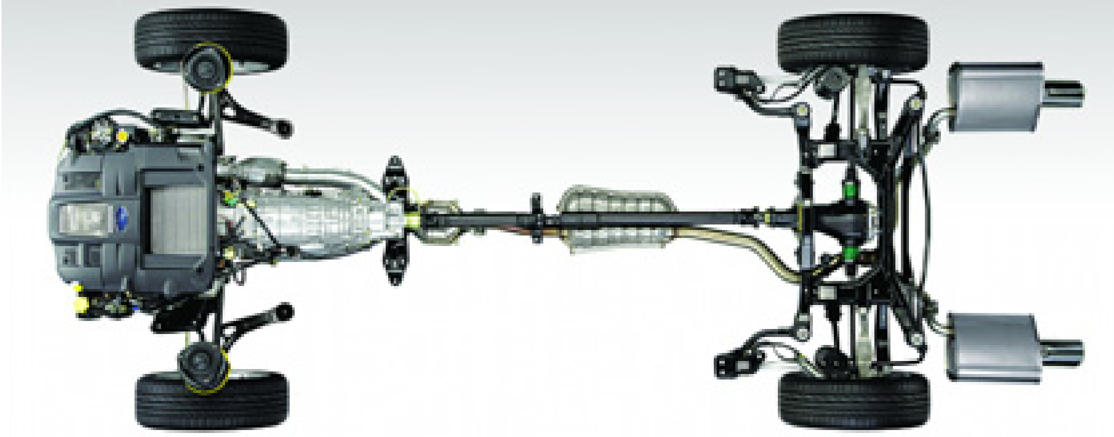
Subaru AWD: Various Varieties

After more than 30 years of producing All-Wheel Drive vehicles, Subaru now offers five configurations to best suit the needs of the vehicle and driver. Here's a primer on the various types of Subaru Symmetrical All-Wheel Drive and which vehicles have each system.



Back in 1972, Subaru introduced the Leone 4WD Station Wagon. It was the first four-wheel drive vehicle designed specifically for everyday driving, rather than for off-road or rugged use. The safety and driving performance aspects of the Leone 4WD proved popular and made the car successful. It quietly set the standard for Subaru to become the global All-Wheel Drive leader of today.

The 1972 Leone 4WD Station Wagon started it all for Subaru AWD.

Subaru Symmetrical All-Wheel Drive

Subaru calls its system of mating a horizontally-opposed (boxer) engine to various types of full-time AWD "Symmetrical All-Wheel Drive." This system is based on the balance of both the powertrain and the straight, nearly-horizontal, flow of power to the wheels. The weight of the flat boxer engine and the transfer components lie very low in the chassis, providing a lower center of gravity, resulting in excellent traction and stability.

The Five Types of Subaru Symmetrical All-Wheel Drive

Subaru currently uses five different types of Symmetrical All-Wheel Drive. Each is specific to the Subaru model and transmission. The five types are:

- Continuous All-Wheel Drive
- Active All-Wheel Drive
- Variable Torque Distribution (VTD) All-Wheel Drive.
- Driver Controlled Center Differential (DCCD) All-Wheel Drive
- Vehicle Dynamics Control (VDC) All-Wheel Drive

Continuous All-Wheel Drive

In Subaru models equipped with a five-speed manual transmission, a viscous-coupling locking center differential built into the transmission case distributes engine power 50:50 front-to-rear. Slippage at the front or rear wheels causes more power to transfer to the opposite set of wheels.

The viscous coupling contains a series of opposing discs attached to the front and rear drive shafts, surrounded in a type of silicone fluid. Slippage at the front or rear wheels causes a rotational difference between the front and rear discs in the viscous unit, which in turn shears the fluid. The shearing action heats the fluid, causing it to thicken. As the fluid thickens, power transfers from the plates rotating faster (the slipping wheels) to those rotating more slowly (the wheels with the best traction). When the slippage ceases, all the discs turn at the same speed, restoring the 50:50 power split.

