SUBARU

Confidence in Motion

Technician Reference Booklet

Lineartronic™ Continuously Variable Transmission Generation 1 (CVT G1)

AUTOMOTIVE Youth Educational Systems PROUD PARTNER

WE SUPPORT PROFESSIONAL CERTIFICATION THROUGH THE National Institute for AUTOMOTIVE SERVICE EXCELLENCE

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THE TRB IS NOT INTENDED TO BE USED AS A SUPPLEMENT OR SUBSTITUTE FOR THE SERVICE MANUAL. ALWAYS CONSULT THE APPROPRIATE SERVICE MANUAL WHEN PERFORMING ANY DIAGNOSTICS, MAINTENANCE OR REPAIR TO ANY SUBARU VEHICLE.

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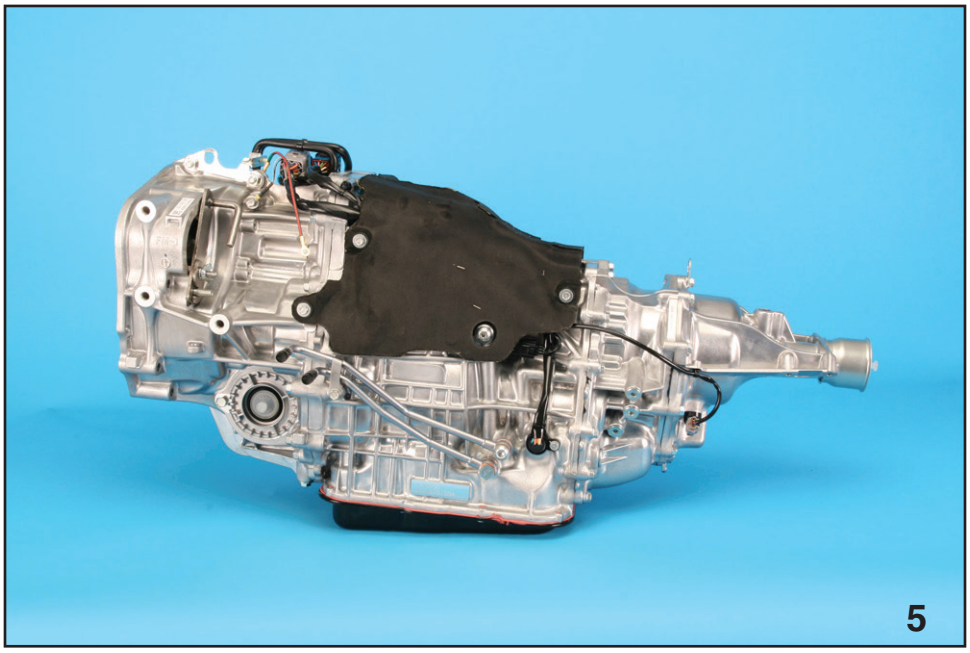
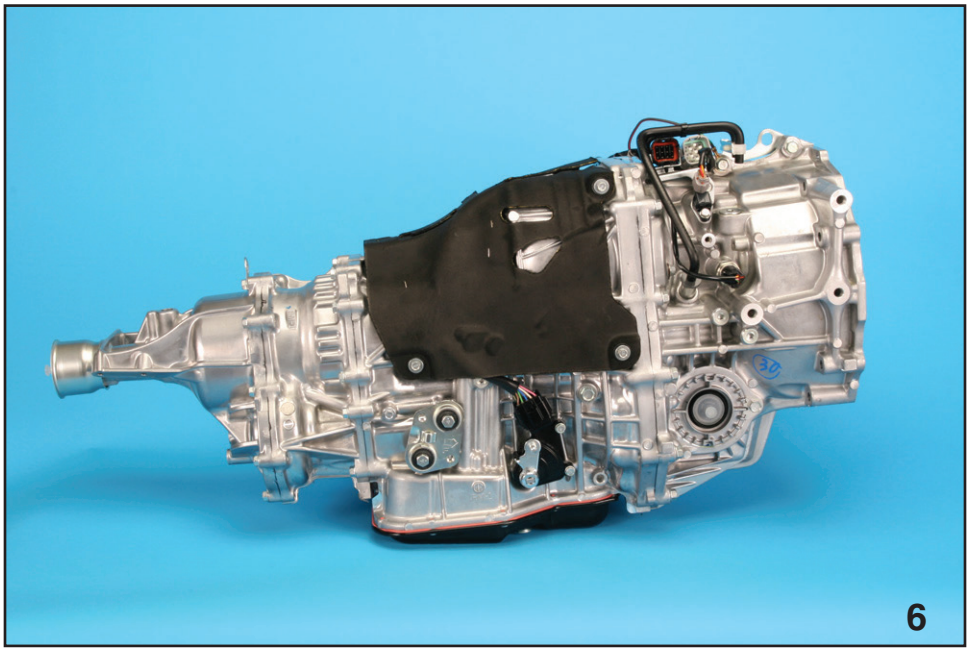
LINEARTRONIC™ CONTINUOUSLY VARIABLE TRANSMISSION GENERATION 1 (CVT G1)



LEFT SIDE VIEW



RIGHT SIDE VIEW

The new Lineartronic™ or Continuously Variable Transmission (CVT) is designed to provide enhanced fuel economy, superb driveability, and optimum gear ratio control for all types of driving conditions.

This transmission may also be referred to as the TR690 in service information.

INTRODUCTION AND CONSTRUCTION

Driver controls include paddle up and downshift switches located on the steering wheel and a console mounted floor shifter with a manual gate.

There are 3 modes of control the driver can choose from which include automatic, manual and temporary manual.

Automatic mode provides gear ratios from 2.37 to 1 in the highest range all the way to 0.39 to 1 in the lowest overdrive ratio. Automatic mode is controlled by placing the console mounted floor shifter into the D range.

NOTE: All gear ratios printed in this TRB are from the gear ratio PID of the SMIII.

Manual mode provides the following 6 gear ratios:

1st	2.18	to	1
2nd	1.45	to	1
3rd	1.03	to	1
4th	0.77	to	1
5th	0.58	to	1
6th	0.40	to	1

Reverse gear in all modes is 2.09 to 1.

The lowest overdrive ratio in Automatic Mode and Manual differs so that while in manual mode a sporty gear ratio is maintained.

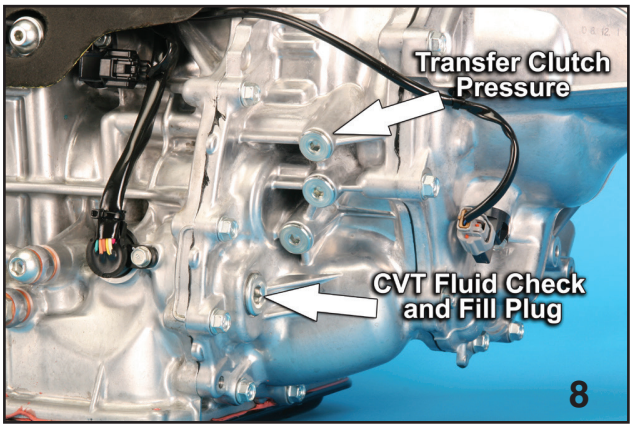
Manual mode is controlled by placing the console mounted floor shifter into the manual gate and using the up and down controls of the steering wheel mounted paddle shift controls.

Temporary manual can be controlled anytime while in automatic mode and activating the paddle shift controls on the steering wheel.

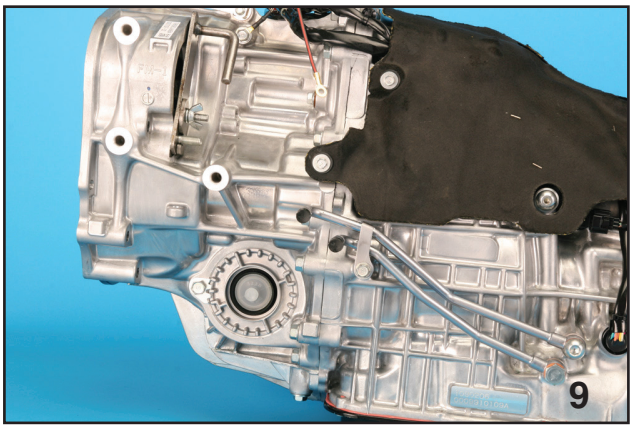
Construction

The Lineartronic™ CVT is divided into 4 sections.

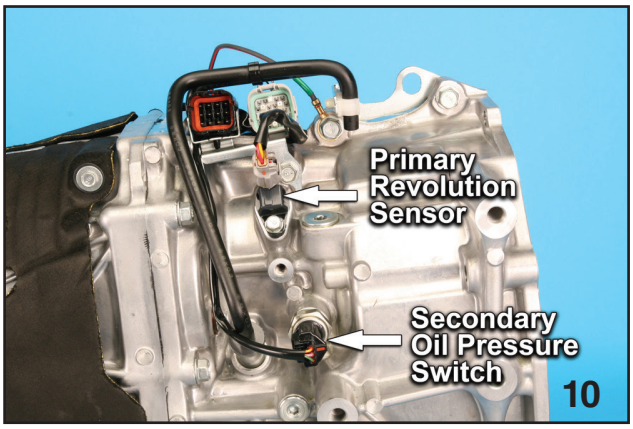
- Converter case
- Transmission case
- Intermediate case
- Extension case



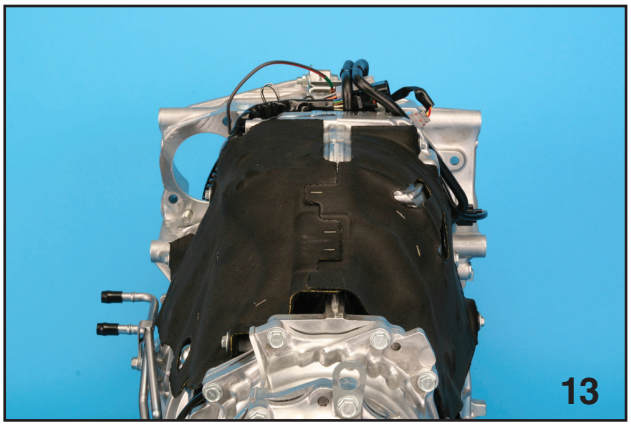
REAR LEFT VIEW



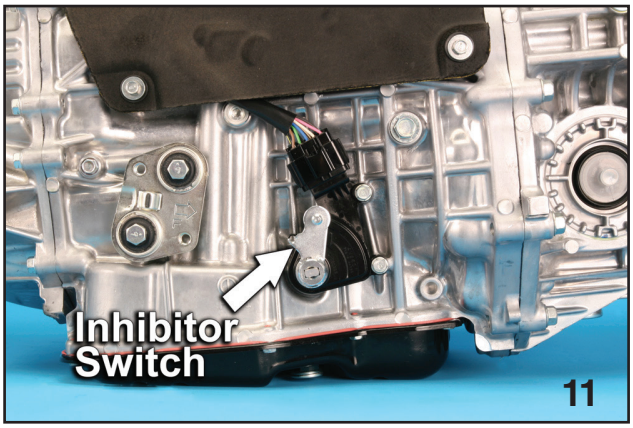
FORWARD LEFT VIEW



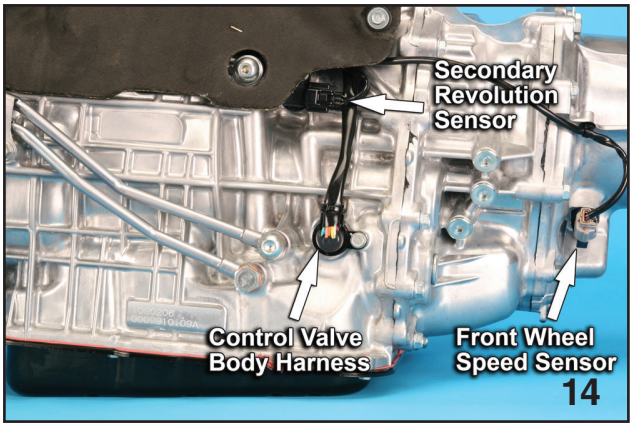
FORWARD RIGHT VIEW



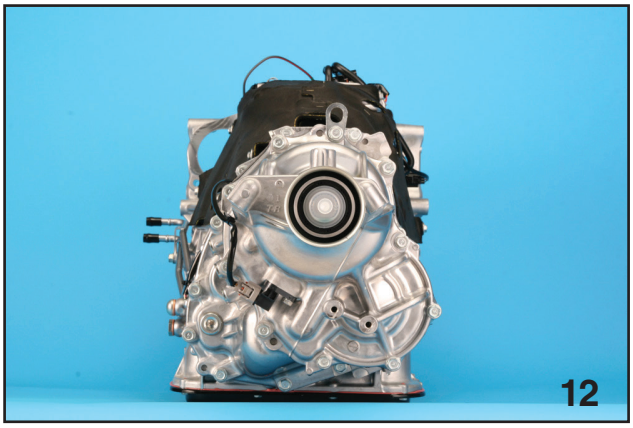
TOP VIEW



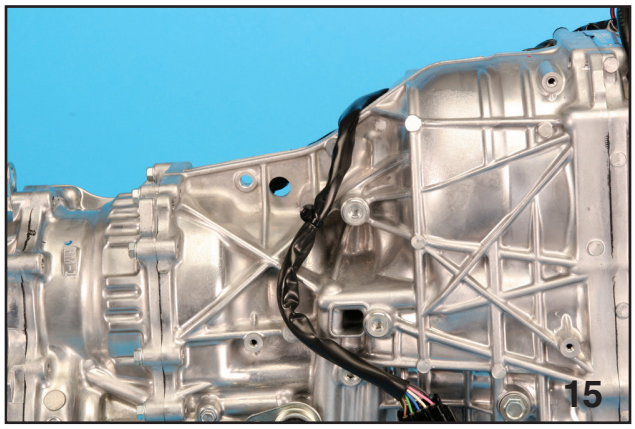
REAR RIGHT VIEW



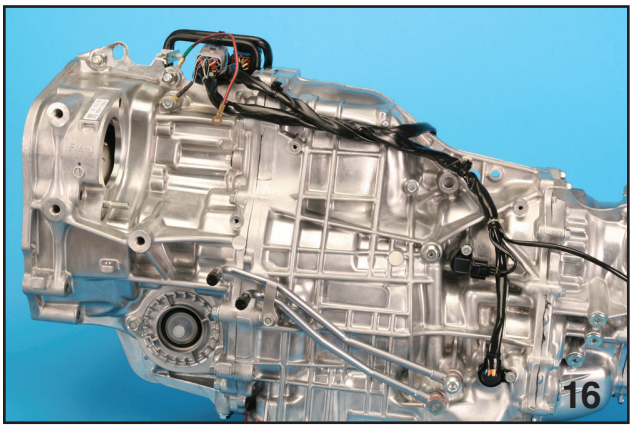
REAR LEFT VIEW



REAR VIEW

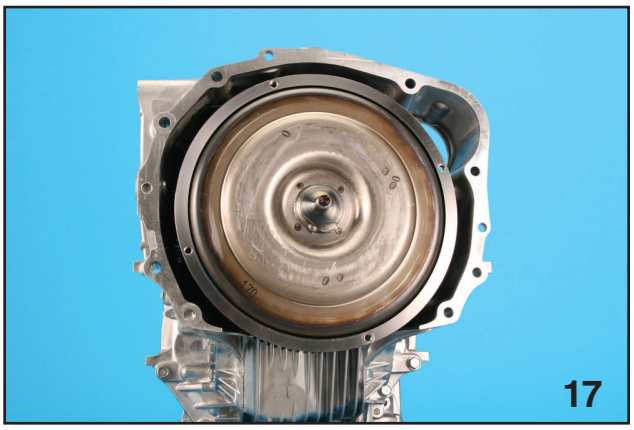


RIGHT SIDE SILENCER OFF

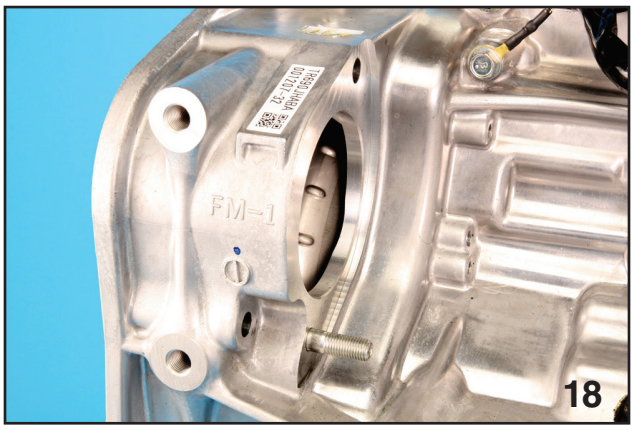


LEFT SIDE SILENCER OFF

A silencer insulation blanket is secured to the upper side of the transmission case. The transmission and inhibitor switch harnesses are routed on the under side.

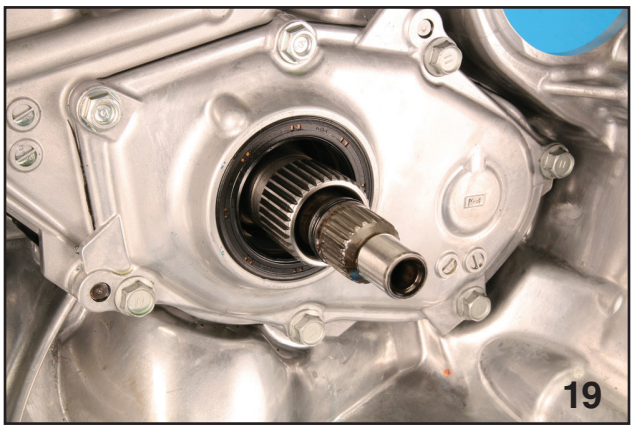


FRONT VIEW

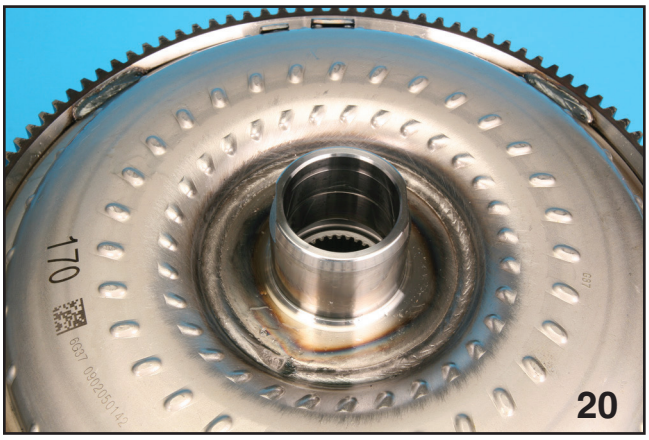


CONVERTER VIEW FROM STARTER MOUNTING

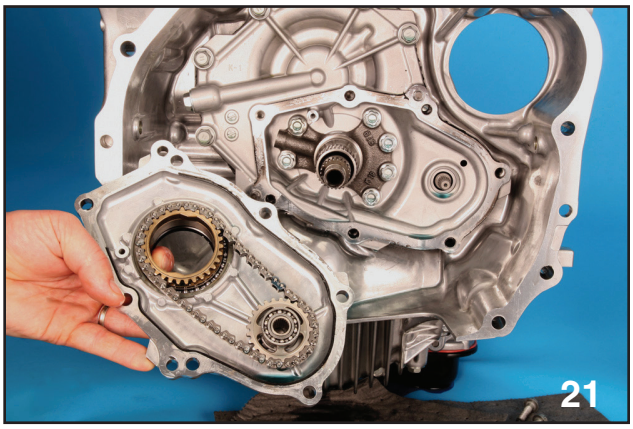
The converter case contains the torque converter, front differential, oil pump, primary revolution sensor, secondary oil pressure switch, input shaft with primary reduction drive gear and input clutch.



