

## Subaru All-Wheel Drive



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## History of Subaru All-Wheel Drive System



## History of Subaru All-Wheel Drive System

Subaru launched its first mass-produced All-Wheel Drive car, the 1.4- litre Leone wagon, in 1972. Subaru's application of All-Wheel Drive to a passenger vehicle was regarded as revolutionary. This soon found popularity as appreciation of its superior handling on normal roads increased. It soon found an audience beyond those wanting to drive on snow-covered, muddy or mountainous roads.

A key progression for Subaru was its Multi-Plate Transfer (MPT). Derived from front-wheel drive, this used hydraulic pressure from the automatic transmission to enable simple one-touch switching between two-wheel drive and All-Wheel Drive – even while the vehicle was moving.



A key feature of MPT is a multi-plate clutch, which controls the rotational differences between front and rear wheels but also allows some slip to occur thereby reducing the tendency of traditional four-wheel drives to “wind up”.

At that time, the selectable AWD in Subaru manual transmission vehicles could also be engaged without stopping. Thus they had a distinct advantage over other 4WDs, as it was possible to transfer the drive to all four wheels without loss of momentum.

All-Wheel Drive was then gradually introduced across the range, including Subaru's first constant AWD vehicle in 1987 – the Vortex XT performance sports coupe.

Subaru then went on to further develop its constant or full time All-Wheel Drive system with the use of a viscous limited slip differential manual transmission and computer controlled Active Torque Split automatic transmission – further distinguishing it from the other brands and ordinary four-wheel drives.

Rally proven  
Subaru All-Wheel Drive System





## Rally proven Subaru All-Wheel Drive System

Subaru passionately believes in building vehicles that perform to the highest standards. Our relentless pursuit of superior engineering solutions and driving technologies is designed to make the Subaru driving experience safe, satisfying and exhilarating. Most notably, our pioneering development of a symmetrical All-Wheel Drive system has placed Subaru vehicles at the forefront of both all-road performance and dependability. For over a decade, Subaru has treated world championship rallying as a mobile laboratory and test environment, providing Subaru with a proving ground for enhancements to reliability, handling and performance. These lessons are then applied to Subaru's full range of production cars.

Subaru's international rally record is proof of the All-Wheel Drive system's effectiveness. The same technology has driven us to ten consecutive Australian Rally Driver's Championship titles, plus eight Australian Rally Manufacturers' titles in Australia's most testing road conditions.



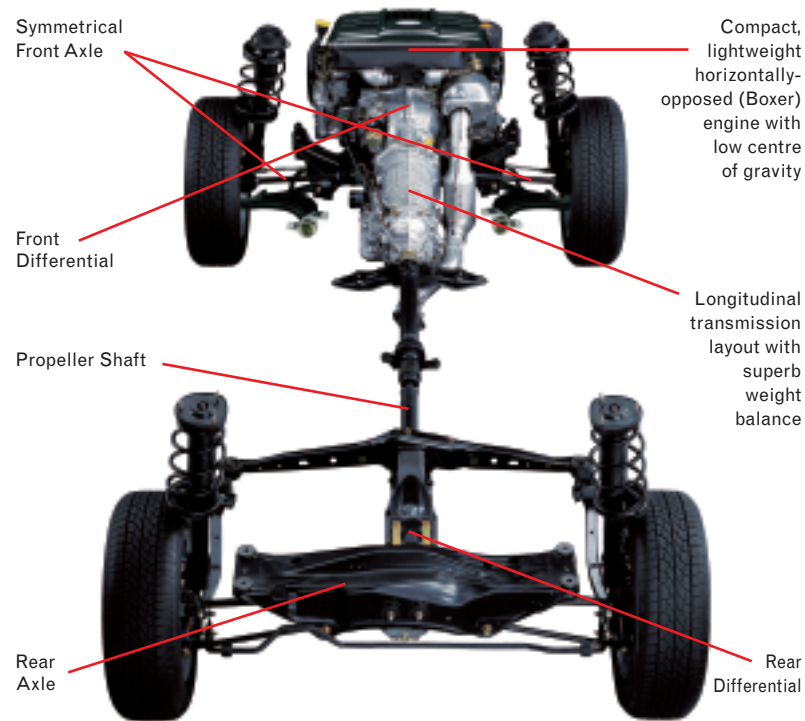
**The Subaru All-Wheel Drive System  
The Subaru Advantage**



## 1. Symmetrical Drivetrain

The Subaru All-Wheel Drive system is based on the principle of symmetry. Symmetry is *“the correspondence in size, shape and arrangement of parts on opposite sides of a plane, line or point.”*

If you viewed a Subaru drivetrain from directly above or below, you would see it has equally proportioned parts on either side. Symmetrical drivetrain means that the engine, transmission, propeller shaft and rear differential are all simply arranged in a perfectly, symmetrical straight line. This is a major design element that translates into balance, control and superb performance handling in all Subaru cars.



## 2. Boxer Engine

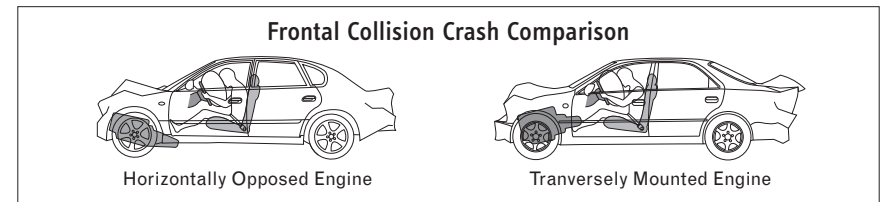


Subaru has been using Horizontally Opposed “Boxer” engines in production motor vehicles since 1966. “Boxer” describes the fact that the cylinders are separated into two horizontal banks, 180 degrees apart – with the pistons resembling the action of a punching boxer.

Traditional in-line and “V” configuration engines all suffer from the inherent disadvantage of vibration, which means extensive countermeasures that often ‘steal’ precious engine power that could have otherwise aided performance.

