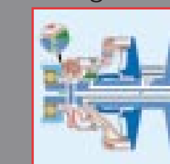
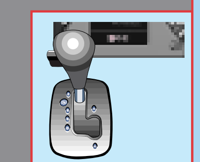
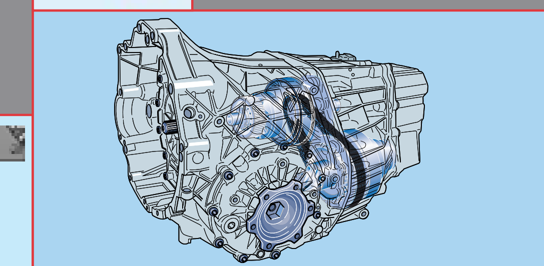
Variable Automatic Transmission multitronic® 01J

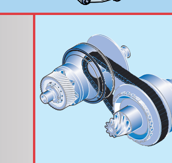
Design and Function

Audi Academy









Audi Academy

Self-Study Program
Course Number 951103

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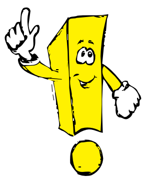
Always check Technical Bulletins and the Audi Worldwide Repair Information System for information that may supersede any information included in this booklet.

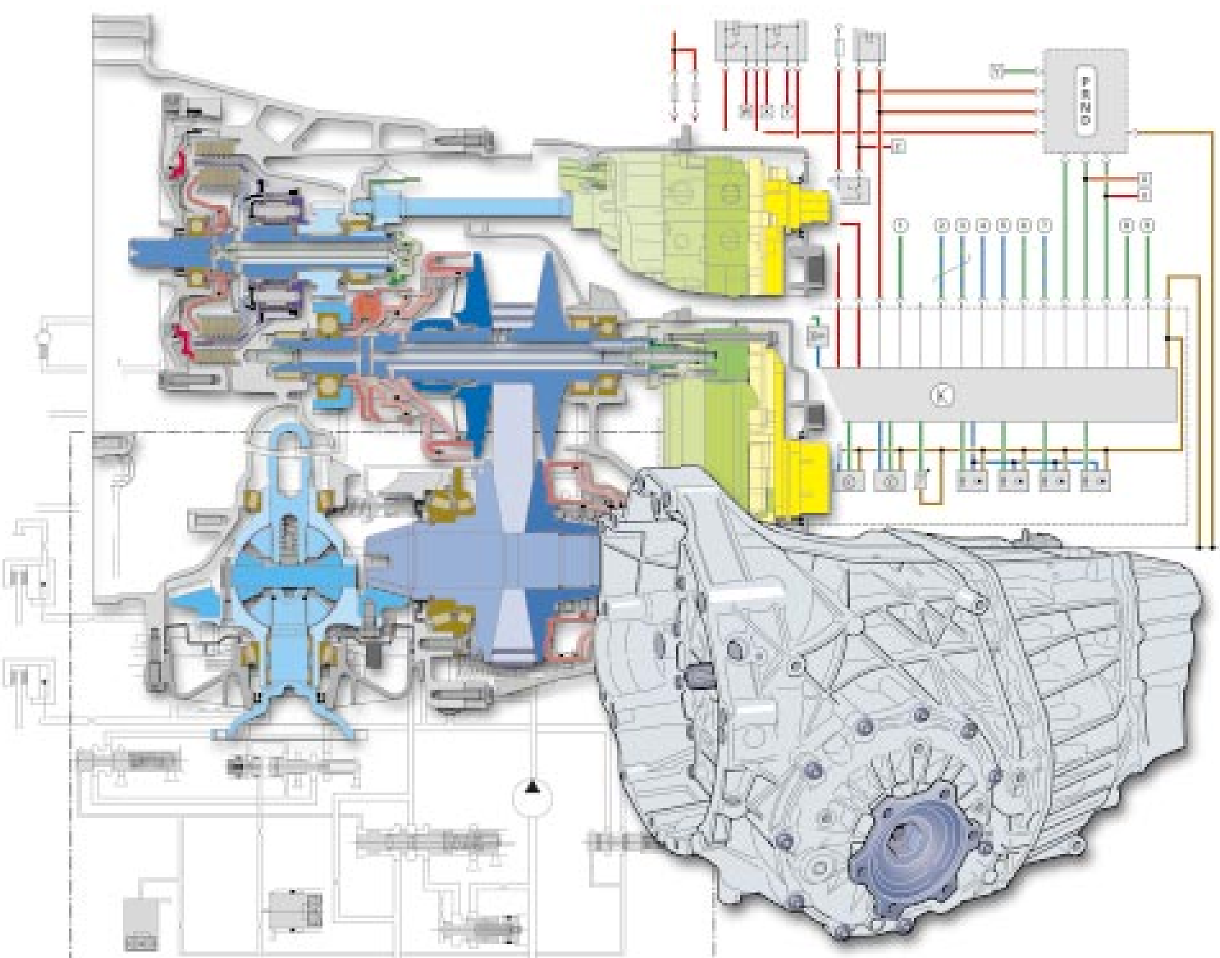
multitronic®

The name multitronic® stands for the new variable automatic transmission developed by Audi. It is also commonly known as a CVT.



CVT is an acronym for “**C**ontinuously **V**ariable **T**ransmission.”

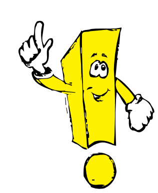
The CVT concept improved by Audi is based on the long-established principle of the chain drive transmission. According to this principle, the reduction ratio between the lowest and highest ratios can be controlled steplessly by means of a Variator.



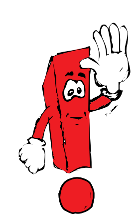
SSP 228/023

Contents

New!



Important/Note!



This Self-Study Program provides you with information concerning variable automatic transmission features and functions.

The Self-Study Program is not a Repair Manual!

When carrying out maintenance and repair work, it is essential to use the latest technical literature.

Transmissions are required to match the torque characteristics of the engine to the vehicle.

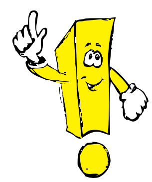
Usually, multi-step reduction gears are used, such as manual transmissions, automated manual transmissions and multi-step automatic reduction gears. A multi-step reduction gear always represents a compromise between handling dynamics, fuel economy and driving comfort.

In an engine, torque flow is not intermittent but continuous. A variable transmission ratio is, therefore, ideal for engine power utilization.

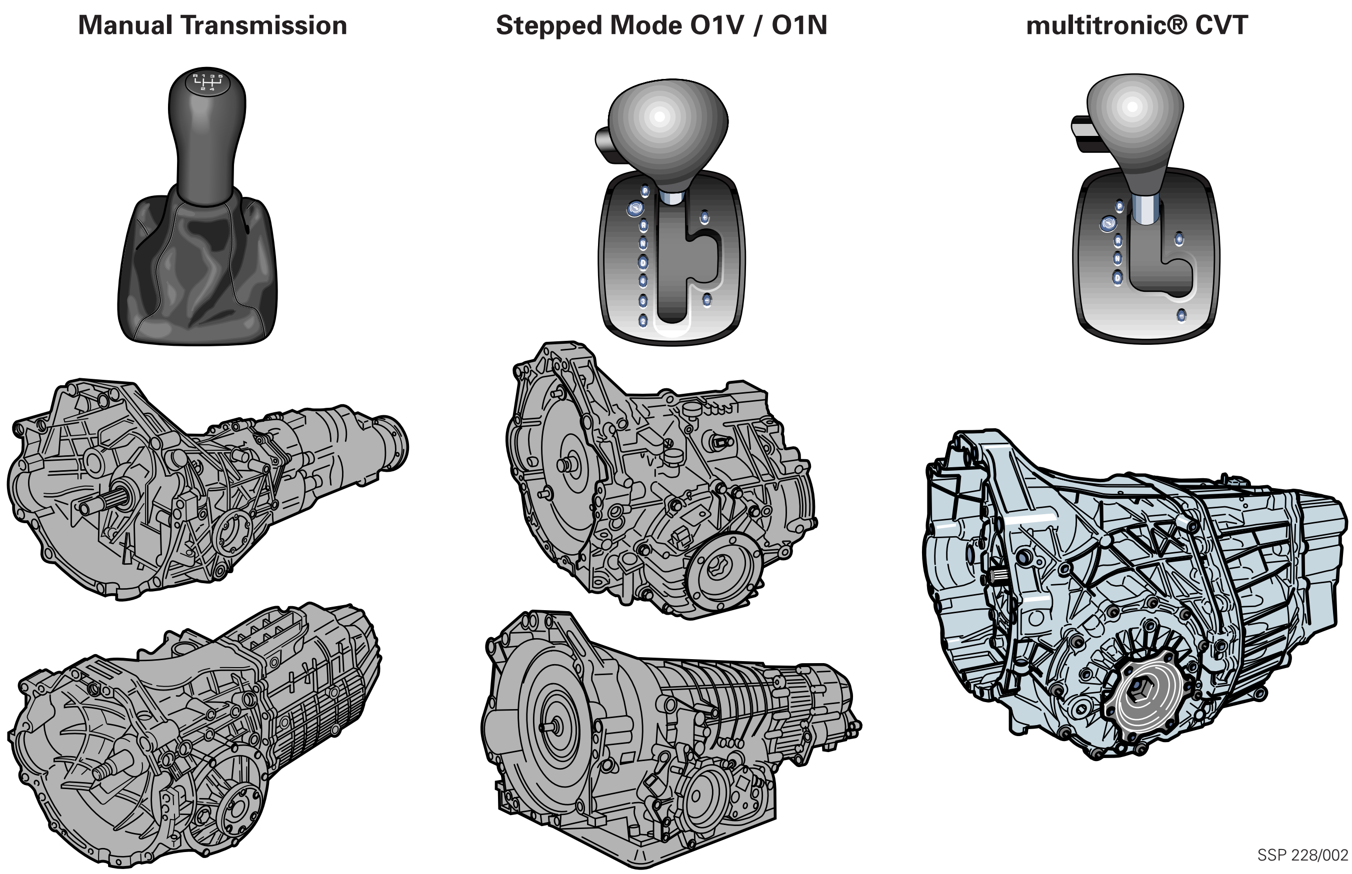
The CVT designs which have been available on the market until now are based upon the “chain drive principle.” Because of their limited abilities to transfer power, however, they have only been suitable for subcompact cars and vehicles in the lower mid-range segment with low engine performance.

Audi chose the belt/chain drive principle for the development of its CVT design, because it is the most advanced form of transmission available today.

Audi’s objective was to develop a CVT design for high-performance premium segment vehicles that sets new standards in terms of driving performance and fuel economy, as well as in handling dynamics and comfort.



Audi is the first to present a CVT that can be used in combination with 3.0-liter V6 engine with 220 bhp (162 kW) and 221 lbs-ft (300 Nm) of torque.



SSP 228/002

The Transmission Concept

Engine torque is transmitted to the transmission through either a flywheel and damper assembly or a dual-mass flywheel depending on engine version.

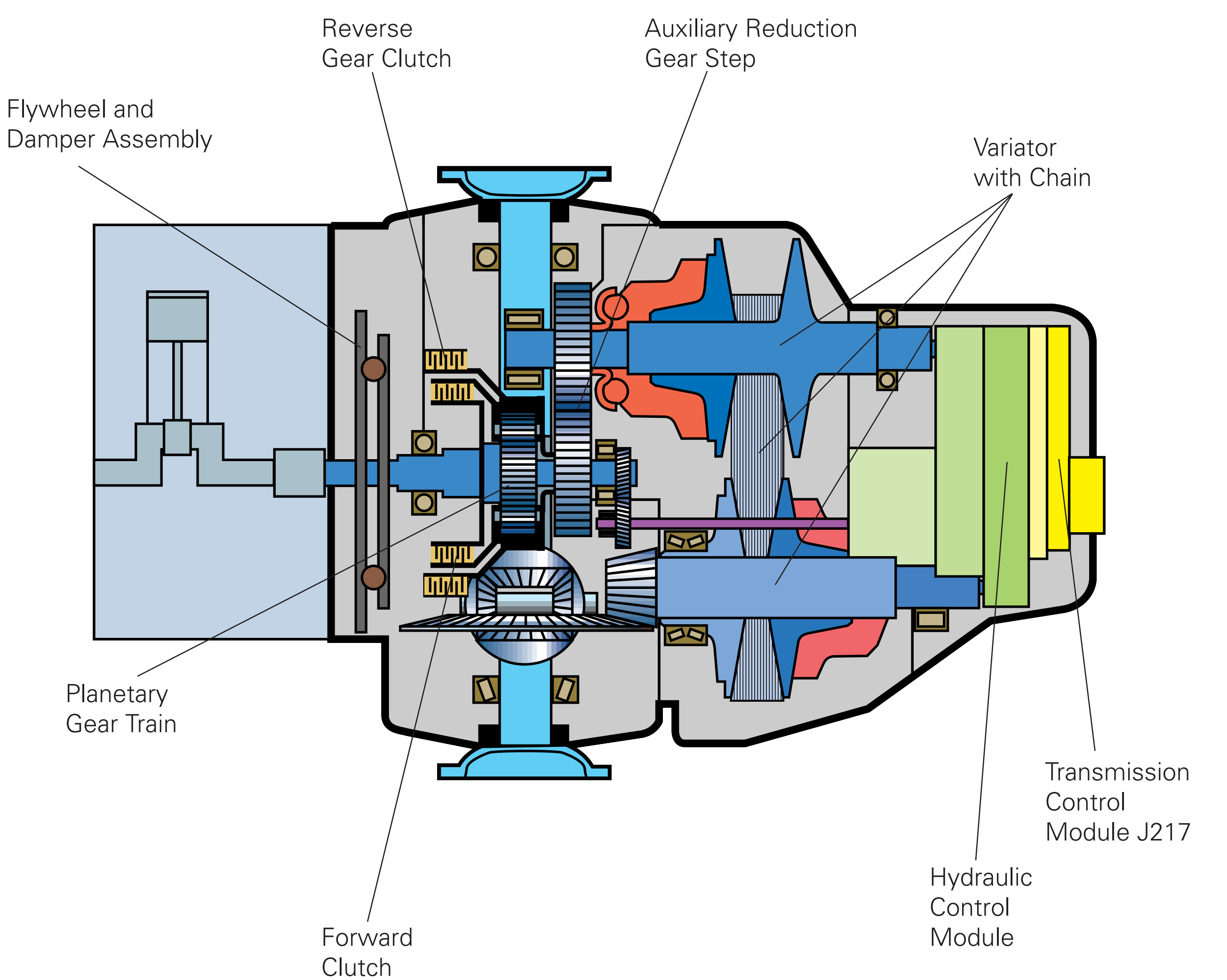
There is one “wet“ plate clutch for forward travel and one for reverse travel; both act as starting clutches.

The rotational direction for reverse is changed by means of a planetary gear train.

The engine torque is transmitted to the Variator via an auxiliary reduction gear step and transferred from there to the final drive.

The electro-hydraulic control, together with the Transmission Control Module J217, forms a unit which is located in the transmission housing.

The Tiptronic function provides six “speeds“ for manual gear selection.



SSP 228/003

The key component part of the multitronic® is the Variator. It allows reduction ratios to be adjusted continuously between the starting torque multiplication ratio and the final torque multiplication ratio.

As a result, a suitable ratio is always available. The engine can always operate within the optimum speed range regardless of whether it is optimized for performance or fuel economy.

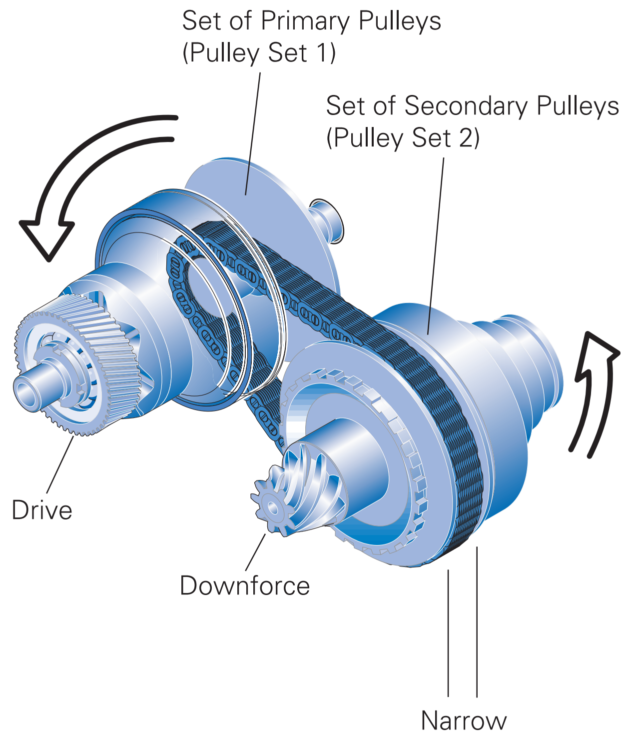
The Variator has two tapered disc pairs — a set of primary pulleys (pulley set 1) and a set of secondary pulleys (pulley set 2) — as well as a special chain which runs in the V-shaped gap between the two tapered pulley pairs. The chain acts as a power transmission element.

Pulley set 1 is driven by the engine through an auxiliary reduction gear step. Engine torque is transmitted via the chain to pulley set 2 and from here to the final drive.

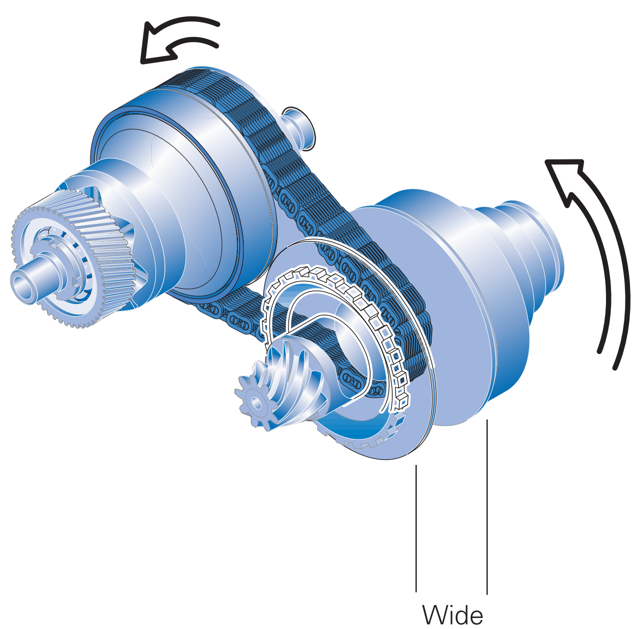
One of the tapered pulleys in each of the sets of pulleys can be shifted on the shaft for variable adjustment of the chain track diameter and transmission ratio.

The two sets of pulleys must be adjusted simultaneously so that the chain is always taut and the disc contact pressure is sufficient for power transmission purposes.

Variator in Starting Torque Ratio



Variator in Final Torque Ratio



SSP 228/043

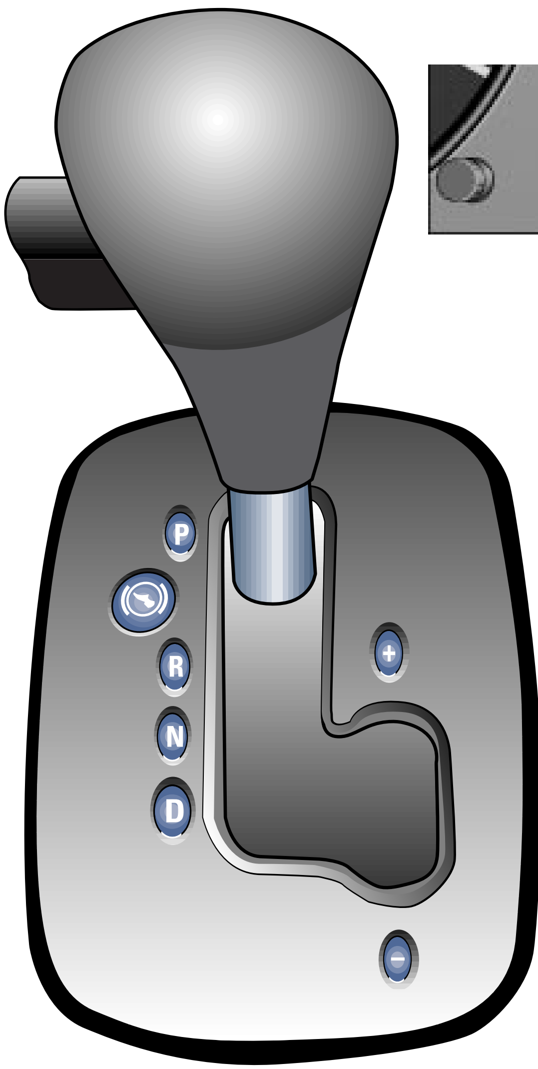
multitronic® for Maximum Comfort

In automatic mode, any ratio is possible within the bounds of the TCM.
The factors that determine rpm are driver input (accelerator pedal position and actuation rate) and rolling resistance.
Transmission ratios are adjusted completely free of jolts without interruption in tractive power flow.

In the Tiptronic function, there are six defined shifting characteristics for manual gear selection. The driver can therefore choose handling dynamics to suit his or her personal preferences. This feature is particularly useful on downhill grades for example, as the driver can determine the engine braking effect by selective down-shifting.

Top speed is achieved in 5th gear.
The 6th gear is configured as an economy gear or overdrive.

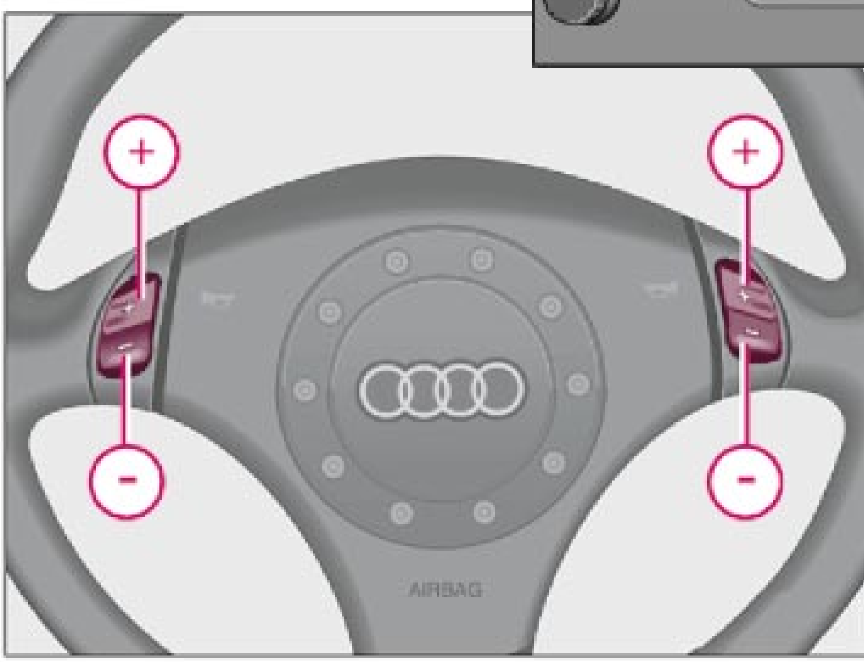
SSP 228/007



SSP 228/038

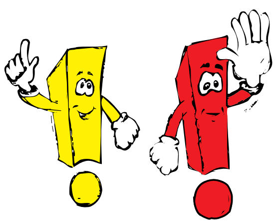
The Tiptronic can also be operated from the steering wheel as an option on some vehicles.

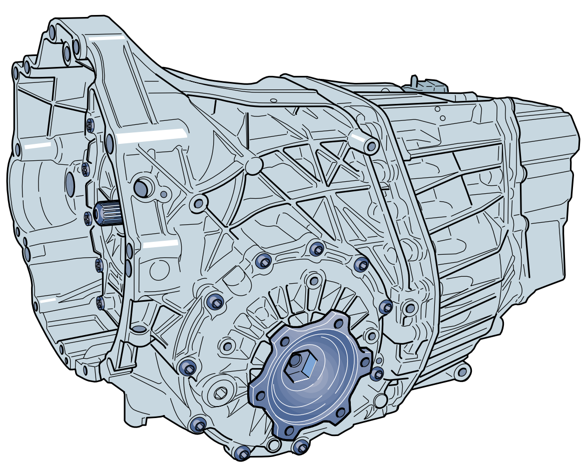
SSP 228/015



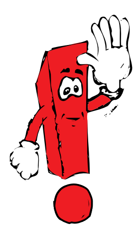
SSP 228/016

Specifications

Designation:	multitronic® 01J
Factory Designation:	VL 30
Code:	DZN
Maximum Transferable Torque:	Maximum 229 lbs-ft (310 Nm)
Range of Ratios of the Variator:	2.40 : 1 to 0.40 : 1
Spread:	6
Ratio of Auxiliary Reduction Gear Step:	51/46 = 1.109 : 1
Final Drive Ratio:	43/9 = 4.778 : 1
Operating Pressure of Oil Pump:	Maximum Approximately 870 psi (6 000 kPa)
 ATF for multitronic®: Axle Oil for multitronic®:	G 052 180 A2 G 052 190 A2
Gear Oil Quantities: ATF New Filling (Including ATF Cooler and ATF Filter) ATF Change Axle Oil	 Approximately 7.9 qt (7.5 liters) Approximately 4.8 qt (4.5 liters) Approximately 1.4 qt (1.3 liters)
Gross Weight (Without Flywheel):	Approximately 194 lbs (88 kg)
Overall Length:	Approximately 24 in (610 mm)



SSP 228/001



All the specifications in this Self-Study Program refer only to the multitronic® with the code DZN.

The Flywheel and Damper Assembly

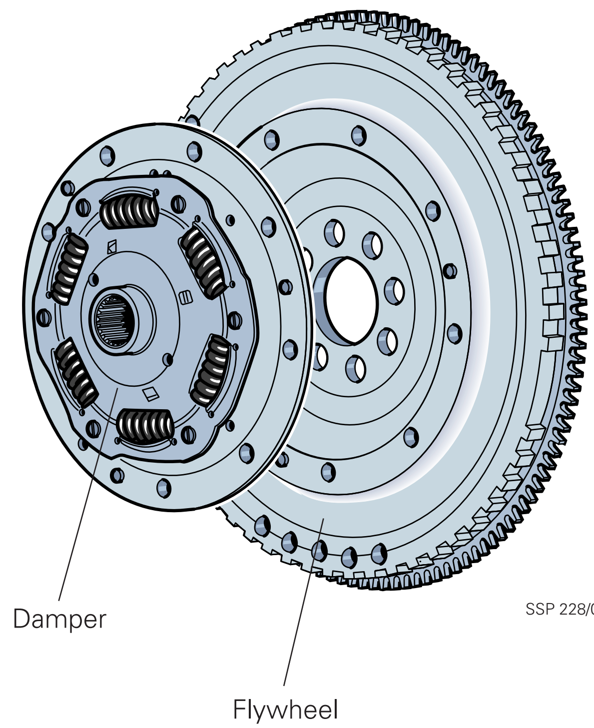
In reciprocating engines, the unevenness of the combustion sequence induces torsional vibration in the crankshaft.

This torsional vibration is transmitted to the transmission and results in resonant vibration, producing noise and overloading components in the transmission.

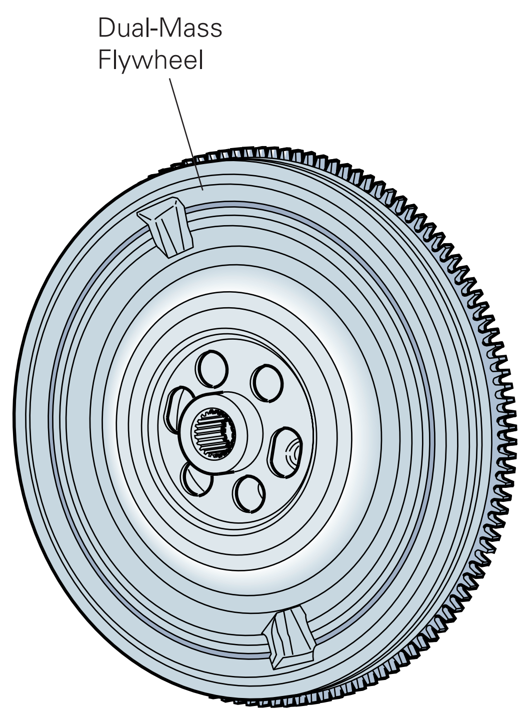
The flywheel and damper assembly and the dual-mass flywheel dampen torsional vibration and ensure the engine runs quietly.

In the 3.0-liter V6 engine, engine torque is transmitted to the transmission through a flywheel and damper assembly.

Because four-cylinder engines do not run as smoothly as six-cylinder engines, a dual-mass flywheel is used in four-cylinder engines.

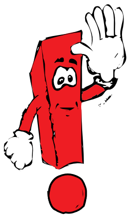


SSP 228/032

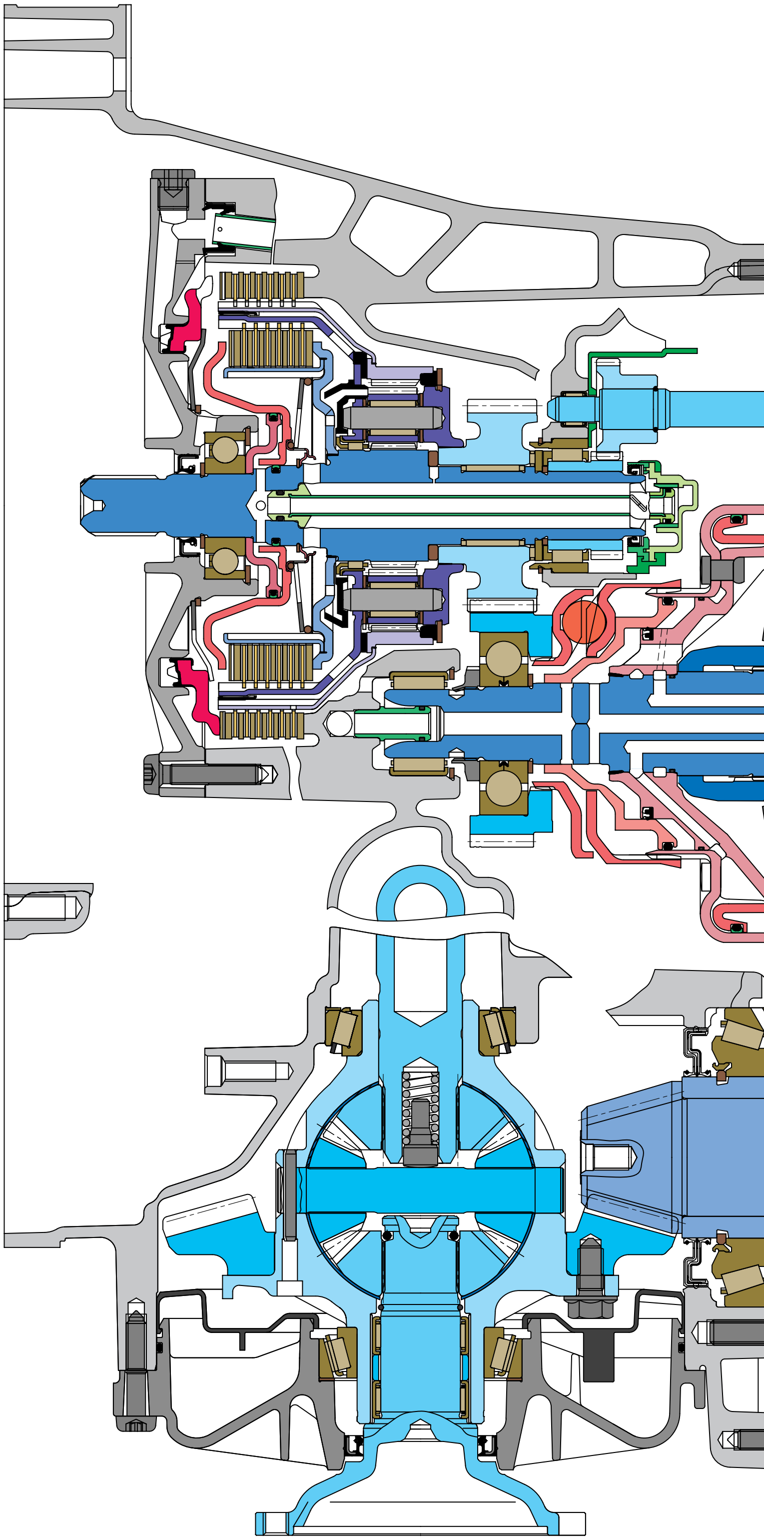


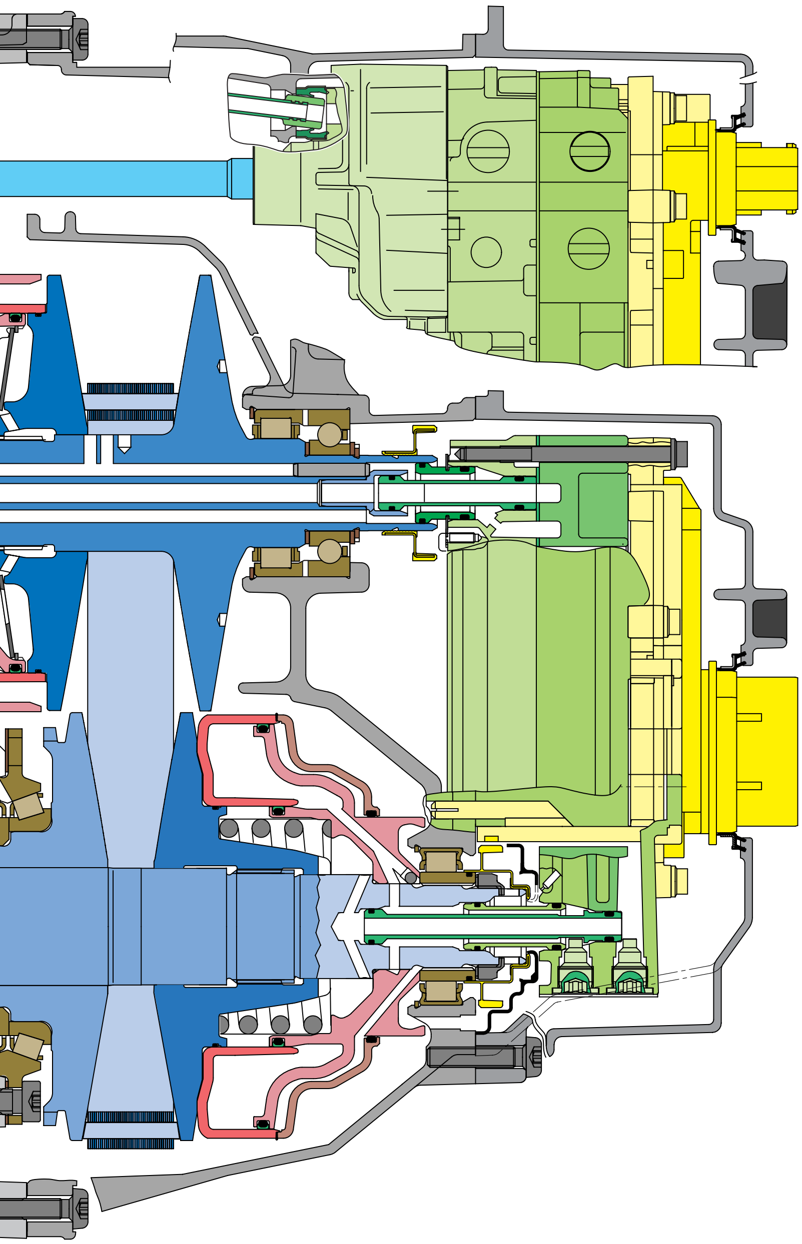
SSP 228/004

Sectional View of Transmission



For better representation, the oil pump and the transfer case are shown folded on the cutting plane.





SSP 228/040

Color Definitions

Housing, Screws, Bolts

Hydraulic Parts/Control

Electronic Transmission Control

Shafts, Gears

Plate Clutches

Pistons, Torque Sensors

Bearings, Washers, Circlips

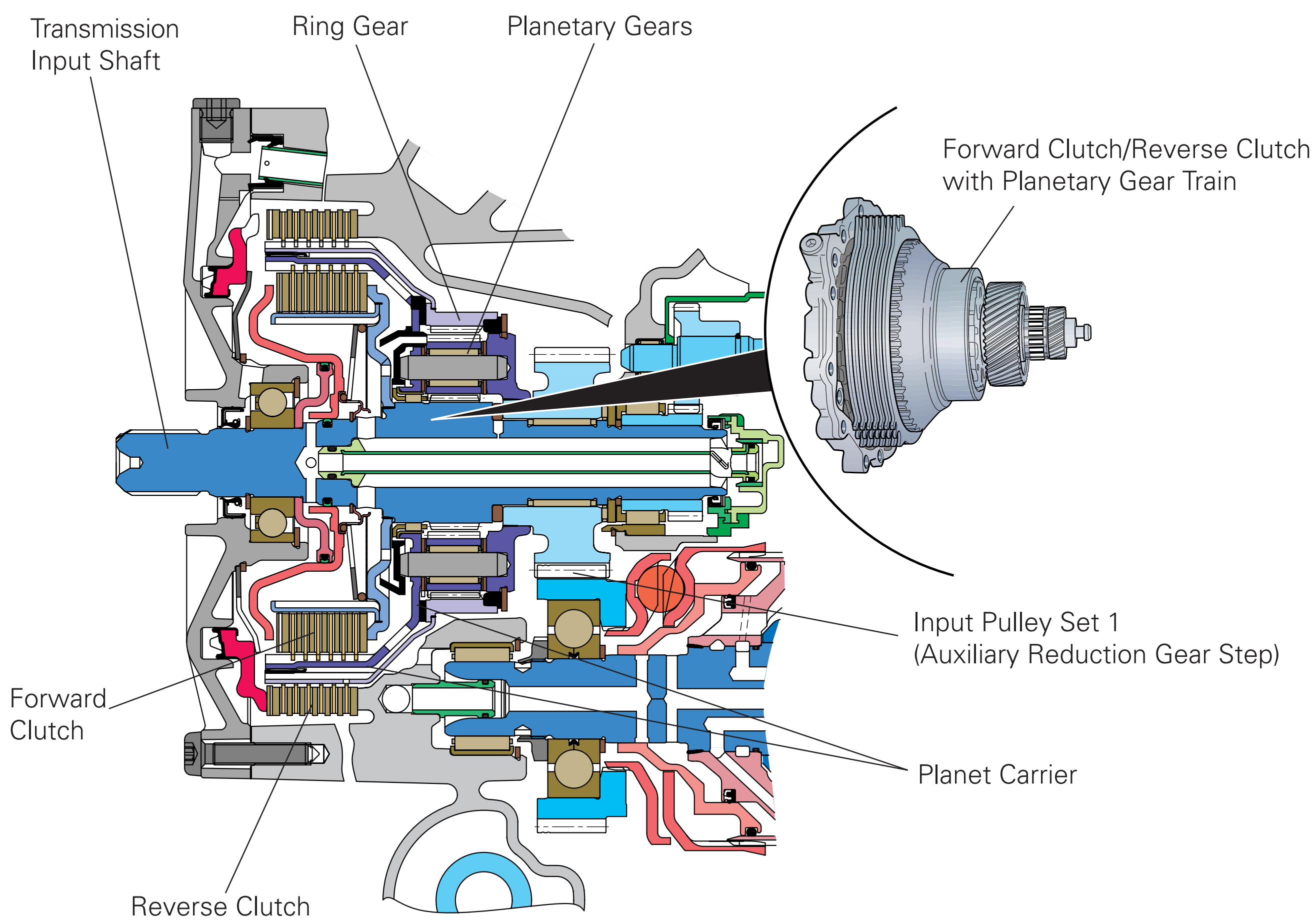
Plastics, Seals, Rubber

The Forward Clutch/Reverse Clutch with Planet Gear Set

In contrast to multi-step automatic transmissions, such as the 01V, which use a torque converter, separate clutches are used for forward and reverse travel in the Audi CVT design. These “wet plate clutches” are also used to execute gearshifts in multi-step automatic transmissions. They are used for driving off and transmitting the torque to the auxiliary reduction gear step. The drive-off process and torque transmission are monitored electronically and regulated electro-hydraulically.

The electro-hydraulically controlled wet plate clutch has the following advantages over a torque converter:

- Low weight
- Very little installation space is required
- Adaptation of clutch engagement characteristic to driving situation
- Adaptation of slip torque to driving situation
- Protective function in the event of overloading or misuse



SSP 228/005

The Planetary Gear Train

The planetary gear train is constructed as a planet reversing gear set and its only function is to change the rotational direction of the transmission for backing up.

