System overview

Introduction

The Mark25 brake control system

The Mark 25 brake control system with the brake control module (BCM) is an electronic control system which prevents wheel lock up during braking (ABS). By preventing wheel lock up, steering control is maintained and maximum braking effect is utilized.

The brake control system is equipped with:

- Antilock Braking System
- Electrical Brake force Distribution (EBD) for the rear wheel brakes.

The brake control system, as a factory installed option, can be supplemented with:

- TRACS (TRAction Control System)
- STC (Stability and Traction Control)
- DSTC (Dynamic Stability and Traction Control).

EBD

EBD (Electrical Brake force Distribution) is a function for electronically controlling the brake force on the rear wheels and is integrated with the ABS system. The purpose of the control module for electronic brake force distribution (EBD) control is to control the hydraulic pressure in the brake circuit for the rear wheels if the rear wheels tend to lock under braking. This ensures optimal and stable braking. The EBD function replaces the relief valve used in the Mark IV version to reduce the pressure in the brake circuit for the rear wheels.

TRACS

TRACS is a traction control system which is integrated with the ABS system. TRACS is only available on all-wheel drive (AWD) cars. The traction control system distributes driven power between the wheels so that the wheel with the best road traction receives the greatest amount of driven power. The system is mainly designed to assist with moving off on slippery surfaces at speeds up to approximately 60 km/h. TRACS

has only a very limited effect at speeds over 60 km/h. TRACS (traction control system) is always engaged when the ignition is switched on. TRACS (traction control system) is engaged and disengaged using a switch under the climate control module (CCM). From model year 2003 inclusive, the TRACS function cannot be disabled manually.

STC

STC (stability and traction control) consists of two components:

- Traction Control – this function is described above under TRACS. The traction control function is always engaged when the ignition is switched on. The traction control function together with the stability function is engaged and disengaged using a switch under the climate control module (CCM). From model year 2003 inclusive, the Traction Control function cannot be disabled manually
- Stability Control - stability system which is integrated in the ABS system and stabilizes the car in the event of wheel spin. The brake control module (BCM) transmits a signal to the engine control module (ECM) to reduce engine torque until the slipping wheel(s) has/have stopped spinning. The stability function is always engaged when the ignition is switched on. The stability function together with the traction control function is engaged and disengaged manually using a switch under the climate control module (CCM).

DSTC

DSTC (Dynamic Stability and Traction control) - a dynamic anti-slip system which is integrated in the STC (stability and traction control) system. The DSTC (dynamic stability and traction control) function is engaged when the ignition is switched on but can be disengaged or engaged manually using the switch on the climate control module (CCM).
The DSTC (Dynamic stability and traction control) system consists of the following:

- Traction Control – This function is described above under TRACS
- Stability Control – Described under STC

- Stability Control - Described under STC above
- AYC (Active Yaw Control). The system is based upon a number of sensors which sense the driver's steering movements (steering wheel angle) and the directional, both straight and lateral, movement of the car. The information is used to correct the car in the event of oversteer or understeer
- RSC (Roll over stability control) is a function which monitors the tilt angle rate. If the driver turns the steering wheel quickly, during an avoidance manoeuvre for example, and the car is likely to tip over, the tilt angle sensor registers the rate at which the tilt angle is changing. The DSTC system rights the car. RSC (roll over stability control) is only available on the XC90
- Emergency Brake Assistance is a new function found in cars equipped with DSTC (dynamic stability and traction control) from model year 2002-. The function is integrated in the brake control module (BCM) and monitors the movement of the brake pedal. A sudden movement of the brake pedal (emergency braking) deploys the emergency brake assistance function to achieve optimum braking (more effective than normal braking). Information from the pedal position sensor is used to start the emergency brake assistance function. Full braking force is maintained for as long as the driver maintains or increases the pressure on the brake pedal. If the driver releases the brake pedal the emergency brake assistance function is immediately interrupted. Emergency brake assistance operates from approximately 10km/h up to the maximum speed. This function cannot be switched off.

Control module

The control module is integrated in the ABS hydraulic modulator and is located in the engine compartment. The control module contains the electrical valve coils for the different hydraulic valves.

The main function of the control module is to process the signals from the different sensors and to control the hydraulic pump and the electromagnetic hydraulic valves (inlet and outlet valves) in the ABS hydraulic modulator when controlling the:

- ABS
- EBD
- TRACS
- STC or
- DSTC.

Control modules with the DSTC (dynamic stability and traction control) function also have external sensors which sense the driver's steering wheel movements and the directional behaviour of the car.

The control module communicates with directly connected components and other control modules via the Controller Area Network (CAN).

The control module checks calculations and all input and output signals via the built-in diagnostic functions. When the control module detects a fault certain functions are completely disengaged depending on the severity of the fault. At the same time a warning light comes on or a text message will be displayed depending on the fault (see table). When manually disengaging by activating the STC (stability and traction control) / DSTC (dynamic stability and traction control) switch (pressed in for approximately 1/2 second) all functions are disengaged except for the ABS, Electronic Brake force Distribution, emergency brake assistance and vehicle speed signal. In the event of the temperature of the brake discs being too high traction control is switched off to prevent damaging the brake calliper and brake discs. The general warning lamp is only lit by the brake control module (BCM) in the event of faults which affect the emergency brake assistance function. However it can be lit by other control modules which have been affected by faults in the brake control system.

From model year 2003 inclusive, only the

traction control system can be disengaged manually. A traction loss warning lamp and a text message in the combined instrument panel are also used for models from this date.

	Warning lamp			
	ABS	Brake	Wheel spin / text display	General
ABS	X			
EBD		X		
TRACS			X	
STC			X	
DSTC			X	
EBA				X

Any diagnostic trouble codes (DTC) are stored in the control module memory. This information can be read off using VIDA via the data link connector (DLC) in the car.

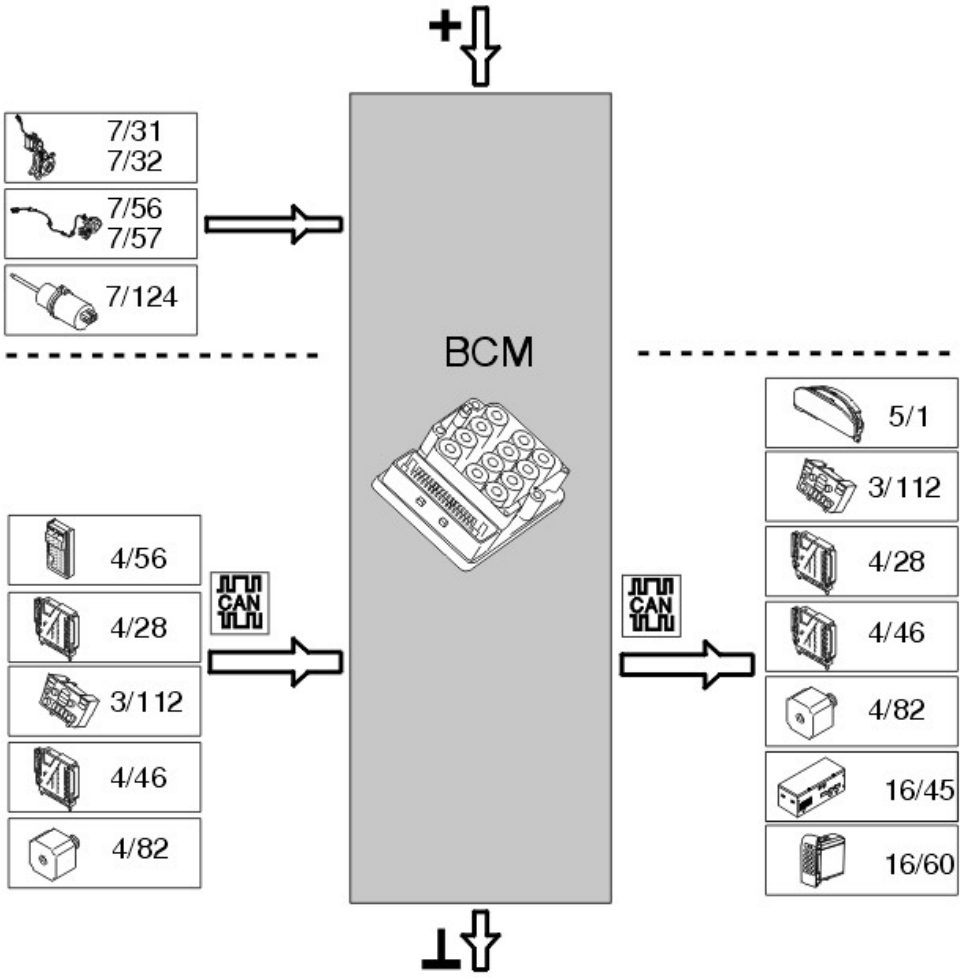
When the car is driven the control module checks that a signal is received from the wheel sensors. When the car reaches 20 km/h for the first time (40 km/h if the brake lamp switch is activated) the control module checks the pump motor and the hydraulic valves by quickly activating them. A noise is then heard from the hydraulic pump, this is completely normal. The ABS function is first activated when the speed of the car exceeds approximately 7 km/h. Traction control functions from start.

Signals, brake control module (BCM) with or without STC (stability and traction control) / TRACS (traction control system)

The table below summarizes the input signals to and output signals from the brake control module (BCM). The signal types are divided into directly connected signals, serial communication and Controller area network (CAN) communication. The following illustration displays the same information with the Volvo component designations.

Input signals	Output signals
Directly connected: Four Wheel sensors (7/31, 7/32, 7/56, 7/57) Pedal position sensor (7/124)	Directly connected:

Via Controller Area Network (CAN) communication: Central electronic module (CEM) (4/56). Provides information about the car configuration. Gearbox control module (TCM) (4/28). Provides information about the current gear, next gear and lock-up status (automatic gearbox only). Climate control module (CCM) (3/112). Provides information that the driver has switched of the STC (Stability and traction control) function. Engine control module (ECM) (4/46): - Via the central electronic module (CEM): The signal indicates if the engine is running or not, the current engine speed (RPM) and the current torque - Provides information about the driver's intentions concerning acceleration or deceleration for calculating the stability control (STC only). Differential electronic module (DEM) (4/82). Provides information about the torque distribution to the rear wheels and the function status (All-wheel drive (AWD) only).	Via Controller Area Network (CAN) communication: Driver information module (DIM) (5/1): - Vehicle speed - Receives a request about the lighting of the ABS-, brake, and traction control warning lamp in the combined instrument panel - Receives a request about which text message should be displayed in the combined instrument panel. Climate control module (CCM) (3/112). Receives a request to light/turn off the indicator in the STC button. Gearbox control module (TCM) (4/28): - Receives a request to delay a gear change in the event of a substantial speed difference in the front wheels - Receives information about the position of the brake pedal sensor. Engine control module (ECM) (4/46): - Receives a request to decrease torque during stability control - Receives information about the position of the pedal. Differential electronic module (DEM) (4/82). Receives information about the brake function (AWD). Road Traffic Information Module (RTI) (16/45). Receives information about the rotation speed of the front wheels. Used to measure distance. Phone Module (PHM) (16/60). Receives information about the travelled distance, used when the Global Positioning System makes calculations.