The “Boxer” layout offers clear advantages in weight and size. Its length and height are considerably less than a conventional in-line engine. The centre of gravity is low and closer to the centre of the car, meaning better, more stable cornering. This also has the added safety advantage of forcing the engine below the cabin, rather than into it, in the event of a frontal collision. Subaru Boxer engines are also manufactured from lightweight aluminium alloy. This contributes to fuel efficiency and improved handling. The engine has optimum balance as a result of its layout – particularly important for sports and performance driving.

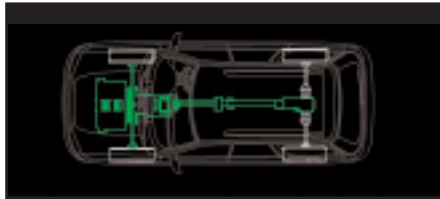
The horizontally opposed pistons also cancel each other's vibrations, meaning overall low vibration, smooth operation even at high revs and outstanding engine response, without the need for extra “balance shafts” commonly used in conventional engines.



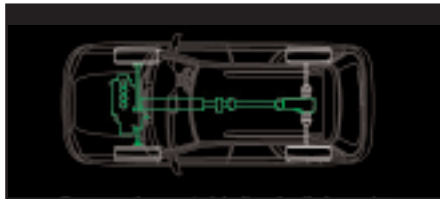


## 2. Boxer Engine (cont.)

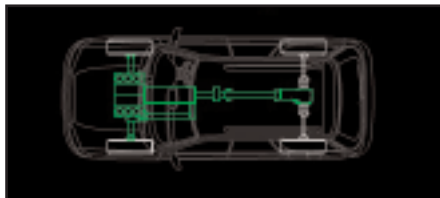
### Boxer and All-Wheel Drive Advantages Comparison



Horizontally-opposed Boxer engine with symmetrical All-Wheel Drive system



Transversely-mounted, in-line, 4-cylinder engine with 4WD system



Longitudinally-mounted, V6 engine with 4WD system



Longitudinally-mounted, in-line, 6-cylinder engine with 4WD system

## 3. Transmission

Subaru's powertrains are mounted longitudinally – meaning the engine, transmission, propeller shaft and rear differential are all simply arranged in a perfectly, symmetrical straight line.

Combined with the low centre of gravity, this close to ideal front/back and lateral weight distribution directly contributes to the driving stability and precise handling of Subaru.

The compact design leaves room for the transmission – which includes the All-Wheel Drive transfer mechanism – to be mounted inside the wheelbase (between front and rear wheels).

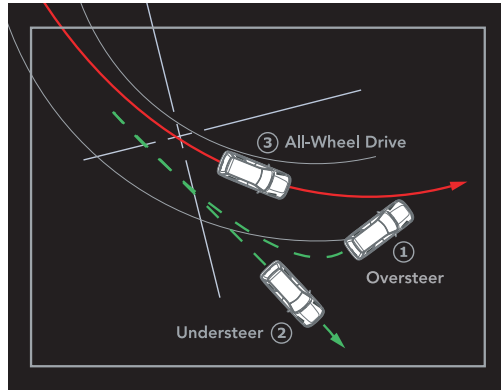
This allows for better weight distribution and contributes to the driver's all-round sense of good balance when driving a Subaru.

The entire system uses fewer parts and produces less movement than other engine and drive combinations – increasing fuel efficiency, durability and reducing noise.



## 4. Power Distribution

### AWD vs. FWD vs. RWD



The most important advantage that an All-Wheel Drive system can provide is traction or grip. Traction is “a force that prevents a wheel slipping.” This force or grip is extremely important as a safety feature because it provides for stability and control. Let's look at how the Subaru All-Wheel Drive system achieves this through the distribution of motive power.

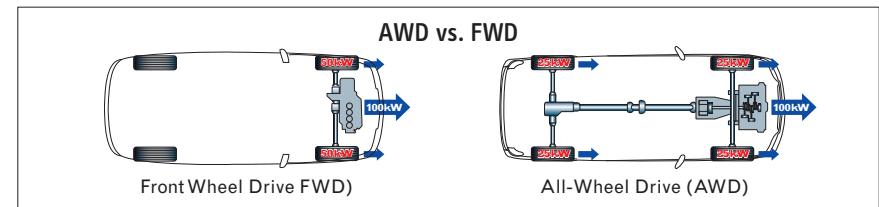
An All-Wheel Drive (AWD) vehicle distributes motive power to all four wheels, which means that the traction limit is approximately twice that of a two-wheel drive vehicle.

This is because in a front-wheel drive or rear-wheel drive vehicle the non-drive axle is only used to transmit cornering or braking power. Consequently the drive axle has to transmit twice the motive power of an All-Wheel Drive (AWD) vehicle.

As a result the traction limit is reached at half the motive power output of an All-Wheel Drive vehicle. For example if a tyre's traction limit is 30 kW and an engine produces a motive power output of 100 kW, in the case of a 2WD vehicle 50 kW would be delivered to each tyre

exceeding its threshold by 20 kW. The result is that the wheels will lose traction and spin when full power is applied. This also means in a front-wheel drive vehicle there is no traction capacity to transmit steering forces and all control may be lost.

In the case of an All-Wheel Drive (AWD) vehicle the 100 kW is distributed to all four tyres. Assuming that the weight distribution is symmetrical then the motive power output will also be evenly distributed at 25 kW per wheel and below the tyre's threshold of 30 kW.



The result is the vehicle moves away without wheel spin, safely under control. If the traction of the road changes suddenly, AWD has a better chance of proceeding without traction loss than a 2WD. For example, if you encounter mud washed across the road during cornering, the torque distribution of an AWD to all four tyres, rather than two tyres on a two-wheel drive, provides additional traction to deal with the slippery surface.

