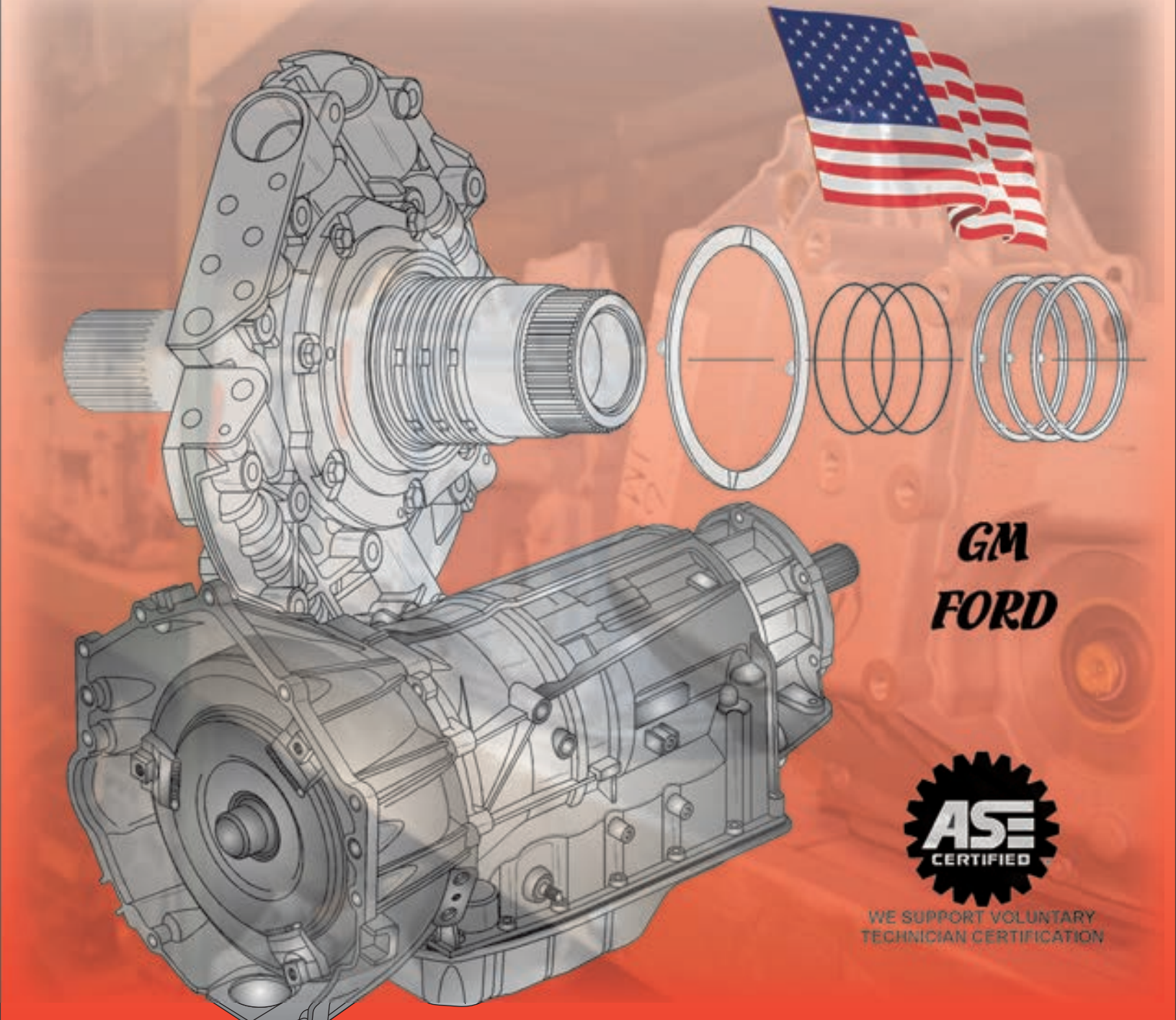
ATSG

AUTOMATIC TRANSMISSION SERVICE GROUP

2012 TRANSMISSION SEMINAR

TECHNICAL SERVICE INFORMATION



GM

FORD

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IT HELPS TO BELONG TO A TECH SERVICE...

BUT BELONG TO A TECH SERVICE THAT HELPS

Raybestos IFC

"ATSG's 2012 Technical Training Seminar"

ATSG Seminars

Welcome to ATSG's 2012 Technical Training Seminar. Since we celebrated 25 years of doing seminars in 2011, we decided to arrange the manuals so as to begin with the Red instead of the White. Originally there were only 2 manuals, Red and Blue. When the White manual was added to meet the need of increased information, it was placed first in the line-up and has remained in the White, Red then Blue order for years. Now with a clean break-away by our 25th, we begin our All American order of the manuals; Red, White and Blue! The order of content remains basically the same, GM, Ford, Chrysler and Imports. Within this order we also handle medium duty trucks and our continued hybrid training. So without any further delay, let's get started beginning with GM.

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GM & Ford

General Motors

Ford

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MODE $06 DIAGNOSTICS

SCAN TOOL MODES

When Onboard Diagnostics II was developed as a means of monitoring vehicle emissions, the Society of Automotive Engineers (SAE) developed guidelines for managing the information obtained with a list of "diagnostic modes" that scan tools would have to provide. The scan tool modes and other OBD-II requirements can be found in a document called SAE J1979.

Mode $01 - This mode is used to request and display sensor data, open/closed loop status, whether switches are on or off and any other datastream Parameter Identification Data (PID) the system or scan tool is capable of displaying. It will also indicate which control module requested the MIL to be turned on.

Mode $02 - Provides Freeze Frame data - stores Mode $01 PID data at the time a pending or confirmed DTC is stored.

Mode $03 - Reports "confirmed" emission-related DTCs stored in each OBD-II module (DTCs that are illuminating the MIL).

Mode $04 - Clears/erases all emission-related DTCs in all OBD-II modules and resets all diagnostic and freeze frame data.

Mode $05 - This mode shows 02 Sensor Tests (Min/Max Values).

Mode $06 - Provides monitoring test values and malfunction limits for various OBD-II monitors. Service technicians can use the data to see which monitors failed and by how much.

Aftermarket parts manufacturers can use this data to ensure that replacement parts are compatible with the OBD-II system.

Mode $07 - Reports "pending" emission-related DTCs stored in each OBD-II module (DTCs that are getting ready to light the MIL). It also insures that the MIL will not be set falsely.

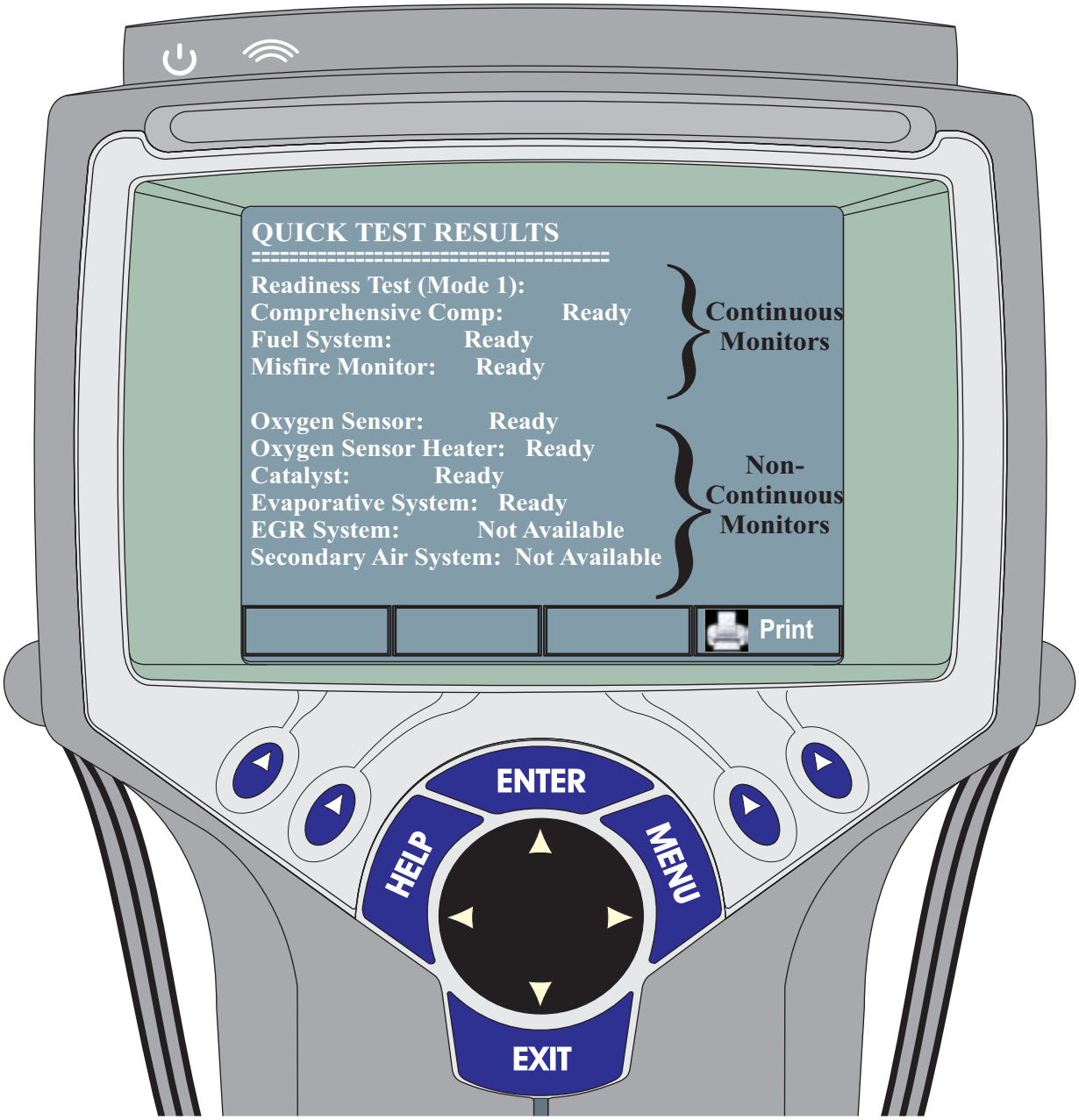
Mode $08 - This mode provides EVAP or any other self tests that are available through the scan tool using bi-directional controls.

Mode $09 - Allows a service technician or I/M test technician to obtain vehicle VIN, module calibration number (CALID), and Calibration Verification Number (CVN) for every OBD-II module.

NOTE: Mode $06 information can be hard to find due to a lack of scan tool navigation knowledge or is not clearly labeled. Below is a list of where to find Mode $06 information on the more commonly used scan tools.

Snap-On SOLUS & MODIS: This is under “Generic or Global OBD-II”, there you will find “Non-Continuously Monitored Systems”, then go to “Select Services” and you are in.
OTC Genisys: Open “Application Manager”, select “Scan Diagnostics”, then Global OBD-II. On the next screen, select “Special Tests”, then “Component Parameters” and you are in.
Bosch Mastertech: Press “F1” for SCANTEST from the main menu. From the FUNCTION MENU select “F1” again, From the next menu select “F1” for OBD-II FUNCTIONS. From the next menu select “F5”, SYSTEMS TESTS. From the next menu select “F2”, OTHER RESULTS and you are in.
Auto Enginuity: Select ONBOARD TEST RESULTS and you are in.

MODE $06 DIAGNOSTICS



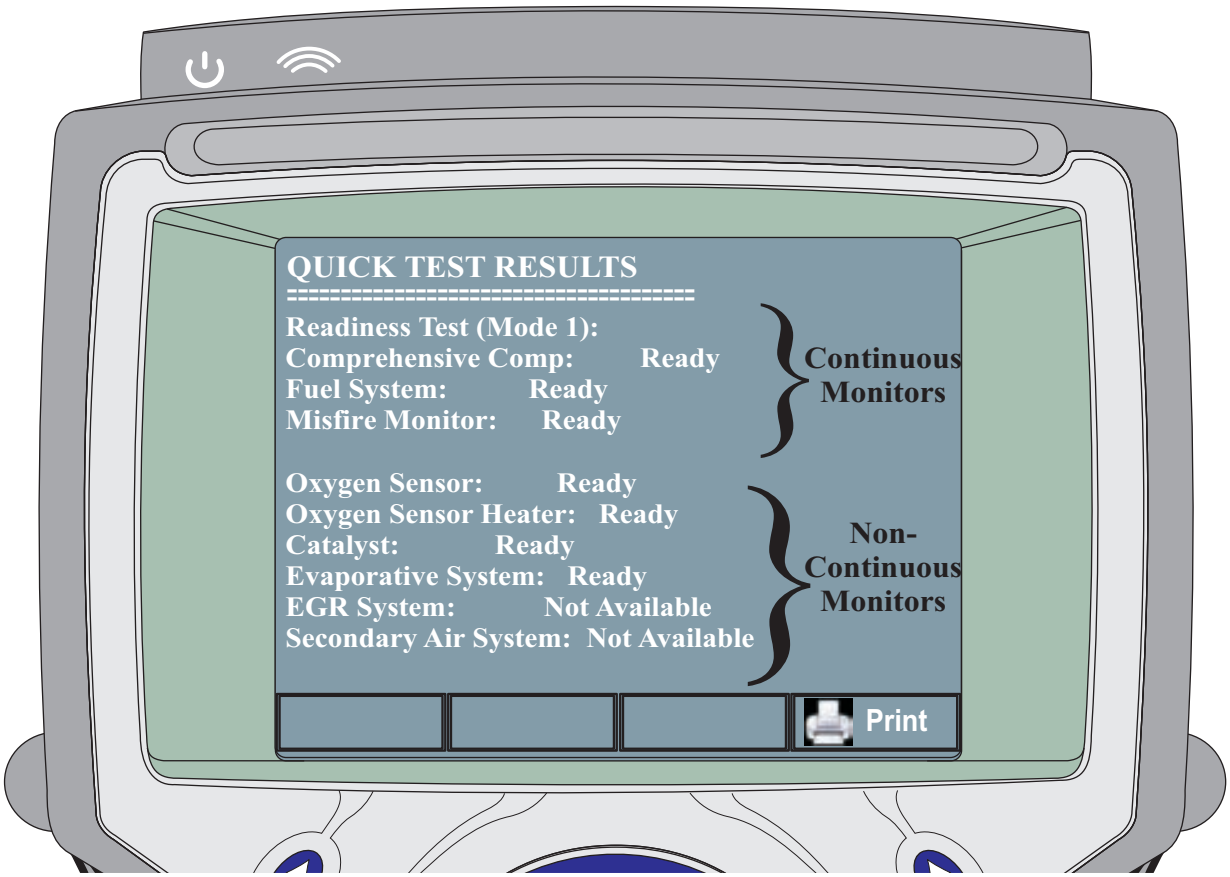
Mode $06 is accessed through the scan tool by first selecting the Global OBDII option upon which the first screen will provide quick tests results for Continuous and Non-Continuous Monitors.

The PCM is programmed to run test sequences on the vehicle's operating system which are referred to as Monitors. When conditions are right various monitors will run to inspect its associated system. The condition required to run these monitors are called Trips. There are 2 types of monitors; Continuous and Non-Continuous monitors. Continuous monitors are just that, they are continually checked and should always read as COMPLETE, DONE, YES or READY. The same is true with Non-Continuous monitors for the exception that these monitors run a trip once. They must all read COMPLETE. DONE, YES or READY. This is imperative before Mode $06 data is used for any diagnostics as the information will be invalid. When conditions are right, Mode $06 allows scan tool access to the most recent test results for non-continuous monitors.

Figure 1

SAP
6

MODE $06 DIAGNOSTICS



General Understanding of Continuous Comprehensive Component Monitors (CCM)

Comprehensive Component Monitors (CCM) is an on-board strategy designed to monitor a failure in any electronic component or circuit that provides input or output signal to the powertrain control module (PCM) and is not exclusively monitored by another monitor system.

Open circuits, out-of-range value, or a failed rationality check will cause the monitor to fail and produce a Diagnostic Trouble Code (DTC).

The components monitored may belong to the engine, ignition, transmission, air conditioning, or any other PCM supported subsystem. Here are some examples of Comprehensive Component Monitors (CCM)

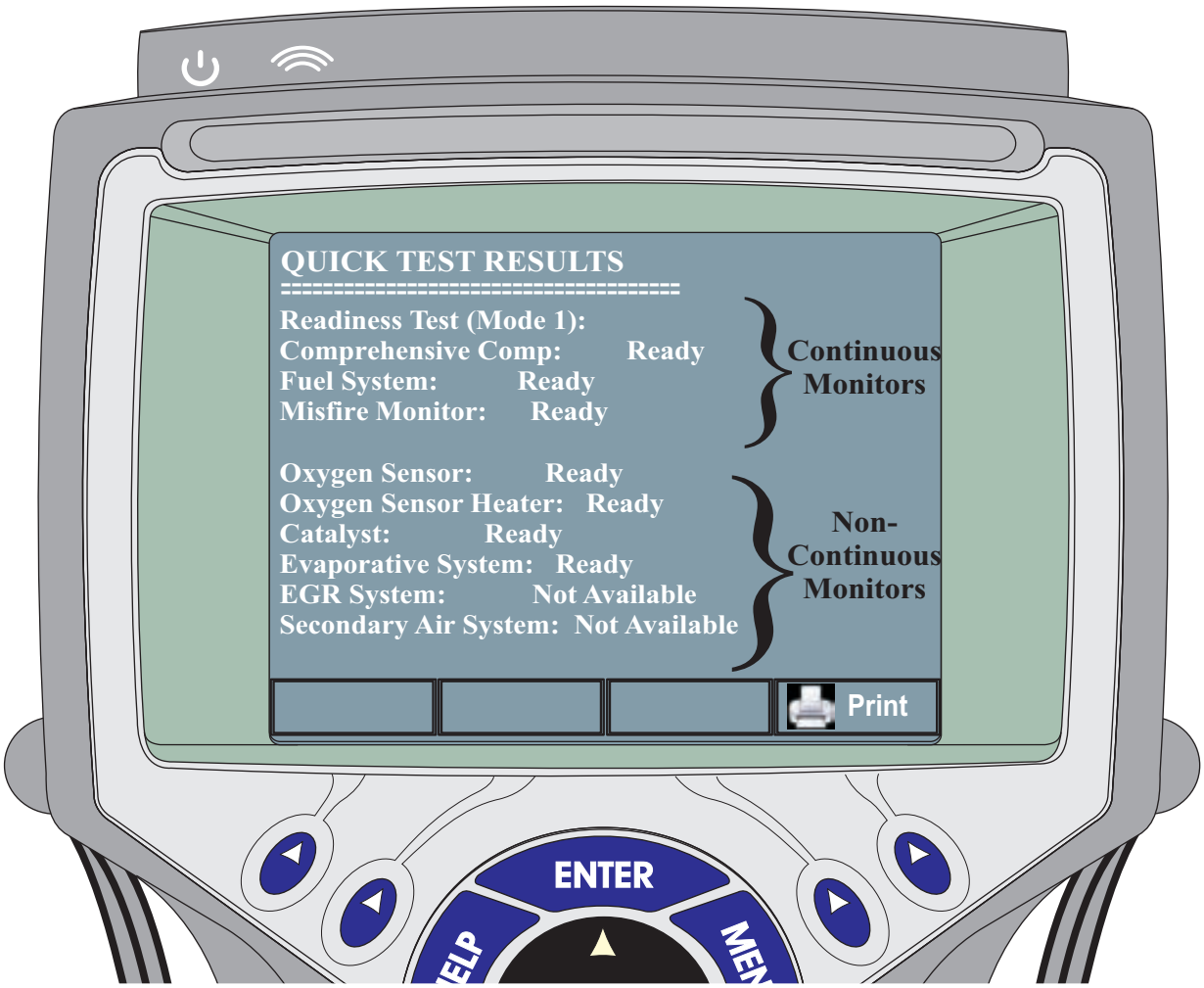
1. Inputs:
Mass Air Flow sensor (MAF), Intake Air Temperature sensor (IAT), Engine Coolant Temperature sensor (ECT), Throttle Position sensor (TP), Camshaft Position sensor (CMP), Air Conditioning Pressure sensor (ACPS) and the Fuel Tank Pressure sensor (FTP).

2. Outputs:
Fuel Pump (FP), Wide Open Throttle A/C Cutout (WAC), Idle Air Control (IAC), Shift Solenoid (SS), Torque Converter Clutch (TCC) Solenoid, Intake Manifold Runner Control (IMRC), EVAP Canister Purge Valve, Canister Vent (CV) Solenoid.