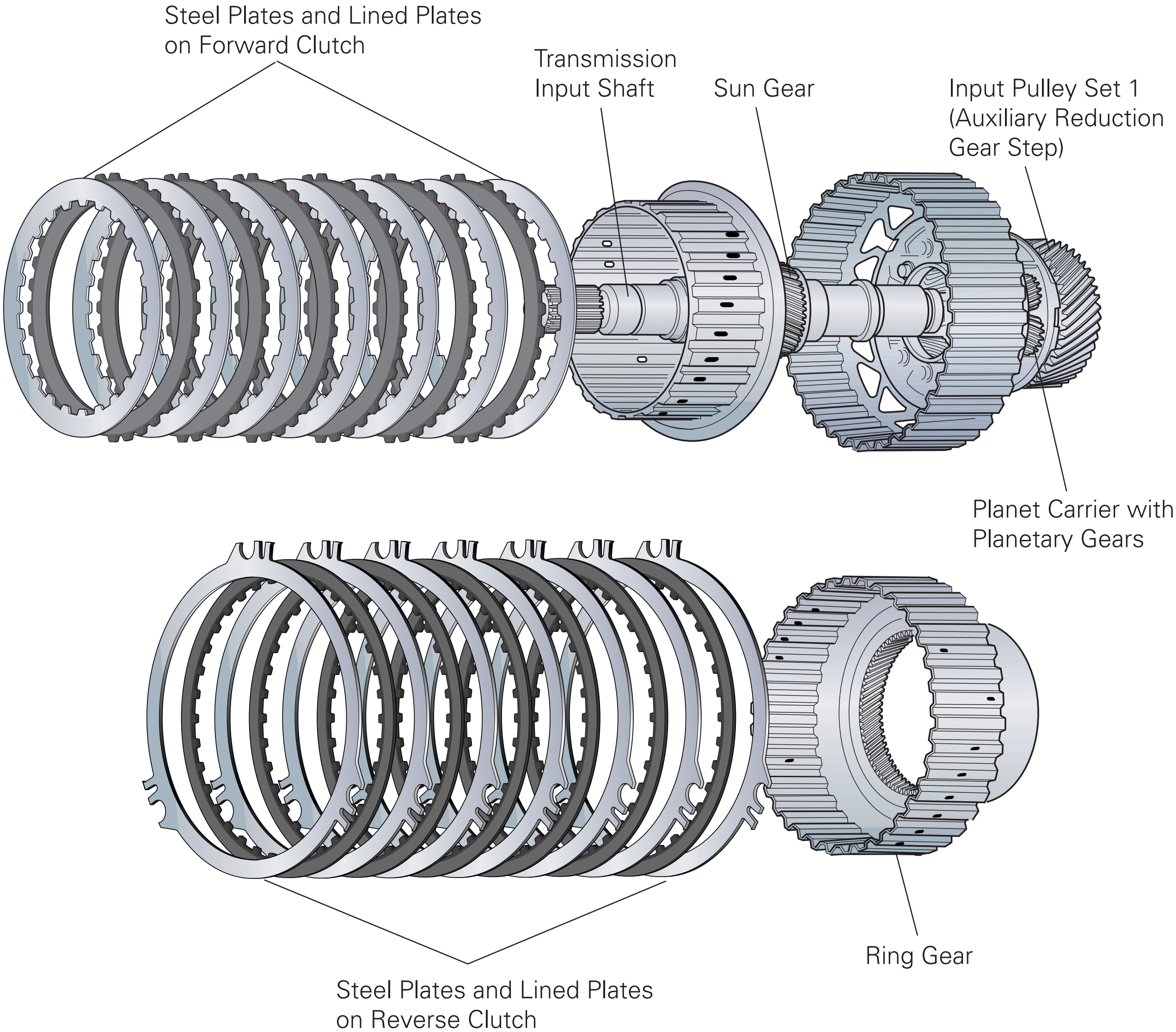
The reduction ratio in the planetary gear train is 1:1 when backing up.

Assignment of Components

The **sun gear** (input) is linked to the transmission input shaft and the steel plates on the forward clutch.

The **planet carrier** (output) is linked to the drive gear, the auxiliary reduction gear step, and the lined plates on the forward clutch.

The **ring gear** is connected to the planetary gears and the lined plates on the reverse clutch.



SSP 228/008

Power Flow in the Planetay Gear Train

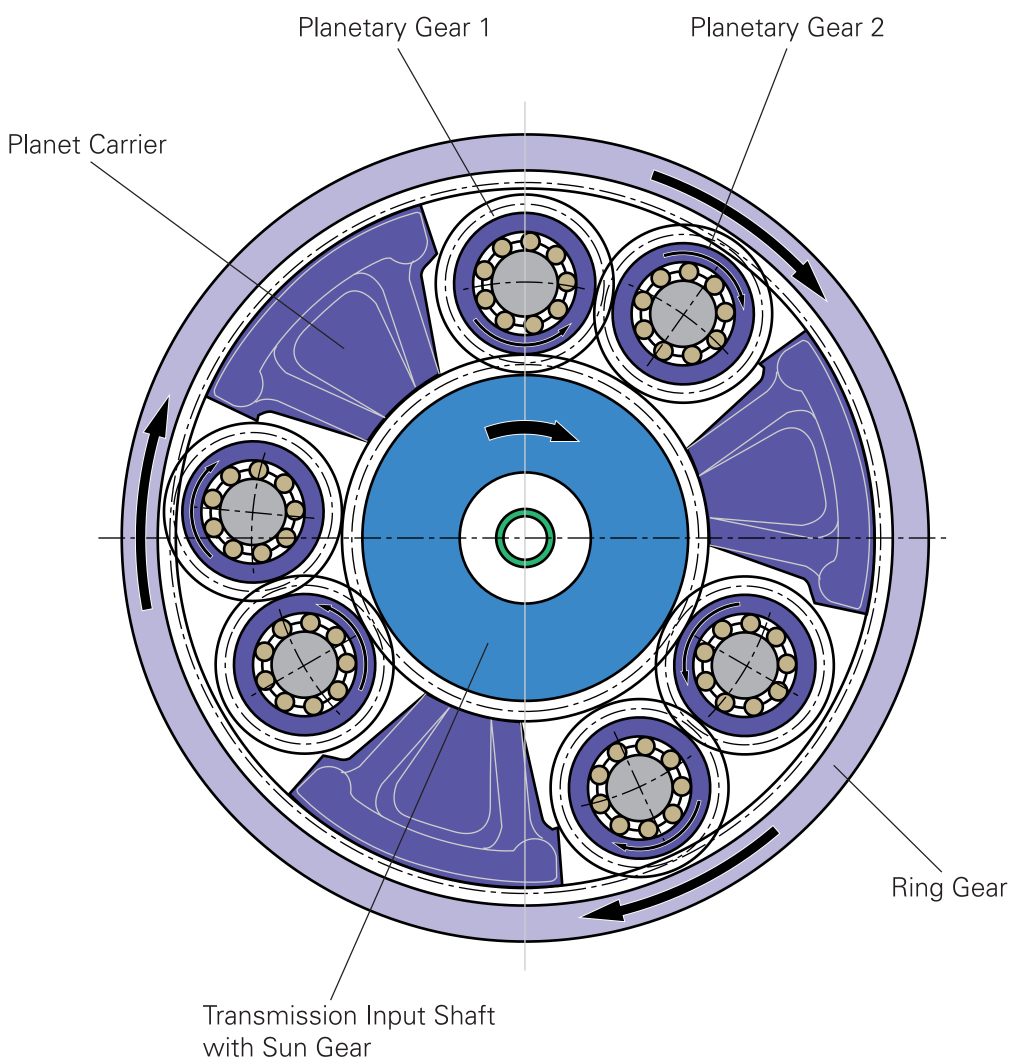
Torque is transferred to the planetary gear train via the sun gear which is connected to the input shaft and drives the planetary gears 1.

Planetary gears 1 drive planetary gears 2, which are in mesh with the ring gear.

The planet carrier (output planetary gear train) is stationary because it acts as the input for the auxiliary reduction gear step and the vehicle is still not moving.

The ring gear idles and rotates at half engine speed in the direction of engine rotation.

Direction of Rotation of Components when Engine is Running and Vehicle is Stationary

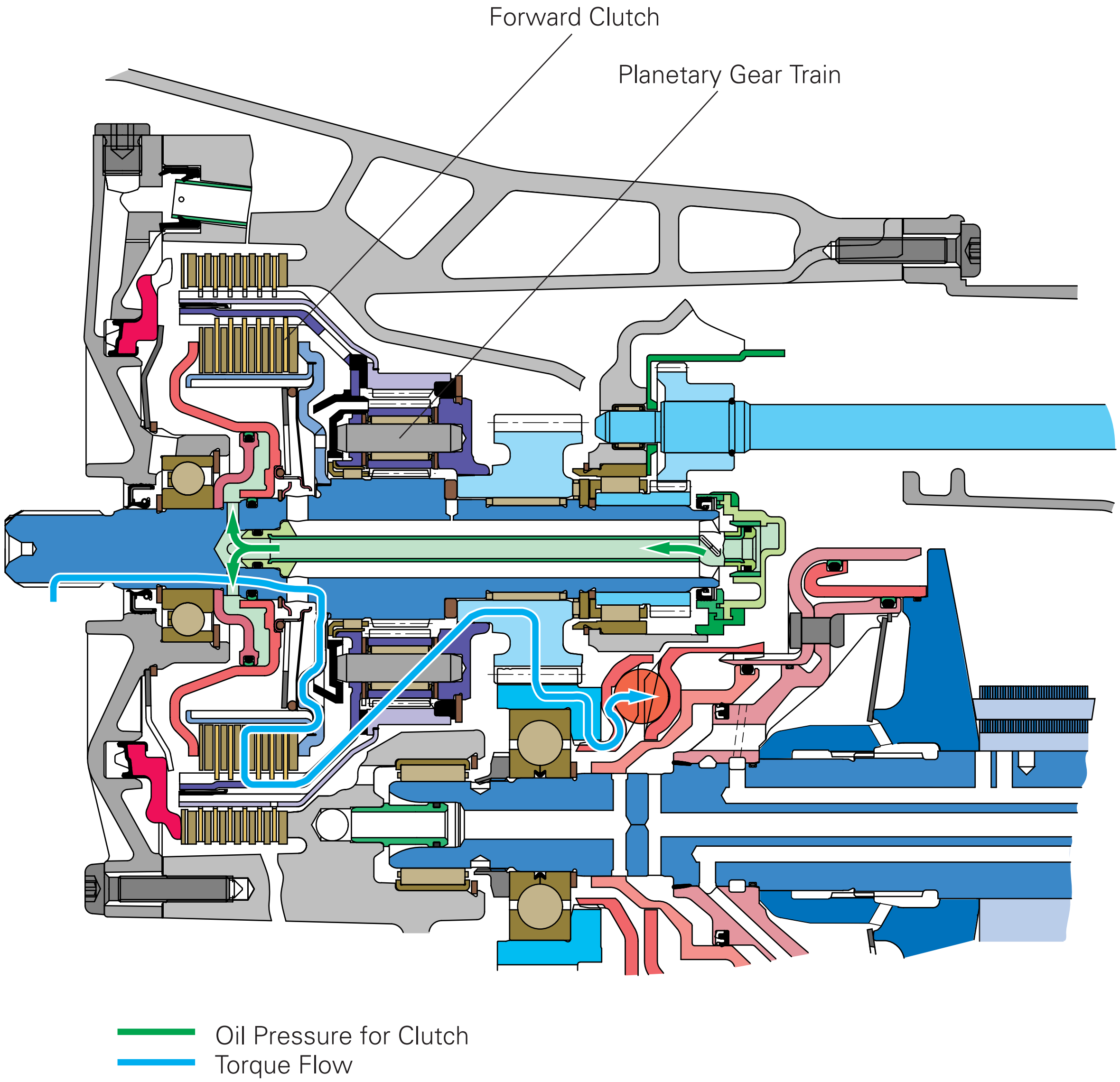


SSP 228/033

Power Flow During Forward Travel

The steel plates on the forward clutch are linked to the sun gear and the lined plates are linked to the planet carrier.

When the forward clutch is engaged, it connects the transmission input shaft to the planet carrier (output). The planetary gear train is locked and rotates in the same direction as the engine; the torque transmission ratio is 1:1.



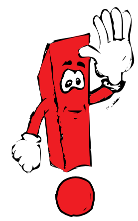
SSP 228/009

Power Flow in Reverse

The lined plates of the reverse clutch are connected to the ring gear and the steel plates are connected to the transmission housing.

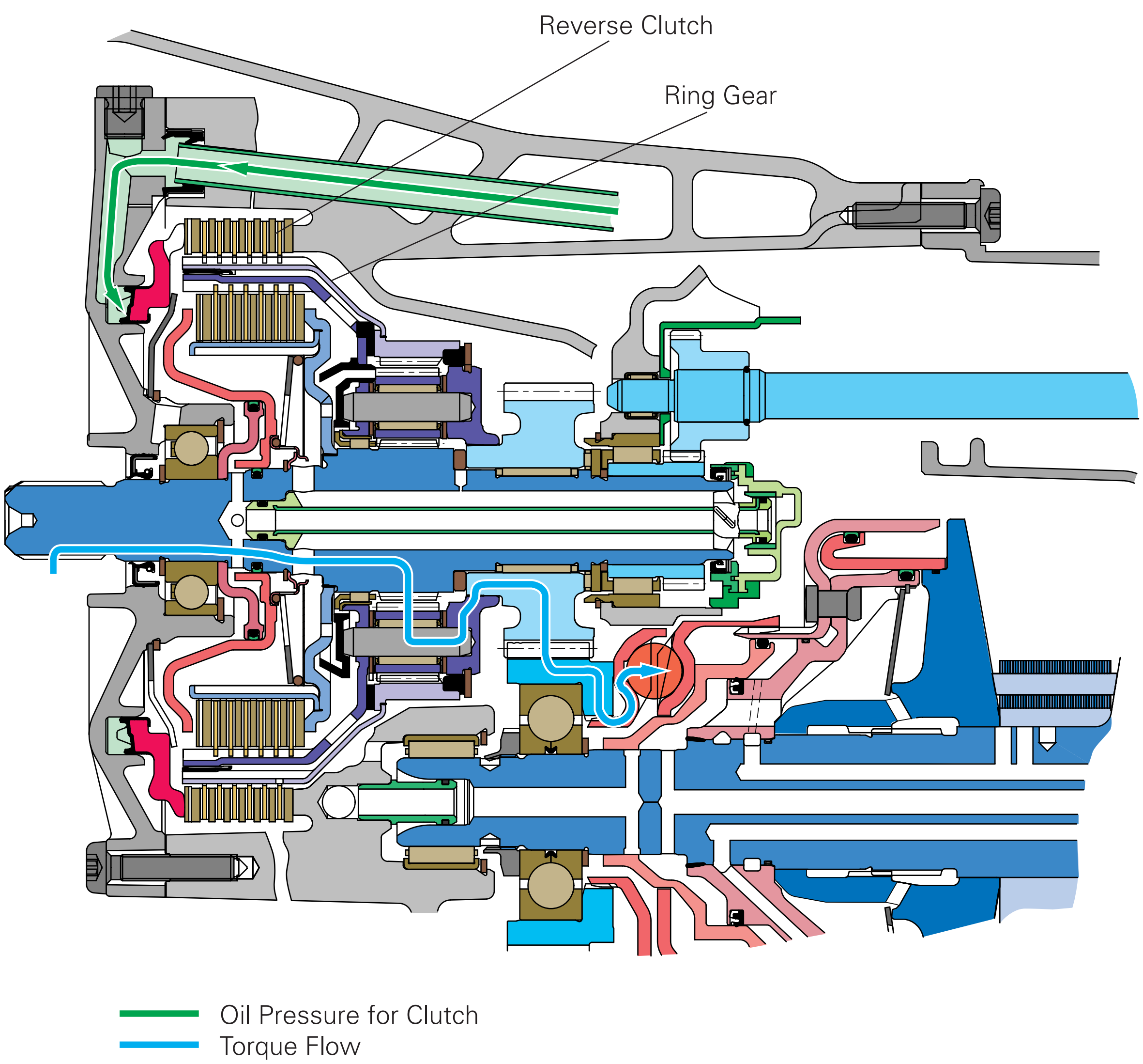
When the reverse clutch engages, it holds the ring gear and thereby prevents the transmission housing from rotating.

Torque is then transmitted to the planet carrier, which begins to rotate in the opposite direction to the engine. The vehicle moves in reverse.



Road speed is limited electronically when the vehicle is in reverse.

The Variator remains in the starting torque ratio.



SSP 228/010

The Clutch Control

Clutch Engagement

Engine speed controls CVT clutch engagement to initiate vehicle motion.

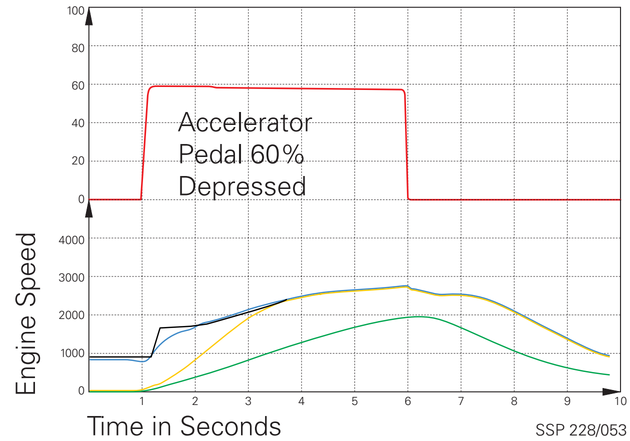
The accelerator pedal angle and application speed set by the driver and the control map requirements of the Transmission Control Module J217 determine the clutch engagement characteristics for each vehicle start from rest.

Depending upon the specific driver inputs for each start, the Transmission Control Module J217 sets a nominal engine speed at which clutch engagement will take place.

With the vehicle at rest, moderate application of the accelerator pedal (characterized by slow movement to a small accelerator pedal angle) initiates the transition from engine idling speed to clutch engagement speed at a relatively low engine speed. Short clutch slip times and low engine speed at clutch engagement will provide the best fuel economy.

For a performance start from rest, heavy application of the accelerator pedal (quick movement to a large accelerator pedal angle) initiates the transition from engine idling speed to clutch engagement engine speed at a higher engine rpm. The greater torque developed at higher engine rpm yields faster vehicle acceleration.

Differences in engine type and performance characteristics also have an effect on CVT clutch engagement characteristics.



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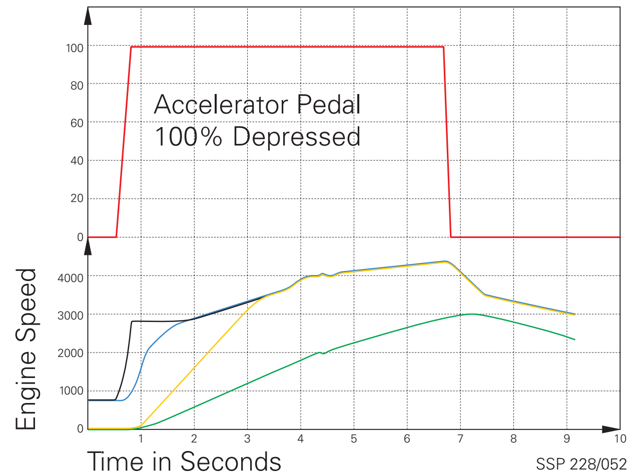

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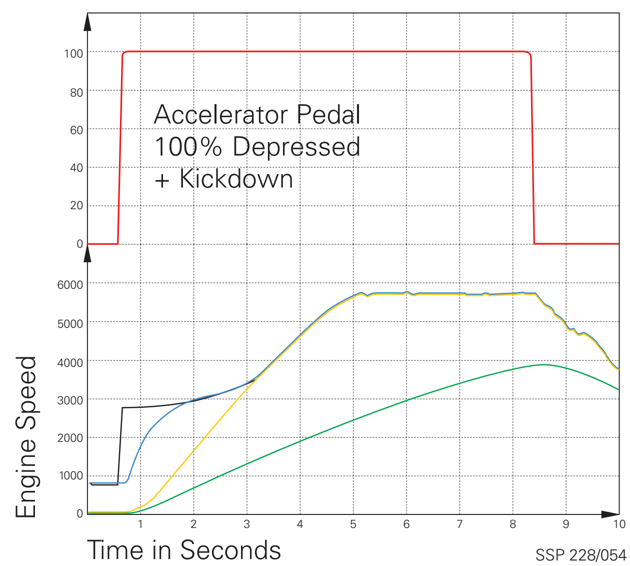
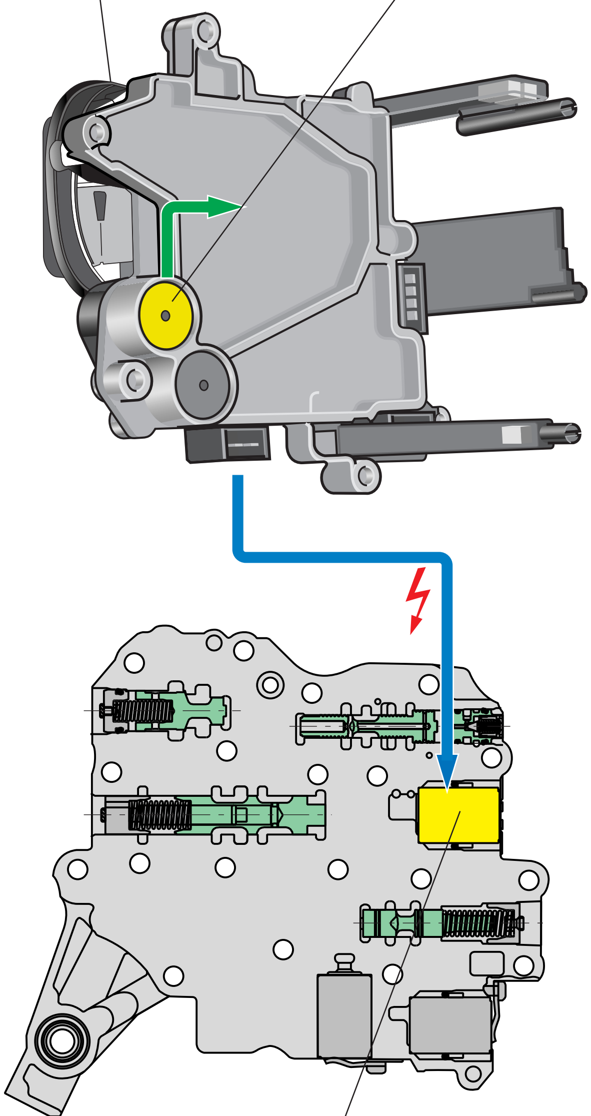


SSP 228/054

Accelerator Pedal Angle
Engine Speed
Nominal Engine Speed
Transmission Input Speed, Pulley Set 1
Transmission Output Speed, Pulley Set 2



SSP 228/075

Electronic Control

The following parameters are used for clutch control:

- Engine speed
- Transmission input speed
- Accelerator pedal position
- Engine torque
- Brake applied
- Transmission oil temperature

The Transmission Control Module J217 calculates the nominal clutch pressure from these parameters and determines the control current for Pressure Control Valve -1- for Automatic Transmission N215. The clutch pressure, and therefore the engine torque to be transmitted by the clutch, changes almost in proportion to the control current (refer to "Hydraulic Control," page 17).

Automatic Transmission Sender -1- for Hydraulic Pressure G193 registers the clutch pressure (actual clutch pressure) in the hydraulic control. Actual clutch pressure is continuously compared to the nominal clutch pressure calculated by the Transmission Control Module J217.

The actual pressure and specified pressure are checked continuously for plausibility and corrective action is taken if these two values deviate from one another by more than a certain amount (refer to "Safety Shut-Off," page 18).

To prevent overheating, the clutch is cooled and clutch temperature is monitored by the Transmission Control Module J217 (for more detailed information, refer to "The Clutch Cooling System," page 23, and "Overload Protection," page 18).

Hydraulic Control

Clutch pressure is proportional to engine torque and is not dependent on the system pressure.

A constant pressure of approximately 73 psi (500 kPa) is applied by the pilot pressure valve to the Pressure Control Valve -1- for Automatic Transmission N215. Pressure Control Valve -1- for Automatic Transmission N215 produces a control pressure which controls the position of the clutch control valve depending on the control current calculated by the Transmission Control Module J217.

A high control current results in a high control pressure.

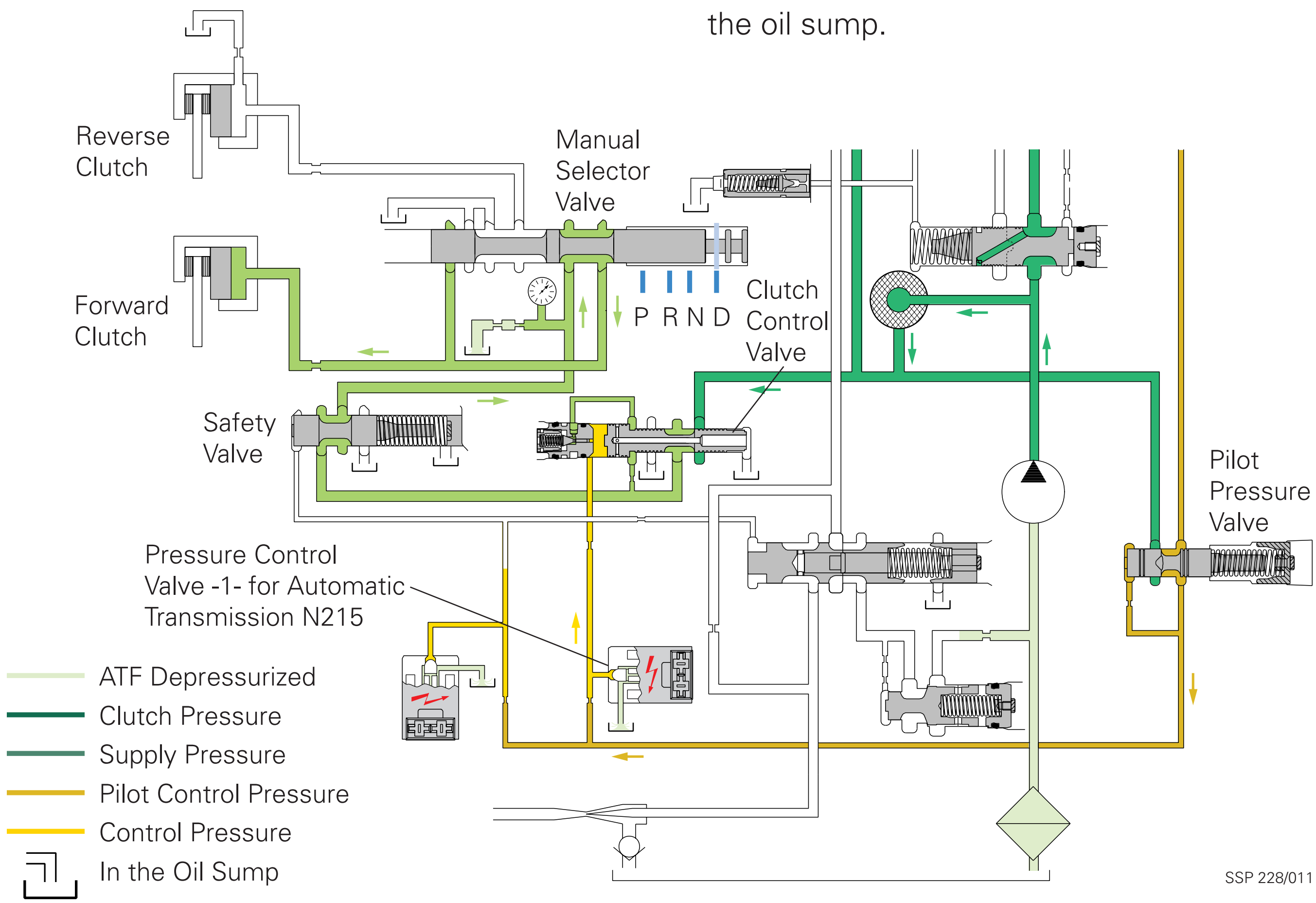
The clutch control valve controls the clutch pressure and therefore also regulates the engine torque to be transmitted.

The clutch control valve is supplied with system pressure and produces clutch pressure in accordance with the activation signal from Pressure Control Valve -1- for Automatic Transmission N215.

A high control pressure results in a high clutch pressure.

The clutch pressure flows via the safety valve to the manual selector valve. The manual selector valve transfers clutch pressure either to the forward clutch (position D) or to the reverse clutch (position R), depending on the selector lever position. The non-pressurized clutch is vented into the oil sump.

In selector lever positions N and P, the supply is shut off via the manual selector valve and both clutches are vented into the oil sump.



Safety Shut-Off

A safety-critical malfunction has occurred if actual clutch pressure is clearly higher than specified clutch pressure. In this case, the clutch is depressurized regardless of the manual selector valve position and other system states.

A safety shut-off is implemented via the safety valve and enables the clutch to open quickly.

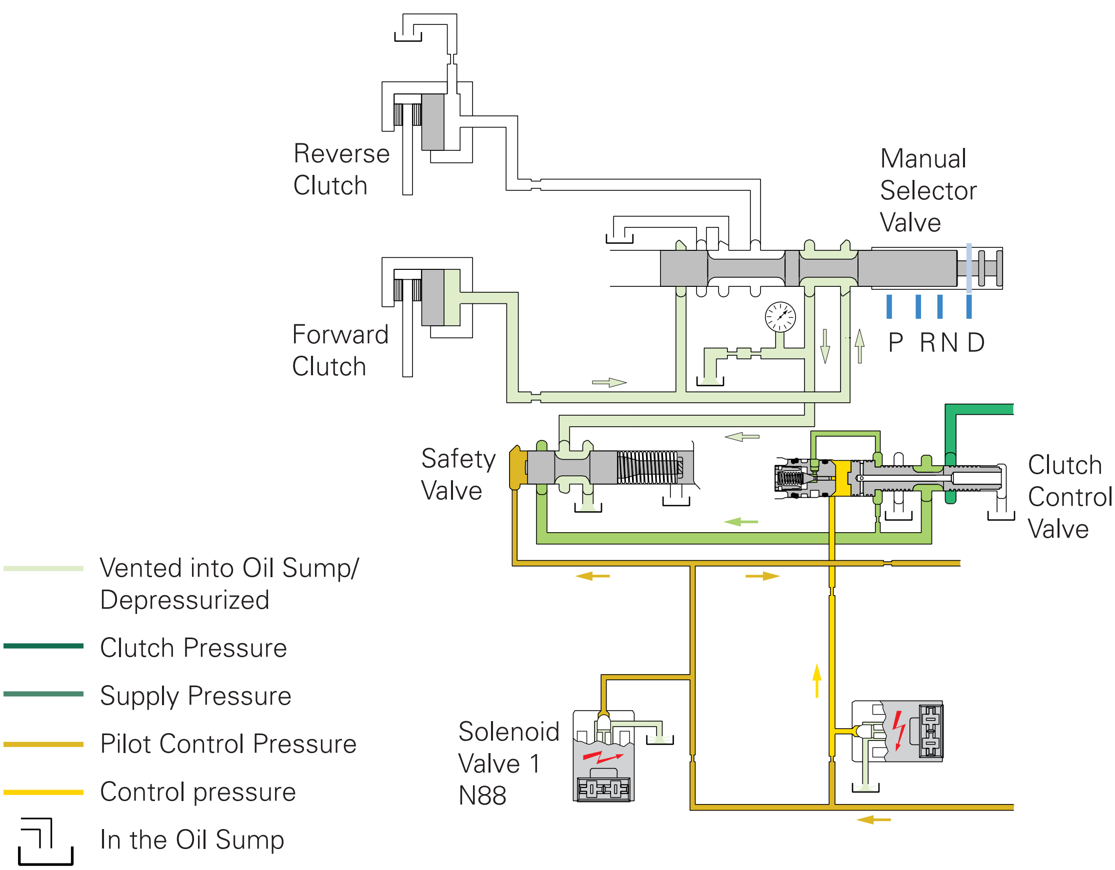
The safety valve is activated by Solenoid Valve 1 N88. At control pressures above approximately 58 psi (400 kPa), the supply to the clutch control valve is shut off and the connection to the manual selector valve in the oil sump is vented.

Overload Protection

Using a model calculation, the Transmission Control Module J217 calculates the clutch temperature from clutch slip, engine torque to be transmitted, and transmission oil temperature. Engine torque is reduced if the measured clutch temperature exceeds a defined threshold because of excess load on the clutch.

Engine torque can be reduced to the upper end of the idling speed range. It is possible that the engine will not respond to the accelerator pedal for a short period of time. The clutch cooling system ensures a short cooling-down time. Maximum engine torque is quickly available again. Overload of the clutch is almost impossible.

Switched Position After Safety Shut-Off



SSP 228/082

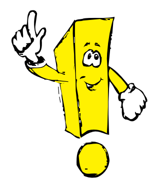
Clutch Control when Vehicle Is Stationary (Slip Control)

The slip control function sets the clutch to a defined slip torque (clutch torque) when the engine is running at idling speed and a drive position is selected. The vehicle behaves in the same way as an automatic transmission with a torque converter.

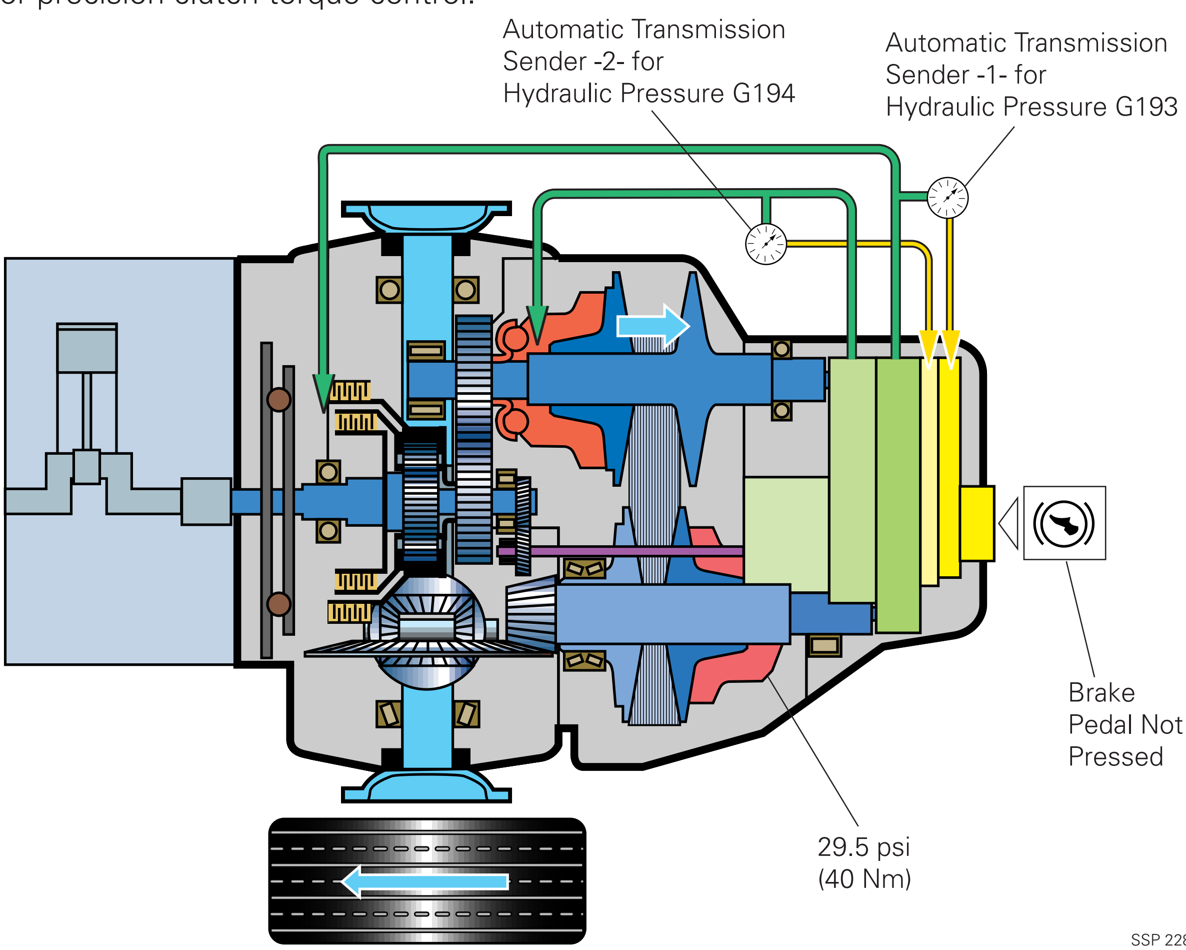
Selective clutch pressure adaptation results in an input torque which causes the vehicle to ”creep.”

Input torque is varied within defined limits depending on vehicle operating state and vehicle road speed. The contact pressure applied by the taper pulleys is sensed by Automatic Transmission Sender -2- for Hydraulic Pressure G194. This information is used for precision clutch torque control.

Because contact pressure is proportional to the actual engine input torque present at pulley set 1, clutch torque can be precisely calculated and controlled using Automatic Transmission Sender -1- for Hydraulic Pressure G193 (for more detailed information, refer to “The Torque Sensor,” page 33).



Slip control allows the vehicle to be maneuvered when parking without pressing the accelerator pedal and therefore enhances driving comfort.



SSP 228/013

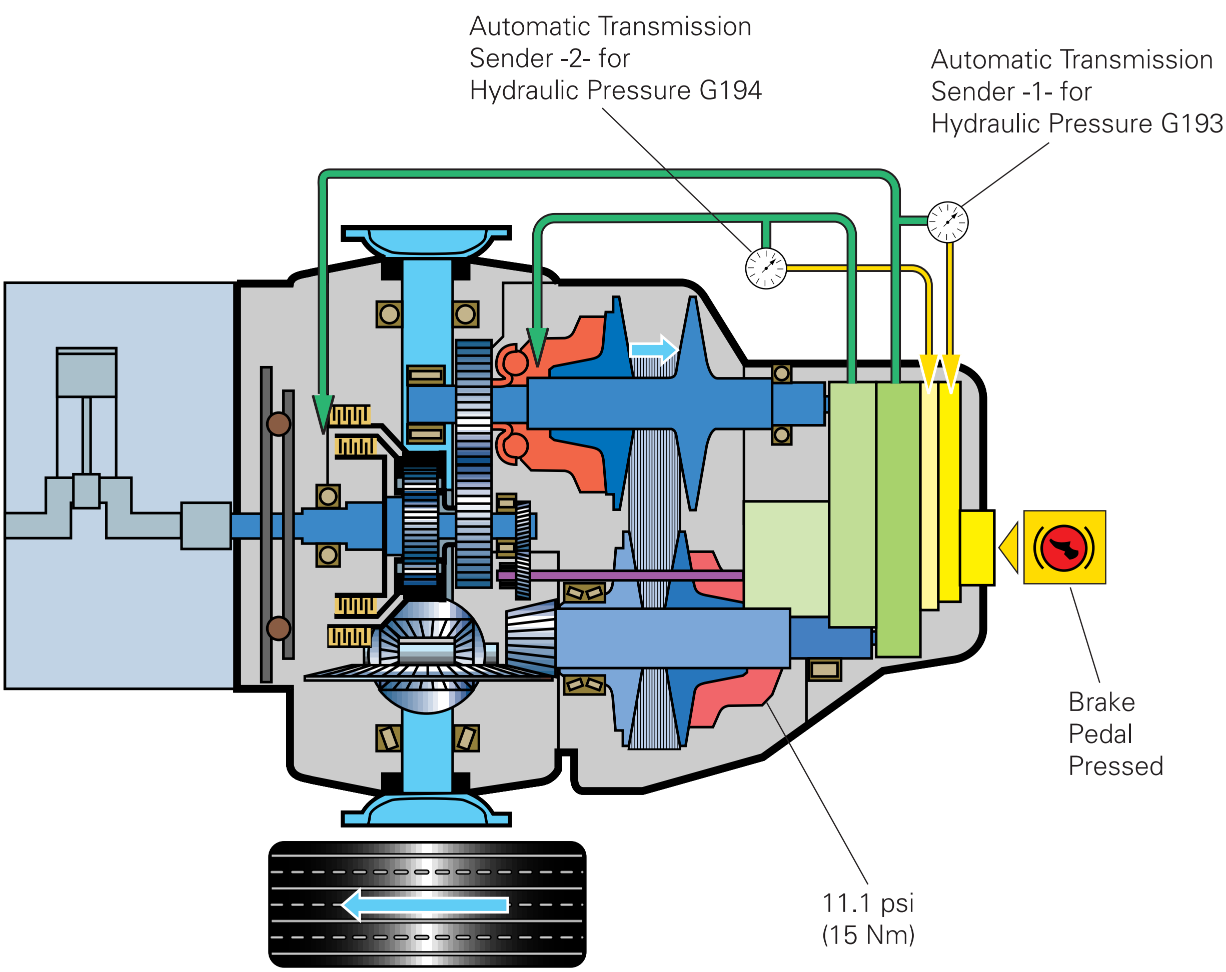
Special Feature of the Slip Control

A special feature of the slip control is the reduction of slip torque when the vehicle is stationary and the brakes are actuated. As a result, the engine is not required to develop so much torque (the clutch is also open wider).

