VOLVO

VOLVO ALL WHEEL DRIVE

INTELLIGENT
FOUR-WHEEL DRIVE

ELECTRONICALLY CONTROLLED AWD

A new generation of all wheel drive in Volvo cars was introduced in conjunction with the launch of the Volvo S60 AWD in autumn 2001. The basic difference between this and earlier systems is that the viscous clutch has been replaced by an electronically controlled hydraulic clutch with an extremely fast response.

ADVANTAGES OF ALL WHEEL DRIVE (AWD)

Four-wheel drive is available on some current Volvo models. However, the purpose of this is not to encourage off-road driving – Volvo cars are intended to be driven on the road!
Basically, all present-day Volvo cars are front-wheel driven. This affords excellent driving stability, especially at high speeds. On loose surfaces, the weight of the engine on the drive wheels ensures an effective grip.
However, it is advantageous to drive the rear wheels also when the weight is transferred to the rear. This applies, for example, when taking off on an uphill slope and/or when towing a trailer. Under these conditions, four-wheel drive is the optimum solution.
A powerful engine is best utilised in combination with four-wheel drive. This configuration offers the best possible acceleration on all surfaces, including dry asphalt.
Volvo's four-wheel drive system – All Wheel Drive – is fully automatic. The driver no longer has to wonder which wheels have the best grip; the system 'thinks' for itself.

Automatic power distribution

The power distribution between the front and the rear wheels in Volvo's AWD models varies, depending on the driving style of the individual driver and on the external conditions.
The system adapts to the surface conditions by dividing the power in a manner which ensures optimum road grip and mobility at all times, especially on slippery surfaces. This process is completely automatic and takes place unnoticed by the driver.
The power distribution between the left and right-hand wheel on each axle is controlled steplessly with the aid of the Traction Control System (TRACS).

Hydraulic clutch

The electronically controlled hydraulic clutch between the front and rear wheels is the key component of the AWD automatic control system.
Mounted adjacent to the rear axle, as is normal in cars with front-wheel drive, the clutch senses the rotational speeds of the input and output drive shafts. If the speeds differ, for example if the front wheels begin to slip, the clutch intervenes and transfers power to the rear wheels.
Power redistribution takes place very quickly. Even before a slipping wheel has had time to rotate a quarter rev, full torque will have been transferred to the wheel (or wheels) which retain road grip.

OPTIMUM CHARACTERISTICS

The intelligent AWD system delivers optimum performance and handling characteristics. The rapid response capability and automatic power distribution offer advantages in all driving situations.

AWD IN DAILY DRIVING SITUATIONS

Takeoff and acceleration

The power is distributed proportionally between the front and rear wheels, as well as between the individual wheels of each pair, depending on the friction between tyre and road. The ratio varies steplessly between 100-0% front and 0-100% rear.
The AWD system makes optimum use of the engine power to propel the vehicle forward, resulting in the best possible traction and acceleration.

Normal driving at constant speed

When driving at constant speed, practically all of the power is supplied to the front wheels, making driving fuel-efficient.
When driving at high speeds, the low torque delivered to the rear wheels also enhances directional stability.

Cornering

The tractive power is distributed in suitable proportions between the front and rear wheels depending on the friction between tyre and road. When cornering, the power is redistributed in several stages:
- The rear wheels receive more power when entering the bend, providing rapid steering response.
- The power is distributed more equally between the front and rear when the car is well into the bend. This affords neutral steering behaviour.
- The power to the front wheels is increased as the car exits the bend, providing a degree of understeer and excellent directional stability. This effect becomes more pronounced the more the driver accelerates through the bend.

As a result, it is possible to corner fast while maintaining directional stability and safety. The system is 'factory-tuned' for each Volvo model to emphasise its particular driving character.

Taking off on loose surfaces

The power is redistributed instantaneously to the rear axle so that it transmits more or less the same torque as the front axle. This significantly improves mobility on loose surfaces and minimises the risk that the front wheels will 'dig in', for example when taking off in loose sand.

Driving on slippery surfaces

The AWD system communicates with the DSTC stabilisation system (if installed). This interaction guarantees unrestricted operation of the DSTC function.
The engine power is reduced at the slightest sign that a wheel is about to spin free, ensuring that all four wheels retain optimum grip.

Braking

The driving power to the rear wheels is reduced practically to zero when the driver releases the accelerator and applies the brakes, maximising the braking power and lateral stability.

Parking

The driving power to the rear wheels is reduced to almost zero when manoeuvring at low speed and in confined spaces, making the steering lighter and reducing the risk of stalling.

Towing

The hydraulic clutch is completely disengaged when the engine is stopped. This makes it possible to tow the vehicle with one pair of wheels raised. The ignition can be switched to position 1, enabling the lights to be turned on.