Active All-Wheel Drive

Active All-Wheel Drive is used on all Subaru models powered by the naturally-aspirated four-cylinder boxer engine and equipped with the four-speed automatic transmission, as well as on the turbocharged Forester 2.5L XT equipped with this transmission. An electronically managed continuously variable transfer clutch actively manages power distribution and ensures that the wheels with the best traction receive more power. Power transfer is governed by slippage in the clutch plates. The Transmission Control Module (TCM) controls the multi-plate transfer clutch.

Active All-Wheel Drive can adjust the power split in an instant, depending on many input factors. If the front wheels begin to slip, the TCM increases hydraulic pressure on the transfer clutch, reducing slippage of the plates and transferring the power to the rear wheels. As the front wheels regain traction, the TCM reduces pressure on the clutch, increasing slippage of the plates and transferring power to the front. The TCM monitors input from speed sensors on the front and rear drive shafts and also takes input from the throttle position and the transmission. All of these factors cause the TCM to select a software strategy that determines how aggressively it adjusts the power distribution.

Active All-Wheel Drive varies the power distribution according to driving conditions. When throttle input signals acceleration, the system responds by transferring more power to the rear wheels to account for rearward weight transfer. When releasing the throttle indicates deceleration, power transfers to the front wheels to enhance braking performance.

The system enhances cornering performance as well. When the driver lifts off the throttle and applies the brake to enter a turn, power transfers to the front wheels for greater steering control. As the car exits the turn and accelerates, power transfers to the rear wheels for added traction.

Variable Torque Distribution (VTD) All-Wheel Drive

Legacy 2.5L GT Limited, Outback 2.5L XT and 3.0L R models equipped with the five-speed automatic transmission, and Impreza WRX and Baja Turbo models equipped with the four-speed automatic transmission, feature Variable Torque Distribution (VTD) All-Wheel Drive. An electronically controlled, continuously variable hydraulic transfer clutch works with a planetary gear-type center differential to control power distribution between the front and rear wheels. Under most conditions, VTD uses a 45:55 front/rear torque split, with the rear-wheel bias helping to reduce understeer and contributing to improved handling agility. VTD responds to driving conditions to continually optimize power distribution on all road surfaces.

The VTD system can vary the power distribution as needed in response to traction conditions. It adjusts the front/rear power distribution in the center differential according to weight transfer under acceleration and deceleration (as indicated by throttle input), always sending more power to the wheels with the best traction.

Driver Controlled Center Differential (DCCD) All-Wheel Drive

The Impreza WRX STI uses Driver Controlled Center Differential (DCCD), the most performance-directed type of Symmetrical All-Wheel Drive. A limited-slip, planetary gear-type center differential provides a performance-oriented 35:65 front/rear power split. In automatic mode, the electronically managed continuously variable transfer clutch can vary the distribution ratio through the center differential as needed to suit driving and road-surface conditions. In manual mode, DCCD allows the driver to vary the front-to-rear torque distribution to optimize performance to suit specific driving conditions.

In 2006 and 2007 models, the front/rear default torque split, a function of the planetary-type differential, has been changed from 35:65 to 41:59 to reduce oversteer while accelerating out of corners. A mechanical limited-slip center differential was also added (to augment the electronically controlled differential) and a steering sensor input to the system to improve torque transfer response by more accurately relaying the car's cornering situation.

In automatic mode, the center differential can vary the split ratio as needed to suit driving and road-surface conditions. Automatic mode provides the best all-around performance for most drivers and circumstances, varying the front/rear torque split automatically depending on driving conditions and driver input. The system responds to acceleration, deceleration, cornering force and wheel slippage to determine the ideal power distribution.

In manual mode, DCCD allows the driver to vary the front-to-rear power distribution to optimize performance to

The Impreza WRX STI uses Driver Controlled Center Differential (DCCD) to switch the All-Wheel Drive system between automatic and manual modes. Seen here, the controls allow the driver to select the mode and the level of center differential locking.

suit specific driving conditions. The driver first selects manual mode with a console-mounted button and then turns a thumbwheel on the center console to select from among six levels of center differential locking. Increasing the lock factor keeps more power at the front wheels, which the driver might want in certain driving conditions, on particular roads or to suit an individual driving style.