Improved motive traction is very important to safety and can also be seen in everyday situations such as:

- AWD gives the ability to accelerate out of harm's way in a situation that would have a 2WD wheel spinning, and possibly involved in an accident
- Towing a boat out of the water up a wet and slimy ramp
- Accelerating rapidly on a slippery road such as loose gravel, wet dirt or on snow and ice

**The Subaru All-Wheel Drive System  
Four Different Systems**



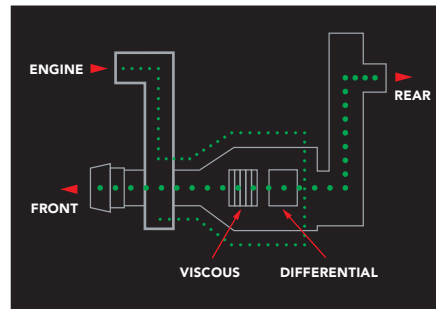
## The Subaru All-Wheel Drive System - Four Different Systems

Subaru is well known for its rally-tested full-time All-Wheel Drive systems. This means that its All-Wheel Drive systems are full-time and constantly on, delivering drive/torque to both the front and rear axles as required. Torque is "the twisting power of a shaft." Torque is required for acceleration and driving of the wheels; therefore, it is important that torque is applied to the wheels that need it.

Subaru also offers a number of different All-Wheel Drive systems for the different models in its range. This ensures that each model's special characteristics are complemented and enhanced by the optimum All-Wheel Drive system.

### 1. Centre Differential with Viscous Limited Slip Differential (LSD)

Subaru employs a viscous limited slip differential (LSD) as a centre differential on the majority of its manual transmission models. This allows the versatility of balancing torque between the front and rear wheels, depending on where traction is required.



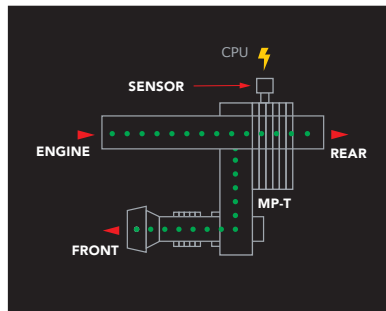
A differential is "a set of gears in a motor car which permit the driving wheels to revolve at different speeds when the car is turning."

The LSD is positioned between the front and rear axles and allows for differences in the rotational speed of the wheels, when driving around a corner. Synthetic viscous fluid is sealed and encased in a housing with two sets of plates, one from each of the output drive shafts. During normal travel, the plates in the LSD spin at the same speed. In this case, the centre differential distributes the drive to the front and rear axles in a 50:50 proportion.

In situations where there is a difference in the rotation speed of front and rear axles, such as during sudden acceleration or on slippery surfaces, this causes the two plate sets within the viscous LSD to rotate at different speeds. The speed variation between the LSD plate sets causes the synthetic viscous fluid to shear, becoming more viscous or thicker, which in turn strengthens the adhesion between the two plate sets. This reduces the speed variation between the front and rear axles and redistributes the drive/torque to the axle with the most traction.

## 2. Active Torque Split - Multi-Plate Transfer Clutch System

This computer controlled electronic constant All-Wheel Drive system is specifically designed for automatic transmission vehicles. Basically, it automatically transfers power from the wheels that slip to the wheels that grip for improved traction.



Subaru's expertise in electronically controlled All-Wheel Drive dates back to 1981. Since then, the company has accumulated a wealth of technological expertise and capability in producing an industry leading automatic All-Wheel Drive system.

The Active Torque Split system uses a computer to electronically control the hydraulic fluid pressure in the Multi-Plate Transfer (MPT) clutch, at the rear of the transmission that directs the drive to the rear axle.

This computer works together with the automatic transmission to measure and monitor information including speed, gear range, accelerator position and rotational speed differences between front and rear wheels.

This input information is then used to calculate and apply optimum torque to the wheels, according to driving conditions. For example, if the front wheels are on a wet or slippery surface and the rear is on dry, more power will be transferred to the back wheels.

A key advantage of this system is that it can continuously vary the drive power to the front and rear as required to prevent slippage. At the same time, it also controls the All-Wheel Drive system to maximise the effectiveness of the Anti-lock Brake System (ABS).

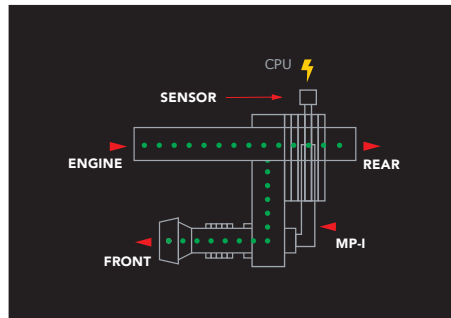
In situations that require more traction, the system can vary drive split up to 50:50 for maximum traction and grip.

This sophisticated coordination of systems ensures greater safety on slippery roads and during acceleration, or braking to avoid accidents.



### 3. Variable Torque Distribution (VTD)

Variable Torque Distribution is a revolutionary and highly sophisticated system for automatic transmission vehicles. This system maintains the high stability of All-Wheel Drive with a more sporty cornering performance and feeling normally associated with rear-wheel drive vehicles – ideal for high performance cars such as the automatic Liberty 3.0R spec.B.



The LSD in this system is controlled electronically, via a multi-plate clutch. This means that it can adapt to the driving conditions such as slippery surfaces and under hard cornering, by varying the torque distribution between front and rear wheels.

Under normal circumstances, the VTD torque distribution has an emphasis on the rear wheels. This reduces understeer normally caused by hard cornering acceleration, resulting in smooth and sporty handling.

In situations that require more traction and grip, VTD can automatically change the torque distribution to a maximum of 50:50 front:rear.

When used in conjunction with Subaru's advanced Vehicle Dynamics Control (VDC), it optimises vehicle control by seamlessly correcting oversteer, reducing understeer and maximising traction and grip. In essence, it complements the vehicle's AWD capabilities by using it as the first line of defence against losing control.

### 3. Vehicle Dynamics Control (VDC)

#### What exactly is Vehicle Dynamics Control (VDC)?

Vehicle Dynamics Control (VDC) is an advanced and intelligent stability control system that assists with maintaining the vehicle's stability under difficult driving conditions.