3. The MIL is activated after a fault is detected on two consecutive drive cycles, if the fault detected affects emissions.

Figure 2

MODE $06 DIAGNOSTICS



Mode $06 Non-Continuous Monitors

Non-Continuous Monitors:
EVAP
Oxygen Sensor or A/F Sensor
Oxygen Sensor Heater
Catalyst
Heated Catalyst
PCV (Model Year 2004)
Thermostat (Model Year 2002)
Secondary AIR
Variable Valve Timing

When a monitor reads Unsupported, Not Supported or Not Available, it means the vehicle is not equipped with that specific system to be monitored. All systems that are monitored should always read COMPLETE. DONE, YES or READY. If a monitor reads Not Complete, Incomplete or Not Ready, there is a problem in the system and may prevent a diagnostic code to be produced.

On some occasions, manufacturers may include test results for a few continuous monitors along with the non-continuous monitors in Mode $06.

Figure 3

Alto - 9

MODE $06 DIAGNOSTICS

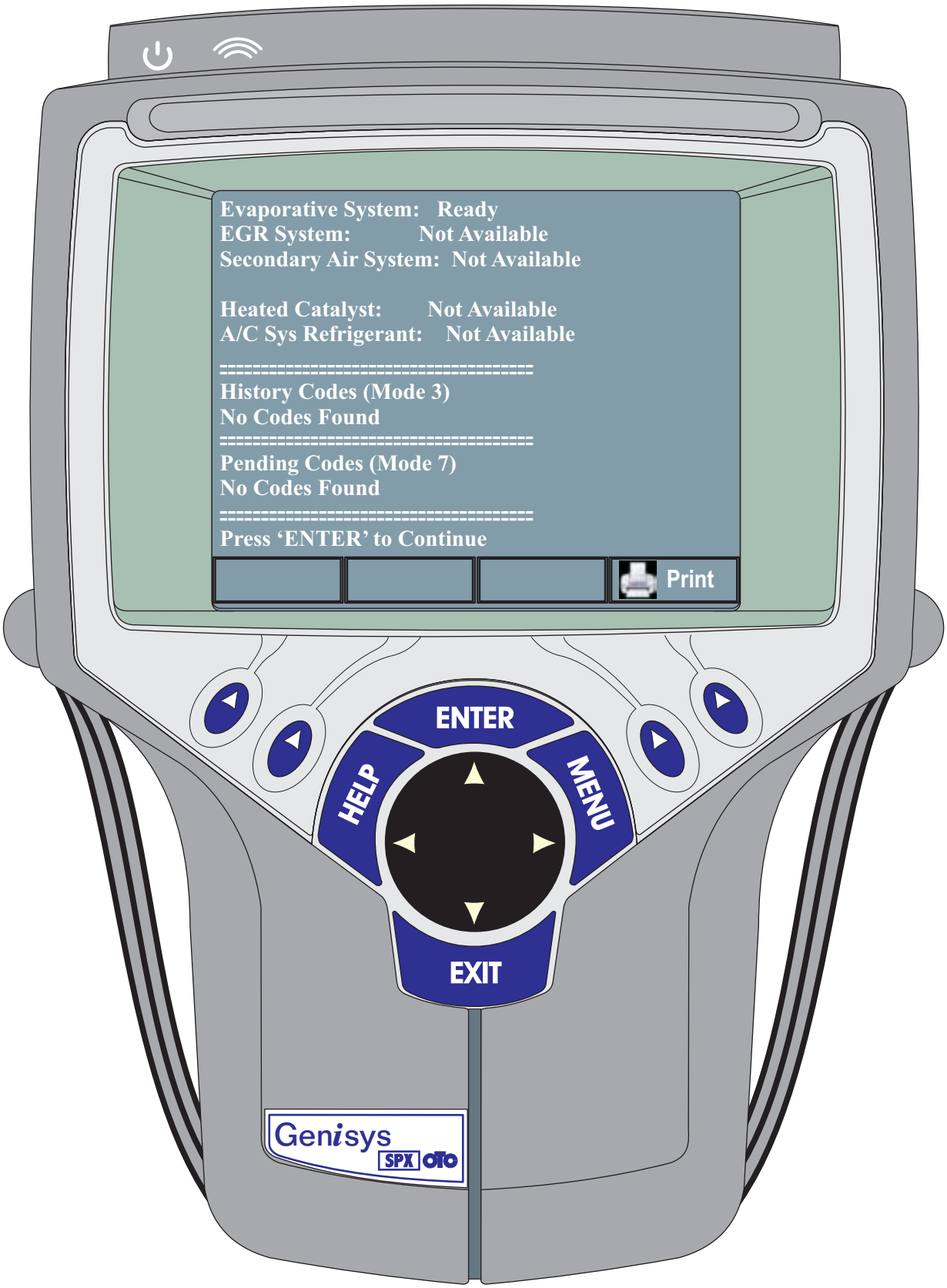
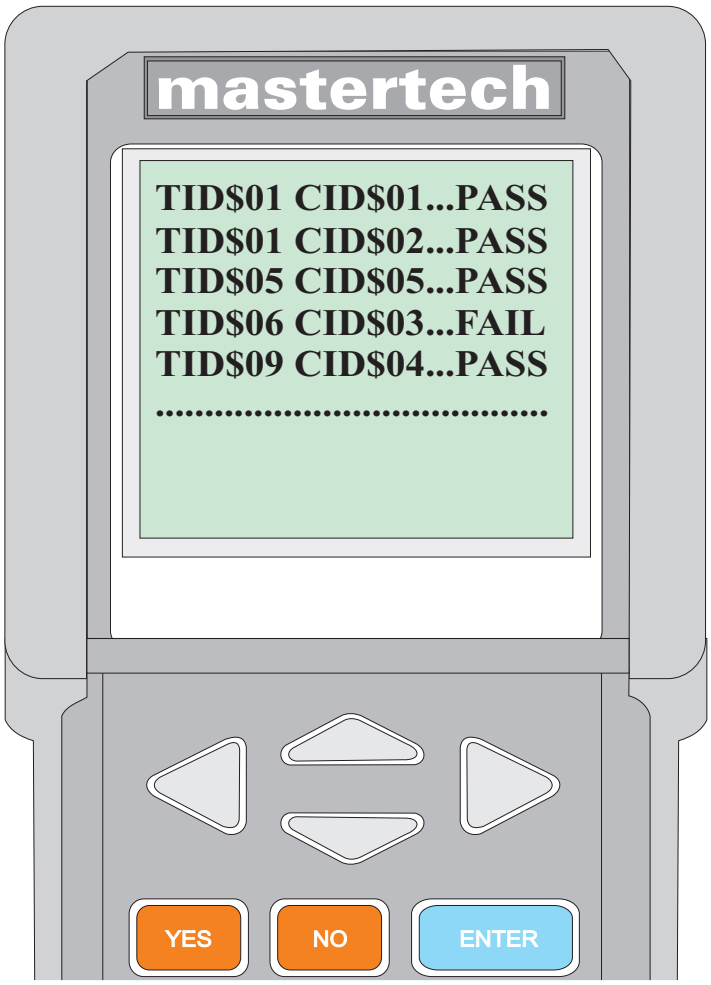


Figure 4

MODE $06 DIAGNOSTICS



Mode $06 Non-Continuous Monitors

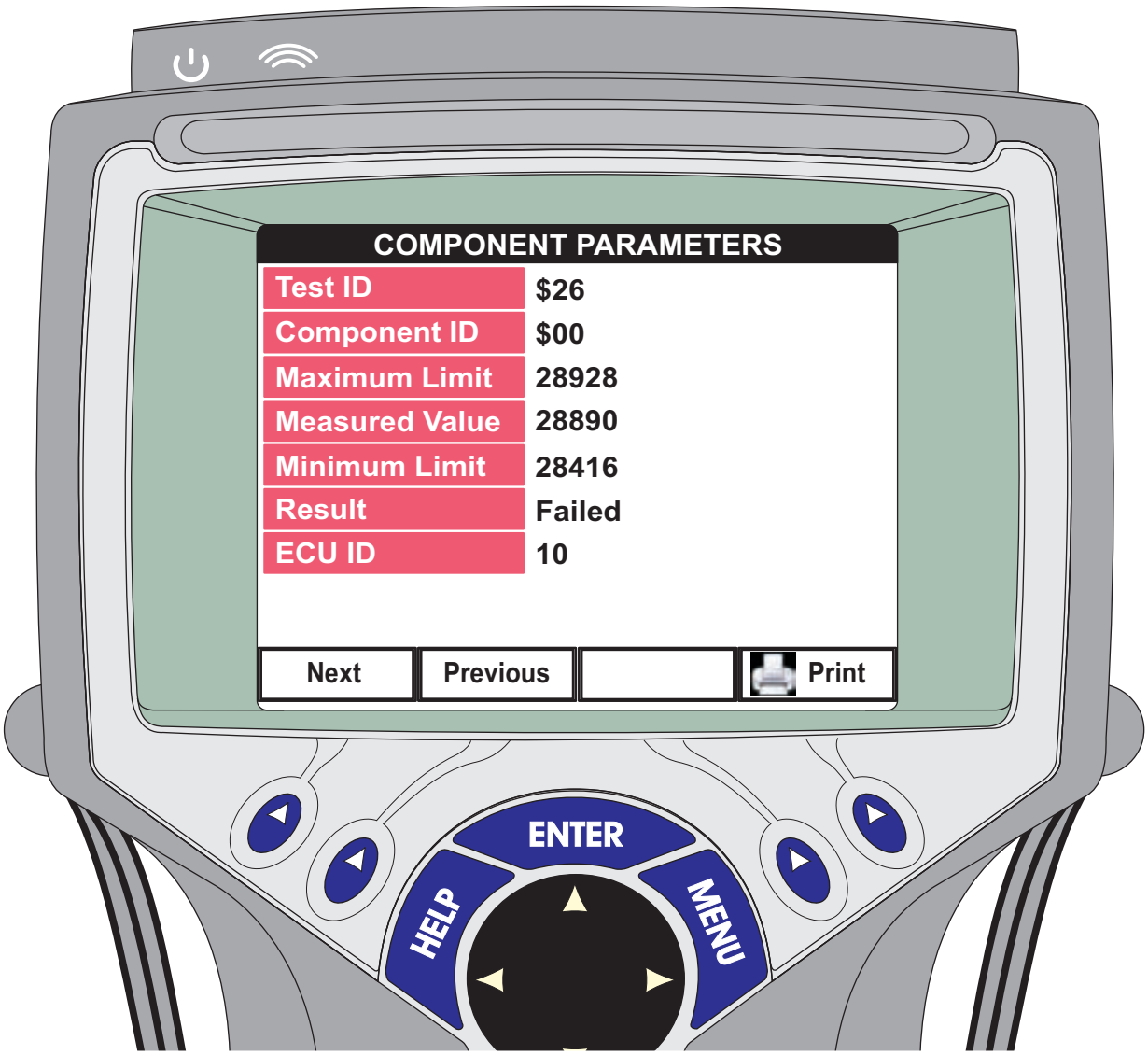
Not all scan tool interfaces support Mode $06 while others when accessed will provide the data in a raw hexadecimal format. There are a few scan tools which will define the hexadecimal code into the component it was assigned to by the manufacturers. If the scan tool being used does not provide this very helpful step, most manufacturers make their hexadecimal coding available per year and vehicle; some for free and some not for free. Either way, to use Mode $06 takes some getting used to. A word of caution, erasing codes or disconnecting the battery will cause Mode $06 information to be missing or false or not appear until all the monitors have been run.

When all the monitors show COMPLETE. DONE, YES or READY in the Quick Test Mode as previously explained, Mode $06 data is ready to be observed.

Once in Mode $06, Test IDs (TID) and Component IDs (CID) assigned by the different manufacturers for various systems and components can be observed. For a failure to occur, the test result must be below minimum or above maximum specifications. If the hexadecimal code for a TID and CID are given and there is a failure, and the scan tool does not convert this information, you will need to gain access to OE information pertaining to that year and make of the vehicle being diagnosed. If the scan tool converts this information, then the min/max test results can be observed right way.

Figure 5

MODE $06 DIAGNOSTICS



Mode $06 Non-Continuous Monitors

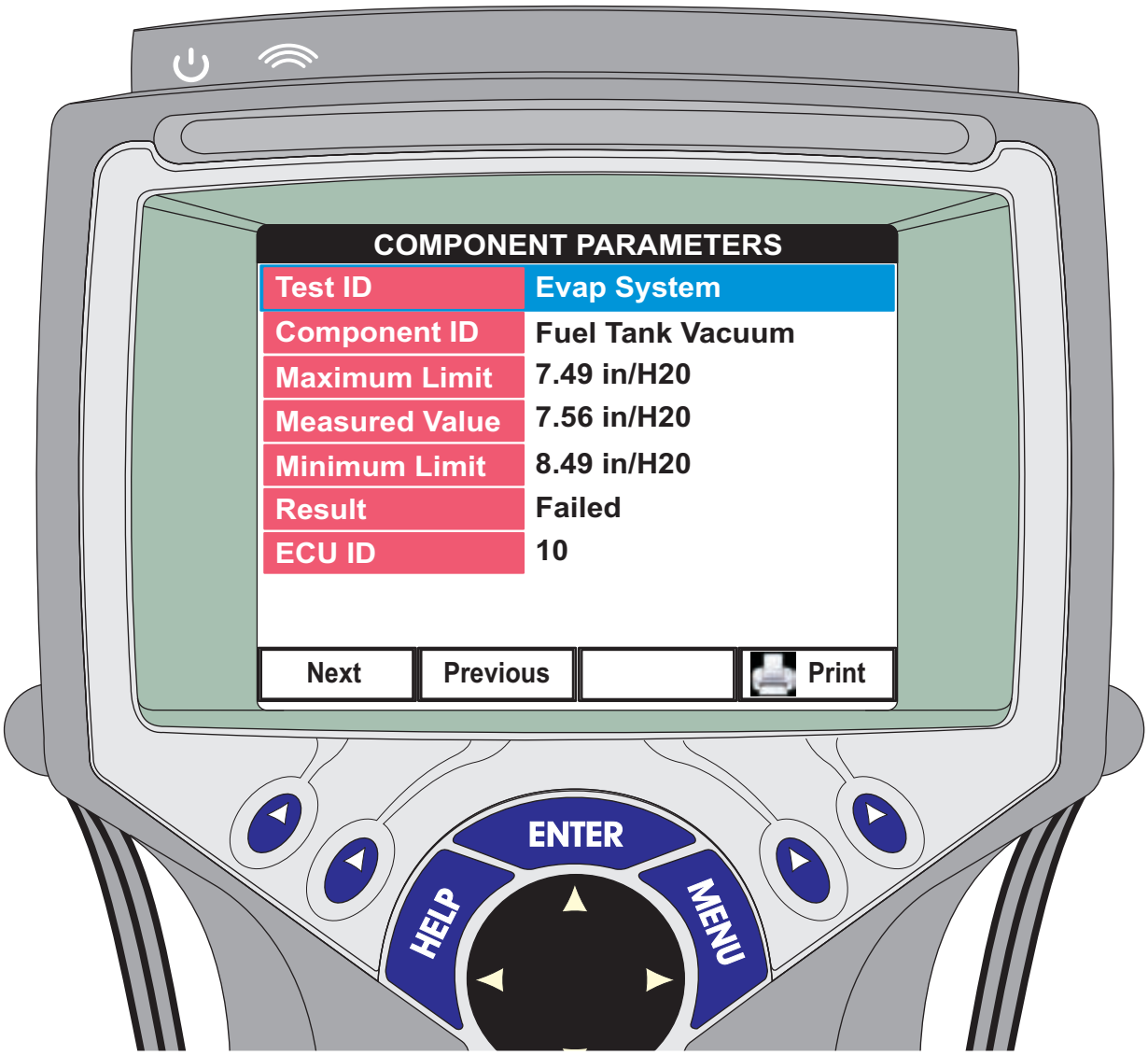
A dollar sign in front of a Mode $06 value indicates that what is to follow is a hexadecimal value as seen on the scan tool display above. These numbers are meaningless unless you can translate them into regular decimal values. Many modern scan tools perform this conversion automatically. When buying a scan tool you may want to ask if the scan tool being considered for purchase can perform these conversions. If your scan tool cannot perform these conversions, then you will have to visit the O.E. manufacturers service information website or search the internet.

When all else fails, the following formula can be used to convert any Mode $06 Hex value into a decimal value: Subtract the measured value from 32,768. Multiply the total by .00195 (don't omit the decimal point), the total will be a decimal figure that should make sense as seen in Figure 7.

Using the example shown above: 32768 - 28890 = 3878... 3878 x .00195 = 7.56 in/H20.
Now the technician can compare this to service information for what the proper operating value should be and can now make the correct diagnosis.

Figure 6

MODE $06 DIAGNOSTICS



Mode $06 Non-Continuous Monitors

In the scan tool display shown above the Mode $06 values have been converted by the scan tool and can now be understood by the technician.

One of the benefits of Mode $06 is that it can provide test results on components before they are bad enough long enough to fail. Since minimum and maximum values are provided, if a measured value is close to a minimum or a maximum value, it's a component on the verge of going bad.

At the least you can always go into Global OBDII and check the status of your monitors especially if you are having drive-ability issues with no stored diagnostic codes. If a monitor will not run, it can not check its related components to be able to set a code. This can point you in the proper direction of diagnostics to begin to resolve the issue at hand.

For more information on Mode $06, visit the bookstore at www.attstraining.com

Figure 7

GM 4L60E
NO ENGAGEMENT - REPEAT PUMP ROTOR DESTRUCTION

COMPLAINT: After overhaul, 02 and up Chevy Trailblazers equipped with the 4.2-6 cyl. and the 300 mm. B-85 Torque Converter with the stall code of VJCX, may exhibit a no engagement concern due to the pump rotor drive lugs breaking.

CAUSE: The cause may be, that during the Torque Converter rebuilding process a shorter converter drive hub was used which caused the build height to be too short. This will allow the Torque Converter drive hub to come out of the Pump rotor when a hard throttle passing gear maneuver occurs, and when the drive hub tries to index itself back into the Pump rotor, it is not aligned breaking the drive lugs off, as shown in Figure 1, which will in turn cause no line pressure/no engagement. ***Note: This can be missed by the R&R tech as the bell housing is enclosed and the Torque Converter to Flex plate bolts are installed thru a small access hole underneath the structural oil pan.***

CORRECTION: Replace the Pump Rotor and or Pump as sometimes the pump is destroyed when the rotor breaks, and refer to Figure 2 and ensure that the Build Height of the replacement torque converter is approximately 6 and 7/16."