Vehicle Dynamics Control (VDC) All-Wheel Drive

The B9 Tribeca and the Outback 3.0L R VDC Limited model combine the VTD All-Wheel Drive system with Vehicle Dynamics Control (VDC) to help the driver maintain directional control and stability. Using a series of sensors throughout the vehicle to measure steering angle, yaw rate, individual wheel speeds and lateral (cornering) g-forces, the VDC system monitors vehicle stability and continuously compares it to the driver's intended direction. If VDC detects instability, it applies corrective action to help restore control.

The VDC system helps keep the car going where the driver steers it, using individual wheel braking and throttle control to correct understeer (front-wheel drift) or oversteer (rear-wheel drift). The four-wheel electronic traction control system (TCS) adds an extra margin of driving safety without impeding VTD All-Wheel Drive operation. The VTD system can vary the power distribution as needed to respond to traction conditions. It adjusts the front / rear power split in the differential according to weight transfer under acceleration and deceleration (as indicated by throttle input), always sending more power to the wheels with the best traction.

The VDC system also incorporates an all-wheel, all-speed Traction Control System (TCS) to help reduce wheel spin. The combination of these two technologies helps provide outstanding handling and control in a wide variety of driving conditions. Controlled by VDC, the VTD center differential – not the traction control system – governs power distribution. The system operates while driving in a straight line or cornering and can help maintain traction even if up to three wheels are slipping. If the driver is applying more throttle than available traction will allow, VDC will reduce engine power. It is important to point out that the VDC system uses traction control as a second line of defense, activated only when VTD alone cannot maintain sufficient traction.

VDC models include a "VDC OFF" switch to turn off the stability and traction control for driving in or extricating the vehicle from deep snow or mud. Under such conditions, the selective braking action that a stability control system provides is not desirable. It is important to point out, however, that even with VDC off, the VTD All-Wheel Drive system remains 100% operational at all times. If VDC is switched off, it will default to "ON" the next time the vehicle is started and driven over 32 mph.

Subaru AWD: Various Varieties

The chart below shows the various types of Subaru Symmetrical All-Wheel Drive types currently used by model and transmission.

Type:	Continuous	Active	VTD	VDC	DCCD
Model:					
Model					
B9 Tribeca				•	
Baja					
Baja Sport	•	•			
Baja Turbo	•		•		
Impreza					
2.5 i models	•	•			
Outback Sport	•	•			
Impreza WRX and WRX STI					
WRX and WRX TR models	•				
WRX Limited models	•		•		
WRX STI					•
Forester					
2.5 X	•	•			
2.5 X L. L. Bean Edition		•			
2.5 XT Limited	•	•			
Legacy					
2.5 i Sedan/Wagon	•	•			
2.5 i Limited Sedan/Wagon		•			
2.5 GT Limited Sedan	•		•		
2.5 GT spec.B Sedan	•				
2.5 GT Limited Wagon			•		
Outback					
2.5 i Wagon	•	•			
2.5 i Wagon with Navigation		•			
2.5 i Limited Sedan		•			
2.5 i Limited Wagon	•	•			
2.5 XT Wagon	•		•		
2.5 XT Limited Wagon	•		•		
3.0 R Wagon			•		
3.0 R L.L. Bean Edition			•		
3.0 R VDC Limited Wagon				•	

