OUTBACK H6

TECHNICAL DESCRIPTION

SUBARU
ALL-WHEEL DRIVE

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ALL-WHEEL DRIVE

SUBARU (AUST) PTY LIMITED

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Note: This Technical Description book is intended for use in conjunction with the 66L Technical Description book that contains other data, which is still relevant to the H6 vehicle. This book only contains the changes and new innovations introduced on the H6.

INTRODUCTION

The introduction of the H6 3.0 litre engine to the Outback range was a necessary and logical evolution to further enhance the vehicles recreational capabilities, particularly for towing, hill climbing and long distance touring. The problem that faced the engineers was the installation of a larger capacity naturally aspirated engine into the same floor pan without upsetting the vehicles handling characteristics.

Retention of the Subaru philosophy of a symmetrical drive train layout with low centre of gravity meant that the new engine had to be a horizontally opposed boxer. However just adding two more cylinders to the front of the existing design created an unacceptable amount of front overhang that produced adverse amounts of understeer and destroyed the vehicle's balance and poise.

The challenge was to produce a boxer engine of approximately the same weight and dimensions of the H4 engine so that the vehicle handling dynamics were retained.

Key achievements were; -

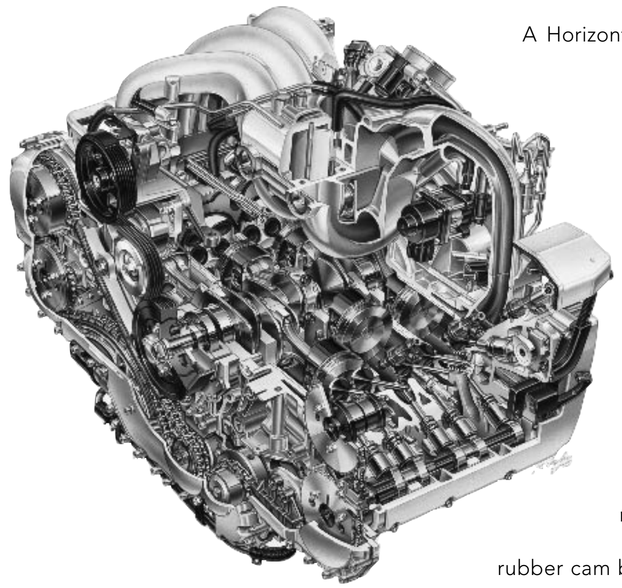
- Creation of a six cylinder 3.0 litre engine (H6) only 20mm longer than the four-cylinder (H4).
- H6 engine only 40 Kg heavier than the H4
- Life of engine, maintenance free camshaft timing chains replacing rubber cam belt drive.
- Variable induction control system for improved volumetric efficiency for improved fuel consumption and power output.
- Exhaust emission exceeds the worlds most stringent European step three emission and Californian standards by a substantial margin.
- Low level of noise vibration and harshness NVH

Other technical innovations introduce on this model are: -

- VDC (Vehicle Dynamics Control) system which combines the active safety components of ABS, traction control and VTD All Wheel Drive automatic transmission in to one total control active safety package.
- More powerful 16 inch front ventilated disc brakes.
- Higher level of side impact protection through strengthening of the 'B' pillar and door beams.

ENGINE

Construction

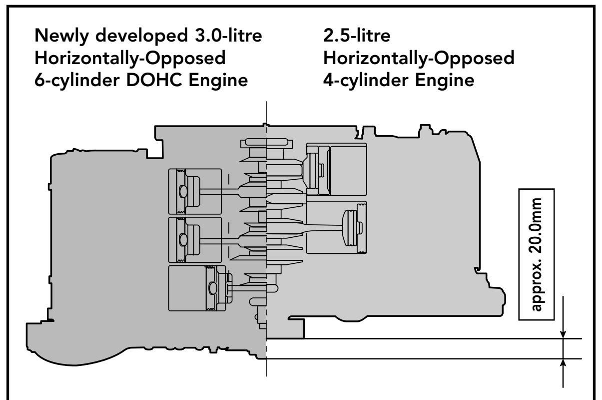


A Horizontally opposed boxer design was used for the new six-cylinder engine all the reasons that had proved it to be so successful in the four-cylinder. Low centre of gravity, symmetrical layout, short length, good natural balance and simple low cost application of the All Wheel Drive system.

The challenge that faced the engineers was to build an engine which was even shorter than the previous six cylinder engine used in the SVX so that it could be installed in the same Outback floor plan without creating excessive overhang and upsetting the vehicle's excellent handling dynamics.

Reductions in the length of the engine where achieved through two major advances, reduction of the bore size and pitch and the replacement of rubber cam belt drive with timing chains.

The bore pitch reduced from 113mm on the four cylinder engine (H4) to 98.4mm, has been made possible by reduction in bore size down from 99.5mm to 89.2mm and by casting the cast iron cylinders into a one piece unit for each bank. Each cylinder now has a cubic capacity of 500cc with a stroke of 80mm compared to 614cc and stroke of 79mm for the H4.