VDC comprises of the following key components:

- VDC Control Module - measures signals from various components to determine vehicle stability, then sends signals to components such as the 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 location 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 its centre of gravity.
- Lateral G Sensor - measures the sideways force applied to the vehicle.
- Pressure Sensor - detects the level of braking force and measures master cylinder pressure between master cylinder and the hydraulic unit.
- Longitudinal G Sensor - detects the acceleration and braking force applied to the vehicle.
- Hydraulic Unit - controlled by electrical signals from the control module, this unit generates and regulates pressure applied to the brakes when VDC is operating.

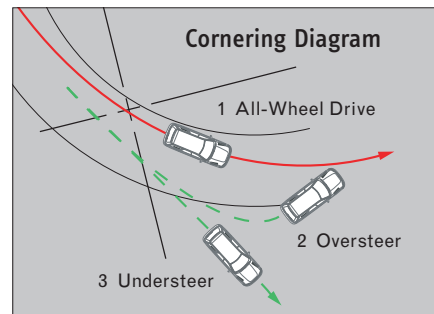
### 3. Vehicle Dynamics Control (VDC)

#### When does VDC come into play?

VDC activates when it detects vehicle instability. Vehicle instability can occur in a number of situations. For example, a vehicle might become unstable during cornering as a result of a loss of grip between the tyres and road surface. This is due to centrifugal forces acting upon the vehicle during cornering. Centrifugal force is *"the apparent outward force acting on a body moving in a curved path."*

Two situations can occur because of centrifugal force when cornering - understeer and oversteer. Understeer happens when the front wheels lose grip before the rear wheels and the front of the vehicle slides outwards. This will result in the vehicle turning a larger radius than the driver intended.

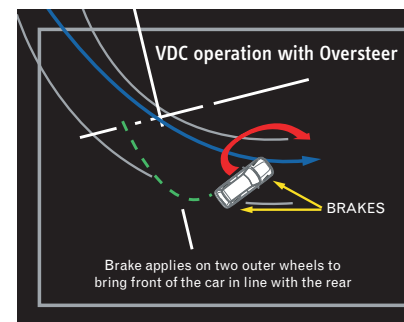
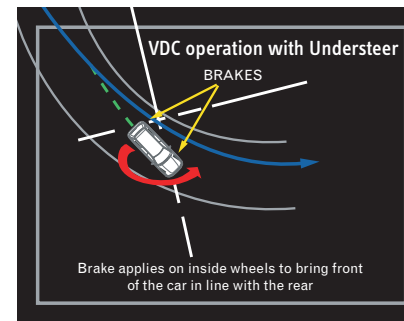
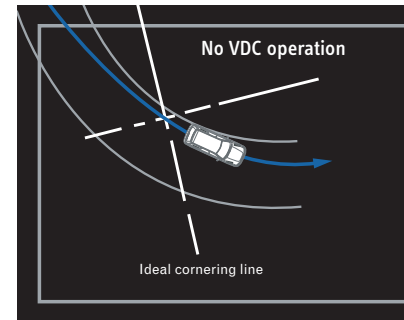
If the rear wheels lose grip first, and the rear of the vehicle slides outwards, this is referred to as oversteer and the vehicle will turn a smaller radius than the driver's intention. Either way, understeer and oversteer result in vehicle instability.



#### How VDC assists vehicle stability?

When the VDC system is in operation, it can vary the drive/torque between the front and rear axles, decrease engine power or apply the brakes individually or as groups to enhance vehicle stability. As an example, in an understeer situation (front wheels sliding outwards), the VDC system may apply the brakes on the inside front wheel (relative to the corner) to pull the front of the vehicle inwards countering the understeer. Conversely,

in an oversteer situation (rear wheels sliding outwards), the VDC system may apply the brakes on the front outside wheel to pull the front of the vehicle outwards thus reducing oversteer.



While VDC is an excellent safety system that maintains stability, it does not automatically drive the car. It helps the driver to maintain control by stabilising and correcting understeer and oversteer. VDC however cannot defy the laws of physics. There is a limit to VDC's ability to stabilise an unstable vehicle; this is dependent on the level of grip between the tyre and road and the speed of the vehicle. The Subaru VDC system is a superior stability control system as it uses the vehicle's AWD capabilities as the first line of defence. This means that the Subaru VDC system works seamlessly with AWD to counter oversteer, reduce understeer and maintain vehicle stability.

#### 4. Driver Controlled Centre Differential (DCCD)

The Driver Controlled Centre Differential (DCCD) is a very advanced and highly sophisticated AWD system suited for high performance requirements. The WRX STI currently uses the DCCD system.



The DCCD system is highly versatile and features both Automatic and Manual modes. The car defaults to Automatic mode on start-up. In Automatic mode, the car uses inputs from the ABS brake sensors, yaw sensor, throttle position sensor, lateral G-force sensor and speed sensor to calculate the best drive/torque distribution between the front and rear axles. In good traction conditions, the drive/torque split ratio between the front and rear axle is biased to the rear. Under reduced traction conditions, the drive/torque split ratio can reach 50:50 to maximise traction for optimum handling, stability and control.

The current DCCD system uses a dual-stage Limited Slip Differential (LSD) system that incorporates both electronic and mechanical LSDs in the center differential. Both LSDs work together to ensure drive/torque transfer is optimised for best handling and traction. The electronic LSD system includes an electromagnetic clutch that varies drive/torque to the front and rear axles. The mechanical LSD complements the electronic LSD by activating an additional LSD effect, to ensure the optimum drive/torque transfer between front and rear axles.

Along with the other sensors (ABS wheel speed, yaw sensor, throttle sensor, lateral G-force sensor, vehicle speed sensor), the DCCD system also features a steering angle sensor (in Automatic mode) to measure precisely the driver's intended steering direction. The steering inputs are then used to activate the electromagnetic LSD to ensure the optimum drive/torque transfer.