This has a positive effect on fuel economy. Noise from the engine running at idle speed when the vehicle is stationary is reduced and much less pressure has to be applied to the brake pedal to stop the vehicle.

If the vehicle rolls back when standing on a slope with only light pressure applied to the brake, the clutch pressure is increased to immobilize the vehicle ("hill-holder" function).

By using two transmission output speed senders (Sender for Transmission Output RPM G195 and Sender -2- for Transmission Output RPM G196) it is possible to distinguish between forward travel and reverse travel, which makes the hill-holder function possible (for further information, please refer to "Sensors," page 63).



SSP 228/012

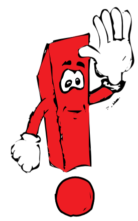
The Micro-Slip Control

The micro-slip control serves to adapt the clutch control (see description of adaptation process, page 22) and dampen the torsional vibration induced by the engine.

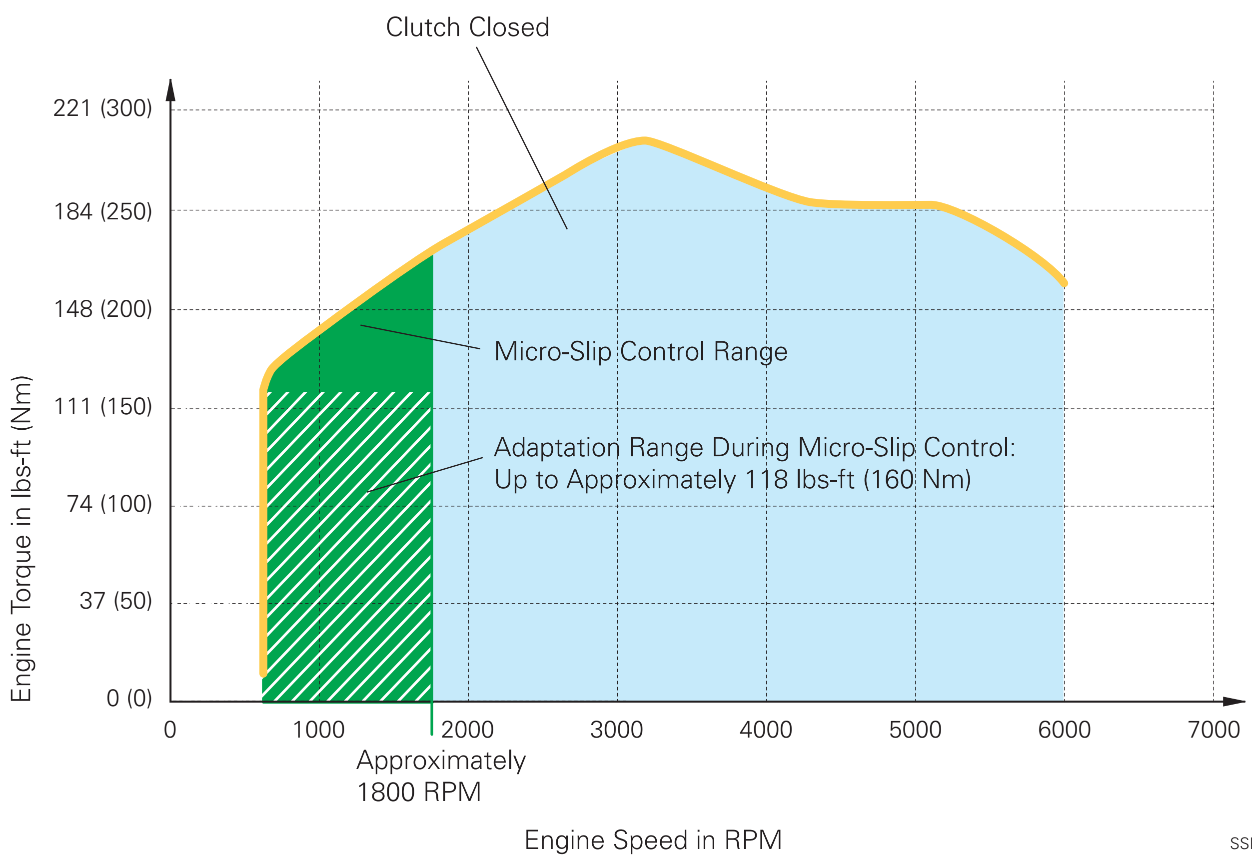
In the part-throttle range, the clutch characteristics are adapted up to an engine torque of 118 lbs-ft (160 Nm).

In the engine speed range up to approximately 1800 rpm and at engine torques up to approximately 162 lbs-ft (220 Nm), the clutch operates in what is known as “micro-slip” mode. In this operating mode, a slip speed (speed differential) of approximately 5 rpm to 20 rpm is maintained between the transmission input shaft and pulley set 1.

For this purpose, the Transmission Control Module J217 compares the signal generated by Sensor for Transmission RPM G182 with the engine speed, making allowance for the auxiliary reduction gear step. Sensor for Transmission RPM G182 registers the rotation of pulley set 1.



As the term “micro-slip” suggests, clutch slip is kept at a minimum so no noticeable penalties in lining wear and fuel economy occur.



SSP 228/092

Clutch Control Adaptation

To be able to control the clutch comfortably in any operating state and throughout its service life, the relationship between control current and clutch torque has to be updated continuously.

This is necessary because the coefficients of friction of the clutches are constantly changing.

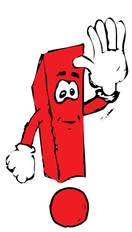
The coefficient of friction is dependent on the following factors:

- Transmission oil (quality, aging, wear)
- Transmission oil temperature
- Clutch temperature
- Clutch slip

To compensate for these influences and optimize clutch control, the relationships between control current and clutch torque are adapted in slip control mode and in the part-throttle range.

Adaptation in Slip Control Mode (Brake Pressed):

As mentioned already, a defined clutch torque is set in slip control mode.
The Transmission Control Module J217 observes the relationship between the control current from Pressure Control Valve -1- for Automatic Transmission N215 and the data from Automatic Transmission Sender -2- for Hydraulic Pressure G194 (contact pressure) and stores these data.
The actual data are used for calculating new characteristics.



Here, "adaptation" means learning new pilot control values.

Adaptation in Part-Throttle Range

In the part-throttle range, adaptation is performed in micro-slip control mode.
In this operating mode the Transmission Control Module J217 compares the engine torque from the Motronic Engine Control Module J220 to the control current from Pressure Control Valve -1- for Automatic Transmission N215 and stores these data.
The actual data are used for calculating new characteristics (see "Micro-Slip Control," page 21).

Summary:

The adaptation function serves to maintain a constant clutch control quality.

The adaptation data also have an effect on the calculation of clutch pressure at higher transmission torques (clutch fully positively engaged).

High clutch pressures are not required, which ultimately has a positive effect on efficiency.

The Clutch Cooling System

The clutches are cooled by a separate oil flow in order to protect them from exposure to excessively high temperatures (particularly when driving away under hard acceleration).

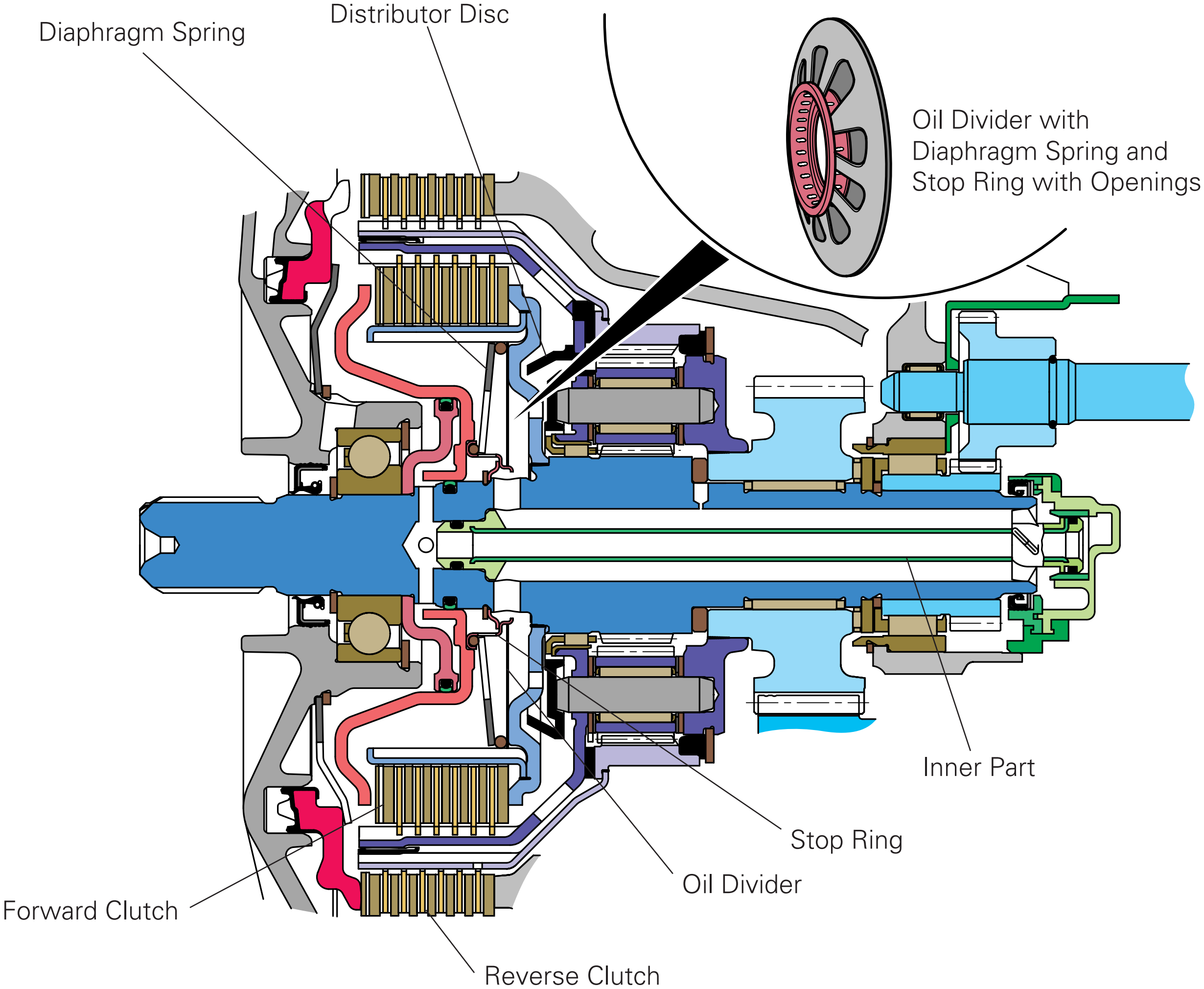
To minimize power losses due to clutch cooling, the cooling oil flow is directed where it is needed by a cooling oil control module integrated into the valve body.

Additional cooling oil is supplied by a suction jet pump (entrainment pump) without placing a demand on oil pump capacity.

To optimize clutch cooling, the cooling oil flows only to the power-transmitting clutch pulley set.

The cooling oil and the pressurized oil of the forward clutch flow through the hollow transmission input shaft. The two oil circuits are separated from one another by a steel tube, the "inner part."

An "oil divider" located at the oil outlet bores on the transmission input shaft guides the cooling oil flow to the forward clutch and the reverse clutch.



SSP 228/064

Cooling the Forward Clutch

If the forward clutch is engaged, the cylinder (thrust plate) of the forward clutch presses the oil divider back.

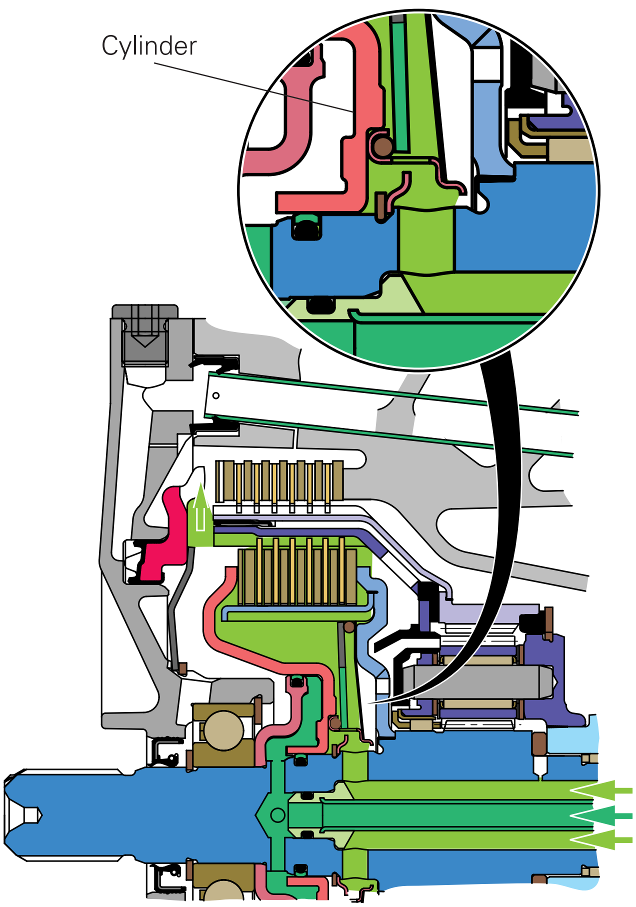
In this position, the cooling oil flows past the front face of the oil divider and through the forward clutch.

Cooling the Reverse Clutch

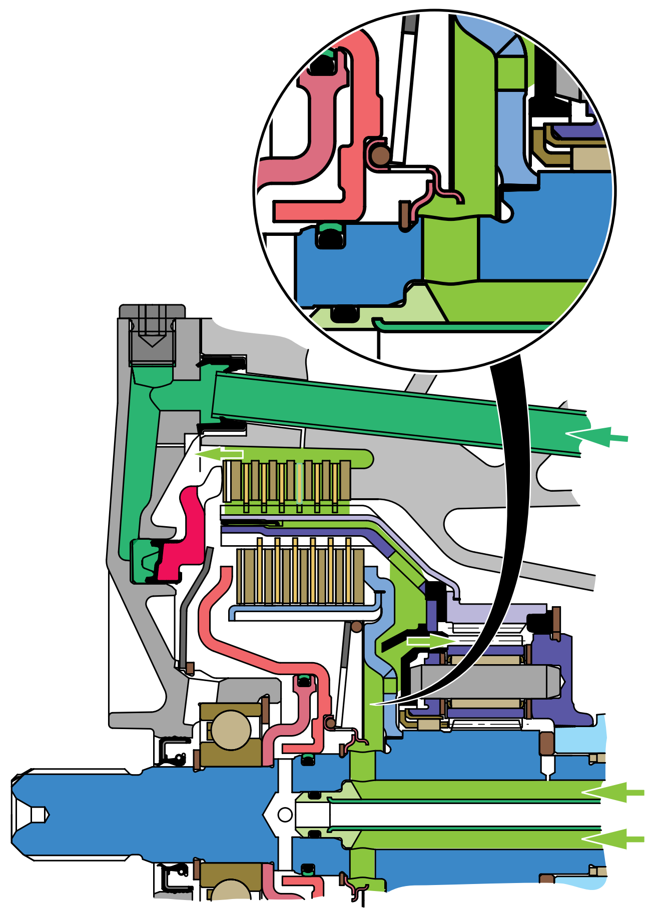
If the forward clutch is not operated (when the engine is running at idling speed or when the reverse clutch is operated), the oil divider is in its basic position.

In this position, the cooling oil flows to the oil divider and is rerouted to the reverse clutch by a distributor plate. Branches in the distributor pulley duct cooling oil to the planetary gear train and provide the necessary lubrication there.

Forward Clutch



Reverse Clutch



Oil Pressure for Clutch

Clutch Cooling Oil Flow

SSP 228/014

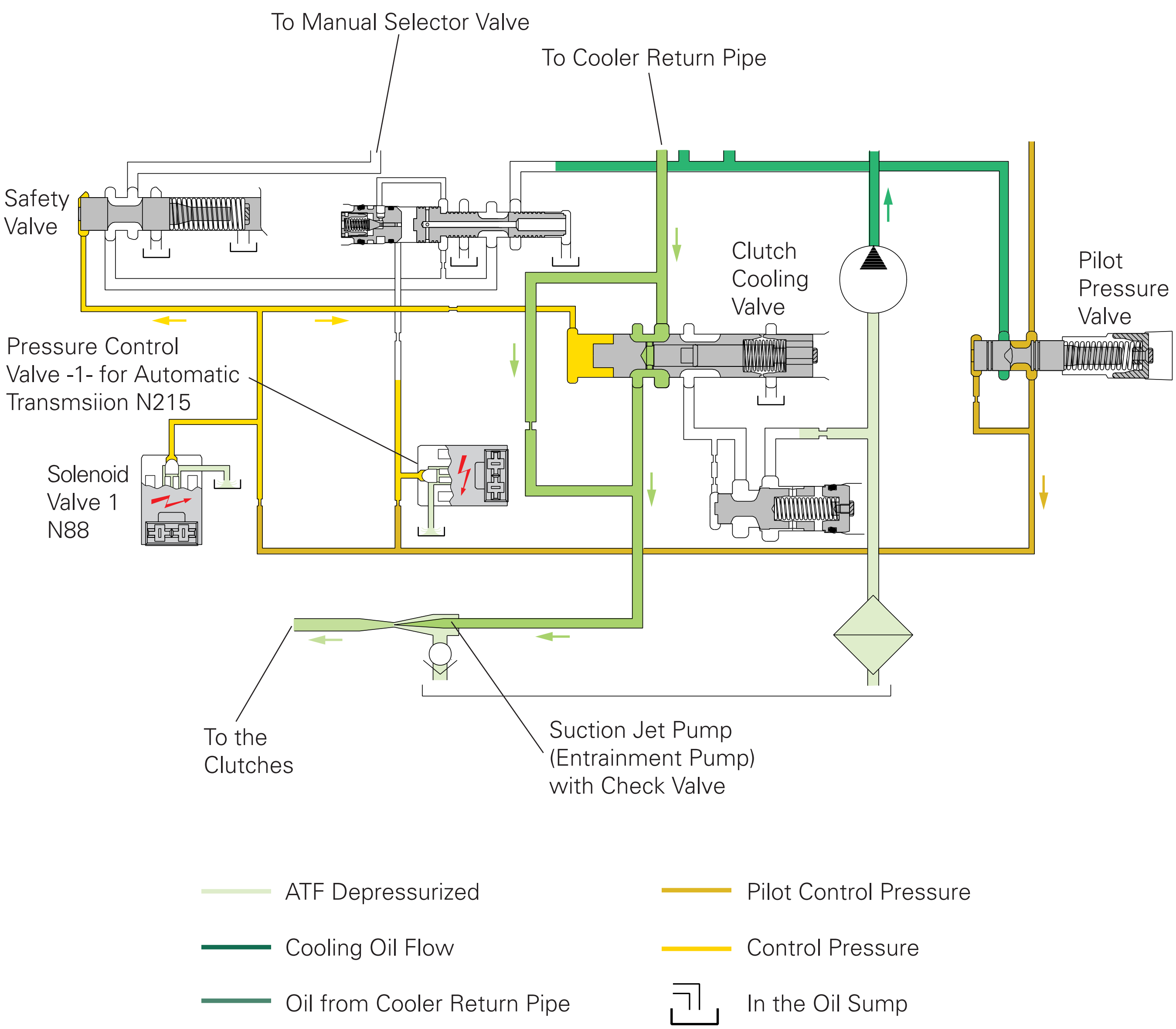
Hydraulic Clutch Cooling Control

The clutch cooling system cuts in at the same time as the clutch control is activated.

The Transmission Control Module J217 applies a defined control current to Solenoid Valve 1 N88. This produces a control pressure which switches the clutch cooling valve.

The clutch cooling valve transfers pressure from the cooler return pipe to the suction jet pump (entrainment pump).

The pressurized oil is used to operate the suction jet pump (entrainment pump) (for further details, refer to "The Suction Jet Pump (Entrainment Pump)," page 46).

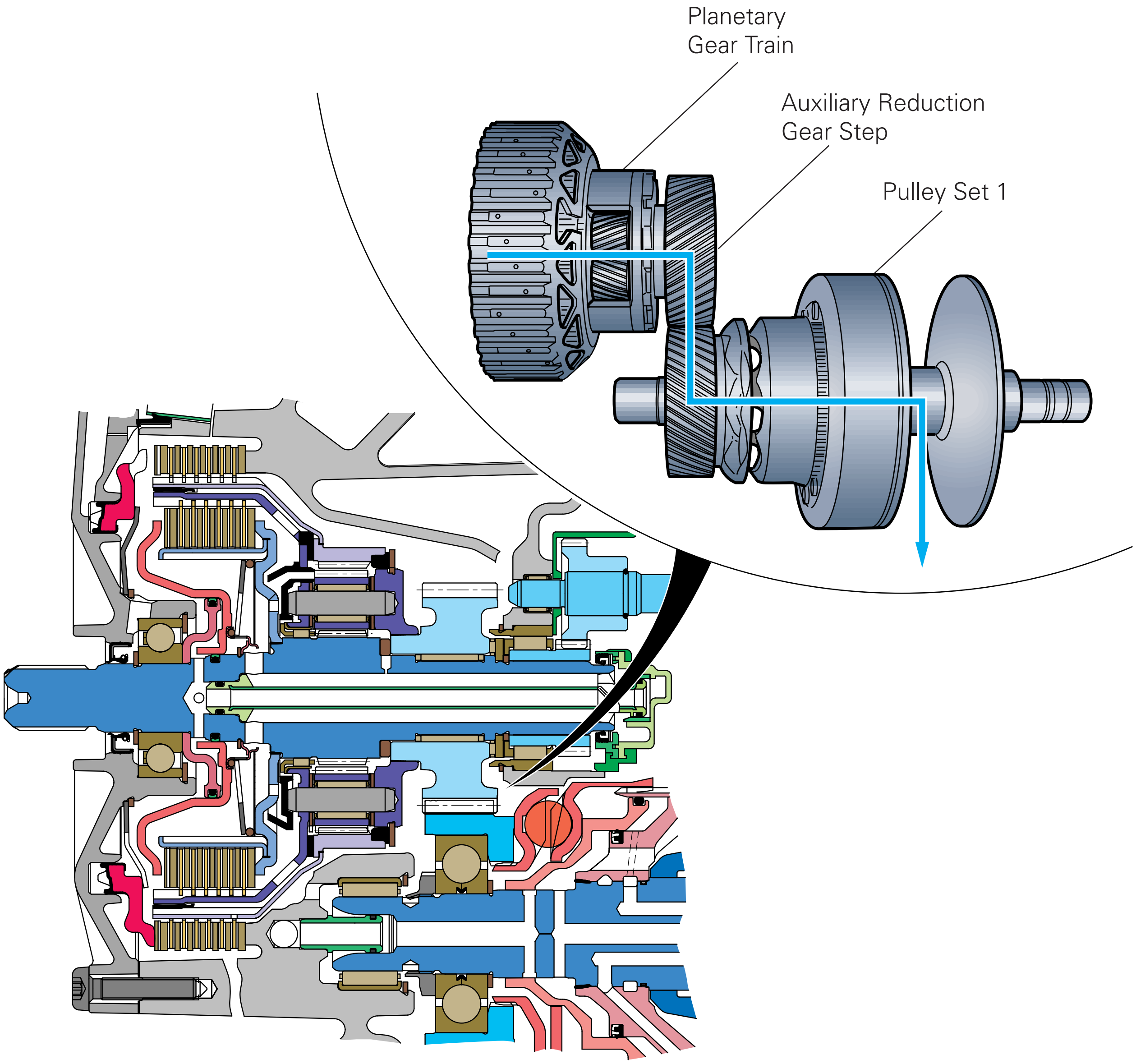


SSP 228/045

The Auxiliary Reduction Gear Step

Due to constraints on space, torque is transmitted to the Variator through an auxiliary reduction gear step.

The auxiliary reduction gear step has different reduction ratios to accommodate different engines to the transmission. As a result, the Variator is operated within its optimum torque range.



SSP 228/017

The Variator

The basic operating principle of the Variator has been explained on page 3. The special features and functions of the multitronic® Variator are described on the following pages.

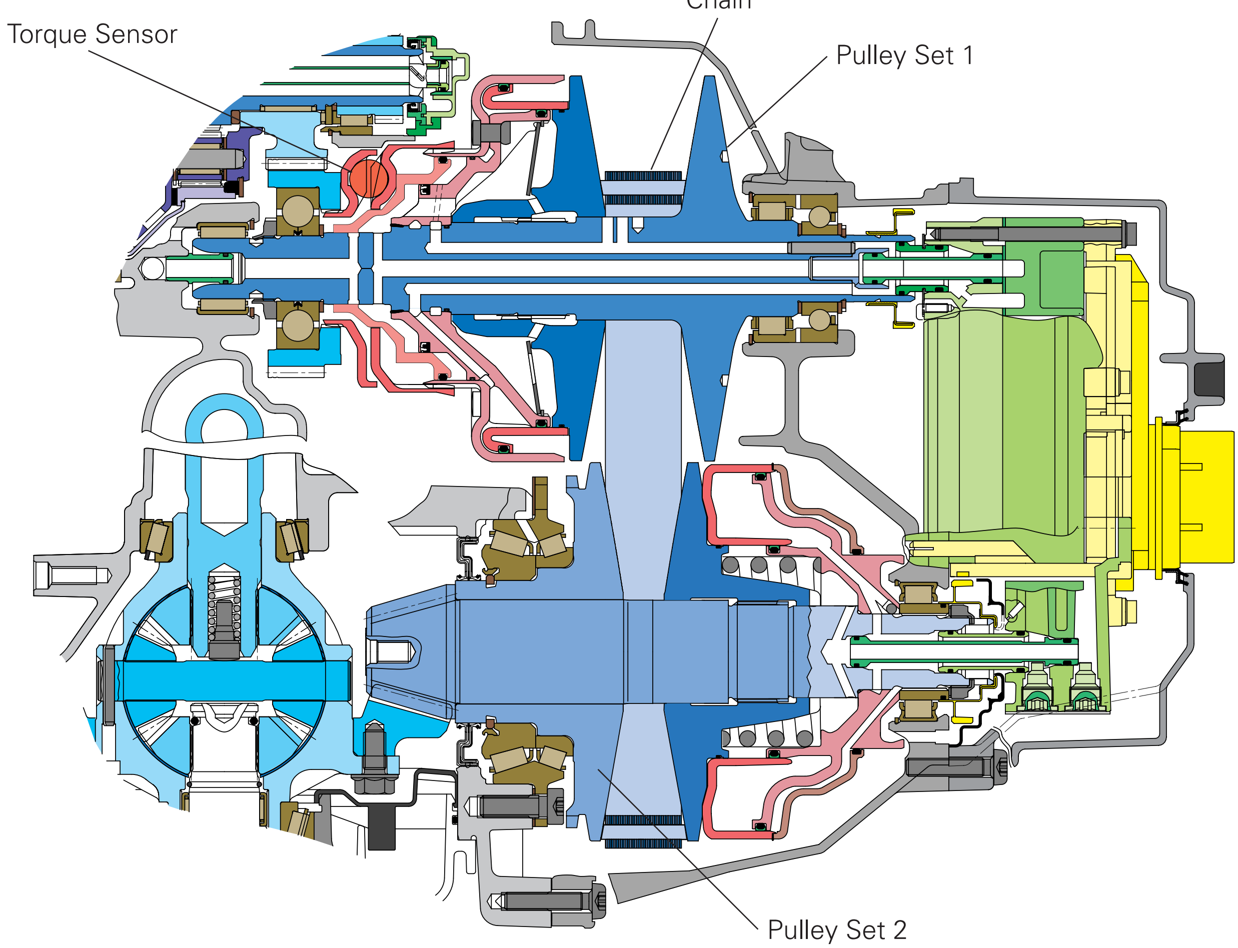
The Concept of the Variator Used in the multitronic®

The operation of the Variator is based on what is known as the dual-piston principle. A special feature of the multitronic® Variator is the torque sensor integrated in pulley set 1 (for more detailed information refer to "The Torque Sensor," page 33).

Pulley sets 1 and 2 each have a separate pressure cylinder for pressing the taper pulleys as well as a separate variable displacement cylinder for transmission ratio adjustment.

The dual-piston principle makes it possible to change the transmission ratio very quickly by applying a small amount of pressure. This ensures that the taper pulleys maintain sufficient contact pressure at a relatively low oil pressure level.

Starting Torque Ratio



SSP 228/018

Adjustment

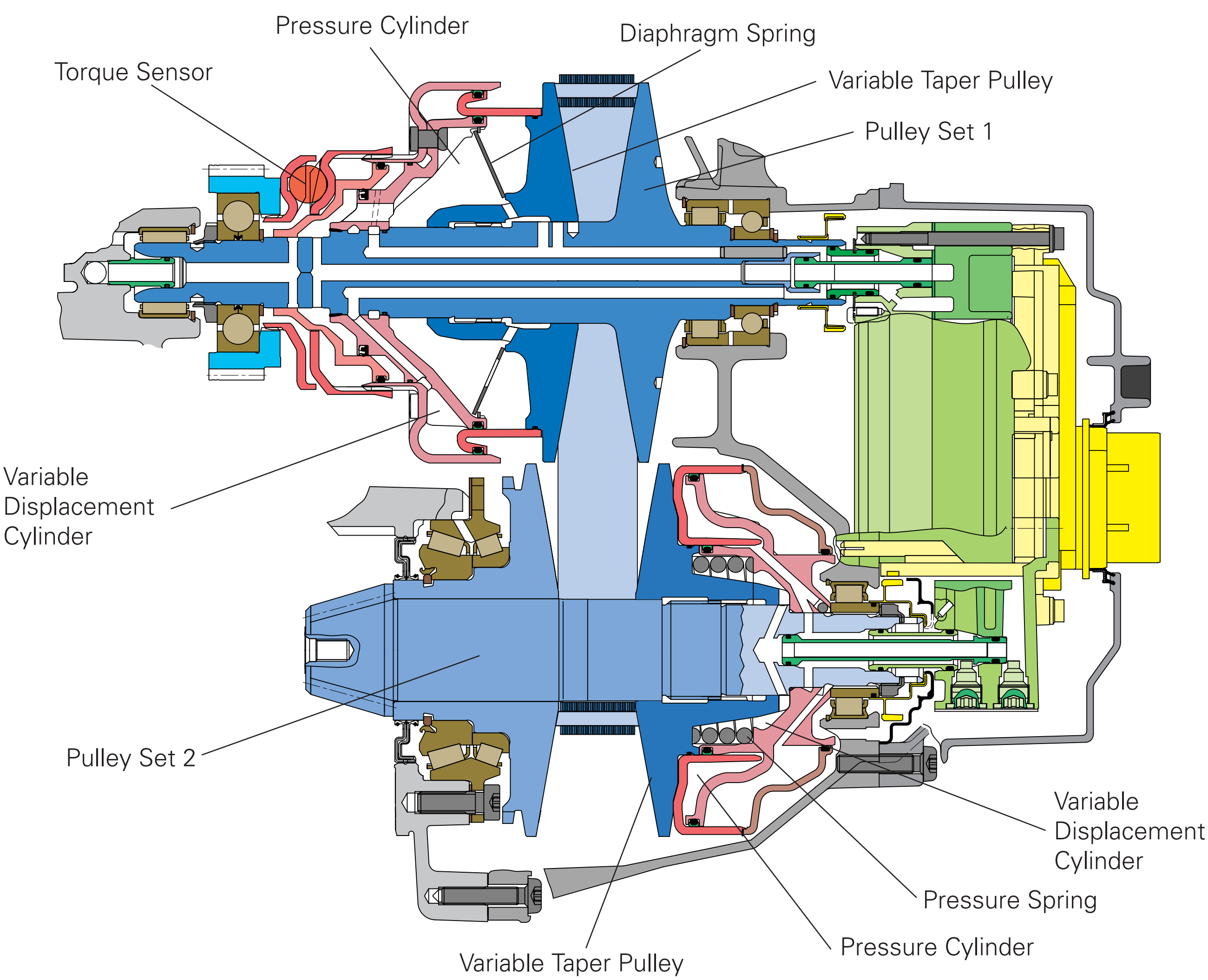
A suitable supply of pressurized oil is required due to the heavy demands on the adjustment dynamics. To minimize the required quantity of oil, the variable displacement cylinders have a smaller surface area than the pressure cylinders. Therefore, the quantity of oil needed for adjustment is relatively small.

This makes high adjustment dynamics and higher efficiency possible despite the low delivery rate of the oil pump.

The diaphragm springs in pulley set 1 and the coil springs in pulley set 2 create a defined basic chain tension (contact pressure) when the hydraulic system is depressurized.

In the depressurized state, the Variator for the starting torque ratio is adjusted by the spring force of the coil springs in pulley set 2.

End Torque Multiplication Ratio (Overdrive)



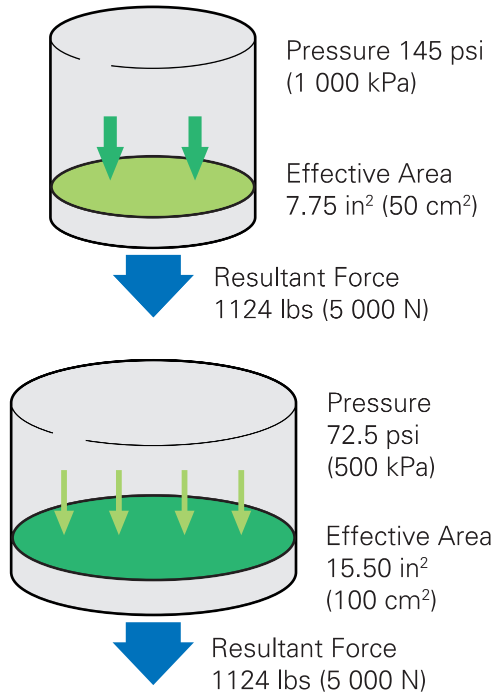
SSP 228/019

Contact Pressure

High contact pressures are required between the taper pulley and the chain to transmit the torque the engine develops. The contact pressure is produced by adjusting the oil pressure in the pressure cylinder as appropriate.

According to the principles of hydraulics, a resultant force (contact pressure) can be varied as a function of pressure and effective area.

The pressure cylinders have a larger surface area and can therefore apply the required contact pressure with less oil pressure. The relatively low oil pressure is also more efficient.



SSP 228/080

Towing

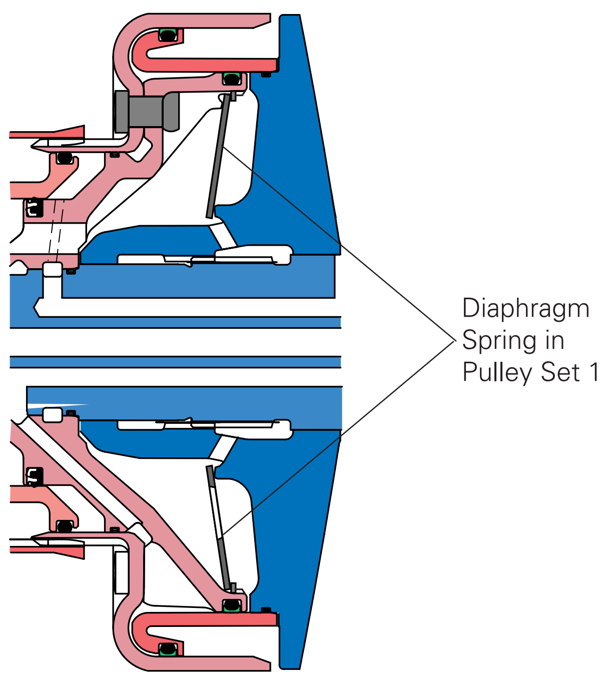
When the vehicle is being towed, pulley set 2 drives pulley set 1 and there is a dynamic pressure buildup in the variable displacement cylinder and pressure cylinder of the pulley sets.

The system is designed in such a way that the reduction ratio is adjusted to approximately 1:1 by the dynamic pressure build-up in the Variator. Pulley set 1 and the planetary gear train are thus protected from excessively high engine speeds.

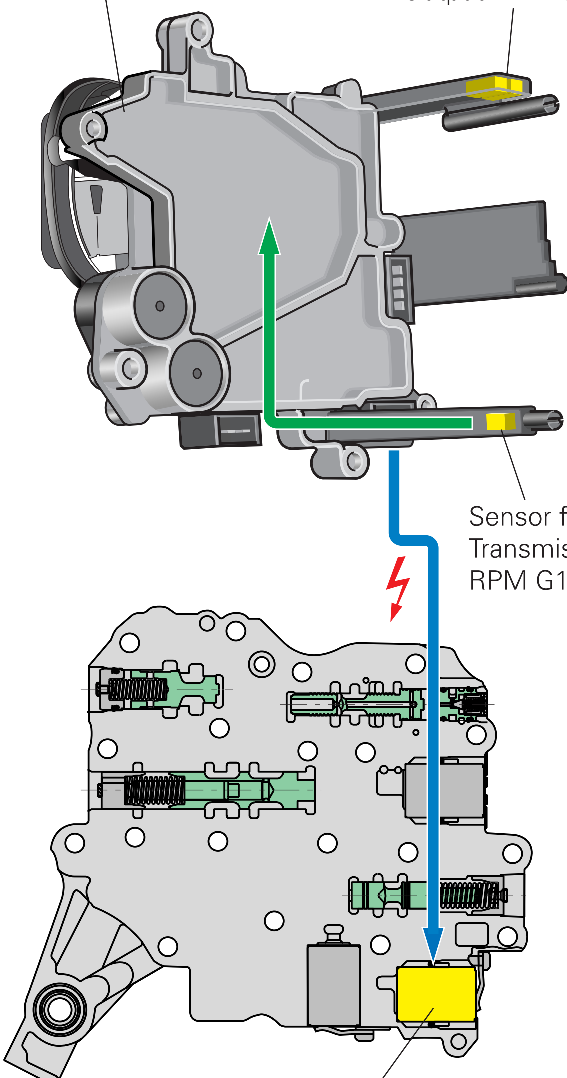
The diaphragm springs in pulley set 1 assist with this process.

For more detailed information regarding dynamic pressure build-up, refer to "The Splash Oil Cover," page 38.

Also observe the towing information given in "Towing," page 91.



SSP 228/081



SSP 228/076

The Transmission Control

Electronic Control

The Transmission Control Module J217 has a dynamic control program for calculating the nominal transmission input speed. It is an improved version of the dynamic shift program (DSP) already being used in multi-step automatic transmissions. The driver input and vehicle operating state are evaluated to provide the best gear ratio in every driving situation (see “Dynamic Control Program,” page 82).

The dynamic control program calculates a nominal transmission input speed depending on conditions.

The Sensor for Transmission RPM G182 registers the actual transmission input speed at pulley set 1.

The Transmission Control Module J217 calculates a control current for Pressure Control Valve -2- for Automatic Transmission N216 based on an actual-value/setpoint comparison. Pressure Control Valve -2- for Automatic Transmission N216 produces a control pressure for the hydraulic reduction valve which is almost proportional to the control current.

Transmission control is monitored by checking the plausibility of the signals from Sensor for Transmission RPM G182 and Sender for Transmission Output RPM G195 as well as the engine speed.