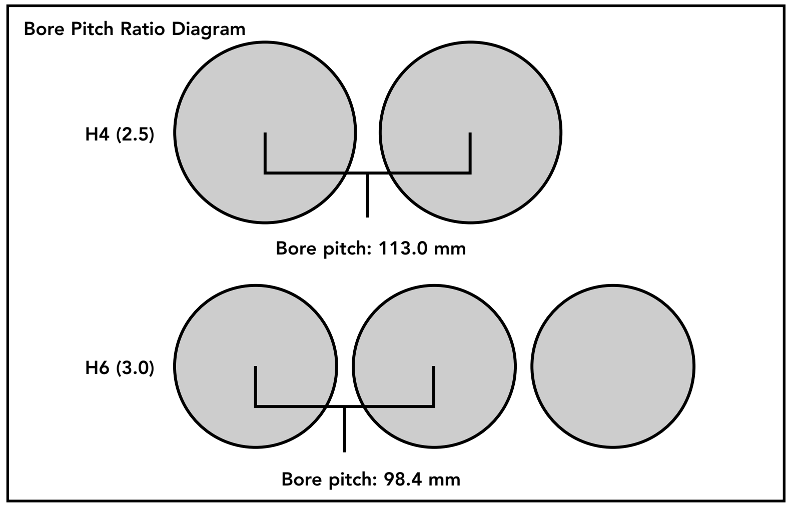
Engine Length Comparison

As with the four-cylinder engine the six-cylinder boxer configuration has the advantage of pistons which move in the horizontal plane from left to right with even lower levels of noise vibration and power loss. This is due in part to the cancellation of the inertia forces created by the downward force of the pistons, which act in opposite directions. With an in-line engine all pistons are moving in the same direction and therefore a larger and heavier crankshaft is required to counteract this inherent imbalance.

The H6 engine also has an additional advantage that contributes to the smoothness and overall balance of the engine and that is sequential firing of the cylinders on opposite banks. In the layout of the 4-cylinder engine the firing order requires ignition for cylinder 1 to be followed by ignition for cylinder 3 both located on the right-bank, and then for ignition of cylinder 2 on the left bank followed by cylinder 4 again both located on the same bank (left-bank). The layout of the 6-cylinder engine however allows for an ignition firing order where opposing cylinders are fired sequentially.

ENGINE

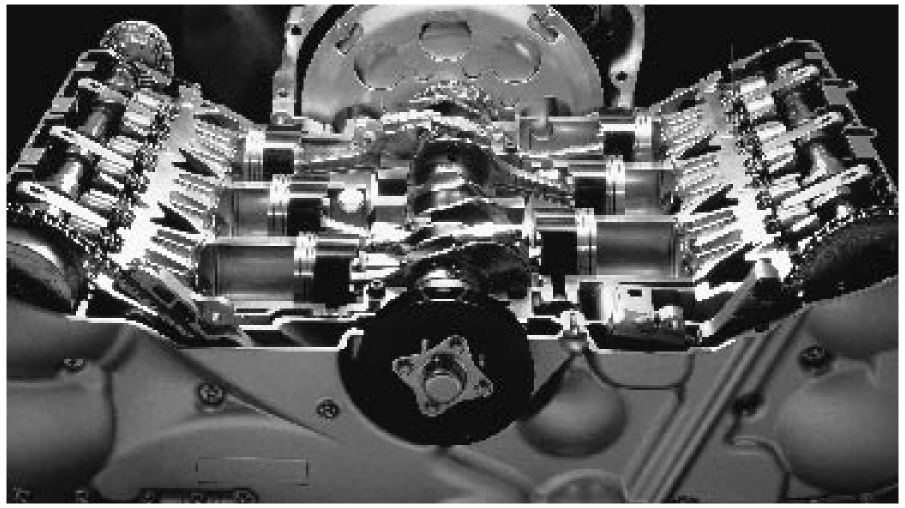
Construction (cont.)



The result of sequential firing is a complete cancellation of the inertia created by the firing of the cylinder moving in opposite directions on opposite banks. This means an even smoother, quieter and more responsive performance than the H4.

As with the H4 the horizontal crankcase design provides for a high degree of strength and rigidity because the crankshaft, which is supported by seven main bearings, is sandwiched between the left and right crankcases. This provides for long life with little wear and tear.

The crankshaft is made from forged high carbon steel with the rear bearing also performing the function of the thrust bearing. This provides for a reduction in the transfer of natural engine frequencies to the transmission and driveline thereby improving N.V.H. levels in the passenger compartment.



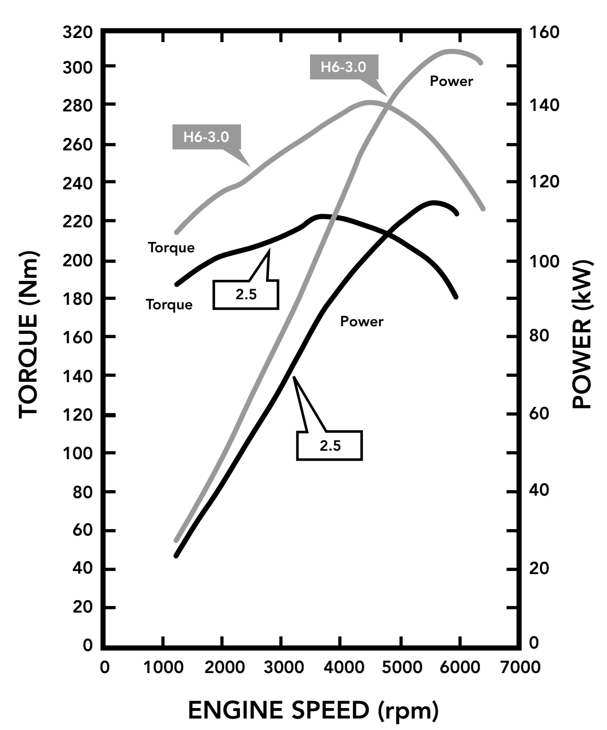
ENGINE

Performance

Peak power and torque outputs occur at relatively high engine speeds of 6000rpm and 4400rpm respectively compared to the 2.5 litre engine. As can be seen however from the power curves the 3.0 litre engine out performs the 2.5 by a big margin across the entire operating range. This torque characteristic provides a smooth and progressive increase in the pulling power all the way up to the mid-to-high rev range.