Special thanks to David Gott Ace Trans. MO

4L60E PUMP ROTOR

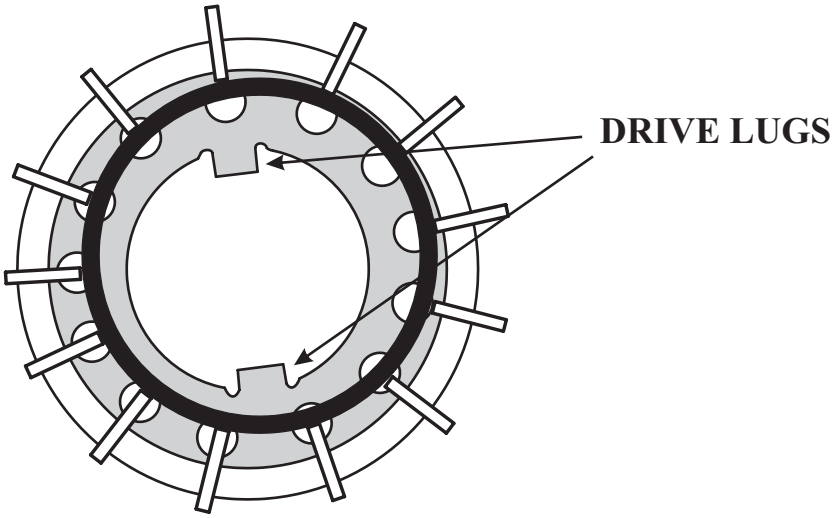
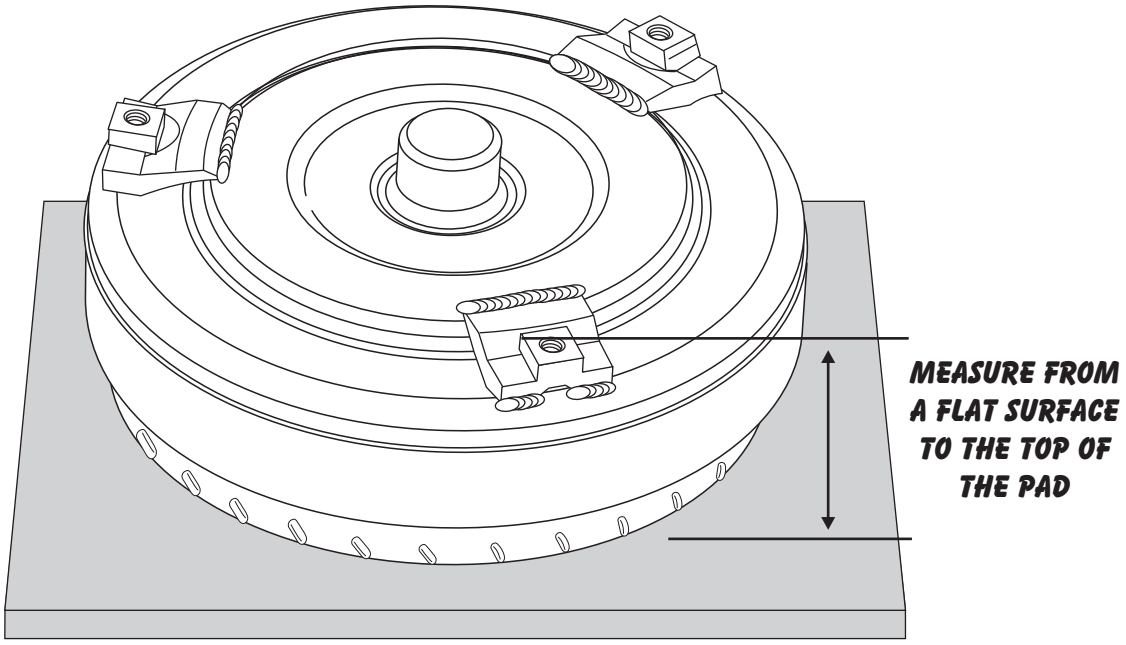


Figure 1

CHECKING OVERALL BUILD HEIGHT



Place Torque Converter on a flat surface neck side down and measure from that surface to the top of the pad as shown above.

B-85 VJCX Build Height is approximately 6 and 7/16"

Figure 2

Filtran
16

5L40E

STOPS MOVING AFTER OVERHAUL OR SERVICE

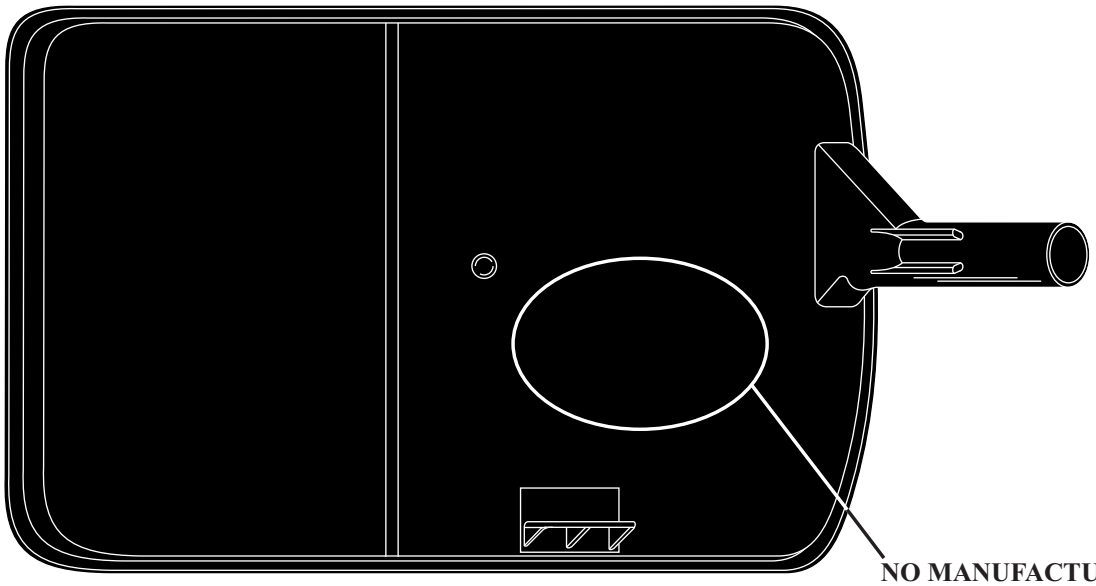
COMPLAINT: After overhaul or servicing of the transmission, the vehicle stops moving during the post repair road test. A line pressure check indicated a sudden loss of line pressure at the time the vehicle stopped moving.

CAUSE: An inferior after market sump filter was installed. In most instances there will be no manufacturer identification anywhere on the inferior filter, see Figure 1.
The inferior filter has lower sloped shallow ribs in the filter cover, Figure 2, which allows the filter media to get sucked into the filter suction tube thereby cutting off the oil supply from the sump.

CORRECTION: Install a quality sump filter which has higher sloped deep ribs on the filter cover as seen in Figure 3 which keeps the filter media from getting sucked up into the filter suction tube.

5L40E STOPS MOVING AFTER OVERHAUL OR SERVICE

INFERIOR FILTER



QUALITY FILTER

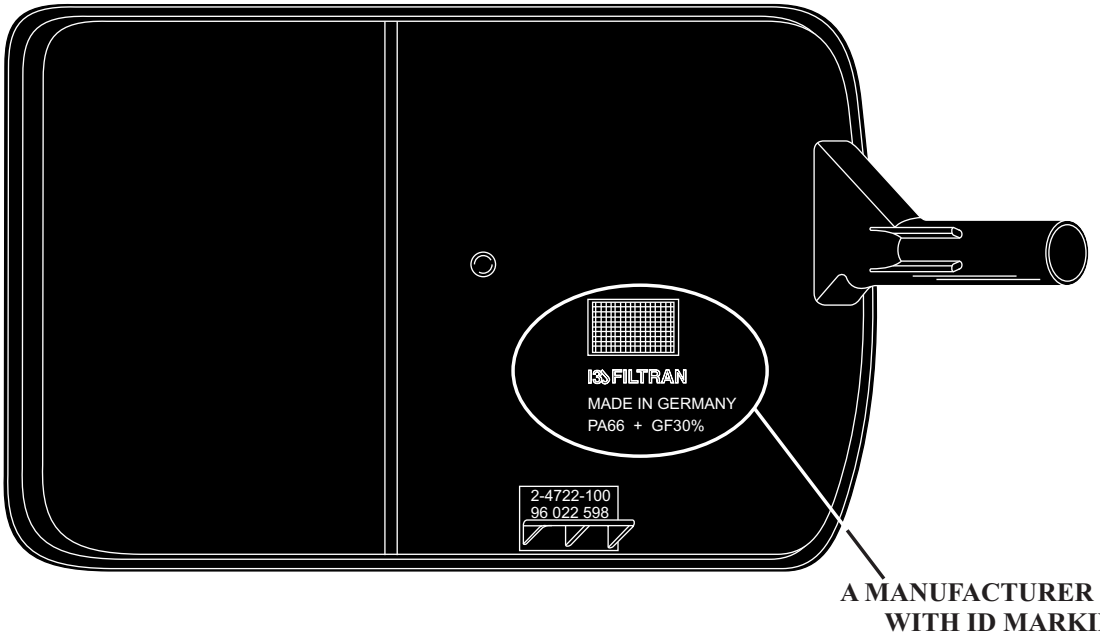
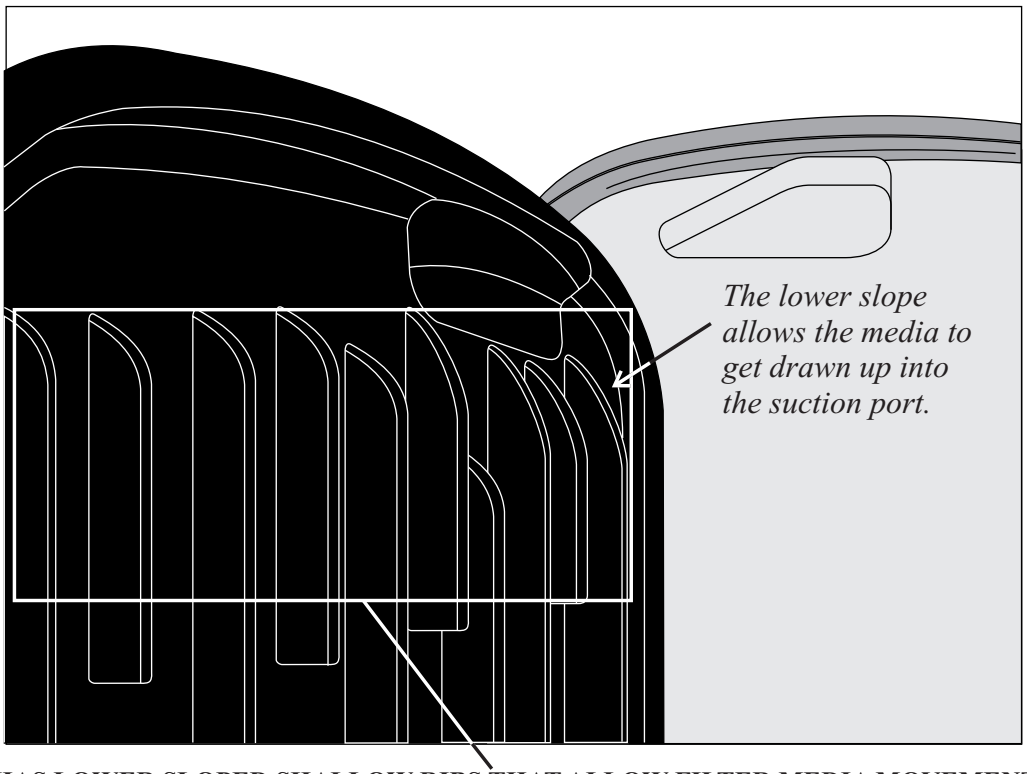


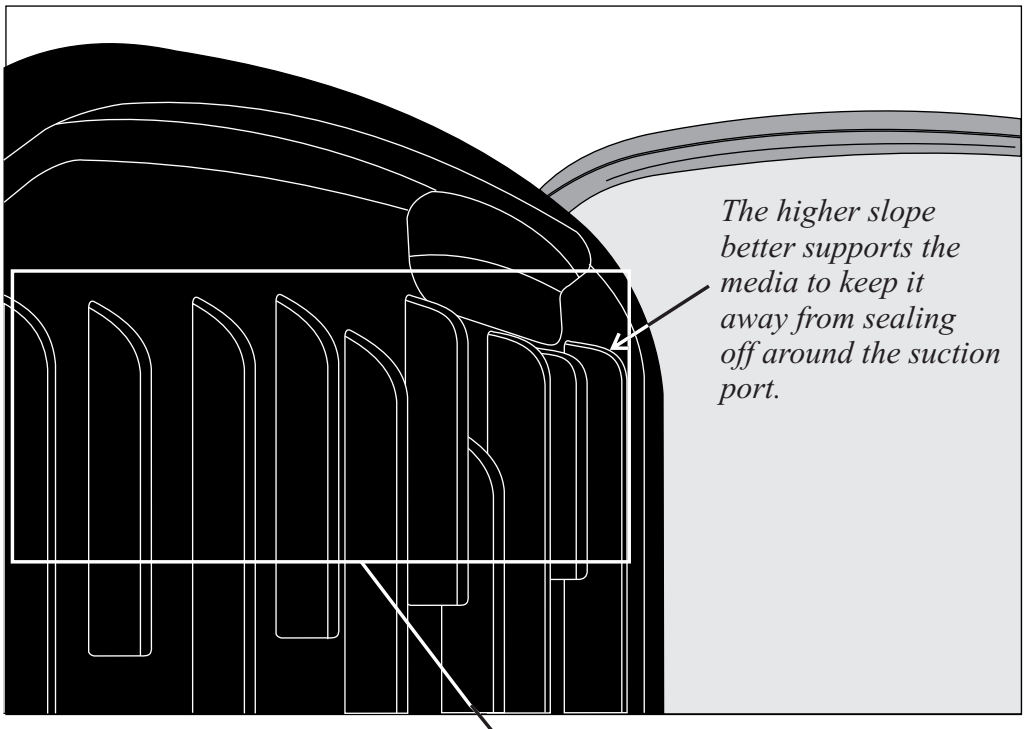
Figure 1

5L40E STOPS MOVING AFTER OVERHAUL OR SERVICE



HAS LOWER SLOPED SHALLOW RIBS THAT ALLOW FILTER MEDIA MOVEMENT

Figure 2



HAS HIGHER SLOPED DEEPER RIBS THAT HOLD THE FILTER MEDIA IN PLACE

Figure 3

6T70/75
P0741 TCC STUCK OFF AFTER REBUILD

COMPLAINT: After rebuild, the transmission exhibits a slipping converter clutch producing code P0741 - TCC Stuck Off. Upon reinspection nothing seems to be wrong so the converter is changed and the transmission reinstalled only to discover the problem remains.

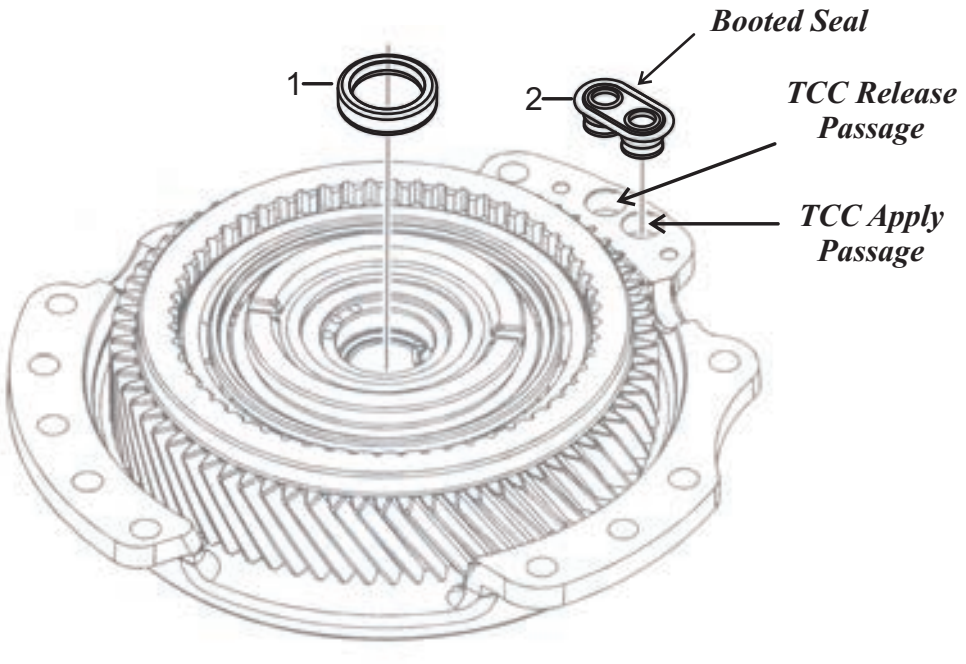
CAUSE: One cause may be that the booted seal (# 2 seal in figure 1) between the case and the front differential transfer gear drive support assembly is installed incorrectly.

It is very easy to think that the boot side of the seal fits into the case and the flat side of the seal against the support assembly. If this is done, when the computer commands a full apply of the converter clutch, the apply pressure being compromised by an incorrectly placed seal causes the converter to slip and P0741 to set.

CORRECTION: The boot side of the seal must fit into the front differential transfer gear drive support assembly as seen in figure 1. The flat side seals against the case half.

The # 1 seal in figure 1 is directional sensitive as well. The open face of the seal goes down into the support as seen in figure 1. If the closed face side of the seal went into the support with the open face upwards, TCC release pressure could exhaust and cause a possible stall when placed into gear or cause the converter clutch to partially apply dragging the clutch causing it to be damaged prematurely.

Many thanks to Bill from Transmission Physicians



1 Front Differential Transfer Drive Gear Support Seal
2 Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly

Figure 1

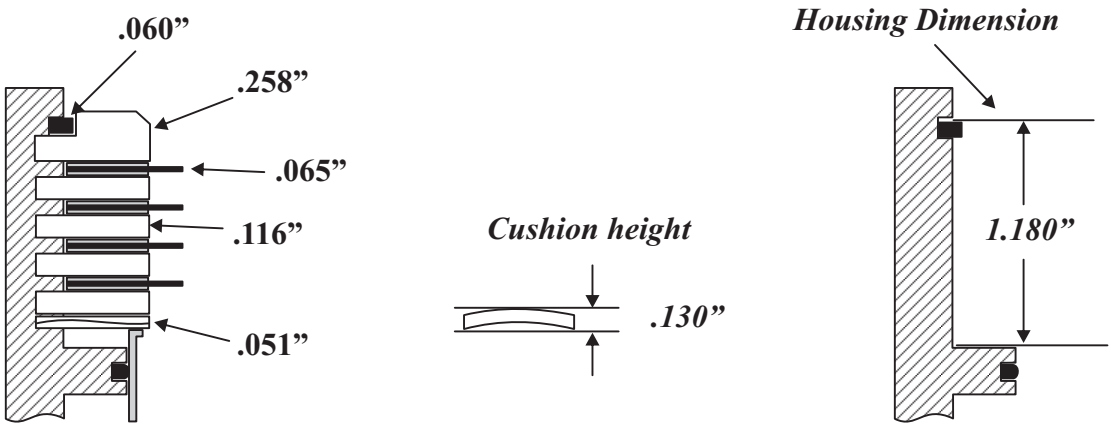
GM 6T70 AND FORD 6F50
3-5-REVERSE DRUM AND CLUTCH ASSEMBLY DIFFERENCES

COMPLAINT: During the overhaul process, a Ford 6F50 3-5-Reverse Clutch drum is used to replace the drum on a 6T70. In stacking up the clutch assembly using a new 6T70 cushion spring, it is noted that the 3-5- Reverse Clutch clearance is too tight.

CAUSE: The cause is the new 6T70 cushion spring being used in a 6F50 3-5-Reverse Drum because the 6T70 and 6F50 3-5-Reverse Drum have different dimensions (See Figure 1). Since the dimensions for these housings are different, the 6F50 utilizes a thinner cushion spring. This thinner Cushion Spring requires less distance from the top of the retaining snap ring to the area on the edge of the piston. Therefore, if the 6T70 cushion spring is used in place of the 6F50 cushion, there will be little to no clearance. Figure 1 also reveals that although the cushion plates are different, the clutch thickness and snap ring thickness are the same for both housings. Refer to Figure 2 for the 6T70 stack- up showing the thicker-wavier cushion spring, and refer to Figure 3 for the 6F50 stack -up.

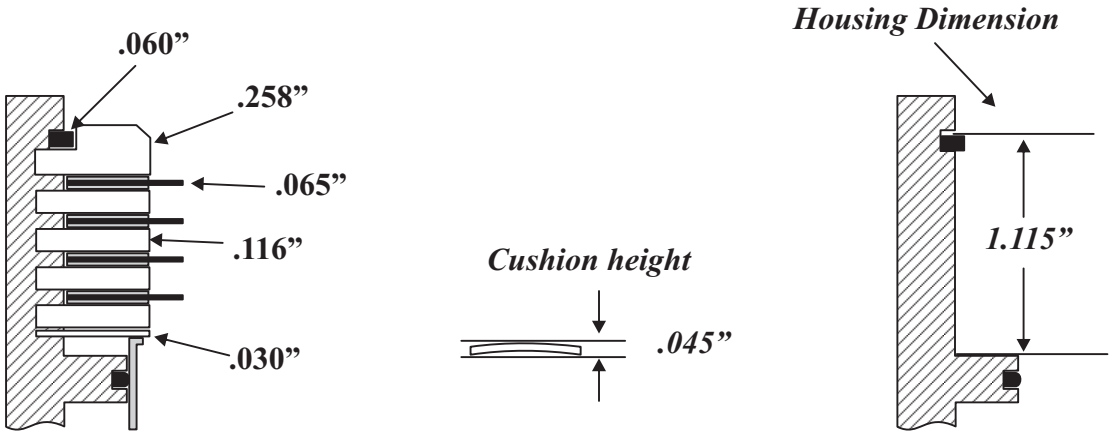
CORRECTION: Verify the dimensions in Figure 1-3 for both the cushion and the 3-5-Reverse Clutch housing and match the correct cushion dimension to clutch housing.