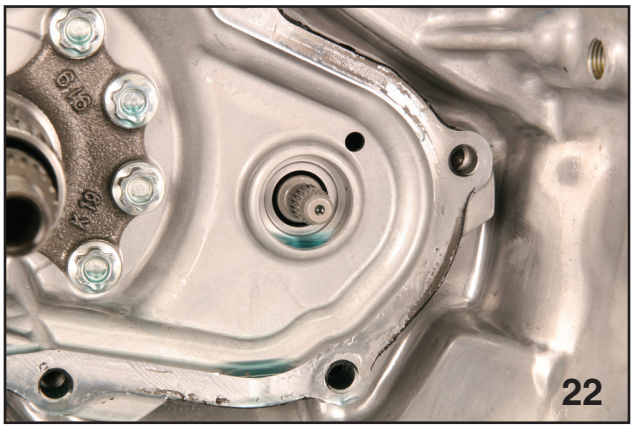
OIL PUMP CHAIN DRIVE HOUSING



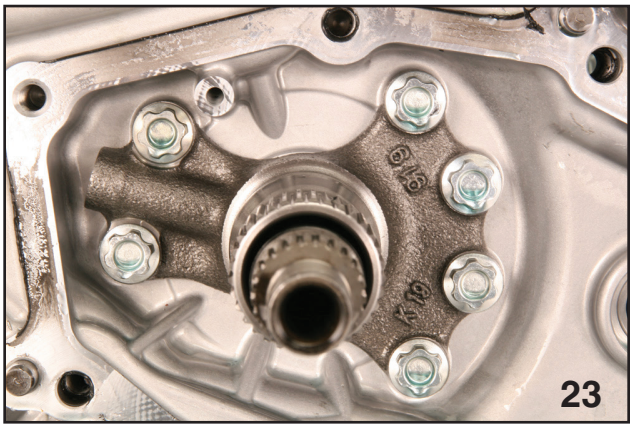
CONVERTER FLATS



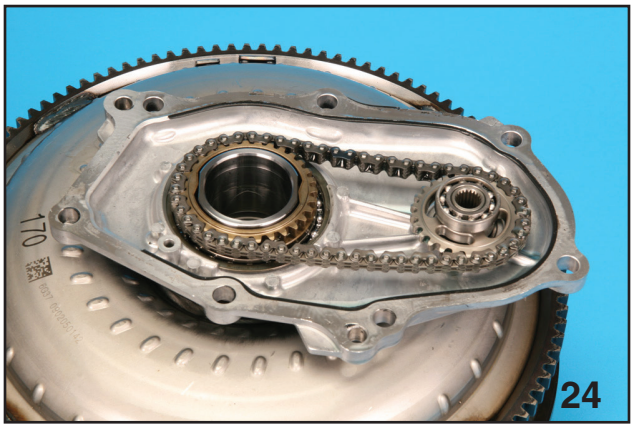
PUMP CHAIN DRIVE AND DRIVEN GEAR WITH CHAIN



OIL PUMP DRIVE SHAFT



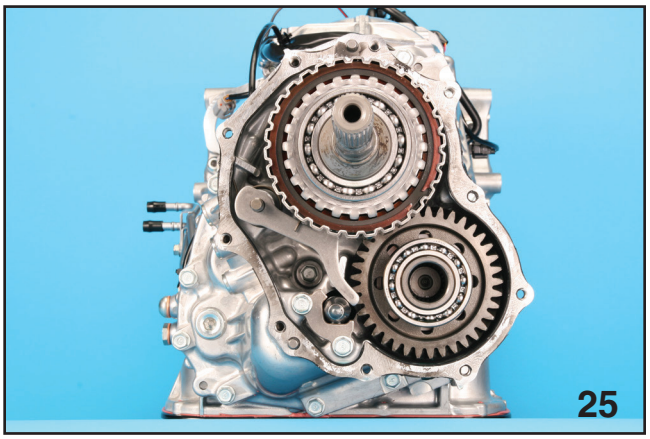
STATOR SUPPORT



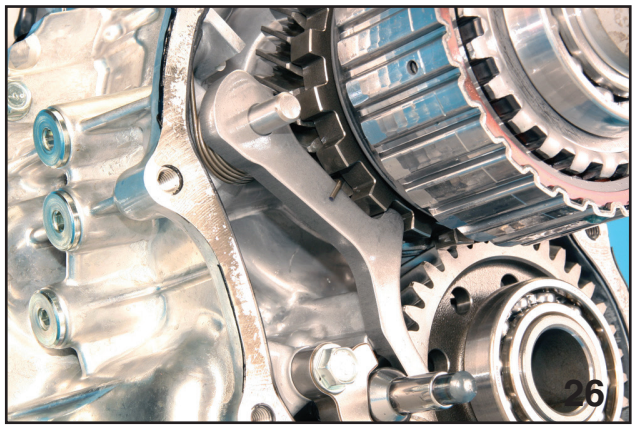
OIL PUMP DRIVE COMPLETE

The oil pump is operated by a chain drive system. The flats of the torque converter hub insert into the oil pump drive sprocket and the oil pump drive chain transmits power to the oil pump driven sprocket. The driven sprocket splines to the oil pump drive shaft.

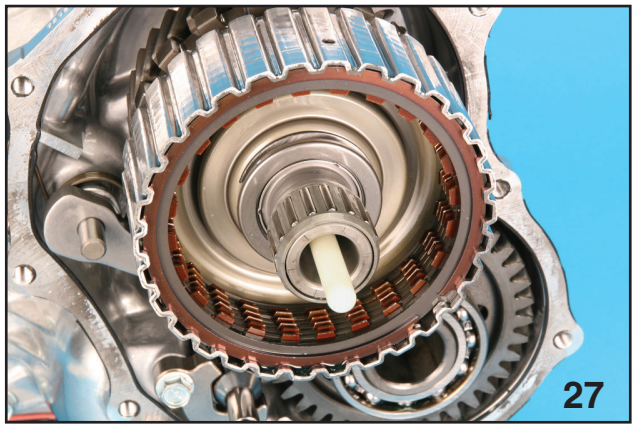
(The oil pump drive provides a speed to the oil pump 1.24 times faster than the engine.)



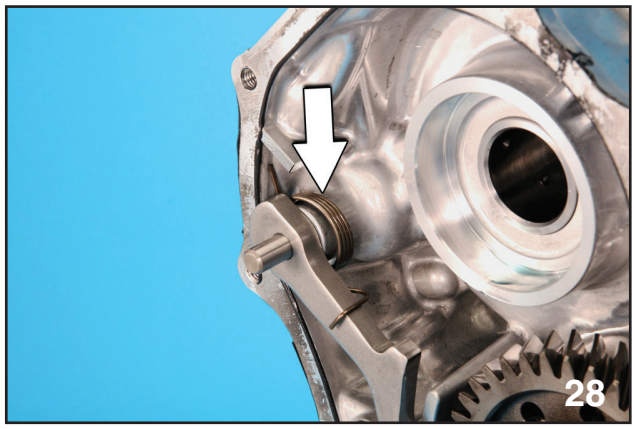
EXTENSION CASE REMOVED



PARKING GEAR ON TRANSFER DRIVE GEAR

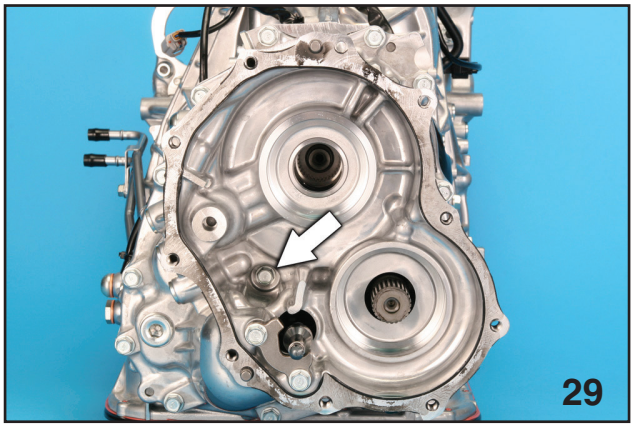


MPT CLUTCH AND LUBRICATION PIPE



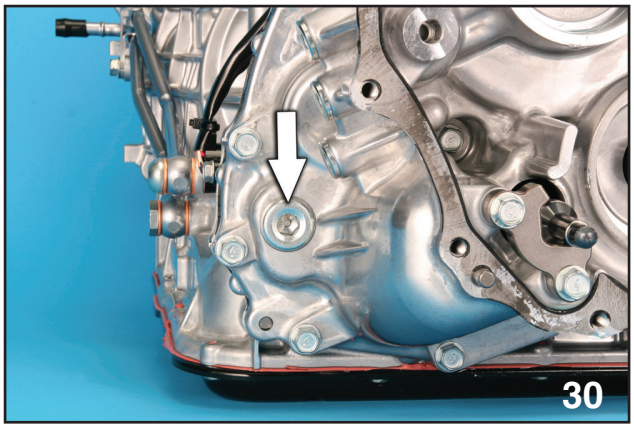
PARKING PAWL SPRING

Removal of the extension housing reveals the MPT clutch, transfer drive and driven gears and parking mechanism.



INTERMEDIATE CASE AND HIDDEN BOLT

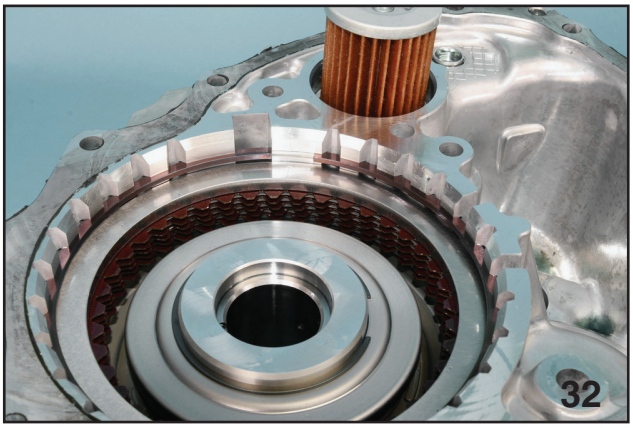
The intermediate case is bolted to the rear of the transmission case. Removal of the intermediate case can be performed after the bolts on the outside edge and one hidden bolt from the sealed area are removed.



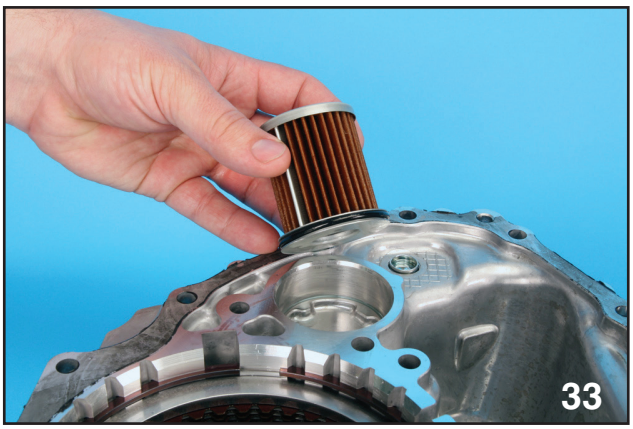
TRANSMISSION FILL/LEVEL INSPECTION PORT

The transmission fill/level inspection port is located on the rear lower left on the Intermediate case. The transmission is not equipped with a traditional dipstick. The cross drilled passage will leak when transmission fluid is at the correct level.

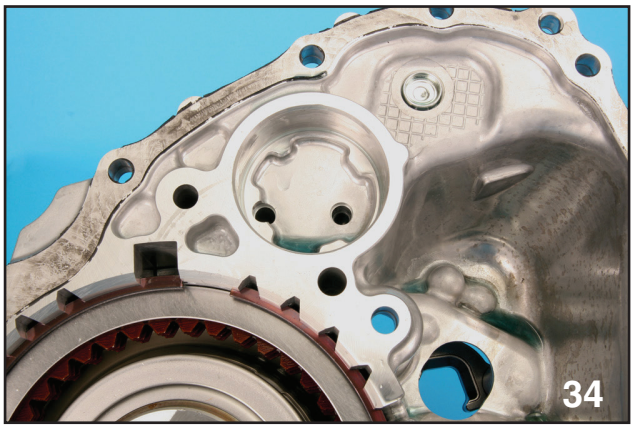
FRONT VIEW OF INTERMEDIATE CASE



OIL FILTER SEATED

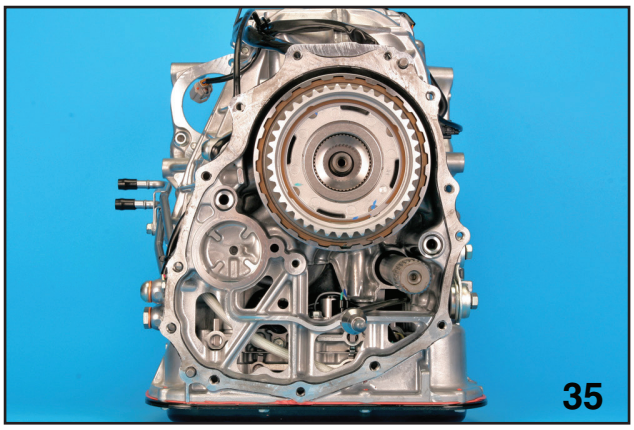


OIL FILTER UNSEATED

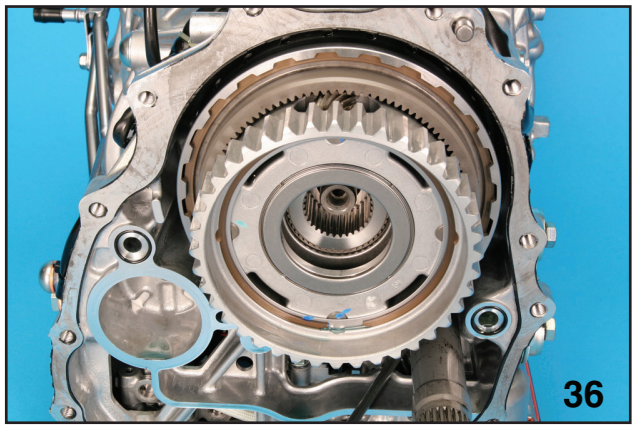


OIL FILTER SEAT IN INTERMEDIATE CASE

The front side of the intermediate case serves as a mount for the oil filter. The filter is equipped with a bypass valve. The reverse clutch is also mounted in the intermediate case and is applied only in reverse.



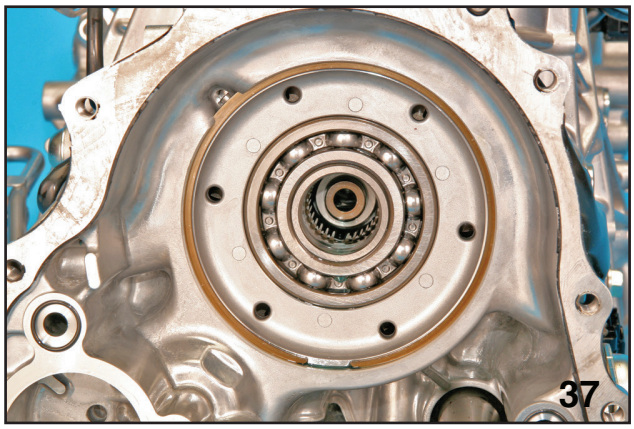
REAR VIEW OF TRANSMISSION CASE



FORWARD AND REVERSE CHANGEOVER MECHANISM

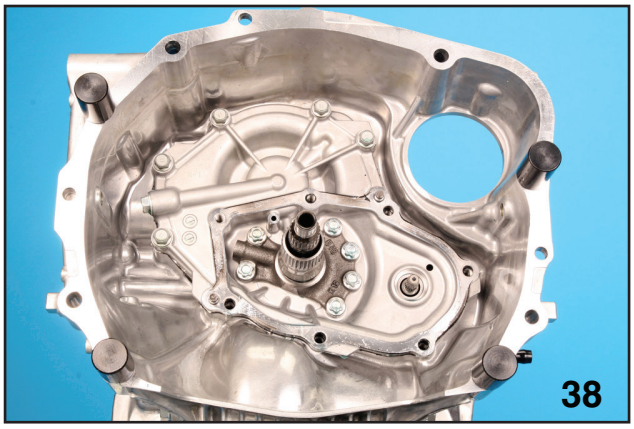
When applied the reverse clutch holds the planetary carrier stationary.

Remove the Forward/Reverse changeover mechanism. The planetary carrier first followed by the forward clutch/internal ring gear/sun gear assembly.



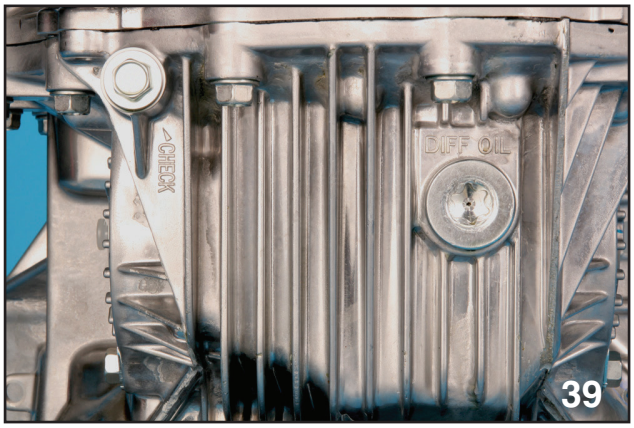
SPLINES OF THE SECONDARY REDUCTION DRIVEN GEAR

The forward clutch drum is splined to the secondary reduction driven gear.



TRANSMISSION STAND TOOLS INSTALLED

Install special tool **18632AA000** (MT-6 stands) to the converter housing and stand the transmission assembly on its end.



DIFFERENTIAL FLUID LEVEL INSPECTION PORT AND DIFFERENTIAL DRAIN

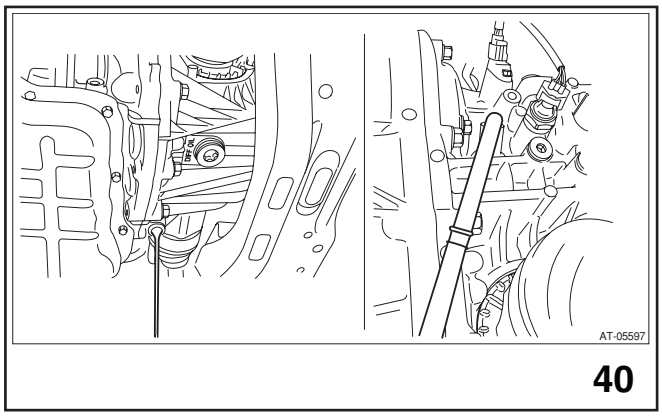
The differential is not equipped with a traditional dipstick. Fluid level is inspected by removal of the Check plug and the cross drilled passage that will leak if the fluid level is full.

NOTE ON NEXT PAGE!

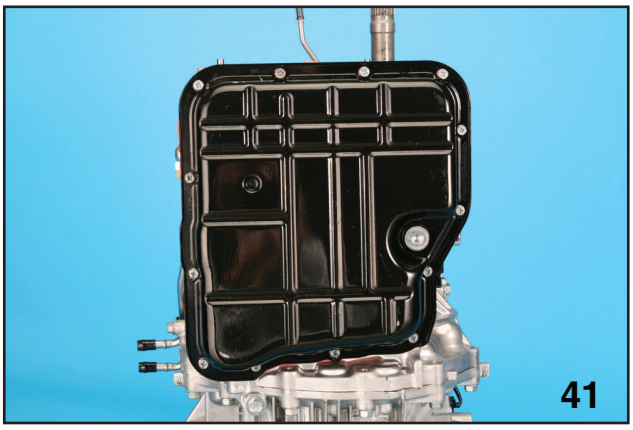
Note: Immediately after removing the overflow drain plug, remaining gear oil (approx. 8 cc) may come out of the overflow pipe. This is not included in the specified amount. When removing the overflow drain plug, make sure the gear oil flows out of the overflow drain plug hole by filling with gear oil.

When the flow of the differential gear oil turns into a narrow stream, install the overflow drain plug.

Note: Use a new gasket

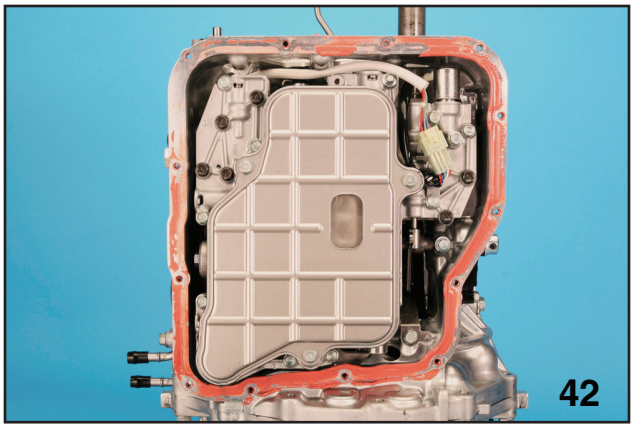


OVERFLOW DRAIN PLUG



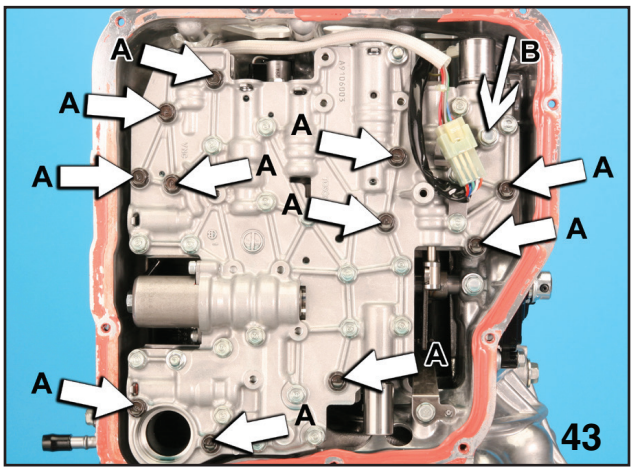
OIL PAN

Remove the oil pan.



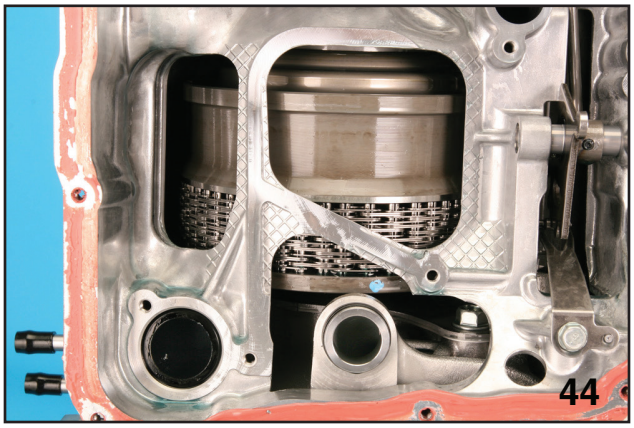
PICK UP SCREEN

Remove the pick up screen.

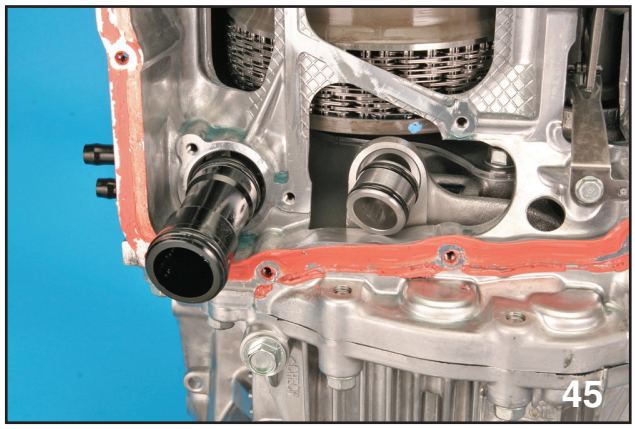


VALVE BODY MOUNTING BOLTS

Disconnect the valve body electrical connector and remove the indicated bolts. Secure the manual valve and remove the valve body from the transmission case.