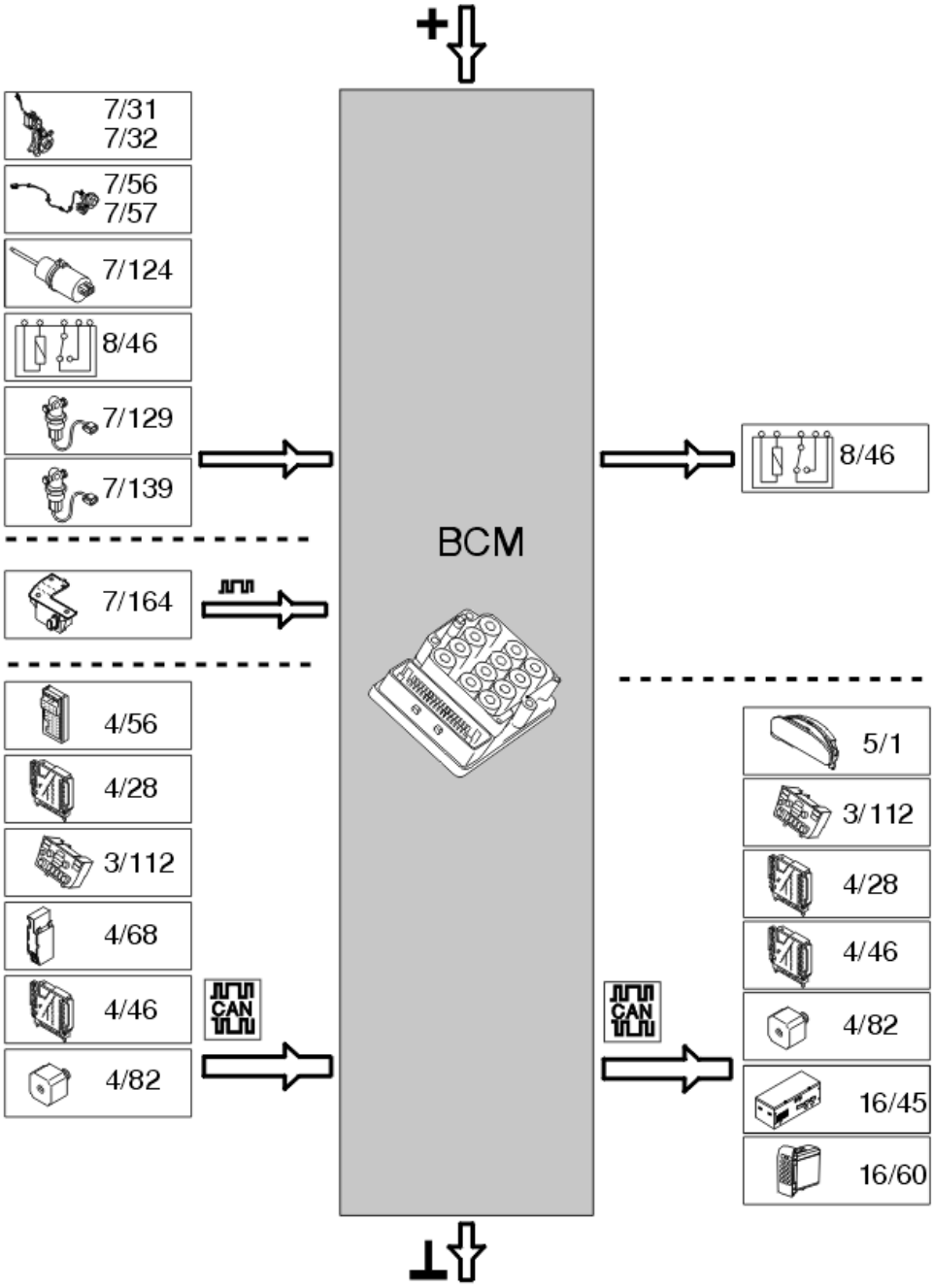
Signals, Brake control modules (BCM) with DSTC (dynamic stability and traction control)

The table below summarizes the input signals to and output signals from the brake control module (BCM). The signal types are divided into directly connected signals, serial communication and Controller area network (CAN) communication. The following illustration displays the same information with the Volvo component designations.

Input signals	Output signals
Directly connected: Four Wheel sensors (7/31, 7/32, 7/56, 7/57) Pedal position sensor (7/124) Activation unit DSTC (Pedal pressure sensor) (8/46) Two pressure sensors (7/129, 7/139)	Directly connected: Activation unit DSTC (Pressure build-up valve) (8/46)
Via internal Controller Area Network (CAN)	Via internal Controller Area Network (CAN)

communication: Sensor module DSTC (7/164). Provides information about the yaw angle speed, lateral acceleration and, on cars with All-wheel drive (AWD), also forward acceleration.	communication:
Via Controller Area Network (CAN) communication: Central electronic module (CEM) (4/56). - Provides information about the car configuration - Provides information indicating that reverse gear has been selected. This is to temporarily switch off the Active Yaw Control function (manual gearboxes only). Gearbox control module (TCM) (4/28). - Provides information indicating that reverse gear is selected to temporarily switch off the Active Yaw Control function (automatic gearbox only) - Provides information about the current gear, next gear and lock-up status (automatic gearbox only). Climate control module (CCM) (3/112). Provides information that the driver has switched of the traction control function. Steering wheel angle sensor module (SAS) (4/68). Provides information: - about the position of the steering wheel to calculate the position of the car - about whether the steering wheel is turned to the left or right - about the speed at which the steering wheel is turned - about the status of the steering wheel angle sensor module (SAS) - about whether the steering wheel angle signal is OK. Engine control module (ECM) (4/46): - Via the central electronic module (CEM): The signal indicates if the engine is running or not, the current engine speed (RPM) and the current torque - Indicates current engine torque when calculating the traction control.	Via Controller Area Network (CAN) communication: Driver information module (DIM) (5/1): - Vehicle speed - Receives a request to light the ABS, brake, and traction control warning lamp in the combined instrument panel - Receives a request about which text message should be displayed in the combined instrument panel. Climate control module (CCM) (3/112). Receives a request to light/turn off the indicator in the DSTC button. Gearbox control module (TCM) (5/1): - Receives a request to delay a gear change in the event of a substantial speed difference in the front wheels - Receives information about the position of the pedal. Engine control module (ECM) (4/46): - Receives a request to decrease the torque during stability control - Receives information about the position of the pedal. Differential electronic module (DEM) (4/82). Receives information about the brake function (AWD). Phone Module (PHM) (16/60). Receives information about the travelled distance, used when the Global Positioning System makes calculations. Road Traffic Information Module (RTI) (16/45). Receives information about the rotation speed of the front wheels. Used to measure distance.

Differential electronic module (DEM) (4/82). Provides information about the torque distribution to the rear wheels and the function status (All-wheel drive (AWD) only).	



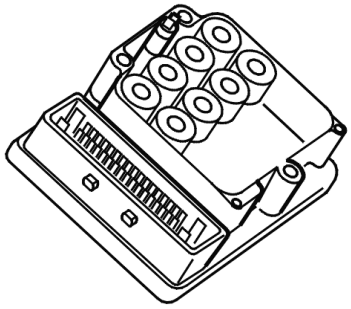
Design

Control module and ABS hydraulic modulator

The brake control module (BCM) is mounted on the hydraulic modulator in the engine

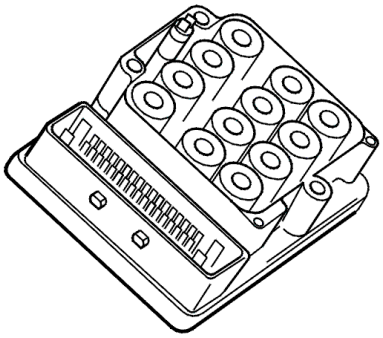
compartment.
The control module is supplied with power via two fuses and connected to ground by two ground terminals.
There are diagnostics for the valve coils.

The brake control module (BCM) is available in two different versions.



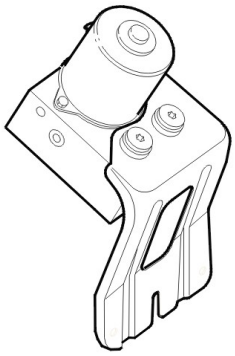
ABS control module

The control module contains two different micro-processors which receive signals from different sensors in the system. The micro-processors operate in parallel and use a program to compute the necessary ABS and electronic brake force distribution functions. The ABS control module has eight valve coils for the hydraulic valves, four outlet valves and four inlet valves.
The control module has a connector for connection to the car wiring.



Control module for STC (stability and traction control), DSTC (dynamic stability and traction control), and TRACS (traction control system)

The control module for STC/DSTC/TRACS has twelve valve coils for the hydraulic valves; four are outlet valve coils, four are inlet valve coils and four are used for stability and traction control.
When replacing brake control modules (BCM) with DSTC, the control module must be calibrated according to the instructions in VIDA vehicle communication or by a special test drive (see test drive schedule DSTC/BCM, description).

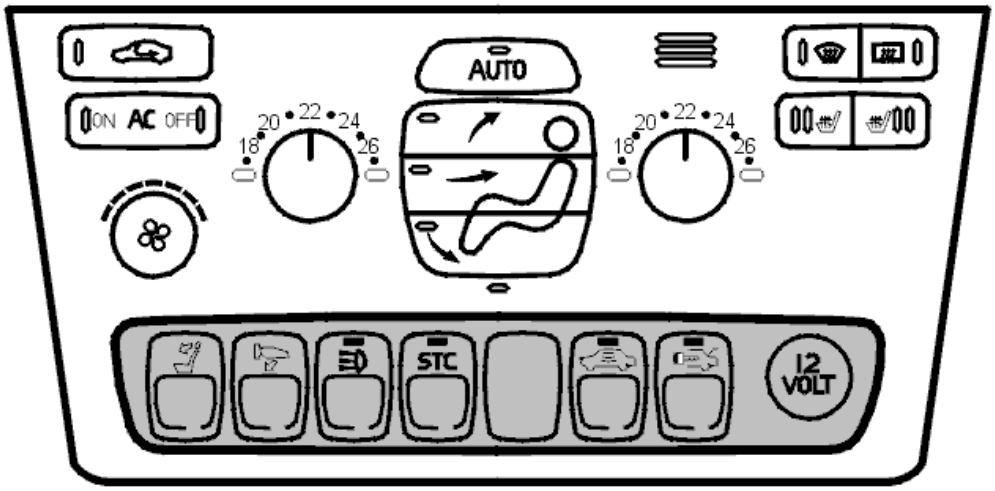


ABS hydraulic modulator

The hydraulic modulator is available in three versions; ABS, STC (stability and traction control) and DSTC (dynamic stability and traction control)/TRACS (traction control system). The ABS hydraulic modulator is located in the engine compartment.
The ABS hydraulic modulator consists of hydraulic valves, check valves and a pump motor. The pump motor builds up the brake pressure required during ABS or stability control.