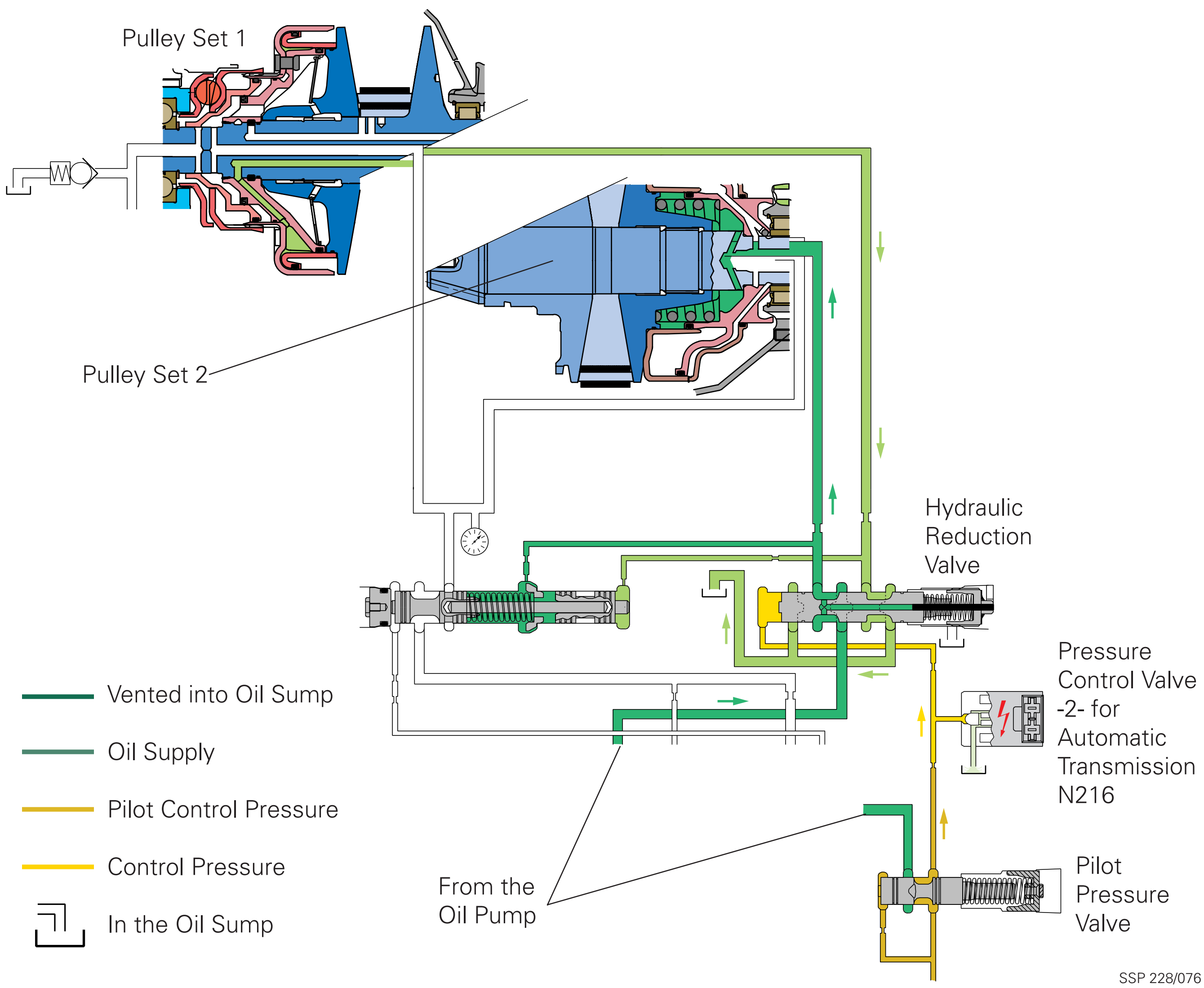
Hydraulic Transmission Control

Pressure Control Valve -2- for Automatic Transmission N216 is supplied with a constant pressure of approximately 73 psi (500 kPa) by the pilot pressure valve. Pressure Control Valve -2- for Automatic Transmission N216 produces a control pressure corresponding to the control current calculated by the Transmission Control Module J217, which influences the position of the hydraulic reduction valve.

A high control current leads to a high control pressure.

The hydraulic reduction valve transfers the adjusting pressure to the variable displacement cylinder of pulley set 1 or 2, depending on the control pressure.

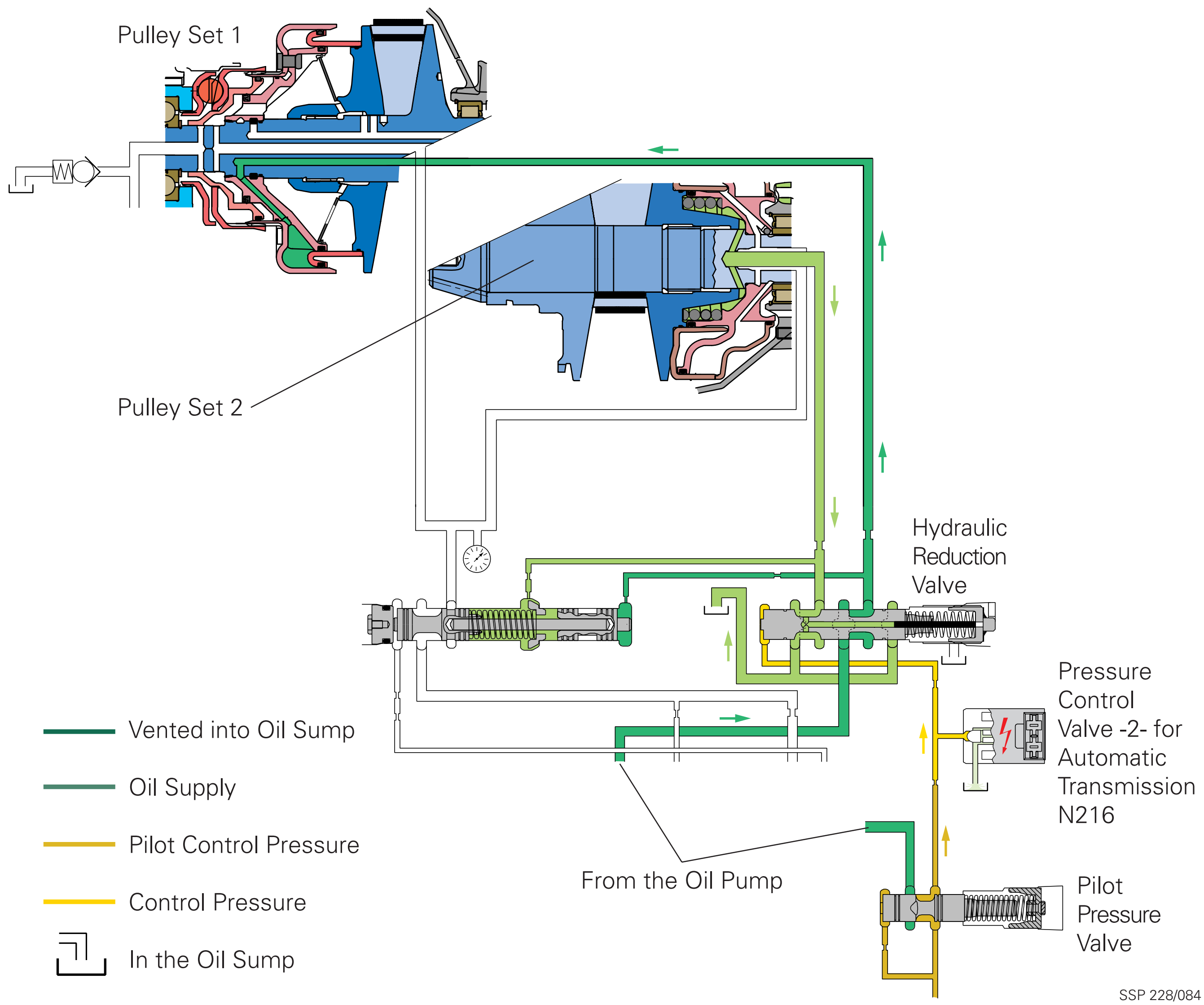
Starting Torque Ratio



The hydraulic reduction valve is closed at a control pressure of between approximately 26 and 32 psi (180 and 220 kPa). At a control pressure of less than 26 psi (180 kPa), the adjusting pressure is transferred to variable displacement cylinder at pulley set 1, and the variable displacement cylinder of pulley set 2 is simultaneously vented to the oil sump. The Variator shifts the reduction ratio towards the end torque multipliction ratio (overdrive).

If the control pressure is greater than 32 psi (220 kPa), the adjusting pressure is transferred to the variable displacement cylinder at pulley set 2 and the variable displacement cylinder at pulley set 1 is simultaneously vented to the oil sump. The Variator shifts the reduction ratio towards the starting torque ratio.

End Torque Multiplication Ratio (Overdrive)



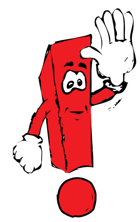
The Torque Sensor

Contact Pressure Control

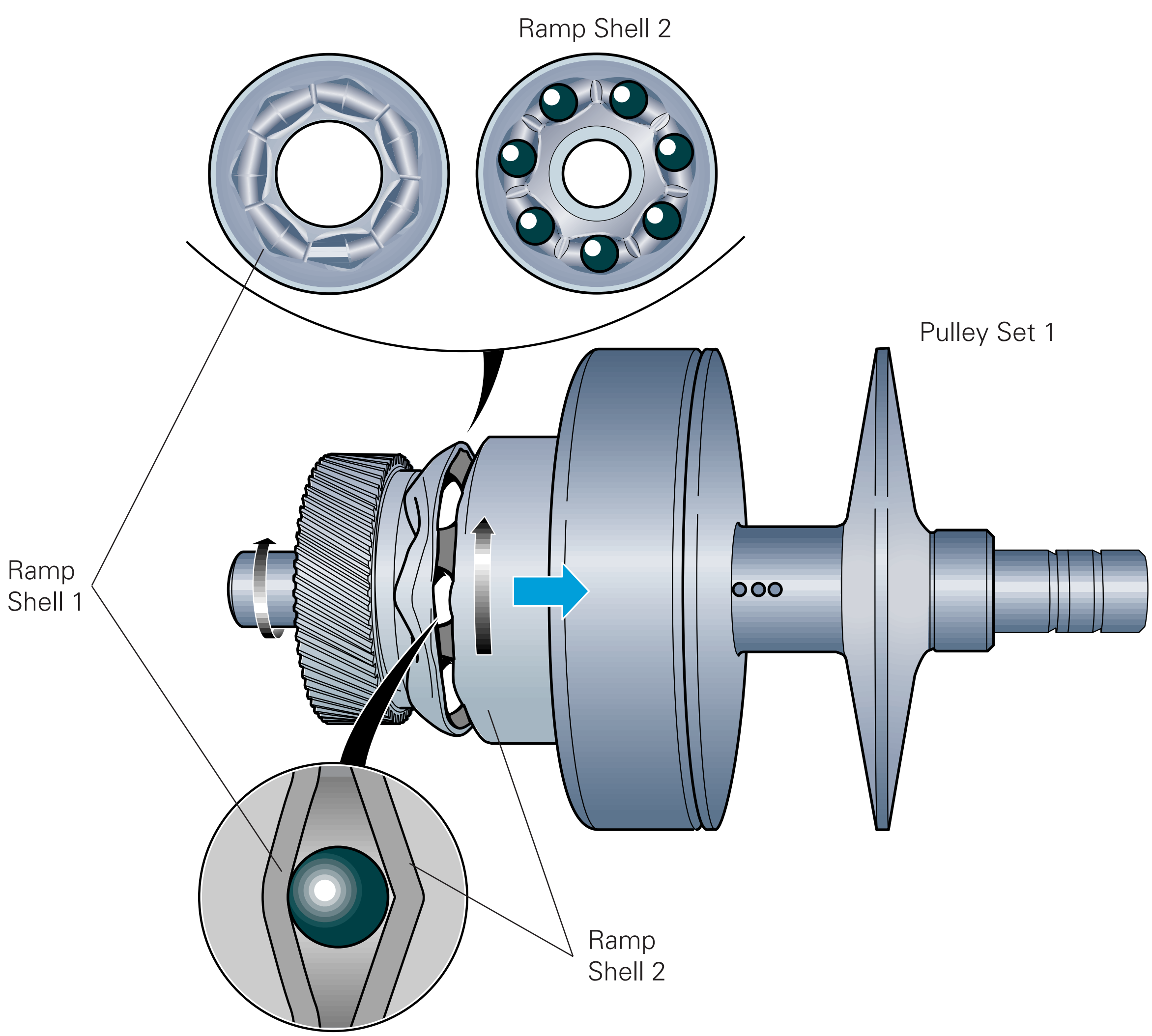
As mentioned before, a suitable oil pressure in the pressure cylinder gives a resultant contact pressure of the taper pulleys. If the contact pressure is too low, slippage of the chain will occur and the chain and pulley sets will be damaged. An excessively high contact pressure, on the other hand, will result in loss of efficiency.

The object, therefore, is to set the contact pressure of the taper pulleys as accurately and safely as possible according to requirements.

A hydro-mechanical torque sensor integrated in pulley set 1 statically and dynamically registers the actual torque transmitted to a high degree of accuracy and sets the correct oil pressure in the pressure cylinders.



The engine torque is transferred to the Variator by the torque sensor only. The contact pressure is controlled hydro-mechanically by the torque sensor.



SSP 228/021

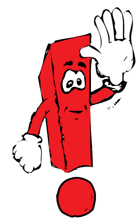
Design and Function

The torque sensor essentially comprises two shells with seven ramps between which steel balls are mounted in bearings. Ramp shell 1 is form-fitted to the output gear of pulley set 1 (output gear wheel of auxiliary reduction gear step). Ramp shell 2 is connected to pulley set 1 by a grooved gearing that allows axial movement and is supported by the torque sensor piston. The torque sensor piston serves to regulate the contact pressure and houses torque sensor spaces 1 and 2.

The shells can be rotated radially towards one another, converting the torque to an axial force (due to the ball and ramp geometry).

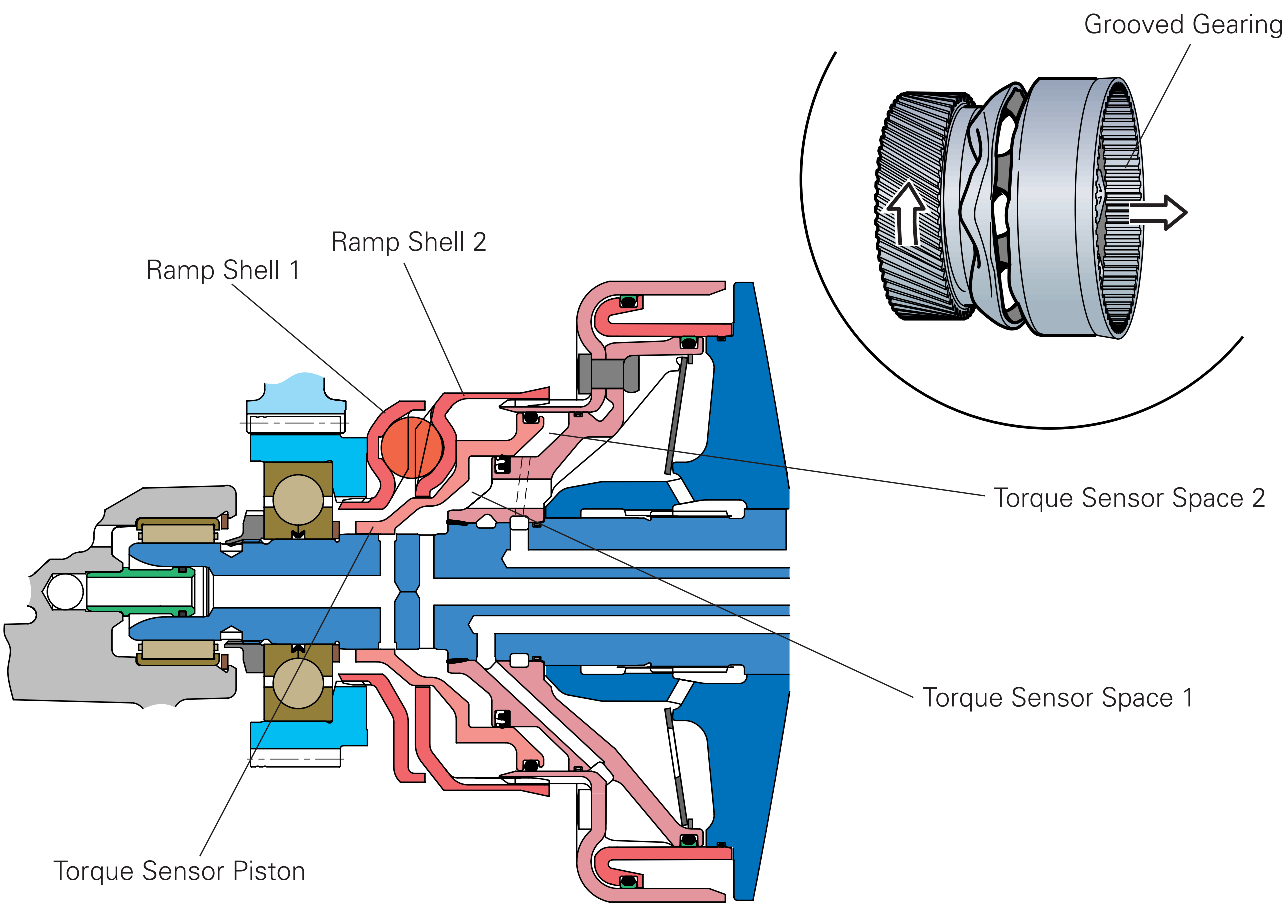
This axial force acts upon ramp shell 2 and moves the torque sensor piston which is in contact with the shell.

The control edge of the torque sensor piston now closes or opens the outlets in torque sensor space 1.



The axial force generated by the torque sensor serves as a control force which is proportional to the engine torque.

The pressure which builds up in the pressure cylinder is proportional to the control force.

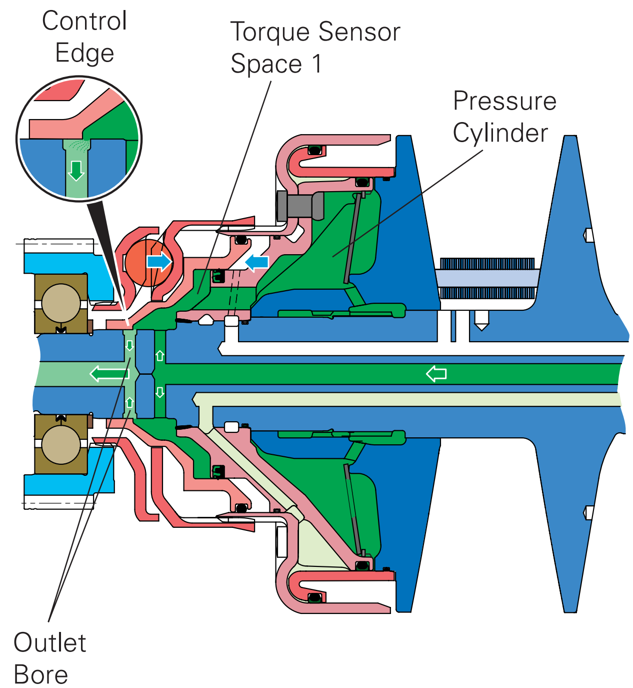


SSP 228/022

Torque sensor space 1 is directly connected to the pressure cylinder.

The system is designed so the axial force generated as a product of engine torque and the pressure in the pressure cylinder form a force equilibrium.

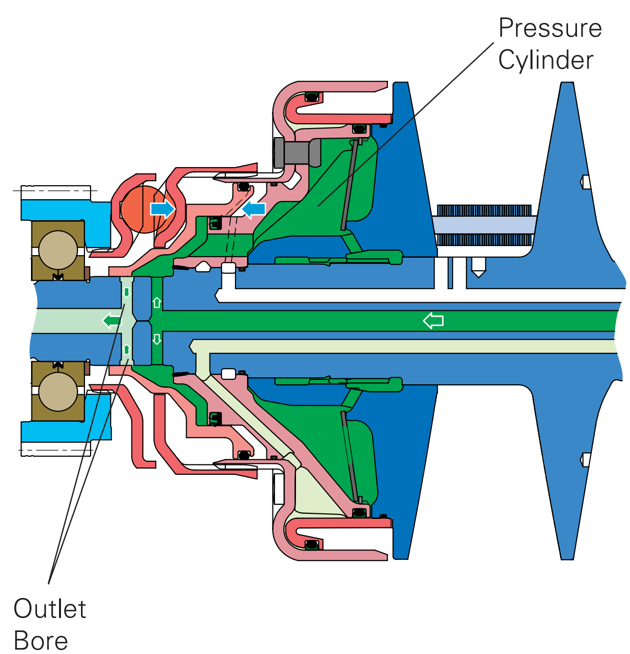
In constant conditions of vehicle operation, the outlet bores are only partially closed. The pressure drop produced by opening the outlet bores (torque sensor) modulates the pressure in the pressure cylinder.



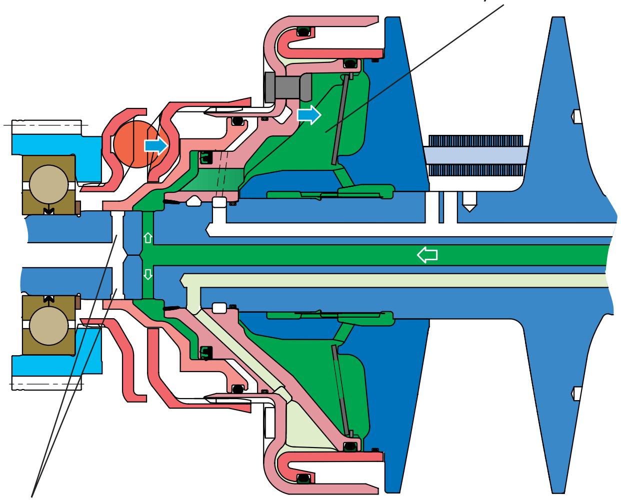
SSP 228/056

If input torque increases, the outlet bores are initially closed further by the control edge. The pressure in the pressure cylinder rises until a force equilibrium again exists.

If input torque decreases, the outlet bores are opened further. The pressure in the pressure cylinder decreases until the force equilibrium is restored.

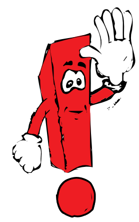


SSP 228/057

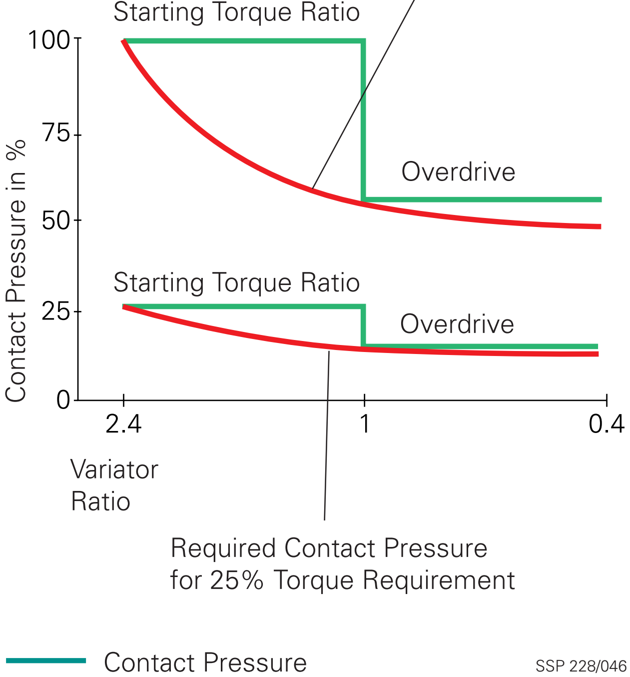


SSP 228/058

At peak torque levels, the control edge closes off the outlet bores. If the torque sensor moves any further, it acts as an oil pump. The displaced oil volume causes a rapid rise in the pressure inside the pressure cylinder and immediately adjusts the contact pressure.



Extremely high peak torques can occur when the vehicle drives over a pot-hole or if the coefficient of friction of the road surface fluctuates considerably (transitions from black ice to asphalt for example).



SSP 228/046

Adaptation of contact pressure depending on transmission ratio

The contact pressure exerted by the taper pulleys depends not only on the input torque but also on chain track radius and, therefore, on the actual reduction ratio of the Variator.

As the diagram shows, the starting torque ratio (clutch engagement) requires the greatest contact pressure.

The radius of the chain is smallest in pulley set 1. For power transmission, only a small number of cradle type pressure pieces are in mesh despite the high input torque.

Therefore, a higher contact pressure is applied by the taper pulleys until a defined reduction ratio of 1:1 is exceeded.

Function and Mode of Operation

The ratio-dependent contact pressure is adapted in torque sensor space 2. The pressure level in the pressure cylinder is varied by increasing or decreasing the pressure in torque sensor space 2. The pressure in torque sensor space 2 is controlled by two transverse holes in the shaft of pulley set 1. These holes are opened or closed through axial displacement of the variable taper pulley.

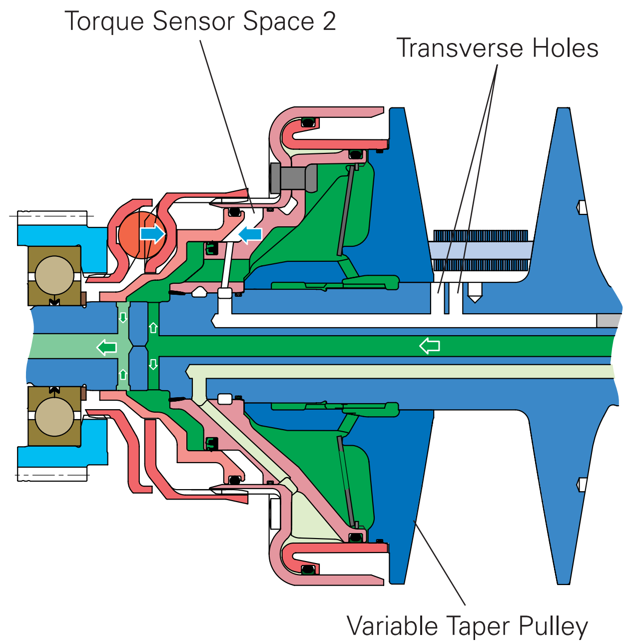
The transverse holes are open when the Variator is in the starting torque ratio (torque sensor space 2 is depressurized).

When the Variator changes the ratio to end torque multipliction ratio (overdrive), the transverse holes are shut off initially. At a defined reduction ratio, the left-hand transverse hole is opened to the pressure cylinder through corresponding holes in the variable taper pulley.

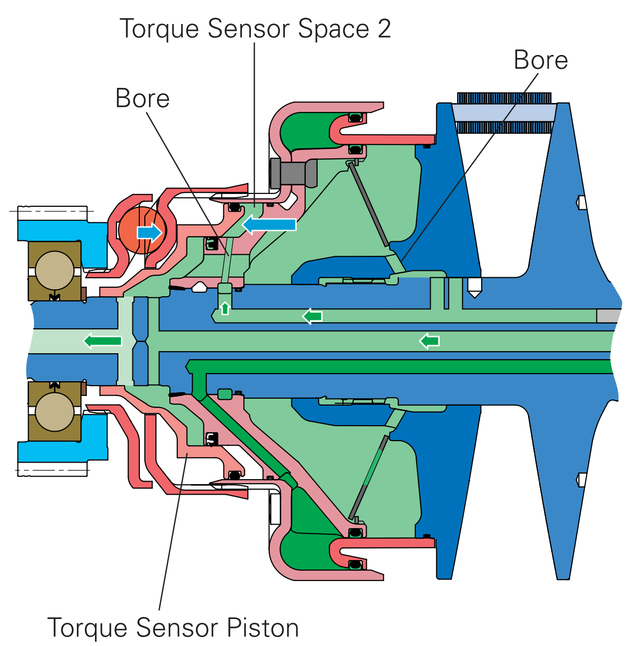
This allows the oil pressure to be transferred from the pressure cylinder into torque sensor space 2. This pressure counteracts the axial force of the torque sensor and moves the torque sensor piston to the left.

The control edge opens up the outlet bores further, reducing the oil pressure inside the pressure cylinder.

The main advantage of the two-stage pressure adaptation process is that a low contact pressure can be utilized in the mid-ratio range which increases efficiency (refer to illustration SSP 228/046, previous page).



SSP 228/059



SSP 228/060

The Splash Oil Cover

Another special feature of the Variator is the “splash oil cover” on pulley set 2 which counteracts the dynamic pressure buildup in the pressure cylinder.

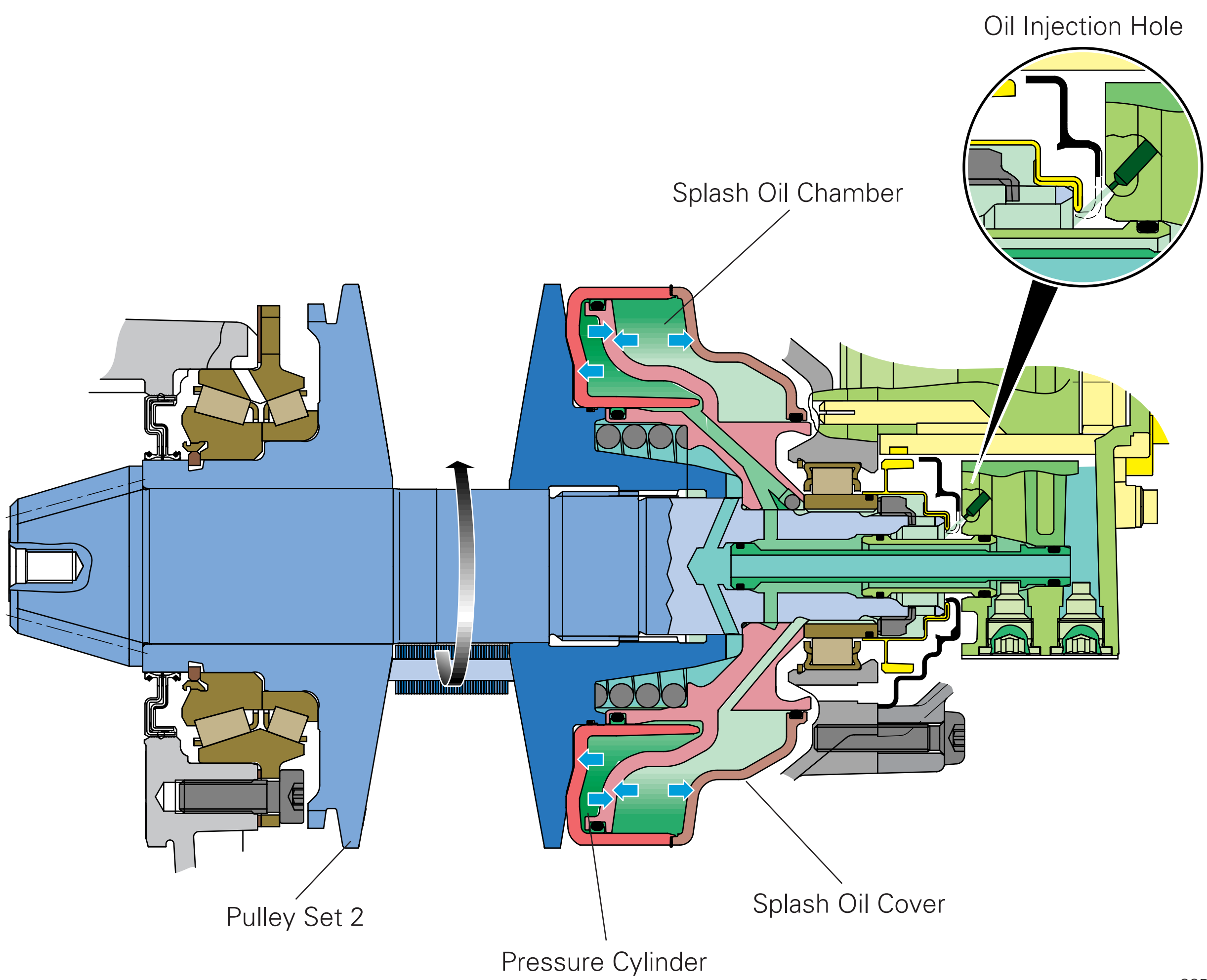
At high engine speeds, the transmission oil in the pressure cylinder is subjected to high rotation-induced centrifugal forces, which leads to a rise in pressure. This process is known as “dynamic pressure buildup.”

A dynamic pressure buildup is undesirable because it unduly increases the contact pressure and has an adverse effect on transmission control.

The oil confined in the splash oil cover is subjected to the same dynamic pressure buildup as in the pressure cylinder. The dynamic pressure buildup in the pressure cylinder is compensated by this.

The splash oil chamber receives its oil supply directly from the hydraulic control module through an oil injection hole. Oil is continuously injected into the splash oil chamber inlet through this hole.

A reduction in volume inside the splash oil chamber (when varying the transmission ratio) causes the oil to be discharged through the supply inlet.



SSP 228/061

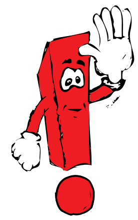
The Chain

The chain is a key component part of the Variator of the multitronic®.

This is the first time that a chain has been used as a driving means in a CVT.

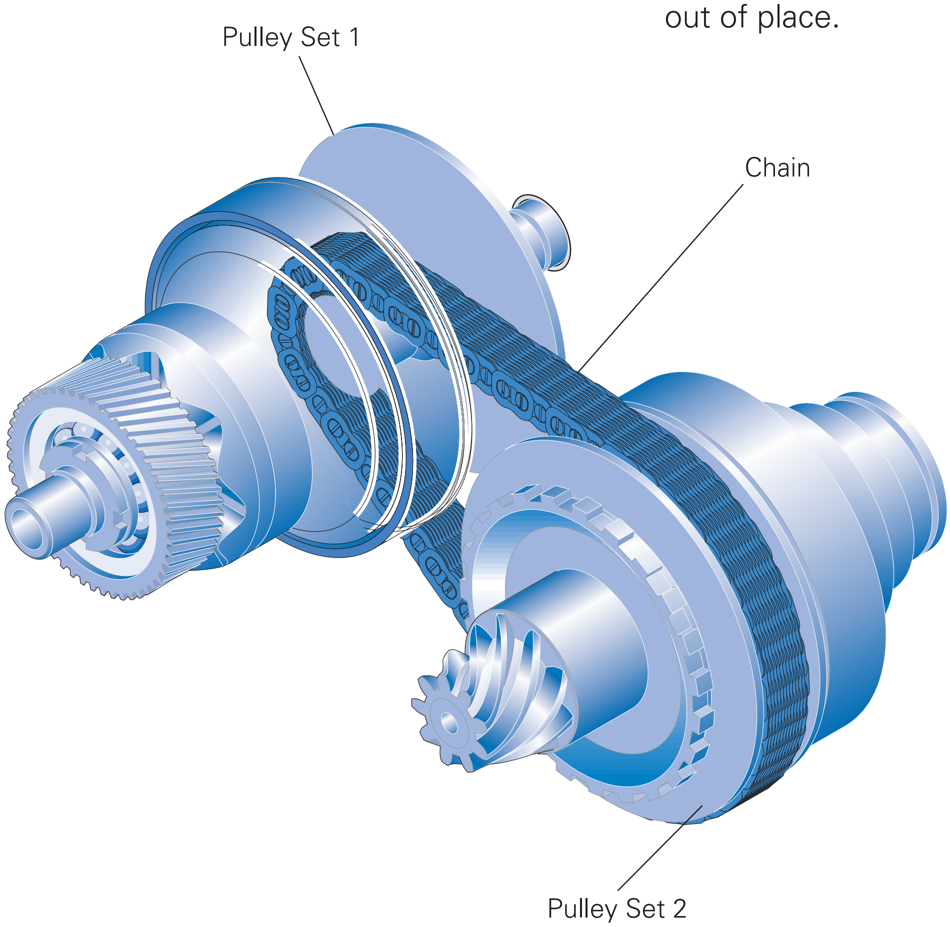
The chain is a new development and has the following advantages over conventional driving means such as sliding link belts or V-belts:

- Very small track radii make possible a large "spread" despite the small size of the Variator.
- High transferable torque.
- High efficiency.

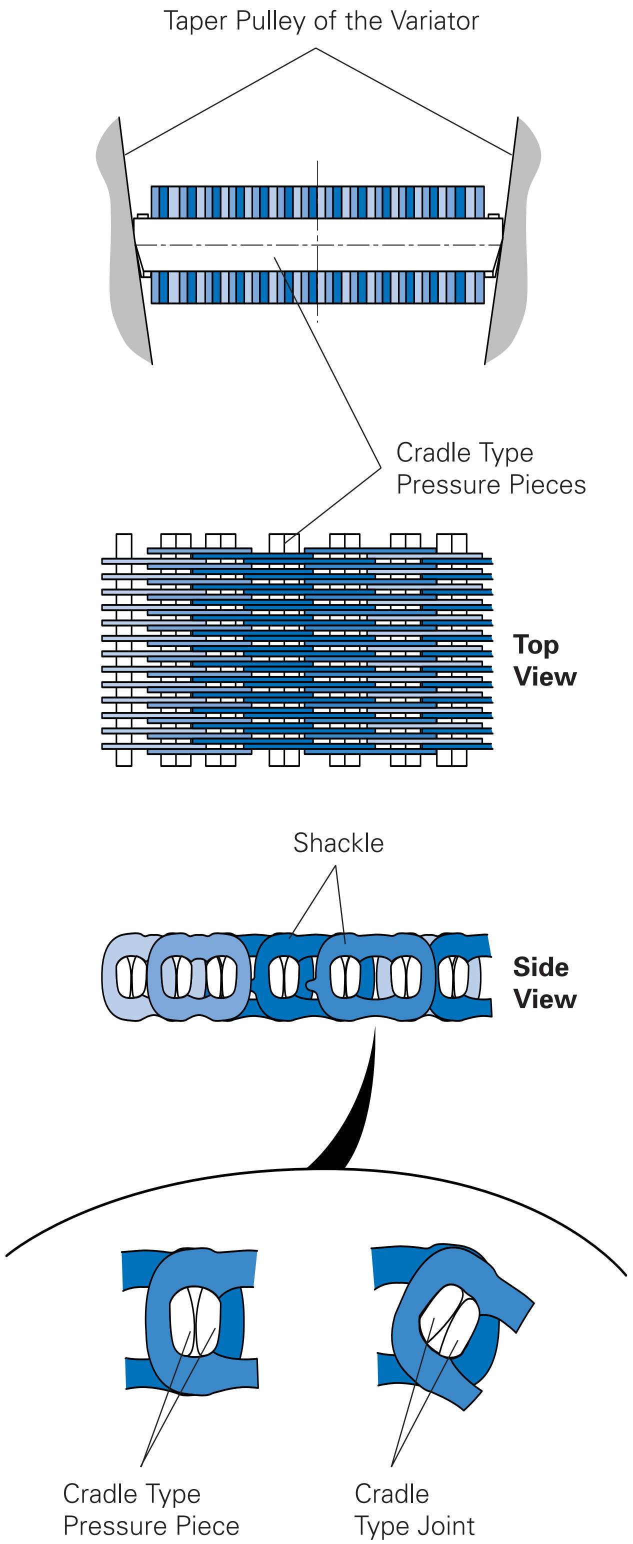


The **spread** indicates the range of ratios which a transmission provides.

The spread is specified as a ratio. The starting torque ratio divided by the spread equals to the end torque multiplication ratio.
In general a large spread is an advantage because both a high starting torque ratio (for good performance) and a low end torque multiplication ratio (for low fuel consumption) are available.
This applies in particular to the CVT concept, since practically all intermediate steps are available and no ratio steps are out of place.



SSP 228/026



SSP 228/027

Design and Function

On a conventional chain, the chain link plates are interconnected by joint pins with a slip fit. For torque transmission, gear teeth move into engagement with the pins between the chain link plates.

The CVT chain uses a different technology.

The CVT chain has adjacent rows of chain link plates linked continuously with cradle type pressure pieces (two per link).

On the CVT chain, the cradle type pressure pieces are "jammed" between the taper pulleys of the Variator as the taper pulleys are pressed toward one another.

The torque is transmitted only by the frictional force between the ends of the cradle type pressure pieces and the contact faces of the taper pulleys.

This is how it works:

Each of the cradle type pressure pieces is permanently connected to a row of link plates so that it cannot be twisted.
Two cradle type pressure pieces form a cradle type joint.

The cradle type pressure pieces now roll off one another with very little friction as they "drive" the chain within the track radius of the taper pulleys.

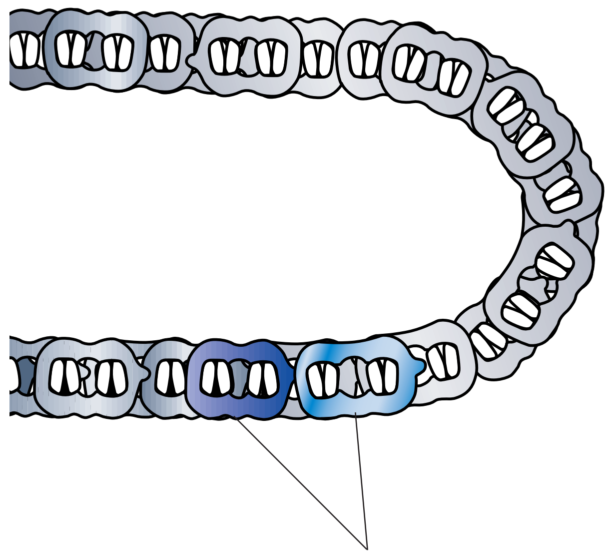
In this way, lost power and wear are minimized despite the high torque and the large angle of bend. The result is long service life and optimal efficiency.

Acoustic Measures

Two different lengths of link plate are used to ensure that the chain runs as quietly as possible.

When using a constant length of link plate, the cradle type pressure pieces strike the taper pulleys at uniform intervals and induce vibrations which cause a noise nuisance.

Using different lengths of link plate counteracts resonance and minimizes running noise.



SSP 228/028

The Oil Supply

In the multitronic®, power transmission is dependent on the electrical power supply and also on the hydraulics.

In order to work, an electric current and adequate oil supply are required.