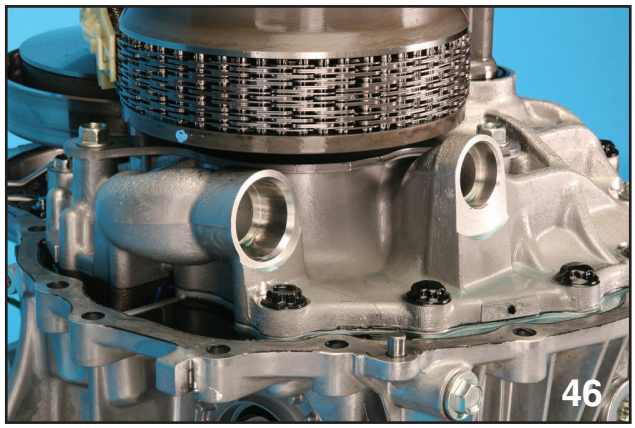


HYDRAULIC PIPES IN PLACE



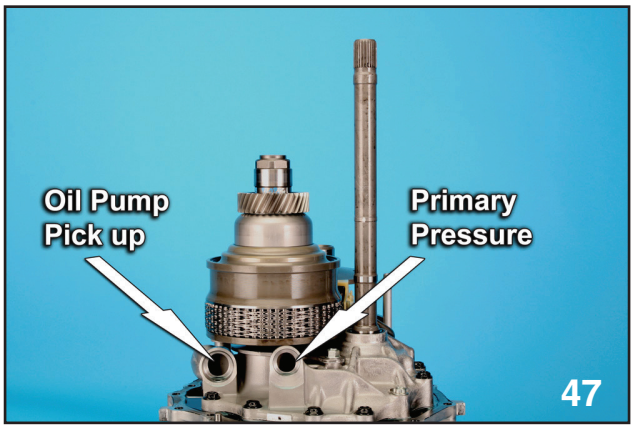
HYDRAULIC PIPES REMOVED

There are two hydraulic pipes that must be removed before the transmission case can be lifted off the converter case.

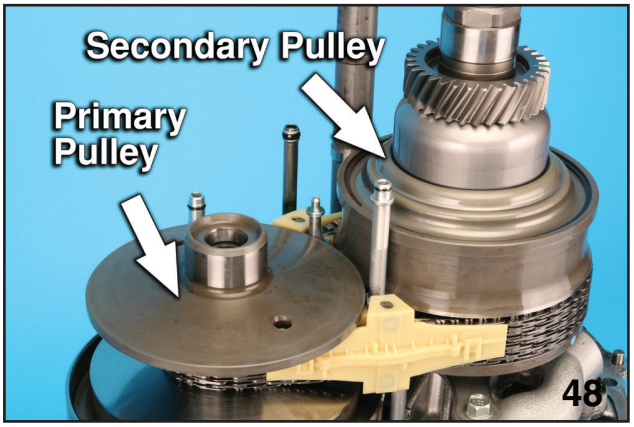


HYDRAULIC PIPES DELIVERY PORTS

Remove the two pipes and the bolts securing the transmission case to the converter housing.

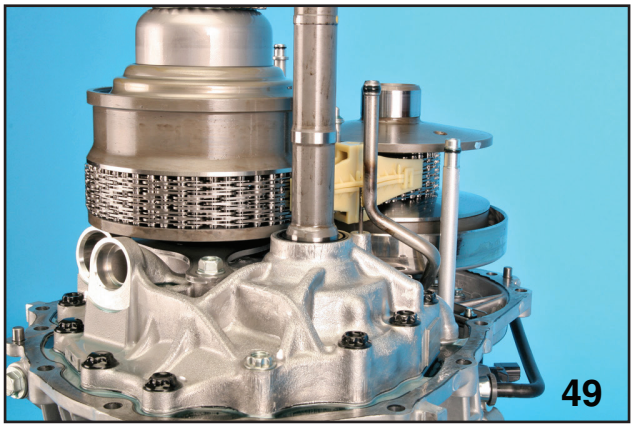


SECONDARY PULLEY AND PINION SHAFT

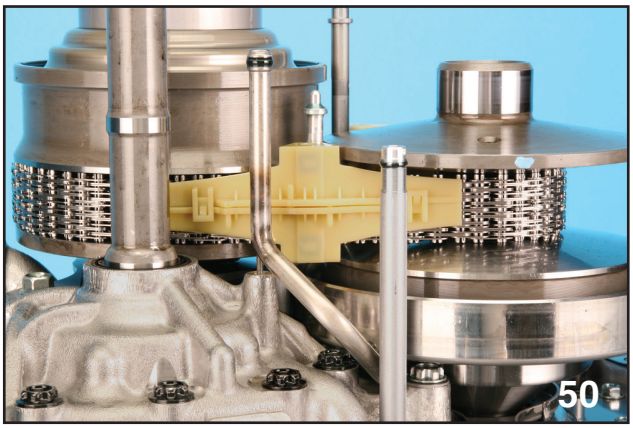


LUBRICATION PIPES AND CHAIN GUIDE

The drive pinion carrier is bolted to the converter housing and serves as a mounting for the Primary and Secondary pulleys.

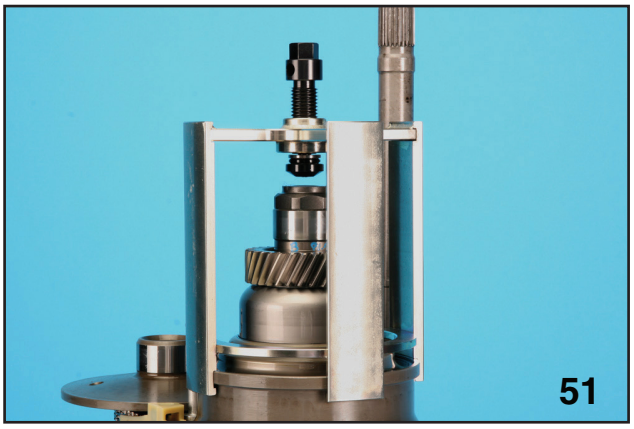


CHAIN GUIDE

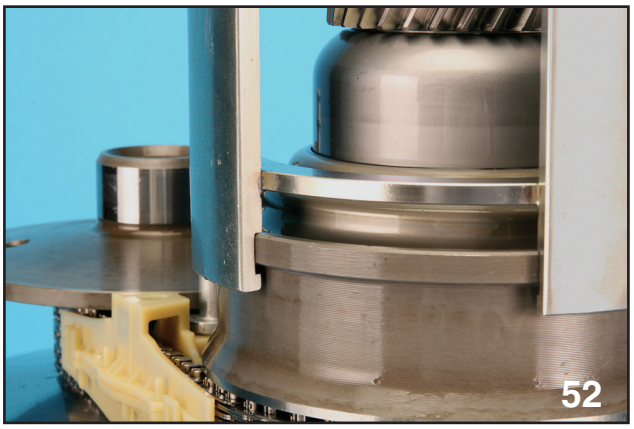


LUBRICATION PIPE SUPPORT

Two chain guides are installed over the chain and reduce vibrations. The guides follow the chain as the ratios change. The guide use a friction clamp to secure each clamp to a lubrication pipe on one side and a case support post on the other.

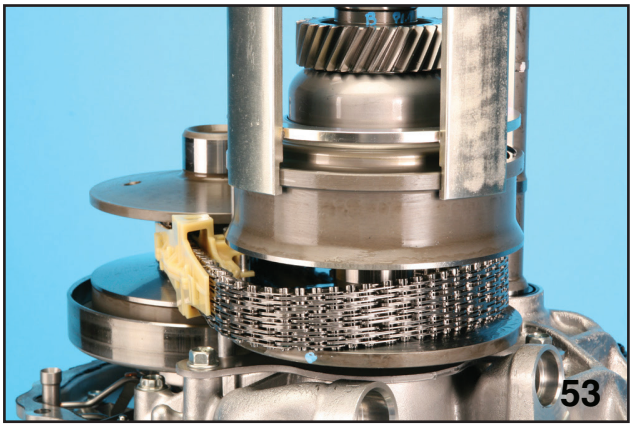


SECONDARY PULLEY RETURN SPRING COMPRESSOR



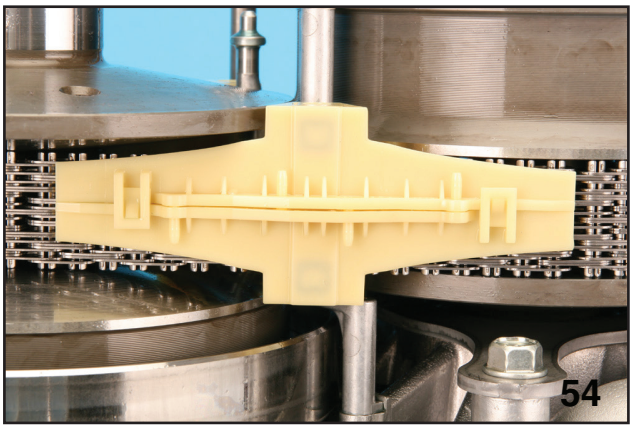
SPECIAL TOOL ENGAGEMENT POINT

Before the chain guides can be removed the tension of the return spring on the secondary pulley must be removed. Install special tool **18769AA000** to the secondary pulley.

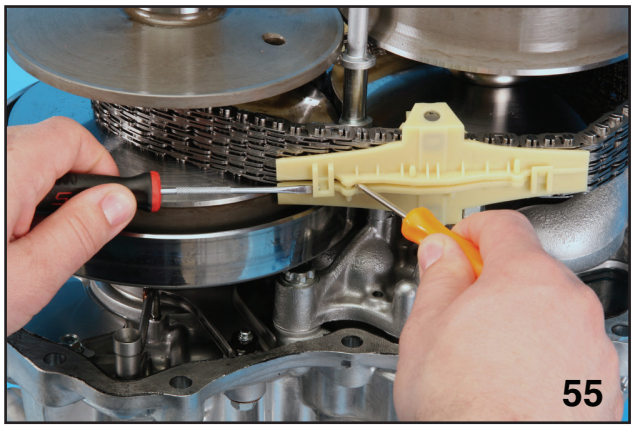


LOOSE CHAIN

Turn the tool clockwise until the tool has reached the end of the threads.



CHAIN GUIDE

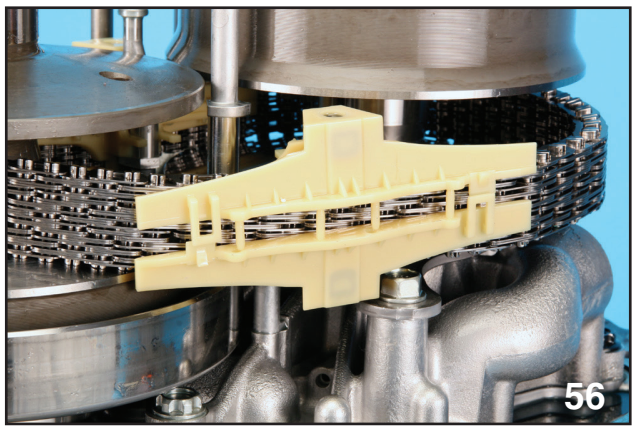


SEPARATING CHAIN GUIDE

Using two small screwdrivers unlock and separate the upper and lower side of the chain guides.

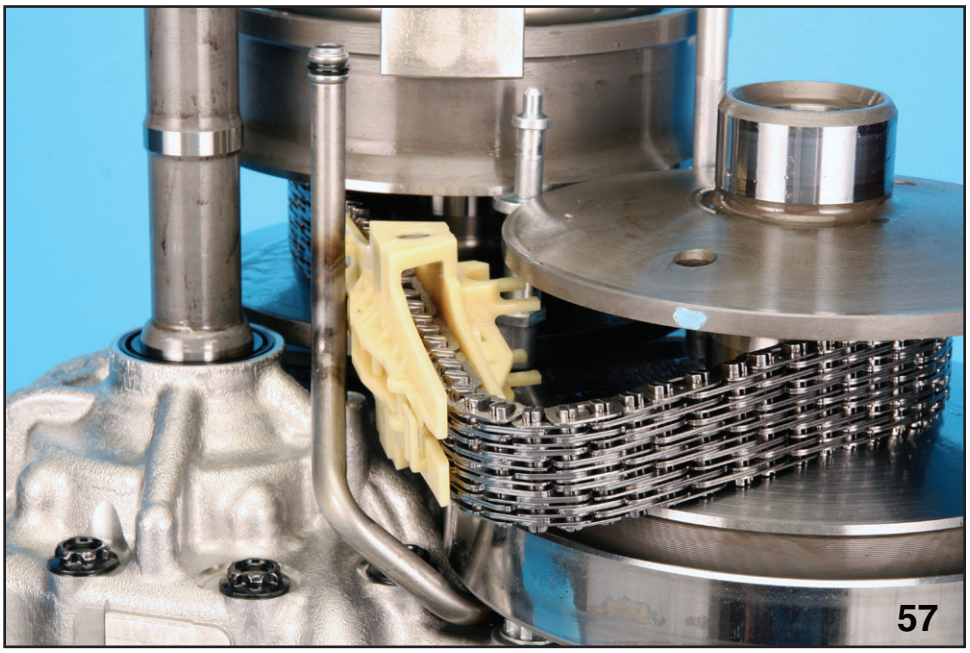
When removing the chain guides, one side engages with a lubrication pipe and will simply be lifted away. The chain guide that secures to a case support post must pass by a lubrication pipe.

Roll the loosened chain so that the chain guide on the side that mounts to the case support post can clear the lubrication pipe. Then remove the chain guide upper and lower halves.



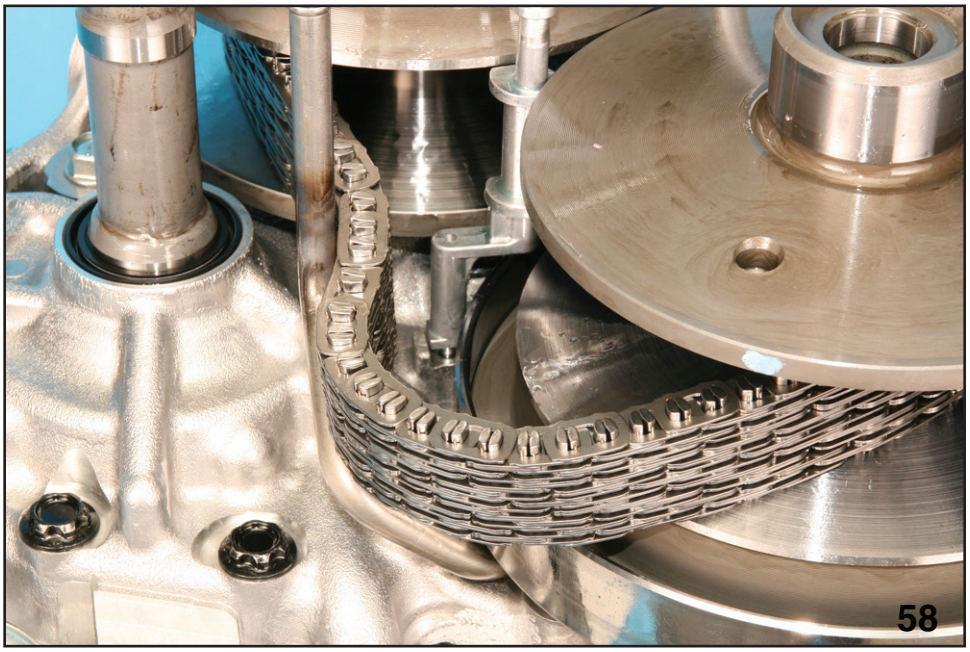
SEPARATED CHAIN GUIDE

NOTES:



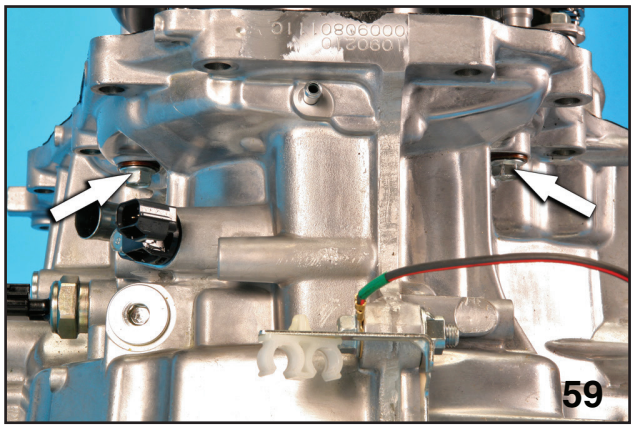
CHAIN POSITIONED FOR CHAIN GUIDE REMOVAL

Remove the two friction fit lubrication pipes and case support post.

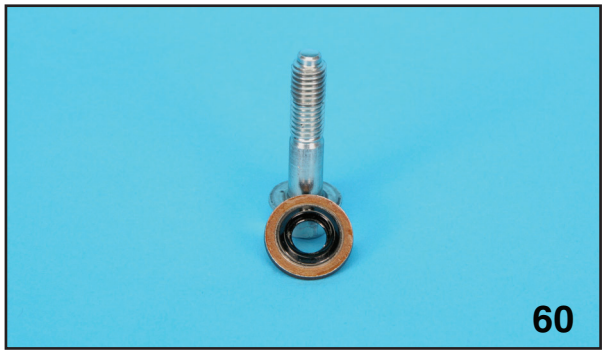


LUBRICATION PIPE REMOVAL

Remove the two secondary pulley mounting bolts.

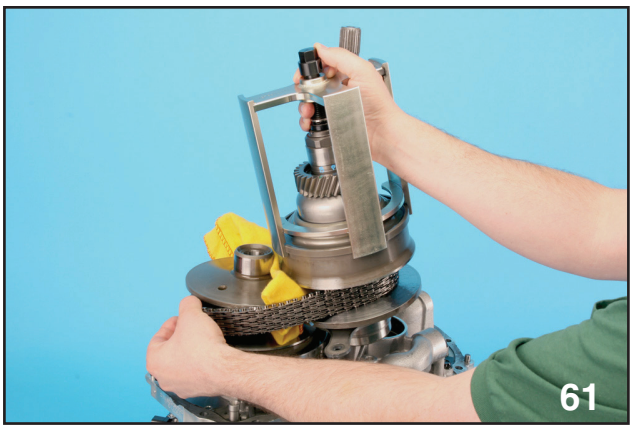


PRIMARY PULLEY MOUNTING BOLT LOCATIONS



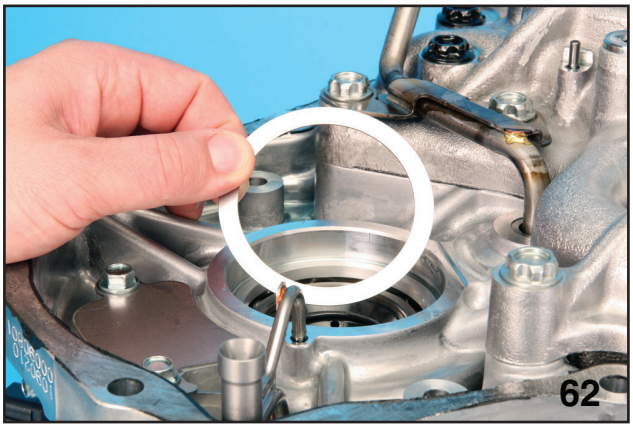
PRIMARY PULLEY MOUNTING BOLT SEALING WASHER

Remove the two Primary pulley mounting bolts. The Primary pulley mounting bolts use a rubber inlaid sealing washer and pass through the converter housing.



CHAIN AND PULLEY REMOVAL

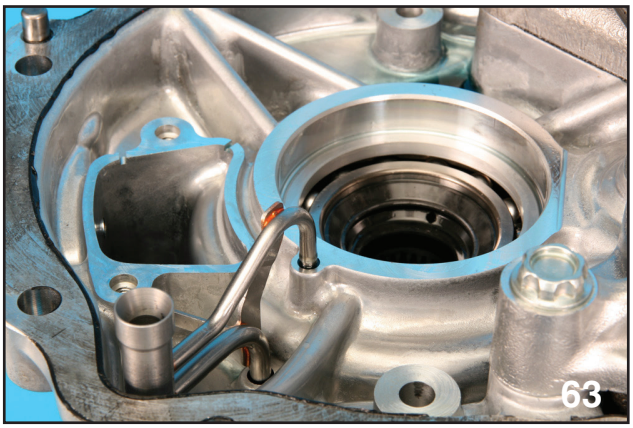
Place a lint free towel over the primary pulley. Pick up the secondary pulley and engage it over the stationary shell of the primary pulley. Lift the chain over the top side of the primary pulley for removal.



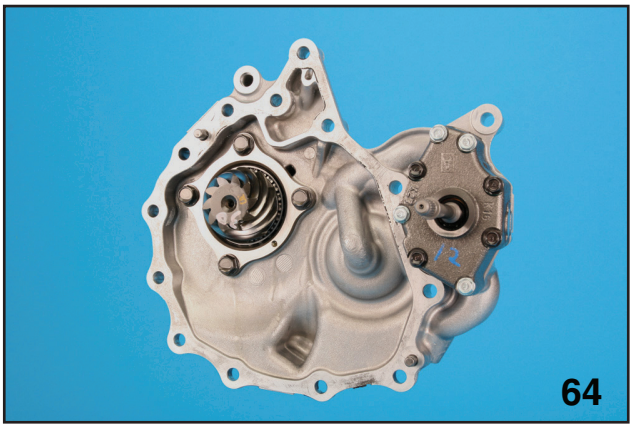
ALIGNMENT SHIM

An alignment shim is located under the bearing of the Primary Pulley.

The transmission vents through a plate and chamber. The external rubber vent hose connects to this chamber through a metal pipe. The bugle shaped pipe guides a lubrication pipe into place during assembly.