There are diagnostics for the pump motor.

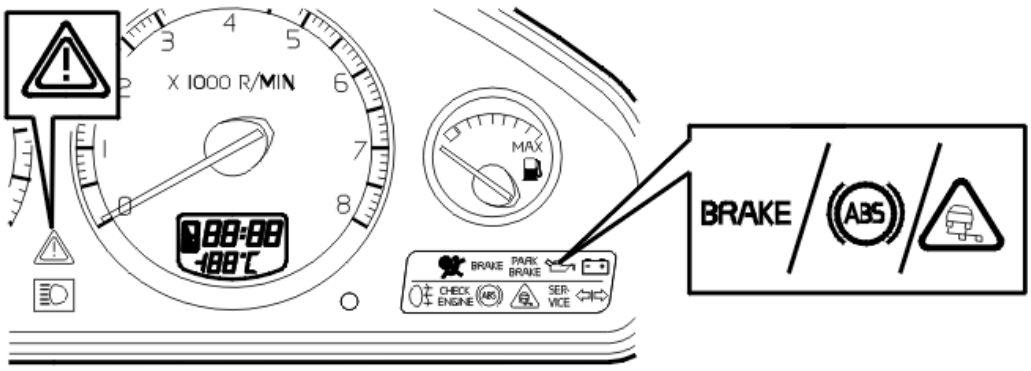
STC/DSTC switch



The switch for STC/DSTC is positioned next to the other buttons on the lower section of the climate control module (CCM). The stability and traction control functions can be switched on and off manually (this applies only to the stability function from model year 2003 inclusive). When the ignition is switched on all functions are engaged. The switches have a green LED indicator which display the ON-position. When STC/DSTC is switched on or off, this is confirmed by a message in the driver information module (DIM). If the STC-/DSTC function is disabled, the other functions work normally.

Note! The illustration displays the switch for cars equipped with STC.

Warning lamps



The brake system uses four warning lamps positioned in the combined instrument panel.

ABS warning lamp

The ABS warning lamp indicates an ABS system fault.

Brake warning lamp

The brake warning lamp indicates:

- faults in the electronic brake force distribution (EBD) function
- that the brake fluid level is too low.

Traction control warning lamp (only cars with STC/DSTC) model year 1999-2002

The traction control warning lamp is on continuously when:

- STC/DSTC is deactivated because a diagnostic trouble code (DTC) is stored
- The STC/DSTC system has been manually switched off
- the brake disc temperature is too high.

The traction control warning lamp flashes when:

- a drive wheel starts to spin during acceleration. The control module is activated to regain traction
- the lateral stability limit is exceeded (the car oversteers or understeers) during active yaw control.

Traction control warning lamp (only cars with STC/DSTC) model year 2003-

The traction control warning lamp is lit continuously when the road surface is slippery.

The traction control warning lamp flashes when:

- there is a risk of a loss of traction

- there is a risk of a loss of traction
- a drive wheel starts to spin during acceleration. The control module is activated to regain traction
- the lateral stability limit is exceeded (the car oversteers or understeers) during active yaw control
- the limit for the anti-roll function is exceed and active yaw control is activated to regain stability.

General warning lamp model year 1999-2002

The general warning lamp (red/yellow) lights only for those faults in the brake control system which disable emergency brake assistance.

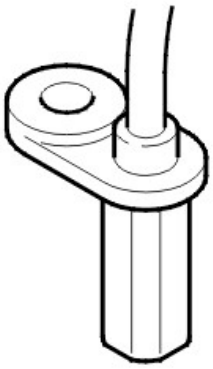
General warning lamp model year 2003-

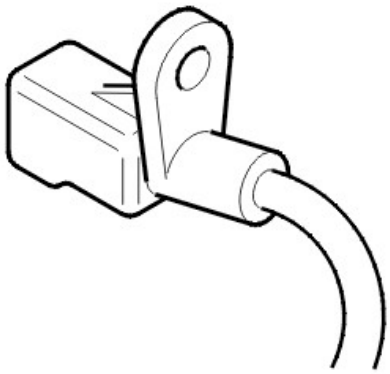
- STC/DSTC is deactivated because a diagnostic trouble code (DTC) is stored
- The brake disc temperature is too high.

Text display model year 2003-

The stability function has been manually disabled using the STC/DSTC switch.

Wheel sensors





There are four wheel sensors, one at each wheel. The wheel sensors supply the control module with information about the rotation speed, acceleration and retardation of each wheel. By recording the pulses, the control module can calculate the wheel speed.

The wheel sensors are active sensors. When the pulse wheel rotates, the sensor generates a pulsed current (quadratic wave) where the strength of the current depends on the position

of the pulse wheel. The signals from the coils in the wheel sensors are then affected by a magnetic resistance element, which generates a current which changes between 7mA and 14mA, and whose frequency increases with speed.

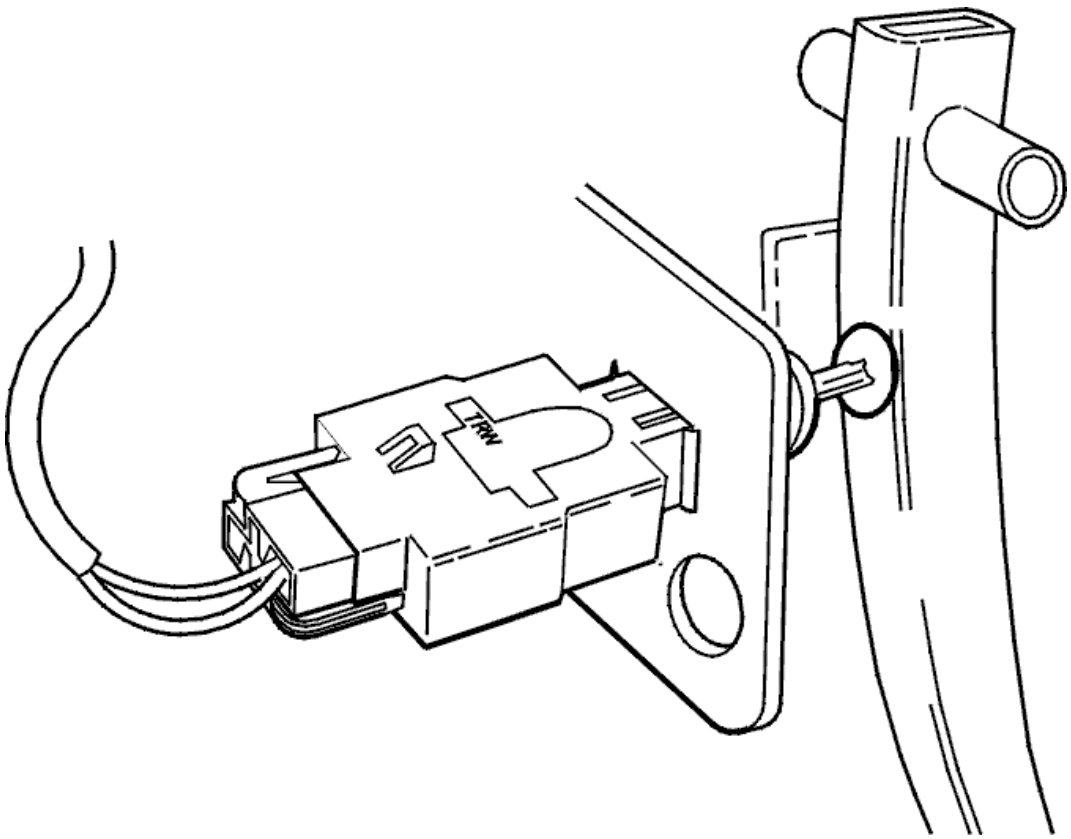
On the front wheels, the pulse wheel is pressed onto the outer constant velocity joint and the wheel sensors are located radially in the shaft housing relative to the pulse wheel. On the rear wheels, the pulse wheel is pressed onto the hub and the wheel sensors are located axially relative to the pulse wheel. The rear pulse wheels can be replaced. Both the front and rear pulse wheels have 48 teeth. In the event of a fault in any of the wheel sensors the following systems will be disengaged or will not engage:

- ABS
- TRACS
- STC
- DSTC.

Electronic brake force distribution (EBD) is available if one wheel sensor is faulty. Electronic brake force distribution (EBD) is disengaged if there is a fault in more than one wheel sensor simultaneously.

The control module calculates the vehicle speed using the signals from the wheel sensors. There are diagnostics for the wheel sensors.

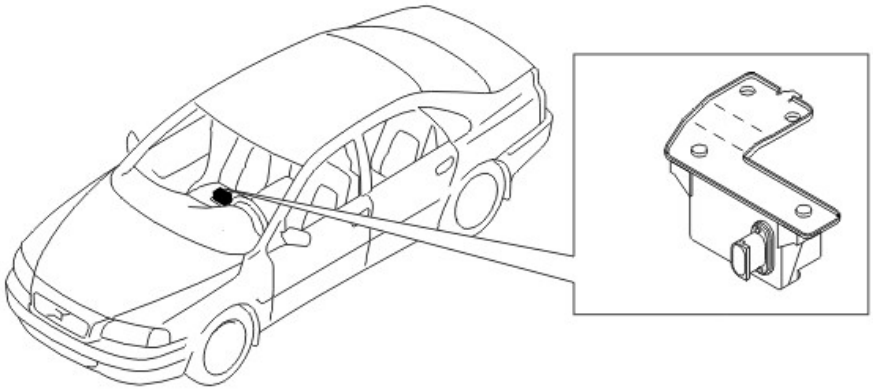
Brake lamp switch



The brake lamp switch is a single pole switch positioned at the brake pedal lever. The brake lamp switch self-adjusts during installation.

The brake control module (BCM) receives information about the status of the brake lamp switch via the engine control module (ECM). The brake lamp switch signal is used by the brake control module (BCM) to diagnose faults in the pedal position sensor.
The brake lamp switch is supplied with power from the battery. When the switch is closed, the signal is grounded through the engine control module (ECM). The engine control module (ECM) then transmits a signal on the Control area network (CAN) indicating that the brake lamp switch has been activated.
There are diagnostics for the brake lamp switch.

