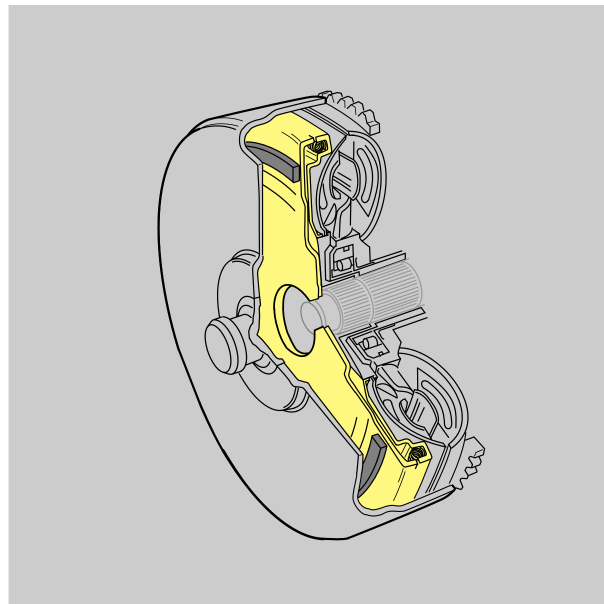
The 01V Automatic Transmission



Design and Function

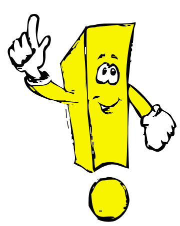
Self-Study Program
Course Number 851903

Volkswagen of America, Inc.
Service Training
Printed in U.S.A.
Printed in 6/2000
Course Number 851903

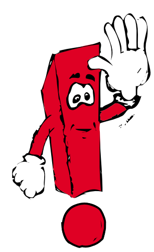
Always check Technical Bulletins and the Volkswagen Worldwide Repair Information System for any information that may supersede any information included in this booklet.

Table of Contents:

New!



Important/Note!



Objectives:

In this program, you will learn:

- How to identify an 01V automatic transmission
- How a basic transmission operates
- How to follow the power flow through an 01V automatic transmission
- How the Torsen® center differential operates
- How the electronic components operate
- How the dynamic shift program operates
- How the emergency running modes operate

01V Automatic Transmission

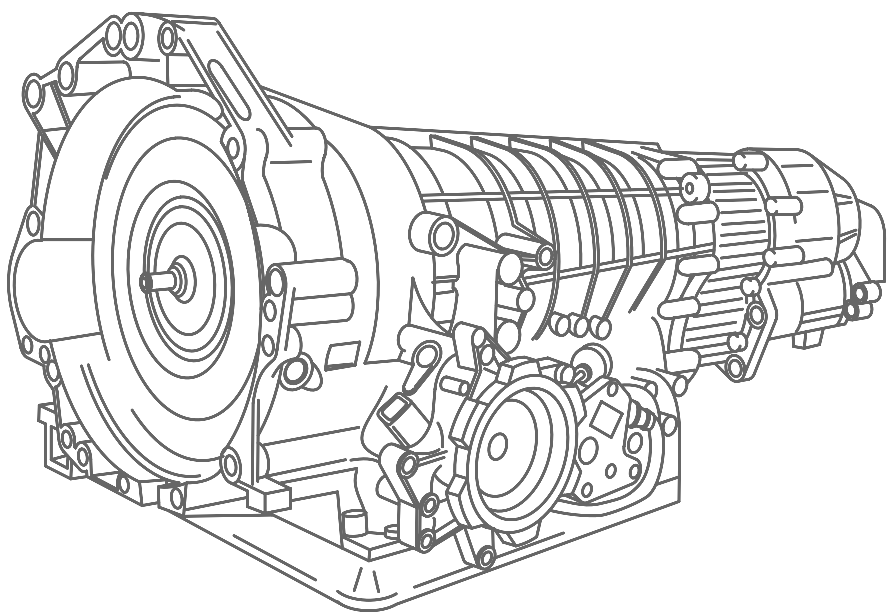
The 01V automatic transmission is manufactured by ZF AG. This transmission offers a high level of driving comfort and handling capability.

01V Application

The 01V is used in the following models:

- Front-wheel drive Passat
- 4Motion Passat

The 01V automatic transmission was introduced in 1998 in the Passat.



01V Automatic Transmission - 5HP19

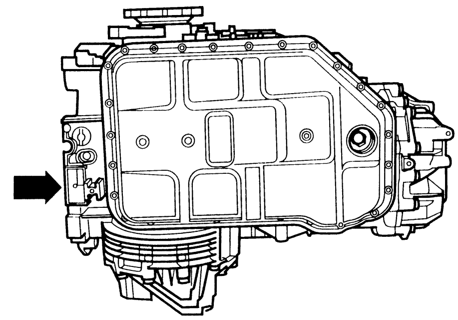
01V Automatic Transmission

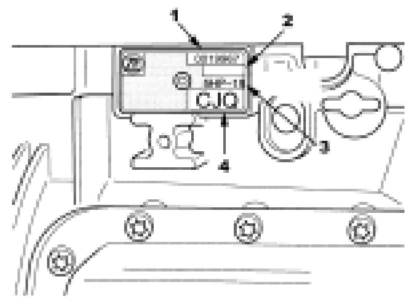
The 01V automatic transmission is generically known as the 5HP19.

The transmission tag on the 01V can be found:

- At the bottom front of the transmission. It is under the left side transmission mount and can be seen using a flashlight.
- On the side of the transmission (not accessible when the transmission is in the vehicle).

Front-Wheel Drive Transmission Tag Locations





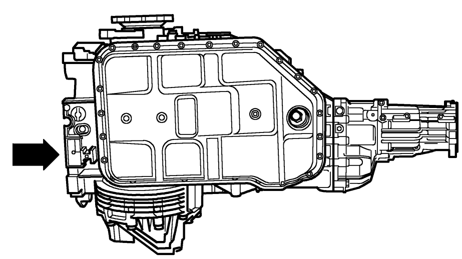
The components of the transmission tag are:

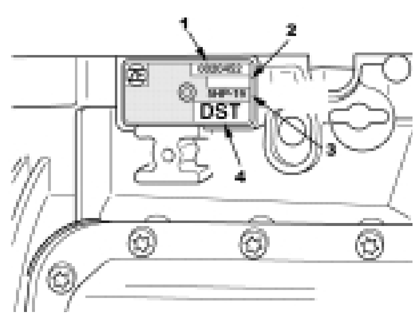
1. Transmission Serial Number
2. Transmission Part List Number
3. Transmission Identification Number
4. Transmission Code Letter

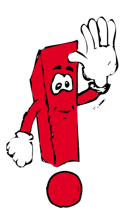
The capacities of the 01V automatic transmission are:

- Initial filling - 9.0 L (9.5 quarts)
- Changing - About 2.6 L (2.7 quarts)
- Lubricant - ATF (FWD) 1.0 ltr G 052 162 A2
- Front and Center Differential Fluid - 0.5 ltr G 052 145 A2.

All-Wheel Drive Transmission Tag Locations







- Additives cannot be added to the Automatic Transmission Fluid (ATF).
- Part numbers are listed for reference only. Always check with your parts department for the latest information.
- Always check VESIS for the correct automatic transmission fluid checking procedure.

Basic Automatic Transmission Operation

Objectives:

- Explain torque converter operation
- Explain torque converter clutch operation
- Explain the function of planetary gearsets
- Explain the difference between clutches and brakes
- Explain the function of the oil pump
- Explain the function of the computer controls
- Explain the function of the sensors and the actuators
- Explain emergency running modes

Hydraulic Torque Converter

Torque Conversion

The basic torque converter consists of the:

- Impeller or Pump
- Turbine
- Stator

The impeller mounts to the converter housing, which bolts to the flywheel. The turbine is splined to the transmission input shaft.

When the engine is running, the impeller slings the oil in the converter into the fins on the turbine. That motion of the oil being thrown against the turbine is what provides the torque to the transmission input shaft and drives the vehicle.

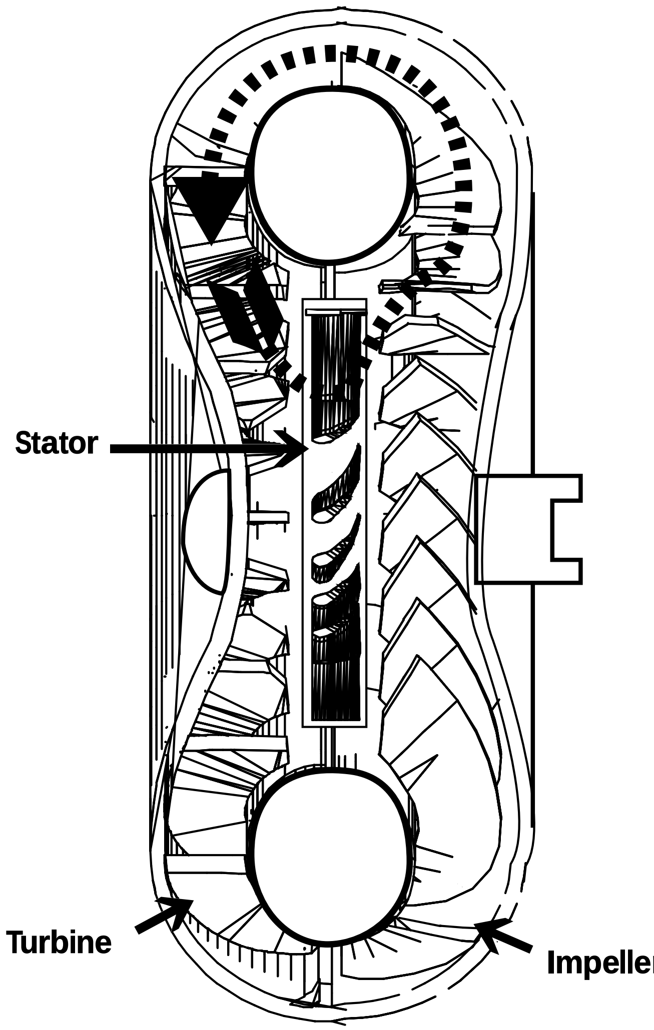
Since there is no direct mechanical connection between the engine and transmission, you can come to a full stop without shifting into neutral or releasing a clutch. The natural slip between the impeller and the turbine allows the engine to keep running when the vehicle is at a full stop, even while in gear.

However, once the oil leaves the turbine, it is moving in the opposite direction of the impeller, and will slow the impeller speed.

The stator corrects this condition. The stator is mounted between the turbine and the impeller. The stator redirects the oil so it is moving in the same direction as the impeller. By changing the direction of the oil as it leaves the turbine, the stator actually increases the overall torque in the system. This process is called torque multiplication.

When the engine is applying power to the torque converter assembly, the stator is locked against its one-way clutch. The stator will unlock and begin to rotate slowly when the impeller and turbine have reached similar speeds.

The torque converter has the ability to multiply the torque of the engine up to 2 1/2 times.



Hydraulic Torque Converter Clutch

In the past, manual transmissions were much better in fuel economy compared to automatic transmissions. This is because a torque converter can only pass about 85 percent of engine power through to the transmission at cruising speeds.

However, engineers came up with a way to make automatic transmissions have better fuel economy. They locked the torque converter housing to the engine by way of friction material.

The Torque Converter Clutch (TCC) locks the transmission input shaft directly to the housing of the torque converter, eliminating the fluid coupling and driving the transmission directly from the crankshaft. This eliminates all slip from the torque converter. Also, since the torque converter produces most of the heat in the transmission, the application of the TCC eliminates all heat production in the converter.

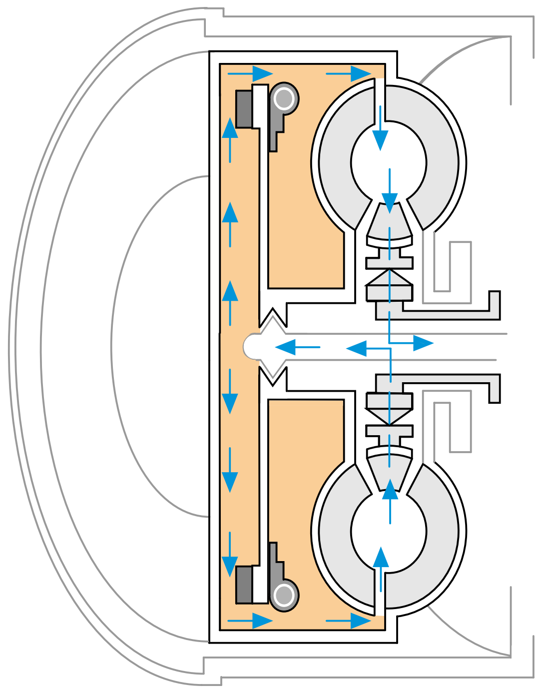
The Volkswagen torque converter clutch in the 01V has three phases of operation: open, control, and lock. These phases can be viewed through the VAG 1551/1552 or the VAS 5051 under the Read Measuring Value Block function.

The TCC is inactive during the open phase. This is normally in the lower gears under high load.

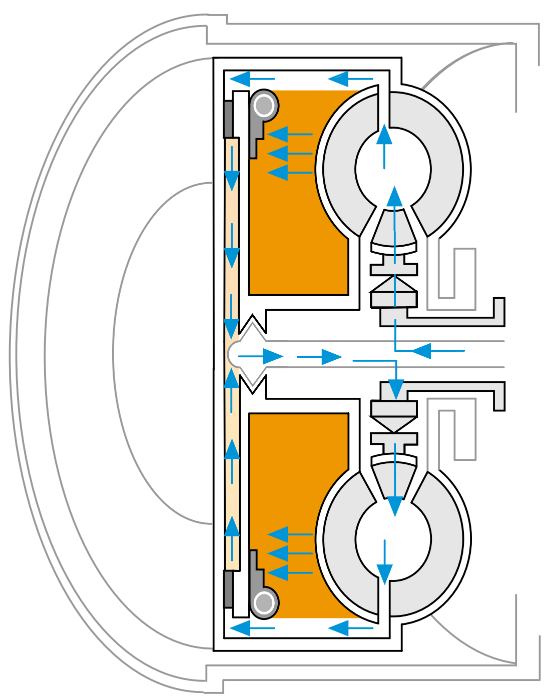
The TCC is applying, but not fully, during the control phase. This usually happens in the lower gears and under heavy throttle.

The TCC is fully applied during the closed phase. This condition occurs in the higher gears and at light throttle. This may also happen in the lower gears in mountainous regions to increase the engine braking effect on the vehicle.

TCC Inactive



TCC Active



Planetary Gearsets

The power transferred through the torque converter is passed on to the planetary gearsets.

Planetary gearsets consist of a central, or sun gear, with planet gears that run on the sun gear and ring gear. These planet gears are attached to the planet carrier.

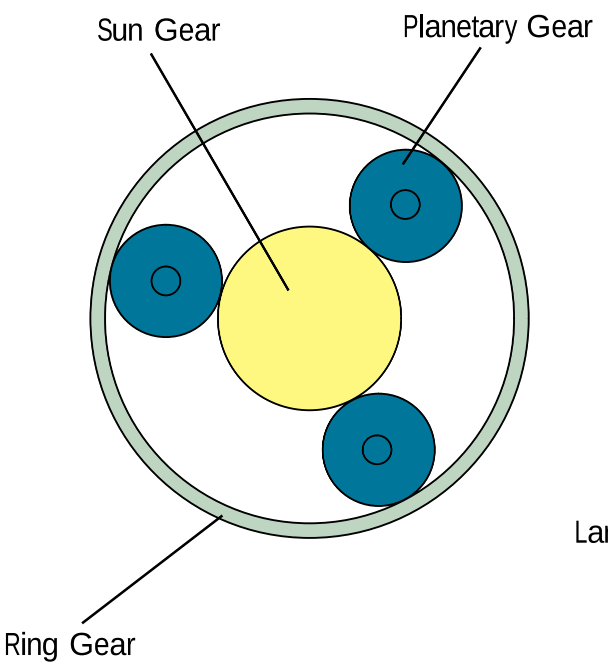
A Simpson gearset is composed of:

- One Sun Gear
- One Planet Carrier with three Planetary Gears
- One Ring Gear

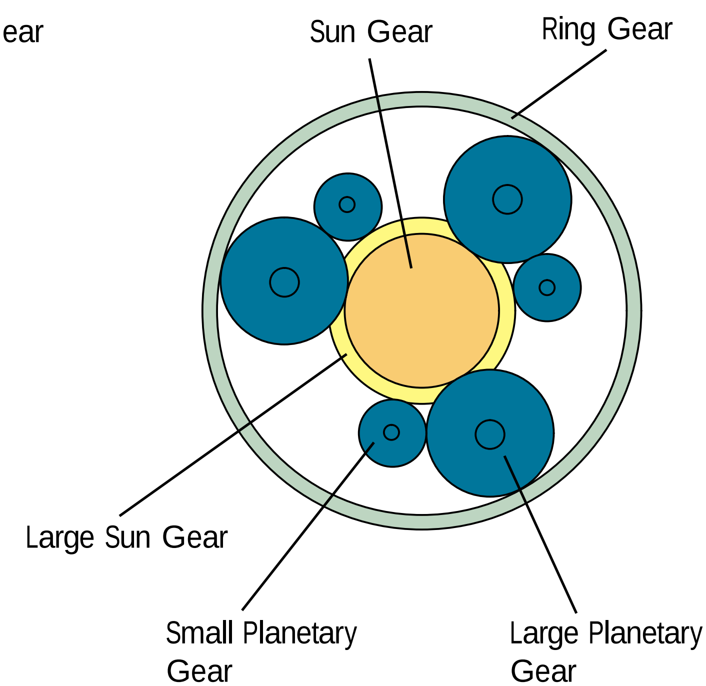
A Ravigneaux gearset is composed of:

- One Small and One Large Sun Gear
- One Planet Carrier with three Small and three Large Planetary Gears
- One Ring Gear

The 01V transmission uses both a Ravigneaux gearset and a Simpson gearset. The function of the planetary gearsets is to create different gear ratios. These ratios are created by holding and driving different parts of the planetary gearset.