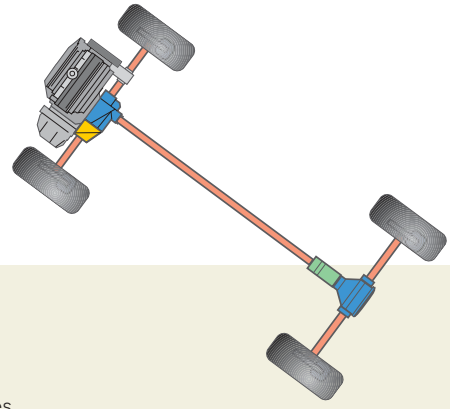
Puncture

The hydraulic clutch control unit program continuously compares the diameters of the four wheels. The program detects if one of the tyres has been replaced temporarily by a slightly different sized tyre. In this event, the system compensates and allows four-wheel drive to be retained.

TECHNOLOGY – PRINCIPLES OF FOUR-WHEEL DRIVE:

The vehicle is equipped with the following components for transmitting engine power to the four wheels:

- A **transfer gearbox** which distributes power to both the front and rear wheels
- A **differential between the front wheels**, which enables the wheels to rotate at different speeds, for example on a bend when the nearside and offside wheels travel different distances
- A **differential between the rear wheels**
- A **differential lock or differential brake**, which locks or brakes a slipping wheel so that the driving power is distributed to both wheels on the same axle. In Volvo's All Wheel Drive system, the new hydraulic clutch is used for this purpose.



Hydraulic clutch

The hydraulic clutch consists of the following main elements:
- A hydraulic pump driven by the difference in speed between the front and rear wheels axles
- A multi-plate, wet clutch which interconnects the drive axles as required
- An electronically controlled throttle valve controlling the oil pressure and, as a result, the front/rear power distribution

Principle of operation

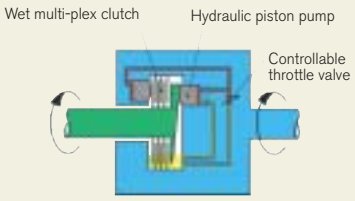
A piston is connected to one drive axle and a sliding caliper to the other. The pump is disengaged when the two axles rotate at the same speed. The pump starts to develop an oil pressure as soon as the input axle begins to rotate faster than the output axle.
This pressure acts on the pistons, pressing the clutch plates together and preventing the axles from rotating at different speeds. Driving power is transferred to the output axle in this way.
The clutch can transmit a high torque even when the speed differential is small, ensuring extremely fast redistribution of the power to the rear wheels.

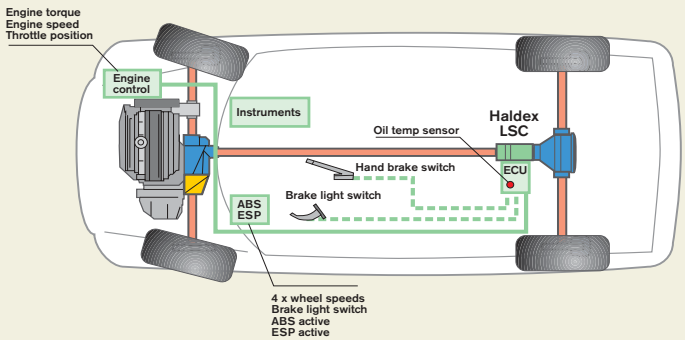
Controllable torque transfer

The oil pressure – and, consequently, the pressure on the clutch plates (which transfer driving power to the rear wheels) – is controlled by the electronically controlled throttle valve in the clutch hydraulic system. When driving on slippery surfaces, a high pressure is established to interconnect the drive axles and supply power to the rear wheels also. By contrast, the pressure is much lower when cornering, parking or driving at a steady speed.
The control range extends all the way from maximum torque transfer (1000 Nm) to complete disengagement of the output axle.

Integrated in electrical system

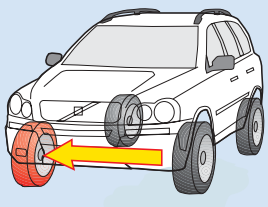
The hydraulic clutch electronics are fully integrated in the car's multiplex-based electrical system. The electronics receive and analyse signals from the engine, transmission and brakes, and also receive information describing the driver's driving style. This information is processed by the hydraulic pump processor and is used to match the power distribution to the prevailing situation. This takes place automatically, unnoticed by the driver.





TRACS

The power distribution between the left and right front wheels – and between the left and right rear wheels – is controlled with the aid of the Traction Control System (TRACS).
The braking system sensors record the rotational speed of the wheels. If one wheel begins to slip – and, as a result, begins to rotate faster than the other wheel on the same axle – the brakes are applied to the slipping wheel and the driving power is distributed to the wheel with the best grip. The optimum driving power distribution for the prevailing situation is established in this manner.



VOLVO

Volvo Car Corporation

MS/PV 523-32418-02. English. Printed on non-chlorine bleached paper by Eskils Tryckeri AB, Borås 2002.