GM 3-5-REVERSE DRUM ASSEMBLY



Note: Housing dimension measured with snap ring seated in groove

FORD 3-5-REVERSE DRUM ASSEMBLY

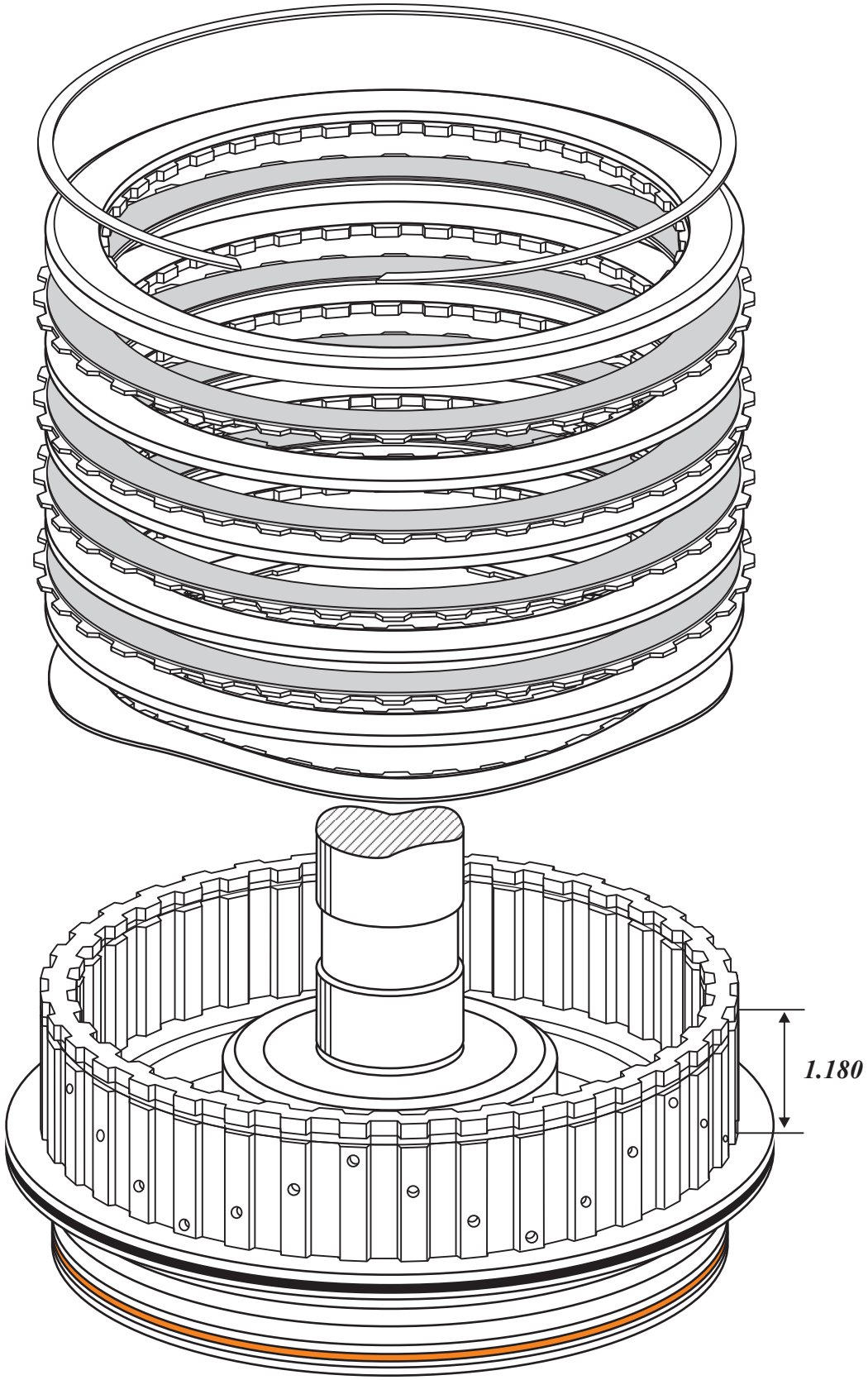


Typical clutch clearance is approximately .065"

Note: Housing dimension measured with snap ring seated in groove

Figure 1

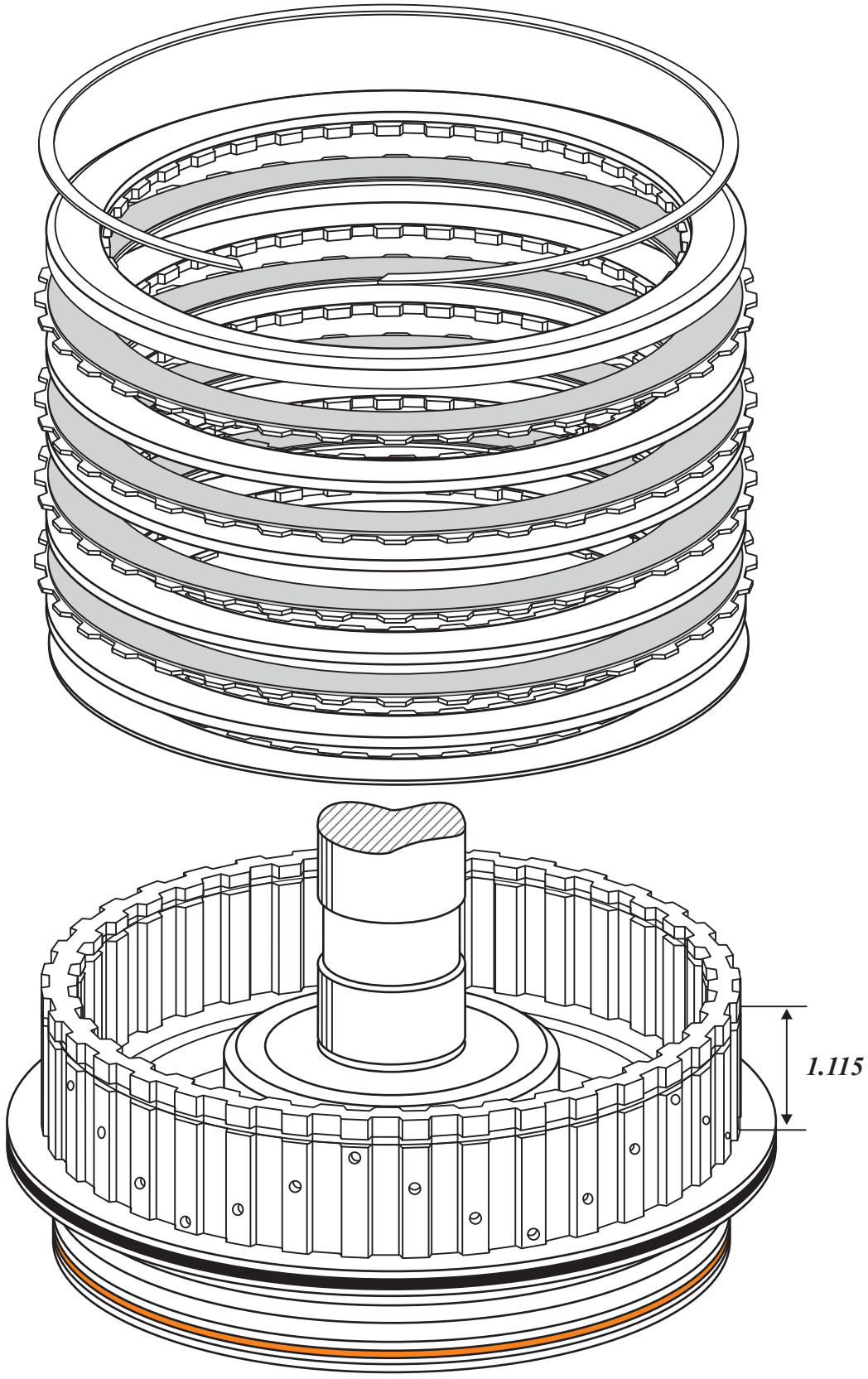
GM 3-5-REVERSE DRUM AND CLUTCH ASSEMBLY



Note: Measured with snap ring seated in groove

Figure 2

FORD 3-5-REVERSE DRUM AND CLUTCH ASSEMBLY



Note: Measured with snap ring seated in groove

Figure 3

Sonnax
25

Exedy
Left
26

Exedy
Right
27

GM 6L80/90
FLARE 2-3 AND OR ENGAGEMENT CONCERNS

COMPLAINT: GM vehicles equipped with the 6L80/90 transmission, built prior to December of 2008 may exhibit a complaint of a flared 2-3 upshift or a delayed with harsh application into Forward and/or Reverse engagements. Note: this complaint has been linked more to a cold condition but may show up at any time.

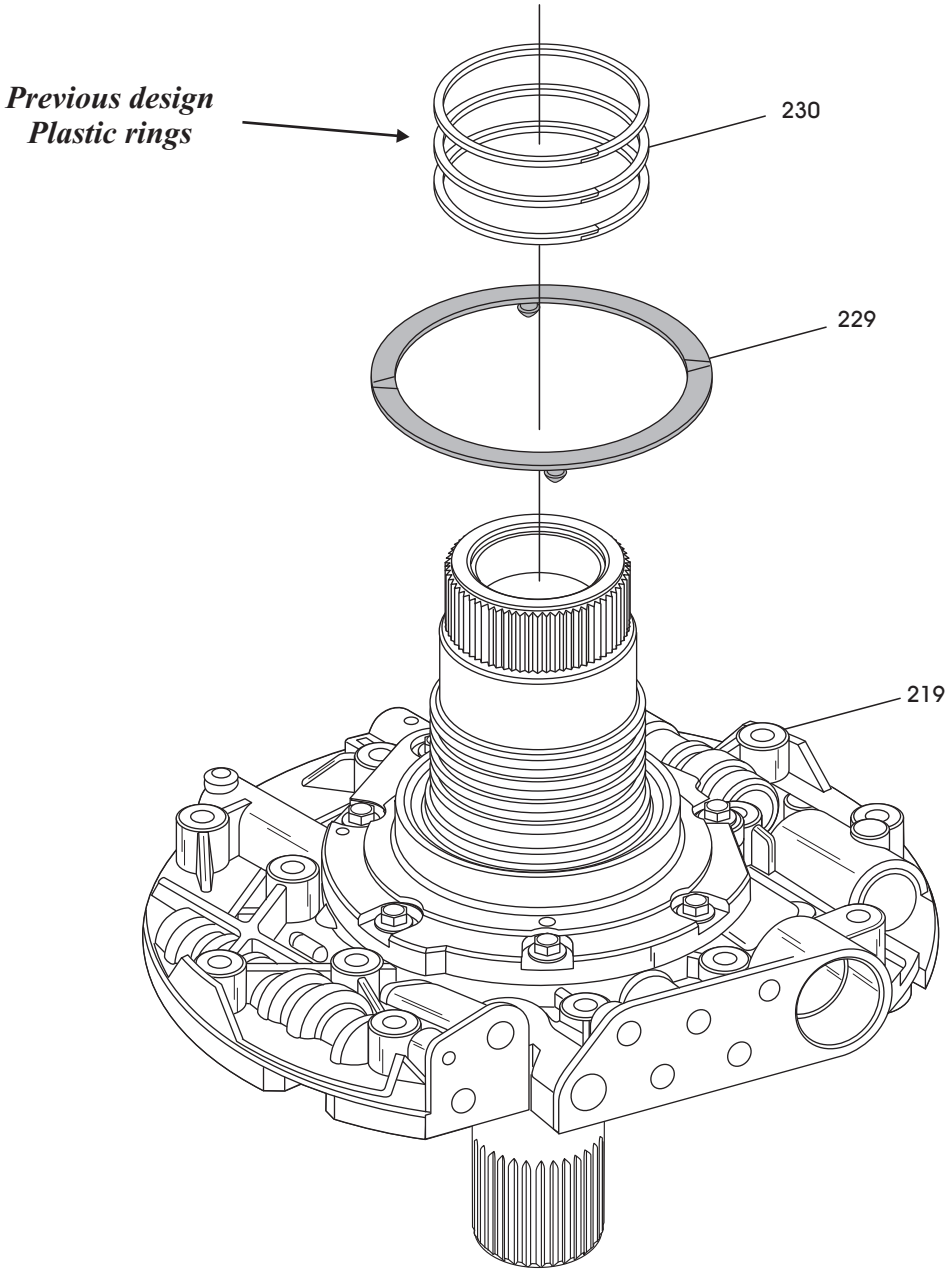
CAUSE: The cause may be, leakage in the sealing ring area on the pump cover which feeds the 1-2-3-4 and 3-5-Reverse Clutch packs, causing a slow application, which can also cause elevated pressure as the TCM may try to adjust for the slow application.

CORRECTION: To correct this condition, replace the previous design pump cover with the one piece sealing rings (Figure 1) with the new two piece design pump cover with anti-rotational tab rings (Figure 2). A machining process was performed on this new pump cover to the ring land so as to accommodate the new anti-rotational tabs on the sealing rings. Note: This two piece sealing ring design was updated to prevent leakage in the 1-2-3-4 and 3-5-Reverse Clutch apply circuits and will retro-fit to previous models as a complete assembly. Refer to Figure 3 to see the mandatory pump alignment ring that must be used when replacing the pump cover. Figure 3 also shows the available alignment tools, and Figure 4 shows the bolt torque and sequence used when replacing the pump cover.

SERVICE INFORMATION:

PUMP COVER 2 PIECE SEALING RING DESIGN.....24248573
(New cover comes with rings already installed)
NOTE: This pump cover is also available from aftermarket sources.

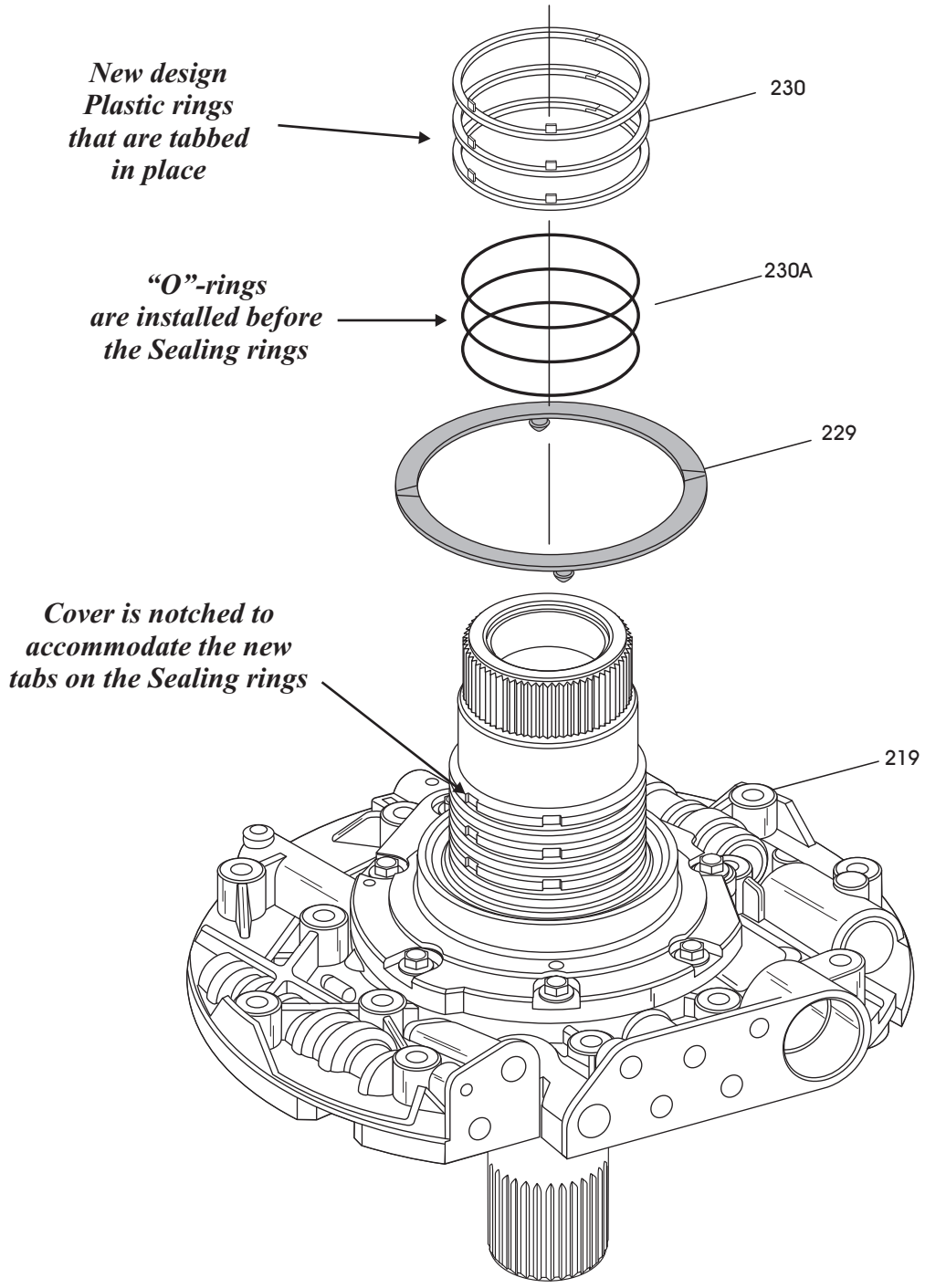
PREVIOUS DESIGN PUMP COVER



219 OIL PUMP COVER ASSEMBLY
229 1-2-3-4 AND 3-5 REVERSE HOUSING THRUST WASHER
230 1-2-3-4 AND 3-5 REVERSE SEAL RINGS (3 REQUIRED)

Figure 1

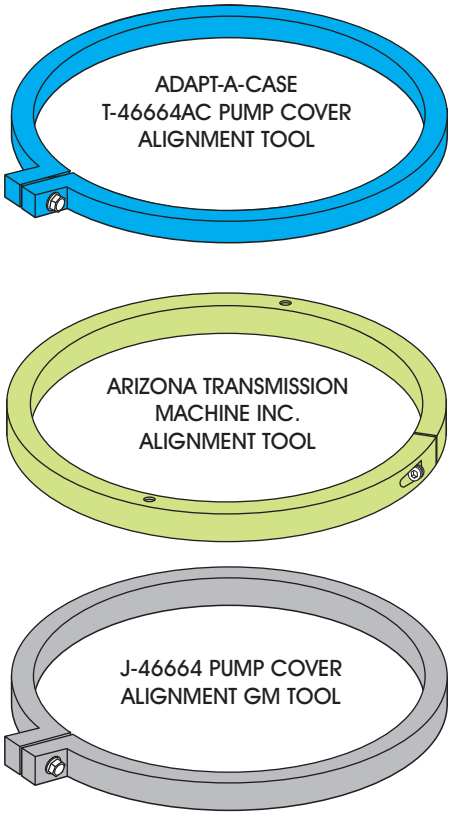
NEW DESIGN PUMP COVER

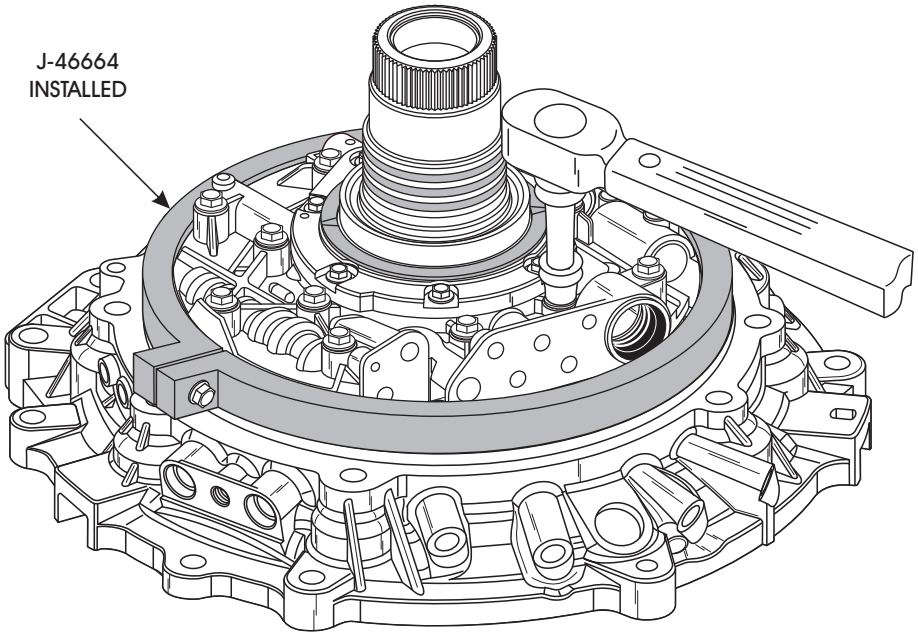


219 OIL PUMP COVER ASSEMBLY
229 1-2-3-4 AND 3-5 REVERSE HOUSING THRUST WASHER
230A 1-2-3-4 AND 3-5 REVERSE SEAL RINGS "O"- Rings (3 REQUIRED)
230 1-2-3-4 AND 3-5 REVERSE SEAL RINGS (3 REQUIRED)

Figure 2

ALIGNMENT TOOL INSTALLATION



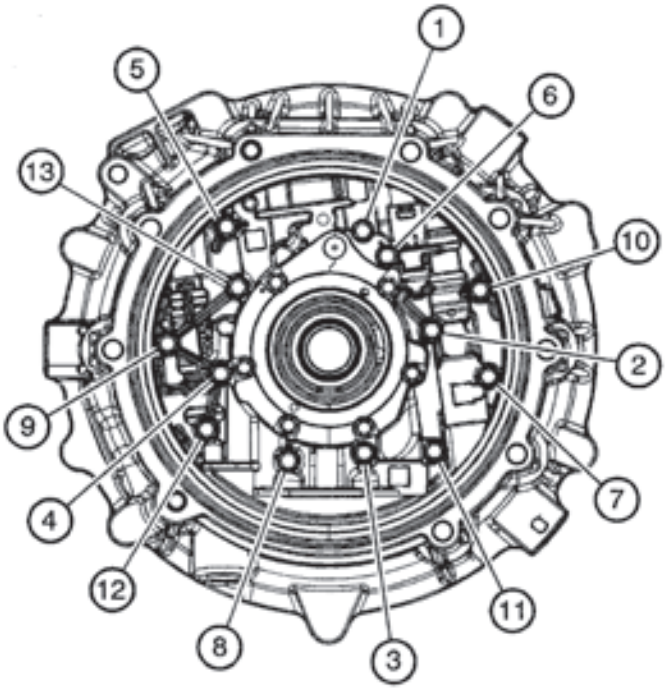


TORQUE BOLTS TO:
11 N·M (97 IN.LB.)
SEE FIGURE 4 FOR SEQUENCE

Figure 3

BOLT TORQUE SEQUENCE

TORQUE BOLTS TO:
11 N·M (97 IN.LB.)