Simpson Gearset



Ravigneaux Gearset

Clutches and Brakes

After the power is transferred from the torque converter, the clutches determine what parts of the planetary gears spin and which are held in place.

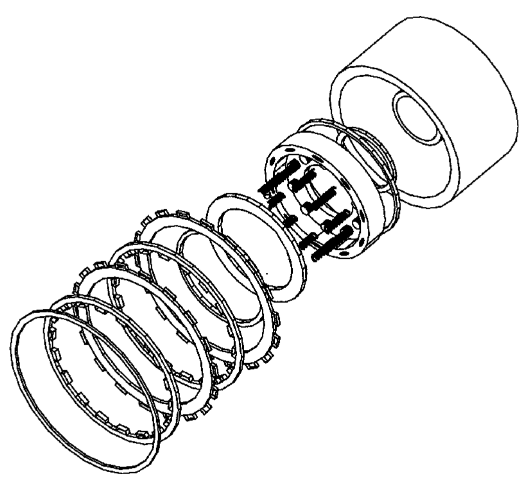
Clutches are a series of friction plates and steel plates alternately splined between two components. When a clutch piston squeezes these plates together, the two components will lock together.

The type of clutches Volkswagen uses are multi-plate wet clutches. This assembly usually consists of four or five clutch discs.

Clutches can either turn or hold a geartrain component. If the clutch pack sits inside a clutch drum, it turns a component.

If the clutch pack splines to the transmission case, it is a holding clutch because it holds a component to the case. Volkswagen refers to holding clutches as brakes.

Some manufacturers use a type of brake called a band. A band wraps around the outside of a clutch drum or geartrain component to hold it in place. Current Volkswagen transmissions do not use bands.



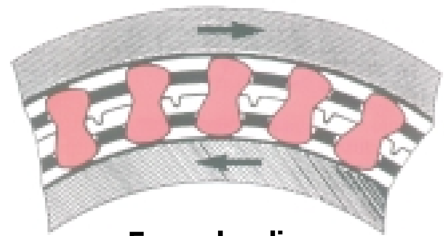
Multi-plate Wet Clutch Assembly

Freewheeling Clutches

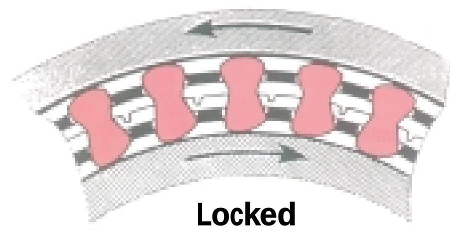
Another type of clutch is the freewheeling clutch. These are known as one-way clutches because they turn freely in one direction, but lock up tight in the other. Freewheeling clutches consist of either spring-loaded rollers mounted in wedge-shaped slots or sprags. Sprags are small, S-shaped pieces held between two smooth races with light spring tension.

When the races are turned in one direction, the rollers or sprags allow the races to slide without interference.

When the races are turned in the opposite direction, the rollers or sprags will wedge themselves between the races, preventing the races from moving.



Freewheeling



Locked

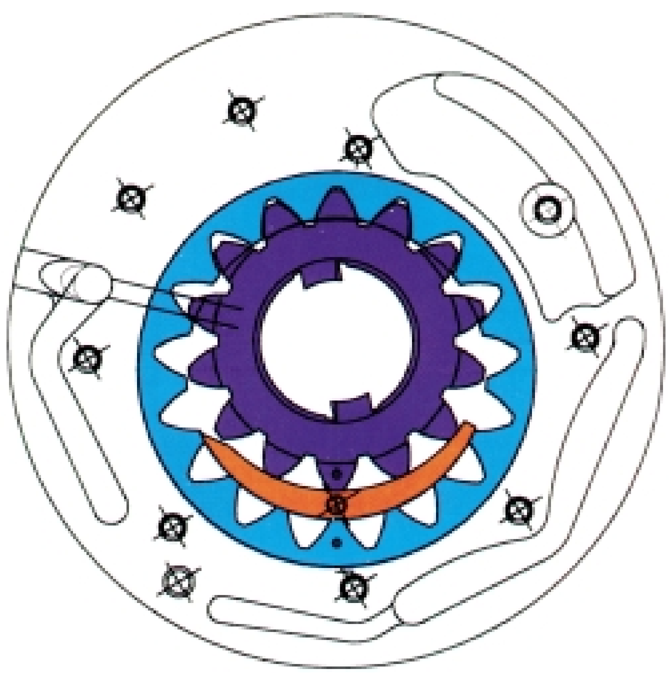
Oil Pump

The oil pump is a crescent-type pump and is located in the area between the torque converter and the transmission housing.

The pump is driven directly from the engine by the torque converter body, and supplies the transmission and selector unit with oil.

The pump draws in the oil through a filter and pumps pressurized oil through the flow control valve. From there, it is passed to the main pressure valve in the valve body.

At higher speeds, any excess pressurized oil is returned to the pump's intake.



Oil Pump

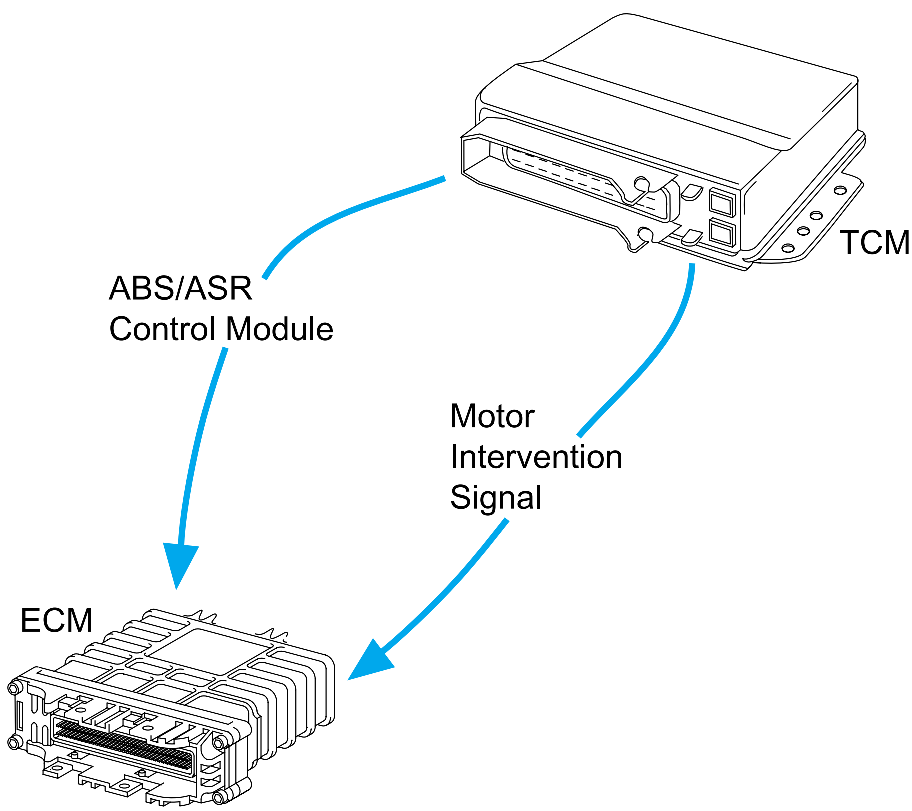
Computer Controls

The Transmission Control Module (TCM) receives signals from many sensors and uses these signals to control when the transmission shifts and how the shifts feel.

Some of the internal transmission sensors are the transmission temperature sensor, the transmission input speed sensor and the transmission vehicle speed sensor.

The main external sensor that the TCM receives information from is the Electronic Control Module (ECM). The ECM supplies signals such as throttle position, engine speed and engine load. However, the TCM also supplies the ECM with signals.

For example, the TCM can tell the ECM when it is planning to shift. The ECM will reduce engine power slightly as the transmission is shifting. As a result, the driver feels a smooth and seamless shift, because the ECM and TCM are working together.



Sensors and Actuators

Sensors

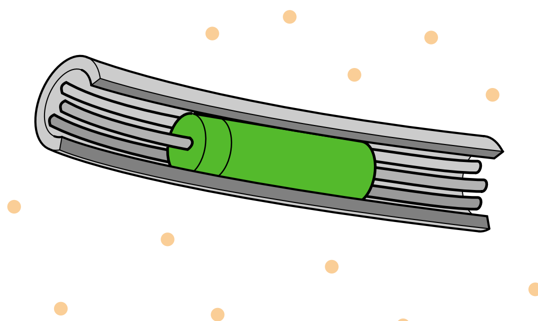
Sensors are components that tell the Transmission Control Module (TCM) what is happening. These components relay the transmission fluid temperature, the transmission input speed, the transmission output speed and many other signals.

This information is then relayed to the TCM. The TCM interprets this information and uses it to control the actuators.

Actuators

The actuators do the work. These are the components that move when commanded. These components are valve body solenoids, pressure control valves, shift lock solenoids and many other components.

The actuators close the loop that the sensors start. As a result, the central computer knows what is happening inside the transmission and how to keep everything operating smoothly.



Transmission Fluid Temperature Sensor

Shift Lock Solenoid (Actuator)

Emergency Running Modes

The 01V has functions called emergency running modes. There are two possible emergency running modes: the default function mode and the emergency running mode.

These modes alter the way the transmission operates when a failure has occurred. These modes are designed to try and eliminate heat production in the transmission, and to allow the vehicle to be driven to safety.

Summary

This section has shown the basics of transmission operation.

Power is transferred from the engine to the transmission through a torque converter. This torque converter is filled with fluid, so there is no direct contact between the engine and the transmission.

The torque converter clutch creates direct contact between the engine and the transmission to help achieve better fuel economy and to cool the transmission fluid.

When the power is transferred into the transmission, it goes into the planetary gearset, which creates different gear ratios.

The clutches and brakes drive and hold the components of the planetary gearset. Clutches are connected to either the input or the output shaft, while brakes are held to the transmission case. One-way clutches turn freely in one direction, but lock up when turned in the other direction.

The oil pump supplies oil pressure to the entire transmission. It is a crescent-shaped pump connected to the torque converter body.

The ECM and TCM communicate with each other to interpret sensor data and control the actuators. This communication affects how and when the transmission shifts.

As a result of these components working together, the transmission transfers power to the wheels smoothly.

01V Automatic Transmission Powerflow

Objectives:

- Explain the components and operation of the Ravigneaux and Simpson gearsets
- Explain which clutches and brakes control the different parts of the planetary gearsets
- Explain which clutches and brakes are active in each gear
- Explain the 01V clutch application chart

01V Planetary Gearsets

The power transferred through the torque converter is passed on to the planetary gearsets.

The 01V transmission has a Simpson planetary gearset and a Ravigneaux planetary gearset.

Planetary gearsets consist of a central, or sun gear, with planet gears that run on the sun gear and ring gear. These planet gears are attached to the planet carrier.

The Ravigneaux gearset is located forward of the Simpson gearset.

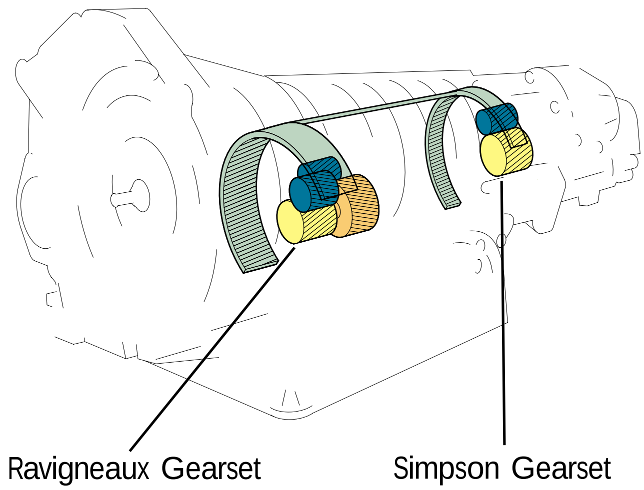
The Simpson gearset is composed of:

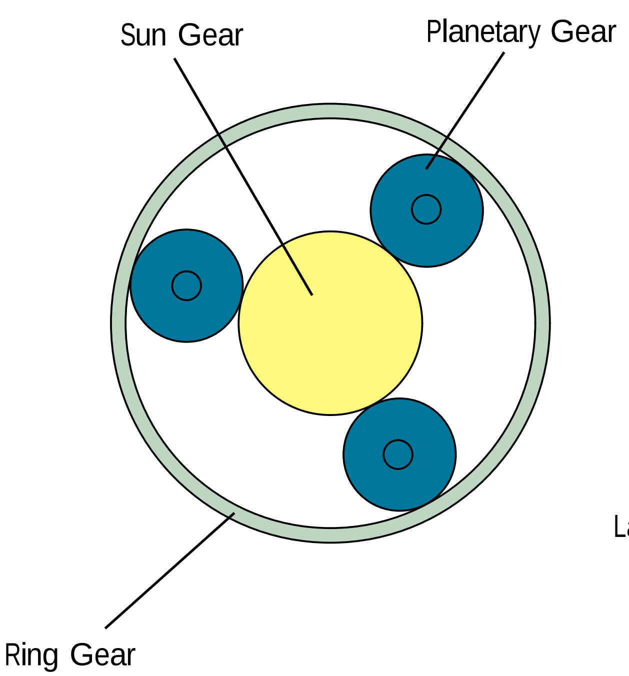
- One Sun Gear
- One Planet Carrier with three Planetary Gears
- One Ring Gear

The Ravigneaux gearset is composed of:

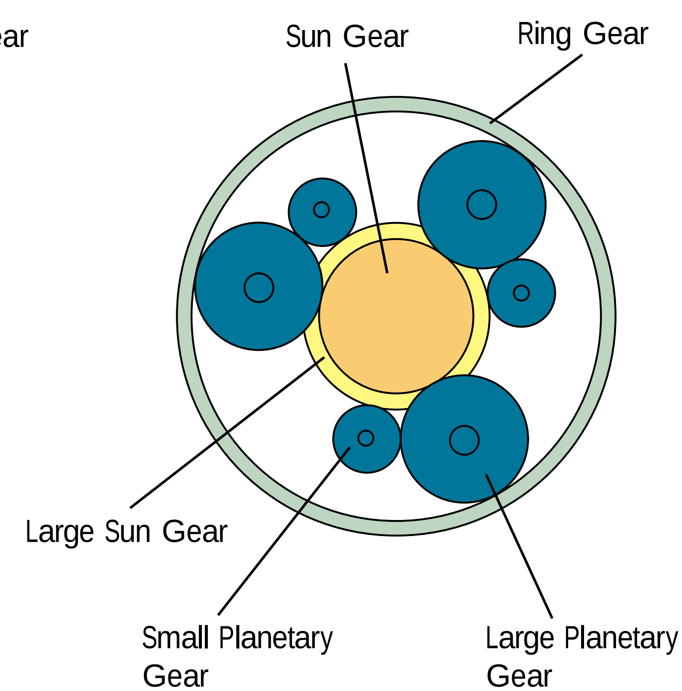
- One Small and one Large Sun Gear
- One Planet Carrier with three Small and three Large Planetary Gears
- One Ring Gear

The ring gears on each of the gearsets are connected to each other and move together.