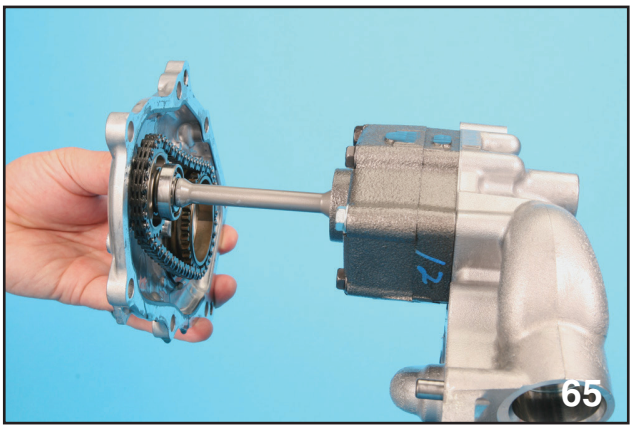


VENT CHAMBER

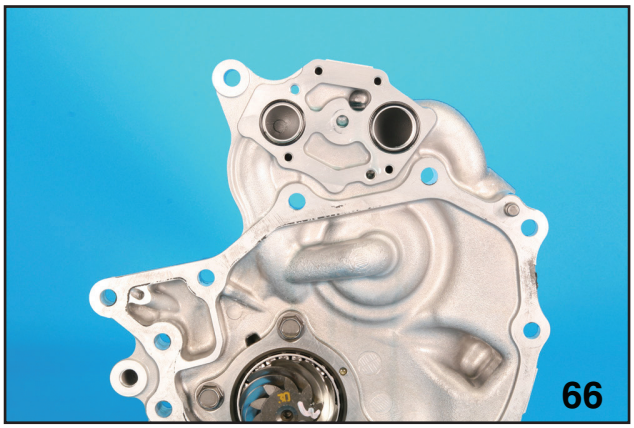


DIFFERENTIAL CARRIER

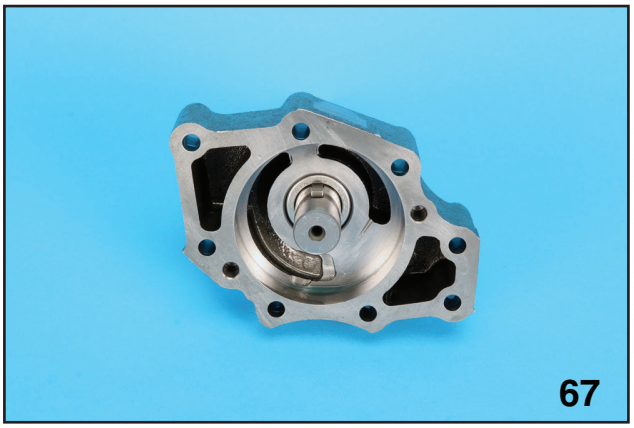
The oil pump is mounted to the differential carrier. The oil pump chain drive driven gear splines to the oil pump drive shaft.



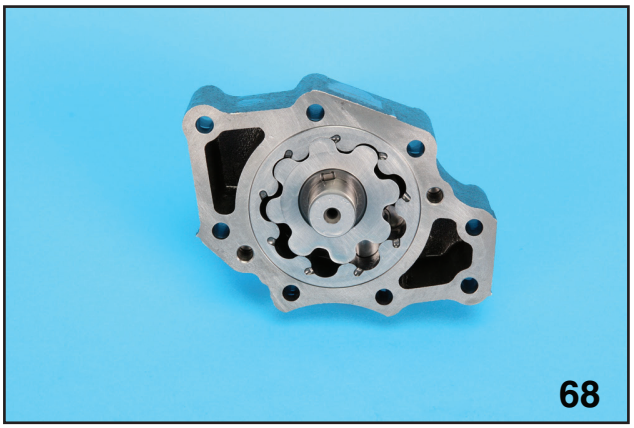
OIL PUMP WITH CHAIN DRIVE



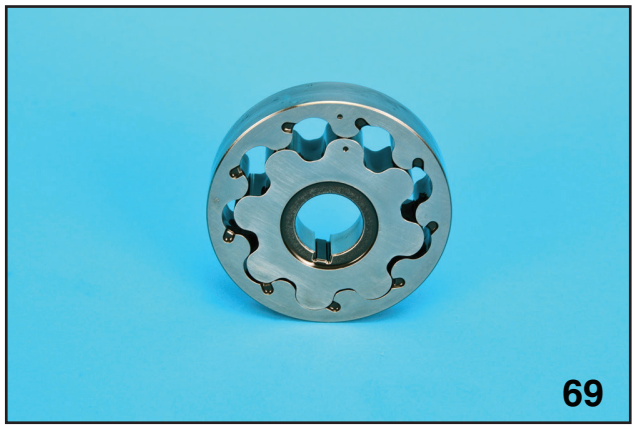
OIL PUMP REMOVED FROM DIFFERENTIAL CARRIER



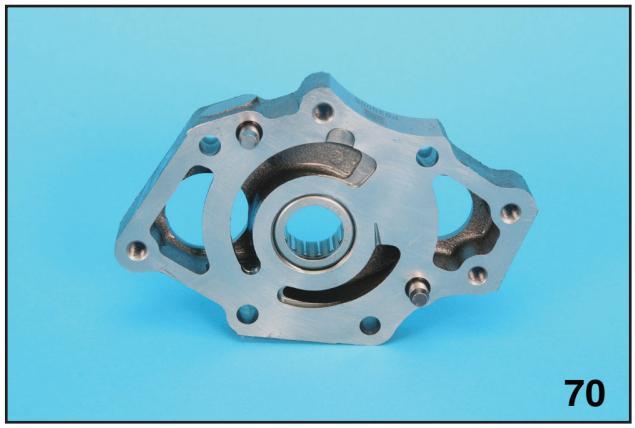
OIL PUMP HOUSING AND DRIVE KEY



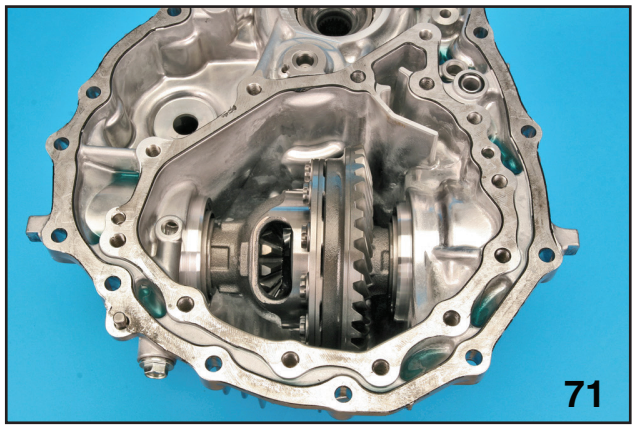
OIL PUMP GEARS IN HOUSING



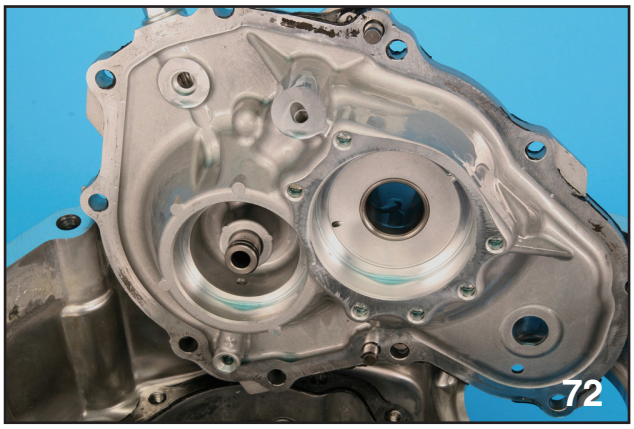
OIL PUMP ORIENTATION MARKS



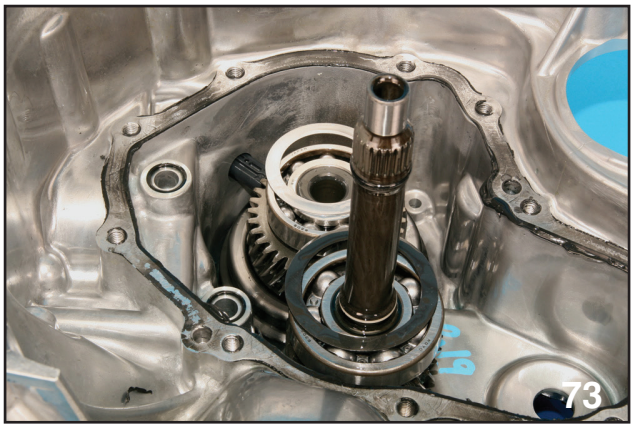
OIL PUMP HOUSING COVER



FRONT DIFFERENTIAL



BOTTOM VIEW OF INPUT CLUTCH COVER



INPUT SHAFT/PRIMARY REDUCTION DRIVE GEAR AND INPUT CLUTCH/PRIMARY REDUCTION DRIVEN GEAR

The transmission case houses the front differential drive retainer, primary pulley, secondary pulley, chain, inhibitor switch, secondary revolution sensor and control valve body.

The intermediate case serves as the mount for the CVT fluid fill and inspection port, Forward and Reverse clutch, secondary drive and driven reduction gears and parking mechanism.

The extension case contains the MPT clutch assembly and front wheel speed sensor.

POWER FLOW AND OPERATION

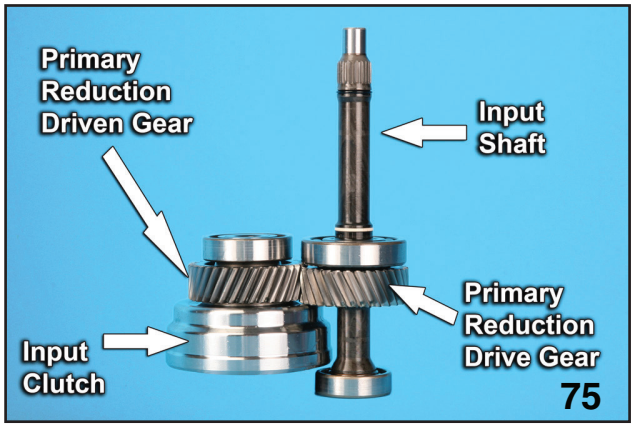
The input of power into the Lineartronic™ CVT is delivered from the engine by a lock-up torque converter. Converter Lock-Up can occur at a low vehicle speed and remains locked until below approx. 19 mph. A fully locked converter ensures all engine power inputs to the transmission and there is no wasted energy. This promotes fuel economy and efficient gear ratio control.

The turbine of the torque converter is splined to the input shaft.

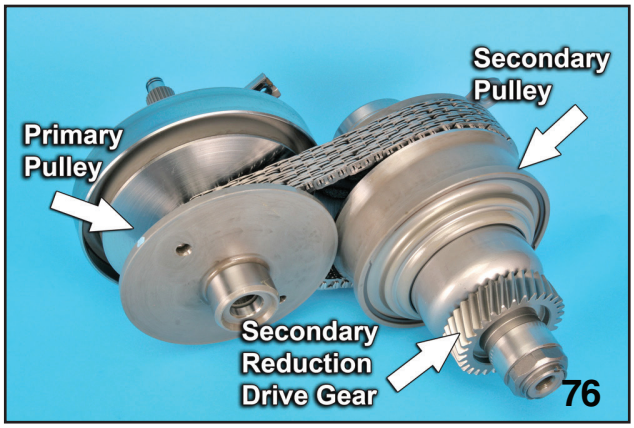
Power supplied to the input shaft is delivered to the primary reduction drive gear.

The primary reduction drive gear turns the primary reduction driven gear which is made onto the input clutch drum. (The shape and design of the CVT requires that power change direction multiple times so the reduction is split. After the final reduction the ratio is near that of a 4 speed automatic.) The Primary speed sensor reads the rotational speed of the primary reduction driven gear.

The splines of the primary pulley insert directly to the driven plates of the input clutch.

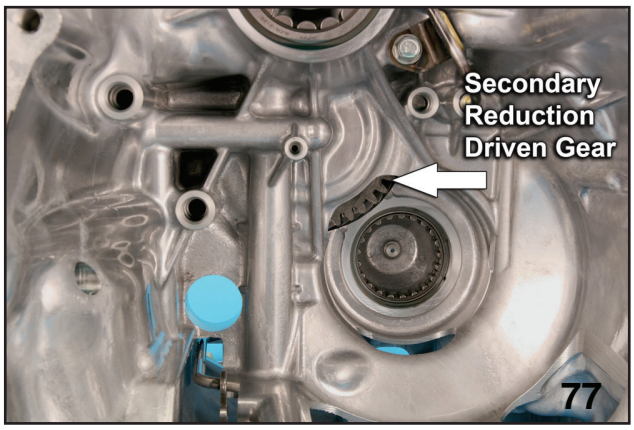


INPUT CLUTCH AND PRIMARY PULLEY



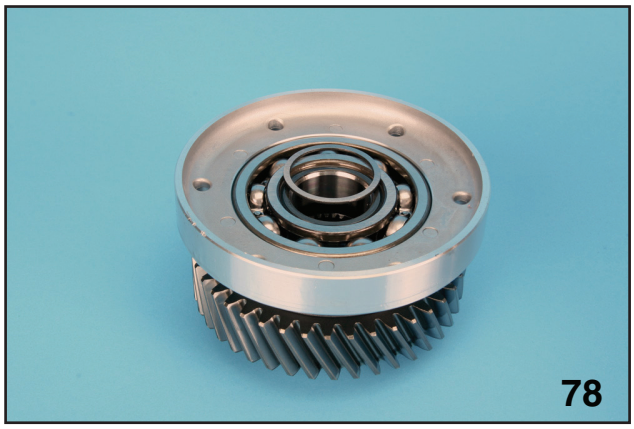
PRIMARY AND SECONDARY PULLEYS WITH CHAIN

The input clutch drives the primary pulley which in turn drives the secondary pulley and the secondary reduction drive gear via the drive chain.

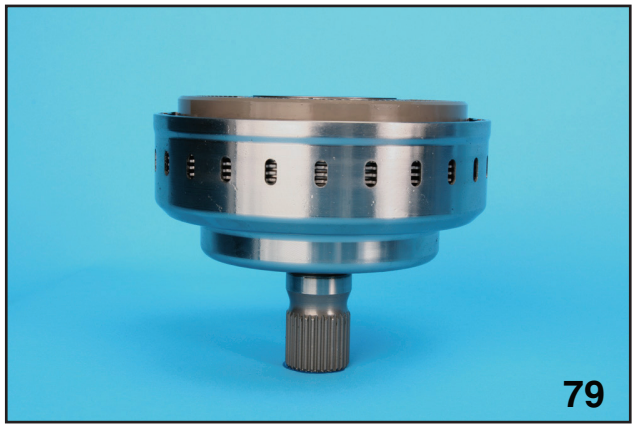


SECONDARY DRIVEN GEAR IN TRANSMISSION CASE

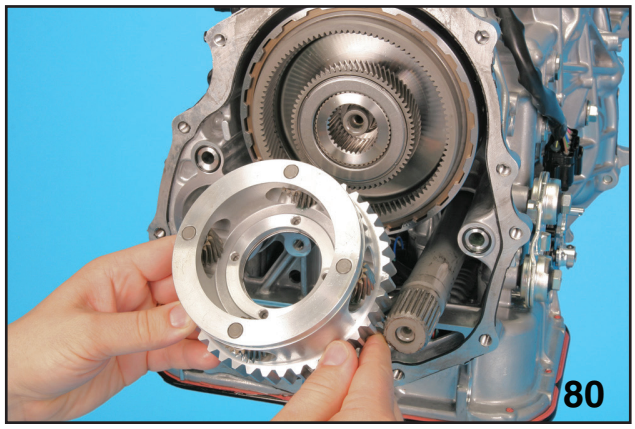
The secondary reduction drive gear rotates the secondary reduction driven gear which is splined to the forward clutch drum.



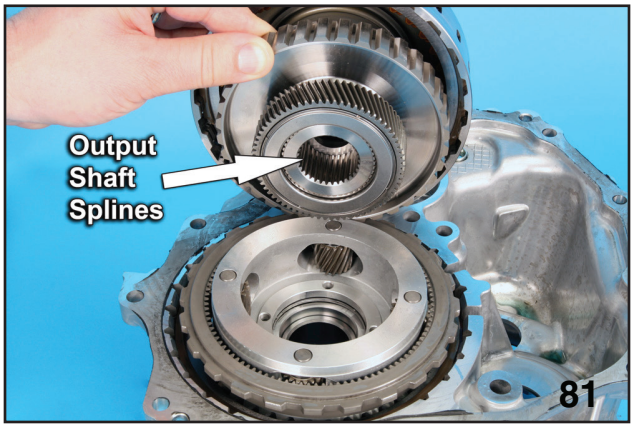
SECONDARY DRIVEN GEAR



FORWARD CLUTCH DRUM



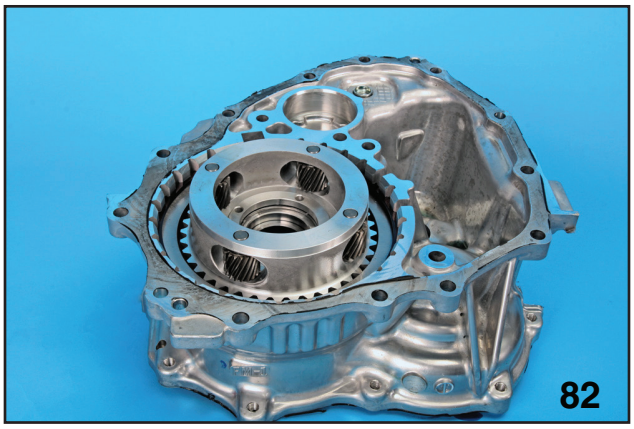
FORWARD CLUTCH AND PLANETARY CARRIER



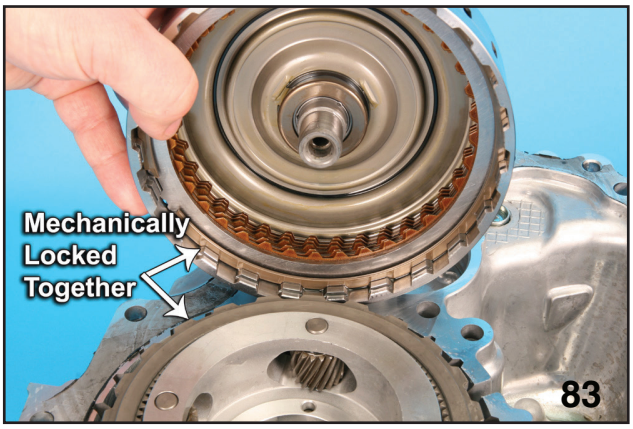
INTERNAL GEAR, TAKEN APART
FORWARD CLUTCH DRUM, AND SUN GEAR

The forward clutch drum houses the forward clutch. The sun gear has a set of splines that engage with clutch plates. When the transmission is in a forward gear range the forward clutch is engaged and locks the sun gear assembly to the forward clutch drum. This provides a one to one ratio to the transfer drive gear.

The internal gear is splined to the forward clutch drum. Whenever the forward clutch drum rotates, so does the internal gear. In a forward gear range the internal gear idles with the planet gears of the planetary carrier and does not perform any power transfer.



PLANETARY CARRIER AND REVERSE CLUTCH



FORWARD CLUTCH DRUM SHOWING ENGAGEMENT TO INTERNAL GEAR

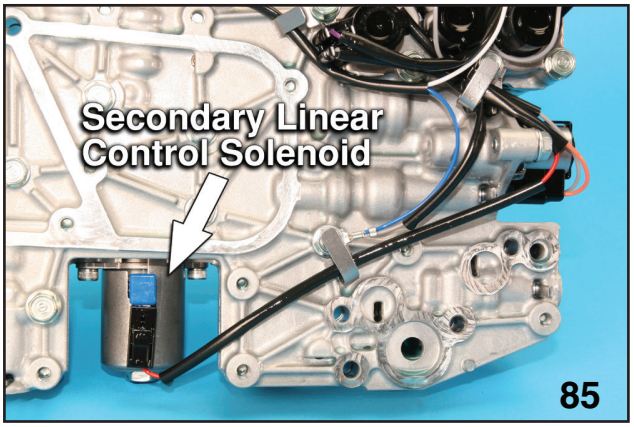
In reverse gear range the planetary carrier that is splined to the reverse clutch, is locked to the intermediate case and cannot rotate.

The internal gear rotating on the now stationary planet gears transfers power to the sun gear in an opposite direction.

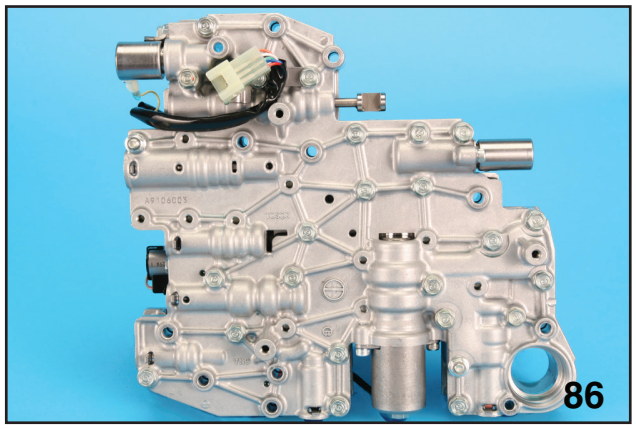
CONTROL VALVE BODY

Seven (7) Solenoids are located on the valve body to control the CVT.