Note: Torque the 13 oil pump cover retaining bolts to 11 Nm (97 in.lb.) using the sequence shown above starting with number 1.

Figure 4

DAACO
33

Hayden
34

WIT
35

6L80 SERIES TRANSMISSIONS

NO MOVEMENT AFTER OVERHAUL

COMPLAINT: After overhaul the vehicle loses both forward and reverse movement. When the Service Fast Learn (SFL) procedure was attempted to reset the shift adapts, it would abort approximately half way through the process.

CAUSE #1: When the transmission was disassembled the 1-2-3-4 clutch pack retaining snap ring was found to have popped out of the clutch drum snap ring groove.
The 1-2-3-4 clutch drum has one machined lug that is different from all the others as seen in Figure 1. If any part of the solid area of the snap ring is positioned against this lug, it will not be fully seated and will pop out of place during the initial road test.

CAUSE #2: When the transmission was disassembled, the input carrier was found to be installed ***upside down.*** This prevented the 1-2-3-4 clutch drum splines from engaging the input carrier. Notice in Figure 3 that the splines on the input carrier and the mating splines in the drum are short. The input carrier will drop over the sun gear and rotate in place which would make it appear normal.

CAUSE #3: When a new 3-5-Reverse clutch drum is replaced, it is installed without the 3-5 -Reverse clutch drum bearing. A new drum does not come with this bearing unless the 3-5-Reverse clutch drum kit is purchased.

CORRECTION #1: Install the clutch pack retaining snap ring so the snap ring gap straddles the machined lug in the drum as shown in Figure 2.

CORRECTION #2: Make certain the splines of the input carrier engage the splines of the 1-2-3-4 clutch drum.

CORRECTION #3: If only a new 3-5-Reverse drum is purchased without the bearing, purchase and install the bearing, see Figure 4. Or, purchase a new 3-5-Revese Drum Kit which comes with the bearing. The bearing removal and installation procedures if needed can be seen in Figures 5 and 6.

SERVICE INFORMATION:

3-5-Reverse Clutch Drum Bearing.....24226393
3-5-Reverse Clutch Drum Kit With Bearing.....24260894

Many thanks to Greg Nader from Sonnax® for providing the necessary material that made this bulletin possible.

6L80 NO MOVEMENT AFTER OVERHAUL

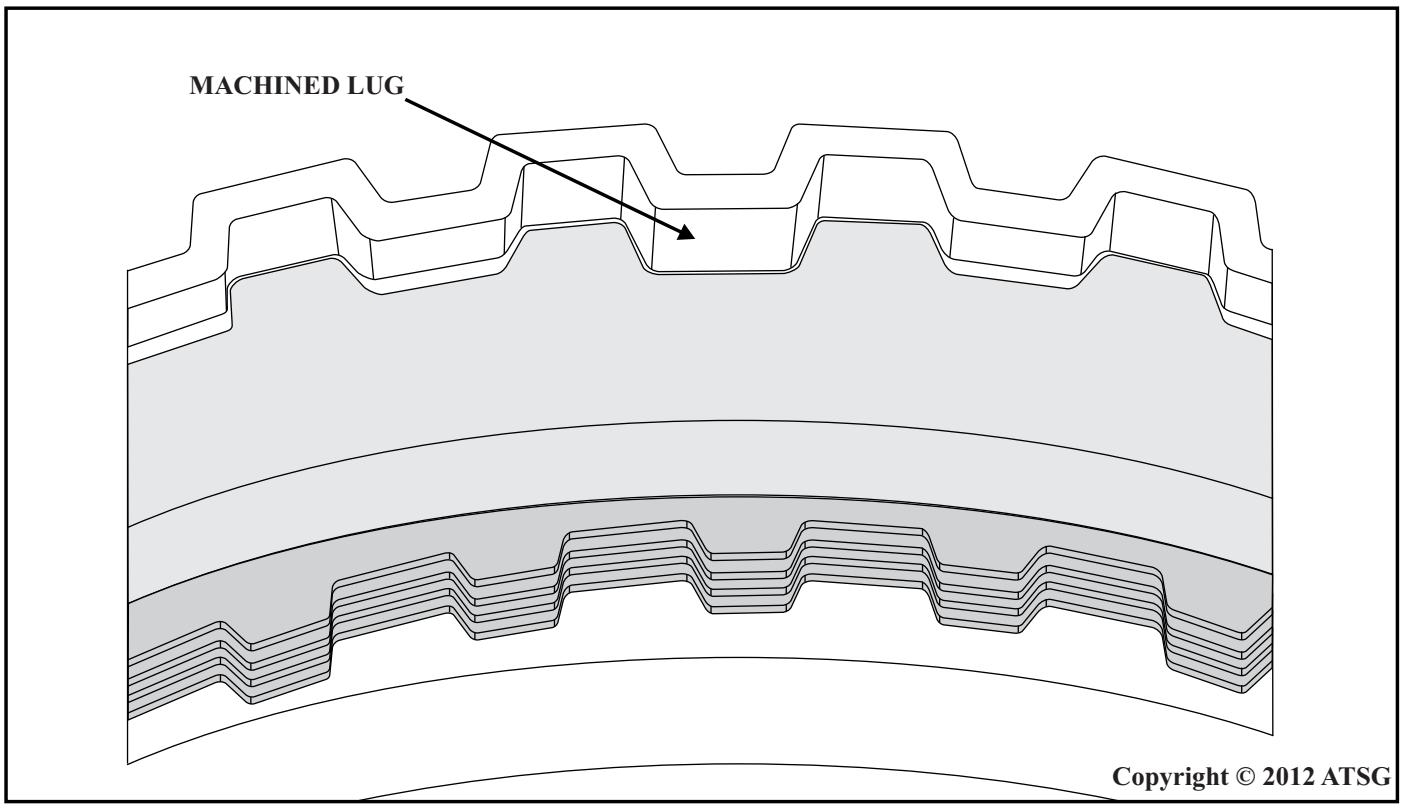


Figure 1

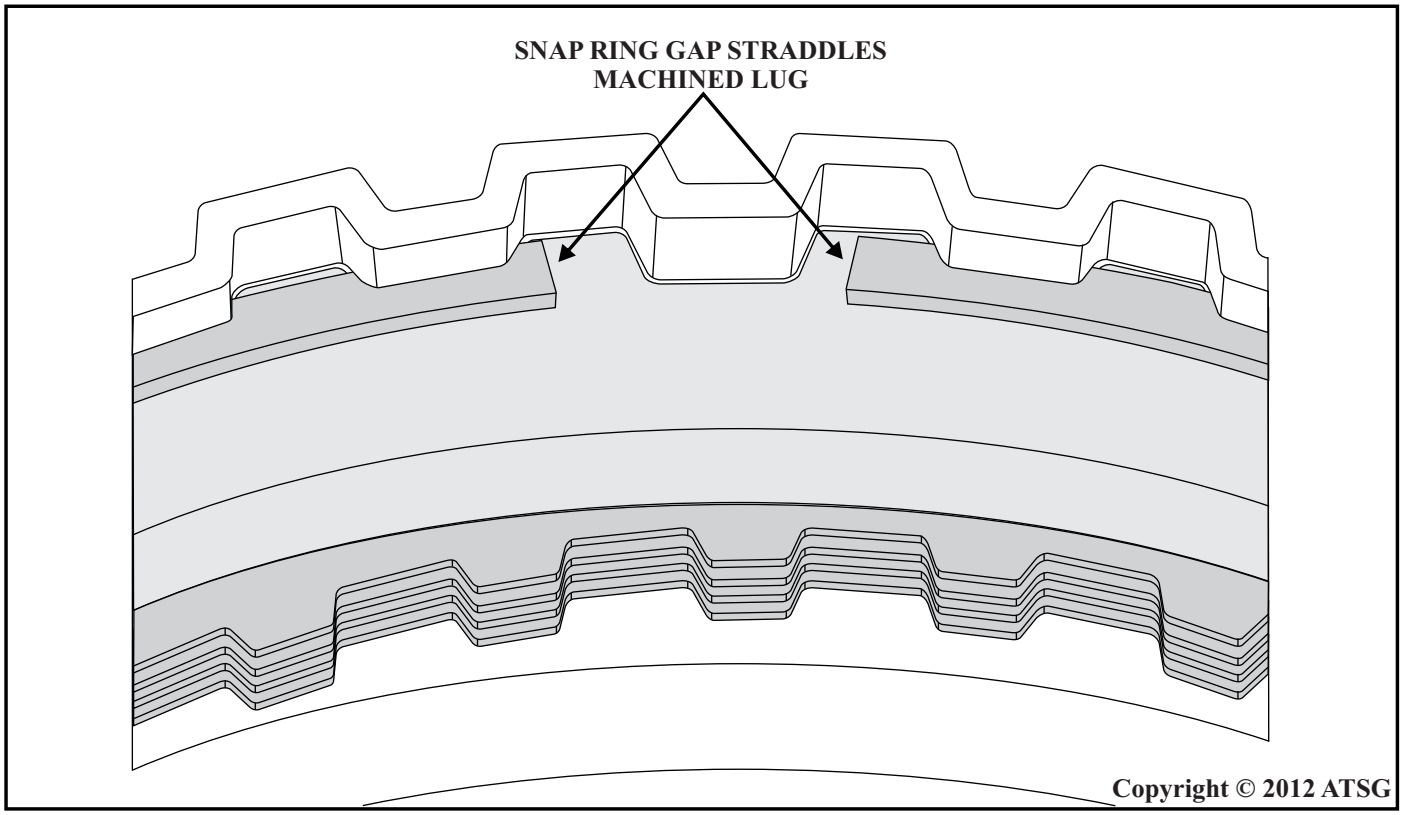
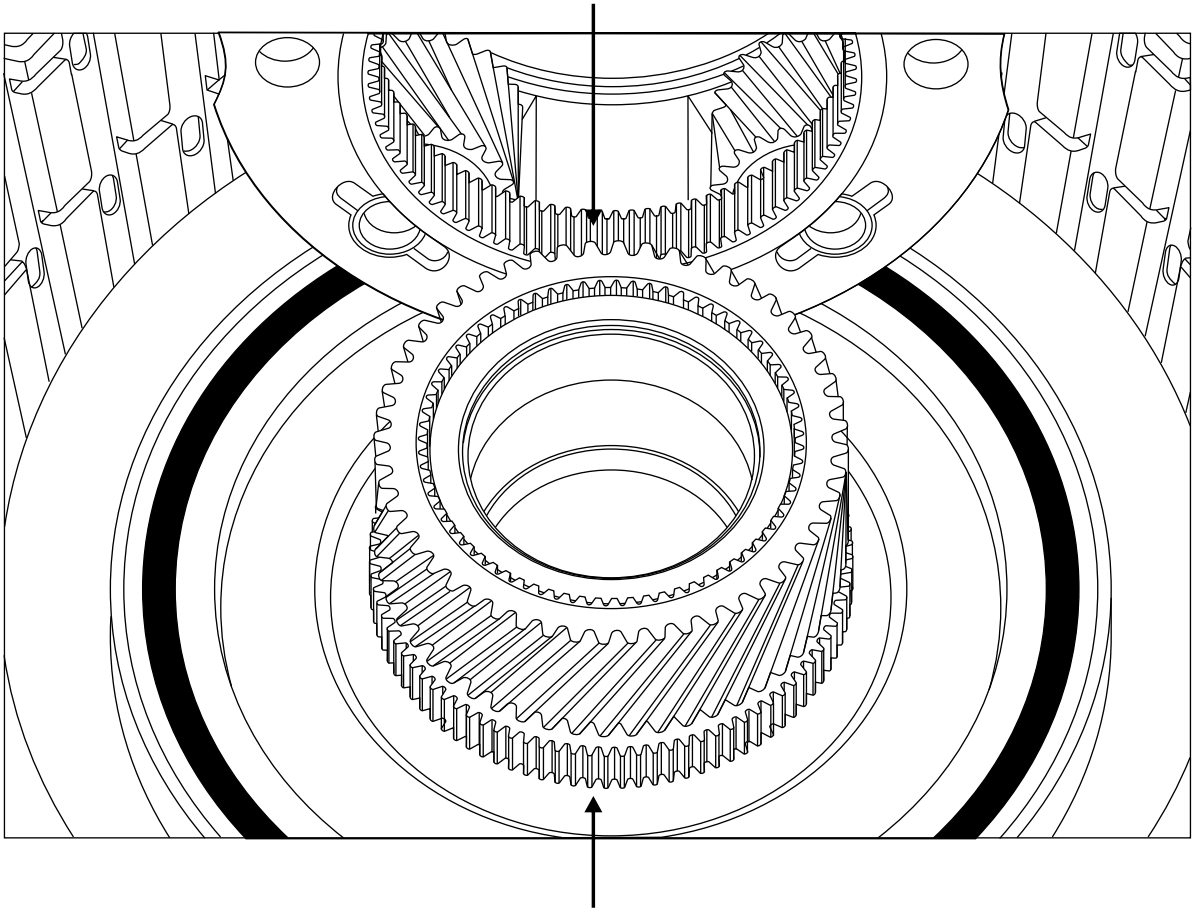


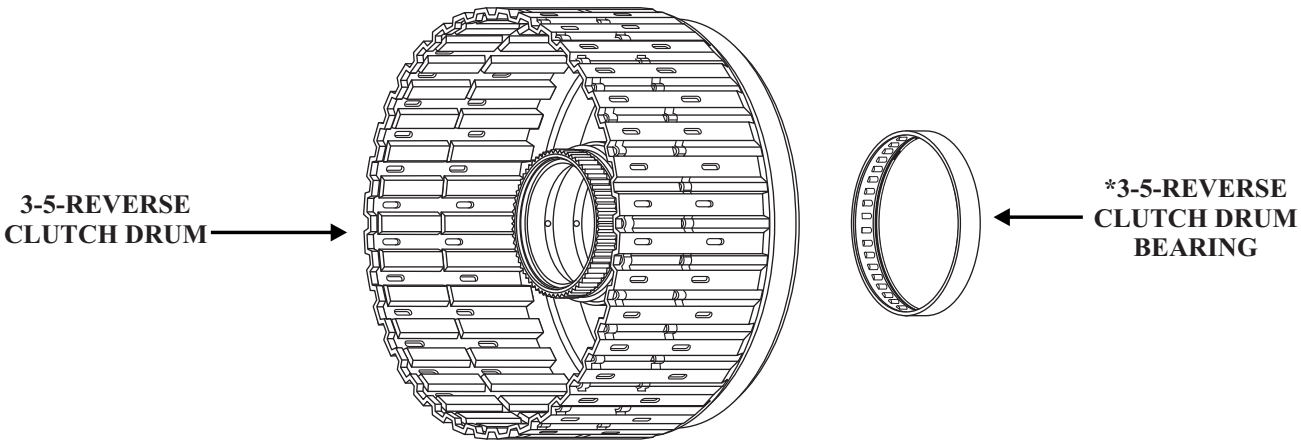
Figure 2

6L80 NO MOVEMENT AFTER OVERHAUL



Make certain input carrier splines engage mating splines in the 1-2-3-4 clutch drum.

Figure 3



***Make certain a new bearing is installed in the 3-5-Reverse drum.**

Figure 4

6L80 NO MOVEMENT AFTER OVERHAUL

BEARING REMOVAL

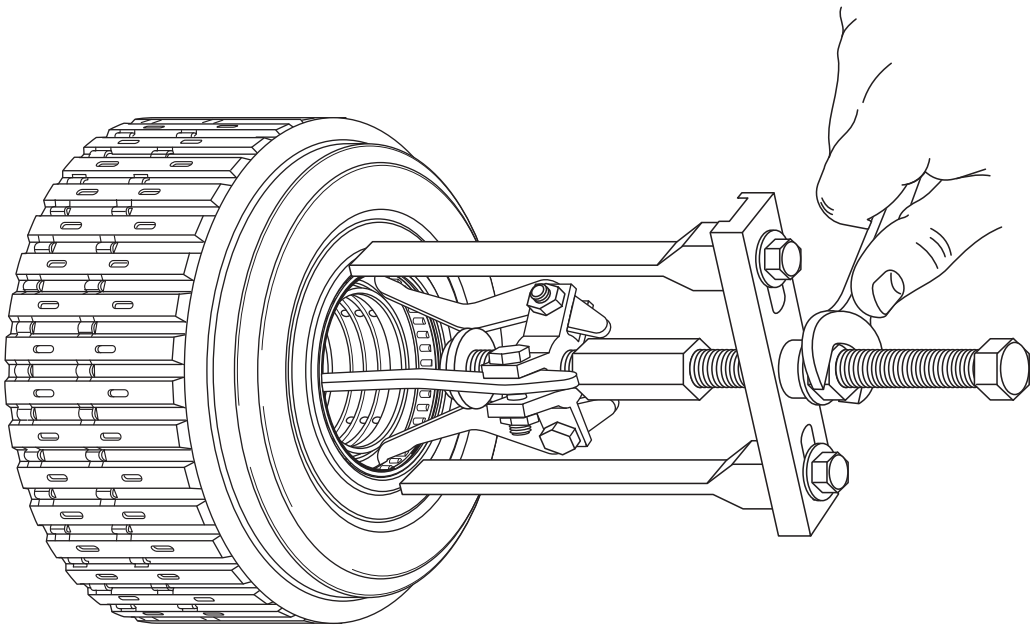


Figure 5

BEARING INSTALLATION

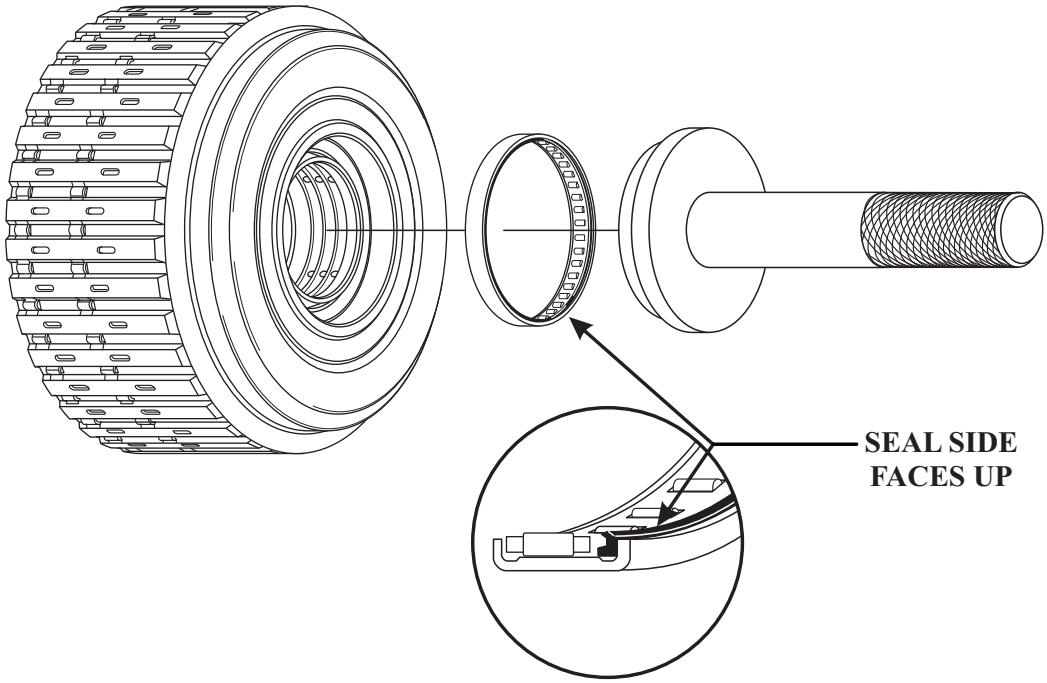


Figure 6

6L80 SERIES TRANSMISSIONS

3-5-REVERSE CLUTCH FAILURE AFTER OVERHAUL

COMPLAINT: After overhaul and during the post repair road test, the transmission feels like it made a gear shift without command. This occurs only on heavy throttle and the gear shift is indistinguishable as to which gear it shifted. Upon disassembly of the transmission the 3-5-Reverse frictions are burnt. When the 3-5-Reverse clutch circuit was air checked, it checked good.