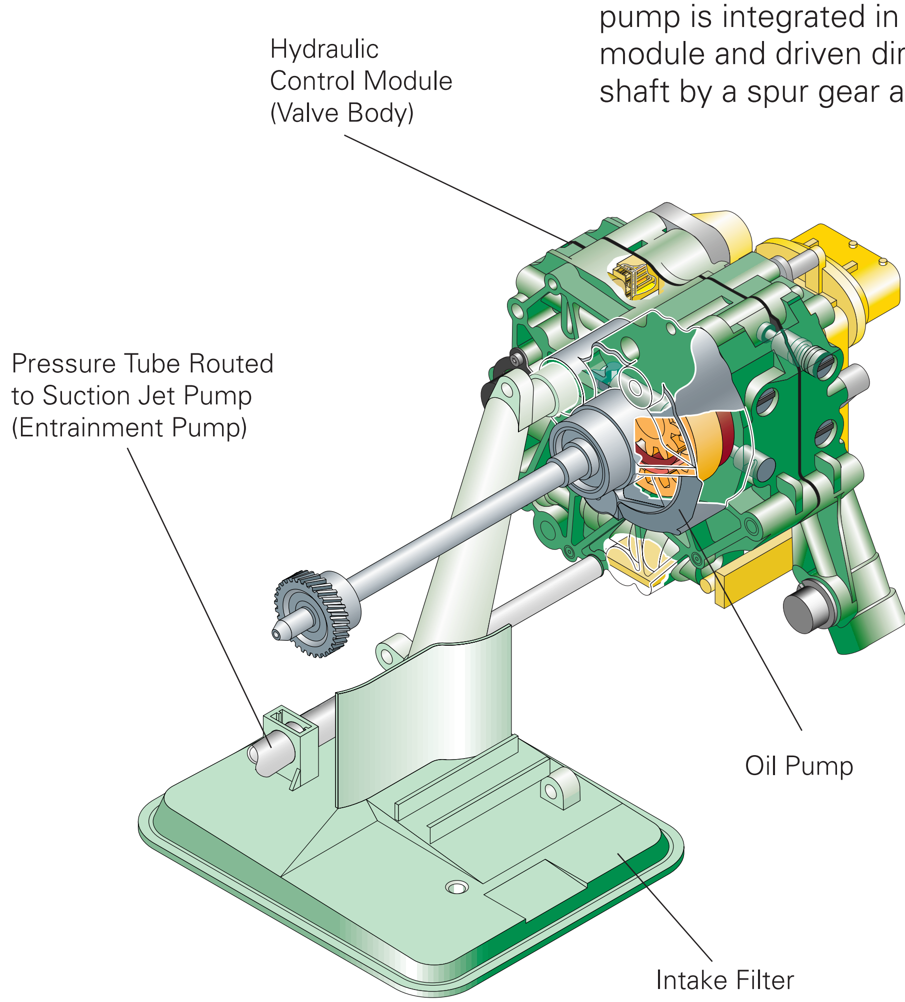
The oil pump is the main power consumer in the transmission and its capacity is important for overall efficiency.

The transmission control and cooling systems are designed to run on a minimum of oil, and an innovative oil supply system has been developed.

The Oil Pump

The oil pump is mounted directly on the hydraulic control module to avoid unnecessary interfaces. The oil pump and the control module form a compact unit, which reduces pressure losses and production costs.

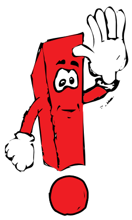
The multitronic® is equipped with an efficient crescent pump. This pump produces the necessary pressures, but requires only a relatively small quantity of oil. A suction jet pump (entrainment pump) supplies the additional quantity of oil required for the clutch cooling at low pressure. The compact crescent-vane pump is integrated in the hydraulic control module and driven directly by the input shaft by a spur gear and pump shaft.



SSP 228/034

As a special feature, the oil pump has axial and radial clearance adjustment.

A pump with good "internal sealing" is required in order to produce high pressures at low engine speeds.



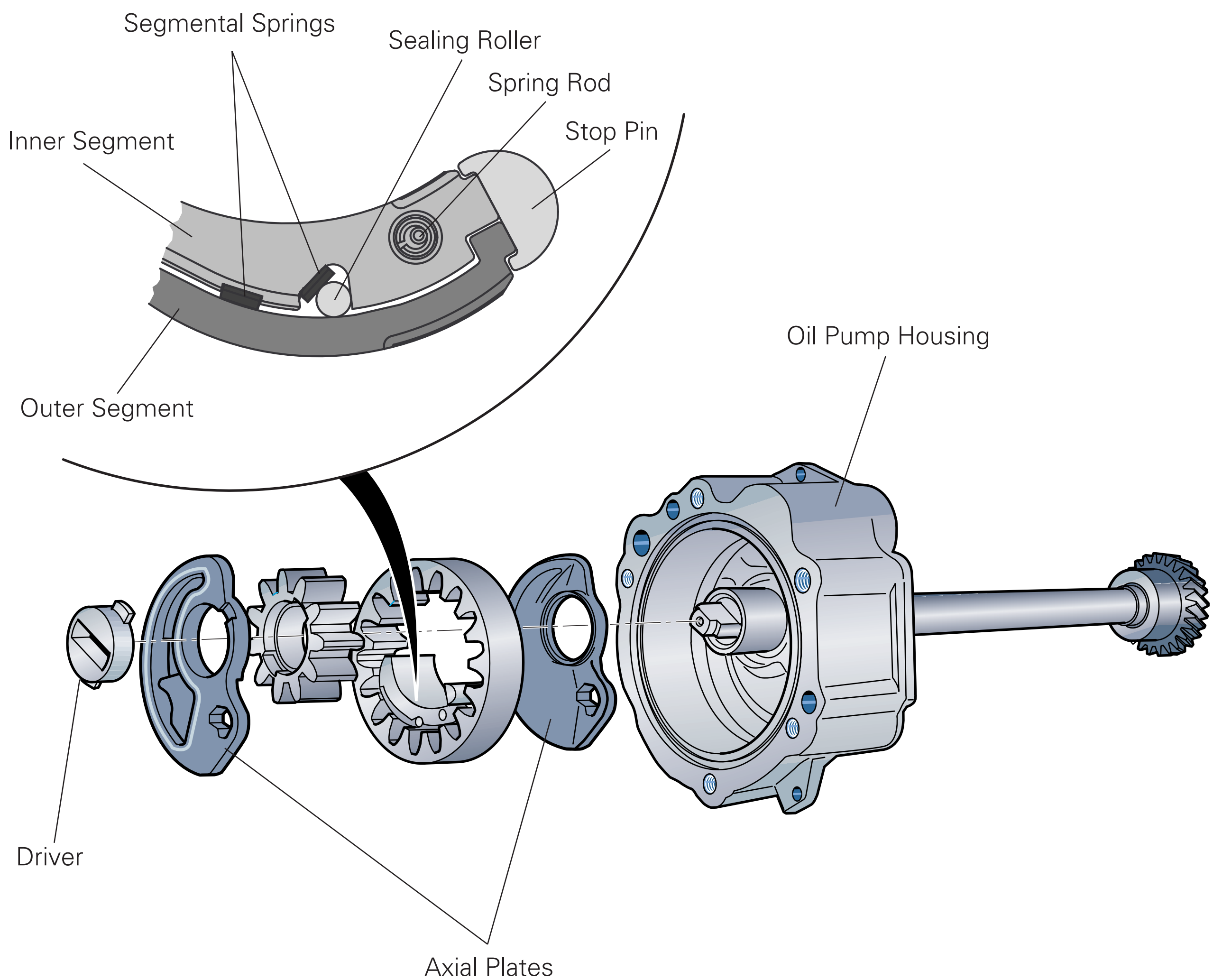
"Internal sealing" refers to the ability of the pump to minimize leakage past the surfaces moving the fluid through the pump.

Conventional oil pumps do not meet these requirements due to component tolerances.

The axial clearance between the gears and the housing, as well as the radial clearance between the gears and the crescent vane can vary depending on the tolerance zone position of the component parts in a conventional pump.

The pressure generated can thus more or less escape "internally."

The result will be a loss of pressure and a drop in efficiency.

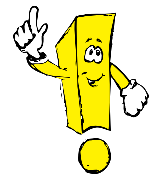


SSP 228/035

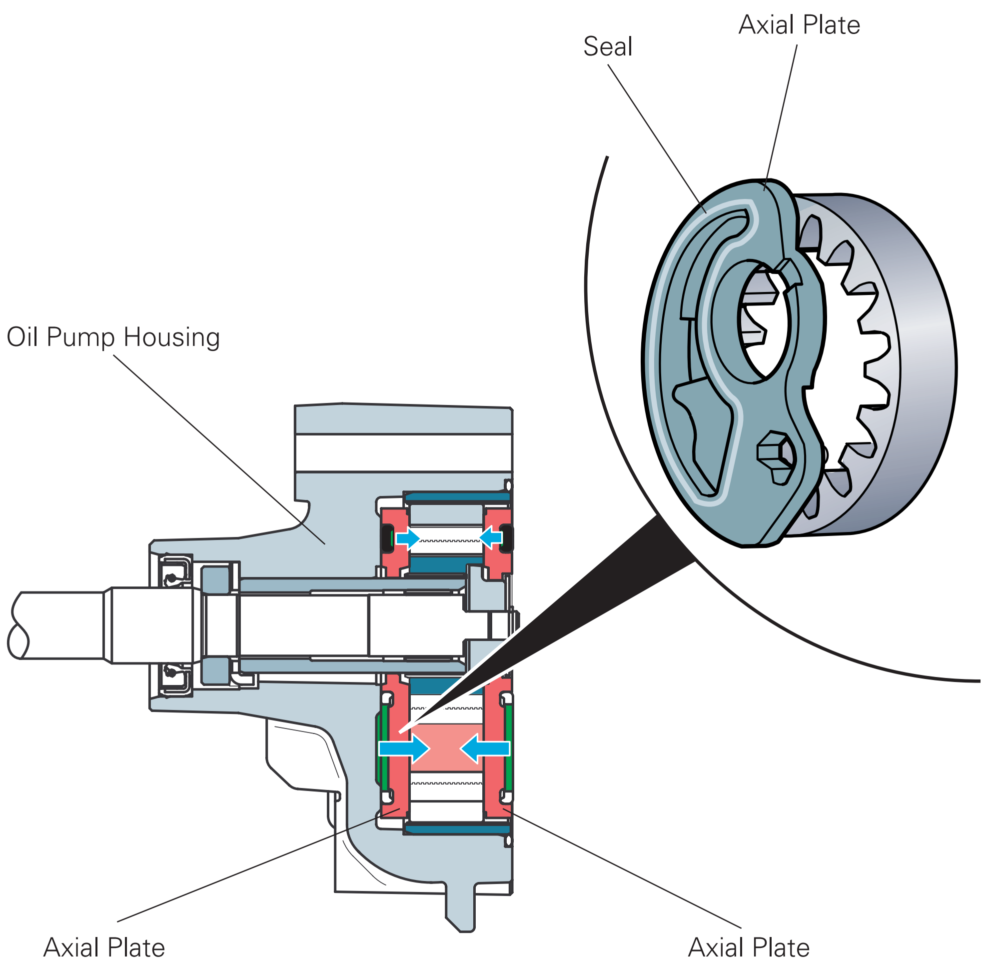
Axial Clearance Adjustment

Two axial plates cover the pressure range of the crescent pump and form a separate discharge casing inside the pump.
They seal the pump pressure chamber laterally (axially). These plates, fitted with a special seal, are supported by the oil pump housing or the pump plate of the hydraulic control module.

The axial plates are designed to allow the pump pressure to act between the axial plates and the housing. The seal prevents pressure from escaping. As pump pressure increases, the axial plates are pressed more firmly against the crescent seal and the pump gears, which compensates for axial clearance.



The axial and radial clearance adjustment allows the pump to generate the required high pressures and simultaneously achieve high efficiency despite its compact design.



SSP 228/051

Radial Clearance Adjustment

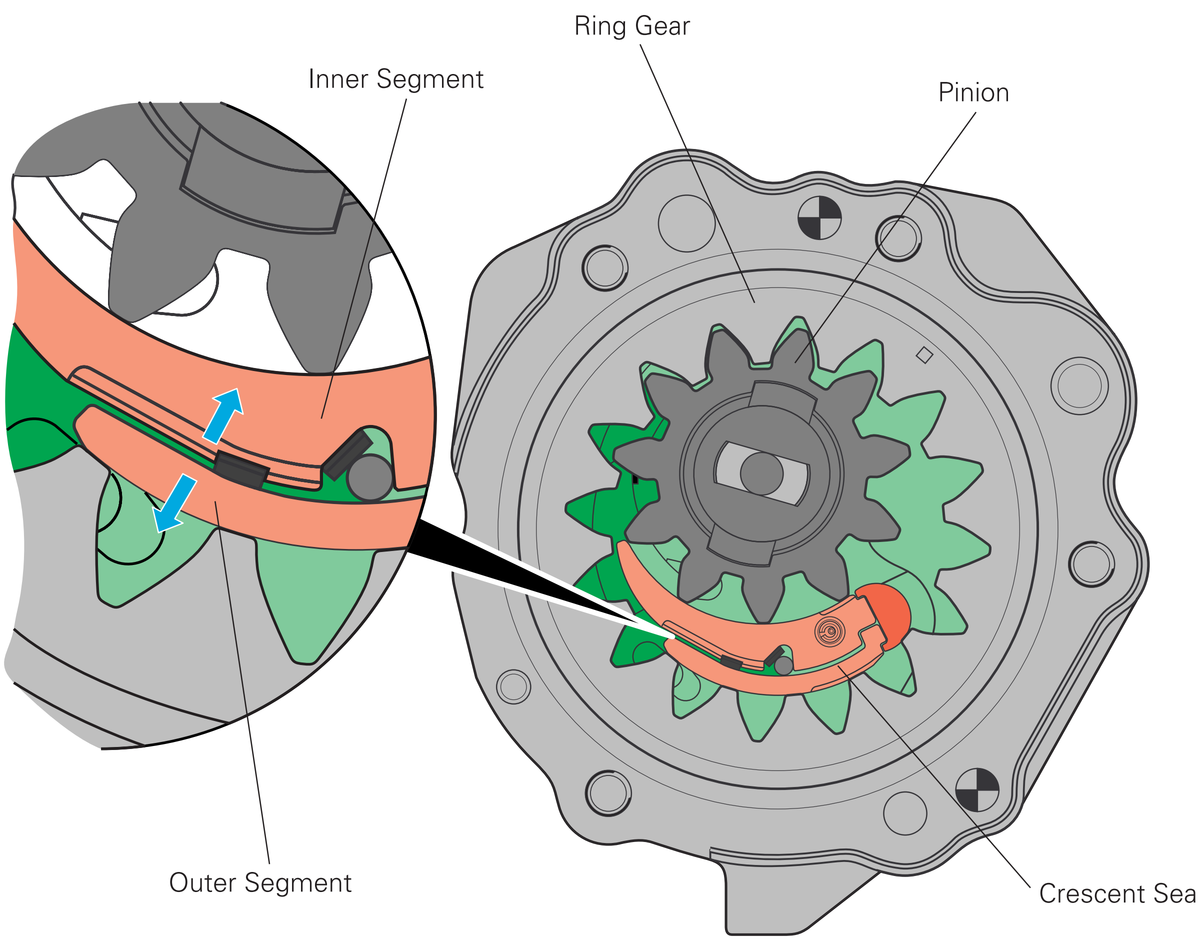
The radial clearance adjustment feature compensates for the radial gap between the crescent seal and the gears (pinion and ring gear).

For this purpose, the crescent seal is split in two segments, the **inner segment** and the **outer segment.**

The inner segment seals the pressure chamber off from the pinion. It also holds the outer segment in a radial direction. The outer segment seals the pressure chamber off from the ring gear. The pump pressure flows between the two segments. The segments are pressed more firmly against the pinion and ring gear as the pump pressure increases, which compensates for radial clearance.

When the pump is depressurized, the segmental springs provide the basic contact pressure for the segments and the sealing roller, and improve the suction characteristics of the oil pump.

They also ensure that the pump pressure can act between the segments and on the sealing roller.



SSP 228/049

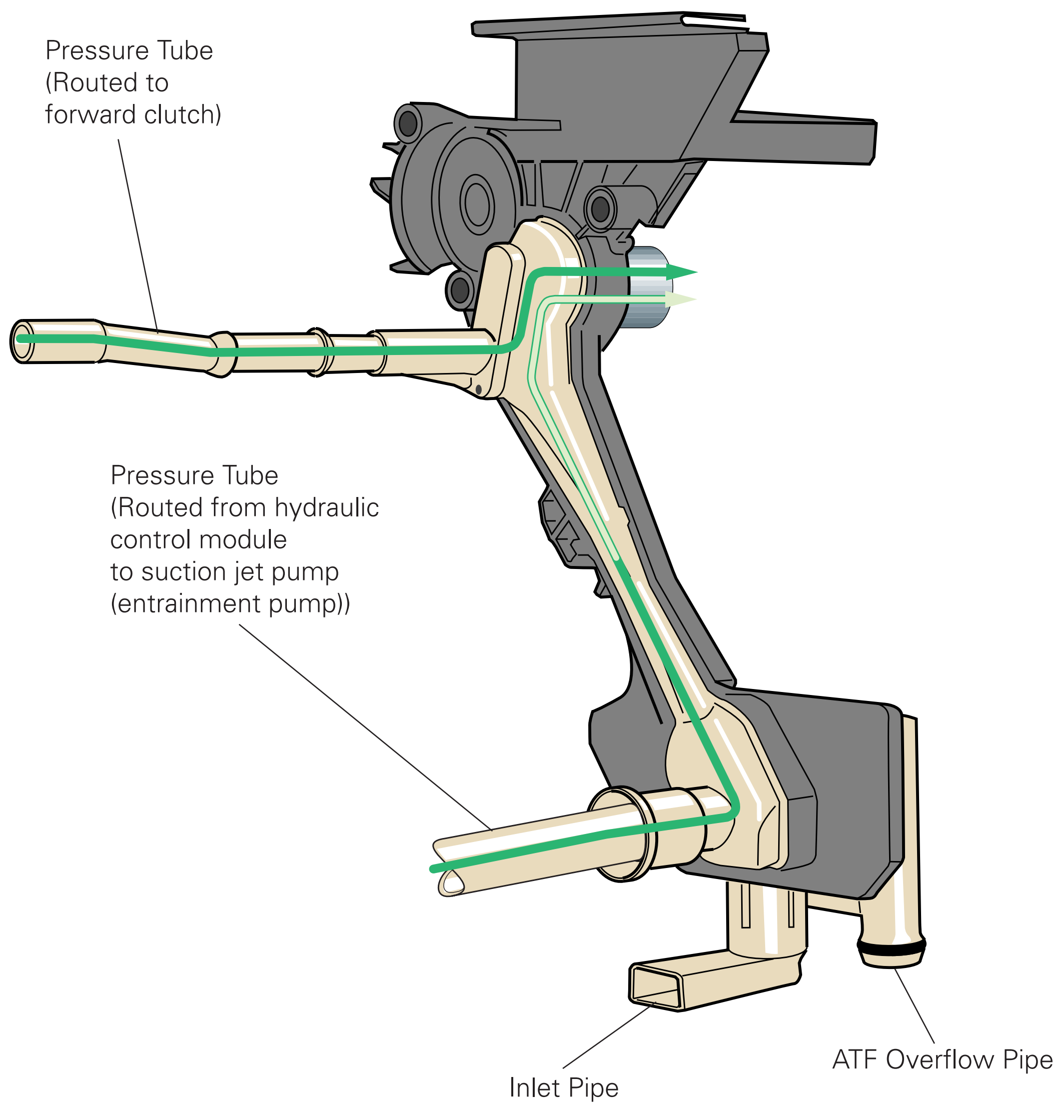
The Suction Jet Pump (Entrainment Pump)

The quantity of oil required to ensure sufficient cooling of the two clutches exceeds the capacity of the internal gear pump, particularly when pulling away (there is high heat buildup due to slip).

A suction jet pump (entrainment pump) is integrated in the clutch cooling system to supply the quantity of oil required for cooling the clutch.

The suction jet pump (entrainment pump) is made of plastic and projects deep into the oil sump.

View of Suction Jet Pump (Entrainment Pump)



SSP 228/036

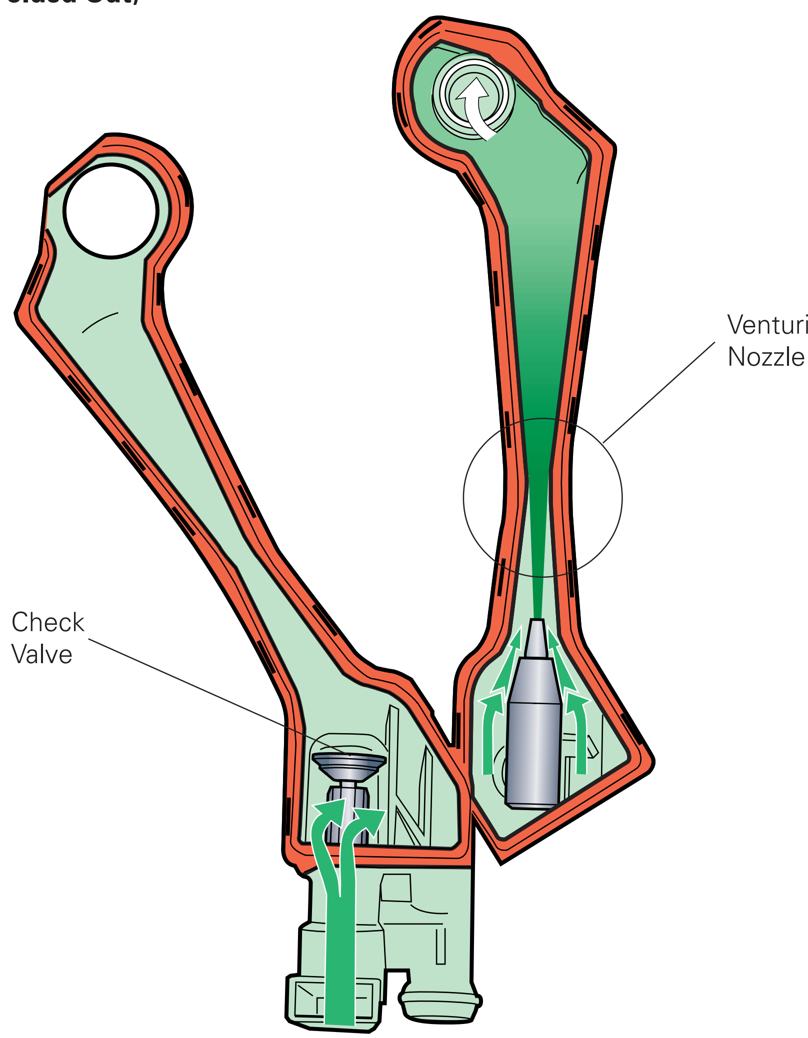
This is how it works:

The suction jet pump (entrainment pump) operates according to the Venturi principle. When the clutch requires cooling, the cooling oil (pressurized oil) supplied by the oil pump is ducted through the suction jet pump (entrainment pump) in the form of a powerful jet. The oil flow through the entrainment pump nozzle results in a partial vacuum which "sucks" oil out of the oil sump and, together with the powerful jet, results in a large, almost depressurized quantity of oil.

The quantity of cooling oil is almost doubled as required without additional pumping capacity.

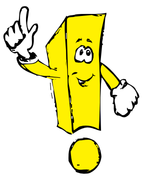
A check valve prevents the suction jet pump (entrainment pump) from running dry and facilitates a quick response of the cooling oil feed.

Suction Jet Pump (Entrainment Pump) (Shown in Profile and Folded Out)



SSP 228/037

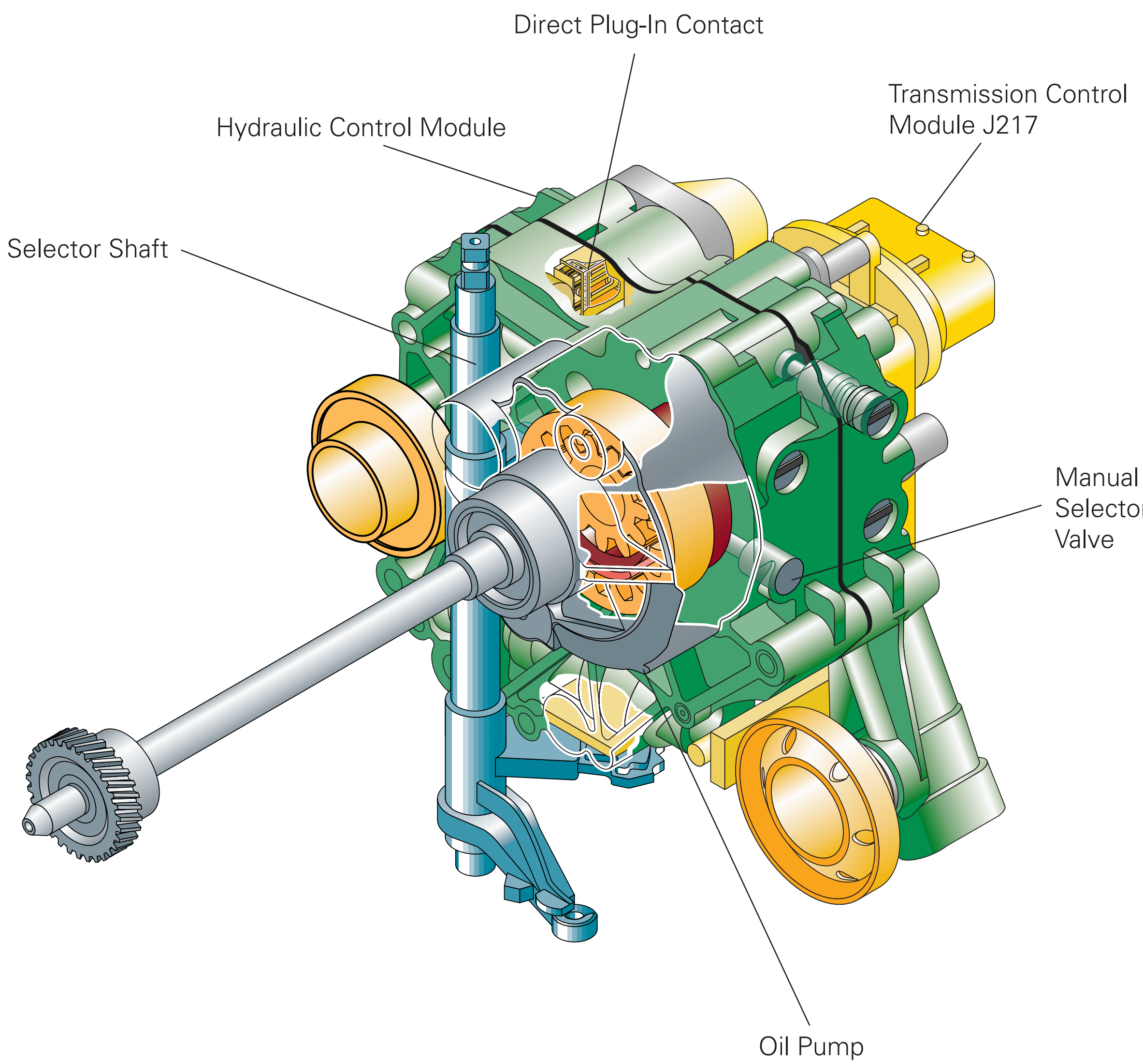
Electro-Hydraulic Control



A new feature is that the oil pump, hydraulic control module (valve body) and Transmission Control Module J217 are combined as a compact assembly.

The hydraulic control module contains the manual selector valve, nine hydraulic valves and three electromagnetic pressure control valves.

The hydraulic control module and the Transmission Control Module J217 are connected electrically by direct plug-in contacts.



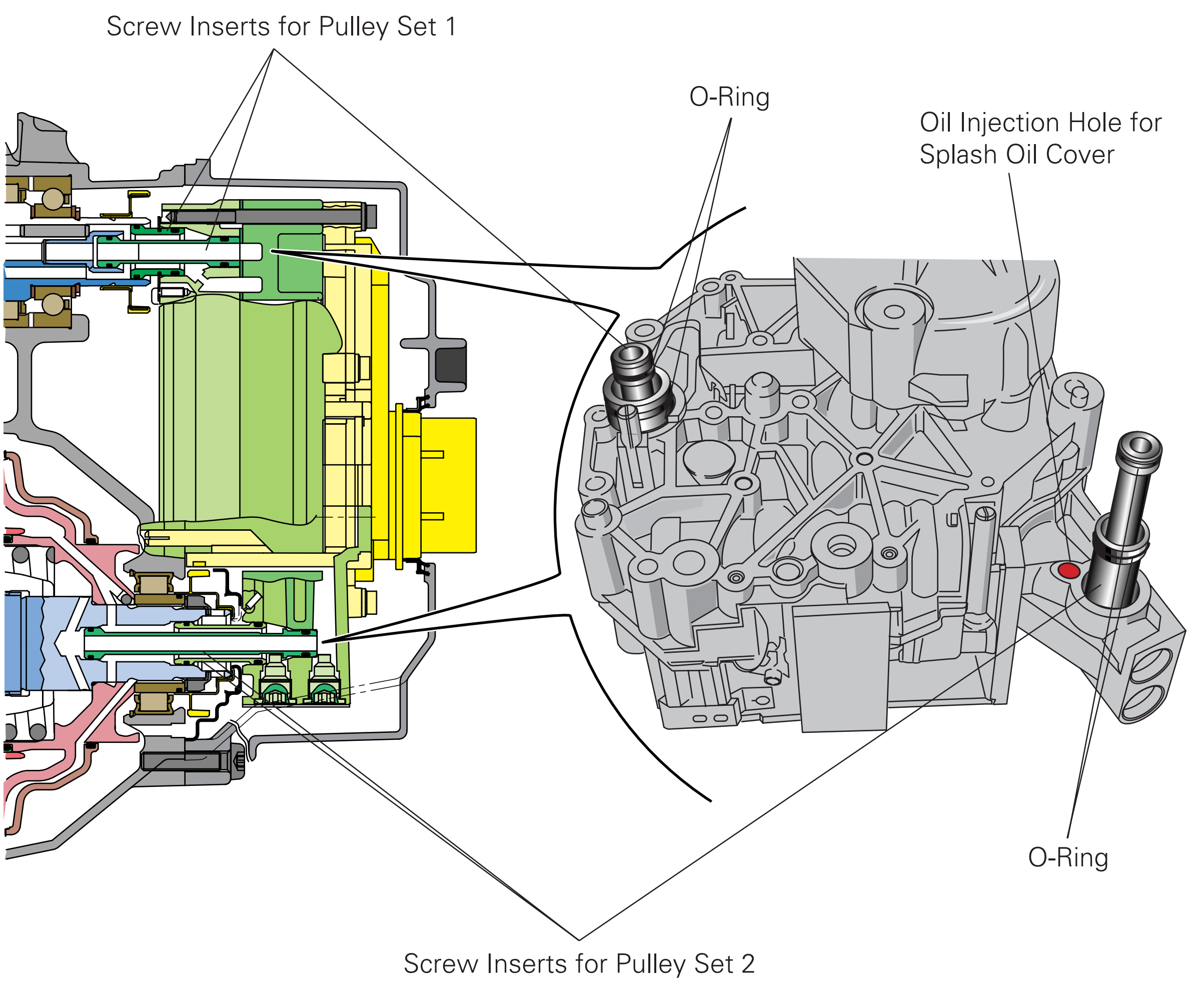
SSP 228/063

The hydraulic control module executes the following functions:

- Forward-reverse clutch control
- Clutch pressure regulation
- Clutch cooling
- Pressurized oil supply to the contact pressure control
- Transmission control
- Supplying the splash oil cover

The hydraulic control module is connected directly to pulley set 1 and pulley set 2 by "screw inserts."

The screw inserts are sealed by O-rings.



SSP 228/085

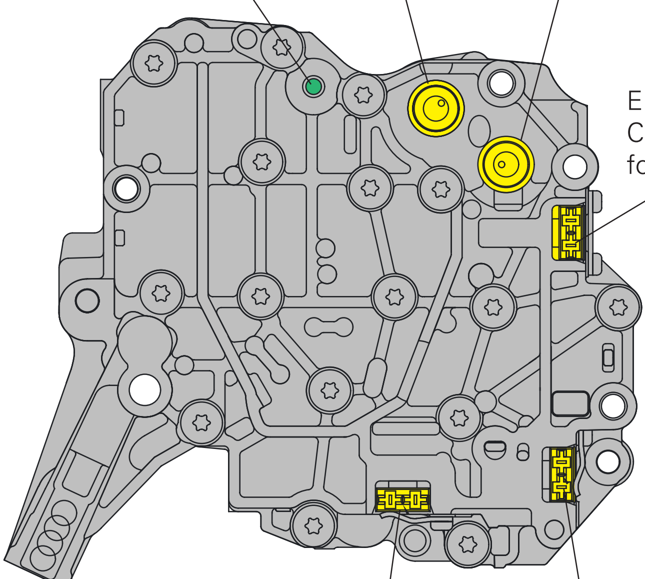
The descriptions of the valves that follow refer to valves not included in the previous module/function descriptions:

To protect the component parts, **pressure limiting valve 1** limits the pump pressure to maximum 1189 psi (8 200 kPa).

The pressure control valves are supplied with a constant pilot control pressure of 73 psi (500 kPa) by the **pilot pressure value.**

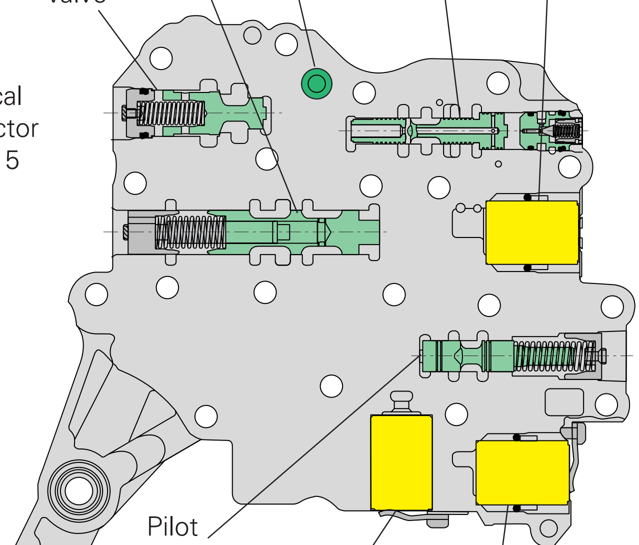
The **minimum pressure valve** prevents the oil pump drawing in engine air when the engine is started. When pump output is high, the minimum pressure valve opens and allows oil to flow from the oil return pipe to the suction side of the oil pump; this improves efficiency.

Hydraulic Control Module (Transmission Control Module J217 Removed)



SSP 228/044

Sectional View of Valve Plate



SSP 228/047

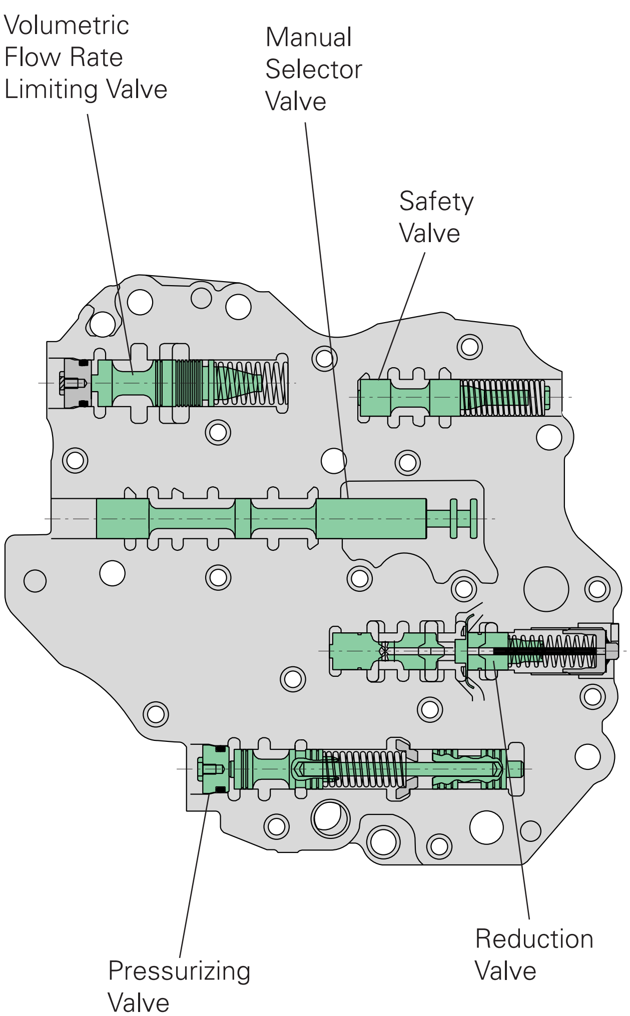
The **pressurizing valve** controls the system pressure so that sufficient oil pressure is always available for a particular function (application of contact pressure or adjustment).

Solenoid Valve 1 N88, Pressure Control Valve -1- for Automatic Transmission N215, and Pressure Control Valve -2- for Automatic Transmission N216 are designed as "pressure control valves."

They convert an electric control current to a proportional, hydraulic control pressure.

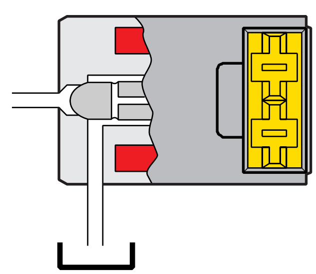
The Solenoid Valve 1 N88 controls the clutch cooling valve and the safety valve. Pressure Control Valve -1- for Automatic Transmission N215 actuates the clutch control valve. Pressure Control Valve -2- for Automatic Transmission N216 actuates the reduction valve.

Sectional View of Pump Plate



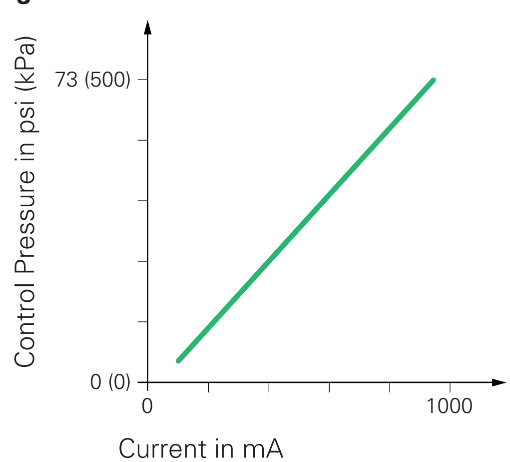
SSP 228/048

Pressure Control Valve (Proportional Valve)



SSP 228/101

Diagram of Pressure Control Valve



SSP 228/100

Selector Shaft and Parking Lock

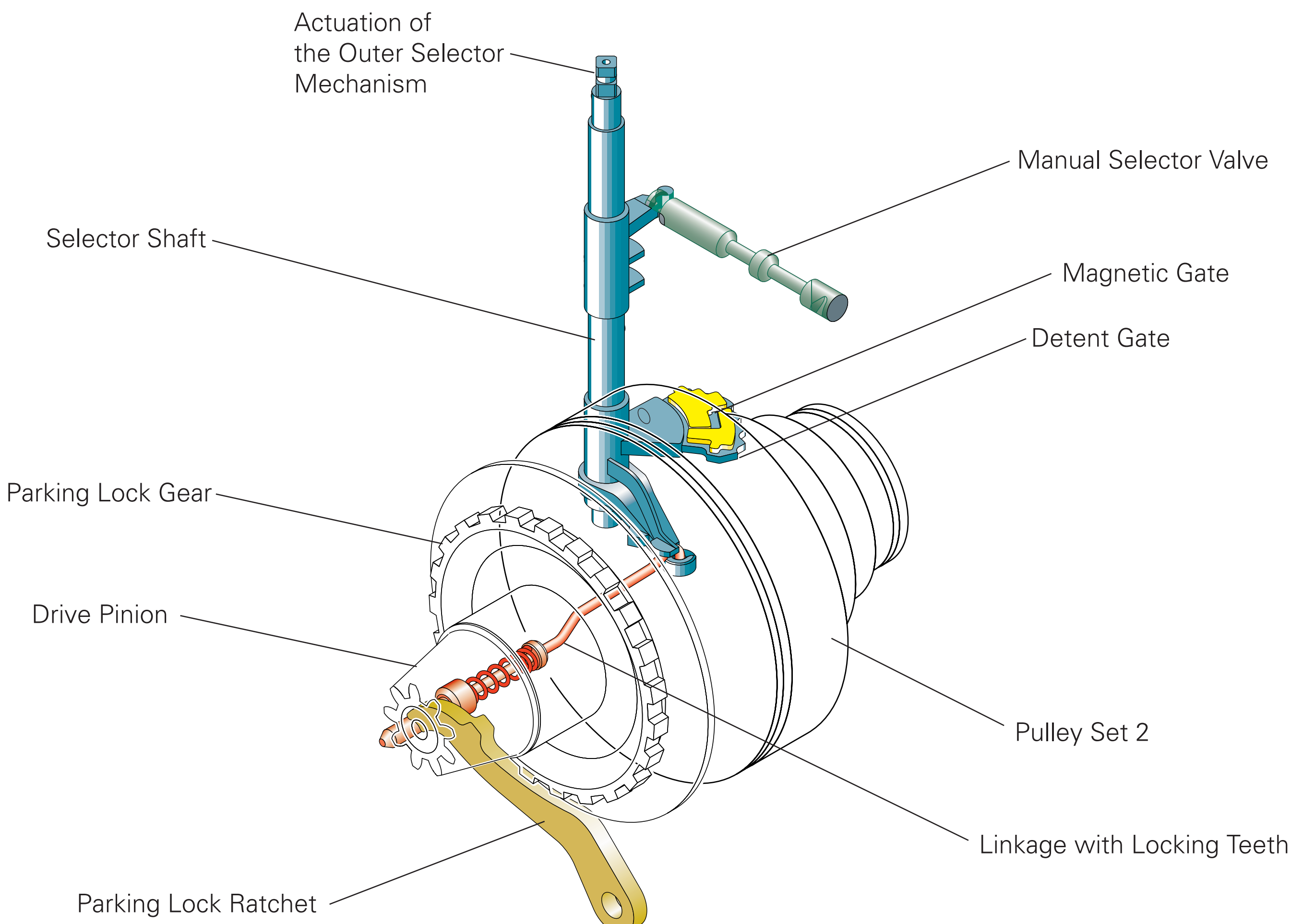
A mechanical connection (cable pull) for transmission of selector lever positions P, R, N and D still exists between the gate selector lever and the transmission.