Sensor module (Only DSTC)

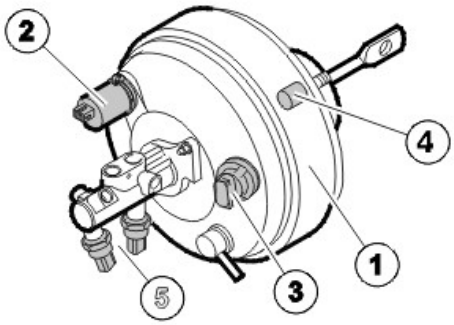


The sensor module is installed under the right-hand front seat and contains two to four sensors, depending on which of the three versions is installed. The information from the sensor module is used for stability calculations in the brake control module (BCM). The sensor module for 2 wheel drive cars contains a yaw angle sensor which measures the yaw angle speed in °/s, and a lateral acceleration sensor which measures lateral acceleration in m/s^2.
The sensor module all-wheel drive (AWD) also contains a yaw angle sensor and lateral acceleration sensor as well as an acceleration sensor which measures longitudinal acceleration in m/s^2.

The XC90 also has a tilt sensor in the sensor module. The tilt sensor gauges the tilt rate in °/s.
The sensor is installed using a new bracket, turned 90°.
The sensor module communicates with the brake control module (BCM) via an internal control area network (CAN).
The supply voltage to the sensor is 12V and is connected to ground.
There are diagnostics for the sensor module.

When replacing the sensor module, the brake control module (BCM) must be calibrated according to the information in VIDA vehicle communication or manually according to the test drive.

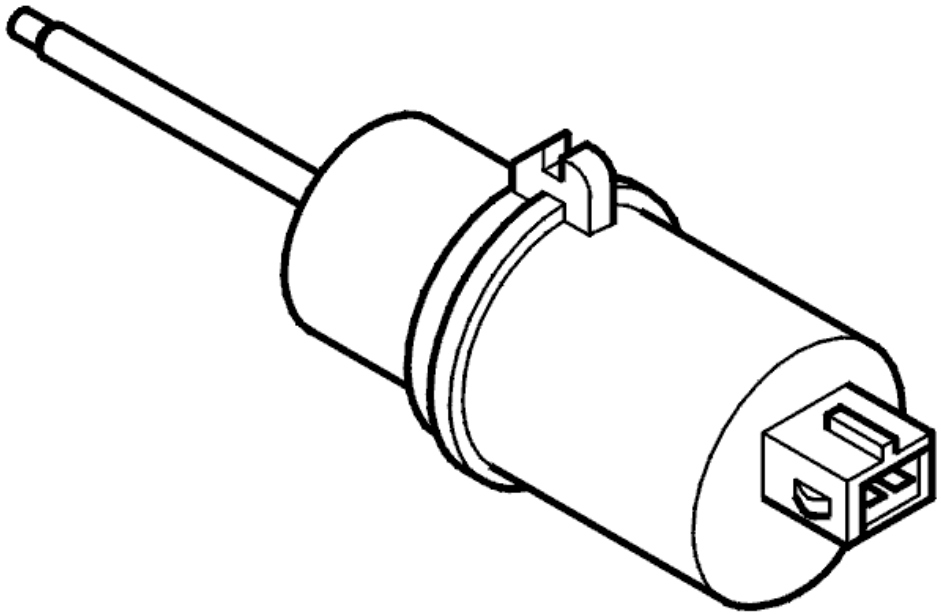
Active servo unit, pedal pressure sensor (DSTC only)



The servo unit is positioned on the bulkhead in the engine compartment. It consists of a vacuum cylinder (1), pedal position sensor (2), pressure build-up valve (3) and pedal pressure sensor (4). The pressure build-up valve and the pedal pressure sensor (activation unit) have a common connector which cannot be replaced. The pedal pressure sensor is positioned in the servo unit and provides the brake control module (BCM) with information about brake activity. If the driver presses the brake pedal during stability control, the control module will take account of this.

The active servo unit is controlled by the brake control module (BCM) and builds up an initial brake pressure. This is so to allow braking during active yaw control. An active brake pressure is obtained within 0.1 seconds. This occurs without the driver needing to brake. The pressure build-up valve opens and allows atmospheric pressure to enter the rear chamber in the servo unit. The brake pressure sensors (5) continuously monitor the brake pressure. The pulse width controlled pressure build-up valve in the servo unit maintains the brake pressure at approximately 10 bar during stability control.

Pedal position sensor

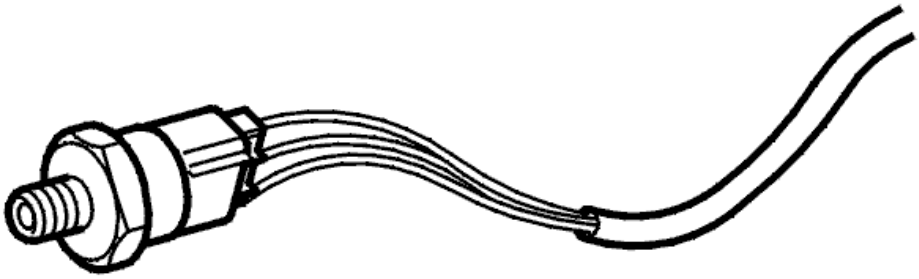


The pedal position sensor is mounted on the servo unit in the engine compartment. The sensor has several functions. It is used to:

- register rapid pedal movements for emergency brake assistance
- shut off the traction control during braking
- to diagnose the function of the brake lamp switch
- it is used by the engine control module (ECM) for cruise control. The signal is transmitted via the control area network (CAN).

The sensor, which responds to the push rod for the pedal, is a sliding potentiometer. 0 mm corresponds to 0 V and 38.5 mm movement corresponds to approximately 95 % of battery voltage (U_{bat}).

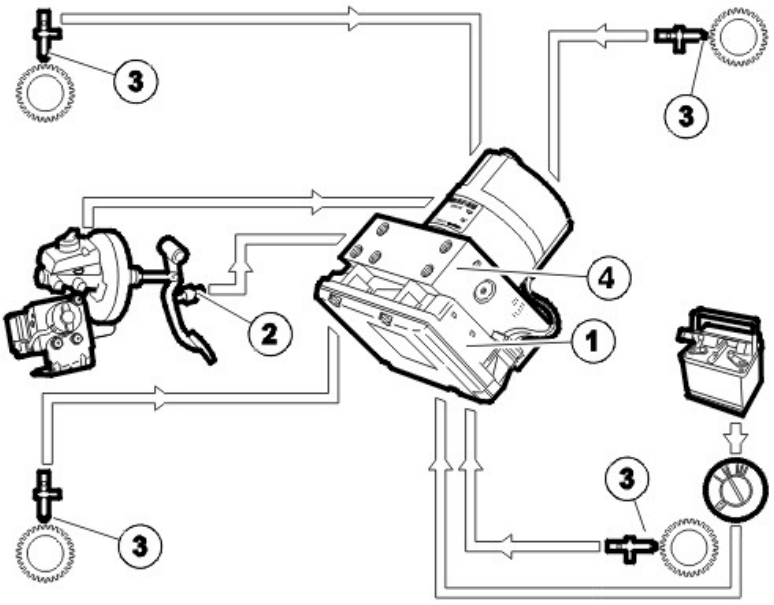
Brake pressure sensor (Only DSTC)



Two brake pressure sensors are positioned on the master cylinder. One sensor is located on the primary circuit and one on the secondary circuit. The information is transmitted via two analogue signals (measurement range 0-5 V) and is used by the brake control module (BCM) to calculate the brake pressure during active yaw control, and when the driver applies the brakes.
The sensors are supplied with voltage via the brake control module (BCM). There are diagnostics for the sensors.
When replacing the brake pressure sensor, the brake control module (BCM) must be calibrated according to the information in VIDA vehicle communication or manually according to the test drive.

Function

ABS function



While driving, the brake control module (BCM) (1) registers the acceleration and deceleration of the wheels. The 4 wheel sensors (3) (one on each wheel) give the brake control module (BCM) information about the rotation speed of the wheels. The brake control module (BCM) calculates the speed of the car using this information and puts it out on the Control area network (CAN). There the signal is accessible for other systems.
During braking, the brake control module (BCM) receives a signal from the brake lamp switch (2) indicating braking. The brake control module (BCM) then goes into standby mode for ABS control. The signal from the brake lamp switch is not required for ABS control, but does give softer control at the beginning of ABS control.
If the brake control module (BCM) detects that there is a risk of wheel lock-up, the ABS hydraulic modulator (4) is affected and the hydraulic pressure for the relevant wheel is adapted so that wheel lock up is avoided.

The pressure in the circuit is controlled so that the maximum possible braking force is transferred to the road surface. This occurs when the wheel rotates with 12-20% slippage on the surface.
ABS is first activated when the speed of the car

exceeds approximately 7 km/h, which means that at speeds below approximately 7 km/h the wheels can lock up. This has no practical effect on the function of the system or from the driver's point of view.

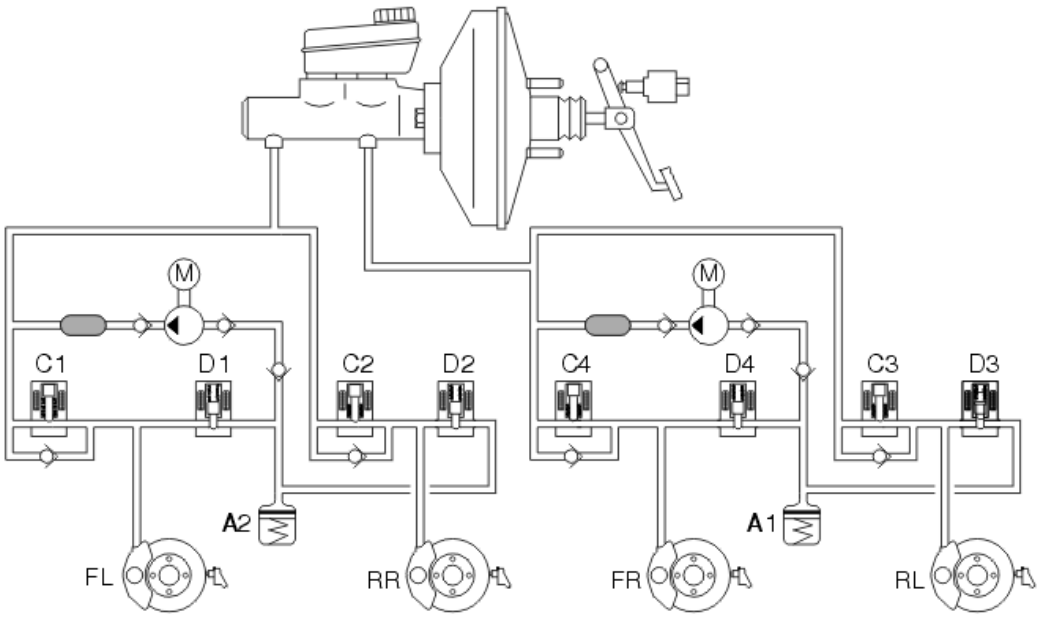
ABS control can be divided into three stages:

1. Open position. (Pressure increase). This is the normal condition during braking. The inlet valve is open and the outlet valve is closed. This permits the brake pressure to pass from the master cylinder to the wheel
2. Pressure retention phase. (Constant pressure). If the brake control module (BCM) detects that one of the wheels is rotating too slowly, the brake control module (BCM) will close the inlet valve. This stops the brake pressure to the wheel from increasing, even if the driver increases the pressure on the brake pedal. If the rotation speed of the wheel continues to fall the control moves into the pressure reduction phase
3. Pressure reduction phase. (Pressure release). The inlet valve remains closed. The brake control module (BCM) opens the outlet valve and starts the pump which transfers brake fluid from the wheel, this reduces the brake pressure. When the rotation speed has increased sufficiently the control module closes the exhaust valve, opens the inlet valve and control returns to the open position.