CAUSE: The 3-5-Reverse Clutch Piston Dam Seal was not installed onto the 1-2-3-4 Clutch Apply Piston. With the Dam Seal not in place there will be a drag on the 3-5-Reverse clutch during a 1-2 shift under heavy throttle operation.
The exclusion of this seal will cause a loss of "Compensator Release" pressure allowing centrifugal force to put a drag on the 3-5-Reverse clutch pack during high rpm conditions prematurely burning the frictions. The exploded view of the 1-2-3-4, 3-5-Reverse drum and all of it's components can be seen in Figures 1 and 2. Item **#418** is the dam seal that was omitted.

CORRECTION: Make certain this dam seal is installed in its proper location (Figure 3). An air check can be performed on the compensator circuit as shown in Figure 4. Had this test been performed it would have revealed a leak existed in this circuit.

Adapt-A-Case
41

VBX
42

Transtar
43

3-5-REVERSE CLUTCH DAMAGE AFTER OVERHAUL

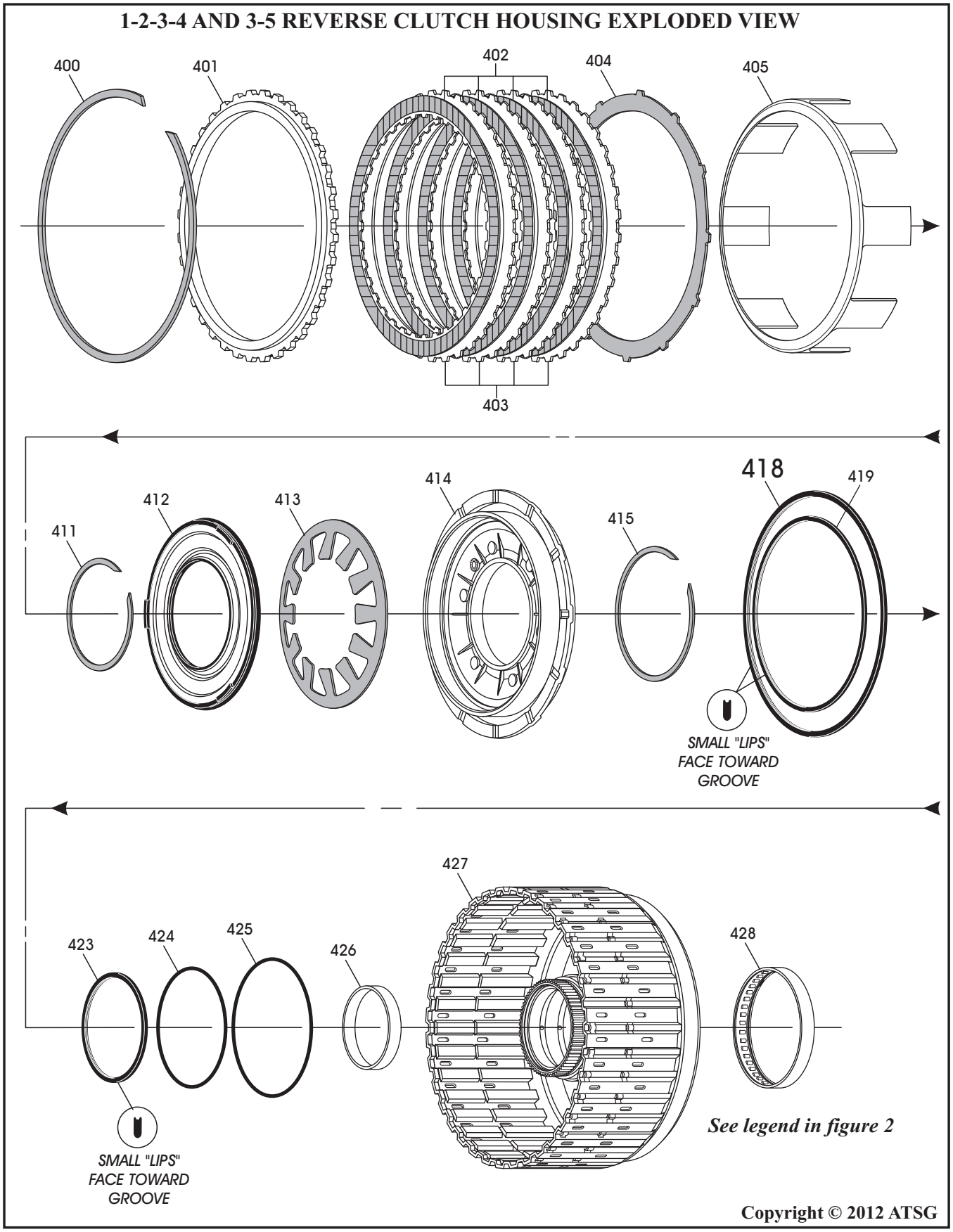
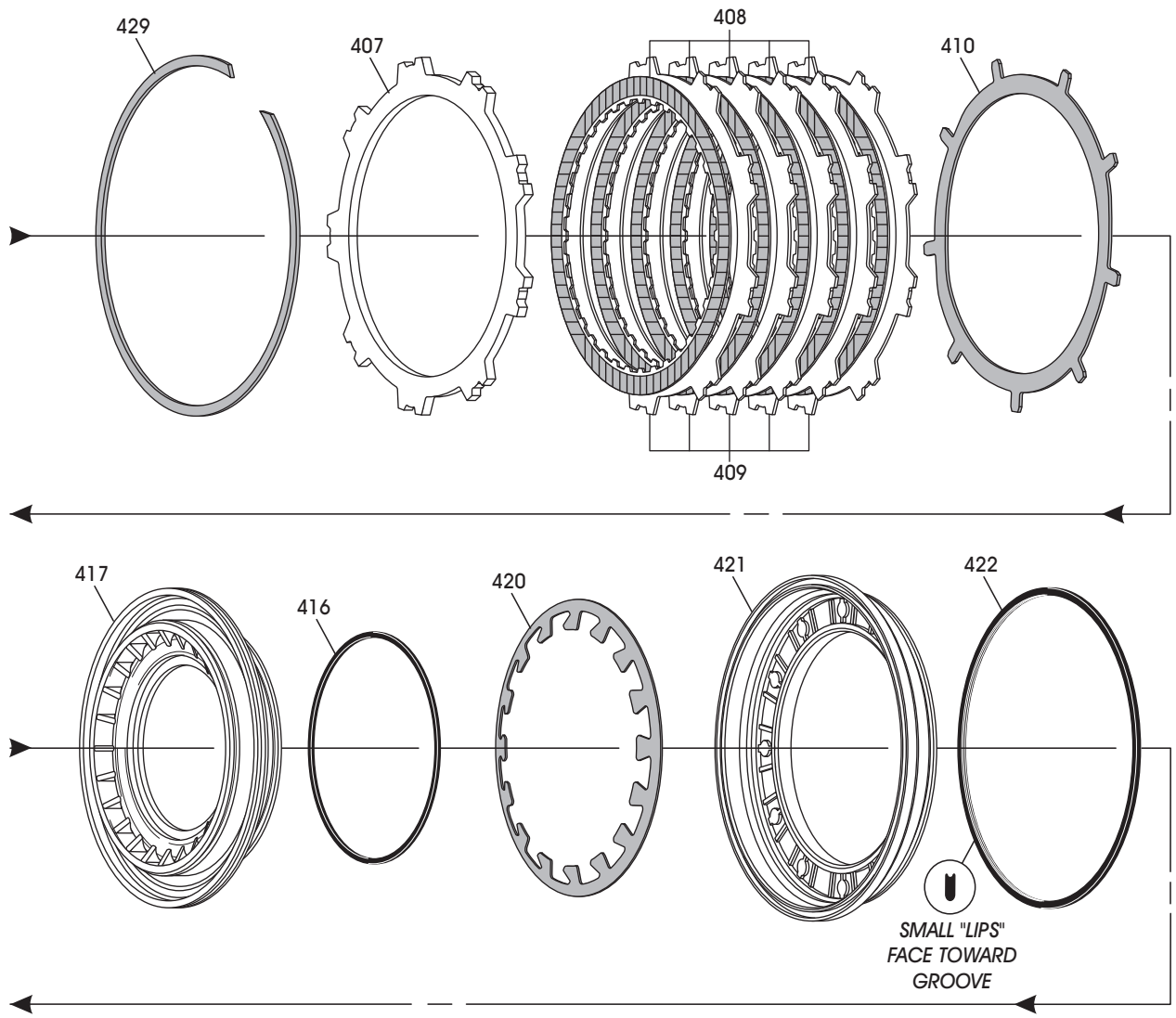


Figure 1

3-5-REVERSE CLUTCH DAMAGE AFTER OVERHAUL

1-2-3-4 AND 3-5 REVERSE CLUTCH HOUSING EXPLODED VIEW

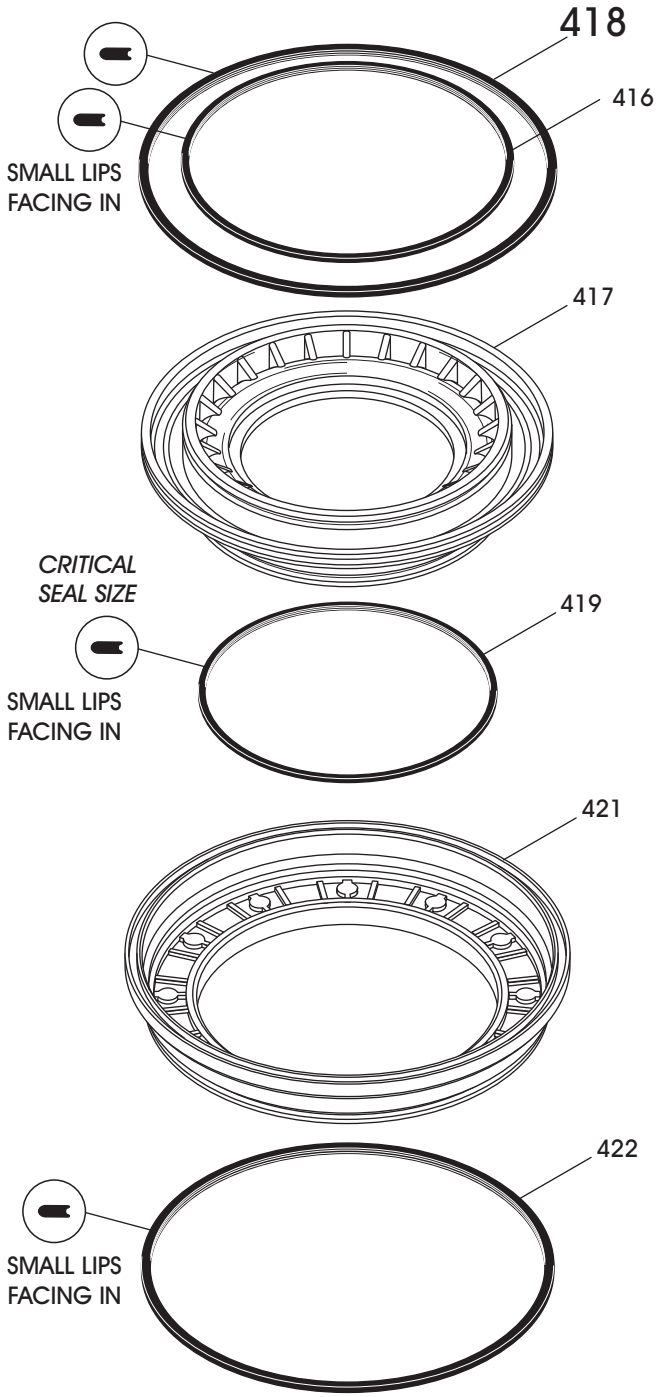


400 3-5 REVERSE CLUTCH BACKING PLATE SNAP RING
401 3-5 REVERSE CLUTCH BACKING PLATE
402 3-5 REVERSE CLUTCH FRICTION PLATES
403 3-5 REVERSE CLUTCH STEEL PLATES
404 3-5 REVERSE CLUTCH "WAVED" PLATE
405 3-5 REVERSE CLUTCH APPLY RING
407 1-2-3-4 CLUTCH BACKING PLATE
408 1-2-3-4 CLUTCH FRICTION PLATES
409 1-2-3-4 CLUTCH STEEL PLATES
410 1-2-3-4 CLUTCH "WAVED" PLATE
411 1-2-3-4 CLUTCH BALANCE PISTON SNAP RING
412 1-2-3-4 CLUTCH BALANCE PISTON
413 1-2-3-4 CLUTCH APPLY PISTON "BELLVILLE" RETURN SPRING
414 1-2-3-4 CLUTCH APPLY PISTON
415 1-2-3-4 CLUTCH PISTON HOUSING SNAP RING
416 1-2-3-4 CLUTCH APPLY PISTON SEAL
417 1-2-3-4 CLUTCH APPLY PISTON HOUSING
418 3-5 REVERSE CLUTCH PISTON DAM SEAL
419 3-5 REVERSE CLUTCH PISTON INNER SEAL (1ST DESIGN)
420 3-5 REVERSE CLUTCH APPLY PISTON "BELLVILLE" SPRING
421 3-5 REVERSE CLUTCH APPLY PISTON
422 3-5 REVERSE CLUTCH PISTON OUTER SEAL
423 1-2-3-4 CLUTCH PISTON INNER SEAL
424 1-2-3-4 CLUTCH PISTON HOUSING SEAL
425 1-2-3-4 CLUTCH PISTON HOUSING SEAL
426 3-5 REVERSE CLUTCH HOUSING REAR BUSHING
427 3-5 REVERSE CLUTCH HOUSING ASSEMBLY
428 3-5 REVERSE CLUTCH HOUSING BEARING ASSEMBLY
429 1-2-3-4 CLUTCH BACKING PLATE SNAP RING

Figure 2

3-5-REVERSE CLUTCH DAMAGE AFTER OVERHAUL

1-2-3-4 AND 3-5 REVERSE CLUTCH PISTON & SEALS EXPLODED VIEW



416 1-2-3-4 CLUTCH APPLY PISTON SEAL
417 1-2-3-4 CLUITCH APPLY PISTON HOUSING
418 3-5 REVERSE CLUTCH PISTON DAM SEAL
419 3-5 REVERSE CLUTCH PISTON INNER SEAL (1ST DESIGN)
421 3-5 REVERSE CLUTCH APPLY PISTON
422 3-5 REVERSE CLUTCH PISTON OUTER SEAL

Figure 3

3-5-REVERSE CLUTCH DAMAGE AFTER OVERHAUL

3-5 REVERSE CLUTCH PASSAGE ID

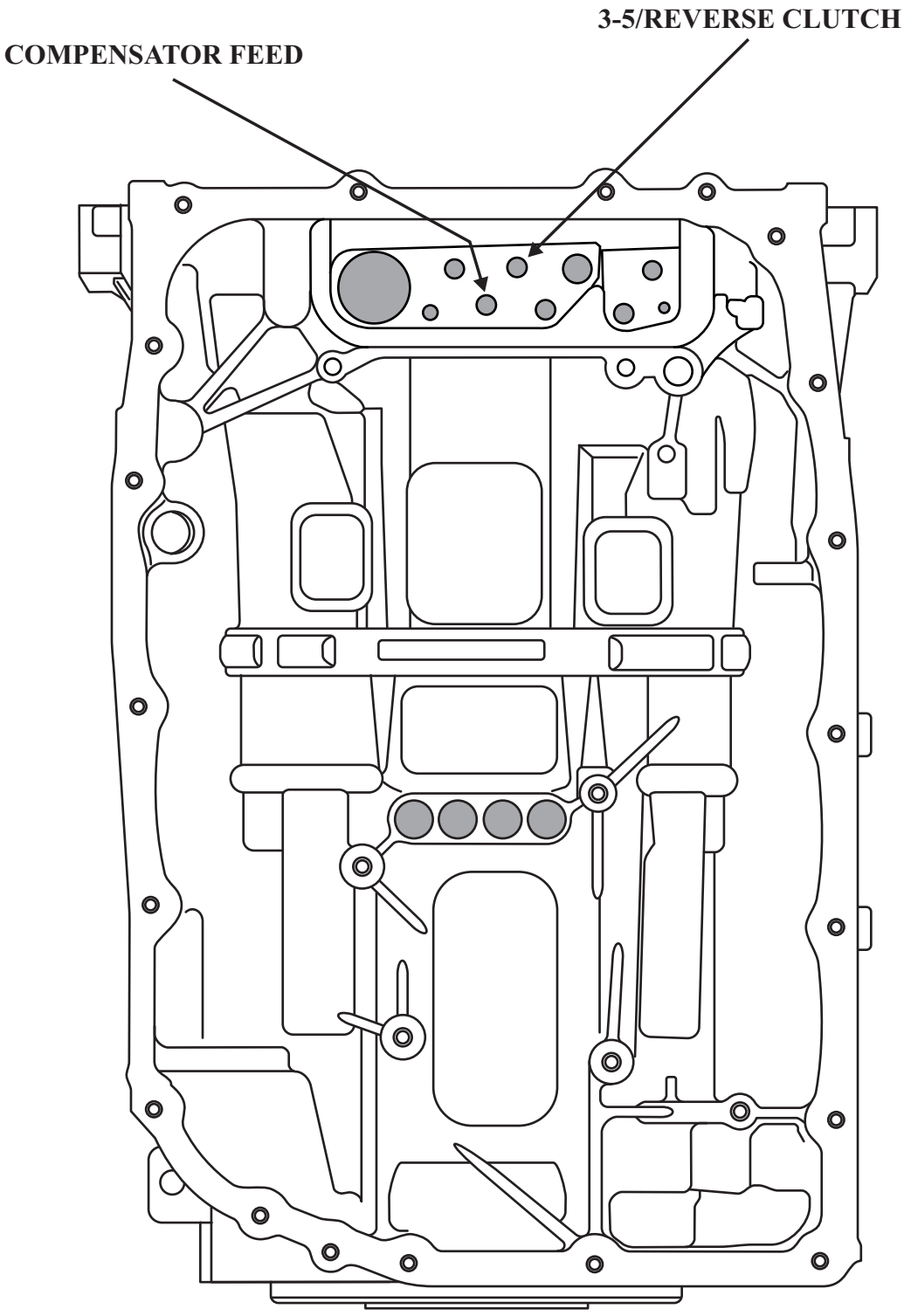


Figure 4

NP263HD TRANSFER CASE

HARSH COAST DOWN SHIFTS

COMPLAINT: A GM truck equipped with an Allison 1000 transmission and a New Process 263HD Transfer Case (Figure 1) may have a complaint of harsh coast down shifts. There may be an oil leak from the rear seal. When scanned for Diagnostic Trouble Codes, P0746 for "Solenoid "A" Controlled Clutch Stuck OFF" or P0776 for "Solenoid "B" Controlled Clutch Stuck Off" are stored. The computer aborts to a failsafe causing the transmission to lose reverse and since the vehicle is so heavy it does not move forward well in high gear failsafe.