H6 MAX PERFORMANCE

DESCRIPTION	SPECIFICATION
Maximum Power	154Kw @ 6.00rpm
Maximum Torque	282 Nm @ 4400rpm
Power to weight ratio	10.3 Kg/Kw
Power per litre	51.4 Kw/Litre
0-400 metres	16.4 sec
0-100 Km/hr	8.9 sec
Fuel consumption litres/Km	
City	11.0
Highway	8.2
Combined	9.74
Towing capacity trailer with brakes and load distribution hitch and transmission cooler kit	1600 kg



Engine Length Comparison Chart

ENGINE

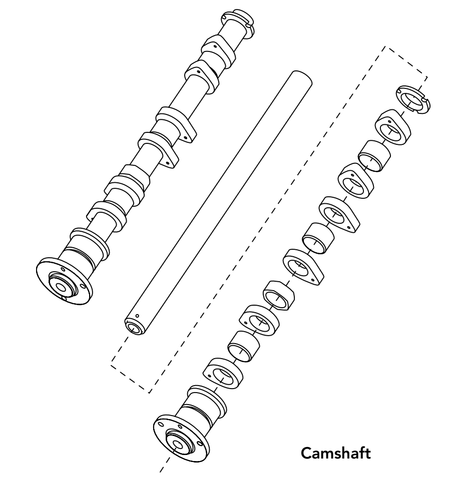
Cylinder Heads and Camshafts

The cylinder heads are similar in design to the H4 engine in that the tumble intake port is used. The "Tumble" intake port has been optimised to create a 'Tumble Swirl' air motion as the air and fuel enters the cylinder. This action ensures uniform mixing of the air with the fuel and for uniform flame travel resulting in increased speed of combustion.

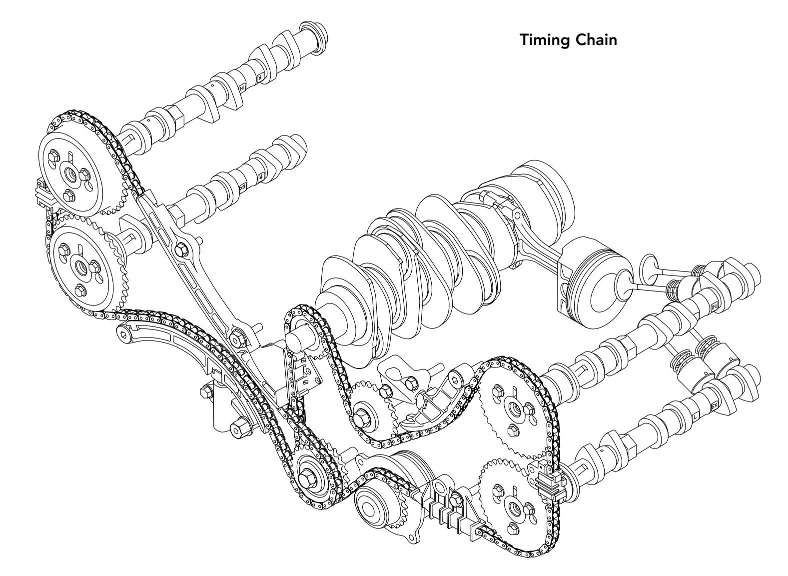
This allows for the maximum gas pressure (downward force) to be applied to the piston 10-15 deg. ATDC when the maximum turning moment on the crankshaft occurs resulting in a greater power output.

The cylinder heads also continue to feature four valves per cylinder arranged in a cross flow format for good engine breathing. This means that as a result of more air being inducted, more fuel can be injected and when combined with the 'Tumble Swirl' action a higher specific power output is obtained with improved fuel economy. Pent roof combustion chambers with a large squish area also help to ensure efficient combustion for good power output and low specific fuel consumption.

The DOHC camshafts are fabricated units made up of sintered cam lobes fused onto carbon steel pipes. This makes it possible to reduce the weight and to obtain high lift wear resistant cam lobes. Each camshaft is supported by five journals with the thrust force being supported by the front journal.



Camshaft



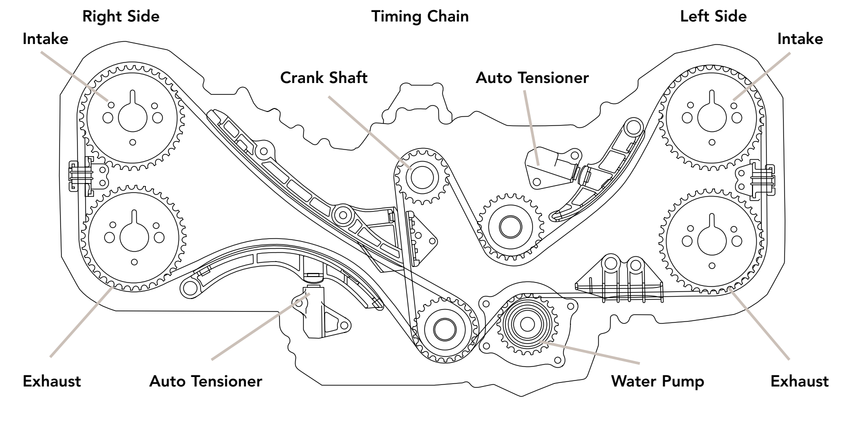
Timing Chain

ENGINE

Camshaft Drive Structure and Timing Chains

In addition to the reduction in bore size and bore pitch the camshaft drive structure was the most significant area in of reduction in engine length.