The following functions are executed via selector shaft:

- Actuation of the manual selector valve in the hydraulic control module, i.e. hydromechanical control of vehicle operating state (forward/reverse/neutral).
- Operating the parking lock.
- Actuation of the multi-functional switch for electronic recognition of the selector lever position.

In selector lever position P, the linkage with locking teeth is displaced axially so that the parking lock ratchet is pressed against the parking lock gear and the parking lock is engaged.

The parking lock gear is permanently connected to the drive pinion.



SSP 228/065

Transmission Housing Ducting and Sealing Systems

Sheathed Sealing Ring System

The multitronic® is equipped with a new sheathed sealing ring system.

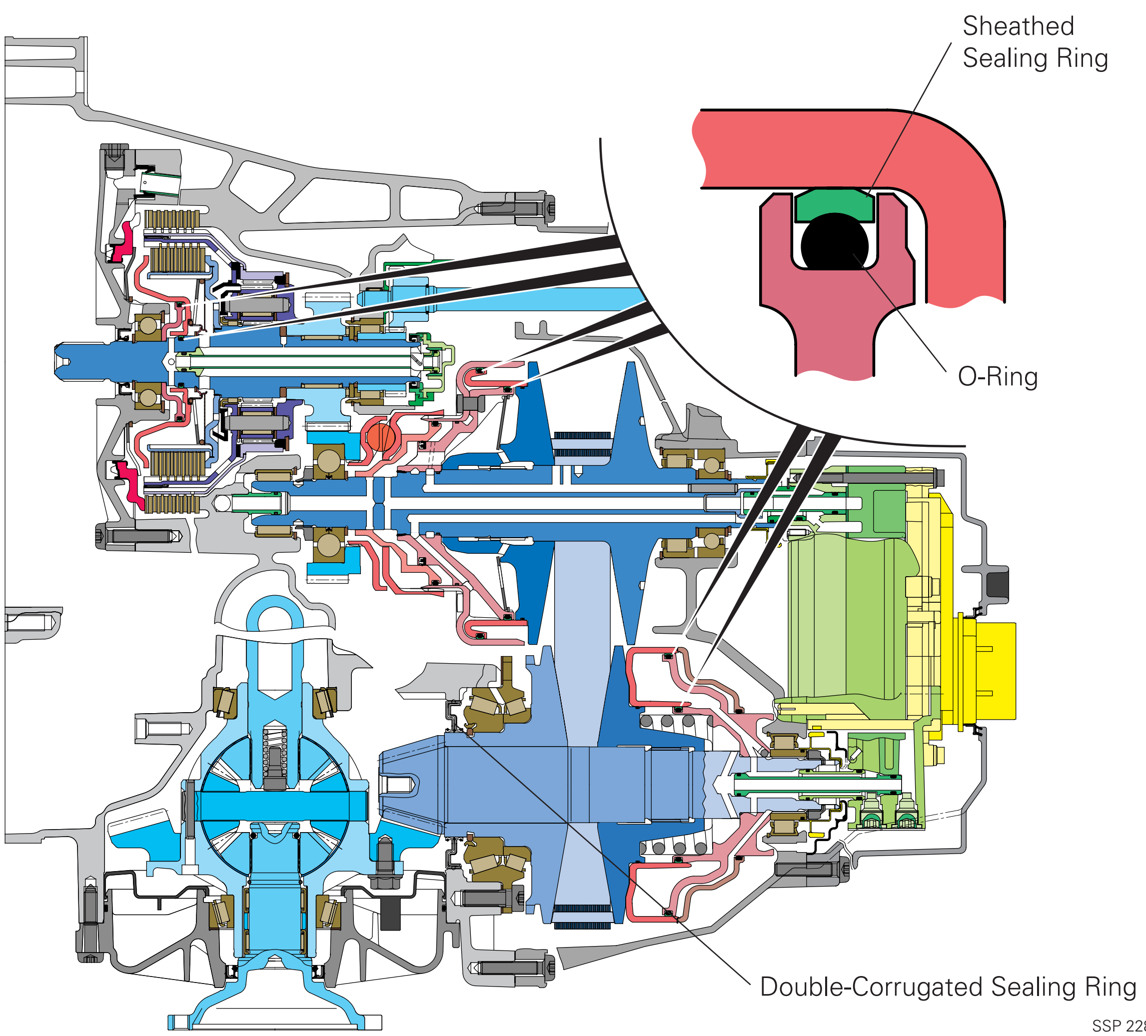
The sheathed sealing rings seal the pressure cylinder and the variable-displacement cylinder of pulley set 1, the pulley set 2, and the piston for the forward clutch.

The O-ring presses down and seals the sheathed sealing ring.

The oil pressure present assists the sheathed sealing rings with contact pressure application.

Advantages of the sheathed sealing ring system:

- Good anti-friction properties
- Low displacement forces
- Wear is minimized
- Stable at high pressures



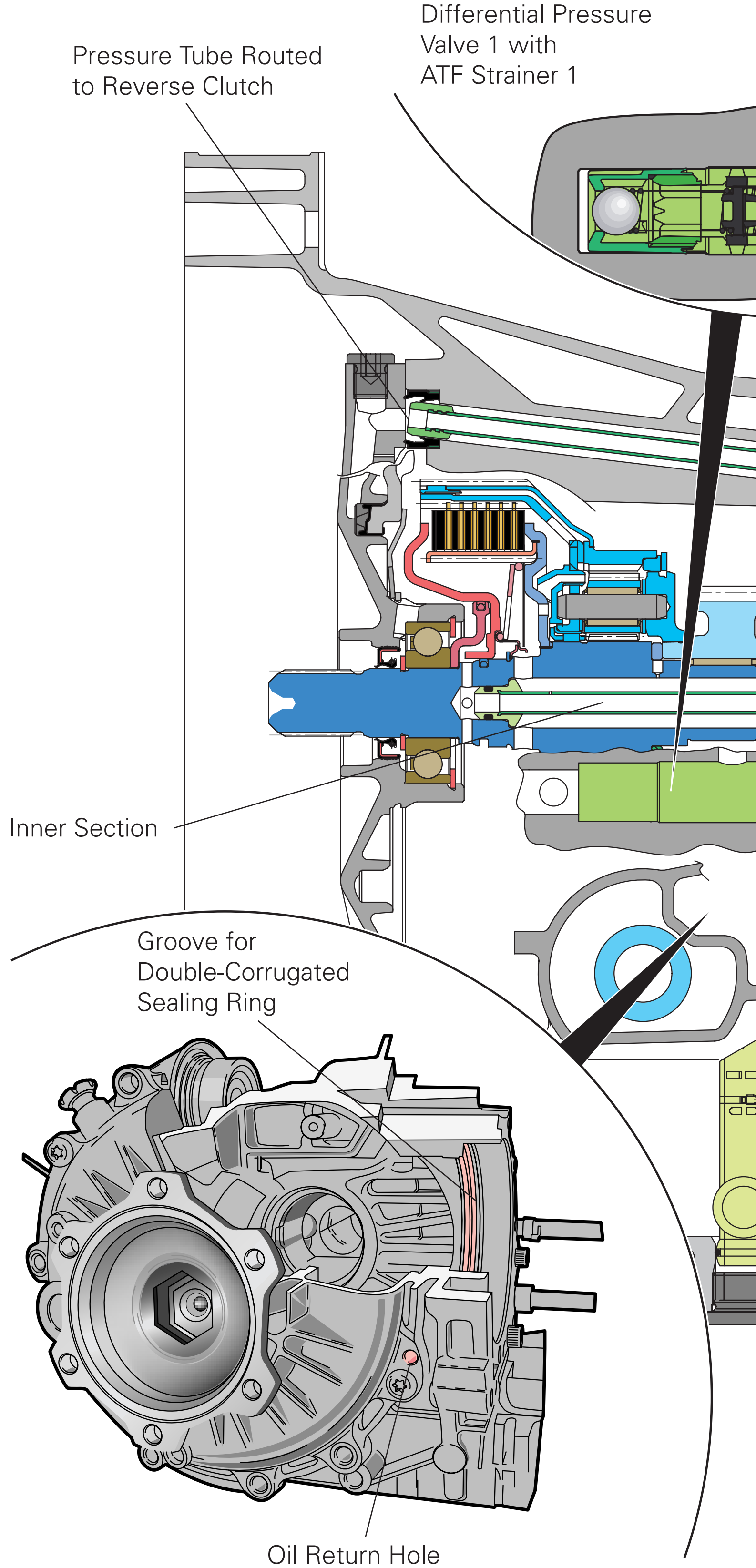
SSP 228?062

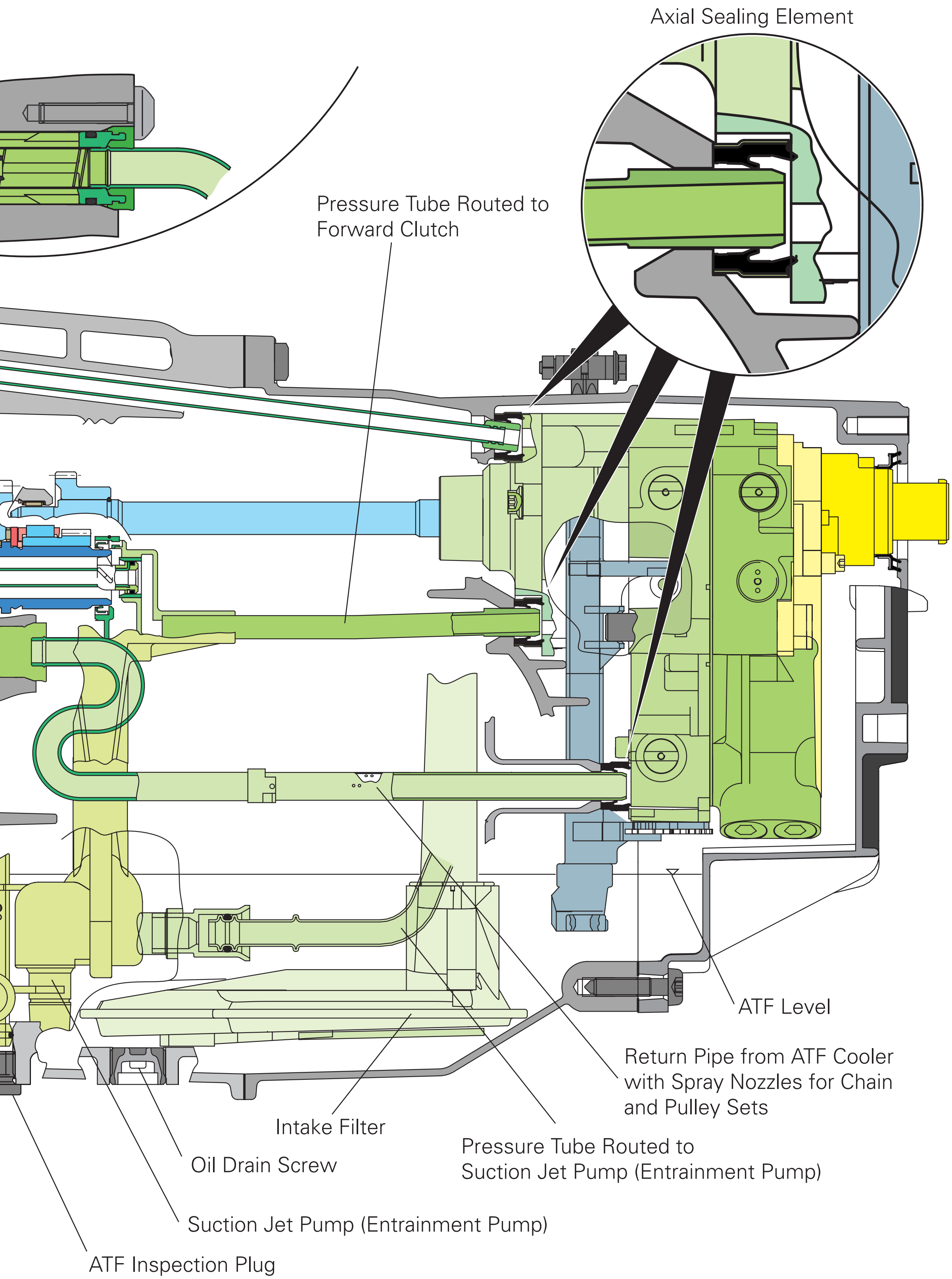
To save weight, the three-piece transmission housing is manufactured from the AZ91 HP magnesium alloy. This alloy is highly corrosion resistant, easy to process and has a 17.6 lb (8 kg) weight advantage over a conventional aluminum alloy. As a special feature, the ATF pressurized oil is not distributed through housing ducts as is usual on automatic transmissions, but almost exclusively by pipes.

Axial sealing elements are used to seal the pipe connections. The axial sealing elements of the pressure pipes have two sealing lips which apply a higher contact pressure as a result of the oil pressure, and therefore seal the pipes reliably. Diagonal pipe connections can also be sealed without difficulty using this technology (e.g. pressure tube connected to reverse clutch). The oil pump intake fitting axial sealing element has sealing beads which seal the fitting by contact pressure.

The double-corrugated sealing ring (see page 53) separates the ATF reservoir from the final drive oil reservoir. It prevents the ATF from entering the final drive and oil from the final drive entering the ATF reservoir.

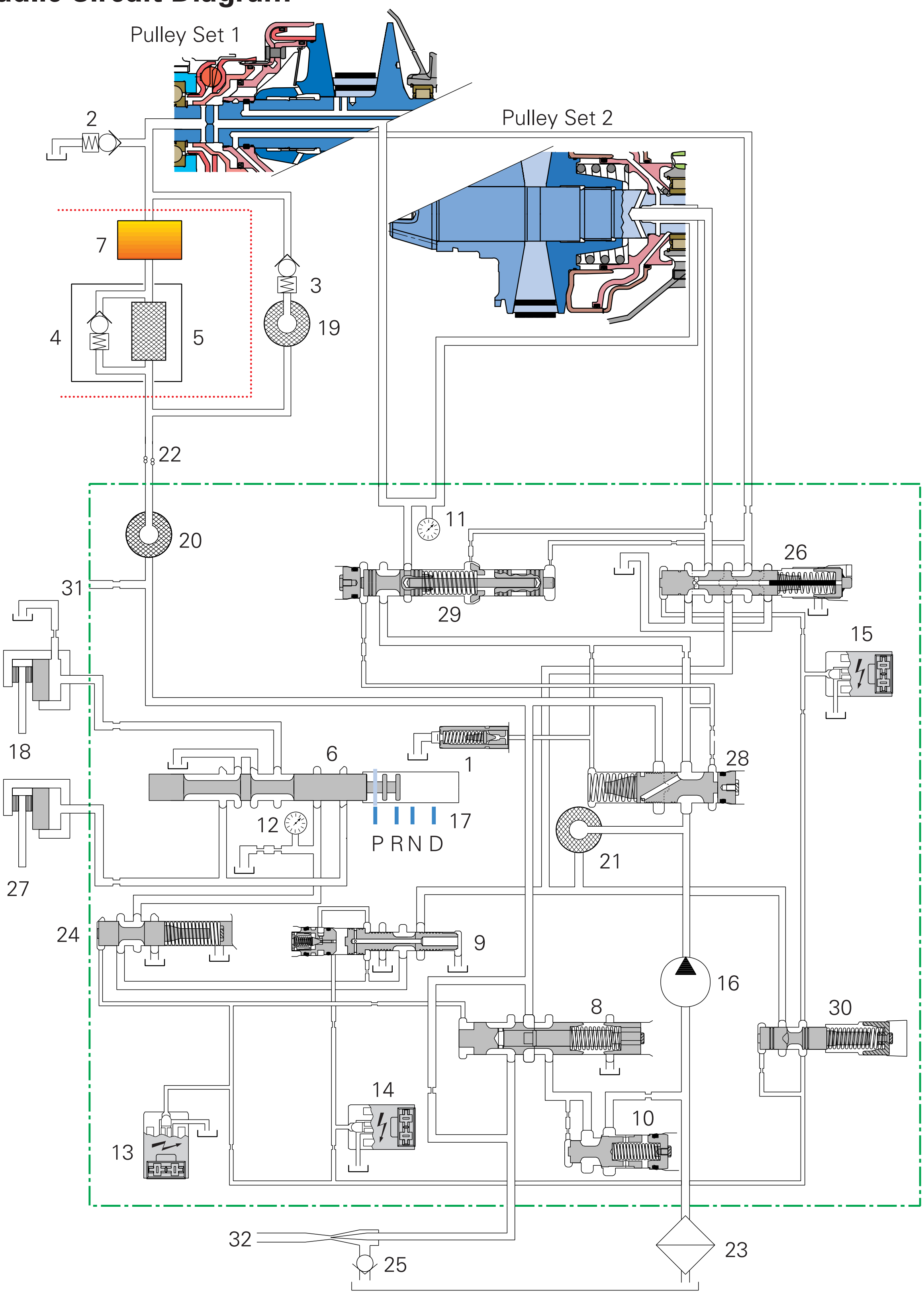
Leaks in the double-corrugated sealing ring become visible at the oil return hole.




Axial Sealing Element
Pressure Tube Routed to Forward Clutch
ATF Level
Return Pipe from ATF Cooler with Spray Nozzles for Chain and Pulley Sets
Intake Filter
Oil Drain Screw
Pressure Tube Routed to Suction Jet Pump (Entrainment Pump)
Suction Jet Pump (Entrainment Pump)
ATF Inspection Plug

SSP 228/041

Hydraulic Circuit Diagram

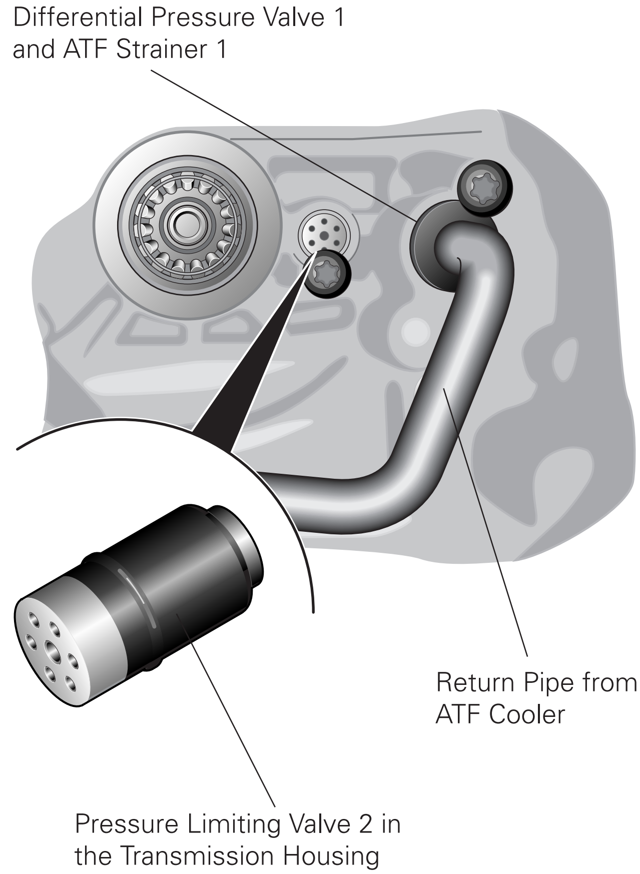


SSP 228/039

Hydraulic Circuit Diagram Legend

(Selector Lever Position P and Engine "OFF")

1 Pressure Limiting Valve 1
2 Pressure Limiting Valve 2
3 Differential Pressure Valve 1
4 Differential Pressure Valve 2
5 ATF Filter
6 Manual Selector Valve
7 ATF Cooler
8 Clutch Cooling Valve
9 Clutch Control Valve
10 Minimum Pressure Valve
11 Measuring Point for Contact Pressure (Registered by G194)
12 Measuring Point for Clutch Pressure (Registered by G193)
13 Solenoid Valve 1 N88 (Clutch Cooling/Safety Shut-Off)
14 Pressure Control Valve -1- for Automatic Transmission N215 (Clutch)
15 Pressure Control Valve -2- for Automatic Transmission N216 (Ratio)
16 Oil Pump
17 Selector Lever Position PRND
18 Reverse Clutch
19 ATF Strainer 1
20 ATF Strainer 2
21 ATF Strainer 3
22 Four Spray Holes for Pulley Set Lubrication/Cooling
23 ATF Intake Filter
24 Safety Valve
25 Suction Jet Pump (Entrainment Pump)
26 Reduction Valve
27 Forward Clutch
28 Volumetric Flow Rate Limiting Valve
29 Pressurizing Valve
30 Pilot Pressure Value
31 To Splash Oil Cover
32 To the Clutches



SSP 228/071

In the Oil Sump

Hydraulic Control Module

Peripheral Components in the Vehicle

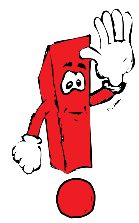
ATF Cooling

The ATF coming from pulley set 1 initially passes through the ATF cooler. The ATF flows through the ATF filter before it is returned to the hydraulic control module.

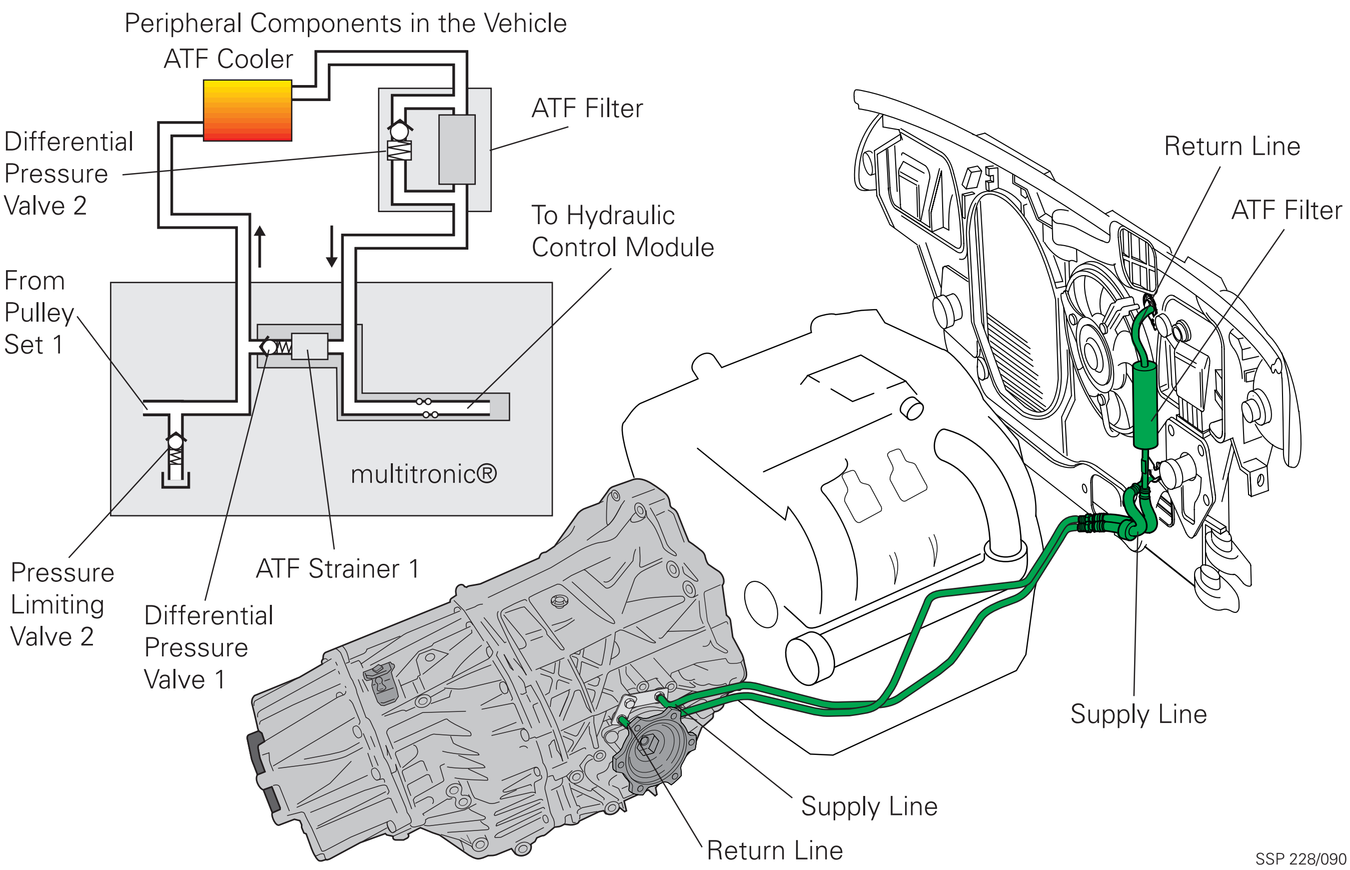
The ATF cooler is integrated in the radiator. Heat is exchanged with the coolant in the engine cooling circuit (oil-coolant heat exchanger).

The differential pressure valve 1 protects the ATF cooler against excessively high pressures (ATF cold). When the ATF is cold, a large pressure difference develops between the supply line and the return line. When a specific pressure differential is reached, the differential pressure valve 1 opens and the supply line is short-circuited with the return line to bypass the ATF cooler. This also causes the temperature of the ATF to rise to normal operating temperature rapidly.

The differential pressure valve 2 opens when the flow resistance of the ATF filter is too high (e.g. filter blockage). This prevents the differential pressure valve 1 from opening and the ATF cooling system from being disabled by the backpressure.



If the ATF cooler is leaky, coolant can enter the ATF. Even small quantities of coolant in the ATF can have an adverse effect on clutch control.



SSP 228/090

Transmission Control Module J217

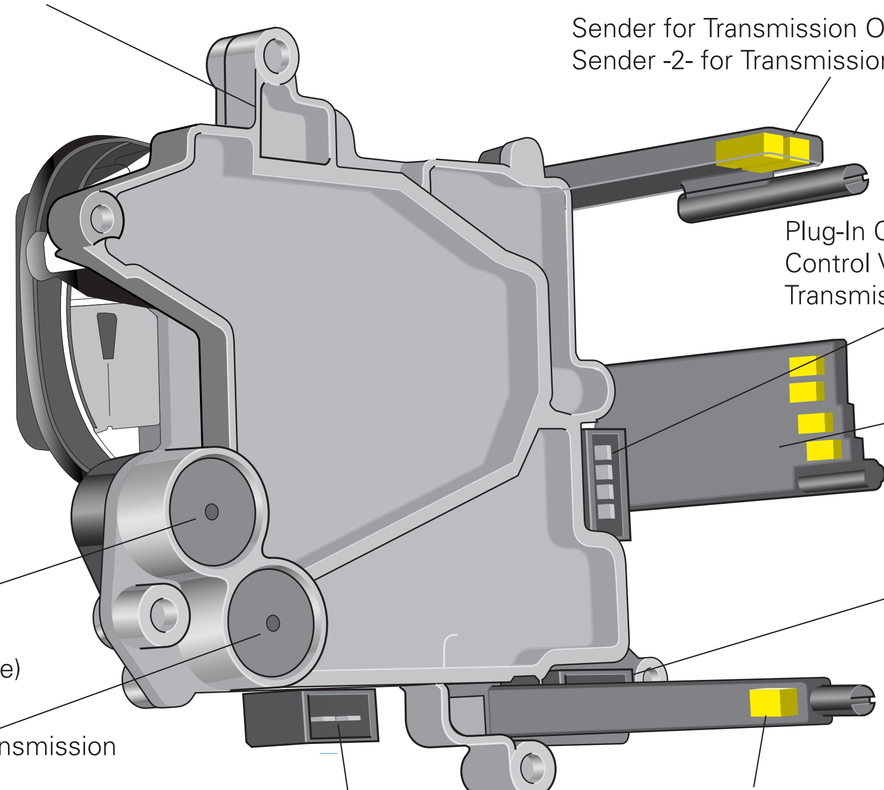
A special feature of multitronic® is the integration of the electronic Transmission Control Module J217 in the transmission.

The control module is attached directly to the hydraulic control module with bolts.

The connection to the three pressure regulating valves is made directly from the control module by means of robust plug-in contacts (gooseneck contacts); there are no wiring connections. A 25-pin compact connector forms the interface to the vehicle.

A further new feature is the integration of sensor technology in the control module.

- Multi-Function Transmission Range Switch F125
- Sensor for Transmission RPM G182
- Sender for Transmission Output RPM G195
- Sender -2- for Transmission Output RPM G196
- Transmission Fluid Temperature Sensor G93
- Automatic Transmission Sender -1- for Hydraulic Pressure G193 (Clutch Pressure)
- Automatic Transmission Sender -2- for Hydraulic Pressure G194 (Contact Pressure)



SSP 228/055

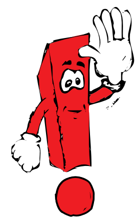
Control

A strong aluminium plate acts as the base for the electronics and serves to dissipate heat. The housing is made of plastic and securely riveted to the base. It accommodates all the sensors, so neither wiring nor plug-in contacts are necessary.

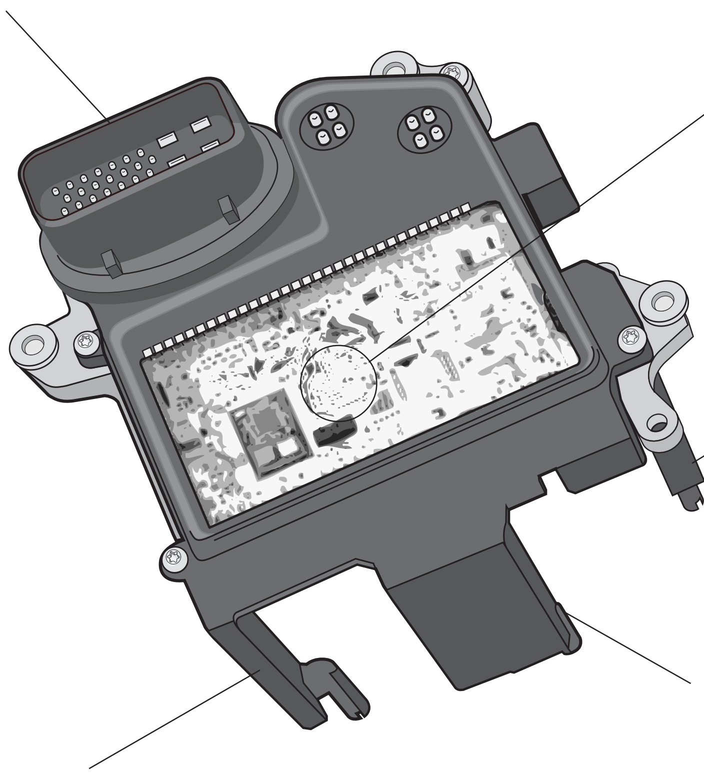
Since the majority of electrical failures are attributable to faulty wiring and plug-in contacts, this construction offers a very high degree of reliability.

Sensor for Transmission RPM G182, Sender for Transmission Output RPM G195, Sender -2- for Transmission Output RPM G196, and Multi-Function Transmission Range Switch F125 are all designed as Hall sensors.

Hall sensors are free of mechanical wear. Their signal is immune to electromagnetic interference, which improves their reliability still further.



Because there are only a few interfaces to the Transmission Control Module J217, the multitronic® does without a separate wiring harness.
The wiring is integrated in the engine harness.



SSP 228/077

Fault Indication

Faults in the multitronic® are registered by the self-diagnosis function. Faults are indicated to the driver on the selector lever position indicator in the instrument cluster based on their effect on multitronic® operation or on driving safety. In this case, the selector lever position indicator also serves as a fault indicator.

Faults are registered by the multitronic® three different ways:

1. The fault is stored and a substitute program enables continued operation of the vehicle with some restrictions. This state is **not indicated** to the driver, since it is not critical with regard to driving safety or multitronic® operation. The driver may notice the fault by the way the vehicle handles and seek the assistance of an Audi dealer.

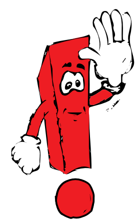
SSP 228/102

2. The fault is stored and a substitute program enables continued operation of the vehicle with some restrictions. The selector lever position indicator also indicates the presence of a fault by **inverting the display.** The situation is still not critical for driving safety or for multitronic® operation. However, the driver should take the vehicle to an Audi dealer as soon as possible to have the fault rectified.

SSP 228/103

SSP 228/104

3. The fault is stored and a substitute program enables continued operation of the vehicle with some restrictions, at least until it stops. The selector lever position indicator indicates the presence of a fault by **flashing.** This state is critical with regard to driving safety or multitronic® operation. Therefore, the driver is advised to take the vehicle to an Audi dealer immediately to have the fault rectified.



In some cases when the display is flashing, vehicle operation will only be maintained until the next time the vehicle stops.
The vehicle can subsequently no longer be driven! In other cases, vehicle operation can be resumed by restarting the vehicle.

Sensors

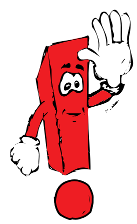
The signals generated by the sensors can not be measured with conventional equipment because the control module is integrated into the transmission. A check can only be performed with the Vehicle Diagnosis, Test and Information System VAS 5051 using the following functions:

- 02 — Interrogate fault memory
- 08 — Read measured value block

This Self-Study Program does not describe the sensor signals in detail.

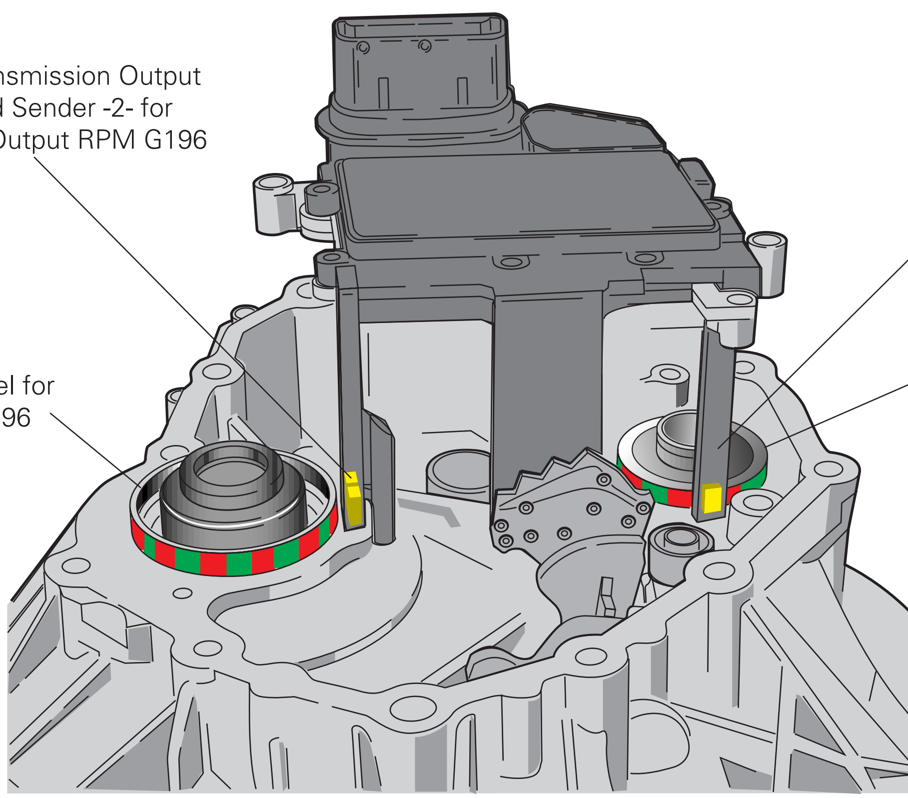
If a sensor fails, the Transmission Control Module J217 generates substitute values from the signals of other sensors as well as the information from the networked control modules. Vehicle operation can thus be maintained.

The effects on vehicle performance are so small that the driver may not notice the failure of a sensor immediately. An additional fault can, however, have serious effects.



The sensors are an integral part of the Transmission Control Module J217. If a sensor fails, the entire control module must be replaced.

Sensor for Transmission RPM G182,
Sender for Transmission Output RPM G195, and
Sender -2- for Transmission Output RPM G196



SSP 228/078

Sensor for Transmission RPM G182 registers the rotation speed of pulley set 1 and therefore represents the actual transmission input speed.

Transmission input speed...

... is used together with engine speed for clutch control (for more detailed information, refer to "The Micro-Slip Control," page 21).

... serves as the reference input variable for transmission control (for more detailed information, refer to "The Transmission Control," page 30).

Effects of failure of Sensor for Transmission RPM G182:

- The clutch engagement is controlled according to fixed parameters.
- The micro-slip control and the clutch adaptation function are deactivated.

Engine speed is used as a substitute value.

Fault indication: none

Sender for Transmission Output RPM G195 and Sender -2- for Transmission Output RPM G196 register the rotation speed of pulley set 2 and with it the transmission output speed.

The signal from Sender for Transmission Output RPM G195 is used for registering rotation speed. The signal from Sender -2- for Transmission Output RPM G196 is used for recognition of direction of rotation and therefore also for distinguishing between forward travel and reverse travel (refer to "Clutch Control when Vehicle Is Stationary (Slip Control)," page 19).

"Transmission output speed" is used...

... for transmission control,

... for slip control,

... for the hill-holder function,

... for determining the road speed signal for the instrument cluster.

If the Sender for Transmission Output RPM G195 fails, the transmission output speed is determined from the signal from Sender -2- for Transmission Output RPM G196. The hill-holder function is deactivated also.

If Sender -2- for Transmission Output RPM G196 fails, the hill-holder function is deactivated.

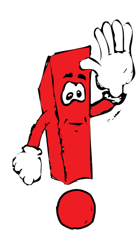
If both senders fail, a substitute value is generated from the information available on wheel speeds across the CAN bus. The hill-holder function is deactivated.

Fault indication: none

Sender Wheels

A magnetic ring with a row of magnets is located on the end face of each sender wheel; the magnets act as north/south poles.

- Sender wheel for Sensor for Transmission RPM G182 has 40 magnets.
- Sender wheel for Sender for Transmission Output RPM G195 and Sender -2- for Transmission Output RPM G196 has 32 magnets.

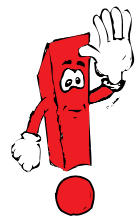


Heavy contamination of the magnetic ring from metal swarf caused by wear can impair the performance of these senders. Therefore, metal swarf adhering to the magnetic ring should be removed before performing other repairs.