Steps 1, 2 or 3 are repeated until braking finishes or the ABS system stops.

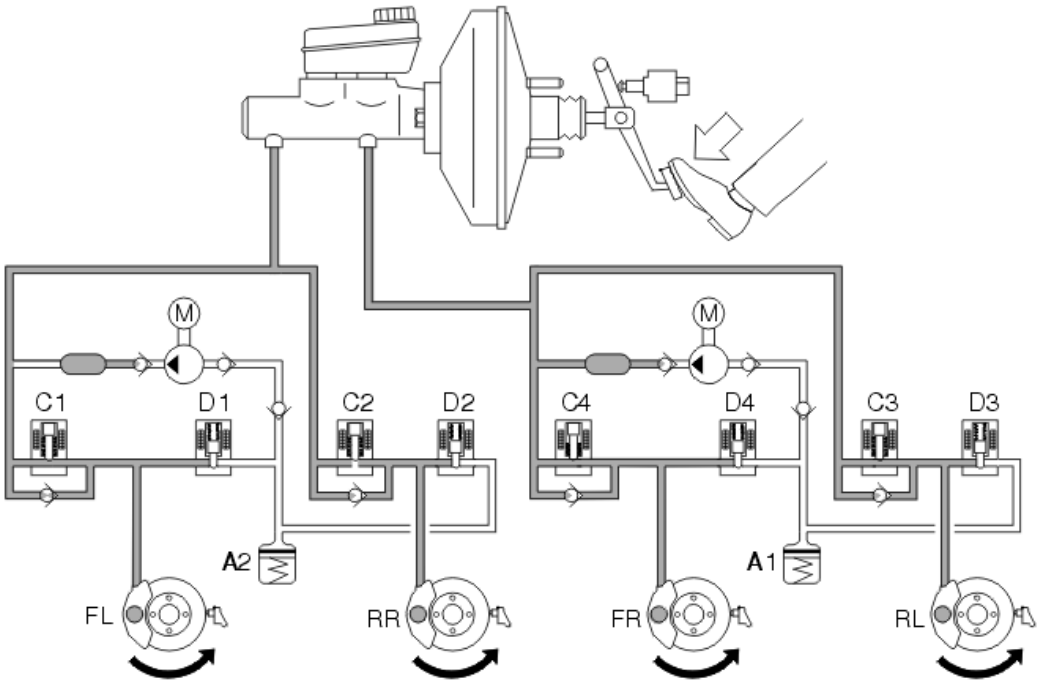
ABS control

No braking



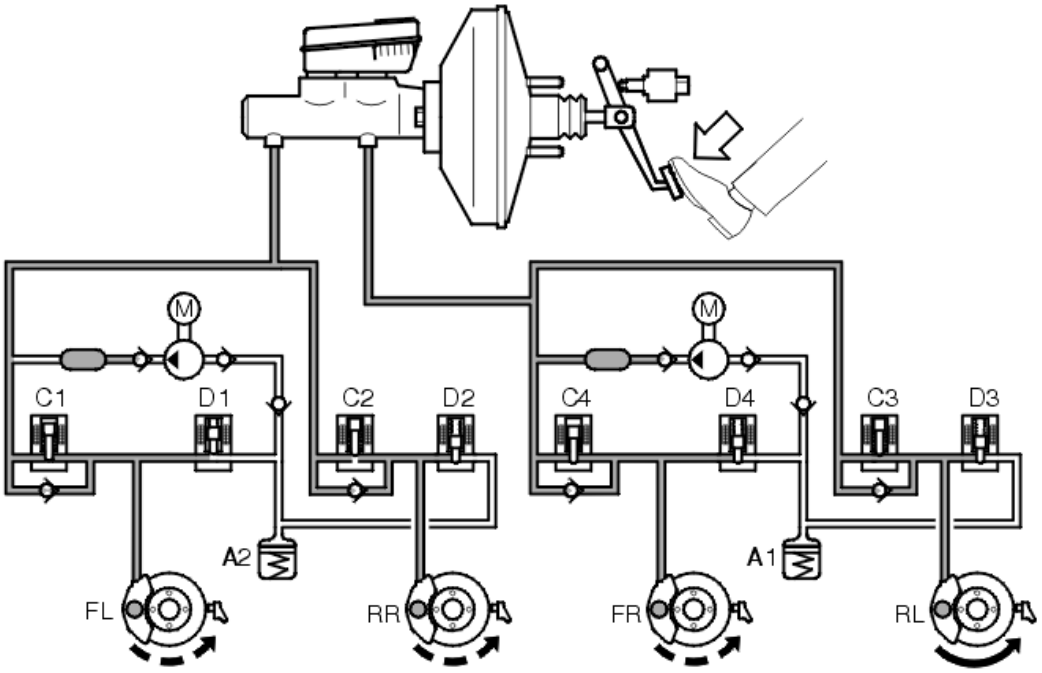
When the driver is not braking, the brake system is unaffected (i.e. the master cylinder is in the rest position and the connections between the brake fluid reservoir and the rest of the hydraulic system is open). There is no pressure in the system. In the ABS hydraulic modulator valve block, the hydraulic valves are in their rest position. In other words, the inlet valves are open and the outlet valves closed.

Braking without ABS



When the brake pedal is depressed, the movement of the pedal is transmitted via the servo unit to the master cylinder pistons and the brake lamp switch trips. When the primary and secondary pistons move forwards in the master cylinder, the openings for the brake fluid reservoir are closed. The hydraulic pressure in the two brake circuits increases and affects the pistons in the brake callipers which press the brake pads against the brake discs.
When the brake pedal is released, the pistons revert to the rest position in the master cylinder. The connection to the brake fluid reservoir opens and the brake system pressure falls. The brake calliper pistons return to their rest positions with the aid of the sealing rings.

Braking with ABS



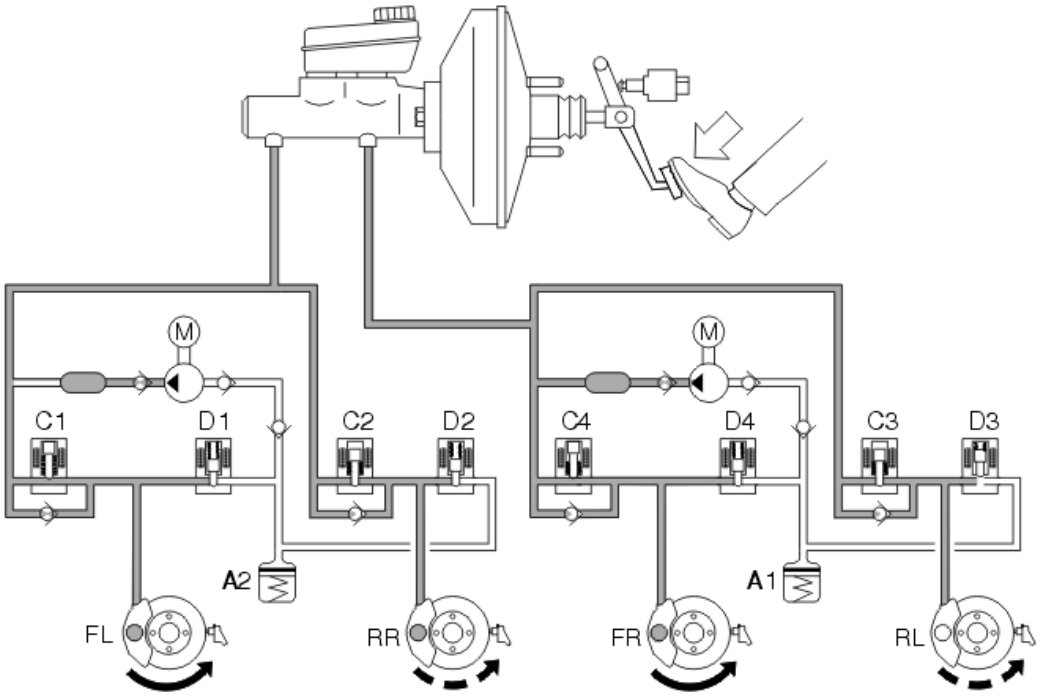
When a wheel locks-up under braking, the brake control module (BCM) begins to close the inlet valve for the relevant brake circuit so that the supply of brake fluid from the master cylinder is interrupted. This means that the hydraulic pressure cannot increase irrespective of the pressure in the master cylinder (constant pressure, see the right-hand front wheel - FR). The hydraulic pump starts at the same time.

If the wheel locks anyway, the outlet valve opens and the brake fluid is allowed back to the accumulators resulting in a reduction in the brake circuit pressure (pressure release, see the left front wheel - FL). This reduces the hydraulic pressure and braking effect, allowing the wheel to accelerate. The hydraulic pump returns the brake fluid from the accumulators to the master cylinder.
When the acceleration is sufficient, the brake control module (BCM) closes the outlet valve and opens the inlet valve, so that the hydraulic pressure in the circuit increases. During the pressure increase phase the required fluid volume is supplied by the master cylinder and the pump if the accumulators contain brake fluid. As the volume of fluid supplied to the brake circuit is greater than the volume released back into the accumulators from the brake circuits, the accumulators only compensate for the volume peaks on the pump suction side. The pump returns the brake fluid from the low pressure accumulators to the master cylinder or brake circuits depending on the position of the inlet valves.

When the pump operates the brake pedal is raised and lowered (pulses). This is normal and is also a warning to the driver that ABS control is active.

The hydraulic pump is operational for approximately 1 second after the ABS control has finished to ensure that the accumulators are empty.

Electronic brake force distribution (EBD)



Electronic brake force distribution (EBD) is integrated in the ABS system and controls the braking forces to the rear wheel brakes.
Electronic brake force distribution (EBD) replaces the relief valve, which otherwise reduces the pressure in the brake circuit for the rear wheels and prevents premature activation of rear ABS control.
Electronic brake force distribution controls the hydraulic pressure in the brake circuit for the rear wheels the rear wheels slip considerably less than the front wheels under braking. This ensures optimal and stable braking.
The brake control module (BCM) controls the brake pressure by controlling the inlet and outlet valves in the rear wheel brake circuits.

The brake pressure in the rear wheel circuits varies, depending on how much the rear wheels slip in relation to the front wheels. This functions tries to keep the rear wheel slippage 0–2 % lower than front wheel slippage. The function is load sensitive.

Generally, the difference between the rear wheel and front wheel slippage under braking is dependent on how hard the brakes are applied

and on the load of the car. Hard braking /light loads cause more slippage, light braking/heavy loads cause less slippage.

