pin configuration

Pin	In/out	Voltage	Amperage	Resistance	Description
1	i	24 V	4* 1,6 A		Feed, diagonal 1
2	u	24 V			Coil, ASR, L
3	u	24 V			Diagnosis
4	u	24 V	<3 A	10–22 Ω	Sol. control valve, R, drive
5	u	24 V	<3 A	10–22 Ω	Sol. control valve, R, drive
6	u	24 V	<3 A	10–22 Ω	Sol. control valve, R, front
7	u	24 V	<3 A	10–22 Ω	Sol. control valve, R, front
8	u	24 V	(1 A)		Valve relay
9	i	24 V	(500 mA)		Feed, control unit
(10)	i				Not used
11	u	24 V	(1 A)		Valve relay, retarder, lock-up
12	u	24 V	<3 A		Valve relay, lock-up
13	i				Diagnosis
14	u				Diagnos
15	i		(14 mA)	1750±100 Ω	Sensor, L, front
16	i		(14 mA)	1750±100 Ω	Sensor, R, drive
17	i		(14 mA)	1750±100 Ω	Sensor, R, front
18	i		(14 mA)	1750±100 Ω	Sensor, L, drive
19	i	24 V	4x1.6 A		Feed, diagonal 2
20	u	24 V			Coil, ASR, R
21	u	24 V	<3 A	10–22 Ω	Sol. control valve, L, drive
22	u	24 V	<3 A	10–22 Ω	Sol. control valve, L, drive
23	u	24 V	<3 A	10–22 Ω	Sol. control valve, L, front
24	u	24 V	<3 A	10–22 Ω	Sol. control valve, L, front
25	u	24 V	(1 A)		Relay
26	u	24 V	(100 mA)		Indicator/warning lamp ABS
27	i	0 V			Earth (–)
28	i				PBM-signal, engine control
29	u				PBM-signal, engine control
(30)	i				Not used
(31)	i				Not used
32	i		(14 mA)	1750±100 Ω	Sensor, L, front
33	i		(14 mA)	1750±100 Ω	Sensor, R, drive
34	i		(14 mA)	1750±100 Ω	Sensor, R, front
35	i		(14 mA)	1750±100 Ω	Sensor, L, drive
(36)					Not used
(37)					Not used
(38)					Not used
(39)					Not used
(40)					Not used
(41)					Not used
(42)					Not used
(43)					Not used
(44)					Not used
45	u	24 V	<3 A	10–22 Ω	Sol. control valve, R, artic
46	u	24 V	<3 A	10–22 Ω	Sol. control valve, R, artic
47	u	24 V	<3 A	10–22 Ω	Sol. control valve, L, artic
48	u	24 V	<3 A	10–22 Ω	Sol. control valve, L, artic
(49)					Not used
(50)					Not used
51	i		(14 mA)	1750±100 Ω	Sensor, R, trailing wheel
52	i		(14 mA)	1750±100 Ω	Sensor, R, trailing wheel
53	i		(14 mA)	1750±100 Ω	Sensor, L, trailing wheel
54	i		(14 mA)	1750±100 Ω	Sensor, L, trailing wheel
(55)					Not used

Number of inputs, outputs: 40.

References to Service Bulletins

VOLVO

Volvo Bus Corporation
Göteborg, Sweden

TP 15837/1 English 2500.04.96