#### 5. Subaru All-Wheel Drive Systems Summary Table

Model		Liberty				Outback		
		2.0R/2.5i		GT/3.0R/ 3.0R spec.B		2.5i		3.0R
AWD system application		5MT	4AT	6MT	5AT	5MT	4AT	5AT
Base	Centre Diff. + LSD	STD		STD		STD		
	Active Torque Split MPT		STD				STD	
Advanced	Driver's Control Centre Diff.							
	Variable Torque Distribution and Vehicle Dynamics Control				STD			STD

Model		Impreza				Forester	
		2.0i / 2.0R/RV		WRX	WRX STI	2.5	
AWD system application		5MT	4AT	5MT	6MT	5MT	4AT
Base	Centre Diff. + LSD	STD		STD		STD	
	Active Torque Split MPT		STD				STD
Advanced	Driver Control Centre Diff.				STD		
	Variable Torque Distribution and Vehicle Dynamics Control						

Subaru  
AWD vs. 4WD vs. 2WD



## 1. What is the difference?

There are more and more AWD and 4WD cars in the market nowadays. What is the difference between AWD and 4WD? Although the two different systems are very similar, fine differences do exist between the two systems.

### Subaru AWD vs. 4WD vs. 2WD

	Subaru AWD	4WD	2WD
<b>Platform</b>	Car based.	Mostly truck based.	Car based.
<b>Conditions</b>	All-weather. Recreational soft-riding.	All-terrain. Serious and extreme rugged off-road driving.	Normal road conditions only.
<b>Drive Path</b>	Full time AWD. All four wheels are driven all the time for maximum traction and grip.	Mostly part-time. Combo systems that allow driver to switch to 4WD when required.	Only two wheels driven, depending on whether the car has a front-wheel or rear-wheel drive.
<b>Low range gear system</b>	Selected models and variants have dual range gears selection.	Usually has a 4WD low range gear.	Not applicable.

Other manufacturers may have part-time AWD systems. These systems can either be automatic or manual. Regardless of the system type, both systems operate with only one axle or two driven wheels at first, until wheel slippage or traction loss is detected.

Automatic part-time AWD systems detect wheel slippages and lost traction, and then automatically switch from two-wheel to four-wheel mode. In manual part-time AWD systems, the driver may also have the option of turning on four-wheel mode as well.

However, there are limitations as well. For example, the option of turning on four-wheel mode can only be made and maintained at low speed. In some cases, the switch can only be made when the vehicle is stationary. Either way, the inherent flaw with the part-time AWD system is that the vehicle always experiences lost traction or grip before the four-wheel mode is activated. In cases where the driver needs to manually activate four-wheel mode, the time required by the driver to identify wheel slippage could be enough to lose total control of the vehicle. Hence, the reactive and passive nature of the part-time AWD system makes it an inherently inferior system.

### Main Competitor Systems – A Quick Summary

- Reactive system: Predominantly front wheel drive vehicles. Under wheel spin conditions, power will be sent to the rear wheels
- Manual system: Require driver input to engage AWD through a button on the dash
- Drives all four wheels constantly, but in a set drive split. This does not change even when wheel slip occurs

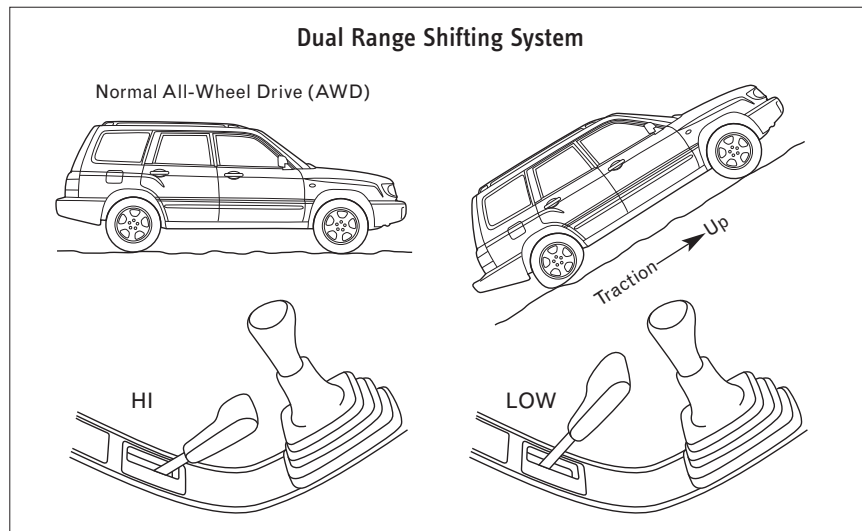
### Key Advantages of Subaru AWD over 4WD and 2WD

- Proven and rally-tested technology for over 30 years
- Full-time and constant, providing the safety of extra grip in all conditions, at all times
- Active, instead of reactive and passive. Subaru's various all-wheel drive systems ensures greater safety and stability
- All-weather driving. Suitable for soft off-riding and all weather conditions
- Optimum traction and grip control all the time



## 2. Dual Range Shifting - Shifting All-Wheel Drive

Some Subaru manual models come with a dual range function. This allows switching to a lower gear range that provides more engine torque multiplication. This is useful when climbing steep slopes, or negotiating difficult terrain, as it provides both additional pulling power and engine braking. Automatic models do not require the dual range function because they have a torque converter that automatically increases available torque for negotiating tough terrain.



## 3. Suspension Benefits

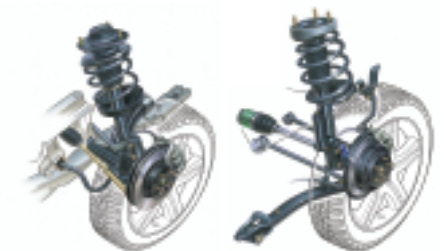
Subaru front suspension is the MacPherson strut independent system featuring offset coil springs, which minimises the friction generated by the up and down movement of the strut.

The effect is to lessen the vibration and feeling of thrust transmitted from the road, thereby providing good ride comfort and road tracking.