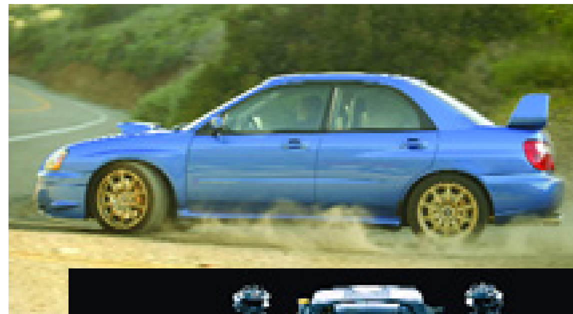
Limited-Slip Rear Differential

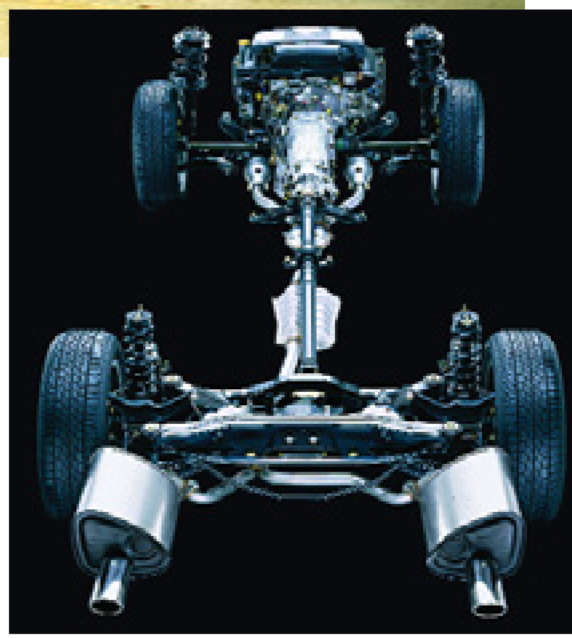
The following Subaru vehicles are equipped with a viscous limited-slip rear differential to further increase traction:

- WRX models
- Outback models, except Sport
- Baja models
- Forester models, except 2.5 X
- Legacy 2.5 GT Limited and 2.5 GT B models

Due to the wide variety of AWD systems used on Subaru vehicles and the slight changes in components from year to year and model to model, always refer the year and model service information for the vehicle you are servicing. The proper information can be obtained on the Subaru Technical Information website at http://techinfo.subaru.com.

The WRX STI is fitted with Driver Controlled Center Differential (DCCD) to allow the driver to select the degree of front/rear torque distribution.





The lower center of gravity and balance of components are characteristics that give Symmetrical All-Wheel Drive superior stability and traction.

Service Note:
Harsh AWD Engagement and TCU Code 45
1999-2002 All Models

You may encounter a 1999-2002 Subaru vehicle with a customer report of a loud bang emanating from the rear of the vehicle during slow-speed acceleration on ice or snow. This may be caused by the transfer clutch being engaged when the system detects wheel slippage.

Inspect the vehicle to see if a TCU Code 45 (intake manifold pressure sensor) is present. If so, first inspect the wiring and connectors as directed in the appropriate service manual. Next, confirm that the AWD system is operating correctly.

Replacement of the TCU may be needed to correct the problem. Please note that if the vehicle is also experiencing an ECM code for the intake manifold pressure sensor, replacing the TCU will not correct the problem. The table below contains the correct replacement TCU for the vehicle. ■

Legacy		TCU	
99MY	2.2L	LHD CAL	31711AE154
		POSTAL CAL	31711AE164
		LHD FED	31711AE404
		POSTAL FED	31711AE414
	2.5L	GT	31711AE174
		OBK	31711AE184
00MY	2.5L	L	31711A10C
		GT	31711AE11C
	2.5L	OBK	31711AE12C
01MY	2.5L	L	31711AF33C
		GT	31711AF34C
	2.5L	OBK	31711AF35C
	3.0L	OBK	31711AF37B
02MY	2.5L	L	31711AF90B
		GT	31711AF91B
	2.5L	OBK	31711AF92B
	3.0L	OBK	31711AF95B

Impreza		TCU	
99MY	2.2L	CAL	31711AE314
		FED	31711AE424
	2.5L		31711AE324
00-01MY	2.2L		31711AE532
	2.5L		31711AE552
02MY	2.5L	TS,OBK	31711AE951
		RS	31711AE961

Forester		TCU
99MY	2.5L	31711AE234
00-01MY	2.5L	31711AE672
02MY	2.5L	31711AF491