Simpson Gearset



Ravigneaux Gearset

Powerflow Overview

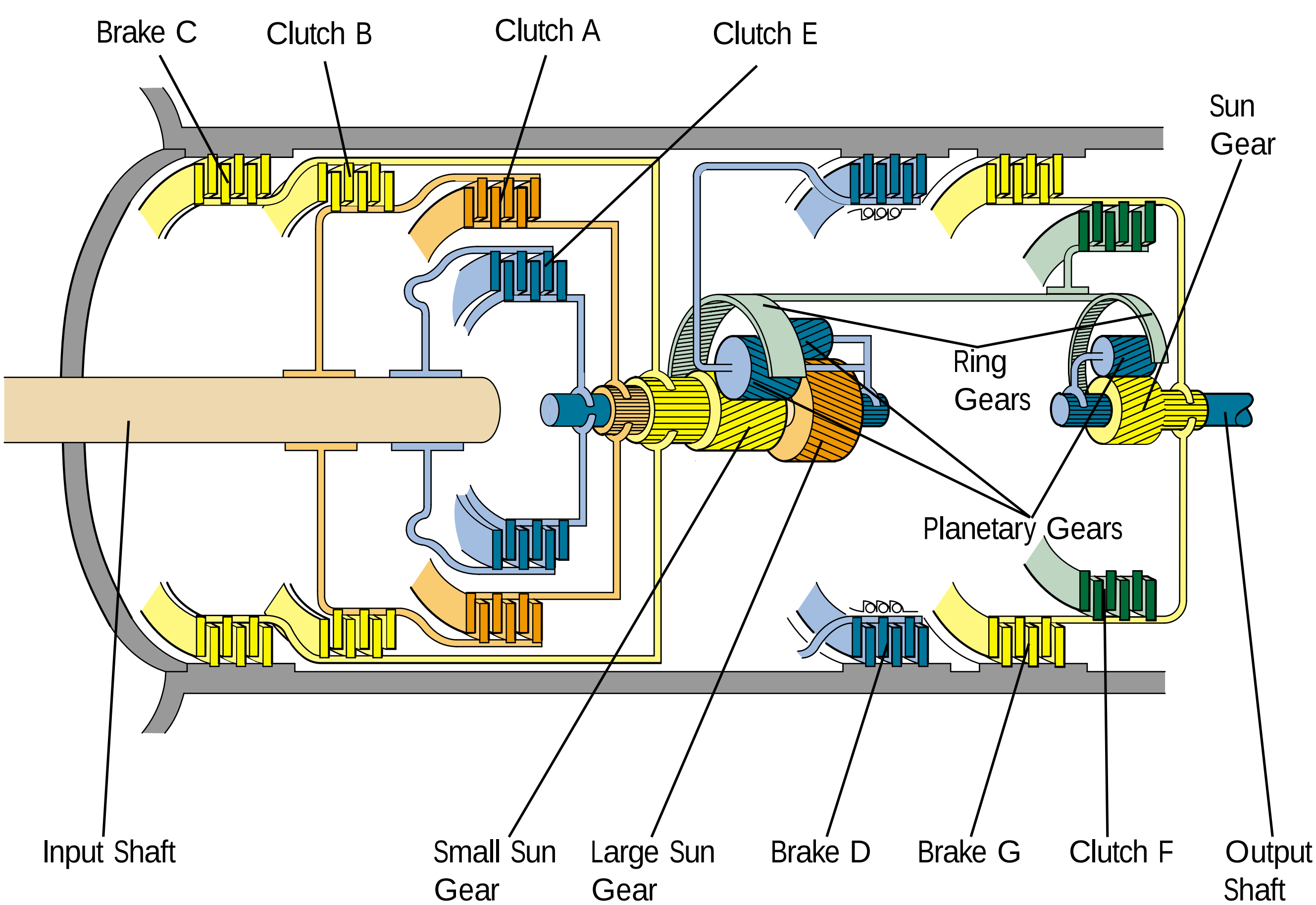
Ravigneaux planetary gearset:

- Clutch A drives the large sun gear
- Brake C stops the small sun gear
- Clutch B drives the small sun gear
- Brake D stops the planet carrier
- Clutch E drives the planet carrier

Simpson planetary gearset:

- Brake G stops the sun gear
- Clutch F drives the sun gear

The output shaft is driven by the planet carrier of the Simpson gearset.



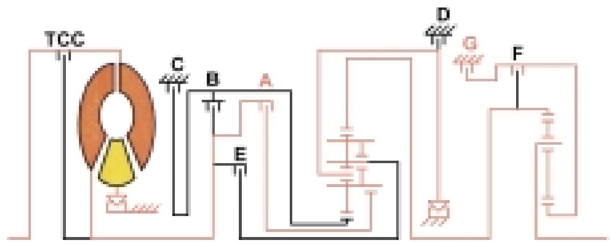
First Gear

Clutch A

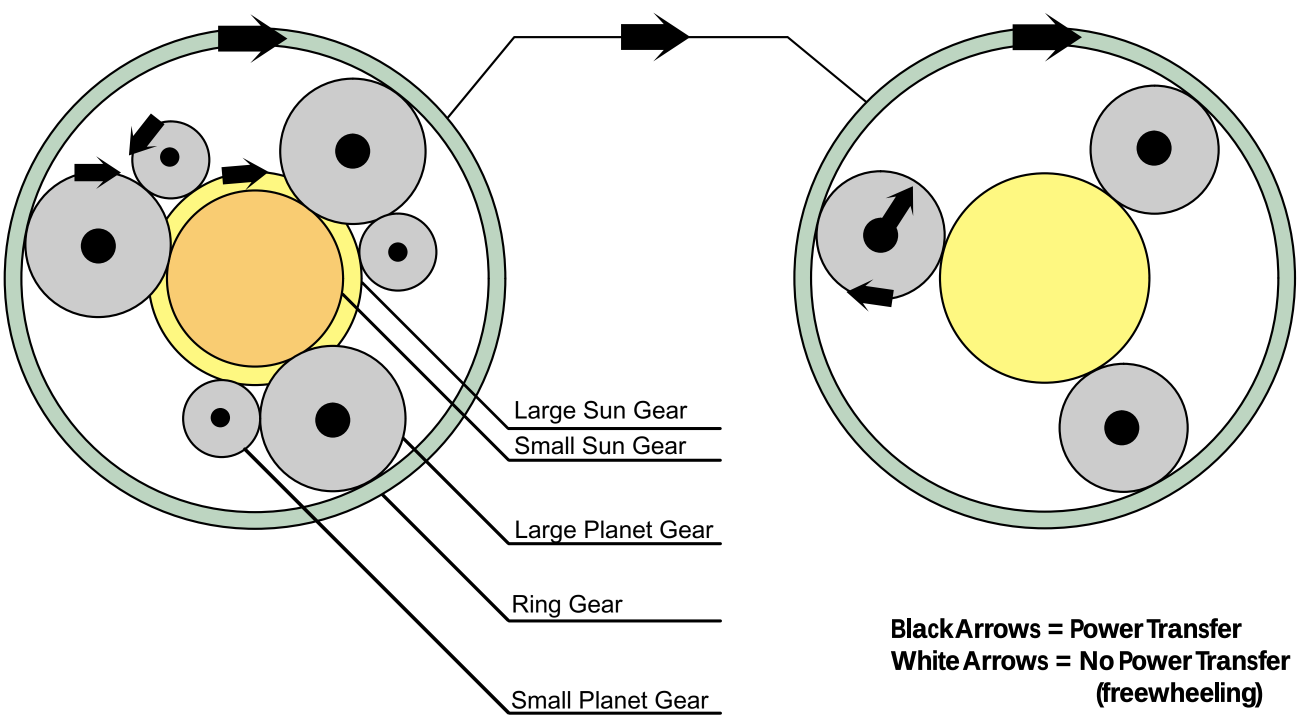
- Drives the large sun gear.
- The freewheel clutch is holding the planet carrier, allowing power to transfer from the small planet gear to the large planet gear. The large planet gear transfers this power to the ring gear.
- The ring gear causes the subsequent (Simpson) ring gear to rotate.

Brake G

- Stops the Simpson sun gear.
- The ring gear drives the Simpson gearset.
- The planetary gears rotate around the sun gear.
- The Simpson planetary housing drives the driveshaft.



Engaged
Disengaged
FL1 = Freewheeling Clutch



Second Gear

Clutch A

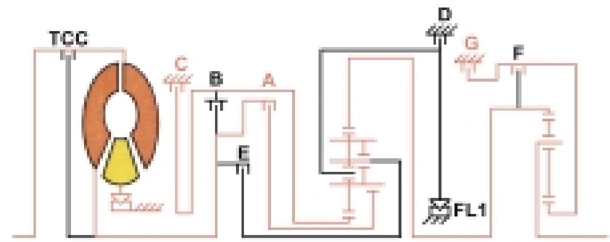
- Drives the large sun gear.
- The large sun gear drives the small planetary gears.
- The small sun gear freewheels in the opposite direction of rotation because the freewheel clutch is holding the planet carrier.

Brake C

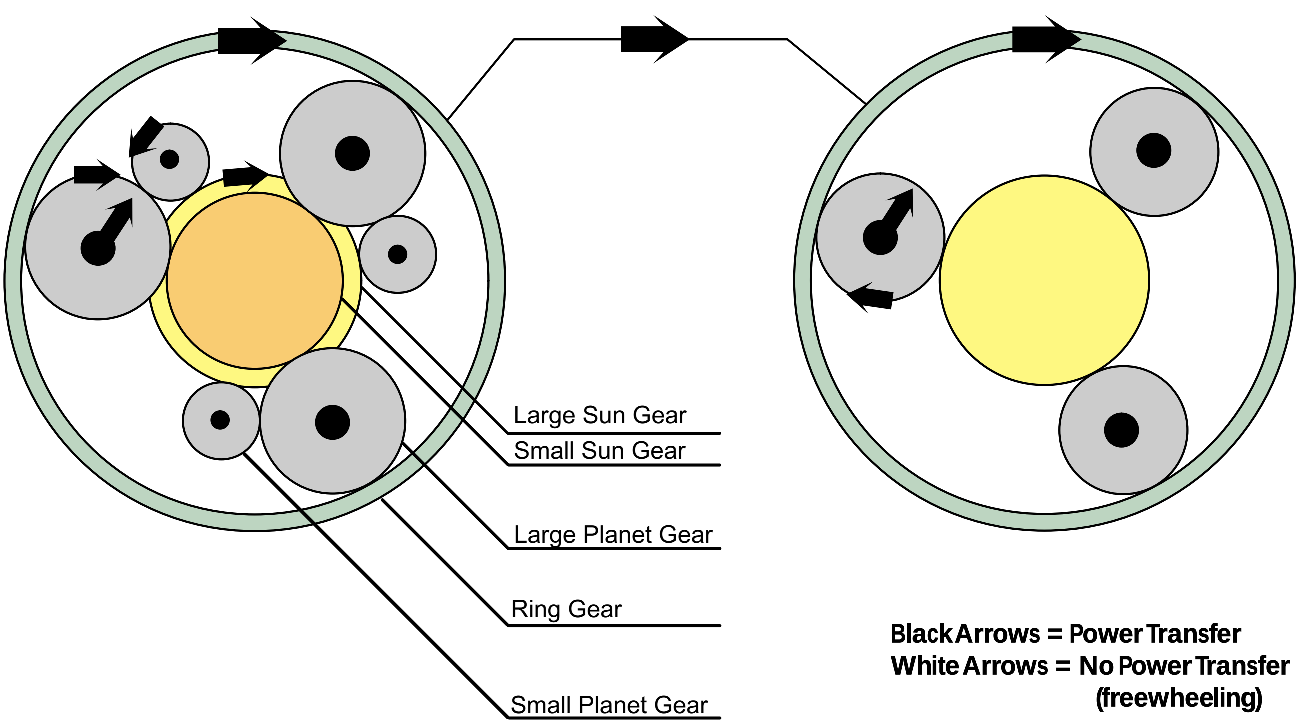
- Stops the small sun gear.
- The large planet gears, driven by the small planetary gears, will travel around the small sun gear in the direction of engine rotation.
- The freewheel clutch is overrun.
- The large planet gears drive the ring gear.
- The Ravigneaux ring gear drives the Simpson ring gear.

Brake G

- Stops the Simpson sun gear.
- The ring gear drives the Simpson gearset.
- The planetary gears rotate on the sun gear.
- The Simpson planetary housing drives the driveshaft.



Engaged
Disengaged
FL1 = Freewheeling Clutch

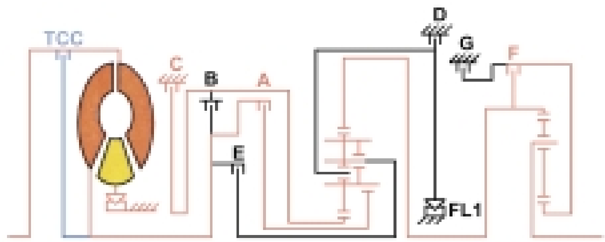


Black Arrows = Power Transfer
White Arrows = No Power Transfer (freewheeling)

Third Gear

Clutch A

- Drives the large sun gear.
- The large sun gear drives the small planetary gears.
- The small sun gear freewheels in the opposite direction of rotation because the freewheel clutch is holding the planet carrier.



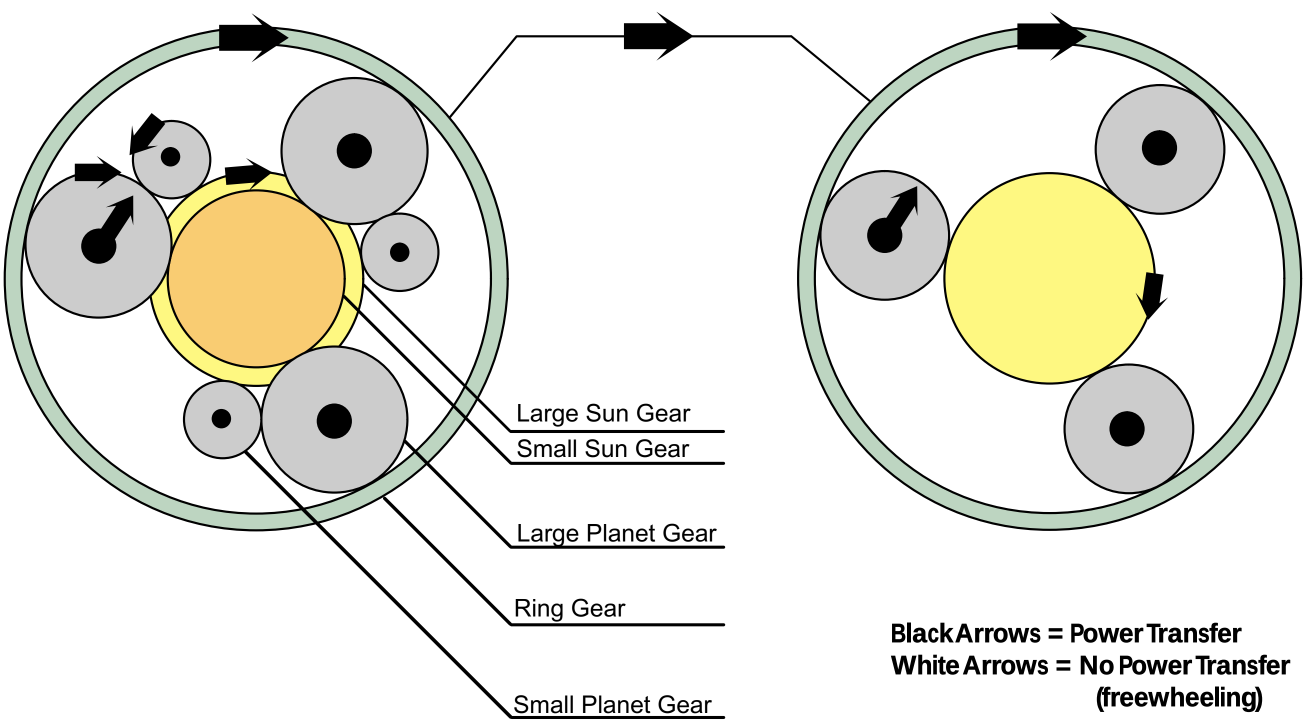
Engaged
Disengaged
FL1 = Freewheeling Clutch

Brake C

- Stops the small sun gear.
- The large planet gears, driven by the small planetary gears, will travel around the small sun gear in the direction of engine rotation.
- The freewheel clutch is overrun.
- The large planet gears drive the ring gear.
- The Ravigneaux ring gear drives the Simpson ring gear.

Clutch F

- Locks the Simpson ring gear, driven by the Ravigneaux gear set, to the Simpson sun gear. The Simpson gear ratio is 1:1.
- The Simpson planet carrier drives the output shaft.