On the Liberty and Outback, a revolutionary multi-link rear suspension design is utilised:

- Reducing the effect of cargo weight on suspension performance
- Keeping suspension component protrusion into the cargo area to a minimum
- Ensuring that tyres are kept perpendicular to the road regardless of cornering, acceleration and braking forces. Cargo load also has a minimal effect on wheel alignment geometry thereby ensuring maximum contact between the tyre and road is maintained

The multi-link system also uses a floating subframe to connect the suspension to the body, which minimises vibration and greatly improves quietness and ride comfort.



#### 4. The disadvantages of 2WD cars

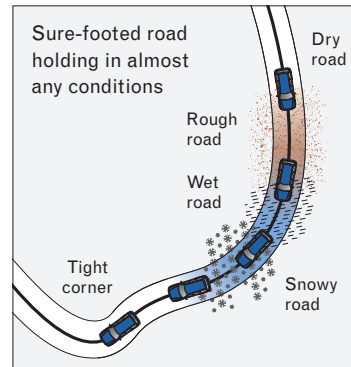
There are inherent advantages of an AWD car over a 2WD car.

With a front-wheel drive (FWD) car, its inherent construction will cause the car to be pulled along, leading to understeer in corners.

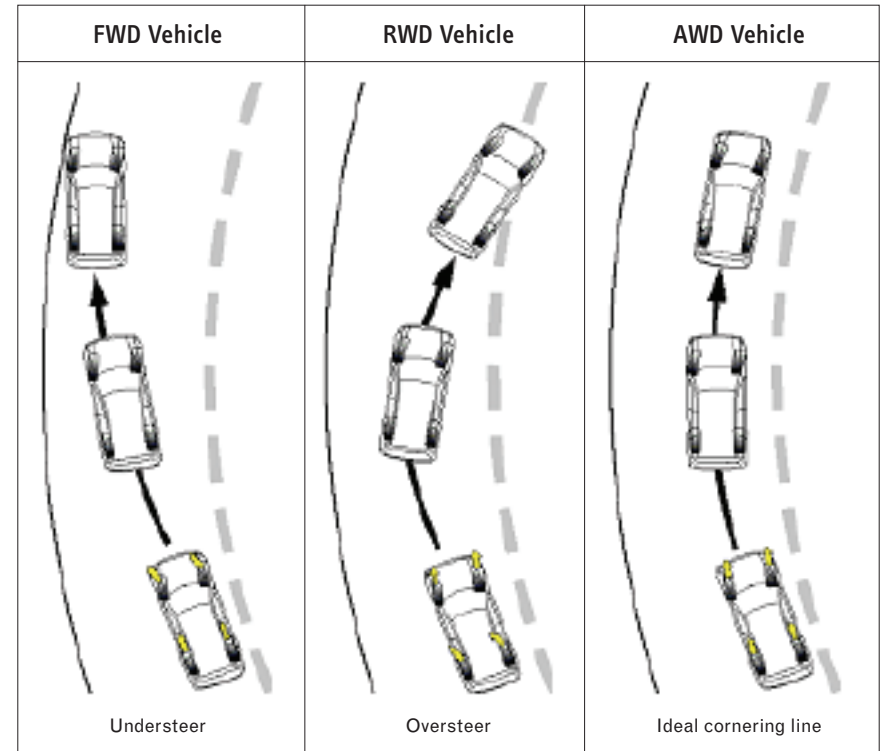
Rear wheel drive (RWD) vehicles get their motive power from the rear wheels, hence oversteering in corners often occurs because the vehicle is being pushed along.

In a 2WD vehicle, engine power is transmitted to the road via two wheels only. In a Subaru constant AWD vehicle, engine power is transmitted to the road via all four wheels.

During slippery conditions, engine power can quickly overcome the traction available in a 2WD vehicle, resulting in a loss of stability and control.



As a Subaru AWD vehicle transmits engine power through all four wheels, the level of traction available is around twice that available in a 2WD vehicle, thus stability, control and safety are enhanced.



**Subaru**  
**Safety Philosophy**



## A) Passive Safety

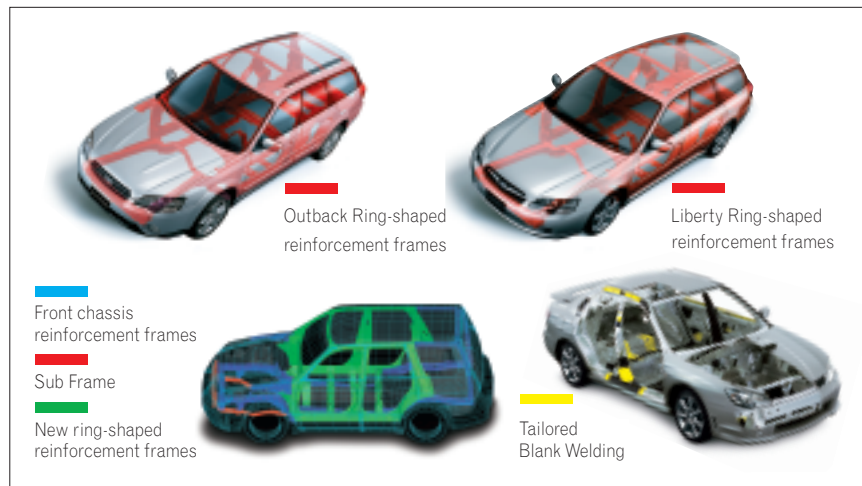
### 1. ANCAP

Subaru cars are well recognised for their focus on safety. All current Subaru Libertys, Foresters and Outbacks have achieved a five star occupant safety rating from the independent Australian New Car Assessment Program (ANCAP). Imprezas have also been awarded a four star occupant safety rating.



### 2. Advanced Thinking in Body Design

All Subaru cars are engineered to provide the best possible protection. The chassis design is incorporated into a protective cell of Ring-Shaped Reinforcement Frames, which absorb the energy of an impact from any direction. Special energy absorbing zones in the door shoulders enhance side protection. The centre pillar is strengthened through the use of a special Tailored Blank Welding process. This process involves laser welding two pieces of steel and stamping them into shape. Key advantages of this process are high strength and light weight.