Therefore the requirement for brake fluid when the hydraulic pump is not activated during electronic brake force distribution (EBD) control is less than during stability and traction control. The fluid volume returned from the brake circuits is taken up by the accumulators.

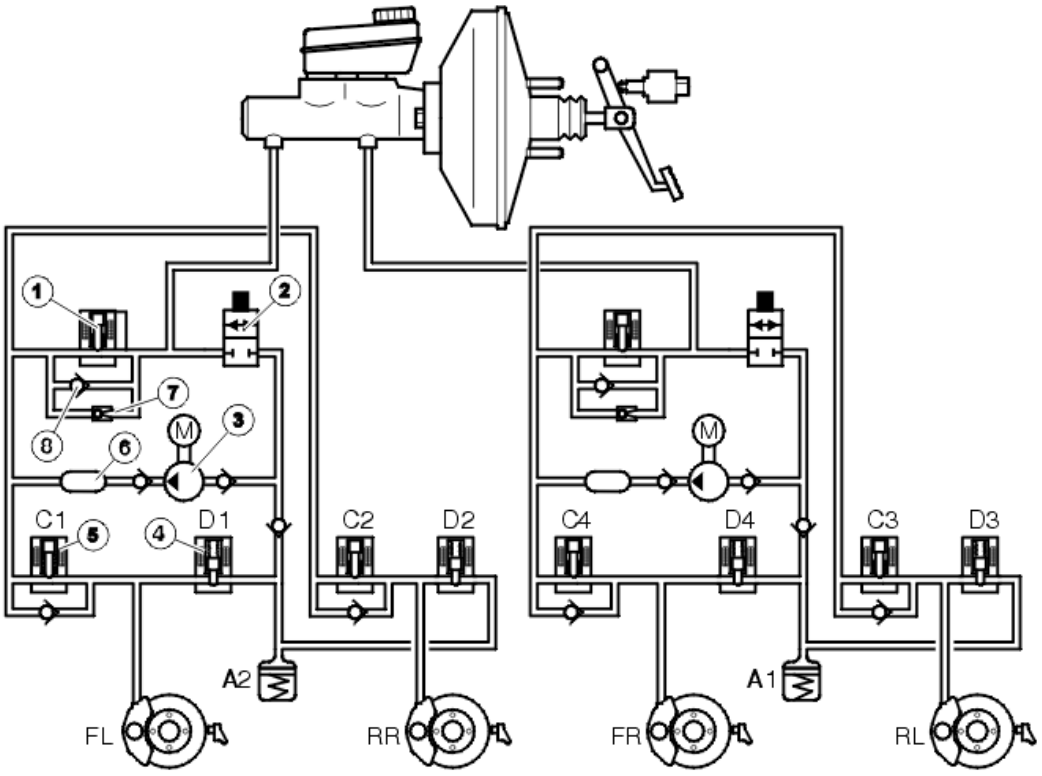
STC (stability and traction control) system

The STC (stability and traction control) system consists of two functions, stability control and traction control. The stability function is controlled by the engine control module (ECM). The traction control function and TRACS (TRAction Control System) operate in the same way. See the “Traction control” section.

Stability Control

Stability control occurs when the brake control module (BCM) transmits a signal to the engine control module (ECM) to lower the engine torque if any of the wheels loose traction. Stability control is available between 0 km/h and top speed. For information about traction control, see the “Traction control” section.

Traction Control



Components

1. Separation valve, normally open
2. Electronic shuttle valve, normally closed
3. Hydraulic pump
4. Outlet valve, normally closed
5. Inlet valve, normally open
6. Pressure equalizer
7. By-pass valve
8. Non-return valve.

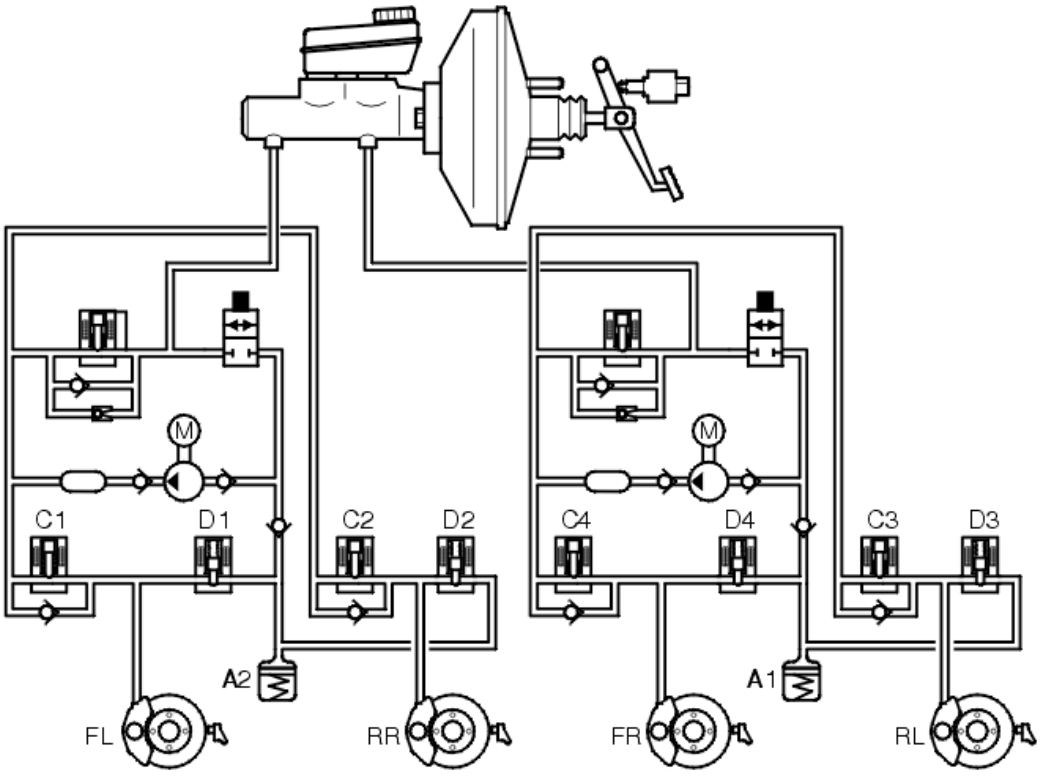
Traction control is integrated in the steering wheel bracket.
The system is mainly designed to assist with moving off on slippery surfaces at speeds up to approximately 60 km/h. Traction control has only a very limited effect at speeds over 60 km/h.
The traction control function is always engaged when the ignition is switched on. The function can be disengaged (model years 1999-2002 only) using the STC/DSTC switch, which is located on the lower section of the climate control module (CCM).
If the brake control module (BCM) registers, via the front wheel sensors, that one of the driven wheels is spinning faster than the other, the

separation valve (1) closes and the hydraulic pump (3) starts so that the brake fluid is pumped to the brake calliper of the slipping wheel. Pressure builds up in the brake circuit and the brakes are applied as much as required so that the drive force is distributed between the driven wheels. The wheel which has the best traction receives the most driven force against the surface. This process is independent of engine output.

On cars with traction control, the brake control module (BCM) continually registers brake usage and calculates the temperatures of the front wheel brake discs. If traction control is engaged and the calculated temperature is too high (approximately 450 °C), traction control cuts out and the wheel spin warning indicator lights (applies to model year 1999-2002). From model year 2003, the general warning lamp (yellow) lights, and a text is displayed in the combined instrument panel. A diagnostic trouble code (DTC) is stored in the brake control module (BCM). Traction control is blocked to prevent the brakes from overheating. The light goes out once the calculated temperature falls below approximately 300 °C and traction control is engaged again. However, the ABS function is always available. Information about the calculated temperature of the brake discs is in the brake control module (BCM) as long as the 30–supply is connected. If the brake system has been used too hard, this may also cause high brake temperatures.

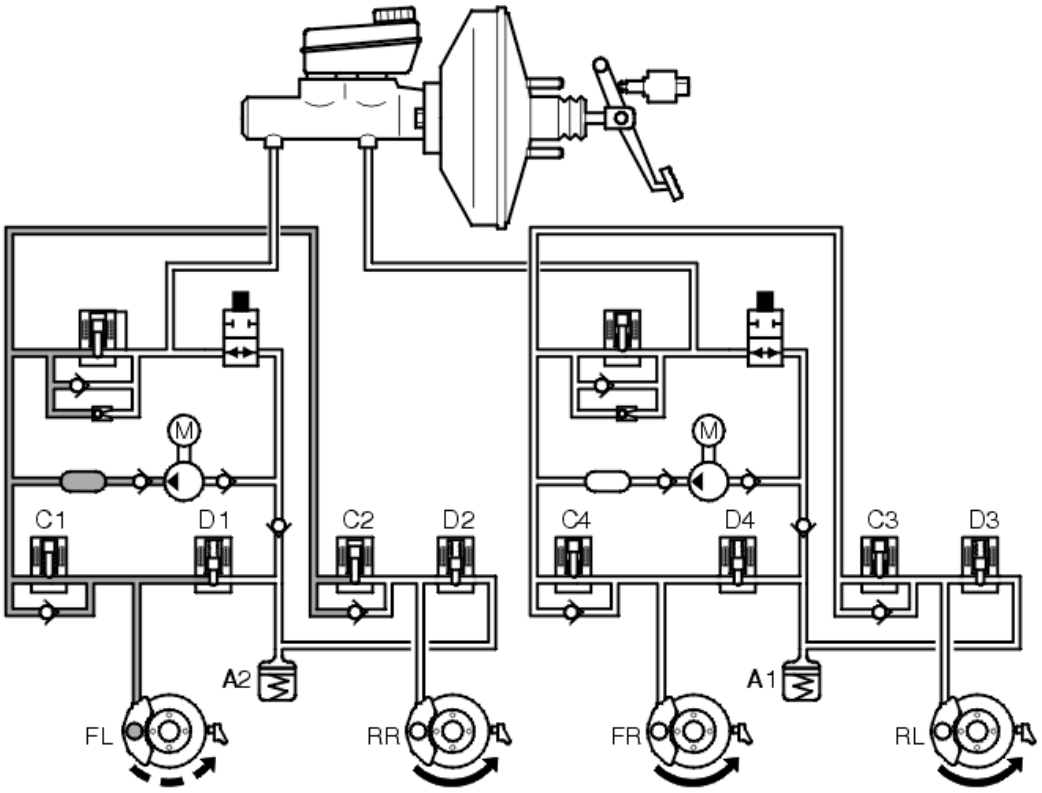
Traction Control

No traction control



When the driven wheels are not spinning the brake system is unaffected (i.e. the master cylinder is in the rest position and the connections between the brake fluid reservoir and the rest of the hydraulic system are open). There is no pressure in the system. In the ABS hydraulic modulator valve block, the hydraulic valves are in their rest position. In other words, the inlet valves and the separation valves are open and the outlet valves closed.