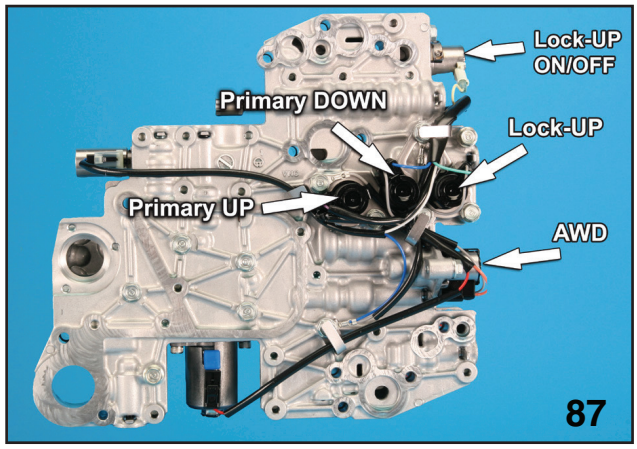
1. Lock-Up ON/OFF solenoid - Changes over the supply pressure to the torque converter between the lubrication pressure and the Lock-Up pressure.
2. Lock-Up duty solenoid - Adjusts the torque converter Lock-Up pressure.
3. Primary Up duty solenoid - Performs an Up ratio control
4. Primary DOWN duty solenoid - Performs Down ratio control.
5. F&R clutch linear solenoid Adjusts the Forward and Reverse clutch pressure.
6. AWD duty solenoid - Adjusts the transfer clutch pressure.
7. Secondary linear solenoid - Adjusts the line pressure.



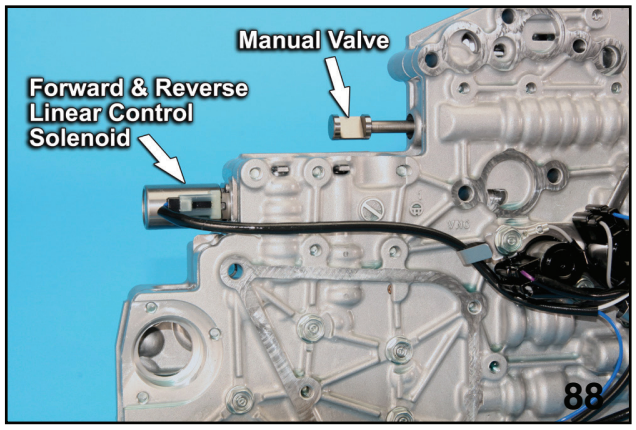
SECONDARY LINEAR CONTROL SOLENOID



VALVE BODY BOTTOM VIEW



VALVE BODY TOP VIEW



FORWARD AND REVERSE LINEAR CONTROL SOLENOID

Sensors and Switches

1. Secondary Hydraulic Pressure Sensor - Detects the pressure of the secondary hydraulic circuit.
2. Front Wheel Rotation Sensor - Detects the front wheel speed. (Transfer Driven gear).
3. Secondary Rotation Sensor - Detects the secondary pulley rotation speed. (Secondary Reduction Driven gear).
4. Primary Rotation Sensor - Detects the primary pulley rotation speed. (Primary reduction Drive gear).
5. ATF Oil Temperature Sensor - Detects the ATF temperature.
6. Inhibitor Switch - Enables engine start when the select lever is set at P or N. • Detects the shift position.

NOTE: Turbine Revolution speed is a calculated value using the Primary Revolution Sensor and engine speed

During the time while the engine is being started, the rotational speed of the oil pump is not fast enough to provide sufficient oil pressure to engage the input clutch. While this condition exists the transmission provides no resistance to engine start.

After combustion begins and the engine speed crosses 400 RPM, the Primary and Secondary pulleys are charged and then the Input Clutch engages. This ensures the pulleys cannot move until the tension pressure on the chain has been established. As the Input Clutch engages and engine power is delivered to the rotational components of the transmission.

As the pressure increases the tension chamber of the Primary and Secondary Pulleys are charged and a clamping force of 1 GPA or 145,000 p.s.i. on the chain is established. This force prevents chain slippage and ensures that the attitude of the chain is maintained throughout all gear ratios.

In temperatures below -22°F (-30°C) the viscosity of the transmission oil would prevent proper transmission operation. This condition is controlled by the design of the input clutch. The all steel drive and driven plates, at this low temperature, will slip against each other and prevent the engines total power from transferring to the rotational parts of the transmission. The slipping action increases the temperature of the oil and as the viscosity of the oil lowers, the degree of engine power flowing into the transmission increases.

The Primary and Secondary pulleys each have one moveable half or shell that allows the ratios to change. The Primary pulley shell is on the forward end of the transmission and the secondary shell is towards the rear. This design ensures proper chain movement and reduces the number of parts necessary to achieve all gear ratios. Additional control towards low ratio is provided by a return spring built inside the Secondary Pulley.

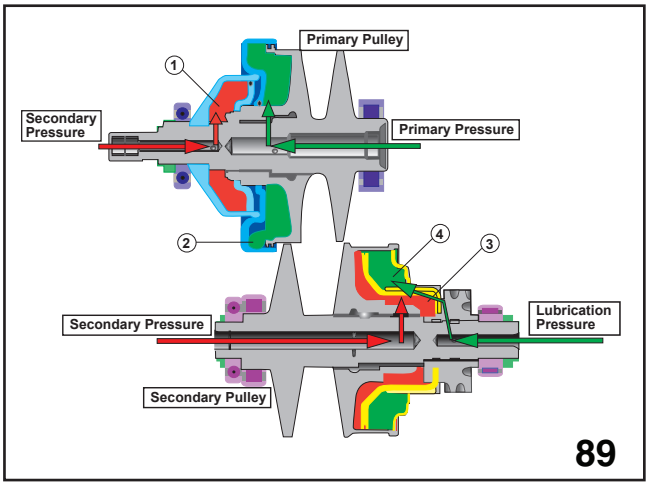
The pressure that creates the force to change ratios is named Primary Pressure. Primary Pressure is delivered to the Primary pulley shell. As the primary pressure increases the gear ratio decreases (Moves towards overdrive). Primary pressure applied to the Primary Pulley pushes the shell closed, forcing the chain to ride higher up on the pulley.

The rotating chain driven by the primary pulley delivers power to the secondary pulley by pulling. During ratio control to overdrive the chain is squeezed to ride on the outer circumference of the primary pulley. The chain during ratio control to overdrive, pulls the secondary pulley apart. This forces the chain to ride on the inner circumference of the secondary pulley.

During ratio control to higher gear ratios the primary pressure is drained and the tension of the return spring pushes the secondary shell closed. The chain now riding higher on the Secondary Pulley pulls the Primary Pulley shell open, creating a higher gear ratio.

The gear ratio is maintained when primary up and down ratios are balanced with the force of the return spring.

Number of moving parts



PULLEY (ARTWORK)

The Primary Pulley has a ratio chamber and a tension chamber. Pressure applied to the ratio chamber forces the moving shell to overdrive. The tension chamber would do this also but its force is cancelled out by the tension chamber of the Secondary Pulley that pushes the Secondary Pulley moving shell to low ratio. This balanced force does not influence gear ratio. Its only purpose is to clamp the chain.

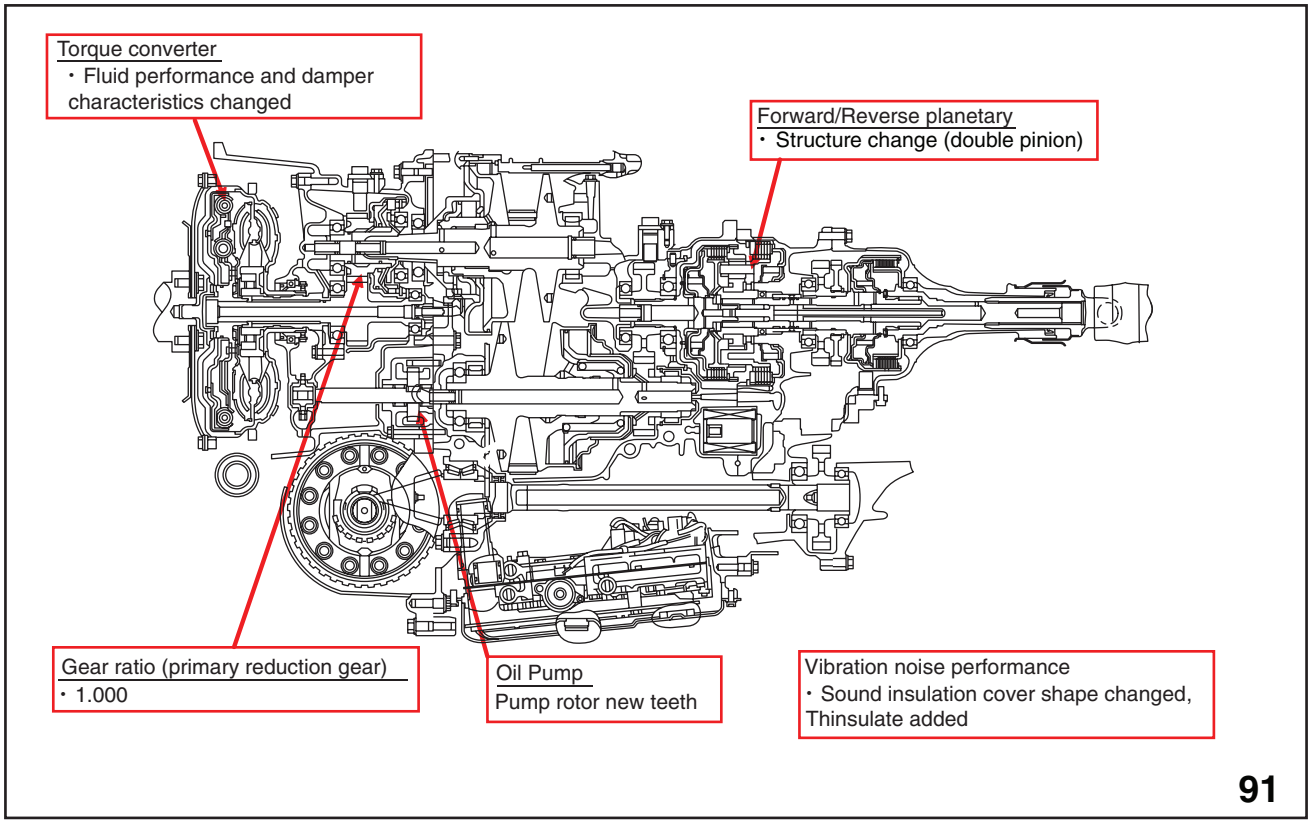
2015 CVT G1 / TR690 ENHANCEMENTS

Lineartronic Continuously Variable Transmission High-torque Generation 1 (CVT G1/TR690)

Introduction

The High-torque CVT Generation 1 is equipped on all EZ 3.6 models for 2015 Legacy and Outback models.

Note: The High Torque CVT G1 (TR690) still uses the orange colored CVT-High Torque fluid. Do not mix this fluid with any other varieties.

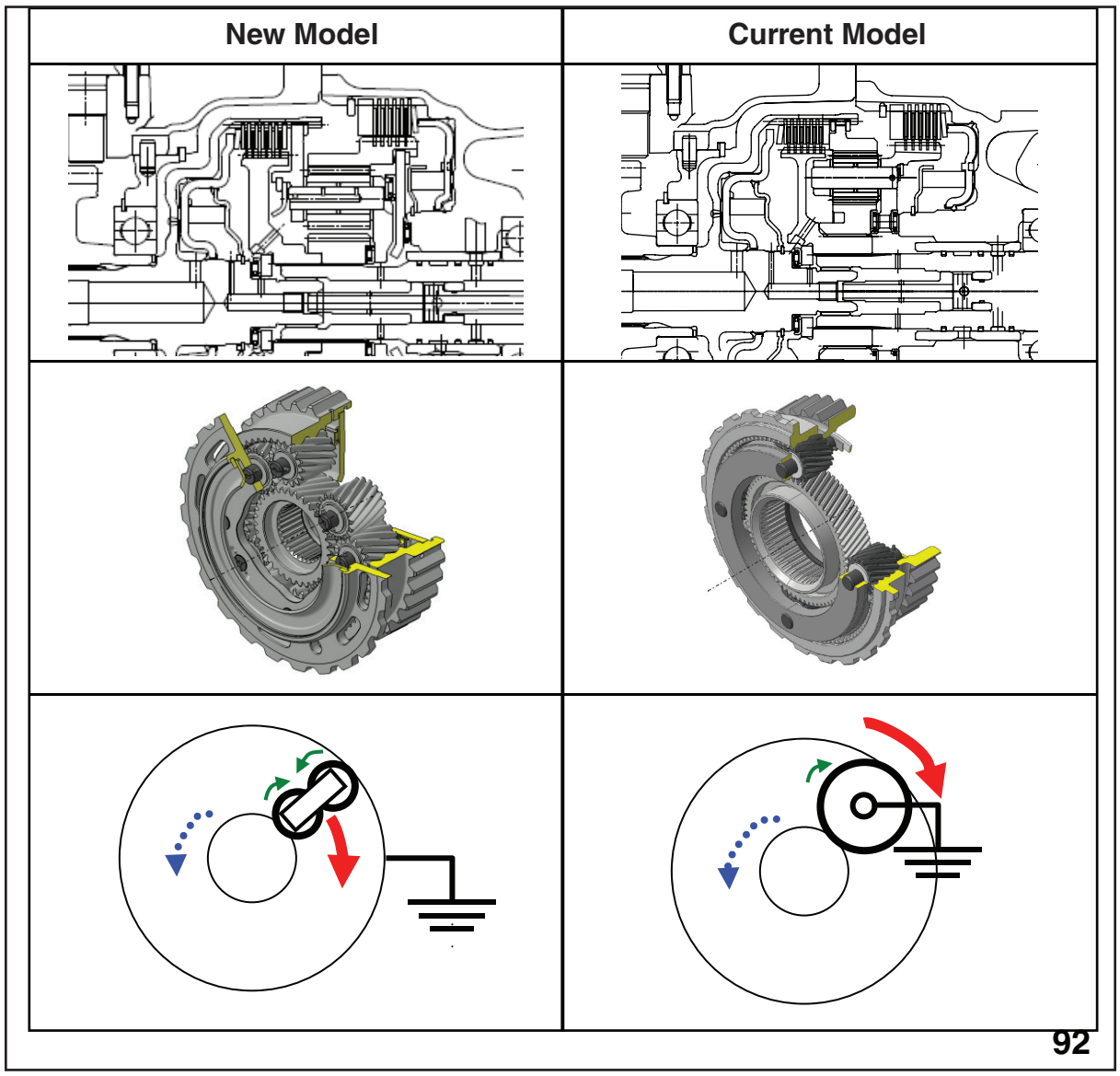


HIGH TORQUE CVT G1 (TR690) ENHANCEMENTS

Forward & Reverse Changeover mechanism

The F&R Changeover has been redesigned to improve vehicle performance in the Reverse range. Internally, the planetary gear set after the secondary pulley has been reconfigured with different input, output, and fixing members.

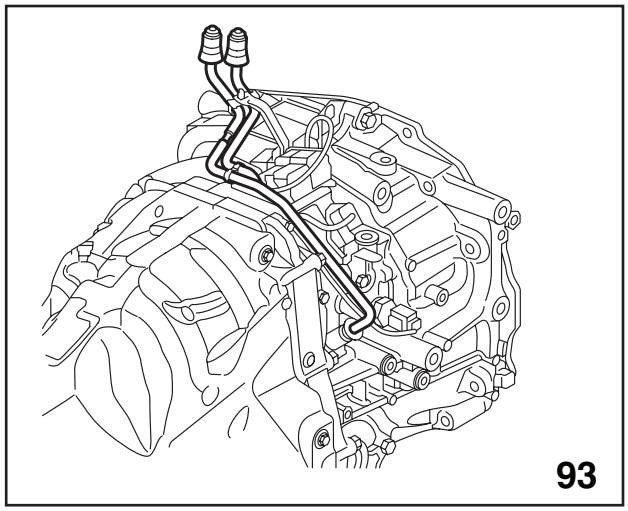
Reverse gear	2015 TR690	2014 TR690	Reference TR580
Input	Planetary carrier	Internal gear	Sun gear
Output	Sun gear	Sun gear	Planetary carrier
Fixing	Internal gear	Planetary carrier	Internal gear
Reverse gear ratio	0.972	0.669	1.024
Planetary carrier type	Double pinion	Single pinion	Double pinion



FORWARD AND REVERSE CHANGEOVER COMPARISON

Vent

Similar to the G2 CVT, the vent lines have been redesigned for the High-torque G1 CVT. In comparison, the High-torque G1 CVT uses 2 breather lines and caps.



CVT VENT LINE

TCM

The TCM on High-torque CVT G1 models is located on the passenger side of the engine compartment. It uses the same SST Check Board Harness for electrical diagnostics.

TCM LOCATION

FAIL-SAFE

Note: Most fail-safe results will remain in effect after a problem corrects itself until the ignition key is cycled.

BEFORE READING FAIL-SAFE: THE BOLD-UNDERLINED TEXT IS THE RESULT OF OPEN CIRCUIT FAILURES. SHORT TO GROUND FAILURES MAY PRODUCE DIFFERENT RESULTS.

Fail-Safe Function

The new Lineartronic™ CVT performs diagnoses to the following devices in order to secure safety and minimum drivability upon a trouble.

If trouble is detected, it makes the AT OIL TEMP light flash at 2 Hz cycles and allows the user to retrieve DTC by SSM III and identify the trouble point easily.

1. PRIMARY ROTATION SENSOR

If trouble occurs with the primary rotation sensor, the Lineartronic™ CVT continues the control according to the engine speed value during torque converter Lock-Up or the secondary rotation sensor value when the torque converter Lock-Up is off.

No driveability issues result.

2. SECONDARY ROTATION SENSOR

If trouble occurs with the secondary rotation sensor, the Lineartronic™ CVT continues the control according to the front wheel rotation sensor value.

No driveability issues result.

3. FRONT WHEEL ROTATION SENSOR

If trouble occurs with the front rotation sensor, the Lineartronic™ CVT continues the control according to the secondary rotation sensor value.

No driveability issues result.

Note: All three Rotation Speed Sensors are Hall Effect type and require power to operate. All three receive power from a single fuse. If Rotation Speed Sensor power supply is lost the displayed gear ratio on the SMIII is not accurate. There will be a slipping feeling results from the vehicle starting in an overdrive gear ratio and the operation of the torque converter to prevent stalling. The TCM cannot judge actual gear ratio with loss of all speed sensors. Driveability results will be a slipping feeling during initial take off and a stair stepping up ratio on full throttle acceleration after the vehicle has achieved some vehicle speed. The TCM will use the vehicle speed signal in the CAN communication to perform the down and up gear ratio control. The vehicle will start off in overdrive and upon reaching a forward vehicle speed of 2 to 5 mph a down ratio occurs followed by up ratios dependant on the received CAN vehicle speed signal.

This will not occur in reverse gear so a nose down, down hill grade, dependant on vehicle load and down hill angle, may result in may result in no vehicle movement. (Fixed overdrive ratio is almost maximum).

4. SECONDARY HYDRAULIC PRESSURE SENSOR

If trouble occurs with the Secondary Hydraulic Pressure Sensor, the Lineartronic™ CVT stops the pressure feedback control and performs an open loop control.

A delayed down ratio at coasting may result.

5. SECONDARY LINEAR SOLENOID

If trouble occurs with the Secondary Linear Solenoid, the Lineartronic™ CVT stops the solenoid driving current supply, providing a mechanical maximum hydraulic pressure for the secondary pressure.

Higher engine speeds will be present during driving as a result of no torque converter Lock-Up. Some engagement shock will occur when going into Drive or Reverse.

6. F & R CLUTCH LINEAR SOLENOID

If trouble occurs with the F & R Clutch Linear Solenoid, the Lineartronic™ CVT stops the solenoid driving current supply, providing a maximum hydraulic pressure corresponding to the secondary pressure for the F & R clutch pressure.

Engagement shock when going into Drive or Reverse, tighter or binding in turns and more aggressive down ratios will result.

7. PRIMARY UP and DOWN DUTY SOLENOIDS

If trouble occurs with the Primary UP or DOWN Duty Solenoid, the Lineartronic™ CVT stops the driving control for each solenoid sequentially to provide a speed change ratio that allows vehicle travel at minimum.

Primary Up solenoid failure results in no ratio control towards overdrive. Gear ratio calculation includes the speed of the torque converter. An unlocked torque converter causes the gear ratio to go lower (2.24 to 1.90) Locked converters carry the gear ratio more towards overdrive.

Primary Down solenoid failure results in a fixed gear ratio to overdrive. Initial acceleration at take off results in a slipping feeling. This is caused by the torque converter operation. There is no torque converter Lock-Up when a primary down solenoid failure exists.

8. Lock-Up DUTY SOLENOID

If trouble occurs with the Lock-Up duty solenoid, the Lineartronic™ CVT stops the solenoid driving control and inhibits any Lock-Up.

Higher engine speeds will occur while driving and overdrive gear ratio will be lower. Gear ratio will not be calculated using the turbine sensor when 8 or 9 are present.

9. Lock-Up ON/OFF SOLENOID

If trouble occurs with the Lock-Up ON/OFF solenoid, the Lineartronic™ CVT stops the solenoid driving control and inhibits any Lock-Up.

Higher engine speeds will occur while driving and overdrive gear ratio will be lower. Gear ratio will not be calculated using the turbine sensor when 8 or 9 are present.

10.AWD DUTY SOLENOID

If trouble occurs with the AWD duty solenoid, the Lineartronic™ CVT stops the solenoid driving control and creates a front wheel drive status.

11. ATF OIL TEMPERATURE SENSOR

If trouble occurs with the ATF oil temperature sensor, the Lineartronic™ CVT continues the control by assuming the specified oil temperature.

The ATF temperature light will not flash to indicate a problem until the vehicle is driven. The ATF light will not flash after the ignition key has been turned off and back on until the vehicle is driven again.