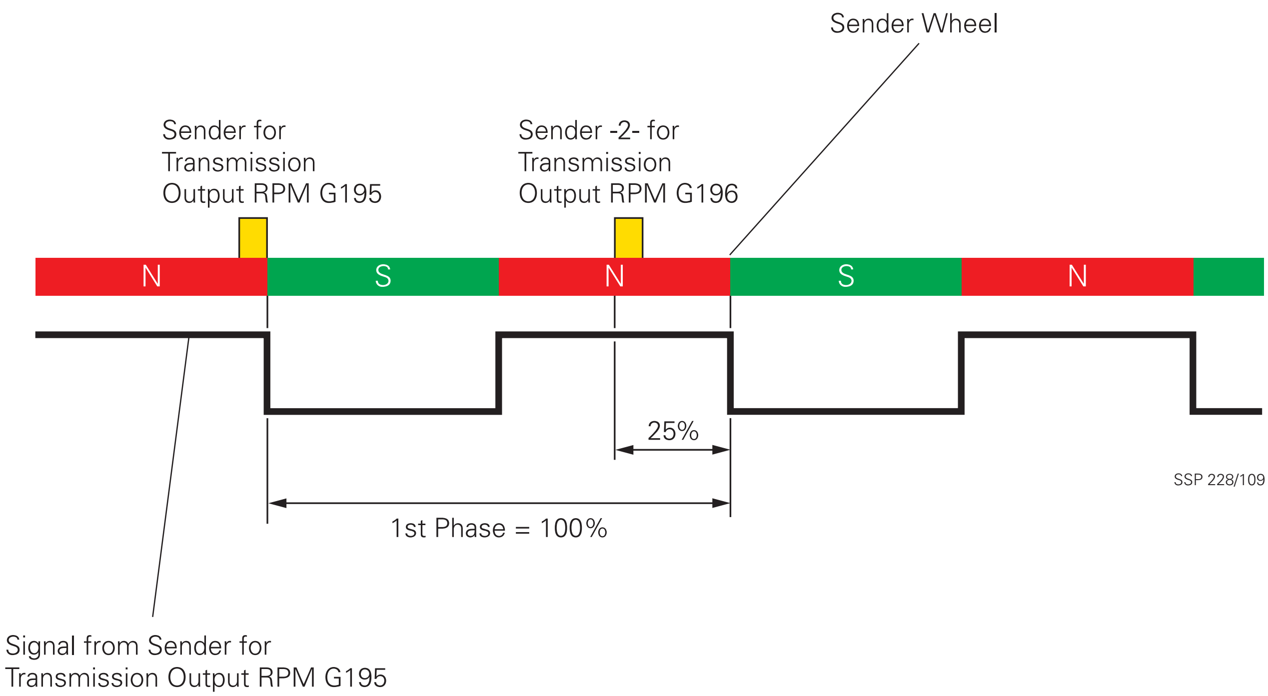
How the Direction of Rotation Is Registered:

A magnetic ring comprising a row of 32 individual magnets (north/south poles) is located on the end face of the sender wheel for Sender for Transmission Output RPM G195 and Sender -2- for Transmission Output RPM G196.

The position of Sender for Transmission Output RPM G195 relative to Sender -2- for Transmission Output RPM G196 is offset so that the phase angles of the sender signals are 25% out of phase with one another.



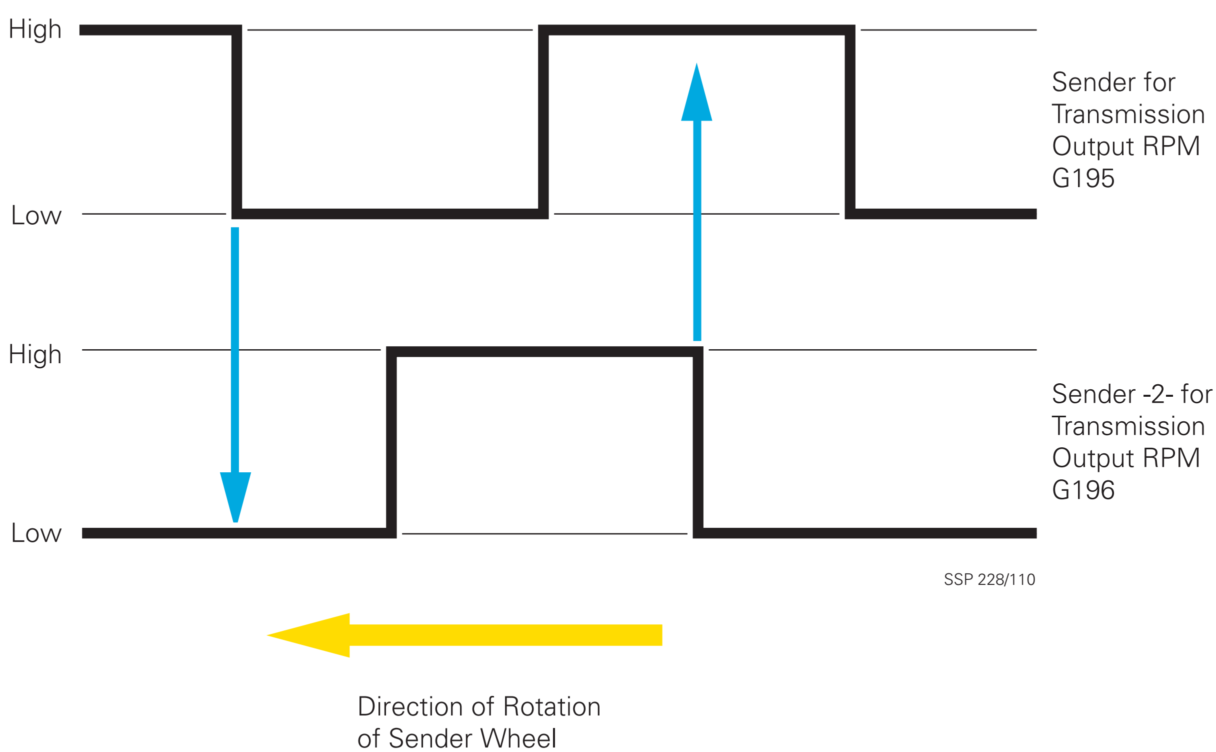
The direction of rotation is registered for the hill-holder function.



After ignition "ON," the control module observes the falling edges of the signals from the two senders and records the levels of the other senders.

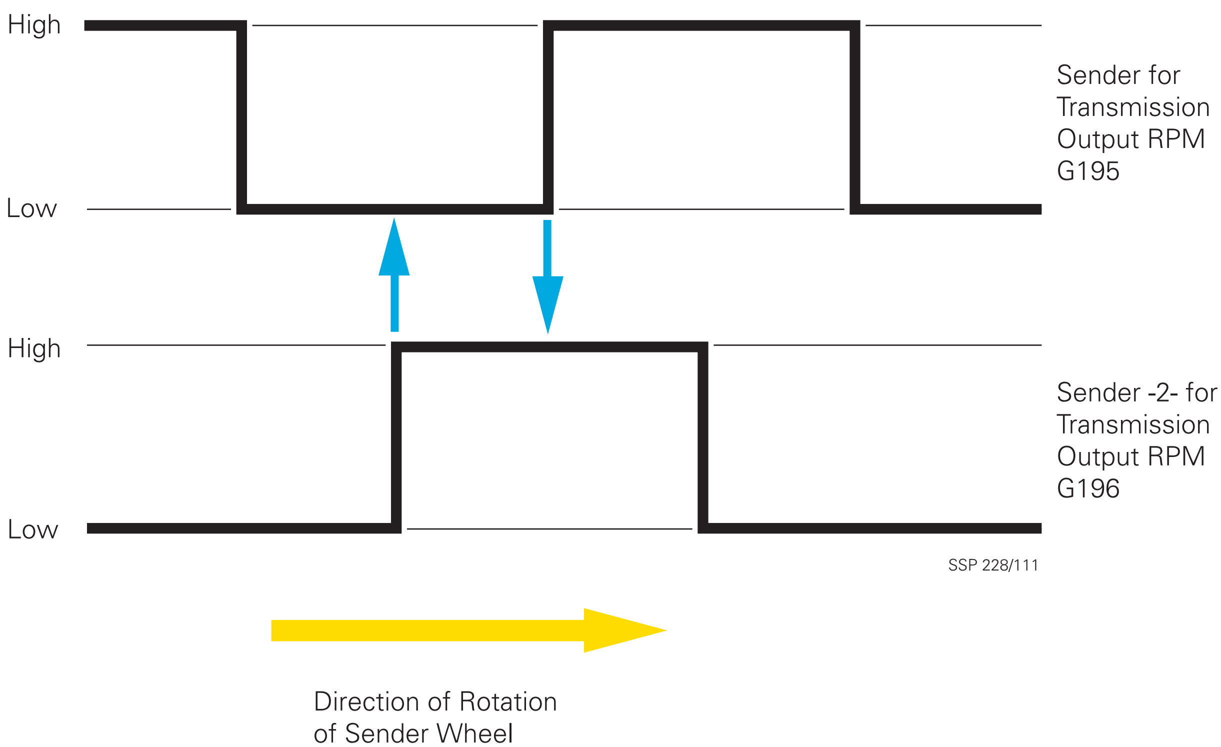
As shown in the example, the level of Sender -2- for Transmission Output RPM G196 is "low" at the falling edge of the signal from Sender for Transmission Output RPM G195, and the level of Sender for Transmission Output RPM G195 is "high" at the falling edge of the signal from Sender -2- for Transmission Output RPM G196. The Transmission Control Module J217 interprets this "pattern" as forward travel.

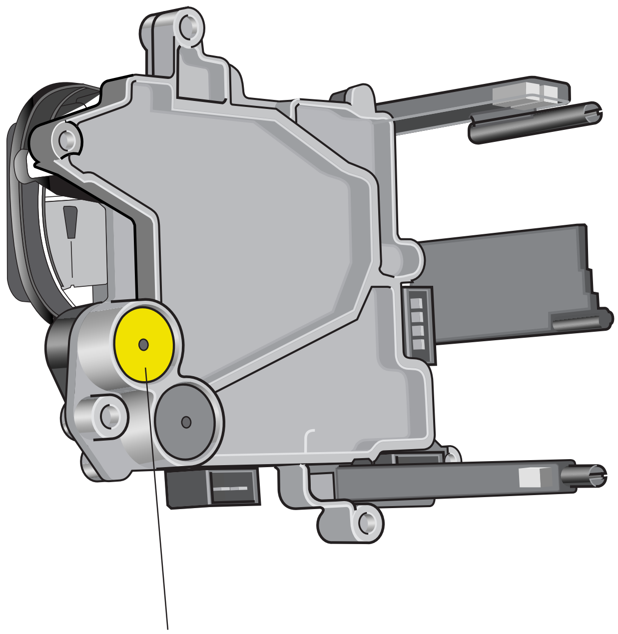
Forward Travel



In this example, the level of Sender -2- for Transmission Output RPM G196 is “high” at the falling edge of the signal from Sender for Transmission Output RPM G195 and the level of Sender for Transmission Output RPM G195 is “low” at the falling edge of the signal from Sender -2- for Transmission Output RPM G196. The Transmission Control Module J217 interprets this “pattern” as reverse travel.

Reverse Travel





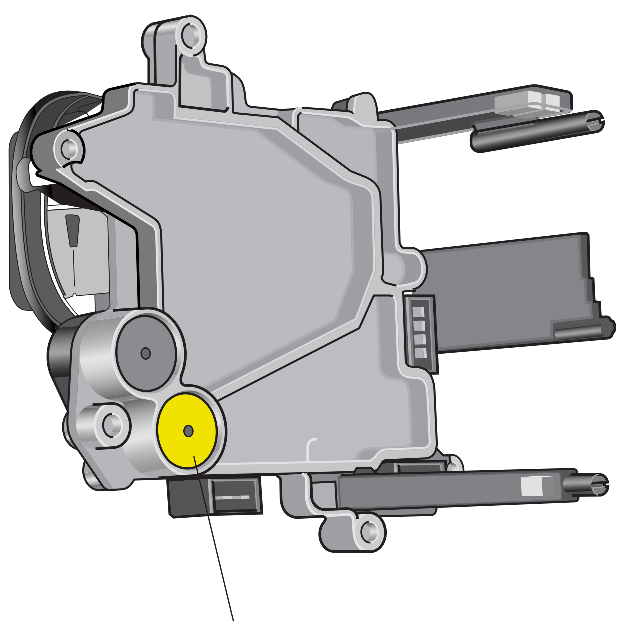
SSP 228/093

Automatic Transmission Sender -1- for Hydraulic Pressure G193

Automatic Transmission Sender -1- for Hydraulic Pressure G193 registers the clutch pressure of the forward- and reverse-gear clutches and is used for monitoring the clutch function (see “The Clutch Control,” page 15).

Clutch pressure monitoring has a high priority, so malfunctioning of Automatic Transmission Sender -1- for Hydraulic Pressure G193 usually causes the safety valve to be activated (see “Safety Shut-Off,” page 18).

Fault indication: flashing



SSP 228/094

Automatic Transmission Sender -2- for Hydraulic Pressure G194

Automatic Transmission Sender -2- for Hydraulic Pressure G194 registers the contact pressure, which is regulated by the torque sensor. As the contact pressure is always proportional to the actual transmission input torque, the transmission input torque can be calculated very accurately using Automatic Transmission Sender -2- for Hydraulic Pressure G194.

The signal from Automatic Transmission Sender -2- for Hydraulic Pressure G194 is used for clutch control (control and adaptation of the slip function).
If Automatic Transmission Sender -2- for Hydraulic Pressure G194 malfunctions, the slip control adaptation function is deactivated. The slip torque is then controlled by means of stored values.

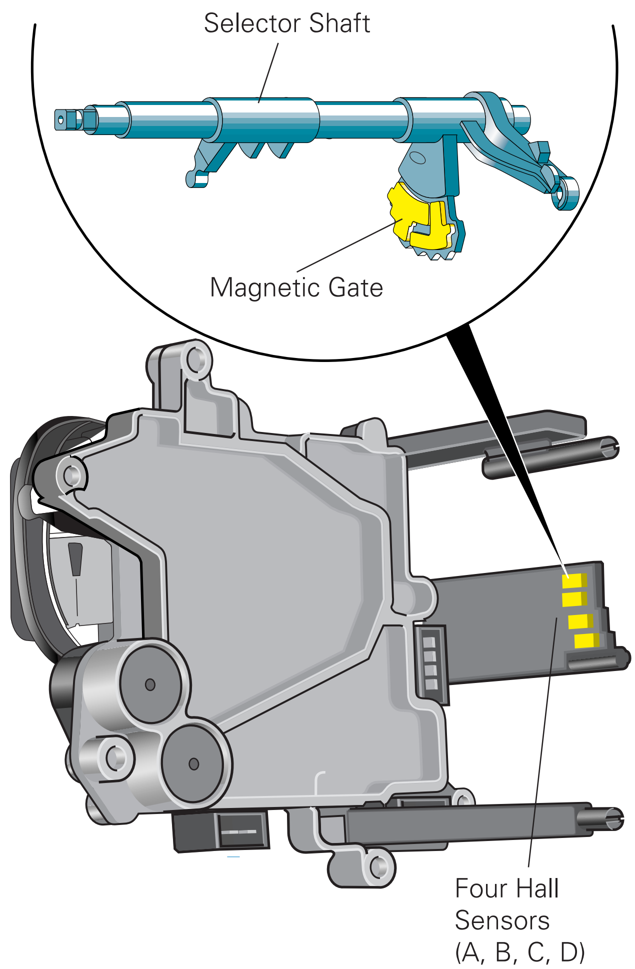
Fault indication: none

Multi-Function Transmission Range Switch F125

Multi-Function Transmission Range Switch F125 has four Hall sensors which are controlled by the magnetic gate on the selector shaft. The signals from the Hall sensors are interpreted in the same way as the positions of mechanical switches.
A high level means: switch is closed (1).
A low level means: switch is open (0).
Therefore, a Hall sensor "switch" generates two signals: "1" and "0."

Sixteen different gearshift combinations can be generated with four Hall sensors:

- four gearshift combinations for the recognition of selector lever positions P, R, N, D,
- two gearshift combinations which are registered as intermediate positions (P-R, R-N-D),
- ten gearshift combinations which are diagnosed as being faulty.



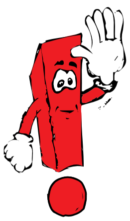
SSP 228/095

Control

Gearshift Combinations

Example:

The selector lever is located in selector lever position “N.” If Hall sensor “C” for example fails, gearshift combination “0 0 0 1” will be implemented.
The Transmission Control Module J217 can no longer identify selector lever position “N.” It recognizes the gearshift combination as being faulty and initiates the appropriate substitute program.



If Hall sensor “D” fails, it will no longer be possible to start the engine.

The Transmission Control Module J217 requires the information on selector lever position for the following functions:

- Starter inhibitor control
- Backup light control
- Park/Neutral interlock control
- Information on the vehicle operating state (forward/reverse/neutral) for clutch control
- Lock ratio when reversing

Different faults in Multi-Function Transmission Range Switch F125 manifest themselves very differently. Pulling away may not be permitted in certain circumstances.

Fault indication: flashing

	Hall Sensors			
	A	B	C	D
Selector Lever Position	Gearshift Combinations			
P	0	1	0	1
Between P-R	0	1	0	0
R	0	1	1	0
Between R-N	0	0	1	0
N	0	0	1	1
Between N-D	0	0	1	0
D	1	0	1	0
Fault	0	0	0	0
Fault	0	0	0	1
Fault	0	1	1	1
Fault	1	0	0	0
Fault	1	0	0	1
Fault	1	0	1	1
Fault	1	1	0	0
Fault	1	1	0	1
Fault	1	1	1	0
Fault	1	1	1	1

For a table of gearshift combinations, please refer to the Repair Manual!

Transmission Fluid Temperature Sensor G93

Transmission Fluid Temperature Sender G93 is integrated into the electronics of the Transmission Control Module J217. It records the temperature of the Transmission Control Module J217 aluminum mounting which is a close approximation of the transmission oil temperature.

Transmission oil temperature influences both clutch control and transmission input speed control. Therefore, it plays an important role in the control and adaptation functions.

If Transmission Fluid Temperature Sender G93 fails, the engine temperature is used to calculate a substitute value. Adaptation functions and certain control functions are deactivated.

Fault indication: inverted

To protect the component parts of the transmission, engine performance is reduced if the transmission oil temperature exceeds approximately 293°F (145°C).

If the transmission oil temperature continues to increase, engine performance is reduced more and more (if necessary, until the engine is running at idling speed).

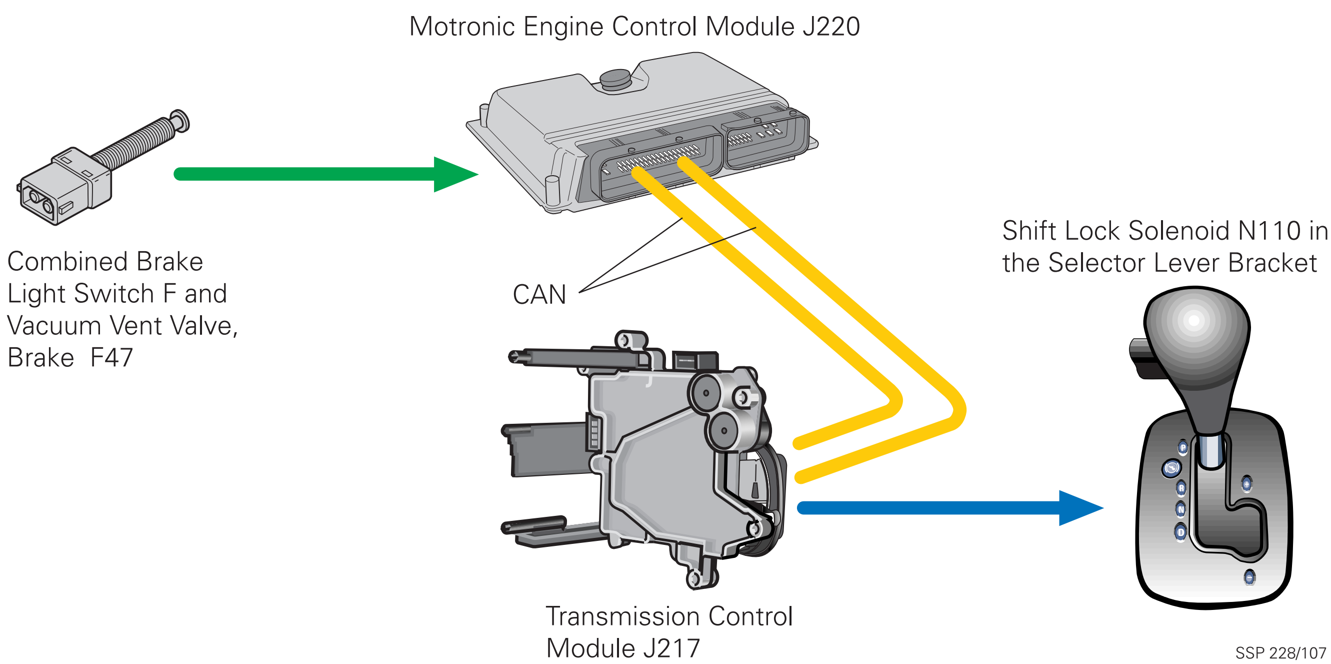
Fault indication: flashing

"Brake Actuated" Signal

The "Brake actuated" signal is required for the following functions:

- For the function of the gear selector lever shift lock
- For slip control
- For the dynamic control program (DCP)

There is no direct interface to the Vacuum Vent Valve, Brake F47. The "Brake actuated" signal is provided by the Motronic Engine Control Module J220 across the CAN bus.



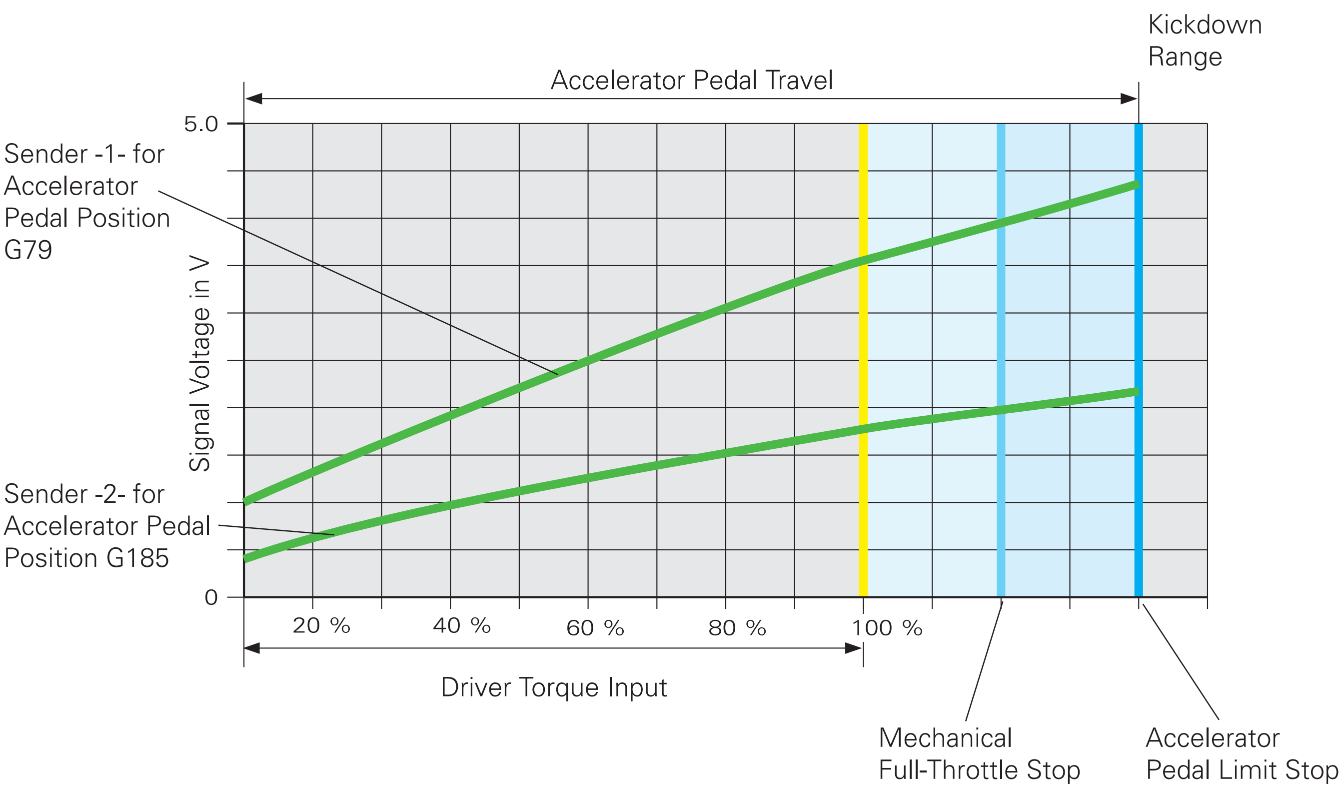
SSP 228/107

"Kickdown" Information

A separate switch is not used for the kickdown information.

A spring-loaded pressure element located on the accelerator pedal module creates a "point of resistance" conveying a "kickdown feel" to the driver.

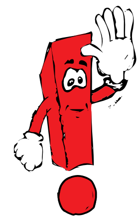
When the driver activates the kickdown function, the full-throttle voltage value of Senders -1- and -2- for Accelerator Pedal Position G79 and G185 in the accelerator pedal module is exceeded. When a defined voltage value corresponding to the kickdown point is exceeded, the Motronic Engine Control Module J220 sends kickdown information to the Transmission Control Module J217 across the CAN bus.



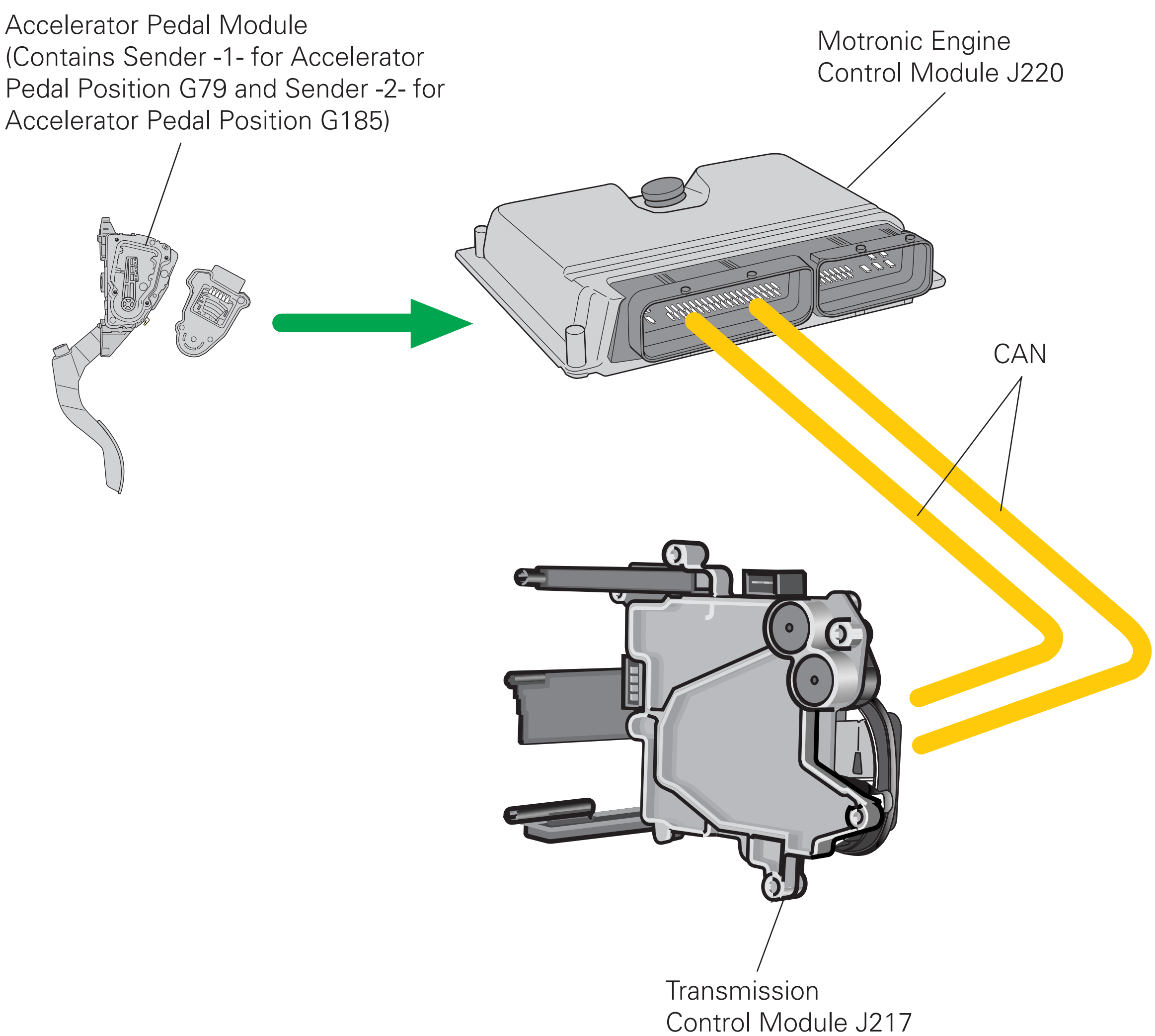
SSP 228/106

In automatic mode, the most sporty control characteristic for maximum acceleration is selected when the kickdown function is activated.

The kickdown function does not have to be continuously activated. After the kickdown function has been activated once, the accelerator pedal need only be held in the full-throttle position.



If the accelerator pedal module is replaced, the kickdown shift point must be calibrated using the Diagnosis, Testing and Information System VAS 5051 (refer to Repair Manual).



SSP 228/108

Tiptronic Switch F189

Tiptronic Switch F189 is integrated on the printed circuit board of the gear change mechanism. It has three Hall sensors which are actuated by a magnet located on the shutter.

A - Sensor for downshift

B - Sensor for Tiptronic recognition

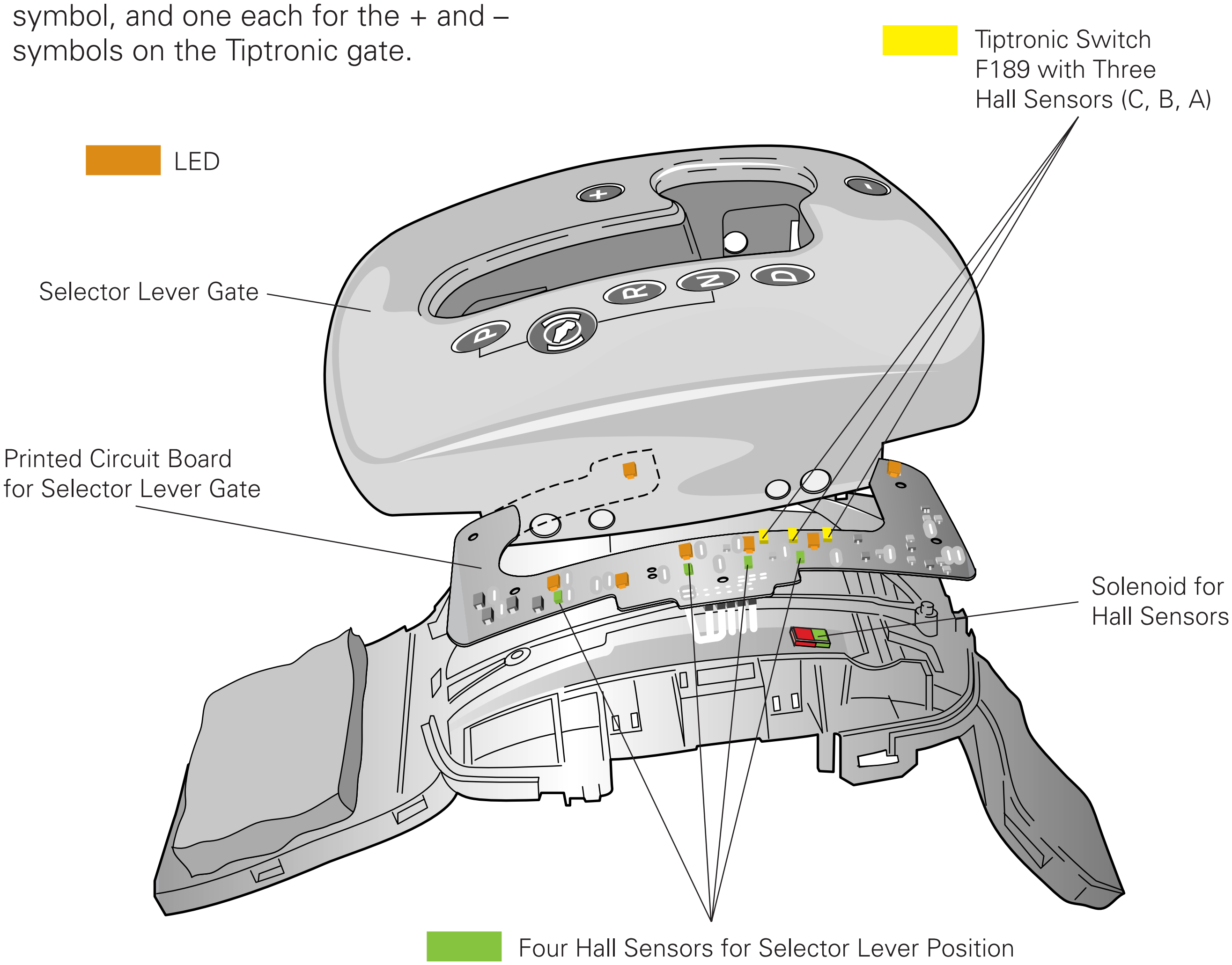
C - Sensor for upshift

Seven LEDs are located on the printed circuit board: one for each selector lever position, one for the "Brake actuated" symbol, and one each for the + and – symbols on the Tiptronic gate.

Each selector lever position LED is controlled by a separate Hall sensor.

The switches of Tiptronic Switch F189 apply ground (low signal) to the Transmission Control Module J217 when actuated. If a fault occurs, the Tiptronic function is disabled.

Fault indication: inverted



SSP 228/079

CAN Information Exchange on multitronic®

In the multitronic® information is exchanged between the Transmission Control Module J217 and the networked control modules, apart from only a few interfaces, across the drivetrain CAN bus.

The system overview shows information which is supplied by the Transmission Control Module J217 across the CAN bus and received and used by the networked control modules.

Transmission Control Module J217

Specified Engine Torque

Specified Idling Speed

Enable Adaptation —
Idling Speed Charge Regulation

Overrun Shut-Off Support

Clutch Protection

Clutch Status

Clutch Torque

Gearshift Operation Active/Inactive

Compressor Switch Off

Selector Lever Position/
Drive Position

Vehicle Road Speed

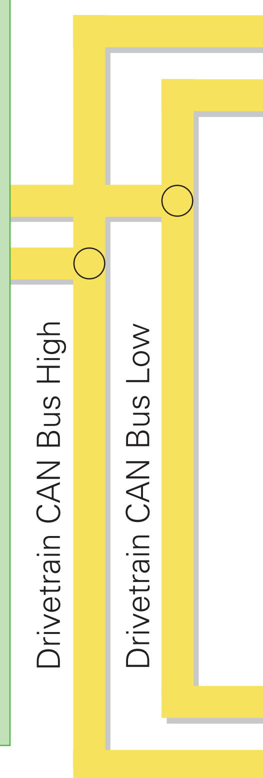
Shift Indicator

Currently Engaged Gear or
Target Gear

Coding in the Motronic Engine
Control Module J220

Emergency Running Program
(Information on Self-Diagnosis)

On-Board Diagnosis Status



**Motronic Engine
Control Module J220**

Engine Speed

Specified Idling Speed

Actual Engine Torque

Coolant Temperature

Kickdown Information

Accelerator Pedal Position

Brake Light Switch

Vacuum Vent Valve, Brake

Intake Air Temperature

CCS Status

CCS Specified Road Speed

Altitude Information

Air Conditioner Compressor Status

Emergency Running Program
(Information on Self-Diagnosis)

**ABS Control Module with
EDL/ASR/ESP J104**

ASR Request

EBC Request

ABS Application

EDL Intervention

ESP Intervention

Wheel Speed, Front Left

Wheel Speed, Front Right

Wheel Speed, Rear Left

Wheel Speed, Rear Right

Information Sent by the Transmission Control Module J217.

Information Received and Evaluated by the Transmission Control Module J217.

Auxiliary Signals/Interface

The multitronic® provides in addition the following interfaces for information exchange by CAN bus:

Pin 15	Signal for engine speed
Pin 6	Signal for shift indicator
Pin 5	Signal for road speed
Pin 2	Diagnosis and programming interface
Pin 13	Signal for Tiptronic (recognition)
Pin 12	Signal for Tiptronic (downshift)
Pin 14	Signal for Tiptronic (upshift)

Signal for Engine Speed

Engine speed is a key parameter for the multitronic®. To increase the reliability of the multitronic®, the information on engine speed is transmitted to the Transmission Control Module J217 by a separate interface and in addition (redundantly) across the CAN bus (see "Functional Diagram," page 80).

In the event of faults or if the separate "engine speed signal" interface fails, the information on engine speed is adopted by the CAN bus as a substitute value.

In the event of faults at the "engine speed signal" interface, the micro-slip control function is deactivated.

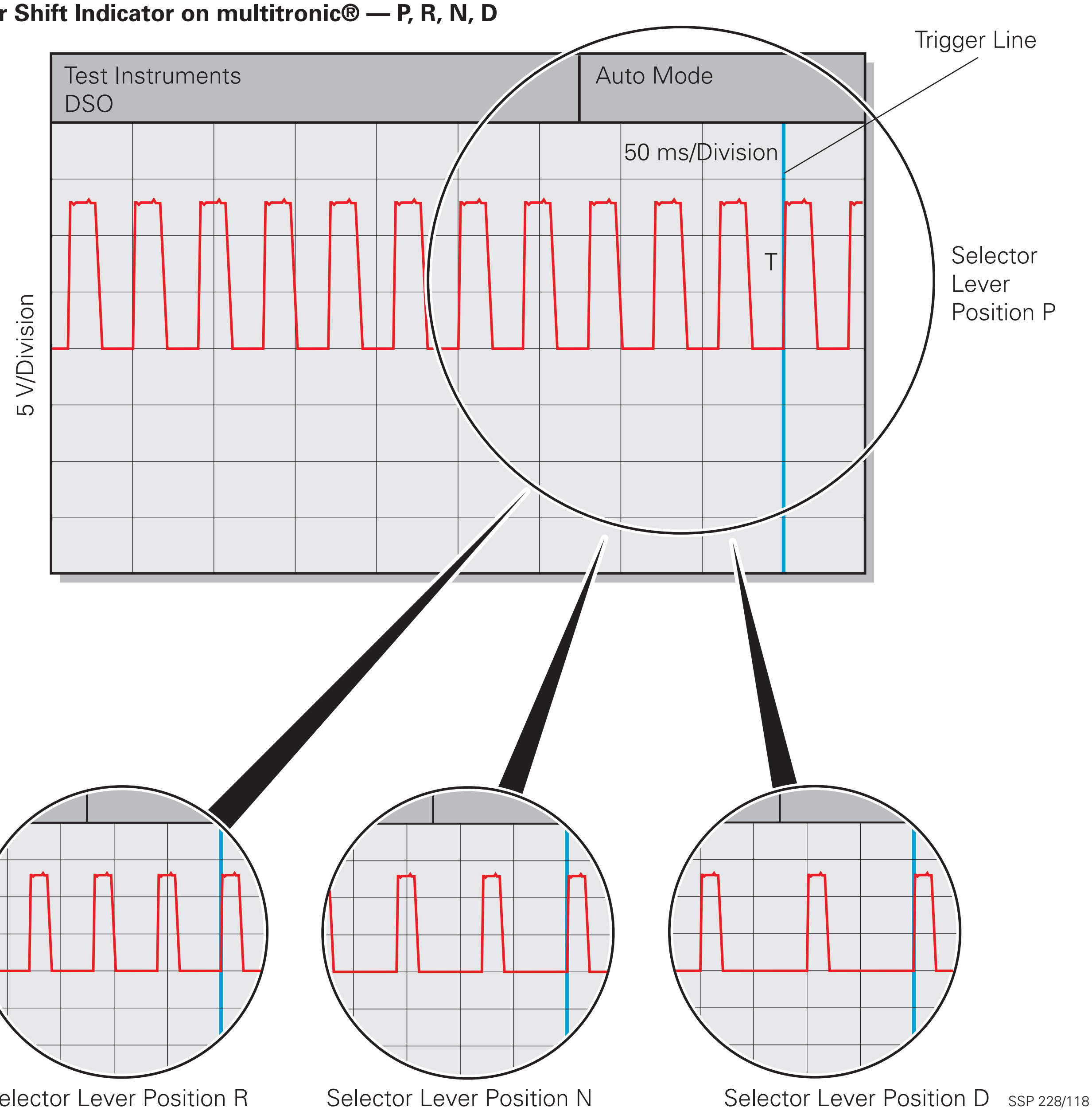
Signal for Shift Indicator

The signal for shift indicator is a square-wave signal generated by the Transmission Control Module J217 with a 20-millisecond constant high level and variable low level.

Each selector lever position or each "gear" in the Tiptronic function is assigned to a defined low-level duration.