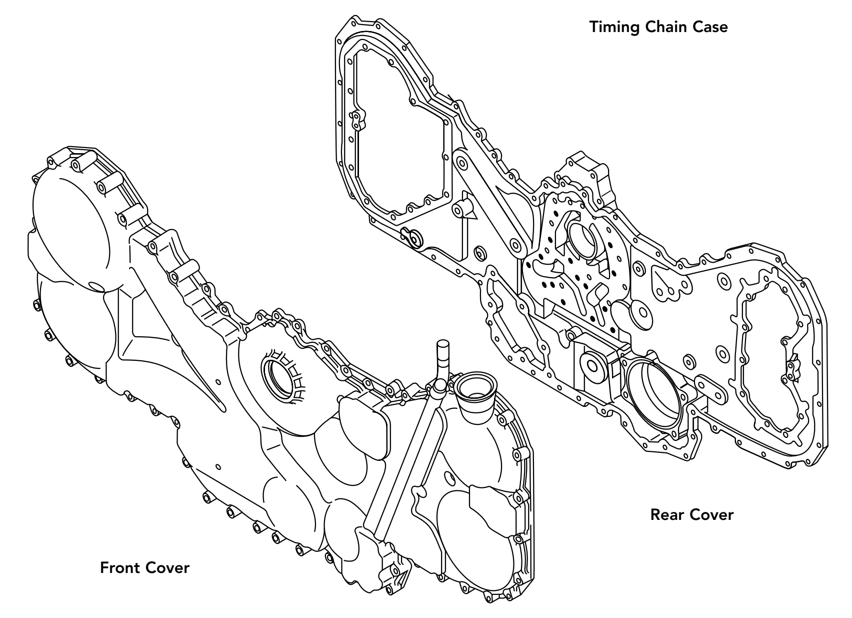
Two high quality single link chains that are designed to last for the life of the engine drive the twin camshafts per cylinder head (DOHC). The left side camshafts are driven directly by the crankshaft, while the right side is driven via a double tooth idler pulley located underneath the crankshaft pulley. This arrangement utilises the bank offset, (right-bank slightly more forward than the left-bank) to accommodate the space necessary for the chain drive without increasing the engine length.



Two automatic maintenance free mechanical engine oil pressure tensioner's maintain a constant chain tension and a spring loaded serrated plunger maintains the correct chain pressure even when the engine is not running.

The timing chain case is aluminium diecast with a front and rear cover that sandwiches the chain, gears and tensioners. These covers have been specially designed using Finite Element and Acoustic analysis to reduce chain noise

Direct acting cam followers operate the valves and adjustment, which is required to be checked every 150,000Km is via, shims.

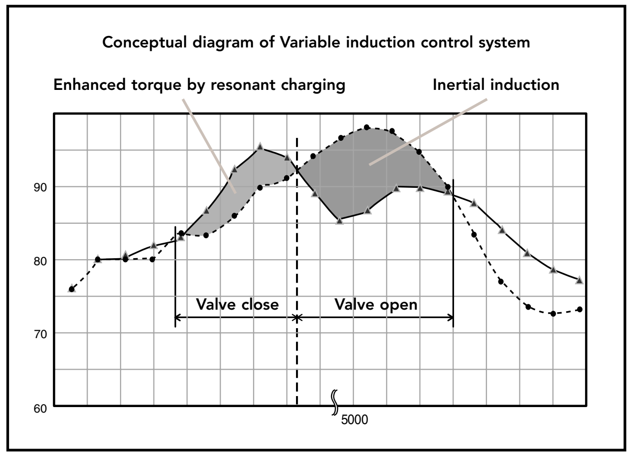


Timing Chain Case

ENGINE

Intake System

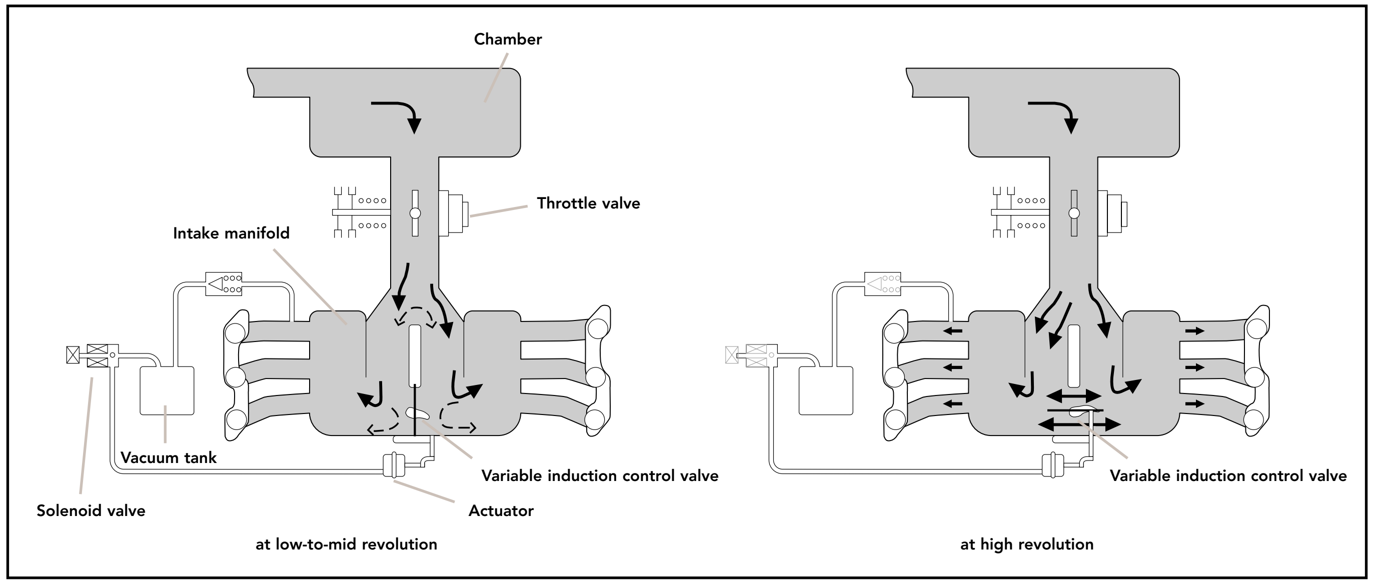
The intake manifold features a Variable Induction Control System which, has a variable air intake path, to take advantage of air inertia and resonant frequency, to maximise the amount of intake air charge in the cylinders.