Each cycle will first indicate a problem exists with an engagement shock going into drive or reverse. While driving before the ATF temperature flashes the gear ratio will be in a mid range and not low enough to provide proper acceleration. This creates a slipping feeling. A steep down hill slope will result in no reverse.

The vehicle will go to proper gear ratios after the ATF temperature light flashes.

12.INHIBITOR SWITCH

If no input or multiple input occur consecutively in the TCM input circuit, the Lineartronic™ CVT continues the control by selecting a range according to the following priority order.

D R N P

Engagement shock will occur when shifting into Drive or Reverse.

13.MANUAL SWITCH

If an ON failure is detected for the manual switch, the Lineartronic™ CVT inhibits the manual mode.

14.HIGH-SPEED CAN COMMUNICATION

The new Lineartronic™ CVT exchanges information with various control modules including the engine control system via. the high-speed CAN communication and constantly checks the reliability of communication by monitoring the incoming information mutually. If TCM detects a CAN communication error in the CAN communication line or any system, it continues the control by replacing the data necessary for transmission control with the appropriate backup values.

Vehicle will exhibit binding on turns, banging sound and feeling from rear end as transfer duty jumps from approx. 40% to 100%.

A feeling of delayed coasting.

15.SELF-SHUT RELAY

If the TCM self-shut relay is not activated due to a malfunction even when the ignition switch is ON, the transmission goes to a no-control state because it cannot supply power to each solenoid. Even in this case, TCM makes the AT OIL TEMP light flash via. the CAN communication to alert the driver to the malfunction.

Vehicle will exhibit a slipping feeling, a delayed coasting after releasing the gas pedal and maybe unable to move in reverse when facing downhill on a steep incline. Transmission fluid smell at 225°F (107°C).

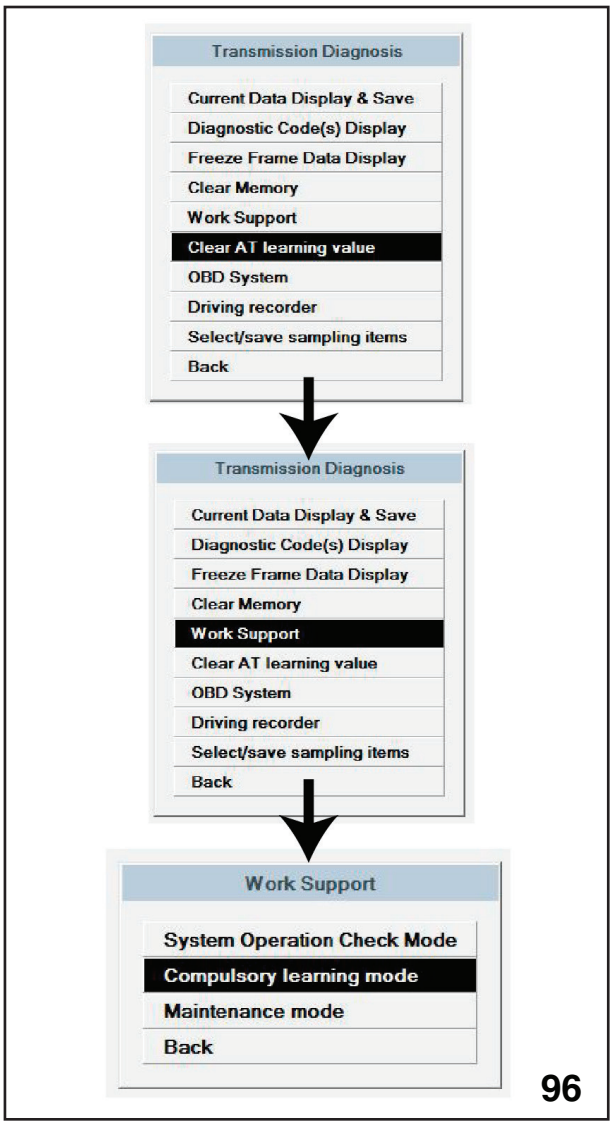
Fluid Level Inspection
(Only if external signs of leakage are present or during scheduled maintenance.)

1) Start the engine and wait until Subaru Select Monitor indicates a Lineartronic™ CVT fluid temperature of 86~104°F (30°~40°C)
2) Lift up the vehicle.
3) Move the select lever from P to R, then to N and finally to D, afterwards again from D to N, next to R, and finally to P, while the engine is idling, to make the Lineartronic™ CVT fluid is circulating within the transmission.
4) Lift up the car, with the engine ON and remove the filler plug.

Attention:
Because the engine is in idling condition, please be sufficiently careful during checking the fluid level.

(Subaru CVT fluid 86°F (30°C)	
Exchange cycle	No replacement, except under severe conditions (Frequent towing)
Fluid quantity L US qt., Imp qt.	11.3~11.8 (11.9~12.5, 9.9~10.4)

There are 4 special procedures of the Lineartronic™ CVT that can be performed with the SMIII.



COMPULSORY LEARNING MODE

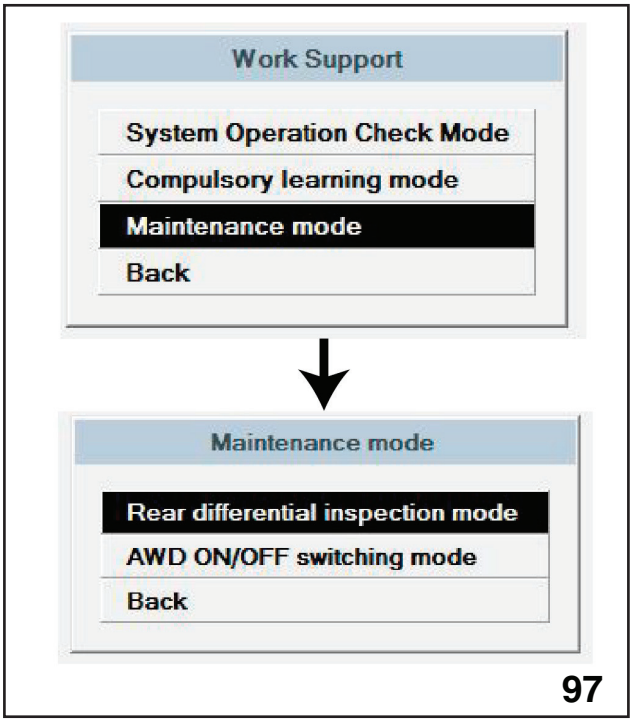
Perform Compulsory learning mode when any of the below have been preformed.

- Clear memory 2/Clear AT Learning Value
- Changing the CVT fluid
- Changing the TCM
- Changing the transmission
- Changing the control valve body

Note: All learning procedures for the CVT must be performed with the vehicle elevated on a lift.

Note: All Rear Differential Inspection procedures for the CVT must be performed with the vehicle elevated on a lift.

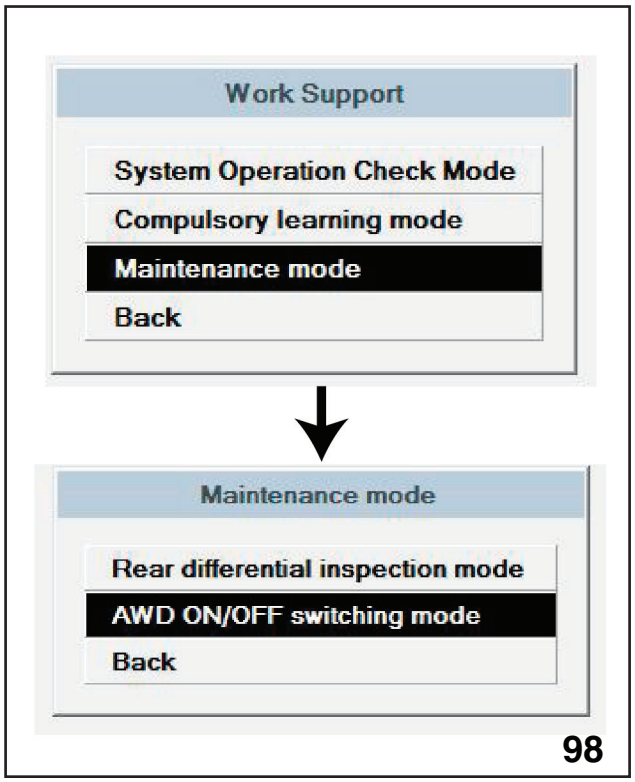
Note: Cycle the ignition key to off after Compulsory Learning mode. This will complete the learning process.



REAR DIFFERENTIAL INSPECTION MODE

- Rear differential replacement

Perform rear differential inspection mode after the rear differential has been replaced or to check for an installed incorrect rear differential.

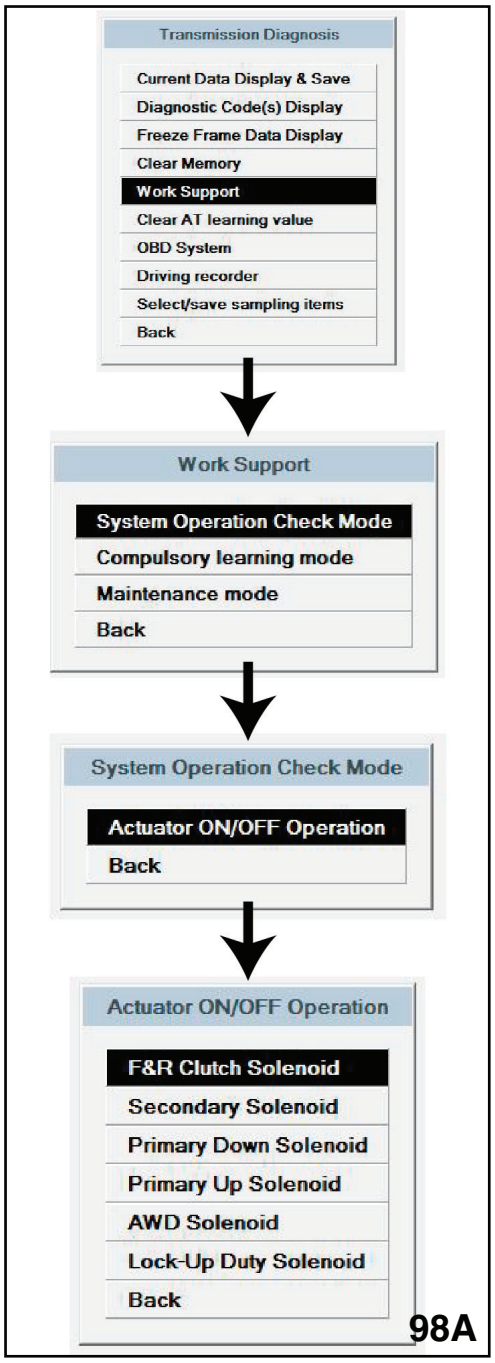


AWD ON/OFF SWITCHING MODE

- Perform AWD ON/OFF switching mode when performing AWD related diagnostics.

NOTE: Return vehicle to AWD after repair or diagnosis.

Note: All procedures must be performed as indicated on the SMIII screen.



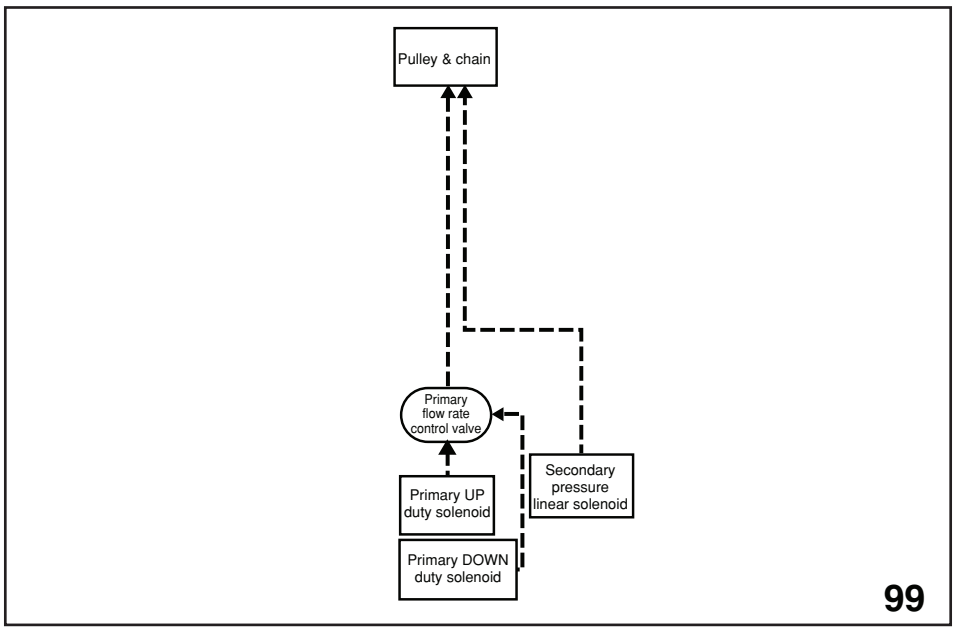
ACTUATOR ON/OFF OPERATION

- Actuator ON/OFF Operation can be used to aid in electrical diagnosis of the individual control valve solenoids.

NOTE: Make sure the engine is not running when performing any Actuator ON/OFF functions.

NOTE: After performing any Actuator ON/OFF functions, perform a clear memory.

Normal Operation

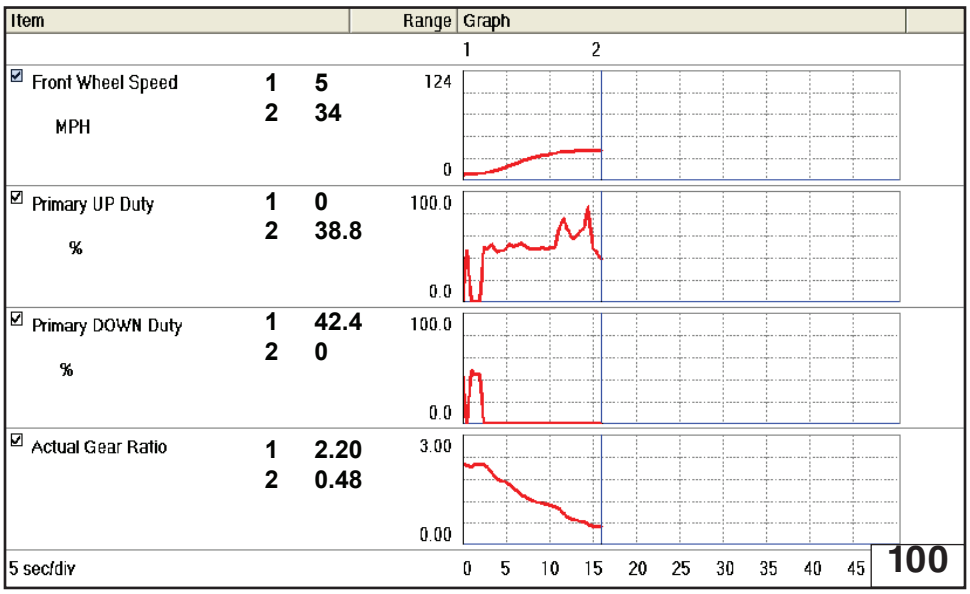


PRIMARY UP AND DOWN AND SECONDARY PRESSURE SOLENOID SCHEMATIC

Primary UP and Primary DOWN duty solenoids control the position of the Primary Flow Rate Control Valve.
Primary UP duty positions the Primary Flow Rate Control Valve to apply pressure.

The Primary DOWN duty positions the Primary Flow Rate Control Valve to drain pressure.

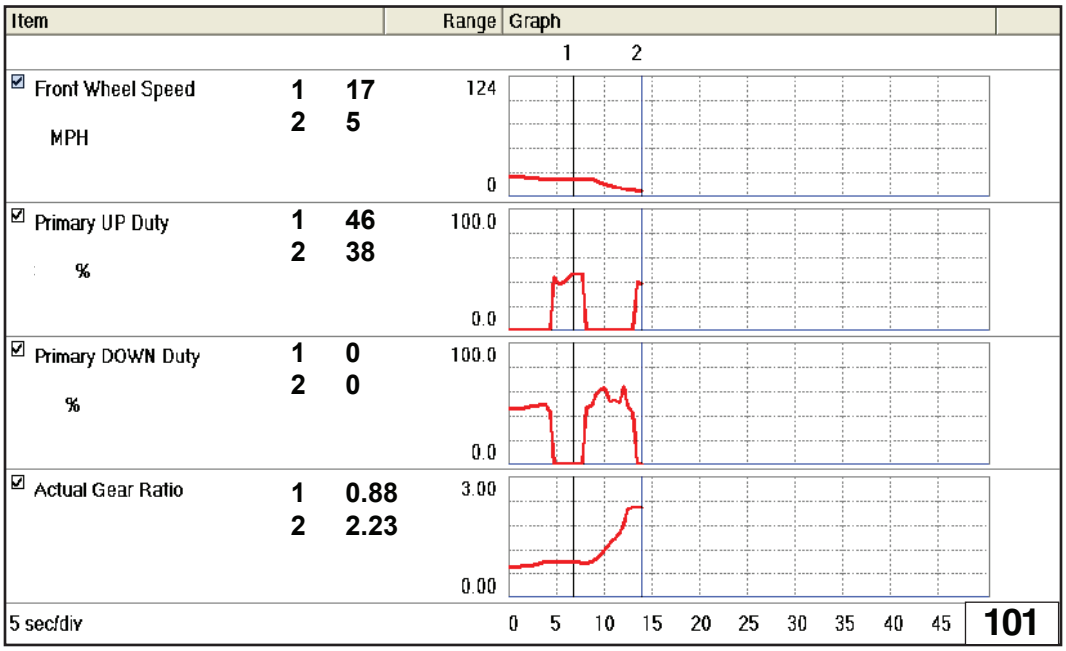
Secondary Pressure Linear solenoid creates clamping force.



UP RATIO DATA

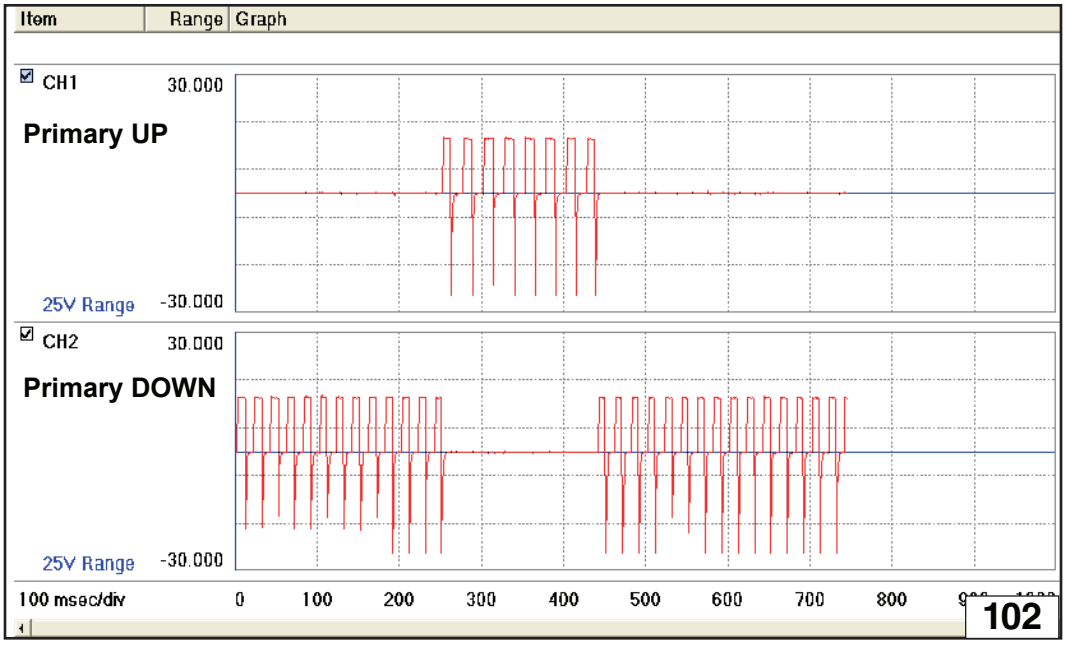
Note: Primary/Secondary = Gear Ratio

Normal Primary UP duty ratio will initially go very high when controlling up ratio and then decrease slightly once the TCM has reached the proper gear ratio.