Black Arrows = Power Transfer
White Arrows = No Power Transfer (freewheeling)

Fourth Gear

Clutch A

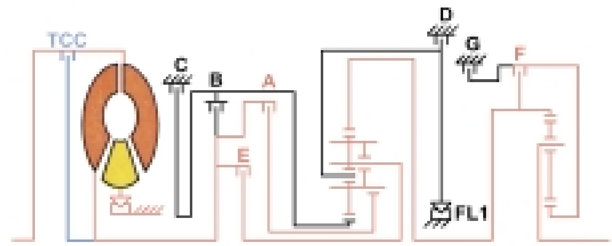
- Drives the large sun gear.

Clutch E

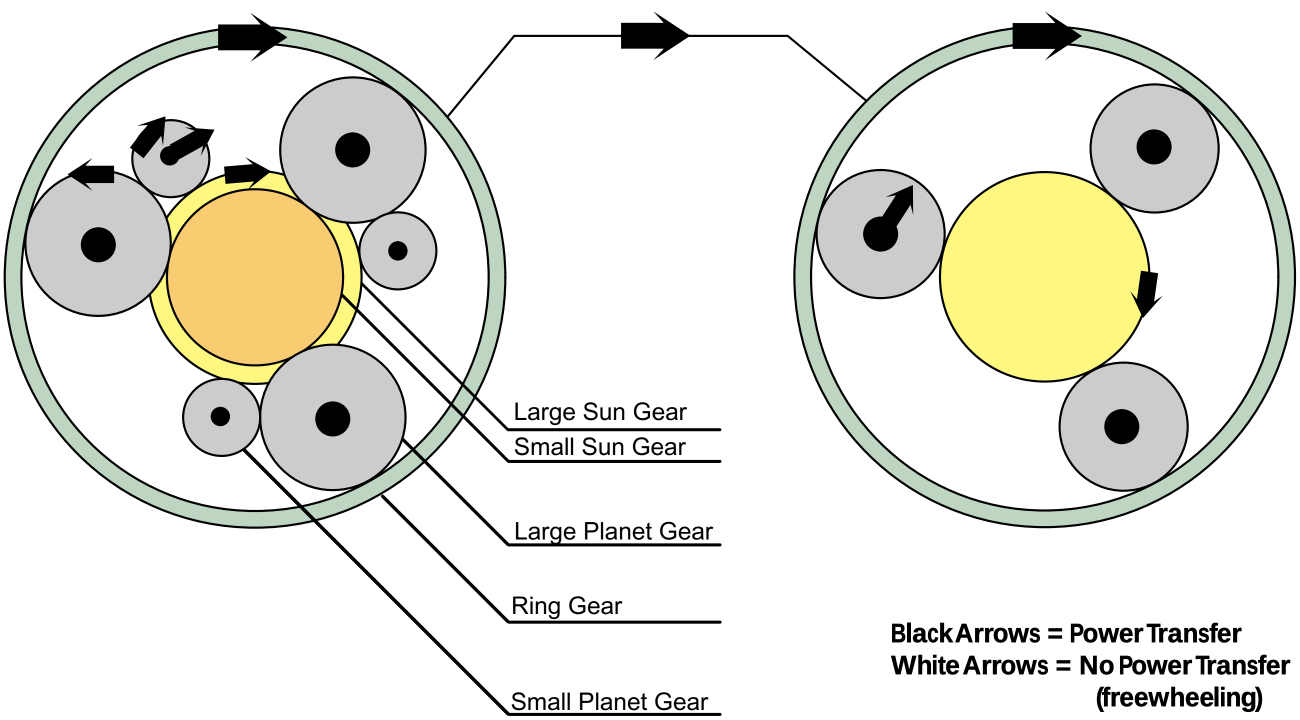
- Drives the planet carrier.
- The planet carrier causes the Ravigneaux assembly to turn 1:1.
- The Ravigneaux ring gear causes the Simpson ring gear to rotate.

Clutch F

- Locks the Simpson ring gear, driven by the Ravigneaux gear set, to the Simpson sun gear. The Simpson gear ratio is 1:1.
- The Simpson planet carrier drives the output shaft.
- Transfer from input shaft to output shaft is 1:1.



Engaged
Disengaged
FL1 = Freewheeling Clutch



Black Arrows = Power Transfer
White Arrows = No Power Transfer (freewheeling)

Fifth Gear

Clutch E

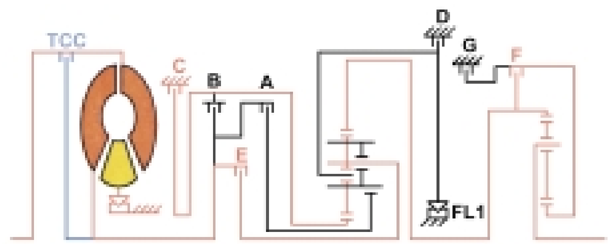
- Drives the planet carrier.

Brake C

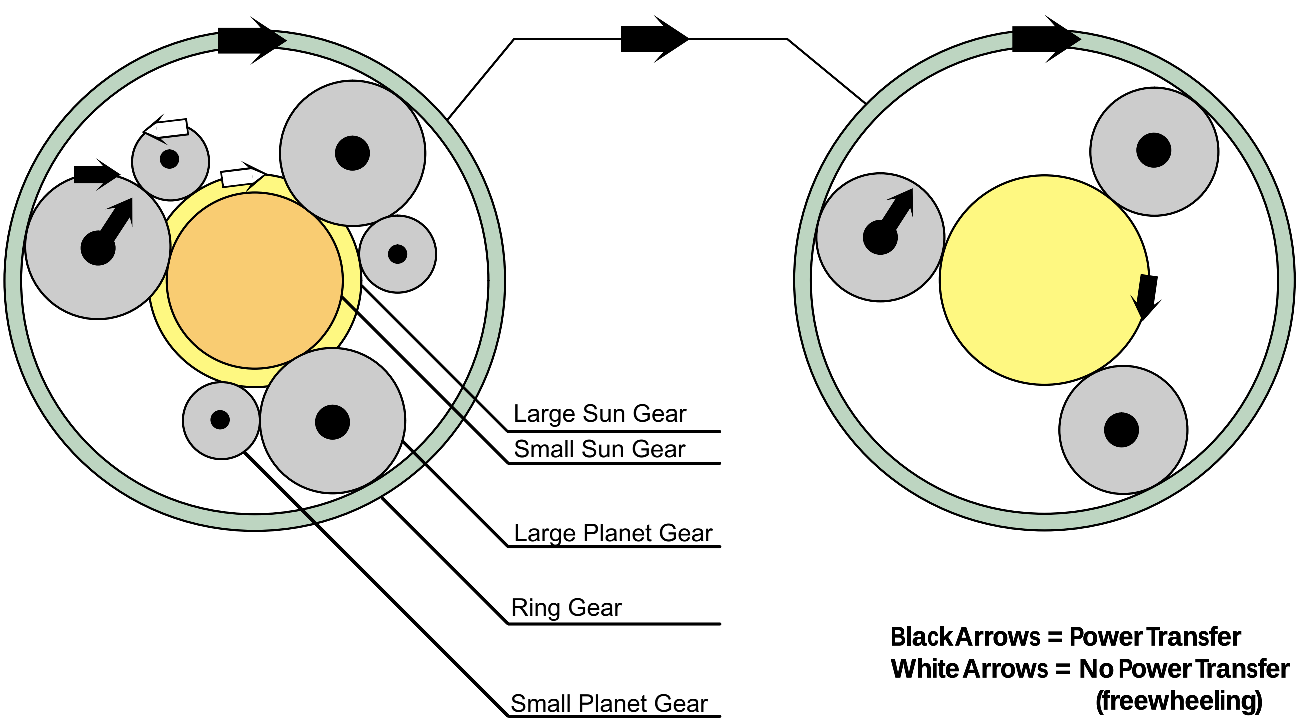
- Locks the small sun gear.
- Planetary gears roll on the smaller sun gear and drive the ring gear (overdrive).
- The Ravigneaux ring gear drives the Simpson ring gear.

Clutch F

- Locks the Simpson ring gear, driven by the Ravigneaux gear set, to the Simpson sun gear. The Simpson gear ratio is 1:1.
- The Simpson planet carrier drives the output shaft.



Engaged
Disengaged
FL1 = Freewheeling Clutch



Reverse

Clutch B

- Drives the small sun gear.

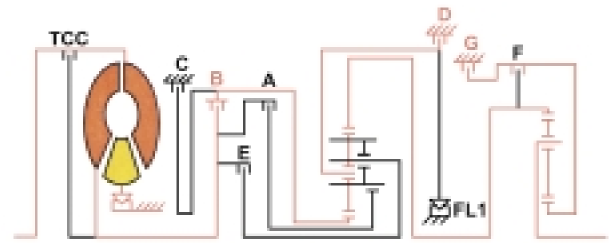
Brake D

- Stops the planet carrier.
- The small sun gear drives the large planetary gears in opposite direction of the small sun gear.
- The large planetary gears drive the ring gear in the same direction as the small sun gear (reverse).
- The ring gear drives the subsequent ring gear.

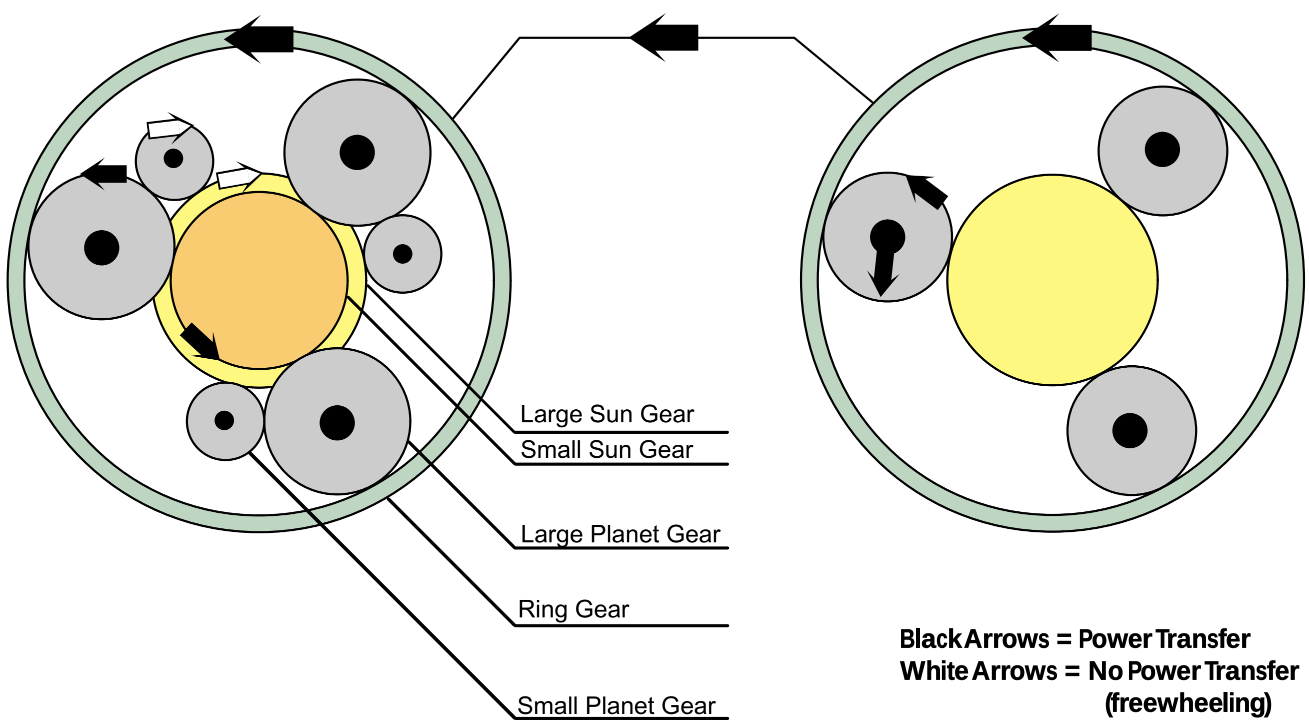
Brake G

- Stops the Simpson sun gear.
- The ring gear drives the Simpson gearset.
- The planetary gears rotate on the sun gear.
- The Simpson planetary housing drives the driveshaft.

A gear reduction is present in both planetary assemblies.



Engaged
Disengaged
FL1 = Freewheeling Clutch



Black Arrows = Power Transfer
White Arrows = No Power Transfer (freewheeling)

Clutch Logic Chart

The clutch logic chart shows what is applied in each gear, similar to the information in the previous pages.

This chart can be very helpful during the diagnosis of a transmission.

For example, if a vehicle comes in that will not shift from first gear to second gear, you can look at the chart and see what is applied.

The only difference between first and second gears is the application of brake C. The symptom would indicate that brake C is not applying.

It is then a matter of determining if the problem is a control problem, due to the wiring or the computer, or whether it is an internal problem, such as a defective valve body, solenoid or clutch.

01V / 5 HP 19								
CLUTCH LOGIC								
POSITION	CLUTCH				BRAKE			FREEWHEEL
	A	B	E	F	C	D	G	1st Gear
R = REVERSE		X				X	X	
N = NEUTRAL				X -			X -	
D, 1ST GEAR	X						X	X
D, 2nd GEAR	X				X		X	
D, 3rd GEAR	X*			X	X			
D, 4th GEAR	X		X	X				
D, 5th GEAR			X	X	X			
2, 2-1 DOWNSHIFT	X					X	X	X
D, 5-4 DOWNSHIFT	(X)		X	X	(X)			
Torque Converter Clutch								

X = Component active
- = Component inactive
(X) = Component active depending on vehicle status (overlapping)

Summary

This section has shown you the overall powerflow through the 01V automatic transmission.

The planetary gearsets, a Ravigneaux and a Simpson, transfer the power through to the driveshaft.

The clutches and brakes control which parts of these planetary gearsets spin and which ones are held. The specific clutch and brake combinations in each gear are given.

Finally, the clutch logic chart is provided as a quick reference to help diagnose the transmission.

The Torsen® Differential

Objectives:

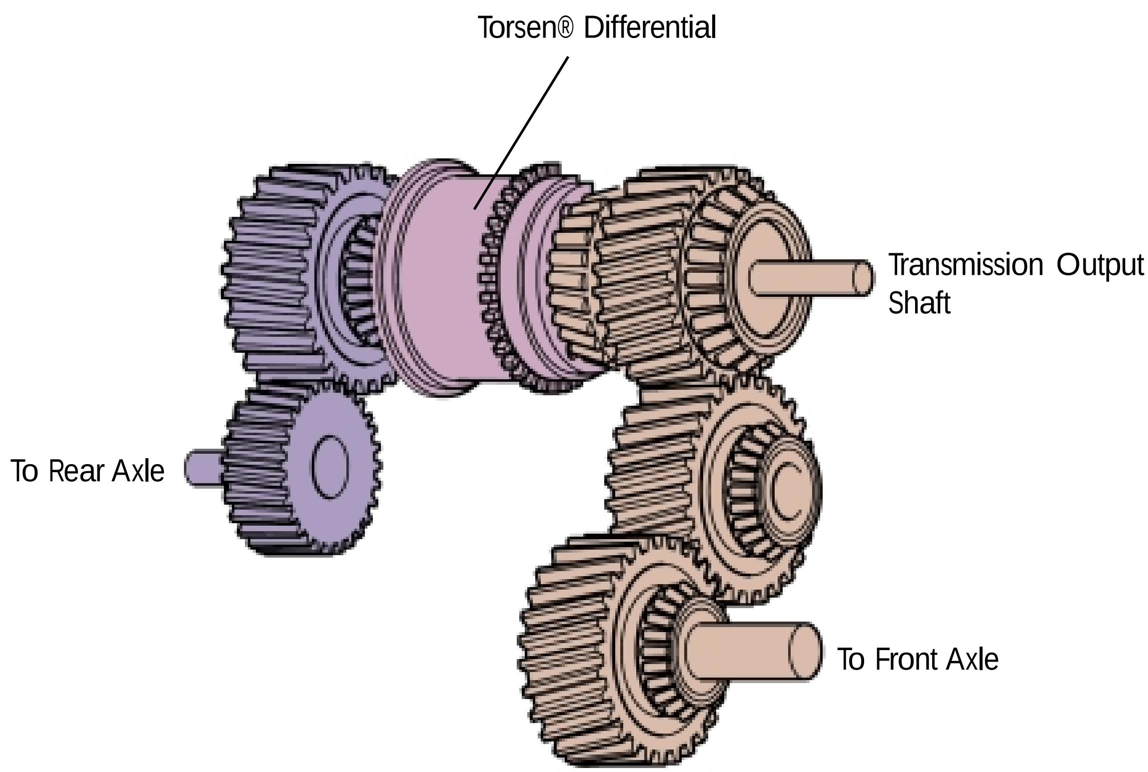
- Explain the application of the Torsen® center differential
- Explain the function of the Torsen® center differential
- Introduce the components of the Torsen® center differential
- Explain the operation of the Torsen® center differential

The Torsen® differential is used in the 01V automatic transmission with all-wheel drive capability. It is located between the front and rear axle shafts, inside the transmission.