Traction control when one or both driven wheels spin



If the car moves off and one or both driven wheels are threatening to slip, the brake control module (BCM) detects this by comparing the signals from the wheel sensors with a calculated reference speed. The control module closes one or both separation valves and the hydraulic pump starts. The separation valve blocks the connection between the pump pressure side and the master cylinder primary circuit /secondary circuit. The inlet valve for the non-spinning wheel closes so that the brake is not applied on that wheel. The hydraulic pump draws brake fluid from the brake fluid reservoir via the electronic shuttle valve and increases the pressure until the by-pass valve opens. The hydraulic pressure reaches the spinning wheel and slows down the wheel so that the driven force is distributed between the driven wheels so that the wheel with the best traction receives the most driven force.

As the pump supplies a greater flow than required by traction control, the excess brake fluid is drained off by the by-pass valve for the master cylinder or is drawn directly up by the pump.

If traction control is manually disengaged (model tears 1999-2002) it can be re-engaged using the switch whilst the wheels are spinning. The function then starts more softly than normal.
The inlet valve closes as soon as the spinning wheel has been slowed down by the brake to a relatively normal speed. Depending on the acceleration of the wheel, the outlet valve opens (brake fluid flows back to the suction side of the pump) so that the pressure in the brake circuit drops or the outlet valve remains closed to maintain the pressure (constant pressure). The outlet valve closes to increase the pressure in the brake circuit, the inlet valve opens and the pressure rises in the brake circuit.

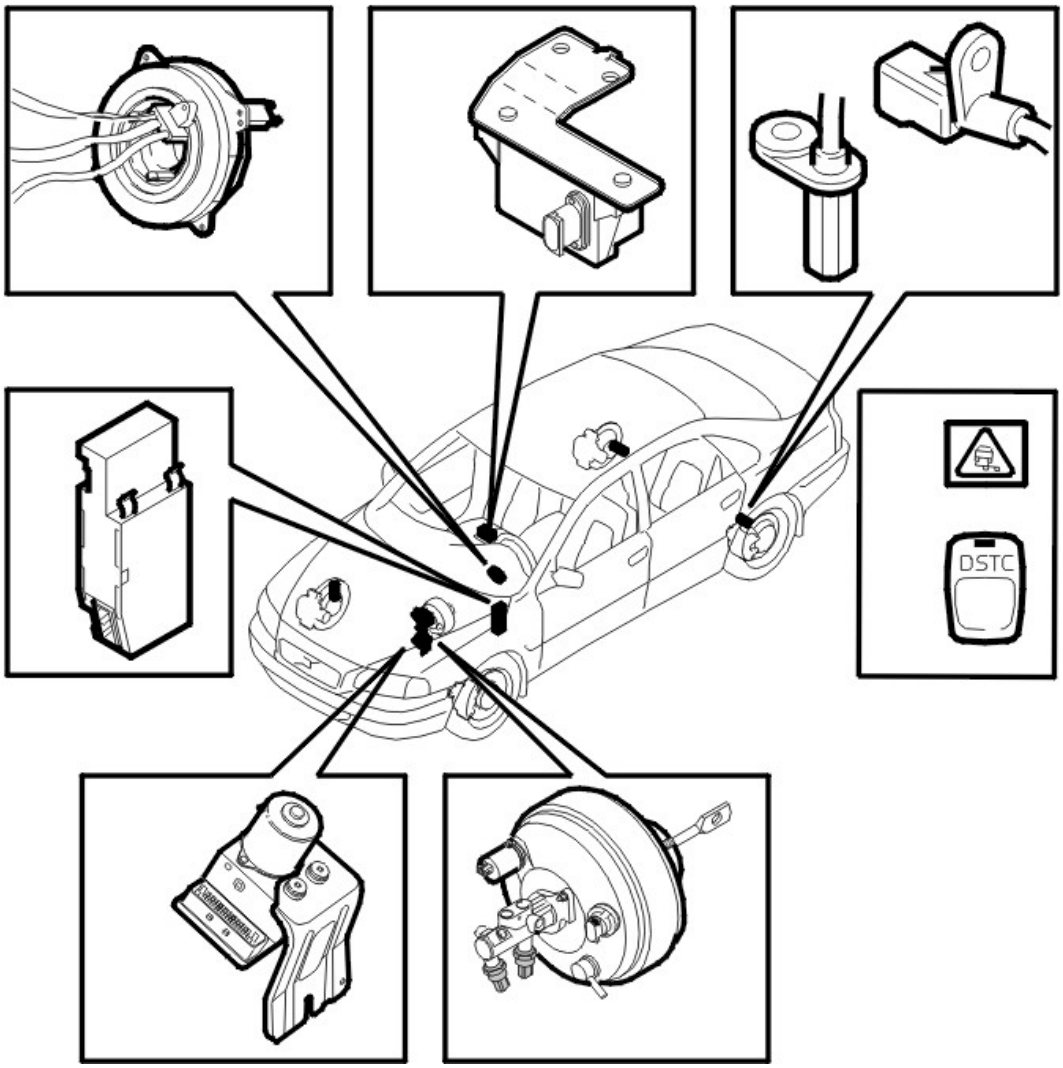
This control brakes the wheel in proportion to optimum slippage until one of the following occurs:

- As friction against the surface becomes greater wheel spin stops
- The process is stopped by the brake control module (BCM) to prevent the brakes from overheating
- Braking occurs
- The function is disengaged using the switch on the climate control module (CCM) (applies to model years 1999-2002)
- The car reaches the speed where traction control ceases.

If the rear wheels lock during traction control (for example the handbrake is applied), the brake control module (BCM) stops traction control to allow ABS to cut-in. The traction control lamp lights (applies to model years 1999-2002).
The separation valve is activated during traction control.
Activating the brakes, which is registered by the brake control module (BCM) via the signal from the brake lamp switch, enables the traction control to be interrupted and the separation valve to open. The electronic shuttle valve closes, so that the pump is unable to draw brake fluid from the master cylinder. The

hydraulic modulator now operates as a normal ABS hydraulic modulator.
A difference in speed between the driven wheels requires traction control. This difference varies with the speed of the car. When the vehicle speed is 0 km/h, a difference in speed of 8 km/h between the driven wheels is required for traction control to function. At a vehicle speed of 20 km/h, a difference of 18 km/h, and at 40 km/h a difference of 25 km/h are required. At higher speeds the differences required between the driven wheel speeds is so great that in practice traction control does not function above 60 km/h.

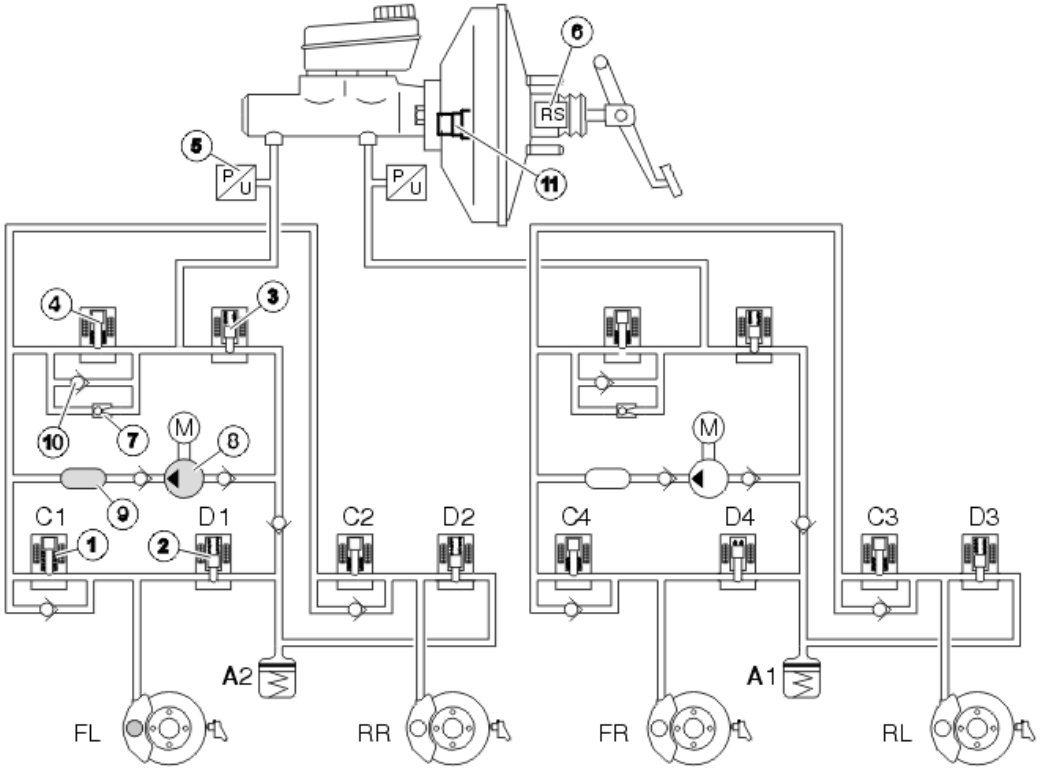
Active yaw control system



The brake control module (BCM) with DSTC (dynamic stability and traction control) uses continuous information from the different

sensors in the system to calculate the positions of the steering wheel and car. The brake control module (BCM) calculates the driving manner of the driver by measuring the steering wheel angle, the engine torque, the speed of the car and brake pressure. The brake control module (BCM) also calculates the behaviour of the car by monitoring the steering wheel angle, steering wheel angle speed, yaw rate speed and lateral acceleration. When the differences between the movements of the driver and the behaviour of the car exceed a certain point, Active Yaw Control limits the engine torque to maintain lateral stability in all driving conditions. Active Yaw Function also activates the servo unit and the individual brake control to control the hydraulic modulator separation valves and electronic shuttle valves and the inlet and outlet valves which correct the car in the event of a skid.