The effective length of the intake manifold is varied according to engine speed. At low speeds the "Variable Intake Valve is closed effectively dividing the intake manifold into two separate pathways. Under this condition the resonate frequency of the air motion caused by the opening and closing of the inlet valves causes the rebounded air to bounce off of the centre wall of the manifold and to be charged into the intake valve which is open on the alternate firing cylinder.

At high speeds, approximately above 4200rpm the variable induction control valve is opened by the ECU via a solenoid and actuator. This increases the air intake length and as a consequence takes advantage of the inertia of the higher air speed created by the increased air path.

The effect is to improve volumetric efficiency and as a result improve engine power output due to the increased amount of fuel and air charge being burnt in the cylinders.



ENGINE

Engine Management and Exhaust Emission System.

The H6 engine complies with most stringent of the world low emission standards. This is achieved by an efficient combustion process and then with a secondary cleansing of the exhaust emission with a total of three catalytic converters.

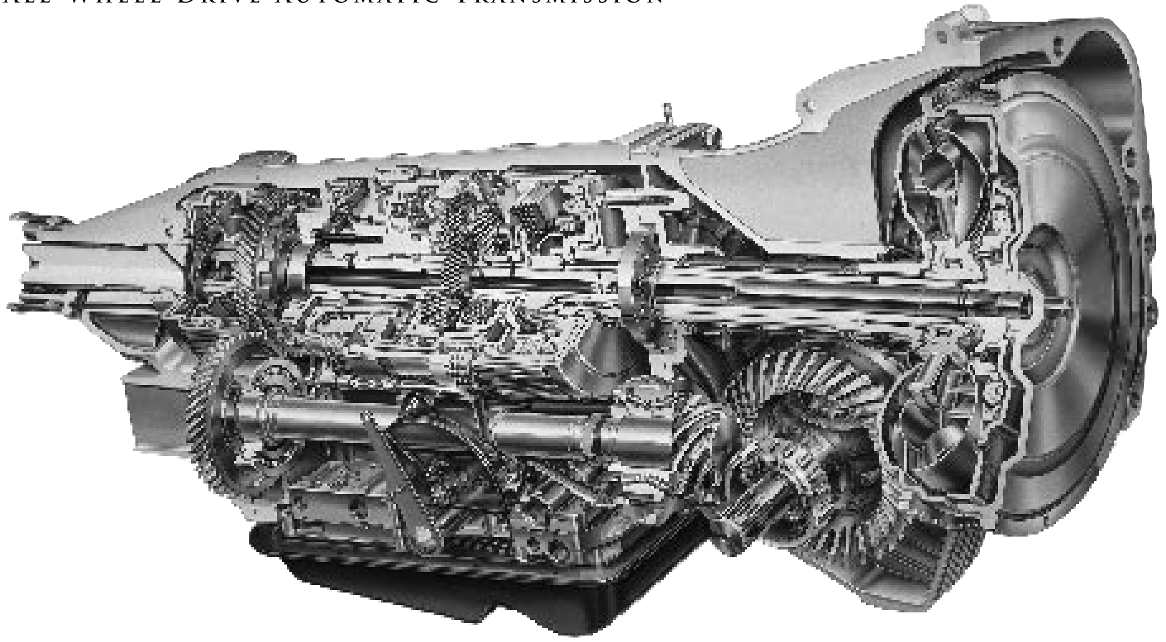
In addition to the standard fuzzy logic feedback control system used on the H4 engine, the H6 engine also features the latest in "On Board Diagnosis" (OBD) which has been developed to comply with the stringent European step 3 emission standard. This system know as EOBD is a development of the USA OBD2 system and features real time monitoring of the engine operating efficiency by measuring the engine and ECU output results. If the system detects any malfunction such as a partial misfire or an out of specification air fuel ratio, a light is illuminated on dash alerting the driver that workshop attention is required. The system then provides the diagnostic Technician with assistance in locating the fault.

Each cylinder has its own ignition coil positioned in the cylinder heads directly above the platinum tipped spark plug. This means no moving parts or high-tension leads to wear and the spark plugs only require replacement every 100,000Km. Engine maintenance up to 100,000Km only requires oil and filter changes every 12500Km. This is due to a 'life of engine' camshaft chain drive system, long life spark plugs and long life serpentine accessory drive belt.

This means that the engine always runs at its optimum condition and should a fault occur the driver is alerted before continued inefficient engine operation adversely effects its economic and environmental operation

TRANSMISSION

VTD All-Wheel Drive Automatic Transmission



The H6 is exclusively equipped with the VTD (Variable Torque Distribution) electronically controlled four speed automatic transmission. The automatic transmission drive-train and electronic control mechanism is the same as that used in the H4 but the All Wheel Drive system provides for a different torque split between front and rear wheels. Improvements in the electronic 'smart' shift control software have also been made to further enhance the shift quality.