The Torsen® differential improves the traction and stability of the vehicle by distributing power between the front and rear driveshafts. Whenever traction is compromised, the Torsen® differential transfers power from the driveshaft that is spinning to the driveshaft that is not spinning.

There is no electronic control to lock or unlock the Torsen® differential. All the torque transfer is done through worm gears using a friction design.

This differential requires no maintenance.



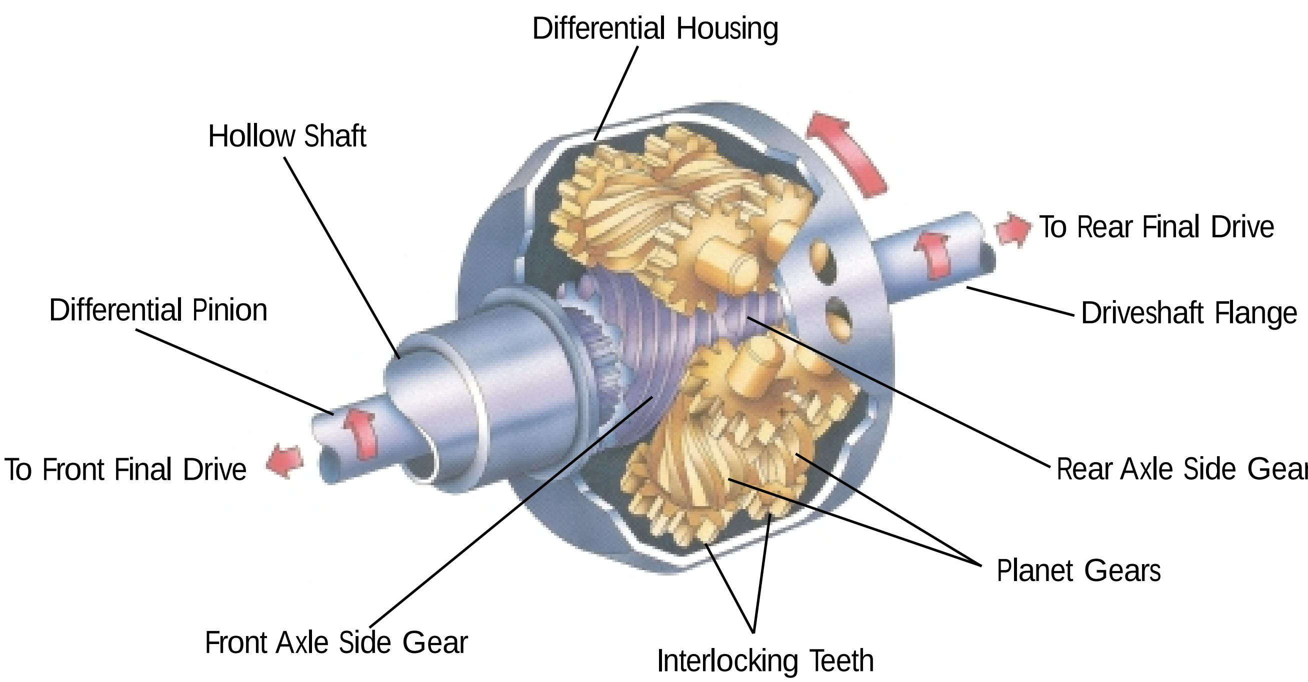
The Torsen® differential is composed of the following components:

- Differential Housing
- Helical Planet Gears (with Spur Gears)
- Helical Front Axle Side Gear
- Helical Rear Axle Side Gear
- Front Driveshaft
- Rear Driveshaft

Inside the Torsen® housing, there are pairs of helical planet gears. The planet gears are held in tight-fitting pockets inside the housing, and are splined together through spur gears at their ends. These spur gears do not allow the planet gears to rotate in the same direction.

The teeth on each of the planet gears mesh with the teeth of one side gear.

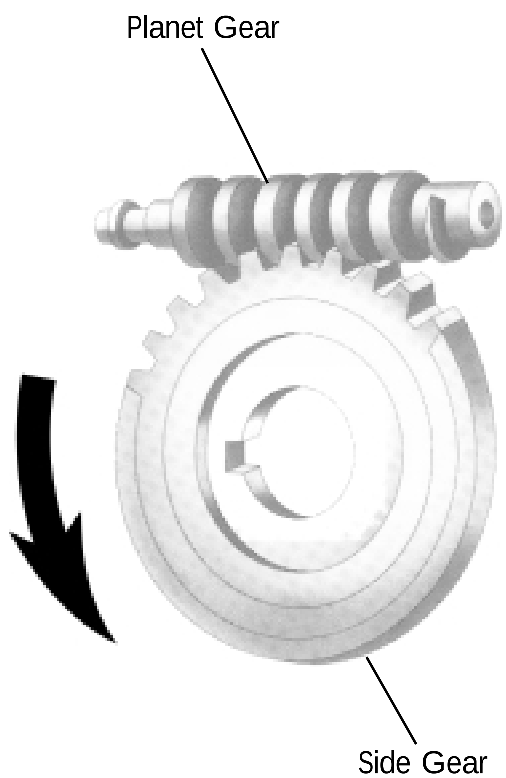
When the vehicle is moving in a straight line with no slip, the transmission drives the Torsen® unit. The Torsen® unit in turn drives the planet gears, which drive the side gears.



When an axle loses traction, the planet gears, through the spur gears, are responsible for the power transfer.

The interlocked planet gears will apply even force to each side gear. Only the planet gear meshed to the side gear that has traction can apply this force. The other planet gear is simply following along.

The maximum amount of power that can be sent to the axle with better traction is determined by the Torque Bias Ratio (TBR). TBR is determined by the angle and shape of the teeth on the side and planet gears. The TBR of the Torsen® differential is about 21. This means that about two-thirds of the torque, or about 67 percent, can be sent to the axle with better traction. The remaining third is sent to the other axle.



Summary

The Torsen® differential is used in all-wheel drive applications. It is made up of worm gears, ring gears, interlocking teeth and a carrier housing. These parts all work together to apply power to the axle that has the most traction.

Electronic Operation

Objectives:

- Explain the operation of the Transmission Input Speed Sensor G182
- Explain the operation of the Transmission Vehicle Speed Sensor G38
- Explain the function of the Kick-down Switch F8
- Explain the Motronic Kick-down Strategy
- Explain the function of the Brake Light Switch F
- Explain the function of the Transmission Oil Temperature Sensor G93
- Explain the function of the Multifunction Switch F125
- Explain ECM to TCM communication
- Explain TCM to ECM communication
- Explain the operation of the 01V Solenoid Valves
- Explain the operation of the 01V Pressure Control Valves
- Introduce the 01V Solenoid Apply Chart
- Explain the function of the Shift Lock Solenoid N110
- Explain the function of the Selector Lever Position Indicator
- Explain the function of the Cruise Control Switch
- Explain the function of the Automatic Transmission Relay J60
- Explain the function of the Ignition Lock J207

Sensors

ECM

Transmission Input Sensor G182

Transmission Vehicle Speed Sensor G38

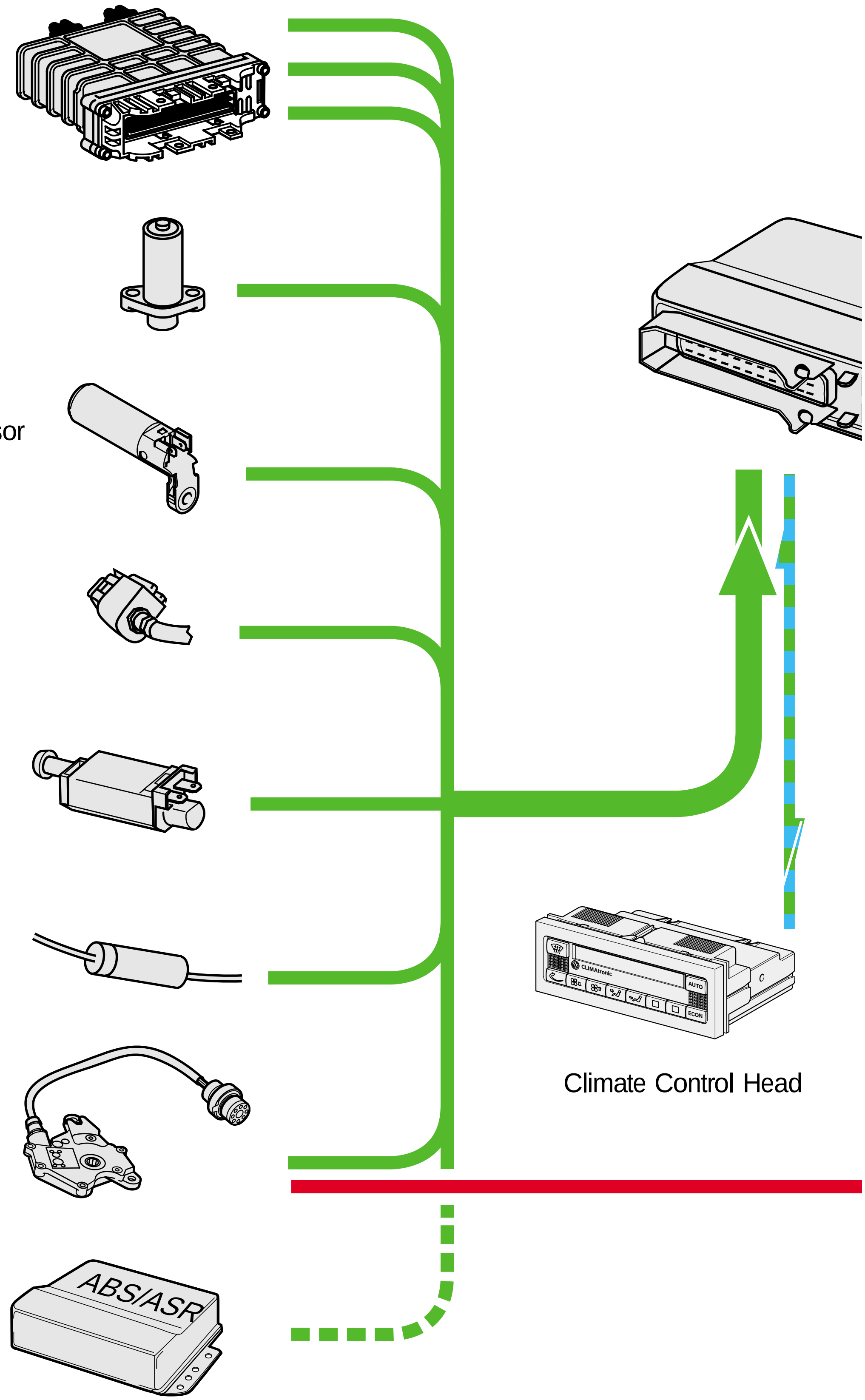
Kick-down Switch F8

Brake Light Switch F

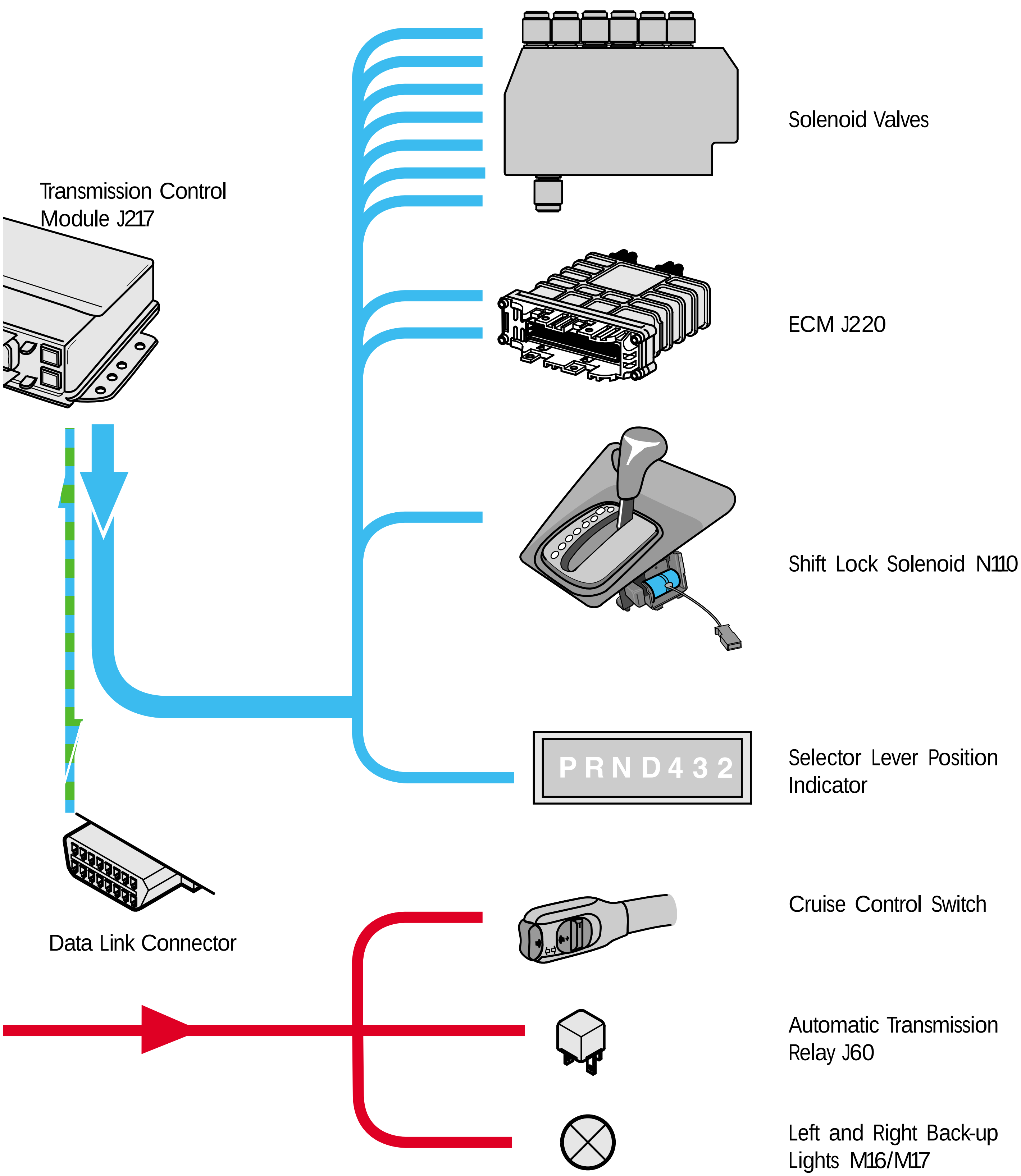
Transmission Oil Temperature Sensor G93

Multifunction Transmission Range (TR) Switch F125

ABS/ASR Electronic Control Module



Actuators


Transmission Control Module J217
Solenoid Valves
ECM J220
Shift Lock Solenoid N110
P R N D 4 3 2
Selector Lever Position Indicator
Data Link Connector
Cruise Control Switch
Automatic Transmission Relay J60
Left and Right Back-up Lights M16/M17

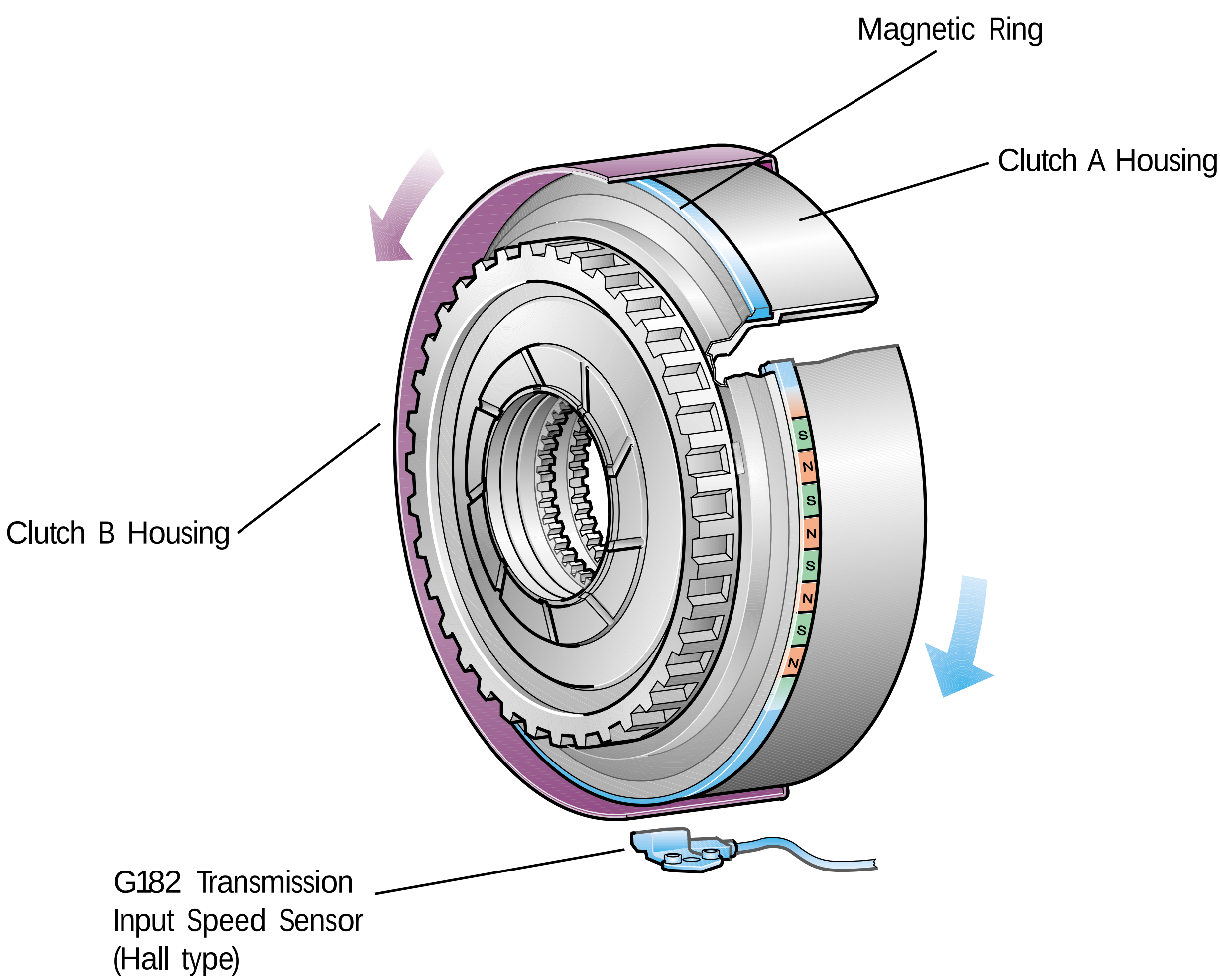
Sensors

Transmission Input Speed Sensor G182

The Transmission Input Speed Sensor G182 is used to measure shift duration. The measured speed change during a shift must meet the mapped speed in the TCM. This mapped speed is dependent on the load of the engine and the speed of the vehicle. The TCM will adjust the shift time accordingly to try and meet the mapped value.