## 3. Supplemental Restraint system (SRS) Airbags and Seatbelt System



All Subaru models have the standard dual front and dual front side airbags for protection of front passengers in the event of a collision. Selected models feature curtain airbags as well, offering greater protection for front and rear occupants in the event of a side collision.

These auxiliary safety devices work in conjunction with the seatbelt system. An important measure in ensuring a high level of passive safety even when SRS airbags are used is the operation of the seatbelts. This is because the effectiveness of the airbag is increased when the occupant is restrained quickly and held firmly in the seat, minimising forward momentum.

Pretensioner seatbelts are therefore used to work in conjunction with the airbags to quickly tighten the belt on impact and remove any slack between the belt and body. Similarly, optimum positioning of the belt is of prime importance in restraining the occupant. All Subaru models therefore have front seatbelt shoulder adjusters and the buckles are integrated into the seat frame to ensure ideal positioning is possible, irrespective of occupant size.



### 4. Better Passenger Protection

All front and rear seatbelts (other than the centre rear lap sash) have height adjustable anchor points, and all three rear seatbelts safeguard passengers with Automatic Emergency Locking Retractors (A/ELR). When extended fully, the belts ratchet back into position for positive securing of child safety seats. The driver's side seatbelt also incorporates a lap pretensioner. Both front seatbelts also have sash pretensioners with load limiter, for better restraint.

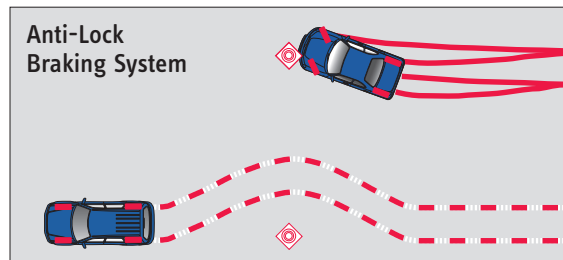
## B) Active Safety

### 1. ABS, EBD and AWD Equals Active Safety

Anti-lock Braking System (ABS) brakes are a fundamental part of the Subaru safety philosophy. Subaru uses a sophisticated and advanced 4-sensor/4-channel/three phase ABS in combination with All-Wheel Drive. The advantage of having ABS is that the wheels will not lock under heavy braking, decreasing stopping distances. It also gives the driver greater steering control under braking. When ABS brakes are applied on a slippery road surface, each of the four sensors (one per wheel) monitors the individual wheel speed and transmits information to a computer. The computer then calculates which wheel is starting to lock and individually uses a three-phase cycle to control the braking force. This provides extremely stable braking characteristics.

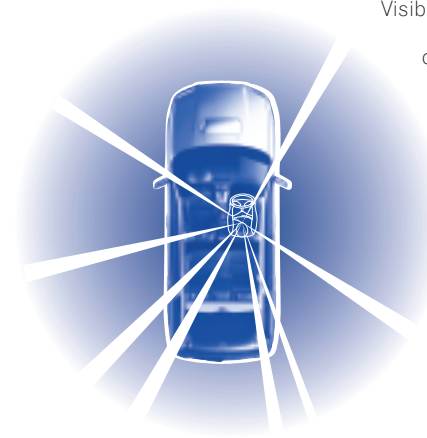
This system is also specially tuned and adapted for Australian road conditions, resulting in reduced stopping distances on gravel surfaces.

The ABS system is also complemented by the incorporation of Electronic Brakeforce Distribution (EBD), specifically to improve rear wheel braking response during deceleration. EBD accurately regulates brake force distribution between front and rear wheels to the 'ideal' level, improving stopping distances.



Older braking systems regulated the force between the front and rear brakes via a mechanical valve. The disadvantage of this was that the brake balance between front and rear was not always at an 'ideal' level, requiring the front brakes to do most of the work. The advantage of having EBD is a more even brake load between front and rear, giving more even brake pad wear and control under heavy braking.

### 2. Seeing Safely



Visibility is of prime importance in motor vehicle design. An optimum field of view is therefore an essential component of active safety design and Subaru has adopted several design standards to minimise blind spots to enable the driver to easily judge the exterior dimensions of the vehicle and control it.

Subaru's dedication to safety includes a commitment to an optimum field of vision for drivers when reversing.

For example, to further improve vision, the spare wheel on the Forester is located inside the boot floor rather than mounted externally on the tailgate.

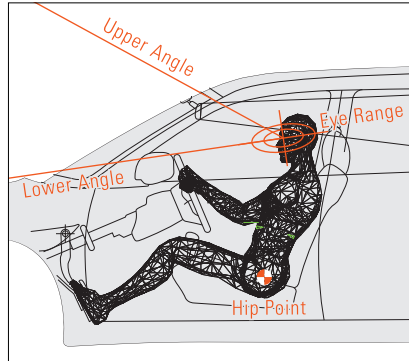
Subaru engineers also designed and positioned the roof so that exterior visibility is maximised, thus reducing blind spots in the driver's field of vision. It is this type of attention to detail for which Subaru is renowned.



### 3. Driving Position

Designed like the cockpit of a jetfighter, the basic Subaru interior design philosophy is to ensure that the driver focuses on one thing – driving.

The choice of the correct eye point, by optimising the seating position, minimises the amount of eye movement and refocusing necessary to take in essential information from the instruments and to activate the controls. The seats also allow optimum adjustment for virtually any driver, minimising fatigue on long drives.



The switches and controls are ergonomically designed to facilitate operation – using sense of touch rather than having to take one's eyes from the road to verify operation.

### C) Anti-theft Protection

#### 1. DataDot Technology

All new Subaru models are fitted with the latest advanced engine immobilisers and DataDot technology. Approximately 7000 microscopic dots are laser-etched with the vehicle's unique Vehicle Identification Number (VIN), then applied to the components of the vehicle via a patented spraying process. Rear window labels warn potential thieves that the vehicle and all its component parts will be easily identifiable for the authorities.