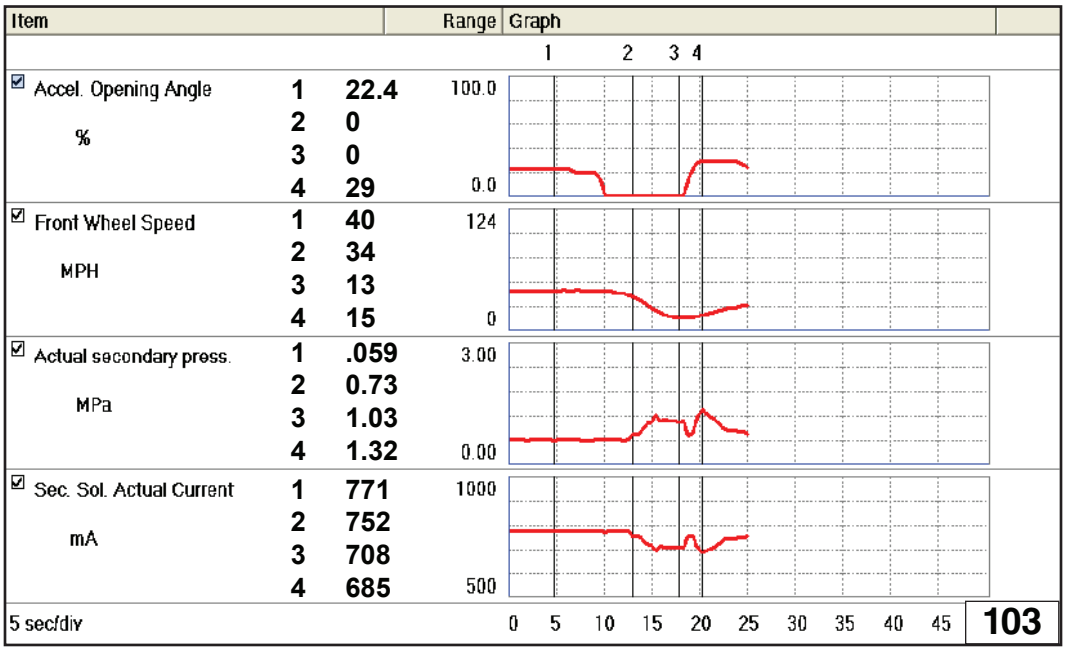


DOWN RATIO DATA

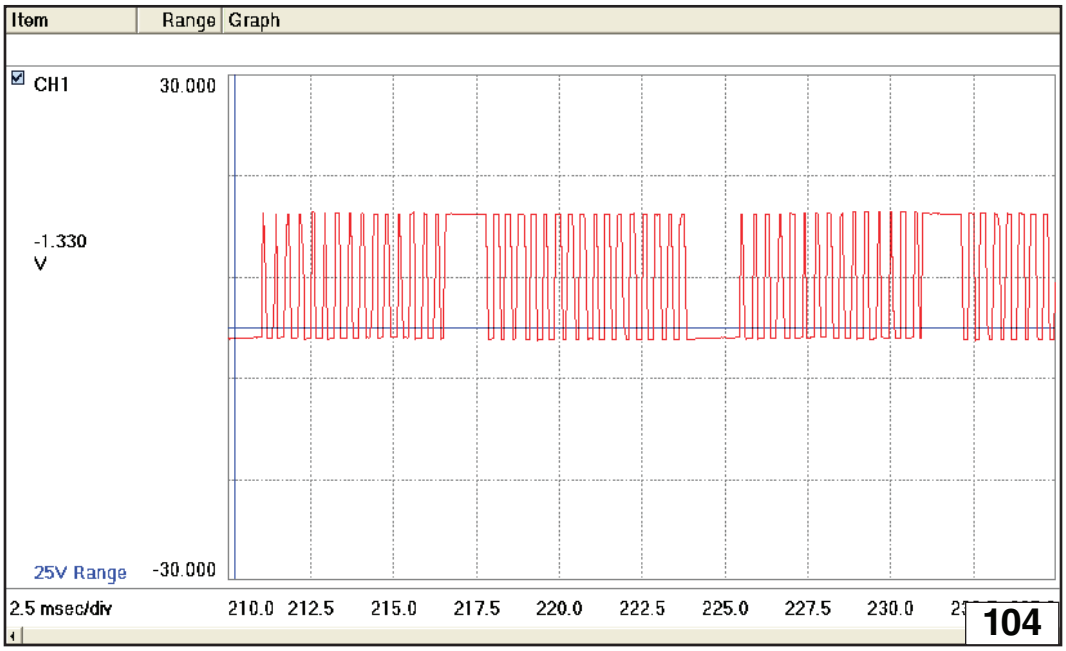
Primary Down duty drains the hydraulic pressure in the Primary Pulley and allows the chain to separate the Primary Pulley. This allows the chain to ride on a smaller circumference.



PRIMARY UP AND DOWN SOLENOIDS.OCL



SECONDARY SOLENOID CONTROL DATA

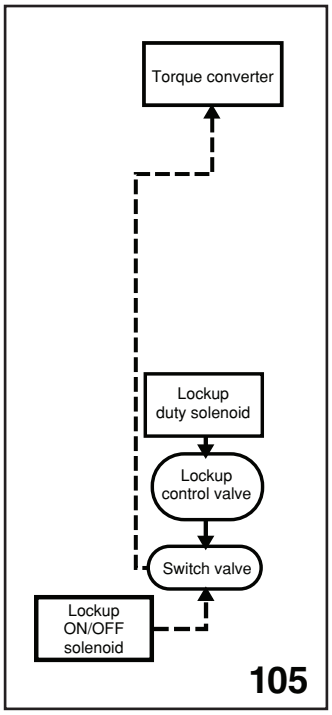


SECONDARY SOLENOID.OCL

The Secondary solenoid operates at a frequency over 2. k Hz. The fast operating speed ensures constant and correct clamping force on the pulleys to the chain.

Clamping force will be lower at low gear ratios and increase as the ratio increases. During acceleration the clamping force is the highest.

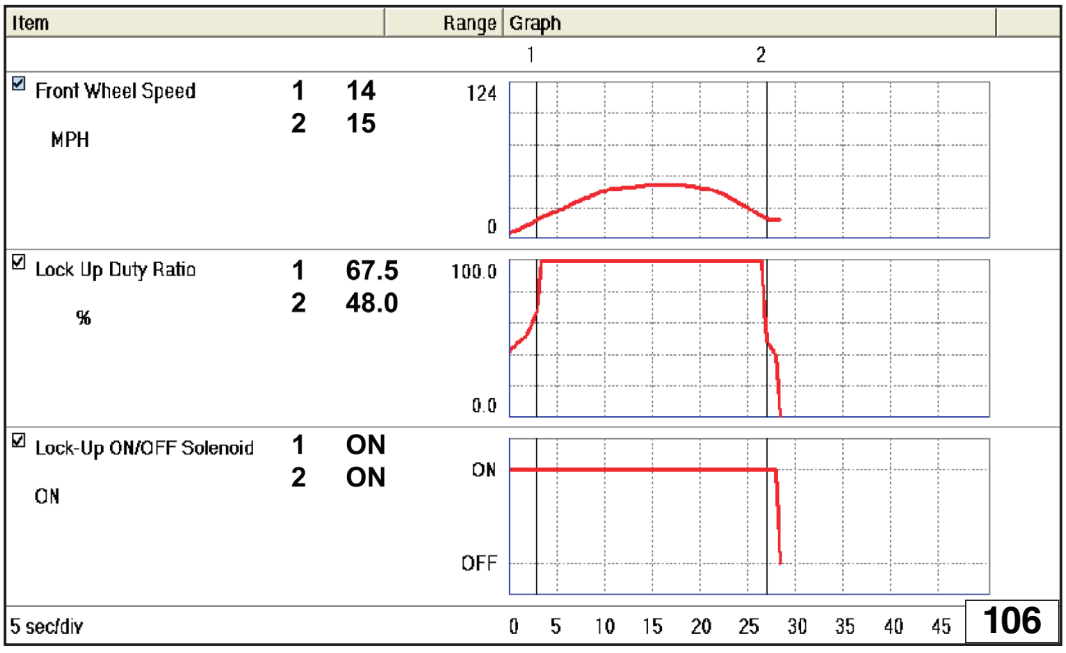
Lock-Up ON / OFF



TORQUE CONVERTER LOCK-UP SCHEMATIC

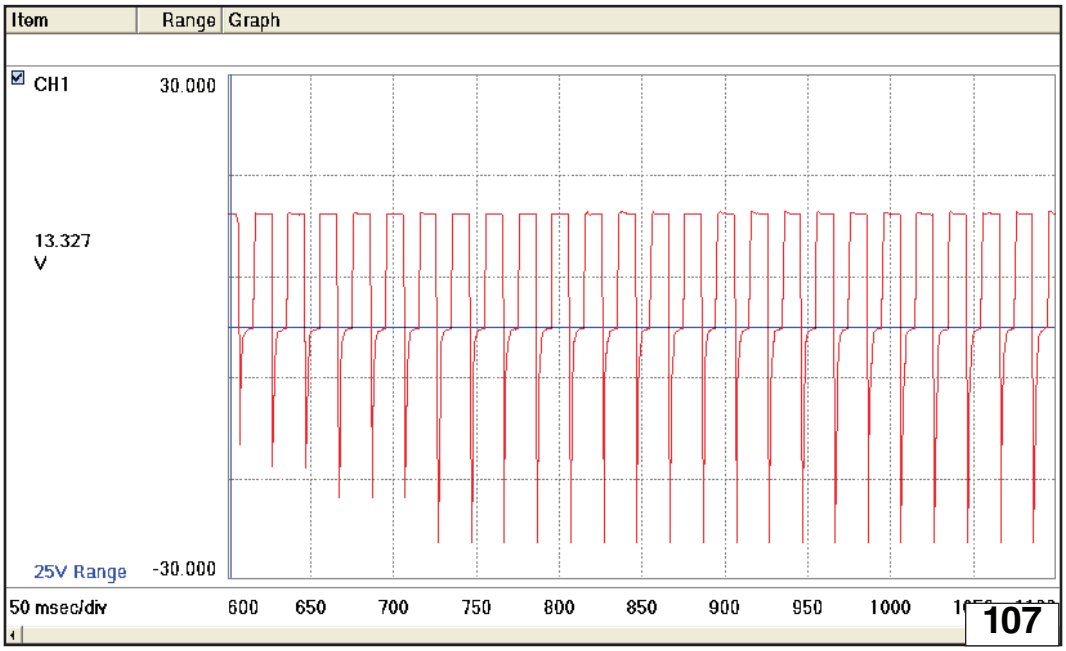
The Lock-Up On/Off solenoid controls the Switch Valve to change from a lubrication circuit to the Lock-Up control circuit.

The Lock-Up duty solenoid controls the Lock-Up Control Valve that provides hydraulic pressure to the piston that locks to the impeller of the torque converter.



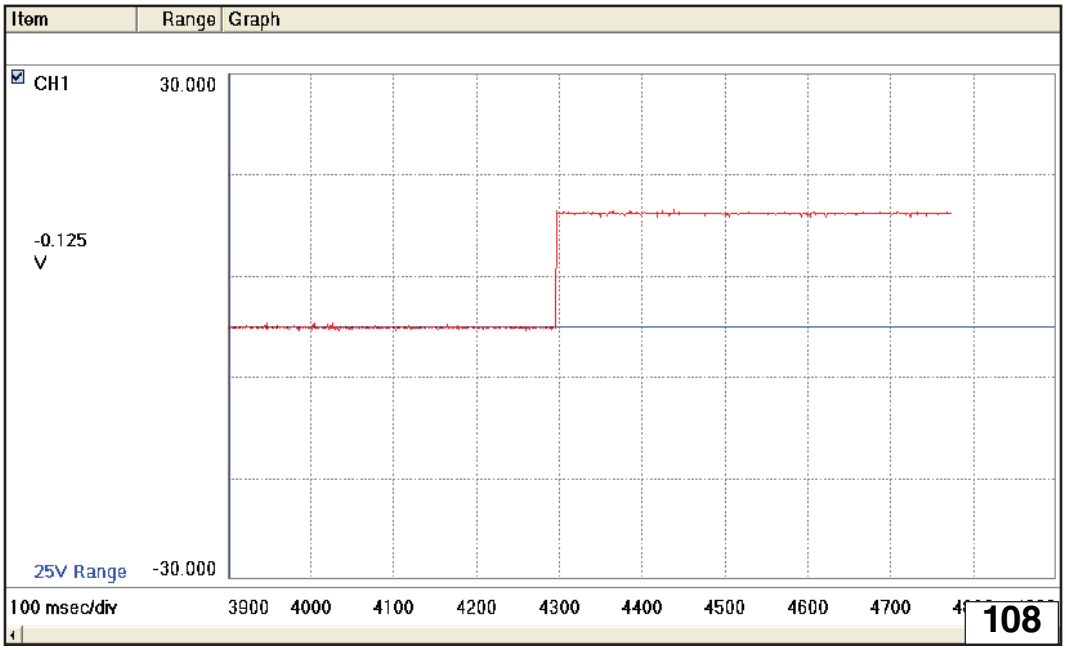
LOCK-UP CONTROL DATA

The Lock-Up solenoid must be on before the duty ratio to the Lock-Up Duty solenoid can be activated. Specific CVT trouble codes will keep the Lock-Up On/Off solenoid off.



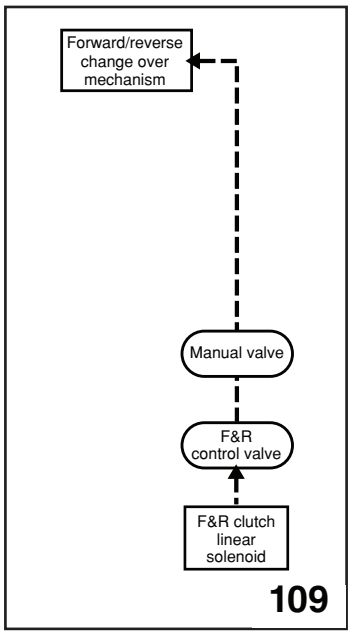
LOCK-UP DUTY.OCL

Lock-Up Duty solenoid ratio less than 100%.



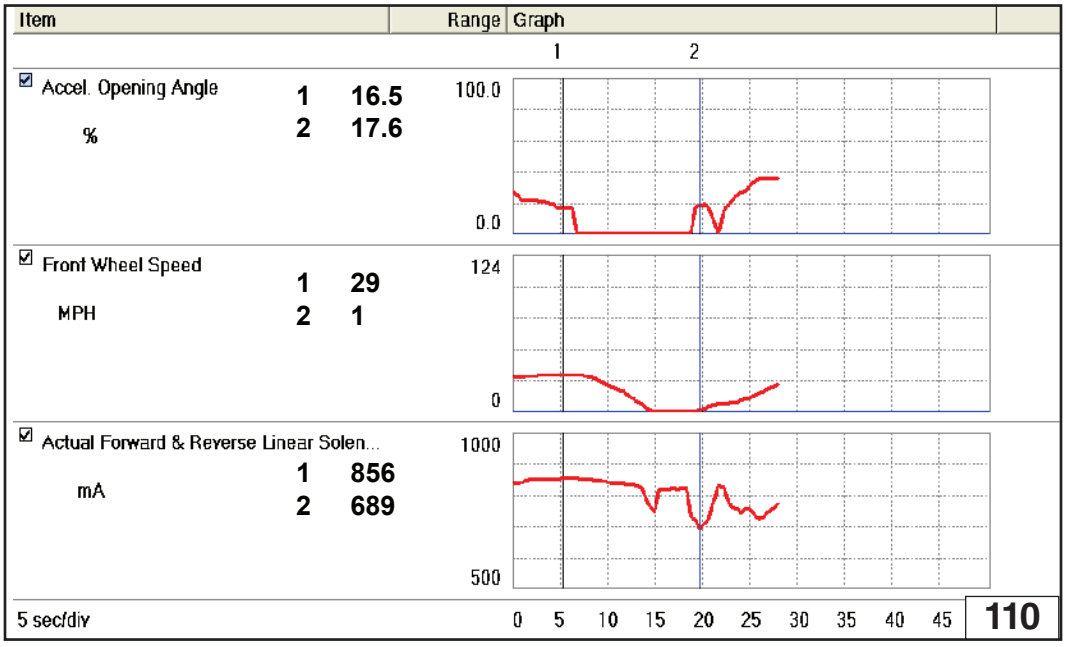
LOCK-UP ON/OFF.OCL

Lock-Up On/Off solenoid changing from off to on.



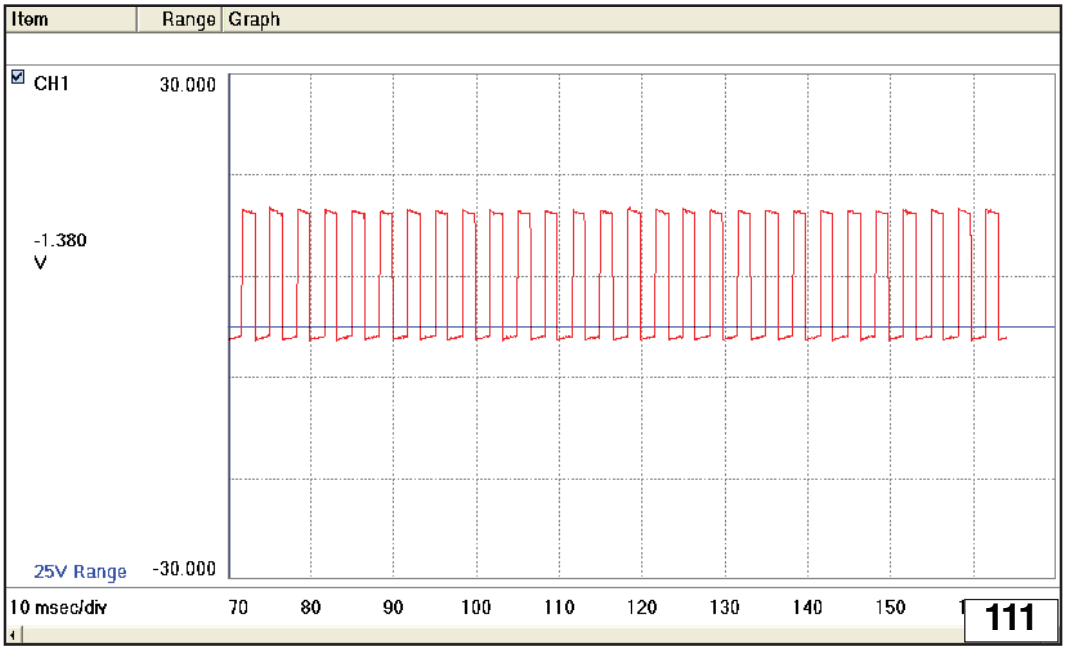
FORWARD AND REVERSE LINEAR SOLENOID SCHEMATIC

The Forward and Reverse Linear Control solenoid provides the controlling pressure that moves the Forward and Reverse Control Valve. The Forward and Reverse Control Valve regulates the pressure routed to the manual valve. The manual valve delivers hydraulic pressure to the forward clutch in a forward gear range and the reverse clutch in reverse gear.



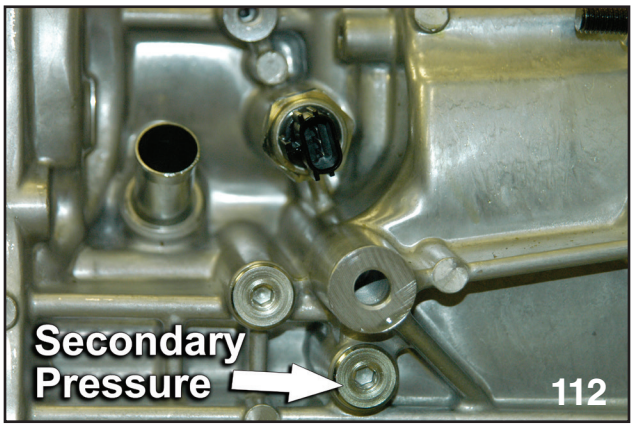
FORWARD AND REVERSE LINEAR SOLENOID DATA

The pressure is regulated to apply varying amounts of force for all types of driving conditions. During normal operation the pressure will be higher during low gear ratios and during acceleration.

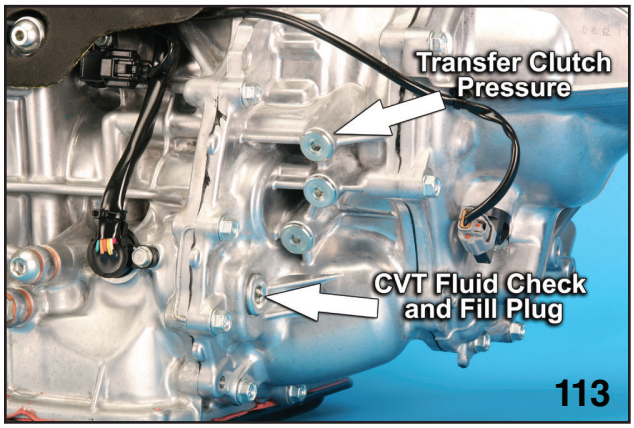


FORWARD AND REVERSE LINEAR SOLENOID.OCL

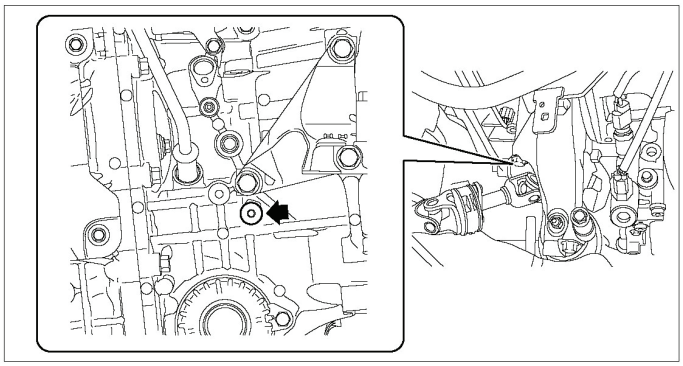
The pressure will be lowered if the vehicle encounters a split friction surface front to rear to reduce shock to the pulleys.