A new Hall sensor replaces an inductive sensor for G182 in the 01V transmission. The Hall sensor can measure input speed better than an inductive sensor and allows more shift control.

Inside the transmission, a magnetic ring is attached to the housing of Clutch A, which spins at the speed of the Ravigneaux planetary carrier (turbine speed). In order for the Hall sensor to sense the magnetism of clutch A, clutch B is made of aluminum (clutch A is inside of clutch B).



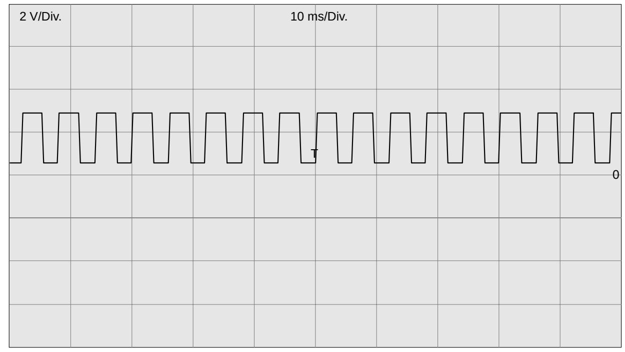
Sensors

G182 Hall Sensor Signal Characteristics

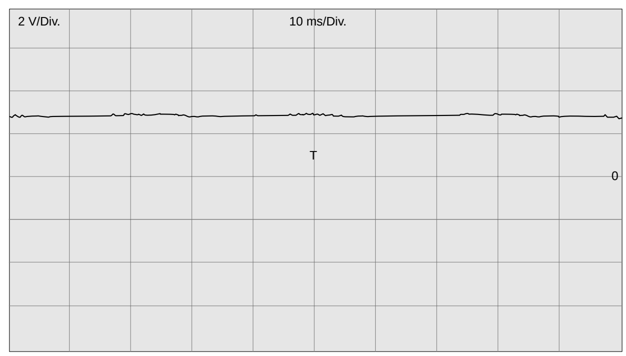
The advantages of a more accurate input speed are:

- Control and adaptations between first gear and reverse. This reduces the engagement jolt when a drive gear is selected from park or neutral, and when a rolling downshift into first is performed.
- Improvement in shift quality in all gears through precise control and adaptation of gearshifts.
- Improvement in self-diagnostic quality through early detection of a slipping clutch or brake.

Good Signal



Poor Signal



Signal Application

The signal of the transmission input RPM is required for the shift transitions between the gears to be smoothly regulated.

Effect of Signal Failure

The transmission will operate in Emergency Mode.

Self-Diagnosis Failure Message

Sensor for the Transmission Input RPM G182
No Signal/Implausible Signal

Sensors

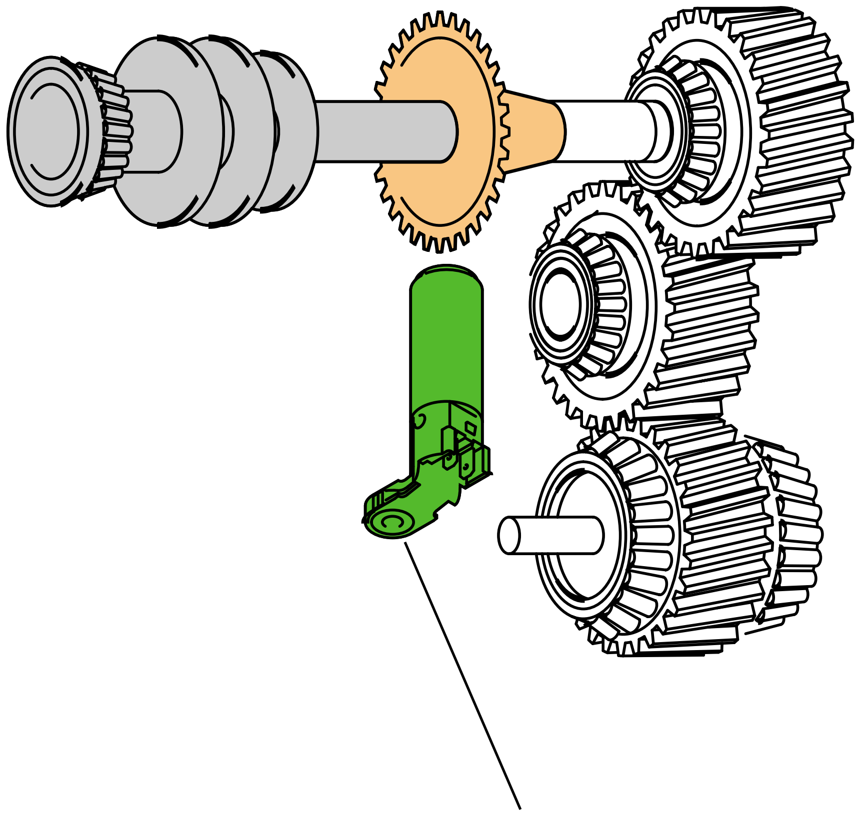
Transmission Vehicle Speed Sensor G38

The Transmission Vehicle Speed Sensor G38 is an inductive sensor that records transmission output RPM.

The ECM calculates the vehicle speed from the transmission output RPM.

Shielding for the signal wires prevents outside electric interference.

The sensor on the 01V front-wheel drive and all-wheel drive uses a trigger wheel on the output shaft for a signal.



Signal Application

The signal of the transmission output RPM is required for the shift transitions between the gears to be smoothly regulated.

Effect of Signal Failure

If the signal fails, the vehicle will operate in Emergency Mode.

Self-Diagnosis Failure Message

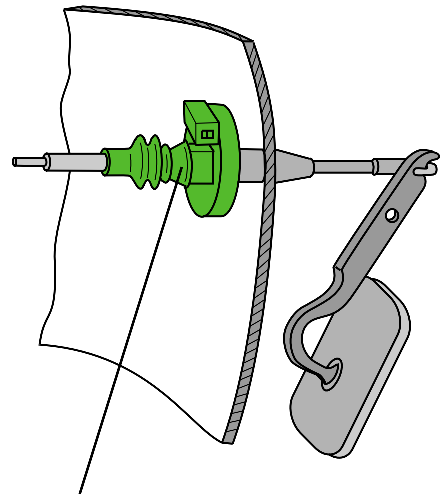
Transmission Speed Sensor G38
No Signal/Implausible Signal

Sensors

Kick-down Switch F8

The Kick-down Switch F8 is activated when the accelerator is completely depressed (to the floor).

All Passats since 1998 that do NOT have Motronic Engine Management 7 (ME7) or newer engine control have a kick-down switch that is integrated into the accelerator cable. The switch is located in the engine compartment in front of the spray guard to the passenger compartment.



Throttle Cable Kick-down Switch

Signal Application

When the driver depresses the accelerator to the floor, the transmission downshifts to accelerate. If the transmission receives this signal in fifth gear, it will downshift to the lowest possible gear, depending on vehicle speed.

As a rule, the automatic transmission holds the lower gears longer to assist in acceleration.

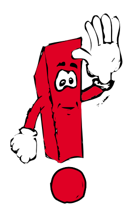
If the accelerator is held in the kick-down position longer, the air conditioning will shut off. This provides more power to the wheels.

Effect of Signal Failure

Tiptronic transmissions will not downshift without a kick-down signal. They will also not recognize a kick-down signal if the throttle is not applied 95 percent or more.

Self-Diagnosis Failure Message

Kick-down Switch F8
Short to Ground/Electrical Malfunction in Circuit



On vehicles with a throttle cable, make sure the cable is adjusted correctly. Incorrect adjustment can cause driveability concerns. Check VESIS for the correct adjustment procedure.

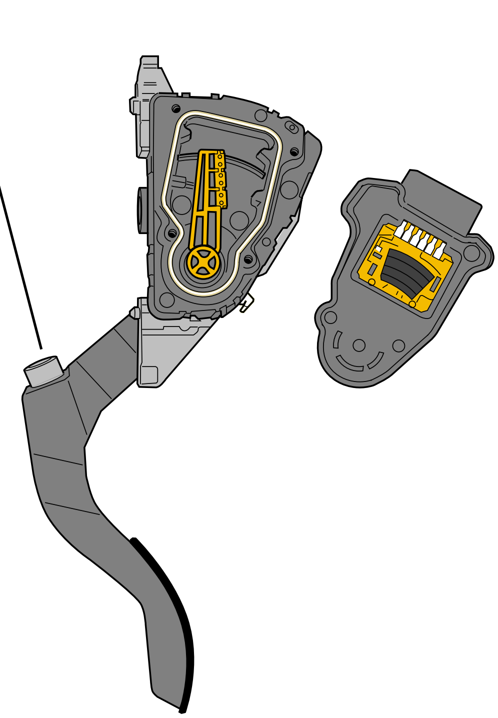
Vehicles with Motronic Engine Management 7 (ME7) do not have a throttle cable. The ME7 kick-down strategy is explained on the next page.

Sensors

Motronic Kick-down Strategy

All vehicles with Motronic Engine Management 7 (ME7) and newer engine control do not have a throttle cable or a kick-down switch. These vehicles have an Accelerator Pedal Module to determine the position of the accelerator pedal.

The Accelerator Pedal Module is made up of two independent potentiometers: G79 and G185. If one sensor fails, the other acts as a substitute.



Accelerator Pedal Module

Signal Application

When the driver depresses the accelerator to the floor, the transmission downshifts to accelerate. If the transmission receives this signal in fifth gear, it will downshift to the lowest possible gear, depending on vehicle speed.

As a rule, the automatic transmission holds the lower gears longer to assist in acceleration.

If the accelerator is held in the kick-down position longer, the air conditioning will shut off. This provides more power to the wheels.

Effect of Signal Failure

The engine will go into Emergency Running Mode.

Self-Diagnosis Failure Message

Throttle Position Sensor G79
Open or Short Circuit/Malfunction

Throttle Position Sensor G185
Open or Short Circuit/Malfunction

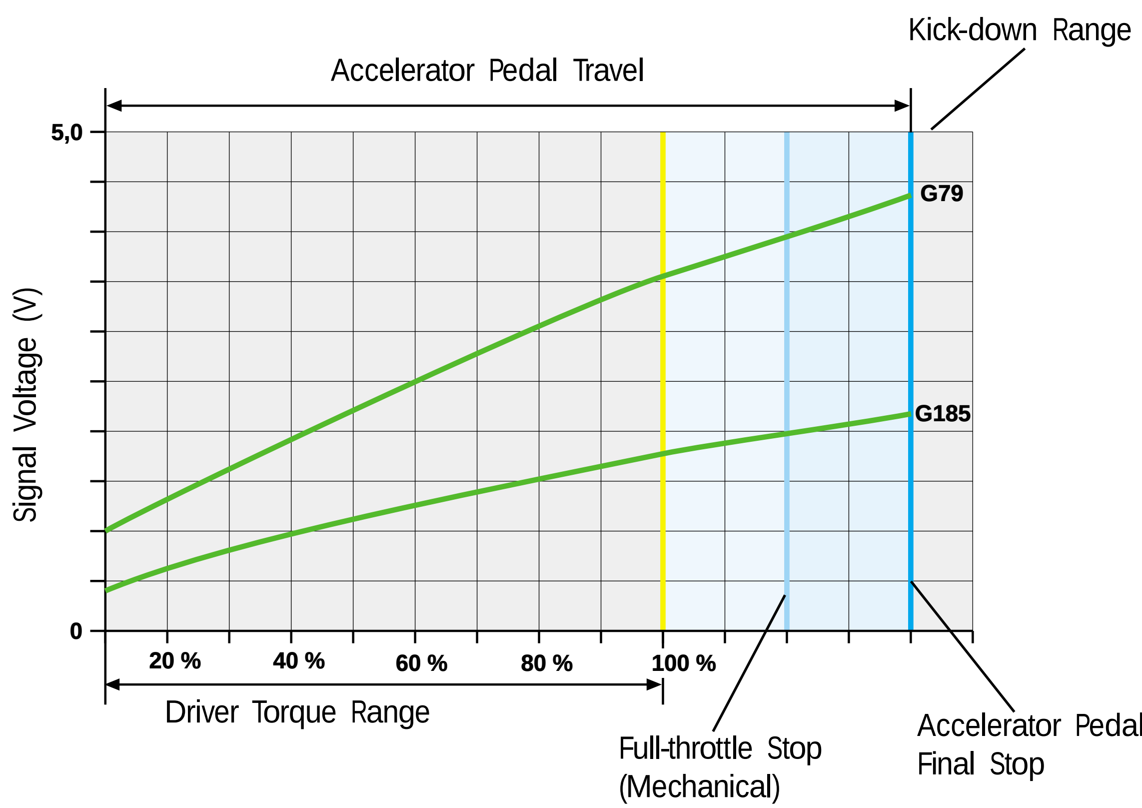
Sensors

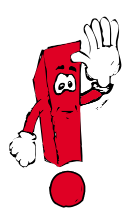
Motronic Kick-down Strategy (continued)

Automatic transmission vehicles have a pressure element in place of the accelerator pedal stop. This pressure element generates a mechanical pressure point which gives the driver a kick-down feeling.

When the driver pushes the throttle pedal to this point, the internal components of the accelerator position sensor will exceed the full-load voltage normally sent to the ECM. The ECM interprets this excessive voltage level as a "kick-down" action and will transfer this information to the TCM.

The kick-down switching point can only be tested using diagnostic testers.





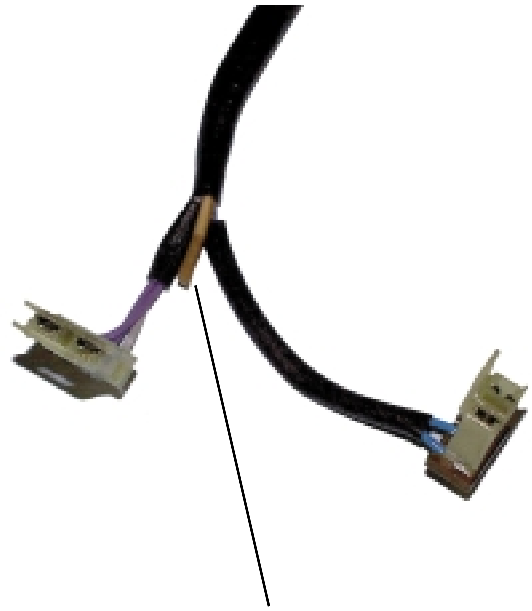
If the accelerator pedal module or the engine control module is changed, the Scan Tool adaptation function must be performed.