## Subaru All-Wheel Drive - FAQs



## Subaru All-Wheel Drive - FAQs

### How is Subaru AWD different to other AWD vehicles?

The advantages with Subaru AWD are the symmetrical layout and optimum balance. The transmission is located behind the engine along the car's centre line. All drive shafts are of equal length. This results in a more stable application of drive force, producing more consistent drivability in any conditions.

### How does Subaru AWD work?

There are four different AWD systems used in the Subaru range. As every Subaru model and variant is different, the AWD system complements the car's unique characteristics.

Model		Liberty				Outback		
AWD system application		2.0R/2.5i		GT/3.0R/ 3.0R spec.B		2.5i		3.0R
		5MT	4AT	6MT	5AT	5MT	4AT	5AT
Base	Centre Diff. + LSD	STD		STD		STD		
	Active Torque Split MPT		STD				STD	
Advanced	Driver's Control Centre Diff.							
	Variable Torque Distribution and Vehicle Dynamics Control				STD			STD

Model		Impreza			Forester		
AWD system application		2.0i / 2.0R/RV		WRX	WRX STI	2.5	
		5MT	4AT	5MT	6MT	5MT	4AT
Base	Centre Diff. + LSD	STD		STD		STD	
	Active Torque Split MPT		STD				STD
Advanced	Driver Control Centre Diff.				STD		
	Variable Torque Distribution and Vehicle Dynamics Control						

### What is Limited Slip Differential (LSD)?

An LSD is a mechanical device that strives to maximise the traction available at each tyre, thus reducing slippage and optimising vehicle stability. It reduces slippage by transferring torque to the output shaft with the most grip.

### What is torque distribution?

Torque distribution – or power transfer to a vehicle's wheels depends upon the grip available between the tyre and road surface. "Drive split" better describes the mechanical distribution of torque between front and rear wheels in the Subaru AWD System.

## Subaru All-Wheel Drive - FAQs (cont.)

Drive split for the four current Subaru AWD systems is as follows:

	Subaru AWD Systems	Drive Split (Front to Rear)	Maximum Drive Split (Front to Rear)
1.	Viscous Coupled Limited Centre Differential	50: 50	50:50
2.	Active Torque Split Multi Plate Transfer Clutch (ACT-4)	Constantly varying	50:50
3.	Variable Torque Distribution (VTD) and Vehicle Dynamics Control	Varies with model year	50:50
4.	Driver Controlled Centre Differential (DCCD)	Varies with model year	50:50

### Are Subaru AWD cars less fuel efficient than the average two-wheel drive cars?

Subaru engineers discovered that powered wheels require less energy to drive than unpowered wheels. Subaru's AWD layout adds a small weight and friction load compared to a 2WD vehicle. However, the advantage of powering all wheels rather than dragging or pushing two wheels reduces any fuel consumption disadvantage to a minimum.

### What kind of terrains and road conditions are suitable for Subaru AWD cars?

In addition to paved roads, Subaru AWD vehicles are suitable for use on many dirt roads. Subaru AWD vehicles can offer handling advantages on roads. AWD vehicles can offer handling advantages on roads and track affected by the wet, mud, sleet, snow, ice, dirt and gravel.

Forester and Outback are considered "soft roaders" and can offer additional abilities on rougher dirt or gravel roads and some "off-road" capability, generally only limited by vehicle ground clearance.

### What is an open differential?

A differential is a mechanical component that distributes torque to the wheels. An open differential does not have a limited slip device. It allows the output shafts to rotate at varying speeds while continuing to supply drive. Its disadvantage lies in its ability to send more torque to the output shaft with the highest speed. In other words, given the right conditions, it directs power to the wheel with slip not the wheel with the grip.

### Do Subaru AWD cars have more mechanical moving parts than average two-wheel drive cars?

Compared to a rear wheel drive car, an AWD Subaru adds front driveshafts, front differential assembly and the front-rear drive splitting mechanism within the transmission. In relation to a front wheel drive car, the AWD Subaru adds a front-rear drive mechanism, tailshaft, rear differential assembly and rear driveshafts.

### What is Vehicle Dynamics Control (VDC)? How will VDC benefit me?

Vehicle Dynamics Control (VDC) is a Subaru vehicle stability system. It is an electronic system that combines the advantages of AWD, ABS and VTD. The system operates by varying torque between the front and rear axles (AWD and VTD), reducing engine power and applying the brakes individually or as groups (ABS) to enhance stability and recovery when the

## Subaru All-Wheel Drive - FAQs (cont.)

**What is Vehicle Dynamics Control (VDC)? How will VDC benefit me? (cont.)**

driver begins to lose control. Although VDC is an aid to stability, the vehicle is still subject to the laws of physics, and poor driving behaviour can still result in an accident. Therefore good rather than poor driving is rewarded with an additional safety margin.

**Is the Electronic Stability Program (ESP) and traction control system used in some non-Subaru vehicles the same as Vehicle Dynamics Control (VDC)? What is the difference?**

ESP is a two-element vehicle stability system using traction control and Anti-lock Braking System (ABS). Vehicle Dynamics Control (VDC) uses traction control and ABS plus a third element – the Variable Torque Distribution (VTD) transmission.

VTD transmission varies the torque applied between the front and rear axles of the Subaru AWD system. VDC has the additional advantage of VTD to aid stability and vehicle control.

**Why is there a need to add mechanical limited slip differential (LSD) to the Driver Controlled Centre Differential (DCCD) used in Impreza WRX STI?**

A mechanical LSD is added to the DCCD to provide more stability in transient situations such as engine torque changes due to varying throttle positions.

**Why buy a Subaru AWD vehicle rather than a 2WD competitor?**

There are many reasons to own an AWD Subaru over a 2WD competitor. Key reasons include road-holding, handling, stability and safety. Would you travel in a car without seat belts? No. If you could have a vehicle with airbags, would you buy one without airbags? Of course not. The Subaru AWD system ranks with seatbelts, airbags, crumple zones, passenger survival cells and ABS as a major safety feature. Unlike seatbelts, airbags etc. that only serve a purpose during an accident; Subaru AWD contributes to accident avoidance as well as driver pleasure. What a combination!