CAUSE: The root cause of these complaints are caused by a severely worn out yoke bushing which damaged the rear case half of the transfer case (Figure 2). Strangely enough, the rear seal may not be leaking at all but there still is a considerable amount of sloppiness in the drive shaft yoke to case half fit. This wear compromised the support of internal components allowing the VSS to rub into the tone ring (Figure 3). The irregular air gap of the speed sensor caused the signal to spike yet not code for the sensor itself and cause all of the above mentioned complaints.
NOTE: Transfer case pump damage may result in VSS tone ring damage with the same above mentioned complaints.

CORRECTION: Depending on the severity of the bushing damage, the rear case half of the transfer case may have to be replaced possibly with the driveshaft yoke. In addition the VSS will be destroyed as well as damage to the VSS tone ring.

A special thank you to Ralph at Alonso Transmission in Miami, Fl. for providing the information that made this bulletin possible.

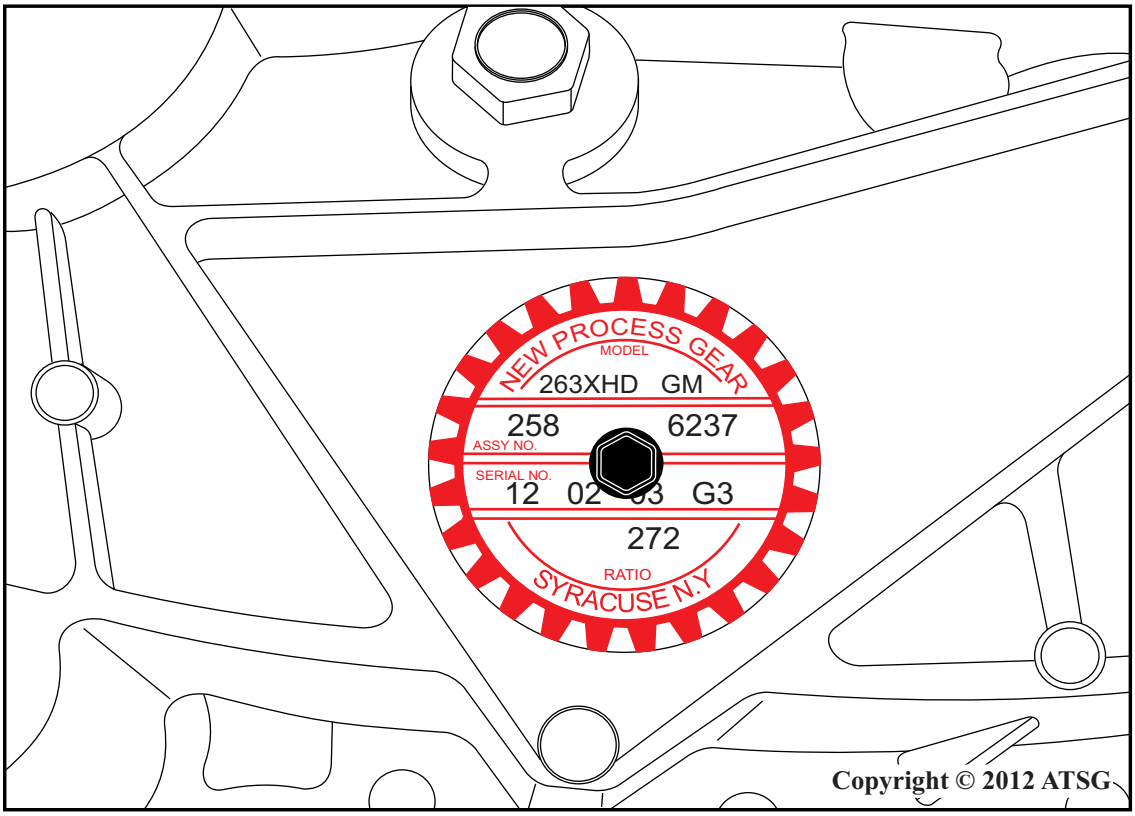


Figure 1

NP263HD TRANSFER CASE

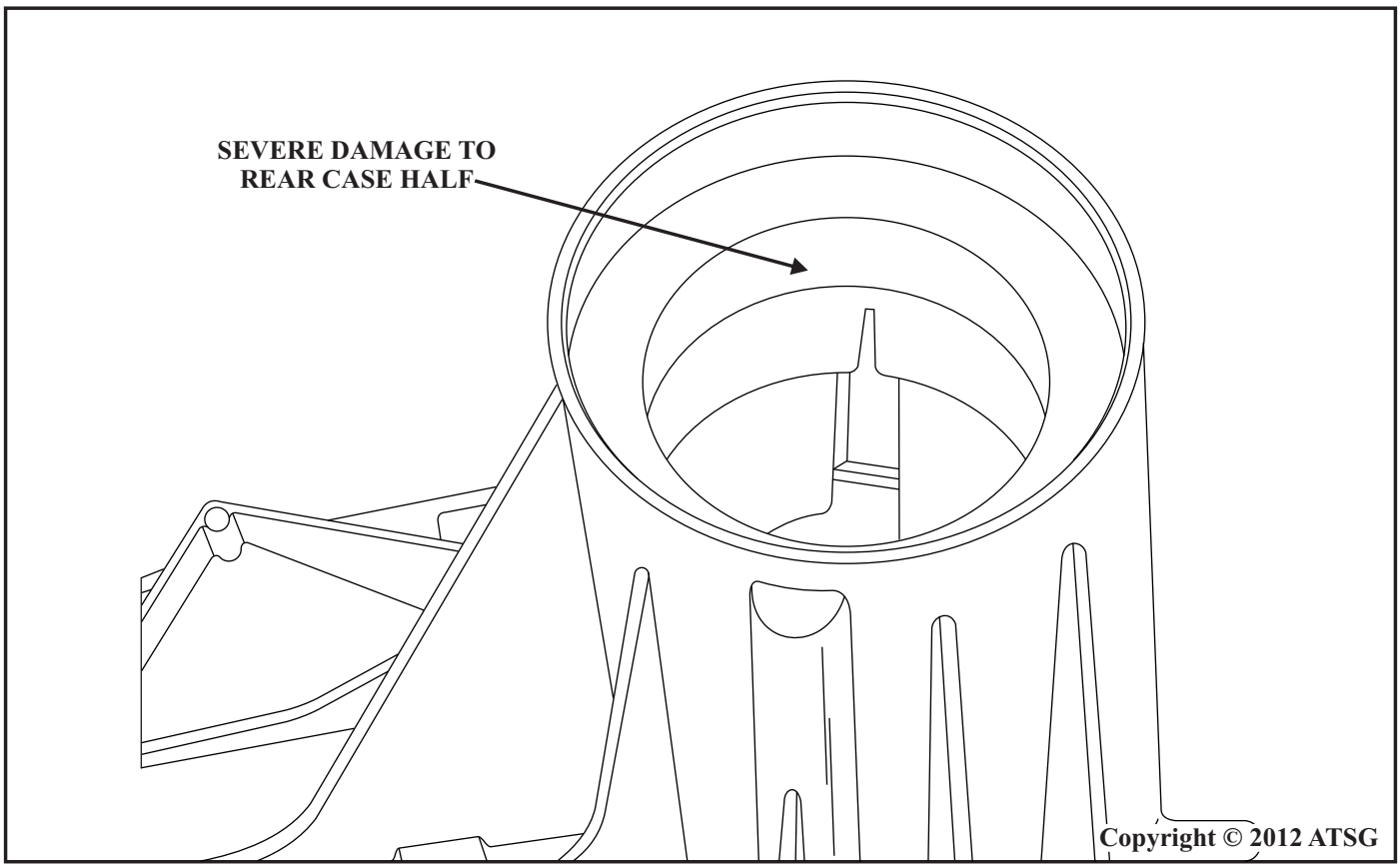


Figure 2

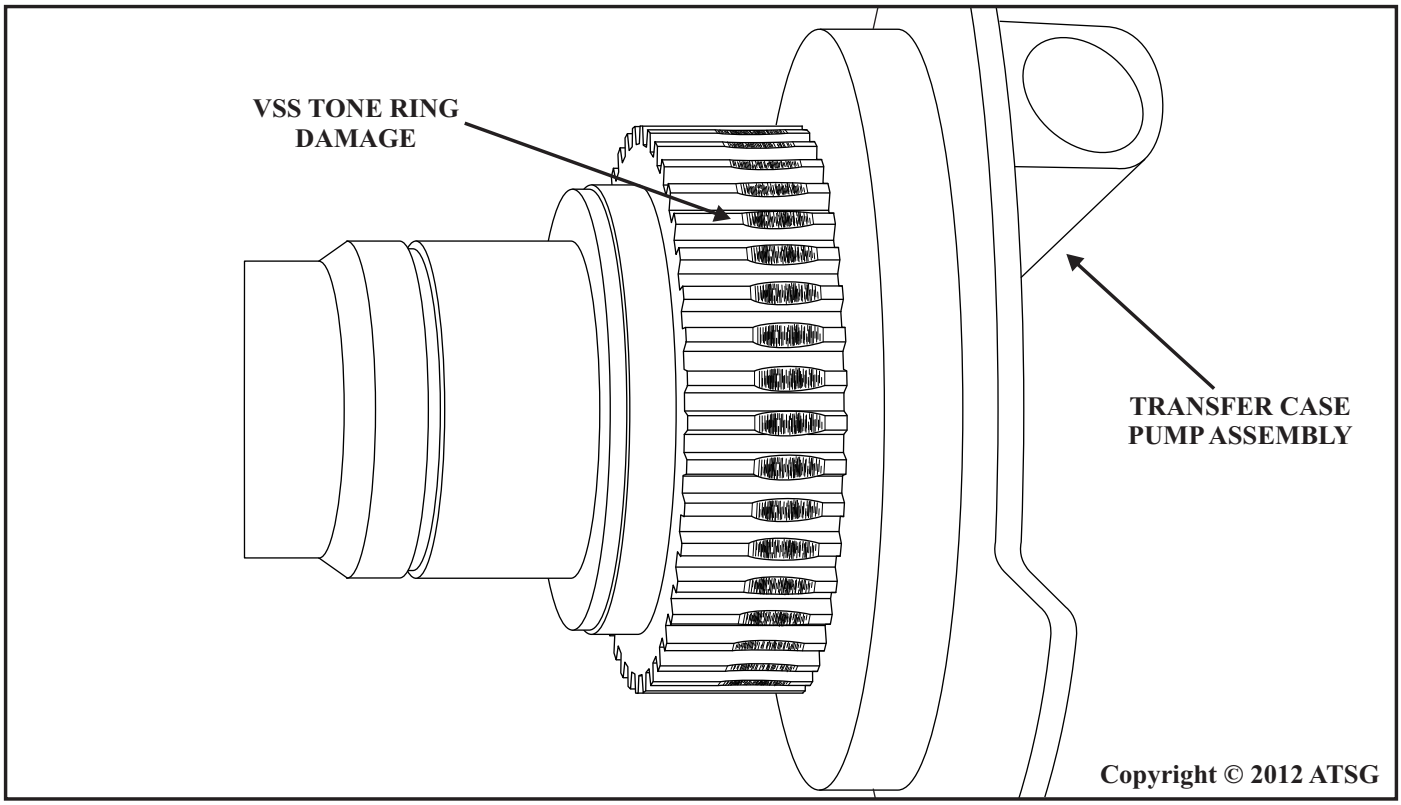


Figure 3

ALLISON LCT 1000/2000

NO REVERSE - NO CODES

COMPLAINT: A 2006 or later GM truck equipped with the Allison 1000/2000 transmission may have a complaint of "No Reverse". There is a "Shift Inhibit" message displayed in the Driver Information Center, and when scanned for diagnostic trouble codes, none are found to be stored.

CAUSE: All the above mentioned complaints are caused by a LOW transmission fluid level caused by leaking cooler lines at the transmission. 2006 and later Allison 1000/2000 equipped trucks are having cooler line connection problems.

CORRECTION: Replace the cooler lines.

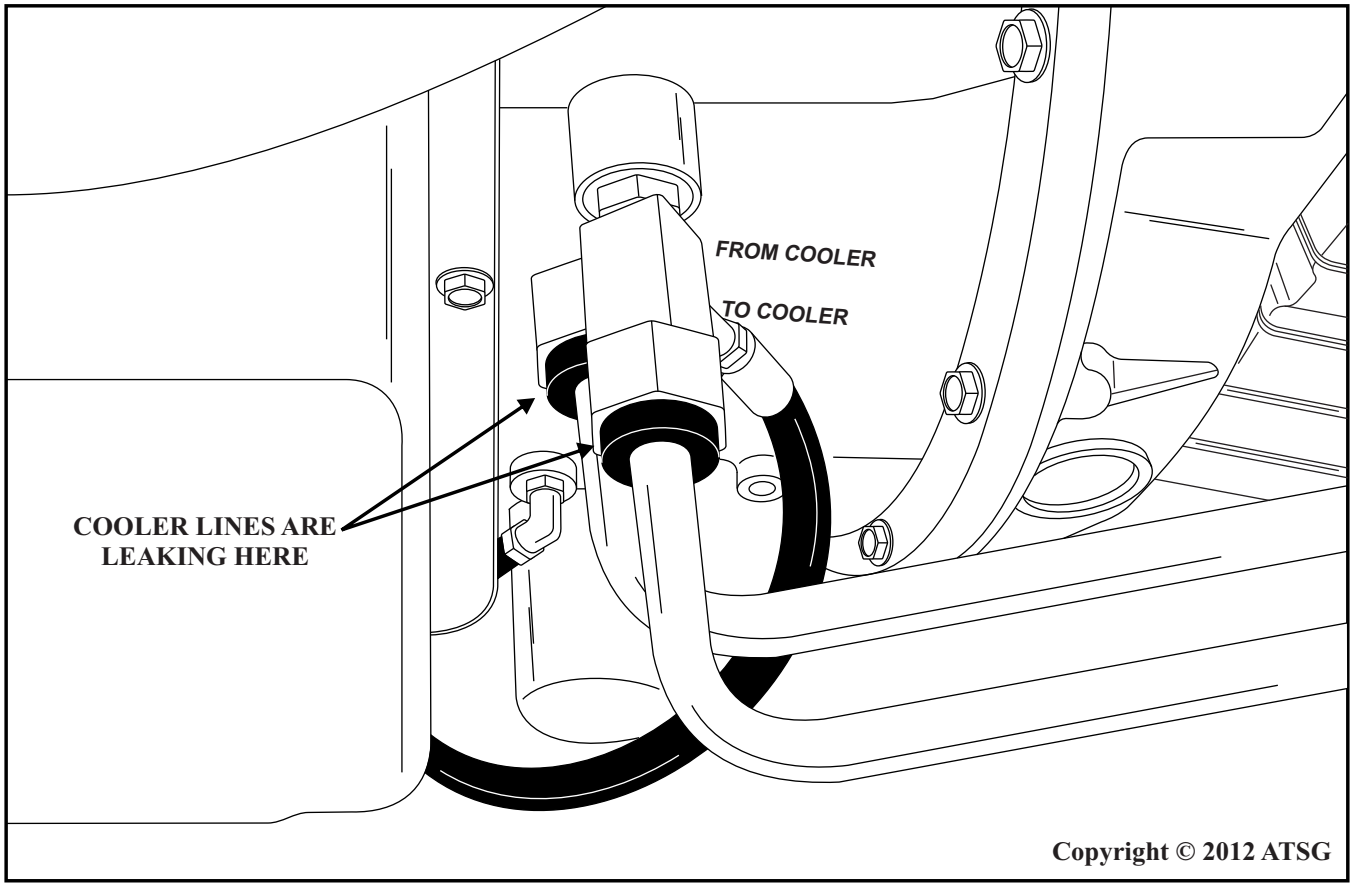


Figure 1

ATSG
51

Superior
52

Superior
53

Wesco
54

GM 2ML70 TWO MODE HYBRID TRANSMISSION

PRELIMINARY INFORMATION

The GM 2ML70 2 Mode Hybrid system first appeared as a 2008 model in the Chevy Tahoe and the GMC Yukon and was followed by the Cadillac Escalade in 2009. The 2ML70 moved into the Silverado and Sierra 1500 series pickups, with all models using the 6.0 Liter gas engine.

The 2ML70 transmission is a four speed rear drive which can be configured in a two or four wheel drive application (Figure 1). The 2ML70 does not use a torque converter, it uses a dampener assembly to smoothly transmit power from the engine flywheel to the transmission.

The 2ML70 uses a vane type pump with the dampener housing as the pump body. This system utilizes stop/start technology and therefore has a 12 volt auxiliary pump to keep the 1-2 clutch primed any time the engine shuts down.

The 2ML70 also utilizes three planetary gear sets, two rotating clutch packs and two fixed clutch packs. In addition it has two 60 kW electric motor/generators which can drive the vehicle on electricity only and can also recharge the 330 volt hybrid battery pack.

The transmission operation is controlled by a Transmission Control Module (TCM) which is located inside the transmission and the hybrid systems operation is controlled by the Hybrid Control Processor (HCP) located under the hood.

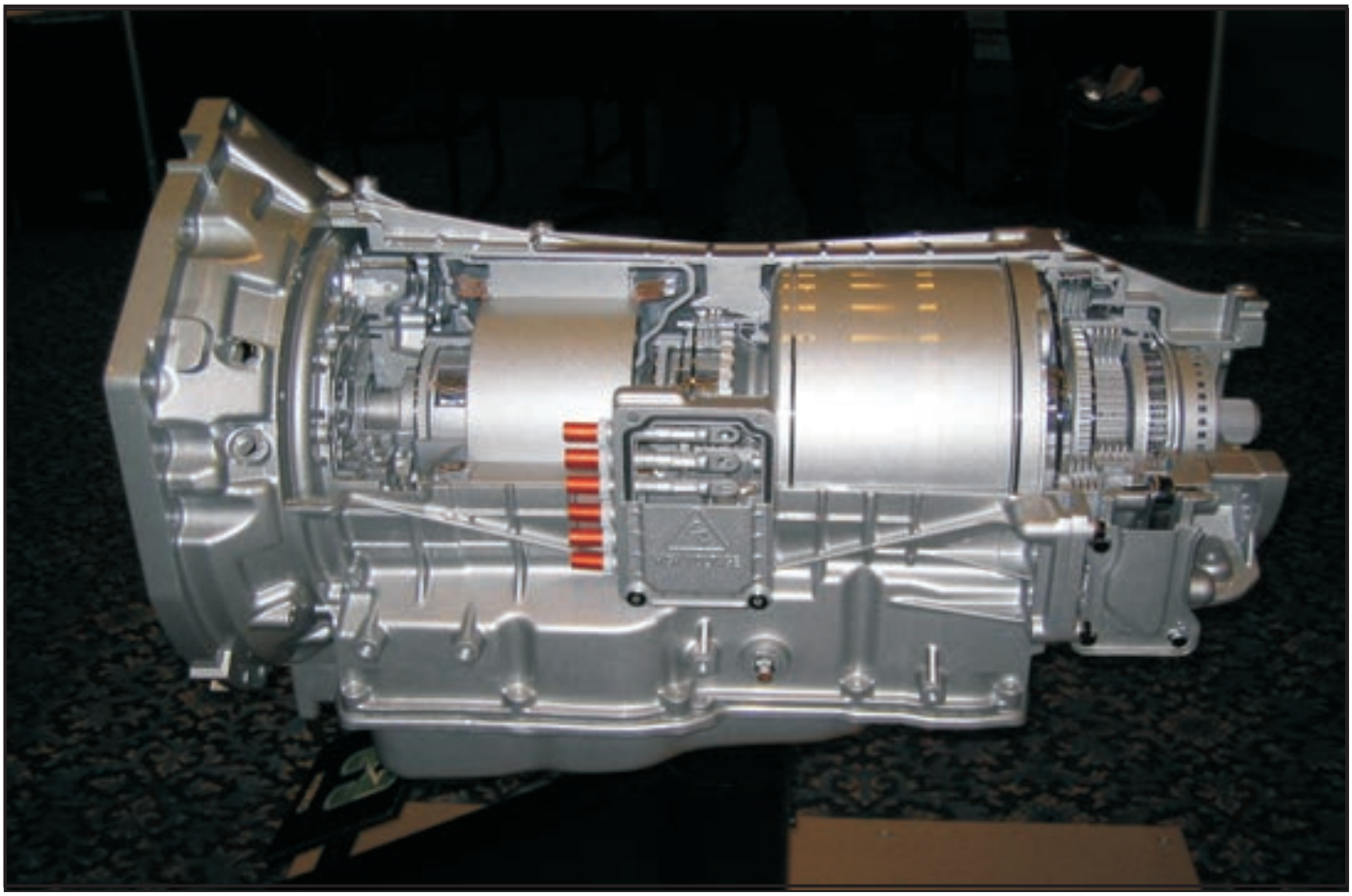


Figure 1

Moose
56

GM 2ML70 TWO MODE HYBRID TRANSMISSION

SHIFT QUADRANT POSITIONS

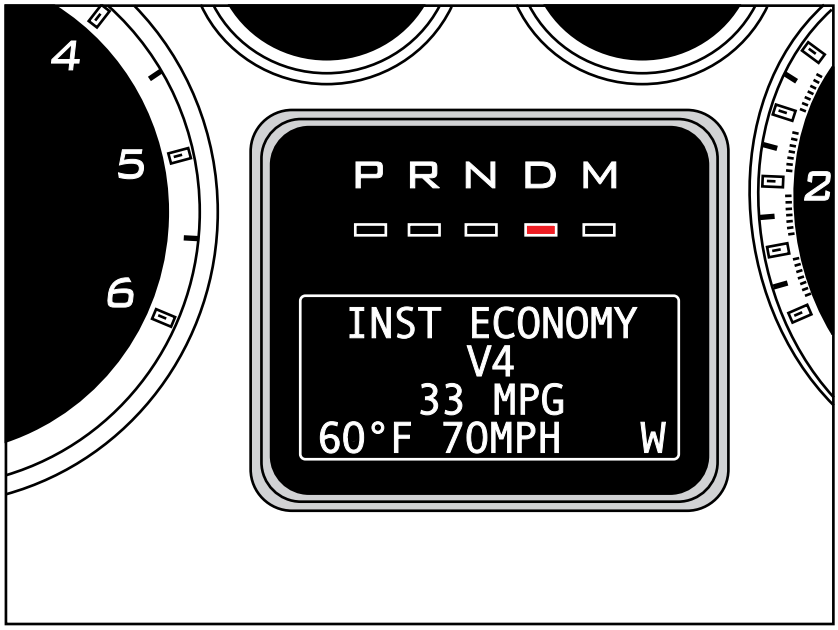
P - Park position locks the rear wheels and prevents the vehicle from rolling forward or backward. In this position the "Shift Lock" control is in use causing the driver to have to step on the brake pedal to release the shift lever.