Sensors

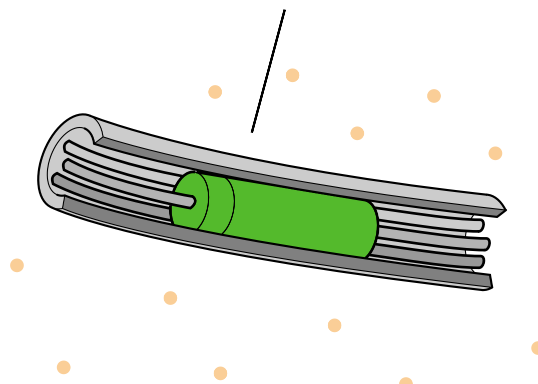
Transmission Oil Temperature Sensor G93

The Transmission Oil Temperature Sensor G93 is a NTC thermistor that continuously monitors the Automatic Transmission Fluid (ATF) temperature. It is located inside the wiring harness that goes to the solenoid valves. This sensor receives a voltage signal from the TCM.

The TCM will use the signal from the transmission oil temperature sensor to initiate special shifting programs during warm-up to bring the catalytic converter(s) up to operating temperature faster.



Transmission Oil Temperature Sensor



Signal Application
The transmission oil temperature is monitored so the transmission will not overheat. If the ATF oil temperature increases to approximately 120 degrees C, the Torque Converter Clutch (TCC) will begin engaging earlier.

Effect of Signal Failure
The TCC will no longer engage.

Self-Diagnosis Failure Message
Sensor for the Transmission Oil Temperature G93 Short to Ground Short to Positive Implausible Signal Electrical Malfunction in Electrical Circuit

Sensors

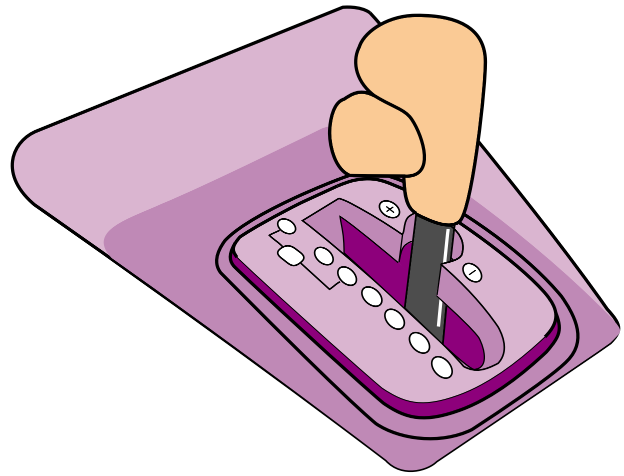
Tiptronic Switch F189

The Tiptronic Switch F189 allows the driver to control which gear the transmission stays in.

When the shift lever is in drive and moved to the passenger side of the vehicle, it will go into the Tiptronic gate. The driver can then either push the shift lever forward to switch to the next higher gear, or push the shift lever back to switch to the next lowest gear.

The TCM will not downshift into a gear that can damage the transmission or cause excess engine speed. Also, the TCM will automatically upshift into the next higher gear when the engine reaches maximum RPM.

The Tiptronic Switch F189 is composed of three separate switches. The center switch detects when the selector lever has entered the Tiptronic gate. The front switch detects when the selector is moved forward in the selector gate, and the rear switch detects when the selector lever is moved back.



Tiptronic Switch

Signal Application
When in drive, moving the selector lever towards the passenger side will enable Tiptronic operation. When in Tiptronic mode, moving the shifter forward will cause a transmission upshift, and moving the shifter back will cause a downshift.

Effect of Signal Failure
Tiptronic will not operate.

Self-Diagnosis Failure Message
Short circuit to ground Tiptronic switch is faulty

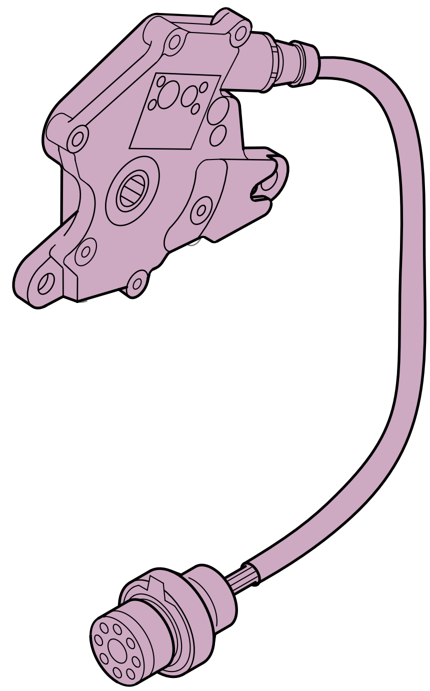
Sensors

Multifunction Transmission Range Switch F125

The Multifunction Transmission Range Switch F125 is mounted on the outside of the transmission housing and is mechanically operated through the control cable of the selector lever.

The Multifunction Transmission Range Switch F125 has the following positions:

P, Z1, R, Z1, N, Z2, D, Z3, 4, Z4, 3, Z4, 2



Multifunction Transmission Range Switch F125

Signal Application

Transmits the position (P, Z1, N, etc.) of the selector lever to the TCM.

Control of relay J60. This prevents the engine from being started when the transmission is in a drive gear.

Supplies power to the cruise control module in D – 4.

Switches the reverse lights on when the transmission is put in reverse.

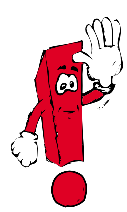
Activates the shift-lock solenoid so the transmission cannot be shifted into gear without the brake pedal being depressed.

Effect of Signal Failure

Driving is still possible in selector lever positions D and R, although shift quality is reduced.

Self-Diagnosis Failure Message

Multifunction Switch F125
Implausible Signal



When adjusting the Multifunction Switch F125, use the Scan Tool to make sure the Multifunction Switch is not in a "Z" position. If the switch is in a "Z" position, the vehicle may not start or operate properly.

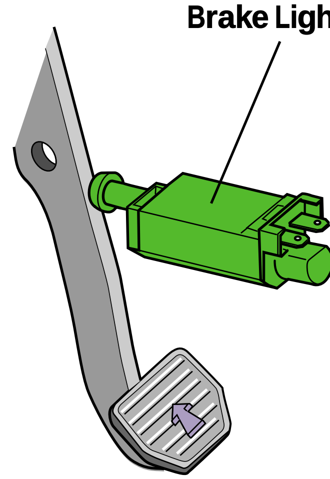
Sensors

Brake Light Switch F

The brake signal is used to modify the shift pattern. The amount of modification depends on engine load and vehicle speed. This signal is also used to release the gear selector lock.

The Brake Light Switch F is located on the brake pedal.

The ECM informs the TCM when the Brake Light Switch F is active.



Signal Application

The brake must be applied in order to release the gear selector lock.

If the brake is applied during deceleration, the transmission will downshift earlier to:

- Provide for engine braking
- Prepare for acceleration

Effect of Signal Failure

If the signal is not being provided to the transmission, the selector lock will not release.

Self-Diagnosis Failure Message

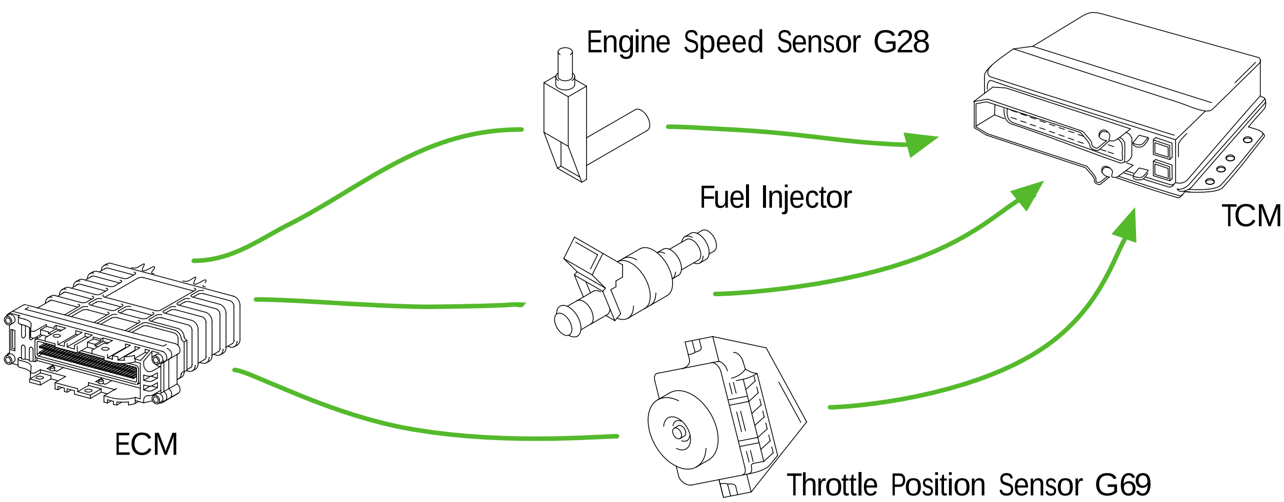
Brake Light Switch F
Implausible Signal
Electrical Malfunction in Circuit

Sensors

ECM to TCM Signals

The ECM (J220) supplies the TCM (J217) with the following three signals:

- Engine speed from the Engine Speed Sensor G28
- Fuel Consumption Signal, calculated from the injector timing by the ECM
- Engine load from the Throttle Position Sensor G69



Sensors

ECM to TCM Signals (continued)

Engine Speed (RPM) Sensor G28

The Engine Speed Sensor G28 sends the engine speed signal to the ECM. The ECM also sends this signal to the TCM.

Signal Application

The engine RPM signal is required for the calculation of the shift pressure.

It is a prerequisite for smooth shifting.

Effect of Signal Failure

If the ECM does not receive an engine RPM signal, the motor will die.

If this signal is not received by the TCM, the transmission will go into Emergency Mode.

Self-Diagnosis Failure Message

RPM information is missing
Open/Short to Ground
Short to Positive
Implausible Signal

Fuel Consumption Signal

The fuel consumption signal is calculated from the injector timing by the ECM.

The TCM recognizes this signal as the instantaneous torque of the engine. The TCM will calculate shift points according to the signal received.

Signal Application

The fuel consumption signal is used for calculating the shift duration points.

Effect of Signal Failure

A replacement value is calculated from the throttle position sensor and RPM signals, then sent to the TCM.

Self-Diagnosis Failure Message

Fuel Consumption Signal
Open Circuit
Short to Ground
Short to Positive
Implausible Signal

Sensors

ECM to TCM Signals (continued)

Throttle Position Sensor G69

The ECM receives a load signal from the engine via the Throttle Position Sensor G69 and passes it on to the TCM.

Signal Application

The Throttle Position Sensor (TPS) G69 signal is required for the TCM to determine engine load when calculating shift points.

Effect of Signal Failure

If a signal is not supplied from the TPS, a substitute value is supplied by the ECM.

If the ECM does not send a signal to the TCM, the transmission defaults to a fixed shift mode without the dynamic shift program.

Self-Diagnosis Failure Message

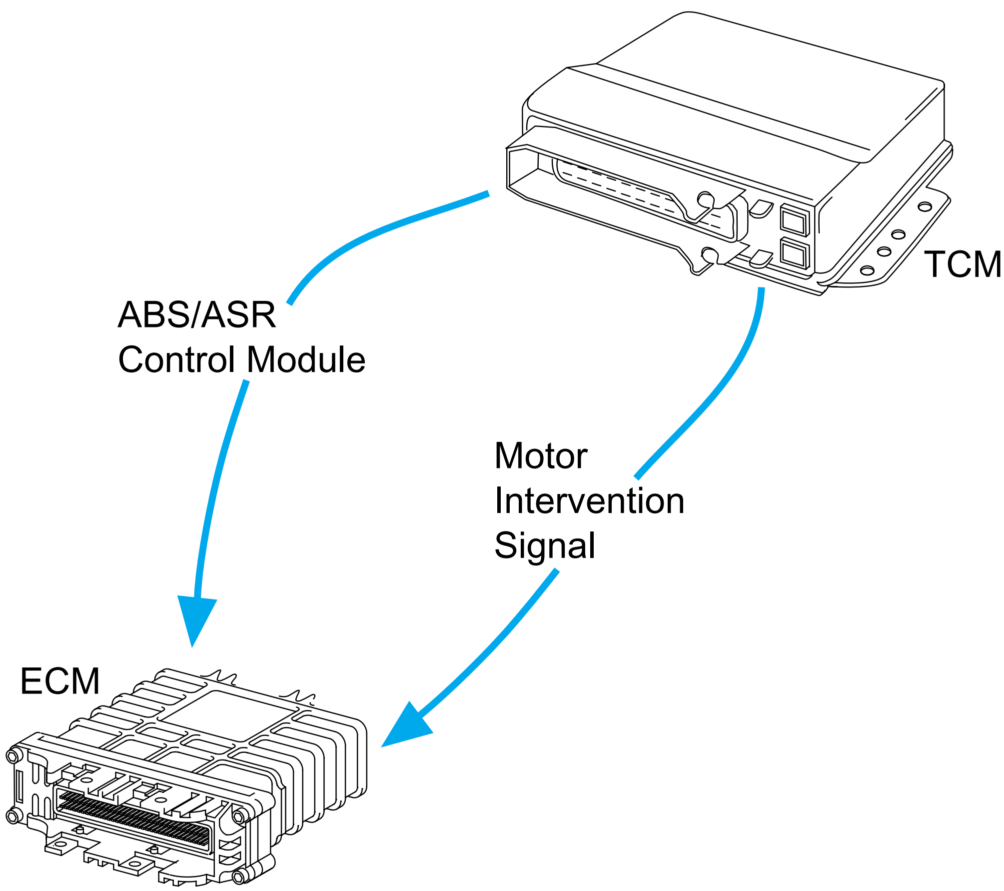
Throttle Position Sensor G69
Signal Too Small
Signal Too Large
Unclear/Undefined Signal

Sensors

TCM to ECM Signals

The two most important signals that the TCM gives to the ECM are:

- Anti-Lock Brake System (ABS)/Anti-slip Regulation (ASR) Control Module signal
- Motor intervention signal



Sensors

TCM to ECM Signals (continued)

Anti-lock Brake System Signal

A signal from the ABS/ASR Electronic Control Module (ECM) is transmitted to the Transmission Control Module (TCM).

The TCM receives the signal when the ASR is active. The TCM passes this information along to the ECM.

Signal Application

If the TCM receives a signal from the ABS/ASR ECM, the TCM supports automatic traction control in that:

- It postpones the shift duration points.
- There is less shifting.

Effect of Signal Failure

No support of the automatic traction control.

Self-Diagnosis Failure Message

No Output

Motor Intervention Signal

When the transmission is ready to shift, the TCM sends a signal to the ECM. The ECM will reduce engine power slightly to make the shift smoother.

Signal Application

The transmission informs the engine when it wants to shift. The ECM adapts injection quantity and timing to reduce engine torque.

Effect of Signal Failure

If the signal fails, the transmission operates in Emergency Mode.

Self-Diagnosis Failure Message

Engine/Transmission Electric Connection
Short to Ground
Short to Positive

Actuators

01V Solenoid Valves N88 through N90

The Solenoid Valves N88 through N90 are located in the valve body. The TCM controls their operation.

Solenoid

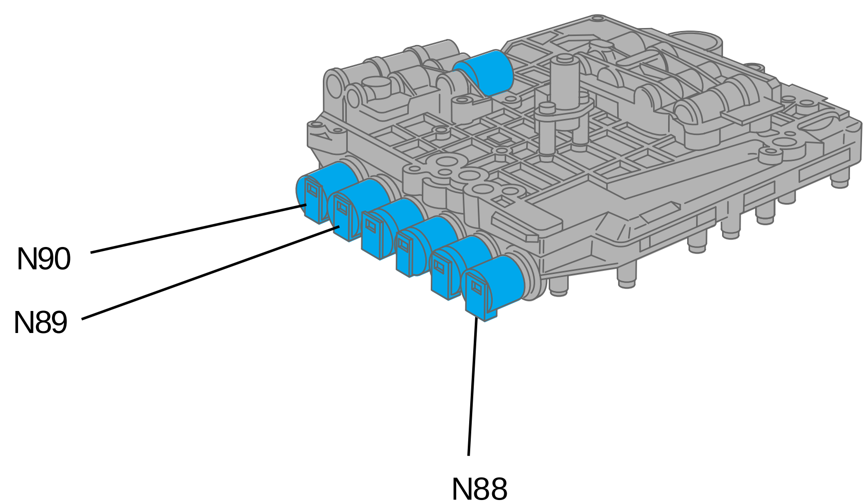
The function of the solenoid valves is to change the electrical signal from the TCM into a hydraulic signal. This is done by pushing on or releasing valves in the valve body.