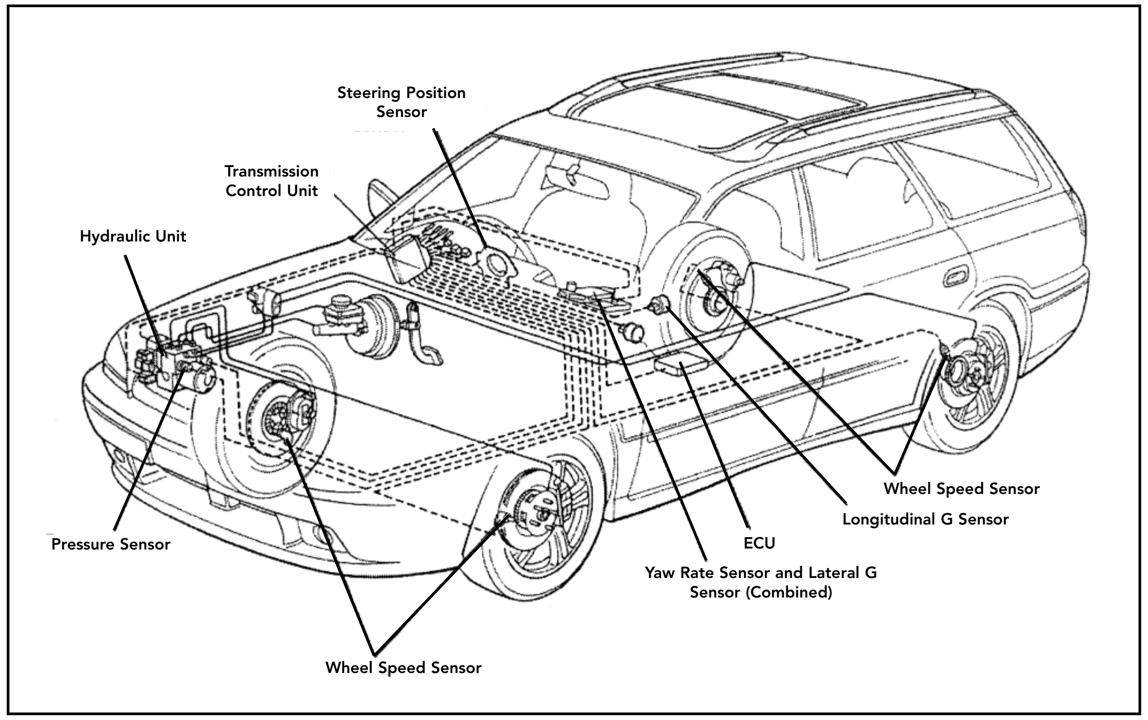
The VTD system uses a compound planetary gear train as a centre differential to split the torque at a ratio of 45% to the front axle and 55% to the rear with a static load distribution. Load distribution however does not remain static when the vehicle is in motion and therefore a limited slip multi-plate clutch is used to vary the drive distribution to match the load movement during acceleration and braking. This system is controlled by the transmission computer, based on input from, front and rear speed sensors, throttle opening, and engine speed. Therefore depending on the driving conditions including front or rear wheel slip the computer determines the best torque distribution to match the conditions.

VTD is also used to enhance the operation of the VDC (Vehicle Dynamics Control) system by allowing more torque to be applied to the rear wheels when road conditions demand it.

ACTIVE SAFETY

Vehicle Dynamics Control (VDC)

The Subaru Vehicle Dynamics Control system (VDC) electronically controls vehicle stability by regulating brake pressure at individual wheels, reducing engine power, or altering the torque (driving force) between the front and rear wheels.



This system detects dynamic forces that are trying to de-stabilise the vehicle and acts to correct them automatically. This is achieved by inputs from a yaw sensor, steering wheel angle sensor, individual wheel speed sensors and a 'G" sensor. The VDC's Electronic Control Module (VDC CM) then calculates the desired vehicle direction, and if necessary controls the various outputs required to regain vehicle stability.

The VDC system raises the threshold of vehicle stability above the already high level achieved by All Wheel Drive. The combination of both systems provides a degree of active safety that is arguably unmatched by any other vehicle manufacturer.

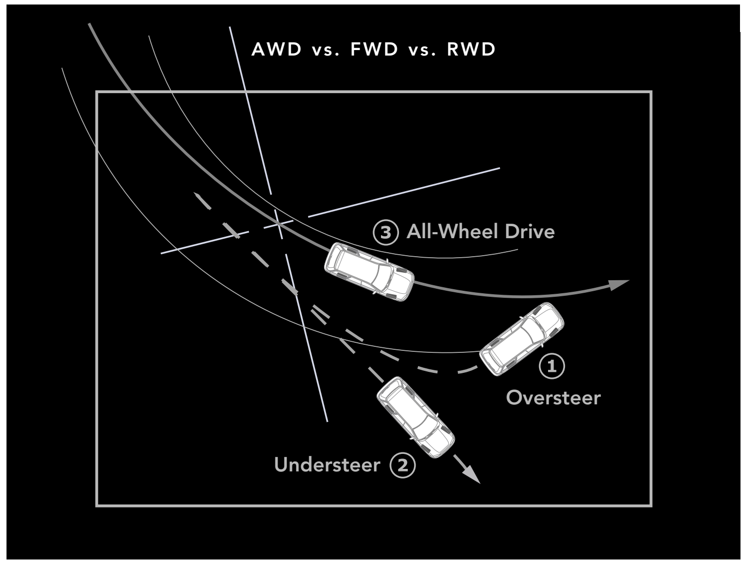
ACTIVE SAFETY

Vehicle Stability.