Active yaw control

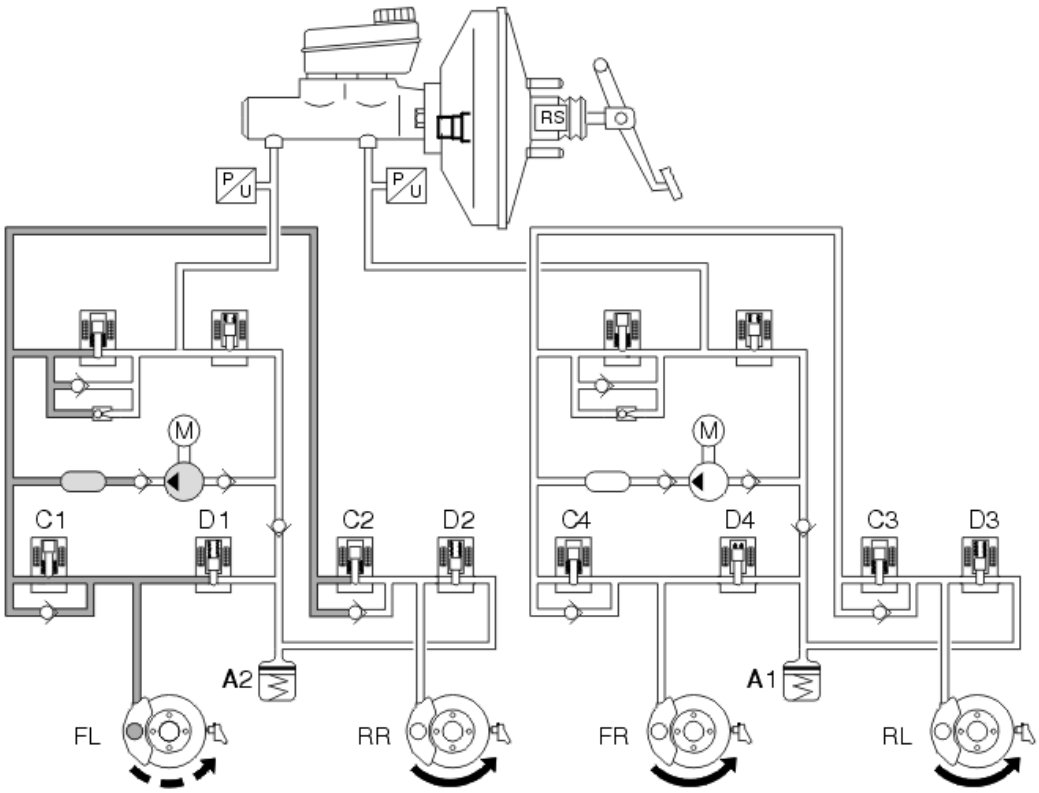


1. Inlet valve, normally open
2. Outlet valve, normally closed
3. Electronic shuttle valve, normally closed
   Separation valve, normally open

4. Separation valve, normally open
5. Brake pressure sensor
6. Pedal pressure sensor
7. By-pass valve
8. Hydraulic pump
9. Pressure absorber
10. Non-return valve
11. Pressure build-up valve.

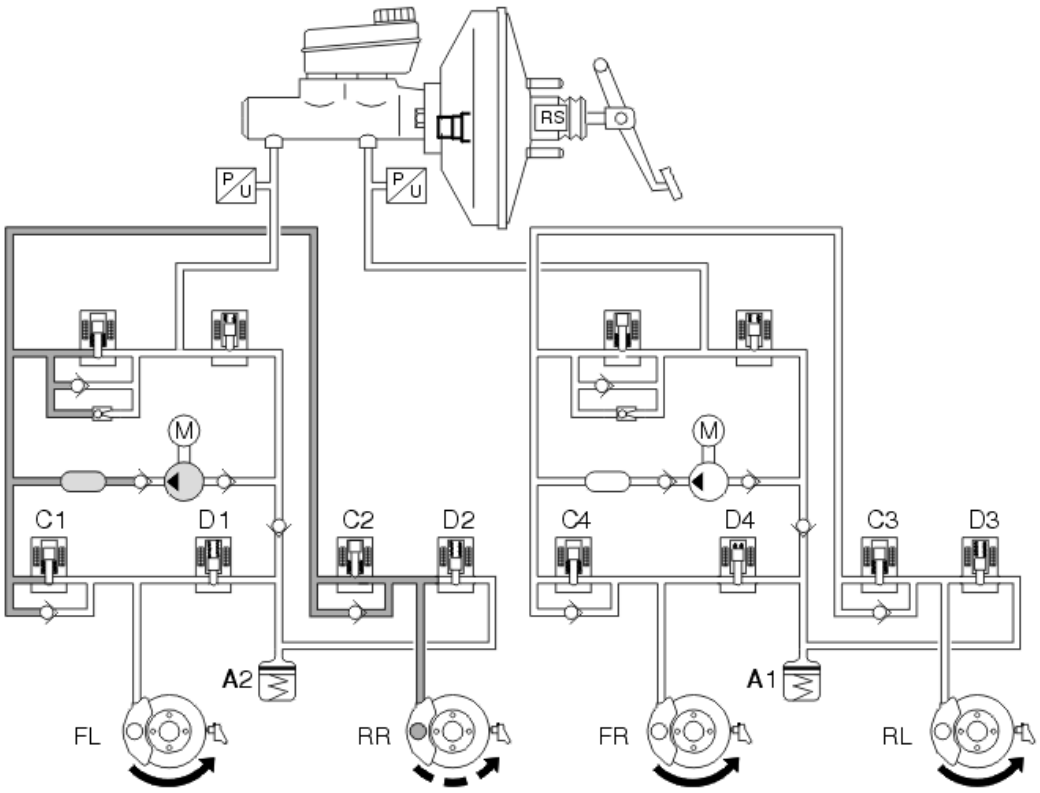
During Active Yaw Control, when the car skids, a vacuum valve opens on the servo unit. The servo unit then quickly builds up pressure without the driver activating the brake pedal. At the same time the hydraulic pump (8) starts and builds up brake pressure. The hydraulic pump takes over braking after the initial phase. The brake control module (BCM) then activates the valves in the hydraulic modulator and checks the individual wheel brake forces by raising, maintaining or lowering the pressure individually to stabilize the car. The brake pedal moves up and down during activation. If the driver presses the brake pedal during stability control, the control module, through the pedal pressure sensor (6) in the servo unit, will take account of the pressure exerted by the driver in the stability control.

Active yaw control oversteer



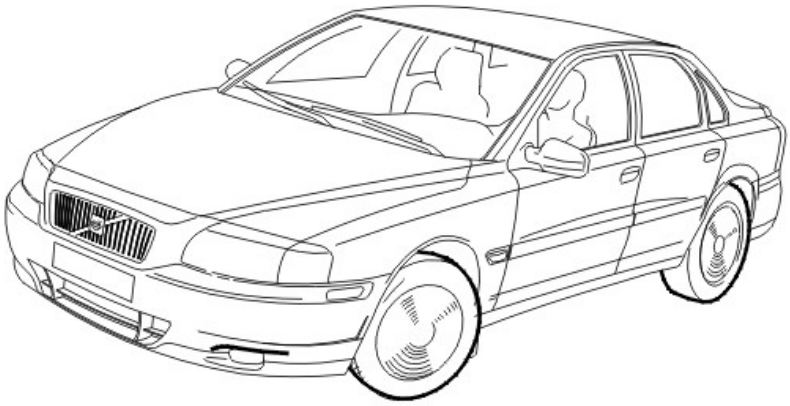
Oversteer is a very dangerous condition which is difficult for the average driver to control. Oversteer is when the car turns more than the steering wheel has been turned. If not corrected, oversteer can lead to the car spinning uncontrollably.
In the example above the car turns to the right and the car oversteers. To counter this the DSTC system has closed the separation valve, opened the electronic shuttle valve and started the pump. The inlet valve (C1) has been left open, while the other inlet valves are closed. This causes brakes the left front wheel, which causes the wheel to lose grip and reduces oversteer.

Active yaw control understeer



Understeer is when the car continues straight forward even though the steering wheel has been turned. Understeer is caused by too much acceleration. When the car understeers the brake control module (BCM) transmits a request for torque reduction to the engine control module (ECM) via the Controller area network (CAN).
In the example above, the steering wheel has been turned to the right, but the car continues straight on. The separation valve closes, the electronic shuttle valve opens and the pump starts. The DSTC system applies the brakes to the right rear wheel by leaving inlet valve C2 open and closing and closing the other inlet valves (C1, C3 and C4). In the event that braking the right rear wheel is not sufficient to get the car back on course, the brake control module (BCM) opens inlet valve C4 and brakes the right front wheel.

Dynamic stability control



When the driver brakes during Active Yaw Control, the brake control module (BCM) releases the active servo unit and increases the brake pressure for a short time as priority is given to the lateral stability of the car. Included in the calculations are the driver's desired brake pressure and functions for:

- Active yaw control
- ABS
- EBD
- Stability control.

In the event of a hand brake turn, the anti-yaw control function is activated if the speed exceeds approximately 40 km/h. At lower speeds the AYC is decreased successively, and at 20-25 km/h will not be noticeable.

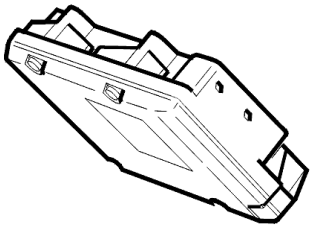
The self diagnostic function, for valves and pump motors, occurs at speeds exceeding 20 km/h after a new drive cycle. The self diagnostic function for the active servo unit takes place when the speed exceeds 11 km/h. The self diagnostics are carried out at each new drive cycle.

If the driver presses the brake pedal during stability control, the control module, through the pedal pressure sensor in the servo unit, will take account of the pressure exerted by driver

in the stability control.

Diagnostic functions

General



The control module has a built-in diagnostic system, Volvo Diagnostic, which continuously monitors internal functions as well as input and output signals.

Diagnostic trouble codes (DTCs)

If the control module detects a fault, a diagnostic trouble code (DTC) is set. Any fault detected during the last run cycle is defined as permanent. Other faults are defined as intermittent. A run cycle comprises ignition on, the car speed exceeding 10 km/h (20 km/h in XC90 with B8444S engine) and ignition off.

Reading and erasing diagnostic trouble codes (DTCs)

Stored diagnostic trouble codes (DTCs) can be read off and erased using this function.

Diagnostic trouble codes (DTCs) can only be erased once all the diagnostic trouble codes (DTCs) have been read off at least once.

Reading off input and output signals

This function can be used to continuously read off the status of the control module's input and output signals.

Activating components

This function can be used to activate components to check that they are working.

Reading off the control module identification

VIDA identifies control modules by reading off a number of codes from the control module memory.

The codes contain the following information about the control module:

- hardware P/N (control module without software)
- hardware serial number (control module without software)
- software P/N
- diagnostic software P/N (part of the software).

Calibrating DSTC (dynamic stability and traction control)

For active yaw control to operate after a repair, brake control modules (BCM) with DSTC (dynamic stability and traction control) must be calibrated. This means that the brake control module (BCM) adjusts the signals from the unique sensors in the DSTC (dynamic stability and traction control) system.
When replacing:

- The brake control module (BCM), data for the steering wheel angle sensor module (SAS), brake pressure sensor and the DSTC sensor module must be calibrated
- The brake pressure sensor, data for the brake pressure sensor must be calibrated
- DSTC sensor module, the data for the sensor module must be calibrated.

Generally calibration must be carried out after repair to a component which affects the position of the steering wheel in relation to the position of the front wheels.
Calibrating is carried out according to VIDA vehicle communication.

Software downloading

New software can be downloaded into the brake control module (BCM). When ordering software, the hardware and the software in the car is compared to the data in the Volvo central database. If the comparison is OK the software is downloaded to the control module. If the comparison between the car and Volvo central database is not OK, the database is updated with the car configuration. When this is

complete the software is downloaded.
For further information regarding downloading, see Design and Function, Downloading Software.