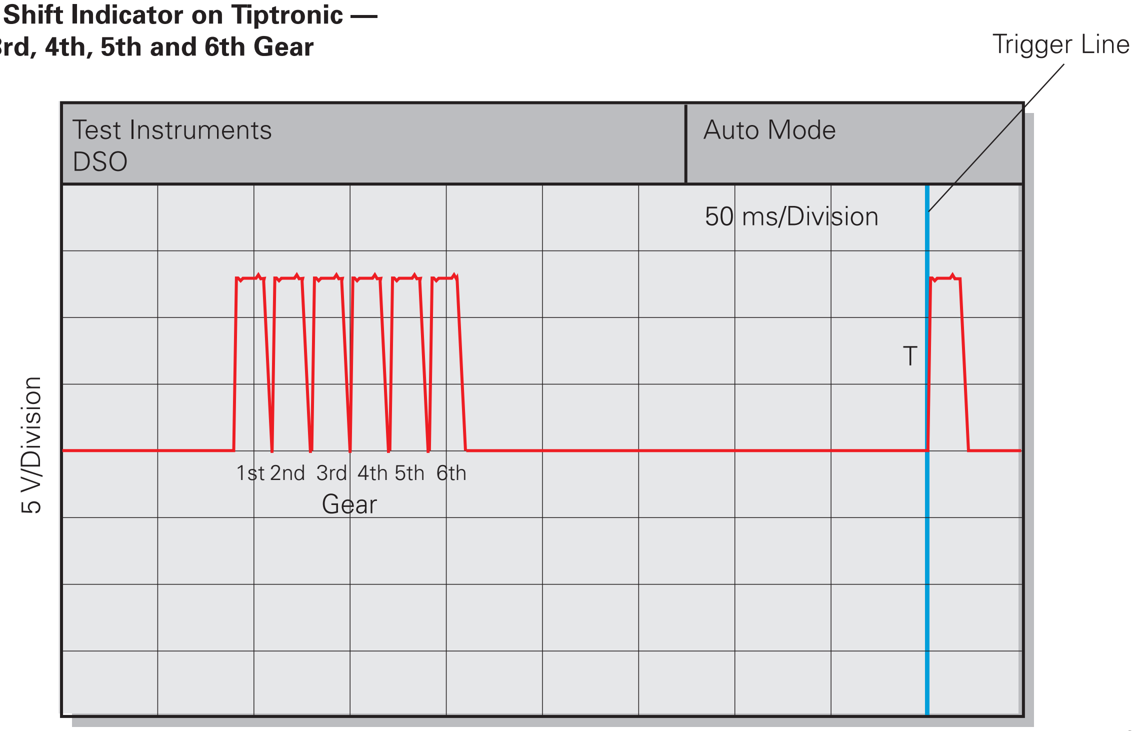
The selector lever position indicator or the shift indicator in the instrument cluster recognizes by the low-level duration what selector lever position or what gear is selected and indicates this accordingly.

Signal for Shift Indicator on multitronic® — P, R, N, D



To simplify the representation, the signals from **all** six gears for the Tiptronic function are shown combined in a **single** diagram.

Signal for Shift Indicator on Tiptronic — 1st, 2nd, 3rd, 4th, 5th and 6th Gear



SSP 228/117

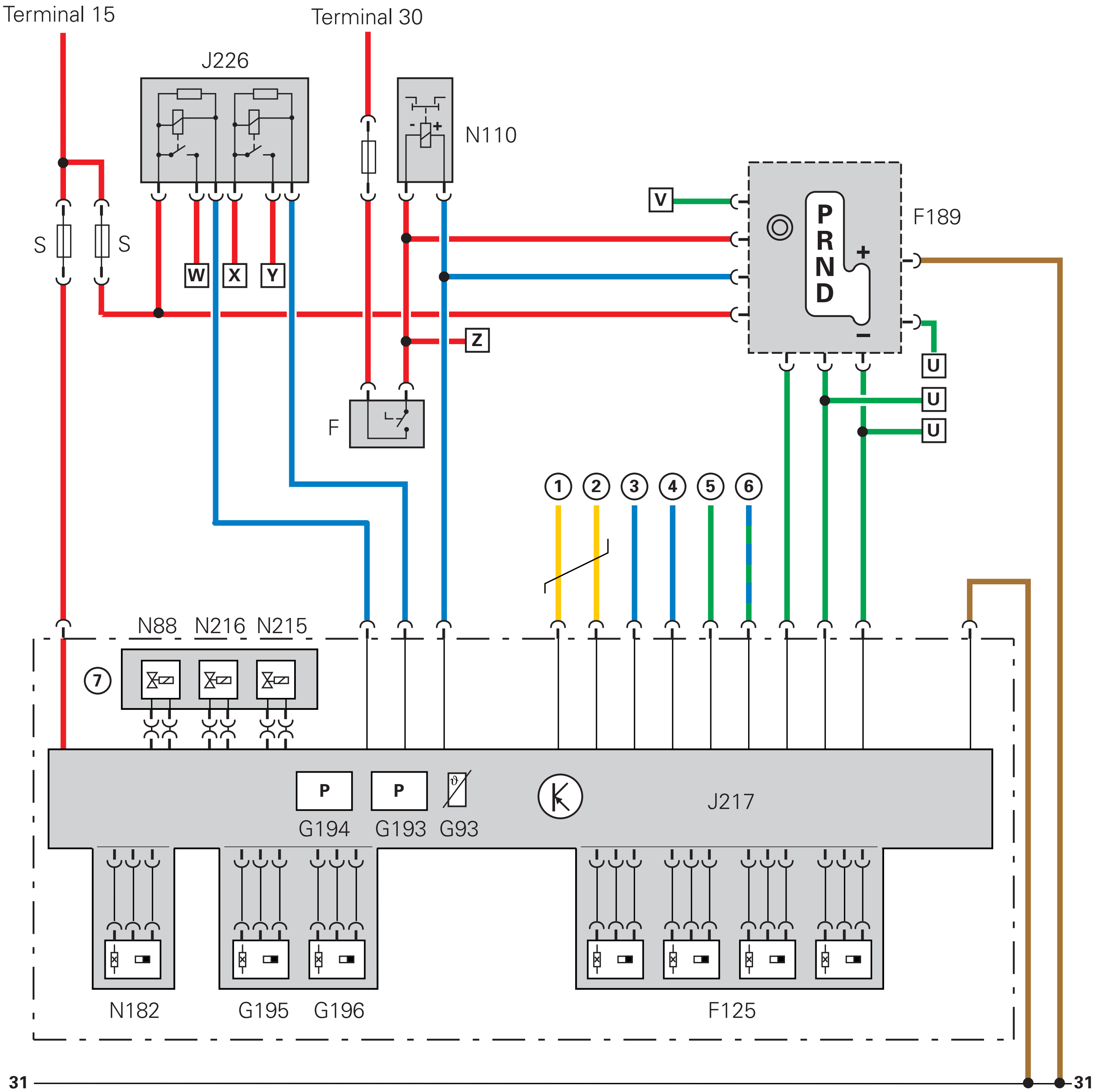
Signal for Road Speed

The signal for road speed is a square-wave signal generated by the Transmission Control Module J217. The duty cycle is approximately 50% and the frequency changes synchronous to road speed.

Eight signals are generated per wheel revolution and relayed to the instrument cluster through a separate interface.

The signal is used here for speedometer operation and is passed on to the networked control modules/systems (e.g. engine, air conditioning system, audio system, etc.) by the instrument cluster.

Functional Diagram



SSP 228/030

Color Codes

= Input Signal

= Output Signal

= Positive

= Ground

= Bidirectional

= Drivetrain CAN Bus

— · — · — multitronic®

Components

F Brake Light Switch
F125 Multi-Function Transmission Range Switch
F189 Tiptronic Switch

G93 Transmission Fluid Temperature Sensor
G182 Sensor for Transmission RPM
G193 Automatic Transmission Sender -1- for Hydraulic Pressure
G194 Automatic Transmission Sender -2- for Hydraulic Pressure
G195 Sender for Transmission Output RPM
G196 Sender -2- for Transmission Output RPM

J217 Transmission Control Module
J226 Park/Neutral Position Relay

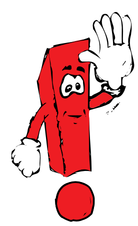
N88 Solenoid Valve 1
N110 Shift Lock Solenoid
N215 Pressure Control Valve -1- for Automatic Transmission
N216 Pressure Control Valve -2- for Automatic Transmission

S Fuse

Connections and Auxiliary Signals

U To Tiptronic Steering Wheel (Option)
V From Terminal 58d
W To the Backup Lights
X From Ignition Switch Terminal 50
Y To Starter Terminal 50
Z To the Brake Lights

1 Drivetrain CAN Bus Low
2 Drivetrain CAN Bus High
3 Signal for Shift Indicator
4 Signal for Road Speed
5 Signal for Engine Speed
6 K-Diagnostic Connection
7 Installed in the Hydraulic Control Module



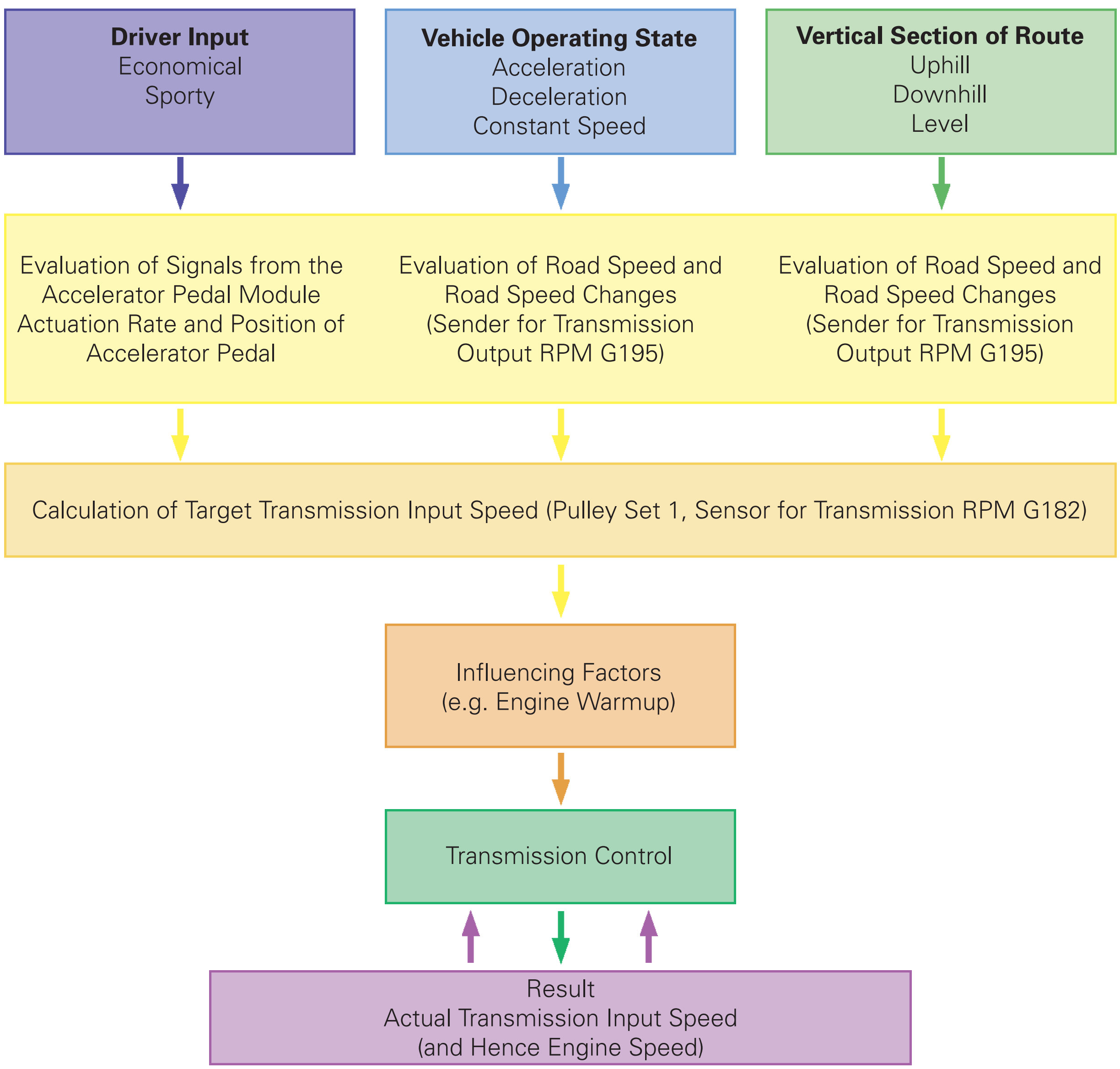
Because there are only a few interfaces to the Transmission Control Module J217, the multitronic® does without a separate wiring harness. The wiring is integrated in the engine harness.

Dynamic Control Program

The Transmission Control Module J217 has a dynamic control program for calculating the target transmission input speed.

It is a further development of the dynamic shift program (DSP) already being used in the CVT.

The object of the dynamic control program is to set the gear ratio so performance matches the driver input as closely as possible. The driving feel should be like driving in manual mode.



For this purpose the system determines the driver's behavior, the vehicle operating state and the vertical section of the route so it can provide the optimum gear ratio in any driving situation.

The Transmission Control Module J217 evaluates the actuation rate and angular position of the accelerator pedal (driver input), as well as the road speed and vehicle acceleration (vehicle operating state), and whether the vehicle is moving up or down a hill or on a level road (vertical section of route).

Using logical combinations of this information, the target level for transmission input speed is set by varying the transmission ratio to match vehicle performance as closely as possible to driver input. These target levels are restricted by transmission input rpm limits and by the performance range parameters from most economical to most sporty. They must also account for the vertical section of the route traveled.

The logical combinations and calculations (control strategy/control philosophy) are defined by the software and cannot account for every eventuality. Therefore, there are still situations in which manual intervention using the Tiptronic function is called for.

Control strategy varies by vehicle model, engine displacement, and control module design.

Driver Input
Economical
Sporty

Vehicle Operating State
Acceleration
Deceleration
Constant Speed

Vertical Section of Route
Uphill
Downhill
Level

Dynamic Control Program Control Strategy

The following examples show control strategy during typical driving situations.

Illustration SSP 228/119 shows the speed characteristics when accelerating at full throttle with the kickdown activated.

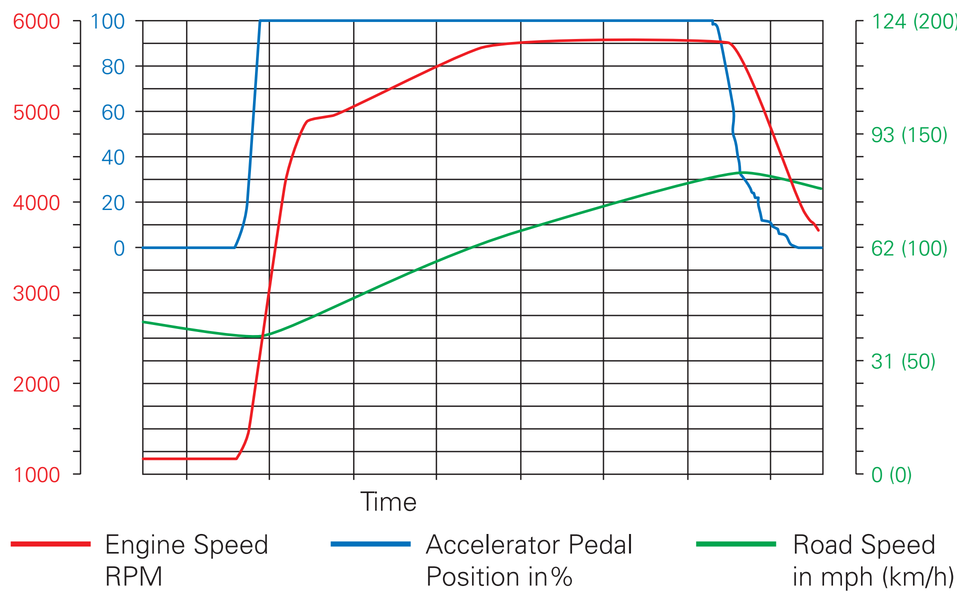
By activating the kickdown, the driver signals to the Transmission Control Module J217 that maximum acceleration is required.

To achieve this, the engine's maximum power output must be provided quickly. For this purpose engine speed is adjusted for maximum performance and maintained until the accelerator pedal angle is reduced.

Although the driver will be required to adjust to this unusual behavior, it makes it possible for the vehicle to accelerate with the maximum possible dynamism. In addition, the vehicle's top speed as a function of rolling resistance is kept at the maximum possible value.

The fact that the engine speed increases quickly but the engine does not accelerate to the same extent results in what is known as the “rubber band effect” or what feels like a “slipping clutch.” This effect is alleviated by “intercepting” the increase in engine speed shortly before maximum engine speed is attained.

Kickdown Acceleration



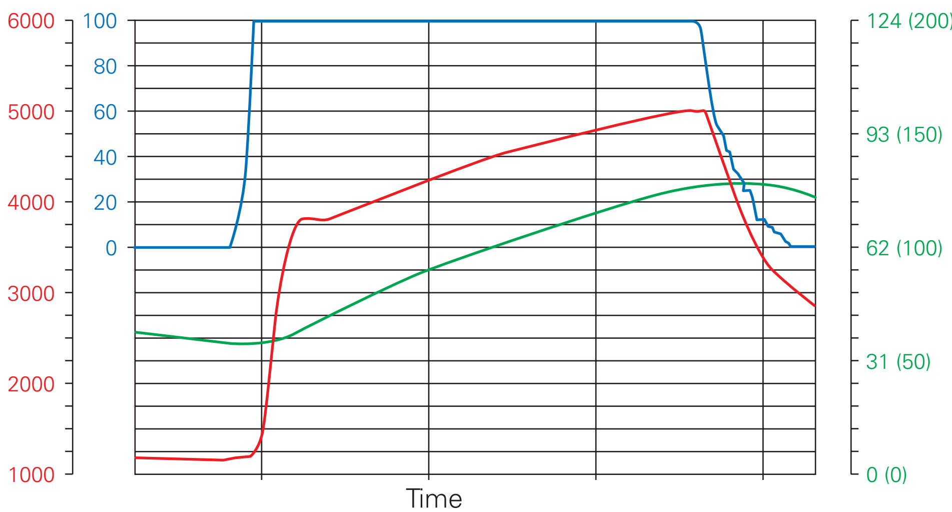
SSP 228/119

To contain this effect, "normal"acceleration at full throttle (without kickdown), as well as acceleration with lesser accelerator pedal angles, are characterized by the speed characteristics shown in illustrations SSP 228/124 and SSP 228/122.

The "engine speed tracking" function is used for this purpose. Engine speed is regulated depending on the position and actuation rate of the accelerator pedal so engine speed increases directly proportional to road speed.

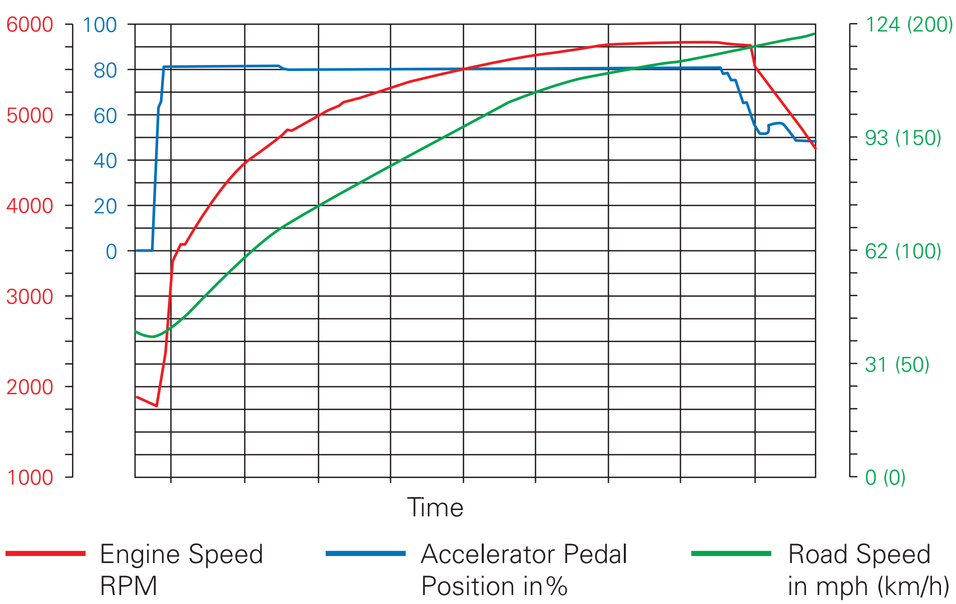
This control strategy simulates the performance of multi-step transmissions and closely matches the driving feel which the driver is accustomed to. In keeping with driving style, the engine rpm level is high (sporty) at large accelerator pedal angles and low (economical) at small accelerator pedal angles.

Full Throttle Acceleration



SSP 228/124

Part Throttle Acceleration, Throttle 80% Open



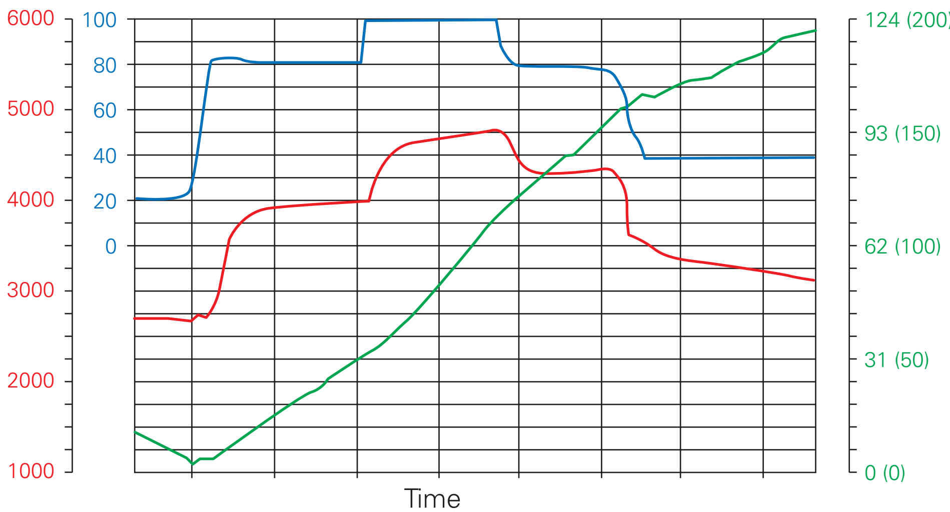
SSP 228/122

Control

As shown in illustration SSP 228/123, quick changes in accelerator pedal position are converted to instantaneous changes in engine speed in order to meet the driver's demands for performance or acceleration.

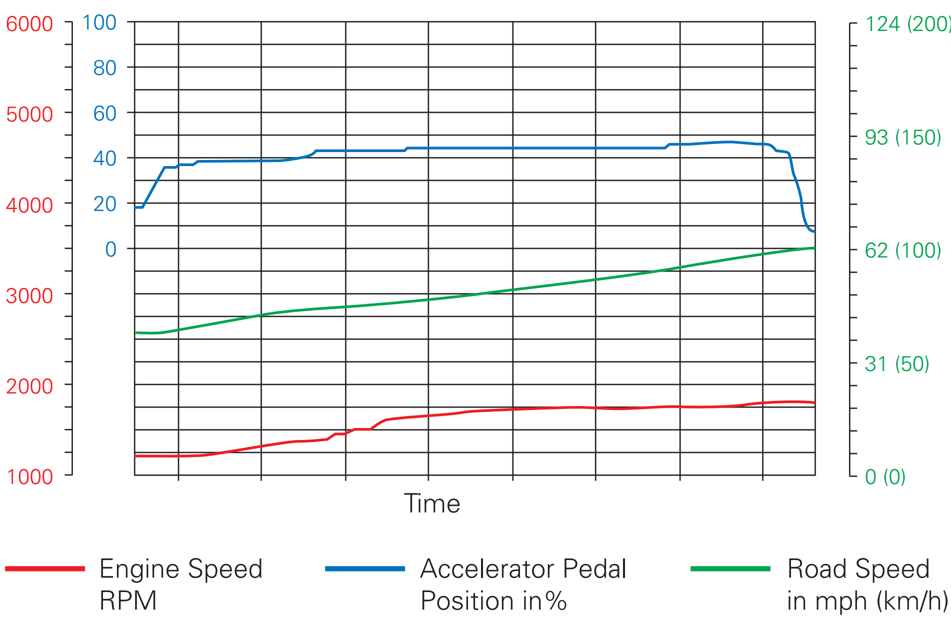
If the driver adopts an economical driving style, as characterized by small accelerator pedal angles and a slow rate of opening of the throttle, then road speed is increased at the lowest engine rpm levels (see illustration SSP 228/121).

Engine Speed Response to Quick Changes in Accelerator Pedal Angle



SSP 228/123

Acceleration in an Economical Driving Mode



SSP 228/121

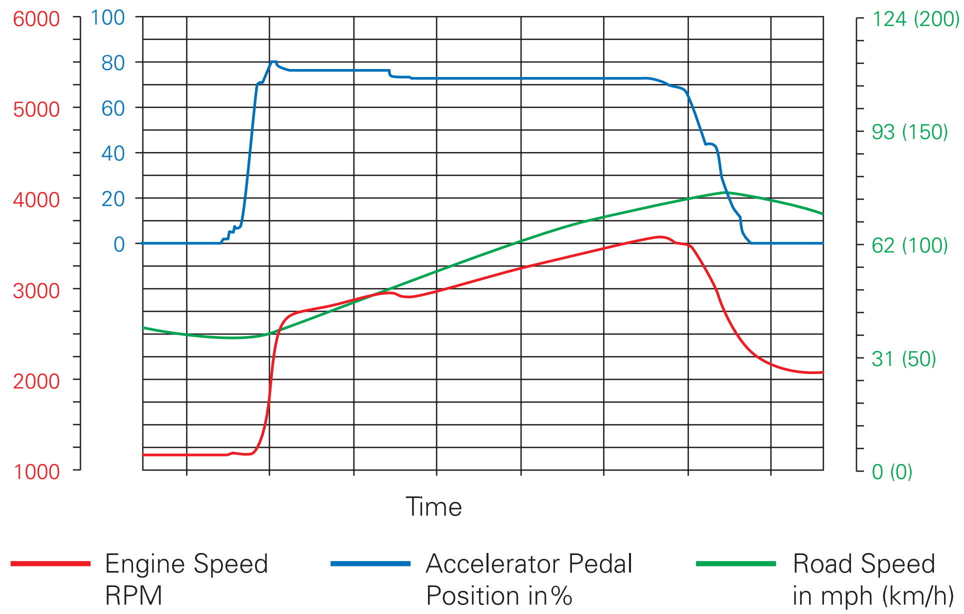
In general, the system responds to a reduction in the accelerator pedal angle by reducing the engine rpm level as shown in illustrations SSP 228/120 and SSP 228/123.

If the accelerator is suddenly released, particularly in a sporty driving mode, the engine speed is "held" at a higher level for longer.

By increasing the braking effect of the engine (high overrun speed), this control strategy helps to brake the vehicle and increases engine dynamism for instant accelerator response.

In addition, unnecessary transmission ratio adjustments are suppressed.

Acceleration with Reduced Accelerator Pedal Angle



SSP 228/120

Motion Resistance

“Power in relation to load” is calculated in order to detect motion resistance (uphill grade, downhill grade, vehicle operation with trailer in tow).

It indicates whether power demand is higher or lower compared to the rolling resistance during vehicle operation on a level surface (unladen).

$P_{Engine\ load}$	=	Power in relation to load
P_{mot}	=	Actual engine output
P_{a}	=	Acceleration work
P_{FW}	=	Power in relation to motion resistance

$$P_{Engine\ load} = P_{mot} - P_{a} - P_{FW}$$

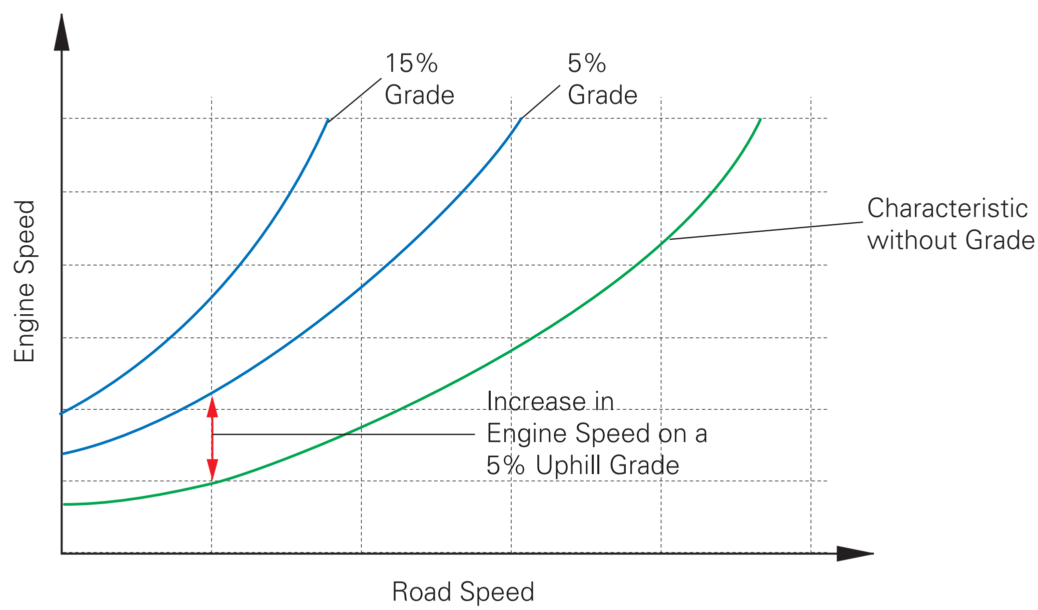
Uphill Grade

Higher power demand may be due to an uphill grade or a trailer.

In this case, the engine speed and output level must be increased through a shorter ratio without the driver constantly having to open the throttle more as shown in illustration SSP 228/091.

In practice the driver will perceive this control strategy, known as “load compensation,” as a comfort increase.

Increase in Engine Speed on a Uphill Grade



SSP 228/091

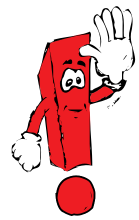
Driving Downhill

On a downhill grade the situation is slightly different. If the driver wants to be assisted by engine brake effect when driving downhill, he must indicate this by pressing the brake pedal (signal from combined Brake Light Switch F and Vacuum Vent Valve, Brake F47).

If the engine is in the overrun phase and road speed increases even though the brake pedal is pressed, the transmission ratio is adjusted towards the starting torque ratio and with it the engine braking force is increased.

If the brake pedal is pressed several times (without reduction in road speed), the Transmission Control Module J217 gradually adjusts the transmission ratio towards the starting torque ratio (see illustration SSP 228/097). Thus the driver has a great deal of control over the intensity of the engine brake effect.

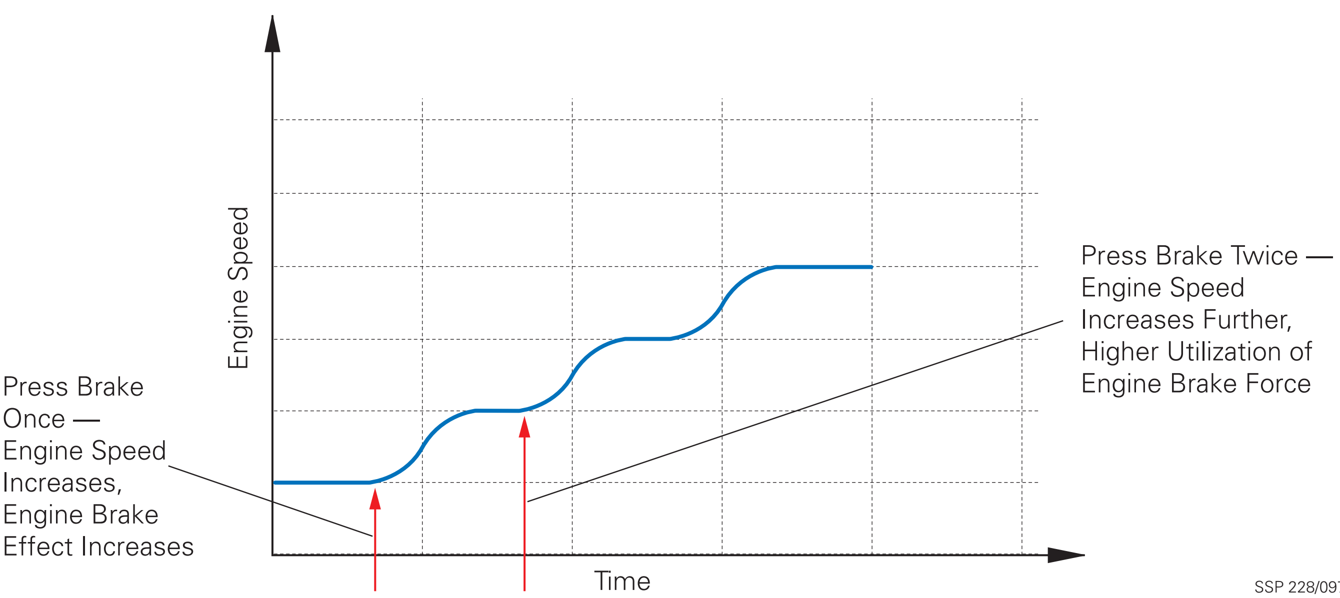
If the downhill slope decreases, the transmission ratio is again adjusted towards the end torque multipliction ratio (overdrive) and the vehicle's road speed increases slightly.



If the driver enters a downhill grade pressing the brake pedal (and holds the brake pedal down), the “downhill function” as described will not be active initially. If the road speed is kept almost constant in this case by applying the brake, the multitronic® will be unable to recognize the driver's intentions and therefore cannot assist the driver by increasing the engine brake effect. However, if the vehicle exceeds a defined rate of acceleration, the “downhill function” will be activated automatically.

Engine braking force can be controlled individually by using the Tiptronic function.

Increase in Engine Speed when Driving Downhill



SSP 228/097

Driving with Cruise Control System (CCS)

In overrun mode, the engine brake effect is insufficient when driving downhill with the cruise control system (CCS) turned on because the transmission ratio is often low.

In this case, the engine brake effect is increased by raising the target transmission input speed (transmission control is adjusted towards the starting torque ratio.)

The CCS set road speed is always slightly higher than the actual road speed. This is due to the control tolerance of the CCS and the safety requirement that the engine must be in overrun mode.

A maximum overrun speed which serves as a limit value for transmission input speed control is stored in the Transmission Control Module J217. When the maximum overrun speed is reached, the transmission ratio is not adjusted further towards the starting torque ratio and therefore is limited.

If the engine brake effect is insufficient at maximum overrun speed, the vehicle's road speed increases and the driver has to apply the brakes.

The Tiptronic Function

As mentioned previously, six “gears” can be selected manually in Tiptronic mode. In this mode, defined transmission ratios are set and “gears” are simulated (see also page 4).

The performance and shift strategies are identical to the multi-step transmission with Tiptronic (mandatory upshift or mandatory downshift).

If the Tiptronic function is selected while driving, transmission output is stabilized at its current ratio for a seamless transition. The first driver action to select a “gear” will result in a shortened step up or down to one of the six preset Tiptronic ratios. The defined transmission ratios are then set step by step by shifting up or down.

Reason:

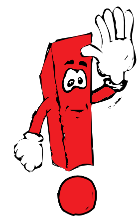
Because the transmission ratio could be between two “gears” at the point of change-over to Tiptronic mode, an immediate change into a defined ratio could lead an abrupt change in road speed depending on the difference in ratio to the next “gear.”

Towing

To make towing possible, design measures have been implemented in the Variator (see "The Variator," page 27 for details).

When towing a vehicle with multitronic®, the following conditions must be fulfilled:

- The selector lever must in the "N" position.
- **The vehicle's road speed must not exceed 30 mph (50 km/h).**
- Vehicles must not be towed further than 30 miles (50 km).



When towing the vehicle, the oil pump is not driven and rotating parts are not lubricated.

Care should therefore be taken in meeting the above-specified conditions since the transmission may otherwise be damaged severely.

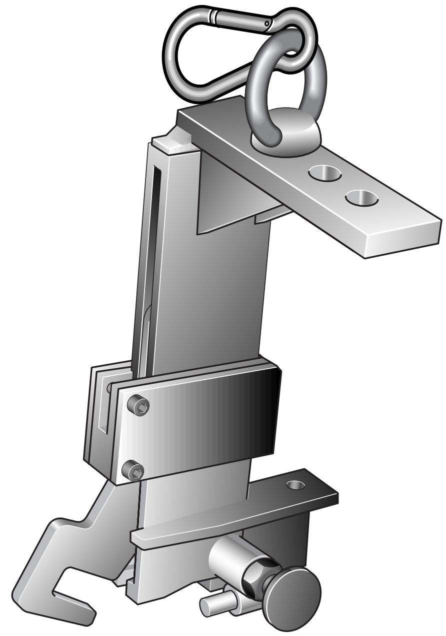
It is **not** possible to start the vehicle by towing.

Special Tools

The following special tools will be required by the service department.

Transmission Lift Hook

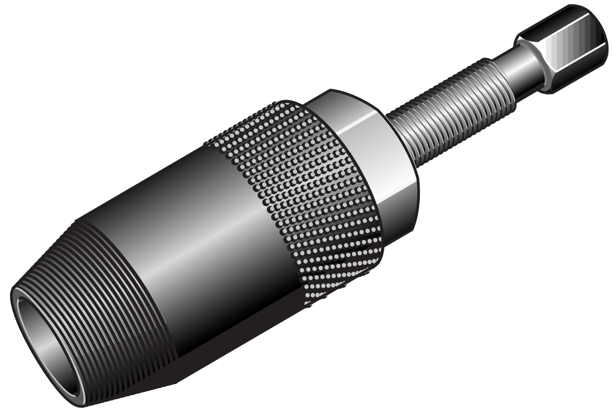
T40013



SSP 228/066

Oil Seal Extractor

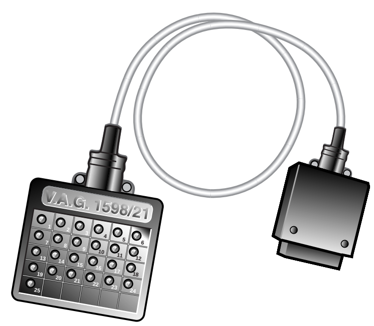
T40014



SSP 228/067

Test Box

V.A.G. 1598/21



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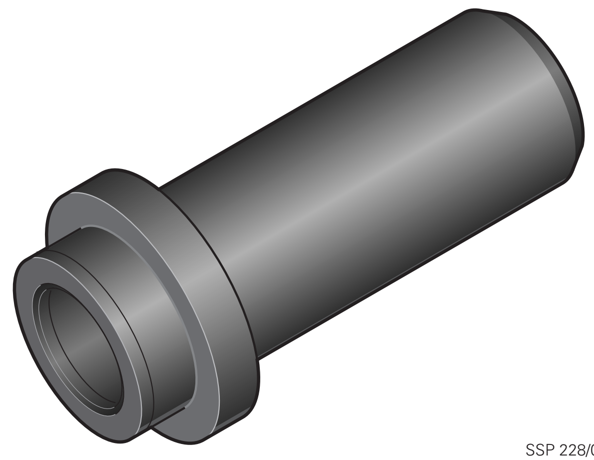
Seal Installer

T40015



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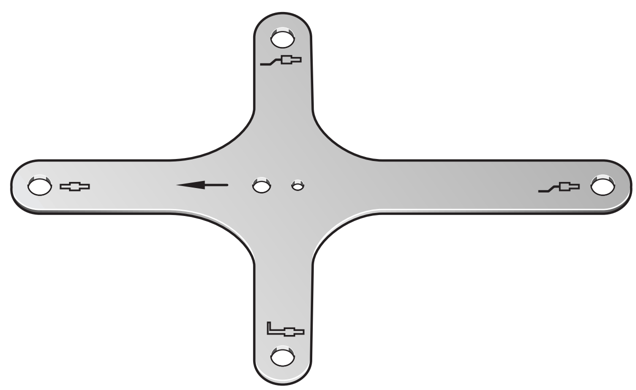
Adjustment Plate

3282/30



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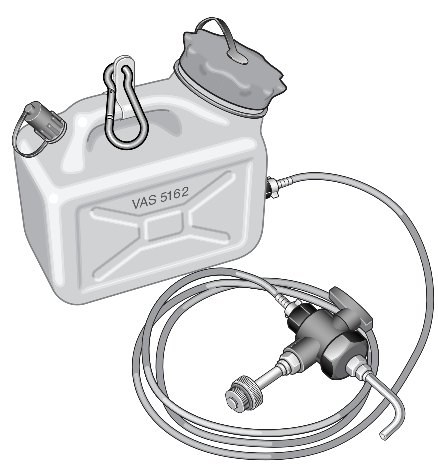
ATF Filler System

VAS 5162



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Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this SSP.

The Knowledge Assessment may or may not be required for Certification.

You can find this Knowledge Assessment at:

www.accessaudi.com

From the accessaudi.com homepage:

- Click on the “ACADEMY” Tab
- Click on the “Academy Site” Link
- Click on the ”CRC Certification” Link

For assistance, please call:

Audi Academy

Learning Management Center Headquarters

1-877-AUDI-LMC (283-4562)

(8:00 a.m. to 8:00 p.m. EST)