During cornering, centrifugal forces act upon the vehicle. These forces try to overcome the grip of the tyres, which leads to the vehicle sliding outwards. If the front wheels lose grip, and the front of the vehicle slides outwards, this is referred to as understeer.

If the rear wheels lose grip, and the rear of the vehicle slides outwards, this is referred to as oversteer.

If too much power is applied through the wheels, traction is lost and this is referred to as wheelspin. If the brakes are applied and traction is lost, this is referred to as wheel lock.



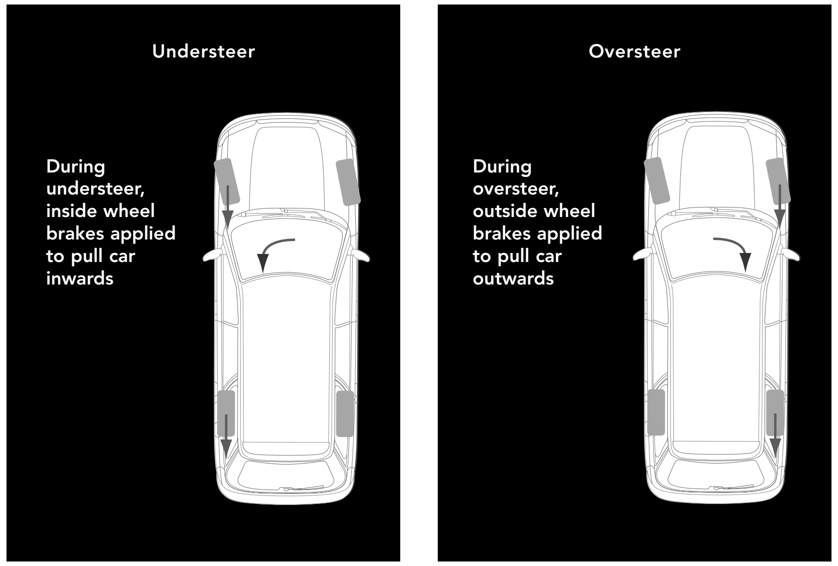
The Effects of Brakes.

Brakes are use to slow or stop a moving vehicle. The brake master cylinder converts the force applied by the driver to the brake pedal to fluid or hydraulic pressure. This pressure is then applied to a brake at each wheel causing the wheels, and therefore the vehicle, to slow or stop.

Because each wheel is braked, the vehicle will slow or stop in a straight line, assuming that the brake system is working correctly. If the brakes on only one side of the vehicle are applied, then it follows that the vehicle will pull or turn towards the side of the operating brakes.

ACTIVE SAFETY

VDC Operation during Cornering



If vehicle stability is lost during cornering, and oversteer or understeer occur, the VDC system uses brake control to stabilise the vehicle. This is achieved by individually applying brake pressure even if the brake pedal is not applied by the driver.

If understeer is detected, (front wheels sliding) then the inside brakes are applied to pull the front of the vehicle inwards.

If oversteer is detected, (rear wheels sliding) then the outer brakes are applied to pull the front of the vehicle outwards.

The Effects of Engine Power

Motive power from the engine is used to propel the vehicle forward. The force from the engine that tries to drive the wheels is referred to as Torque. (Normally stated as Newton Meters or Nm) The work performed to propel the vehicle is referred to as Power. (Normally stated as Kilowatts or kW)

The power through the wheels can sometimes exceed the amount of grip between the tyre and the road. When this occurs, the wheels spin and grip is lost. This loss of grip means the tyre does not stick to the road surface in either forward or sideways directions. Meaning that both forward momentum and cornering power is lost

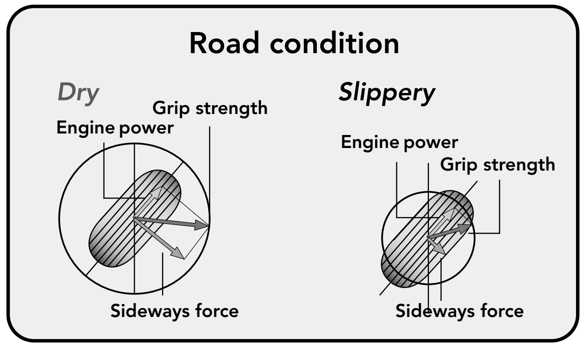
OUTBACK H6

ACTIVE SAFETY

VDC Operation during Wheelspin

If wheel spin and therefore loss of traction is detected, a signal to the engines Electronic Control Module (ECM) instructs it to reduce engine power. This is achieved by reducing the amount of fuel being supplied to the engine by the injectors. The result is a reduction in engine torque leading to a reduction in wheel spin.

The Effects of All Wheel Drive



Subaru's All Wheel Drive system (AWD) sends engine power to the front and rear wheels. By distributing power to all four wheels, there is less likelihood of wheel-spin occurring. This increases tyre grip and therefore vehicle stability.

The H6 VTD All-Wheel Drive system automatically distributes 55% of the driving force to the rear wheels, and 45% to the front. The distribution of vehicle weight however also affects the grip between the tyres and the road surface, as well as the mechanical distribution of torque. To accommodate this shifting of the weight distribution during driving an electronically controlled limited slip clutch is used vary this ratio according to the driving conditions.