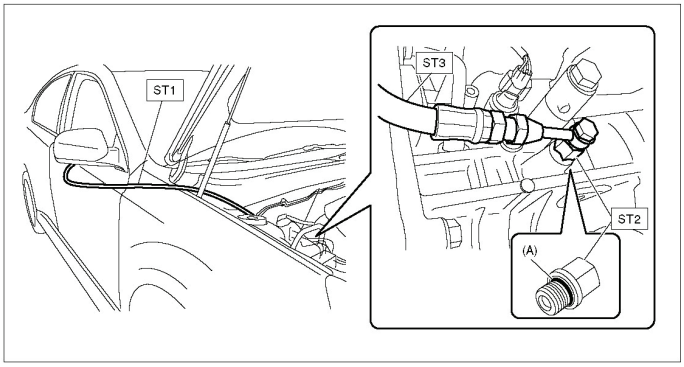


PRESSURE PORT



REAR LEFT VIEW





1) Line Pressure

SST

1. 18801AA000 (ST1)

Oil Pressure Gauge

2. 18681AA000 (ST2)

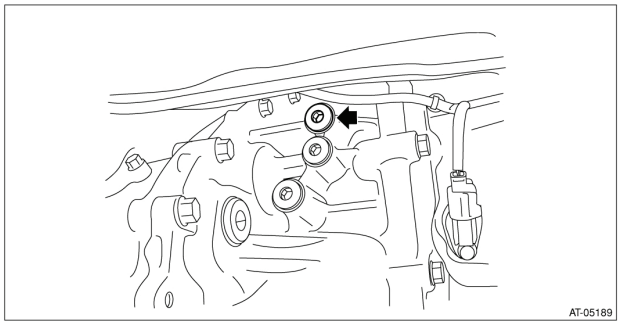
Pressure Gauge Adapter

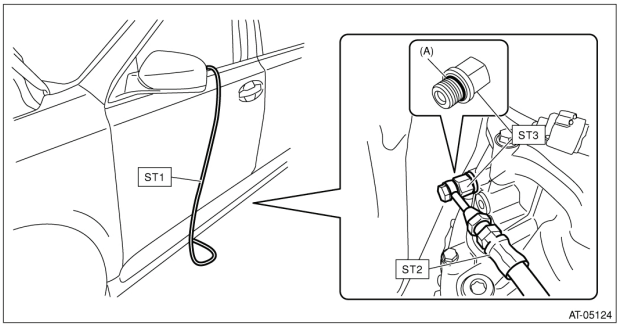
3. 498897700 (ST3)

Oil Pressure Adapter set

114

LINE PRESSURE





2) Transfer clutch pressure

SST

1. 18801AA000 (ST1)

Oil Pressure Gauge

2. 18681AA000 (ST2)

Pressure Gauge Adapter

3. 498897700 (ST3)

Oil Pressure Adapter set

115

TRANSFER CLUTCH PRESSURE

X-MODE™

X-MODE™ is a new driver assistance system that unites all vehicle systems to provide increased traction, vehicle stability, and vehicle control while driving on low friction or multiple terrain surfaces at speeds of 18 MPH or less.

Vehicle control during X-MODE™ operation maximizes the Human Machine Interface (HMI) by providing advanced or retarded vehicle output which allows the driver to provide confident input to the vehicle.

X-MODE™ BUTTON

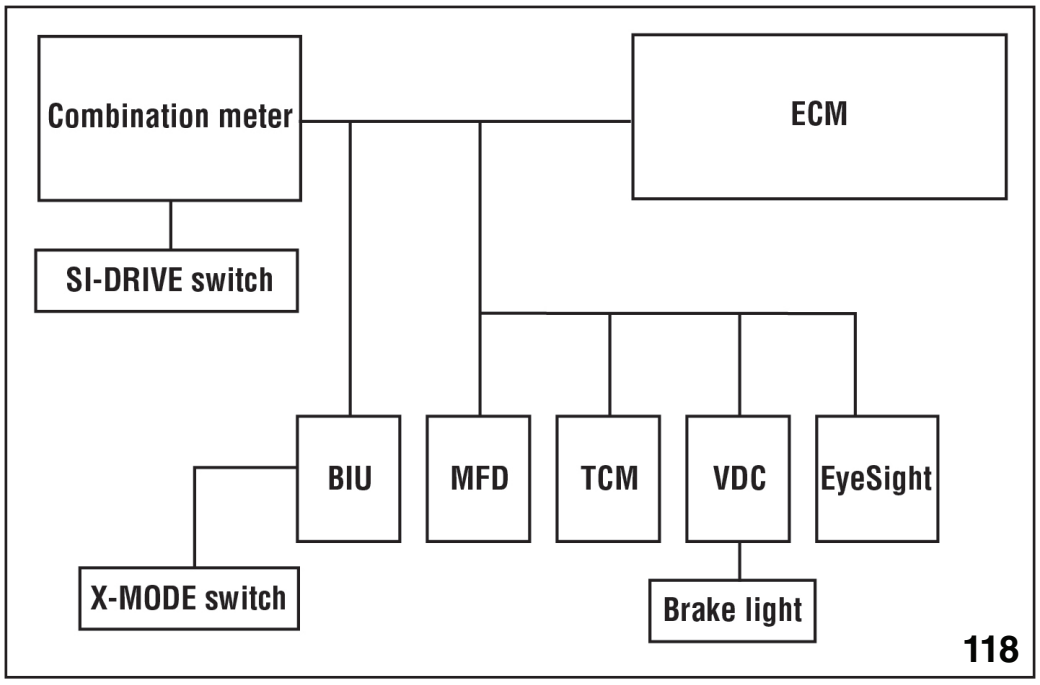
The X-MODE™ switch is located forward of the shifter and must be pressed and released below 18 MPH to activate X-MODE™. Pressing the button at higher vehicle speeds will result in a beeping sound, indicating the vehicle is too fast to activate X-MODE™.

X-MODE™ provides the following:

1. Hill Descent Control (HDC)
2. Stronger Multiple Plate Transfer Clutch operation (25%)
3. Engine torque control (limits throttle control through the ETC on low friction roads while driving with low engine loads and advances throttle response with high engine loads, similar to I and S# mode of SI drive).
4. Faster limited slip differential functions from the Vehicle Dynamics Control
5. Retarded up ratio, and prevents torque converter lock up
6. Adaptive Cruise Control lock out
7. Operation in all gear ranges (forward and reverse)
8. X-MODE™ operational indicators through the Multi-Function Display (MFD): High Grade
9. X-MODE™ and HDC “ON” indicators displayed on combination meter
10. SI drive switch lock out

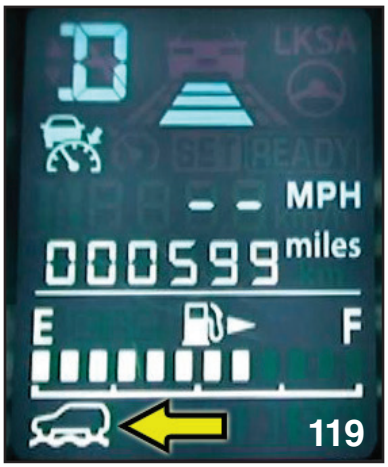
Network Operation

1. X-MODE™ switch is pressed and released.
2. BIU sends an ON signal to the combination meter.
3. Combination meter outputs current mode status (X-MODE™) to the ECM.
4. The ECM confirms the status of the CAN and the ECM requests the combination meter to turn on the X-MODE™ indicator lamp.
5. The ECM outputs an X-MODE™ ON signal to the CAN, and each unit collaborates and starts X-MODE™ control.



NETWORK OPERATION

NOTE: Illumination and flashing of the Hill Descent (HDC) lamp is controlled by the VDC unit.



X-MODE™ "ON" INDICTOR

HDC "ON" INDICATOR

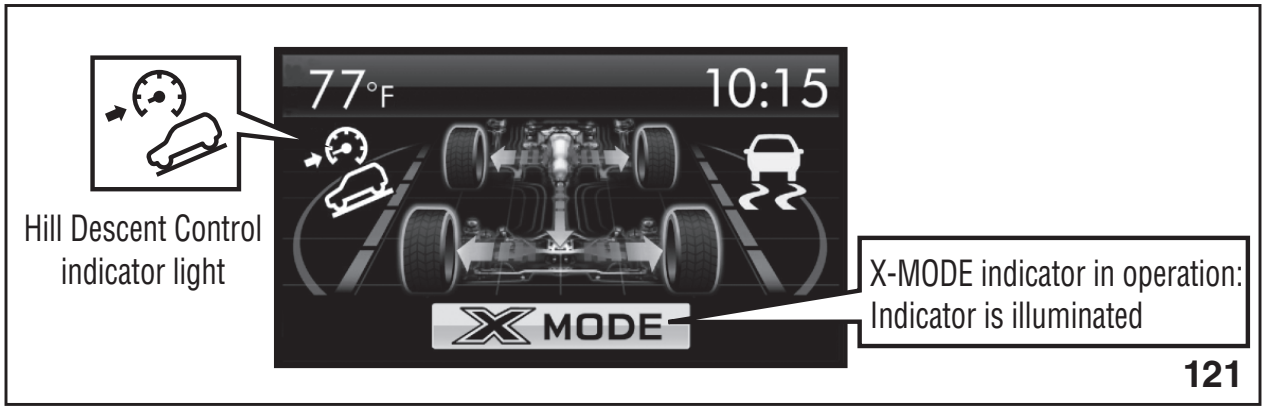
Hill Descent Control (HDC)

HDC is not a cruise control function. It will not advance the throttle setting to increase speed. HDC provides braking automatically to maintain the vehicle's speed which existed at the time the driver released the gas pedal or the brake pedal.

NOTE: HDC functions during downhill driving or on any terrain where the vehicle's speed may increase from gravity or vehicle inertia.

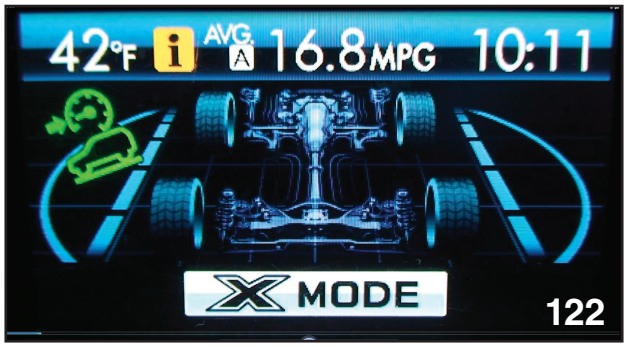
When HDC is in operation, an indicator lamp on the combination meter and multifunction display starts flashing so that the driver can visually check that the system is operating. (During standby, the HDC indicator lamp stays ON steadily.) The brake lights activate when the HDC is operating.

HDC is automatically turned off when the vehicle speed is above 12 MPH, and the X-MODE™ indicator lamp goes out at around 18 MPH.

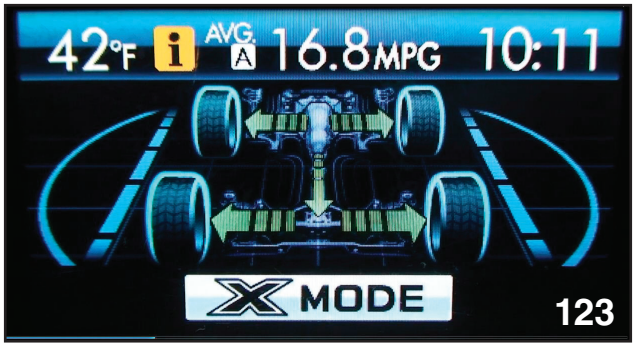


HDC AND X-MODE™

Hill descent control indicator standby: Indicator is illuminated.
In operation: Indicator is blinking.



X-MODE™ "ON" WITH VEHICLE STOPPED



HDC OFF WITH X-MODE™ WITH VEHICLE MOVING

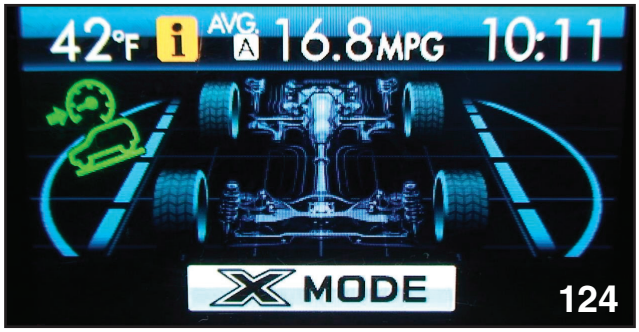
Diagnosis

X-MODE™ software and operating systems are not contained into a single control unit, therefore, no DTCs exist specifically for X-MODE™. X-MODE™ operation requires all members of the CAN to be functioning properly. If a problem with X-MODE™ is suspected or if X-MODE™ will not activate, perform an All Systems Diagnosis. Diagnose and repair any existing problems in the CAN or CAN members.

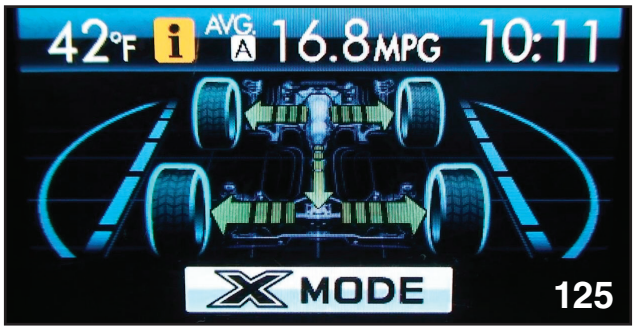
NOTE: **X-MODE™ will not operate if the engine oil or coolant is in an overheated condition.**

NOTE: **X-MODE™ diagnosis is located in the CVT transmission diagnosis section of the Subaru Service Manual.**

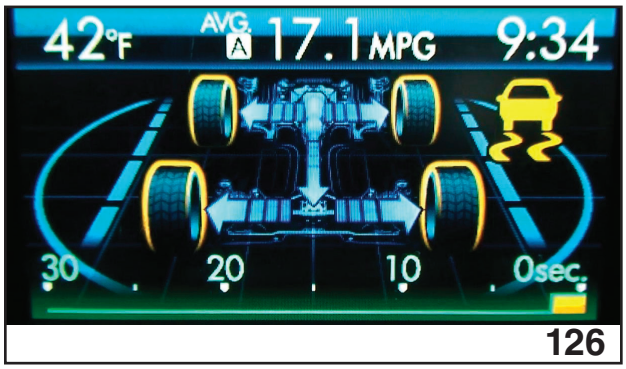
High Grade Multi-Function Display During Operation



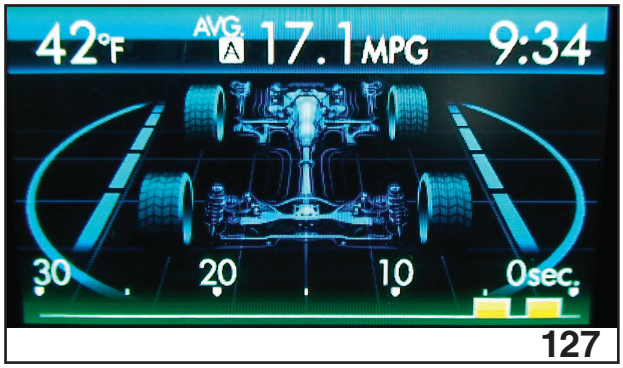
X-MODE™ AND HDC VEHICLE STOPPED



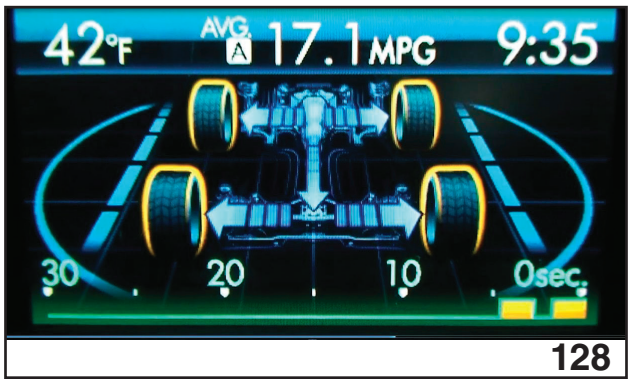
X-MODE™ BETWEEN 12 MPH AND 18 MPH



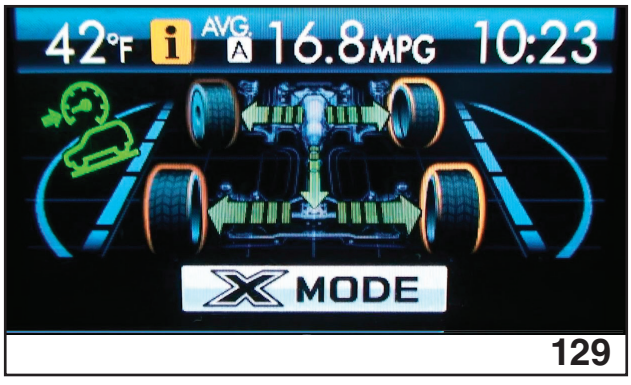
TCS AND VDC ACTIVE RECORDED



VEHICLE SPEED ZERO WITH 2 CONTROLLED EVENT

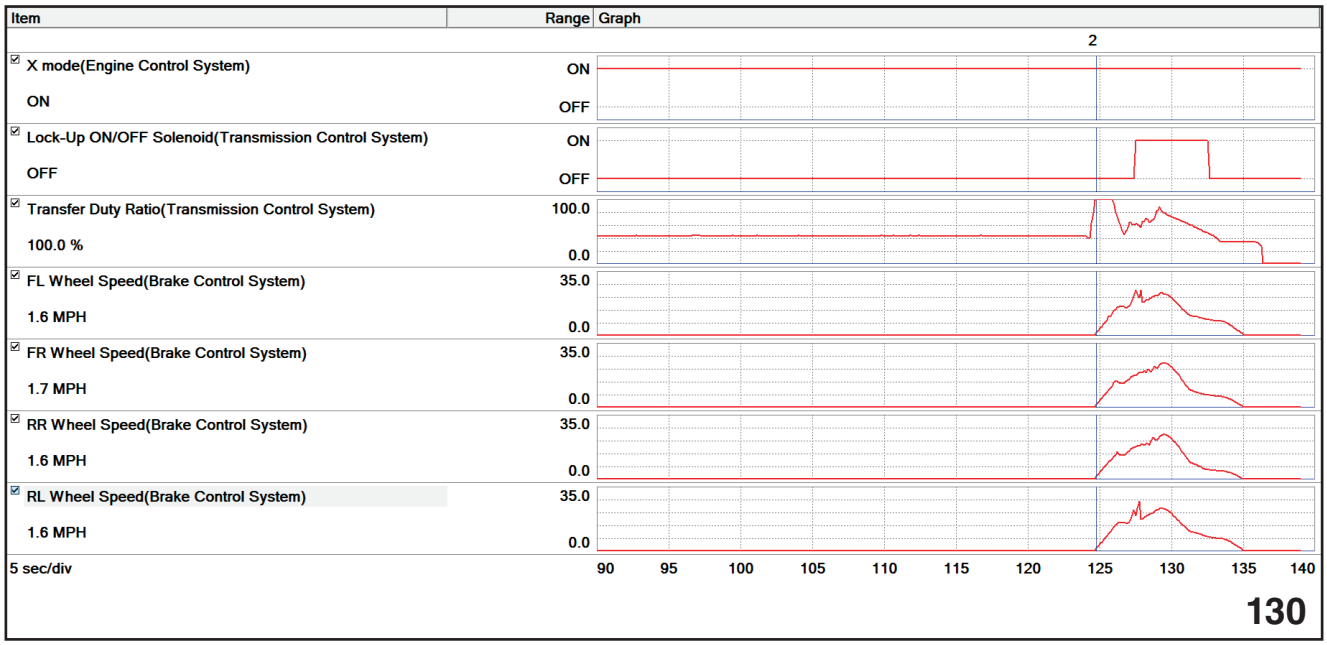


ABS ACTIVE AND 2 CONTROLLED EVENTS RECORDED

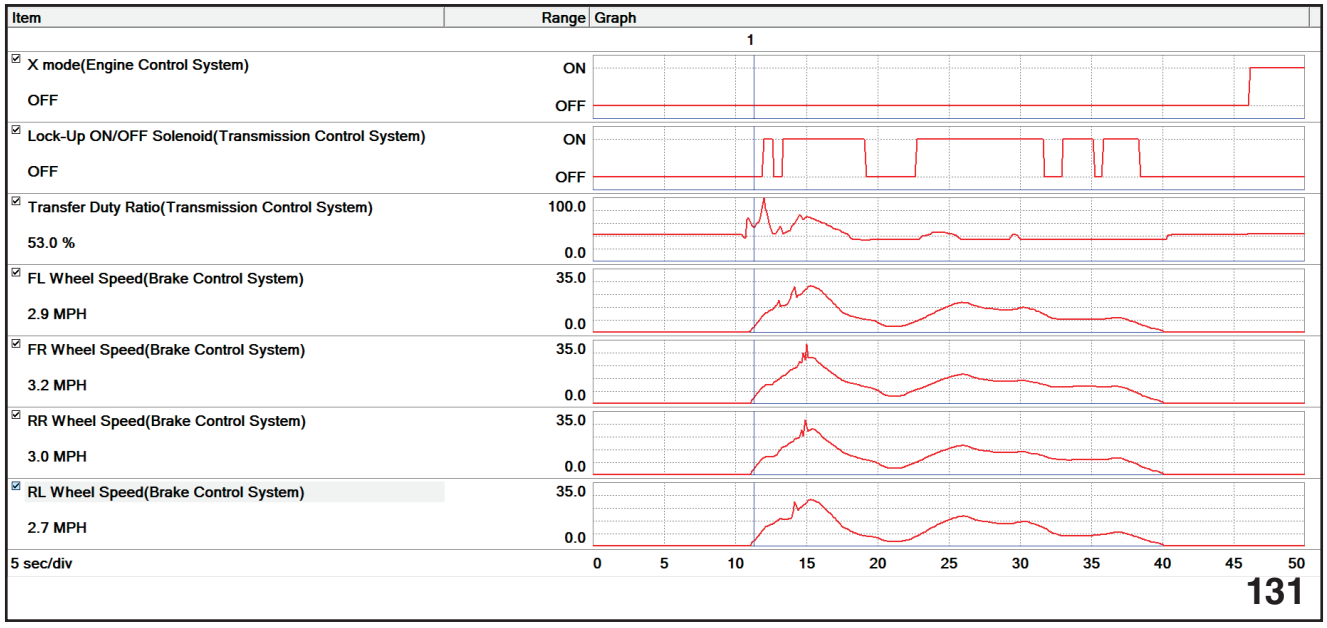


X-MODE™ ACTIVE BELOW 12 MPH

NOTE: **The traction history is for the last 30 seconds.**



SUBARU SELECT MONITOR III DATA X-MODE™ ON



SUBARU SELECT MONITOR III DATA X-MODE™ OFF

MPa	PSi
.1	14.5
.2	29.0
.5	72.5
.7	101.5
1	145
2	290
3	435
4	580
5	725
10	1450
100	14503

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