Keep in mind, even if the solenoid is working properly, the valve in the valve body may be stuck and causing shifting concerns.

Hydraulic pressure is what makes the transmission operate.

The Solenoid Valves N88 through N90 are Yes/No-valves. They are either open or closed, similar to a light switch, which can only assume two possible positions: "on" or "off."

The solenoid valves open or close the oil canals to the clutches or the brakes when the TCM activates them.



Effect of Signal Failure

If the signal fails, the transmission operates in Emergency Mode.

Self-Diagnosis Failure Message

Solenoid Valve N88, N89 or N90
Short to Ground
Short to Positive

Actuators

Pressure Control Valves N91 through N94

The Pressure Control Valves N91 through N94 push on valves in the valve body, regulating the hydraulic pressure during gear changes so the clutches and brakes engage and disengage smoothly and softly.

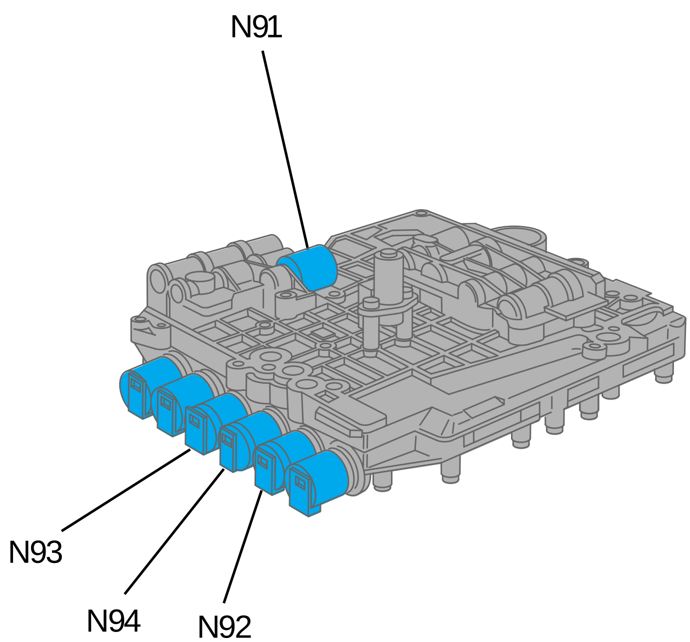
The opening of the pressure control valves directly depends on the value of the electric control current (amperage), which is sent as a signal from the TCM.

This amperage signal sent from the TCM is a duty cycle, which pulses the pressure control valve on and off. This duty cycle can be controlled to provide any position between open and closed.

These types of pressure control valves are known as modulation valves.

Keep in mind, even if the pressure control valve is working properly, the valve in the valve body may be stuck and causing shifting concerns.

Pressure Control Valve



Pressure Control Valve N91

The Pressure Control Valve N91 has the responsibility of regulating the entire amount of ATF required to operate the transmission.

Pressure Control Valves N92 and N93

The Pressure Control Valves N92 and N93 are responsible for regulating the hydraulic pressure when gears are changing to allow for smooth operation.

Pressure Control Valve N94

The Pressure Control Valve N94 engages and disengages the torque converter clutch. It is a modulation valve.

Effect of Signal Failure

If the signal fails, the transmission operates in Emergency Mode.

Self-Diagnosis Failure Message

Solenoid Valve N91, N92, N93 or N94
Short to Ground
Short to Positive

Solenoid and Pressure Control Valve Apply Chart

The Solenoid Logic Chart provides you the information needed to find out which solenoids are applied in which gears.

When the transmisson is shifting incorrectly and no trouble code has been set, there may be a mechanical failure in one of these valves.

Use this chart with the pinout test to determine which solenoid may be causing the concern.

01V / 5 HP 19							
SOLENOID LOGIC							
POSITION	SOLENOIDS			PRESSURE CONTROL VALVES			
	N88	N89	N90	N91	N92	N93	N94
R = REVERSE	X	-	-	X	-	X	-
N = NEUTRAL	X	X	-	X	-	X	-
D, 1st GEAR	X	X	-	X	-	X	-
D, 2nd GEAR	X	X	-	X	X	X	-
D, 3rd GEAR	-	X	X - X	X	X	-	-
D, 4th GEAR	-	-	X - X	X	-	-	-
D, 5th GEAR	X	-	X - X	X	X	-	-
2, 2-1 DOWNSHIFT	X	-	-	X	-	X	-
D, 5-4 DOWNSHIFT	X	-	X	X	X	-	X
Torque Converter Clutch	-	-	-	-	-	-	X

X = Component active
- = Component inactive
X - X = Component active depending on vehicle status (overlapping)

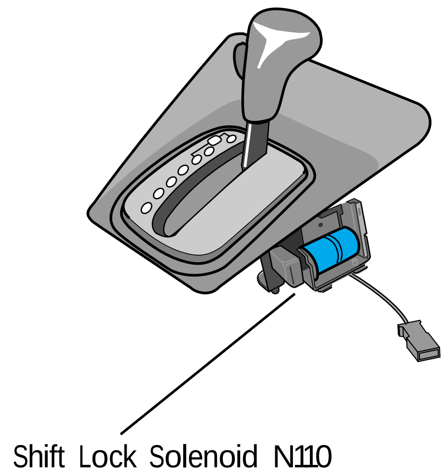
Actuators

Shift Lock Solenoid N110

The Shift Lock Solenoid N110 is located on the selector lever.

This solenoid prevents the operation of the selector lever in the park or neutral positions when the brake pedal is not depressed.

If the shifter is put in neutral while the vehicle is moving, the solenoid will not lock until the vehicle stops or reaches a very low speed.



Signal Application

The TCM will wait for a signal from the Brake Switch before disengaging the shift lock solenoid.

Effect of Signal Failure

In the case of an interruption or a short circuit after the ground of the control line, the selector lever can no longer be moved.

If the short circuit is after positive, the selector lever can be moved to any position without the brake pedal being depressed.

Self-Diagnosis Failure Message

Selector Lever Lock Solenoid N110
Short to Ground
Short to Positive
Short Circuit

Actuators

Selector Lever Position Indicator

The Selector Lever Position Indicator shows the position of the console selector lever. It also shows the selected gear when in Tiptronic mode.

Gear selection is made by the selector lever. At the same time the console selector lever is moved, the shifter cable is moved and the selector lever position is sent to the TCM by the Multifunction Transmission Range Switch mounted on the side of the transmission.

P – Mechanically moves the parking pawl to engage the teeth of the parking lock gear and prevent the vehicle from rolling.

R – A reverse gear lock prevents shifting into reverse until the vehicle has reached approximately two mph.

N – No gears engaged.

D – Automatic position for normal driving.

4 – Fifth gear is blocked. The transmission will operate from first through fourth gears.

3 – Fourth and fifth gears are blocked.

2 – Third through fifth gears are blocked.

The 01V automatic transmission has the following safety functions:

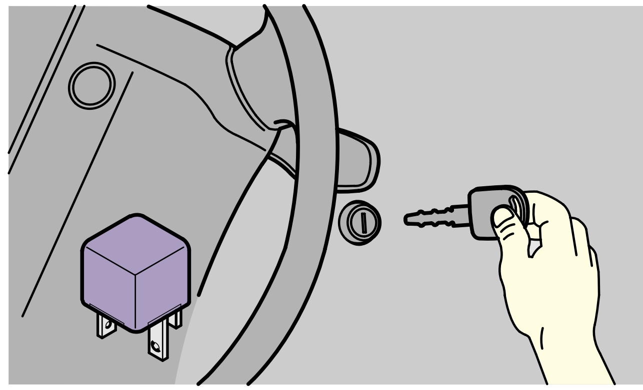
- Automatic Shift Lock III
- Shift Protection (will not let the driver shift the transmission into a gear that will over-rev the engine)

The TCM has a permanent fault memory. If malfunctions occur, emergency running programs and/or Diagnostic Trouble Codes (DTCs) will activate.

Actuators

Automatic Transmission Relay J60/Ignition Lock J207

The relay for the Automatic Transmission J60 and the Ignition Lock J207 prevents engine start if it is in a drive gear. These components are controlled by the Multifunction Transmission Range Switch.



Automatic Transmission Relay and Ignition Lock

Effect of Signal Failure
The start-lock function is inoperable.

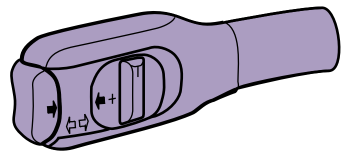
Self-Diagnosis Failure Message
No Output

Switches

Cruise Control Switch

The Cruise Control Switch allows the driver to set a constant speed. Cruise control can be activated in any forward gear, as well as in Tiptronic mode.

The cruise control switch relay has been deleted.



Cruise Control Switch

Signal Application
Transmits driver information to the cruise control module. The cruise control module then sends this information to the TCM and ECM.

Effect of Signal Failure
The cruise control will not operate.

Self-Diagnosis Failure Message
No Output

Dynamic Shift Program

The Dynamic Shift Program (DSP) was introduced in 1992 for the 01F and 01K transmissions. It was a joint development project between ZF and Bosch.

Earlier DSP systems had two driver adaptation modes, while the current DSP has 240 possible driver adaptation modes. Many of these 240 different driver adaptation modes are grouped.

For example, modes 0-60 may all be in the same group and cause the transmission to act the same way. Modes 61-80 might be grouped as well, and so on.

The current mode, or DSP number, can be viewed through the VAG 1551/1552 or VAS 5051 Scan Tool. The cold driving mode will appear as 241 and the Tiptronic mode will appear as 243. Otherwise, the DSP number will be variable. The higher the number is, the harsher the shift will be.

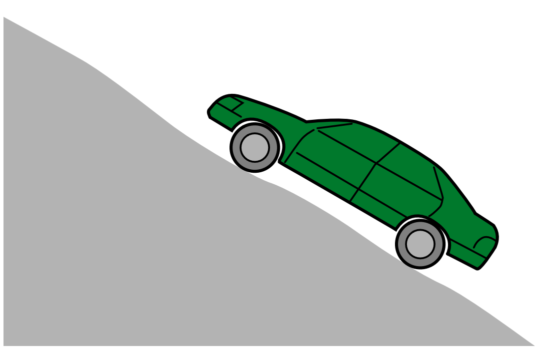
The DSP processes the following inputs to determine the type of driver style:

- Throttle valve position and speed at which the throttle valve changes position
- Vehicle speed – acceleration and deceleration
- ATF temperature
- Selector lever position

The DSP looks at the following when plotting shift adaptation modes:

- Driver behavior
- Driving route profile recognition
- Other spontaneous influences

The type of driving route will be recognized over the basic driver classification.



In addition to the adaptive functions that lead to driving program changes over longer drive time periods, short-term functions provide an increase in the spontaneity of the transmission to special driving situations.

Examples:

- Rapid changes in pedal position can cause the transmission to shift down by one to three driving ranges depending on vehicle speed. This activates rapid downshifting that is independent of the kick-down switch input.
- When the pressure on the accelerator pedal is rapidly reduced, upshifts are not carried out. This prevents upshifts before curves. This function is cancelled as soon as the driver accelerates again.
- The transmission temperature signal is used to trigger the Cold Driving Mode.

Cold Driving Mode 241

During the Cold Driving Mode 241 the engine will not upshift until a higher RPM. Depending on year or model, this is calculated from either engine coolant, transmission oil temperature, or time.

After about 40 seconds, the engine DSP number will shift out of 241 and into a regular number. The cold running procedure is designed to help the catalytic converter(s) heat up quicker.

Mountain Recognition Mode

Mountain recognition takes place mainly through the calculation of actual acceleration vs. engine torque and vehicle speed. This is compared with a set measurement taken on level ground.

This comparison results in an exact measure of the uphill or downhill grade. The DSP can select the correct driving mode to match the incline.

At high ATF temperatures (usually mountain driving), the torque converter lock-up is activated in second or even first gear to reduce the slippage (power loss) in the torque converter. This helps to keep the transmission from overheating.

Default Functions

If the signal of a sensor fails, the TCM tries to establish a substitute-signal from the signals of other sensors. If a substitute-signal can be established, the transmission function, for the most part, will be retained.

With many default functions, the transmission alters its operation in the following ways:

- Shifting becomes harsh
- Dynamic Shift Program does not operate

Emergency Running Mode

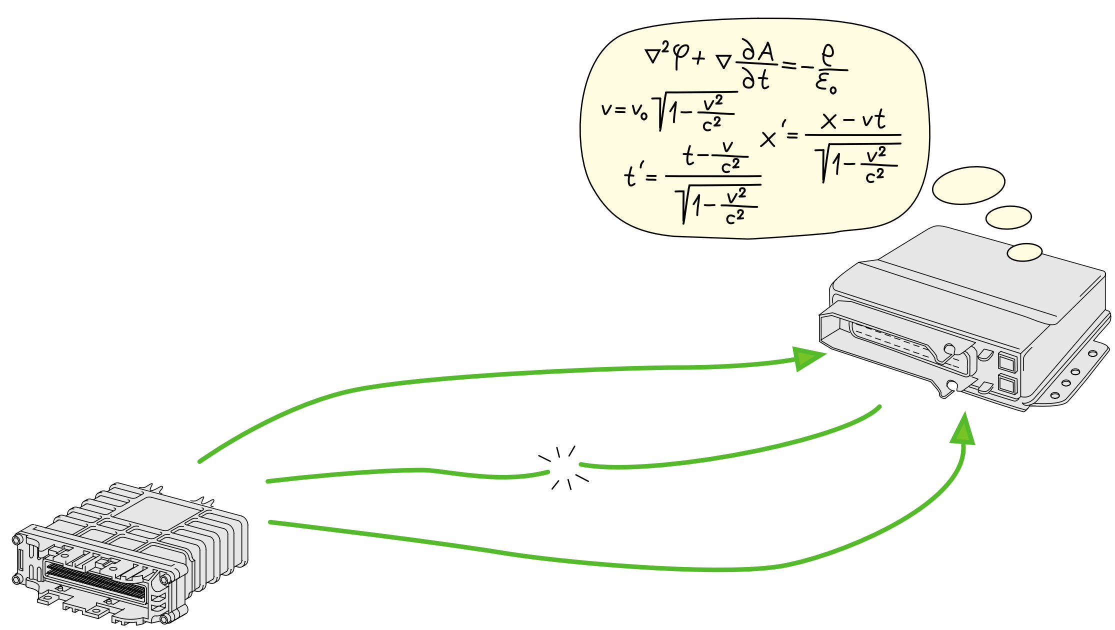
If no replacement signal can be obtained during the default function, the TCM will switch the transmission into Emergency Mode.

Emergency Mode has two possibilities:

- Mechanical Emergency Running Mode with operational TCM
- Mechanical Emergency Running Mode with inoperative TCM

In both instances:

- The transmission shifts hydraulically or mechanically out of drive positions second, third, D and into fourth gear.
- No torque converter clutch lock-up is possible.
- All solenoid valves are de-energized.
- Full line pressure to keep clutches from slipping.
- Reverse can be engaged.
- The park lock in P and N is active.
- All segments of the Transmission Range Indicator G96 are lit in a Mechanical Emergency Running Mode with an operational TCM.
- None of the Transmission Range Indicator G96 segments will illuminate in a Mechanical Emergency Running Mode with an inoperative TCM.



Summary

This section has explained the operation of the electrical components that make the transmission operate properly.

The sensors measure transmission input speed, transmission output speed and many other transmission functions. This information is sent to the ECM and TCM. The ECM and TCM decide how to control the transmission, depending on the information from the sensors.

The actuators control the transmission. By controlling which actuators operate when, the TCM can control the transmission.

This course has presented all aspects of transmission operation.

First, the basic transmission operation was presented. This covered how power flows through a transmission and what controls it.

Next, the specific mechanical components and powerflow for the 01V automatic transmission were presented.

The next section explained the function and operation of the Torsen® center differential.

Finally, the electronic components of the transmission were discussed. These control how the transmission operates.

01V Automatic Transmission Operation and Diagnosis

The test accompanying this course, #851903, has been prepared and shipped as a separate document. Please refer to your copy of that document and follow the testing instructions to complete the TestTest.

Additional copies are available by contacting:

Certification 2001 Program Headquarters

Toll-free Hotline & Testing — 1-877-CU4-CERT (1-877-284-2378)
Fax — 1-877- FX4-CERT (1-877-394-2378)

Hotline assistance is available Monday-Friday
between 9:00 a.m. and 5:00 p.m., EST.

WSP-***-***-**