If wheel spin occurs, or if loss of vehicle stability is detected, a signal is sent to the Transmission Control Module (TCM) to instruct it to regulate the power distribution between the front and rear wheels. This is achieved by controlling the operation of the limited slip clutch in the VTD mechanism. In this way the VDC system controls the power applied to the front and rear wheels to automatically correct any excessive under or oversteer which occurs

Main Components of the VDC System

- VDC Control Module – measures signals from various components to determine vehicle stability, then sends signals to components such as: hydraulic unit, transmission control module, engine control module etc.
- Wheel Speed Sensors – located at each wheel, these sensors provide a signal to the control module relative to the speed of each wheel.
- Steering Position Sensor – measures the actual position of the steering wheel so that the control module can determine the desired vehicle direction.
- Yaw Sensor – measures how much the vehicle is rotating around it's centre of gravity.
- G Sensor – measures how much the vehicle is accelerating or decelerating.
- Pressure Sensor – measures the pressure in the hydraulic pipes connected to the brakes.
- Hydraulic Unit – controlled by electrical signals from the control module, this unit generates and regulates pressure applied to the brakes when VDC is operating.

OUTBACK H6 SPECIFICATIONS

			OUTBACK H6
BODY	Overall Lenght	mm	4720
	Overall Width	mm	1745
	Overall Height @ UM with roof bars	mm	1580
	Wheelbase		2650
	Front Track	mm	1470
	Rear Track	mm	1465
	Min Road clearance @ UM	mm	200
	Approach Angle	deg.	19.3
	Departure Angle	deg.	19
	Breakover angle	deg.	19
	Unladen mass (UM) Automatic	Kgs	1590
	Gross Vehicle mass Auto	Kgs	2030
	Payload Kgs (inc passengers)	Kgs	440
ENGINE	Type		Horizontal 6 Cylinder DOHC
	Capacity	cc	2999
	Bore x Stroke	mm	89.2x 80
	Comp. Ratio		10.7 : 1
	Max output	Kw/rpm	154/6000
	Max Torque	Nm/rpm	282/4400
	Power to weight ratio Auto	kg/Kw	10.3
	Power/litre	Kw/Litre	51.4
	Fuel system		Multipoint sequential injection
	Fuel requirement RON (research octane number)	RON	95 minimum
	Alternator		12 volt 90 amp
	Battery auto		12 volt 52 Amp hr
TRANSMISSION	Type		4-speed elec. Auto full time All-Wheel Drive
	Gear ratio	1st	2.785
	Gear ratio	2nd	1.545
	Gear ratio	3rd	1.000
	Gear ratio	4th	0.694
	Gear ratio	Rev	2.272
	Final Drive axle ratio		4.111
STEERING	Type		Power assisted engine speed senitive rack & pinion
	Turning circle curb to curb	m	11.20
	Tyre size		215/60R16 95H
	Manufacturer		Yokohama
	Model		Geolander G040
	Rim size		16 x 6.5JJ
	Rim offset	mm	48
SUSPENSION	Front		Independent Mcpherson strut coil springs, gas charged linear control dampers
	Suspension travel, Bump/rebound	mm	100/89
	Stabiliser bar diameter	mm	21
	Rear		Independent multi link,coil springs over linear control gas dampers
	Suspension travel, Bump/rebound	mm	130/65
	Stabiliser bar diameter	mm	14

OUTBACK H6 SPECIFICATIONS

			OUTBACK H6
BRAKES	System		Diagonally linked dual circuit with proportioning valve
	Front ventilated disc outer diameter	mm	290
	Front brake caliper (pot size)		Twin Piston floating (2 X 42.8 mm)
	Rear disc outer diameter	mm	286
	Rear brake caliper (pot size)		Single Piston floating (1 x 38.1 mm)
	Brake Booster Type	(size mm)	Vacuum suspended tandem type 205 + 230 mm
CAPACITIES	Fuel tank	litres	64
	Fuel range Km @ AS2877 combined cycle	Km	673
	Engine Oil	Litres	6
	Engine Coolant	Litres	7.8
TOWING	Unbraked trailer	Kgs	500
	Braked trailer	Kgs	1600
	Maximum roof load	Kgs	80
FUEL CONSUMPTION	AS2877 Litre/100 Km		
		City	11.0
		Highway	8.2
		Combined	9.74
PERFORMANCE	Max. Speed Km/hr auto	Km	210 (with speed limiter)
	0-100 Km/hr	secs	8.9
	0 - 400 m	secs	16.4
CARGO	CARGO VOLUME (measured by VDA)		
	With back seat up (To lower end of rear quarter w)	Litres	528
	With back seat folded down (V14)	Litres	1644
INTERIOR	INTERIOR SIZE (measured by SAE/FHI)		
	Front shoulder room SAE W3	mm	1368
	Rear shoulder room SAE W4	mm	1362
	Effective leg room (front) SAE L34	mm	1101
	Effective head room (front) SAE H61	mm	977 (with sun roof)
	Effective head room (rear) SAE H63	mm	942 (with sun roof, centre position)
	Effective head room (rear) SAE H63	mm	945 (with sun roof, side position)
	Rear opening lower width FHI No. 3	mm	1100
	Cargo space height SAE H505 FHI No. 4	mm	844
	Cargo floor width (at floor) FHI No. 2	mm	1370
	Cargo floor width (wheel house) SAE W201 FHI No. 1	mm	1074
	Cargo floor length (back seat up) SAE L203 FHI No. 6	mm	1105
	Cargo floor length (back seat down) SAE L202 FHI No. 5	mm	1630

*Ground clearance at unladen mass. **Gear ratio figures listed are international specification, these figures may vary for Australian models. Subaru Australia reserves the right to change mechanical specification and equipment levels with out prior notice.