R - Reverse position enables the vehicle to be operated in a rearward direction. In reverse, power from the internal combustion engine (ICE) does not contribute to the transmission's final output. Power to drive the vehicle is supplied solely by the generator motor.

N - If necessary, the neutral position enables the engine to start and operate without driving the vehicle. This position should be selected to restart the engine while the vehicle is moving.

D - In the drive position, the transmission will automatically upshift from first to fourth, and downshift from fourth to first according to the normal shift pattern programmed into the TCM.

M - In the "M" (Manual) position, the driver can manually select the range of gears by moving the selector lever towards "+ or -" to cause an upshift or downshift. The transmission will shift up or down depending on the request that is made by moving the selector.
When in the "M" position, the transmission's current gear range will be the highest attainable range with all the lower gears available. The Plus/Minus selections can be used in certain driving conditions such as, towing, hill climbing or the use of engine braking for down hill driving.



Vehicles equipped with Driver Shift Control (DSC) have an "M" position on the PRNDL indicator lamps which permit manual gear selection as indicated by plus and minus icons on the shifter.

Figure 2

GM 2ML70 TWO MODE HYBRID TRANSMISSION

DRIVING MODES

ELECTRIC LAUNCH

When the brake pedal is released, and the accelerator is applied, the vehicle will launch in electric mode. The hybrid low, 1-2 clutch is applied and the drive/generator motor, second position provides output torque to the wheels. Under low speed driving conditions the vehicle operates in full electric mode without starting the ICE or using the drive/generator motor, position one. DC power from the battery flows to the HPCM where it is converted into 3 phase AC power to drive the drive/generator motor, second position. The auxiliary fluid pump runs to provide fluid to the transmission lubrication and hydraulic systems. The vehicle will continue to operate in EVT Mode until additional power is required to accelerate the vehicle. At that point the ICE will start.

EVT MODE 1 (LOW)

After the ICE is started, the system operates in EVT Mode 1 which is used for low speed driving conditions. Utilizing an input split configuration, the ICE drives the drive/generator motor, first position to simultaneously generate electricity to charge the hybrid battery and to provide power through the transmission's mechanical gearing to the drive wheels. The power generated by the drive generator motor, first position is stored in the battery, while the drive/generator motor, second position draws battery power to provide additional output torque. Depending on driving conditions, the ICE will operate in either 4 or 8 cylinder mode to optimize fuel consumption while maintaining output power requirements. Combining EVT operation with Active Fuel Management allows the ICE to operate in 4 cylinder mode over a wider range of operating conditions than a non-hybrid vehicle. The drive/generator motor, second position provides output power to augment the ICE in 4 cylinder mode, and the drive/generator motor, first position can be used to provide smooth acceleration.

EVT MODE 2 (HIGH)

As vehicle speed increases, the system shifts to EVT Mode 2. EVT Mode 2 uses a compound split configuration to transfer power through the transmission during higher speed operating conditions such as highway cruising. Similar to EVT Mode 1, ICE power is used to both generate electricity through the motors and provide output torque via the transmission's mechanical gearing. A synchronous shift point allows the 2 Mode transmission to shift between EVT Mode 1 and Mode 2 without changing speed. The compound split configuration reduces overall electrical power requirements during higher speed operation. Combining the input power split and compound split configurations results in two EVT modes of operation, also provides three mechanical operating points in the transmission, and lowers the overall electro-mechanical power required across the range of vehicle operation as compared to a single mode system.

FIXED GEAR OPERATION

Fixed gear operation is achieved by selectively applying clutches in the transmission to transmit engine power through a mechanical path without the use of electric motors. Advantages of having fixed ratios include the ability to increase engine size without having to increase electric motor size. Improved towing, climbing, and maximum acceleration performance are particularly important. In fixed gear modes the drive/generator motors can be used entirely for power assist, rather than partially, to carry power through the transmission. In addition, the drive/generator motors can be partially powered down during cruising conditions.

REGENERATIVE BRAKING

Regenerative braking is enabled in both EVT Mode 1 and EVT Mode 2. As the driver lifts his foot from the accelerator pedal, and depresses the brake pedal, the electric drive/generator motors are used to decelerate the vehicle by applying negative torque to the output shaft and to generate electricity to recharge the HV battery. The 3 phase AC power generated by the motor is converted to high voltage DC power in the HPCM and stored in the battery.

GM 2ML70 TWO MODE HYBRID TRANSMISSION

DRIVING MODES

REGENERATIVE BRAKING...*continued*

The hybrid operating system coordinates requests for negative torque from the electronic brake module with electric drive/generator motor and ICE control functions.

ENGINE STOP/START

As the driver depresses the accelerator pedal further, demanding increased vehicle speed, the drive/generator motor, first position is used to start the ICE while the hybrid low, 1-2 clutch remains applied and drive/generator motor, second position simultaneously provides output power to the drive wheels. During the ICE start event, the drive/generator motor, first position also provides active damping to reduce torque vibrations from the ICE, and the drive/generator motor, second position is used to damp driveline vibrations. During this event, the inverter draws DC power from the HV battery and converts it to AC power for both drive/generator motors. The HPCM controls each drive/generator motor speed and power independently. The HPCM determines when to stop the ICE and when to restart based on vehicle operating conditions and optimal hybrid battery power and fuel consumption. The ICE is stopped at idle and during deceleration maneuvers to improve fuel economy.

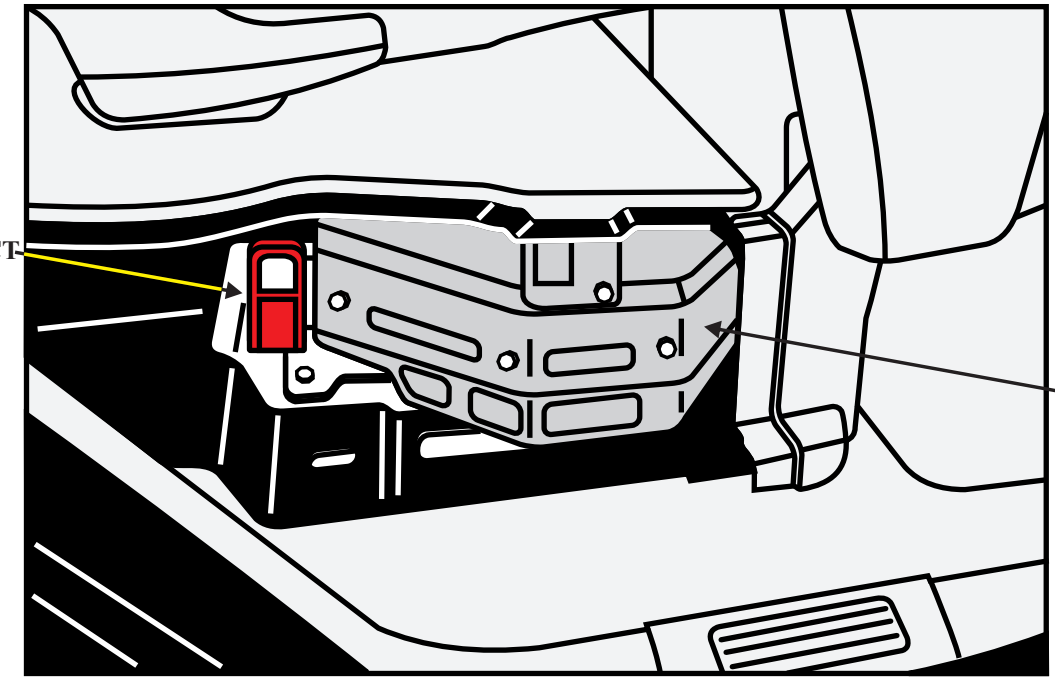
REVERSE

When the vehicle is placed in reverse the hybrid low, 1-2 clutch is applied, and the drive/generator motor, second position spins backwards to provide output torque to the drive wheels.

Note: When the vehicle is placed in reverse the ICE will start if it was in Auto Stop Mode.

GM 2ML70 TWO MODE HYBRID TRANSMISSION

HYBRID BATTERY DISCONNECT SWITCH & HYBRID VEHICLE INVERTER



Swing the passenger side seat up and remove the end trim panel. Locate the orange hybrid battery switch and pull the handle down and out. Be sure to have your rubber Class 0 gloves on.

Figure 3

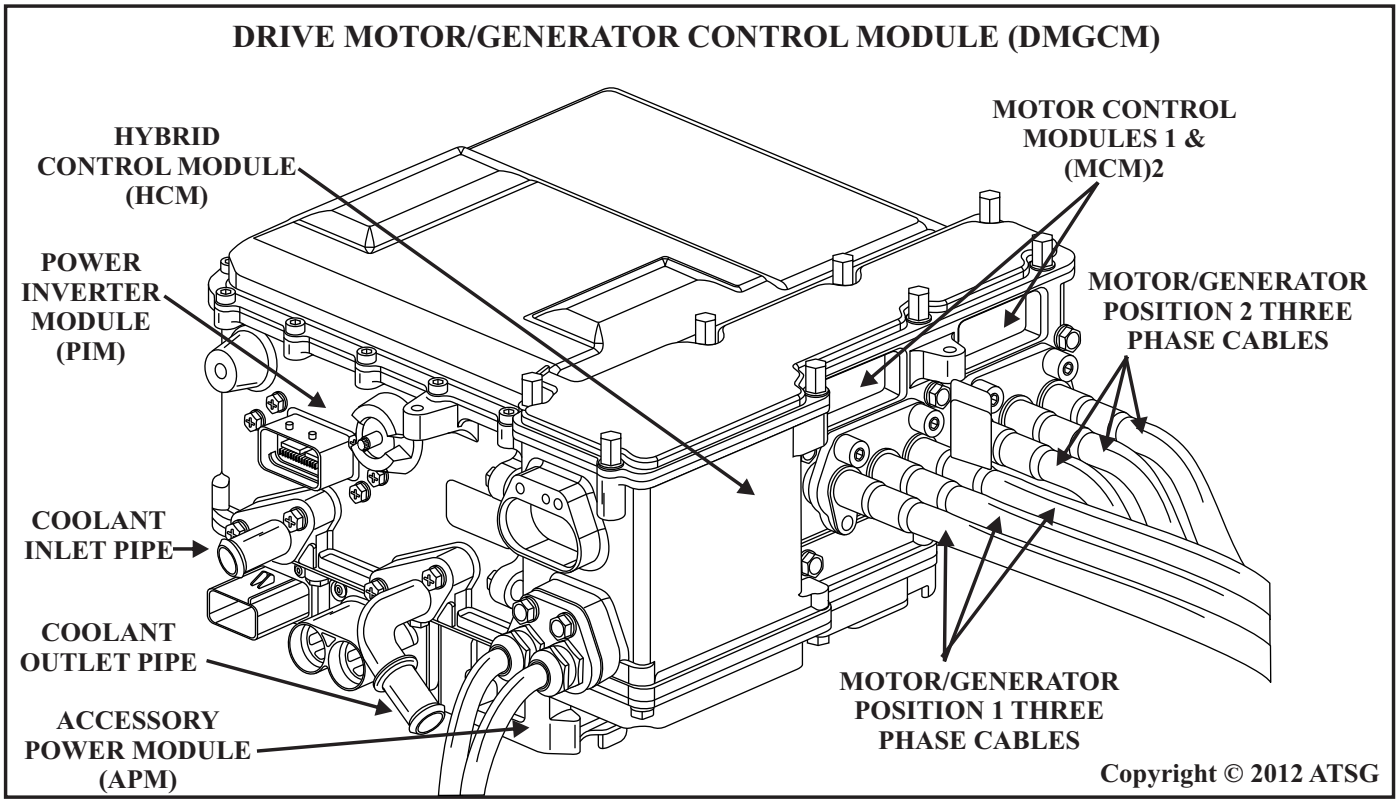
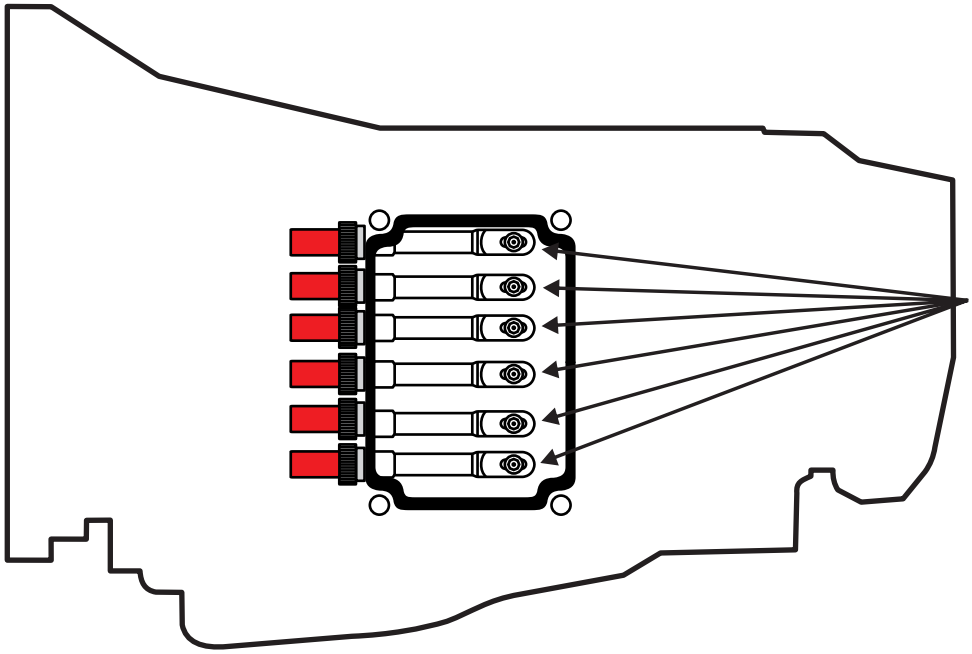


Figure 4

GM 2ML70 TWO MODE HYBRID TRANSMISSION

HIGH VOLTAGE VERIFICATION



After the hybrid battery disconnect switch has been removed, wait approximately 5 minutes for the voltage to dissipate. Then with your Class 0 rubber gloves on and your 1000 Volt Cat III voltmeter, remove the 3 Phase cable cover on the side of the transmission and verify that the high voltage has in fact dissipated.

Figure 5

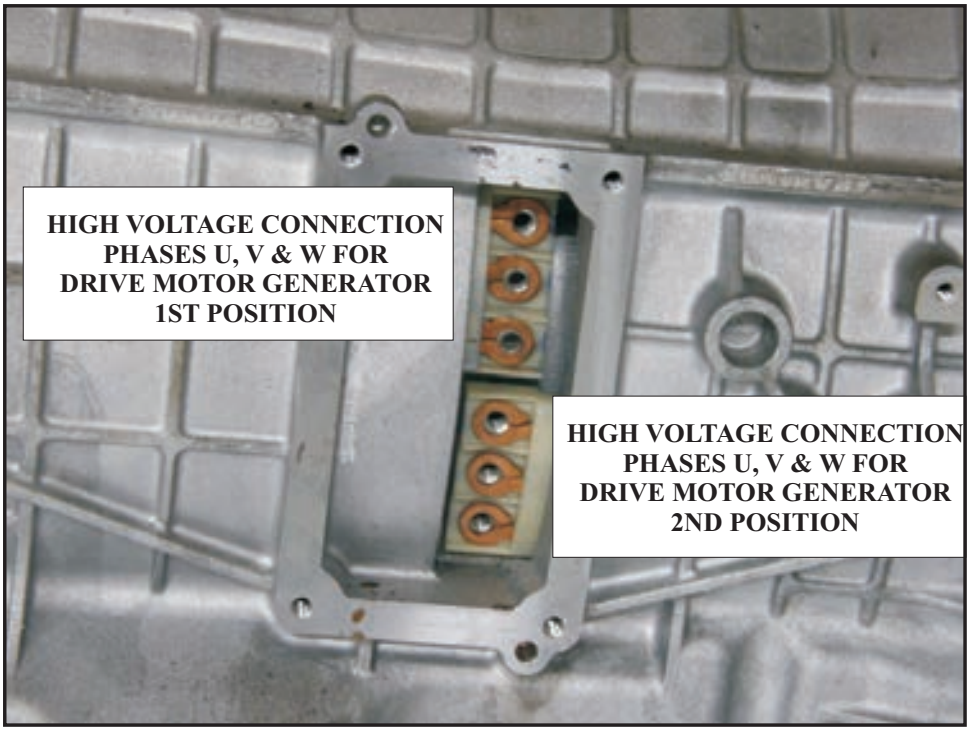
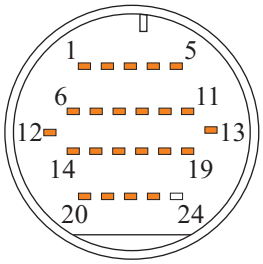


Figure 6

GM 2ML70 TWO MODE HYBRID TRANSMISSION

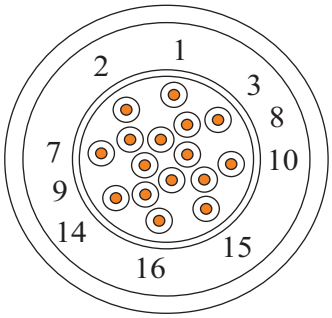
ELECTRICAL CONNECTOR ID



TRANSMISSION CASE CONNECTOR (Y176)
Looking into Transmission Harness Side

1 IMS Terminal H - (Escalade)
2 IMS Terminal J - (Escalade)
3 IMS Terminal K- (Escalade)
4 IMS Terminal L - (Escalade)
5 IMS Terminal M - (Escalade)
6 OSS Neg. to TCM Connector X2
7 OSS Pos. to TCM Connector X2
8 DMG 1 Resolver Motor A Excitation Pos.
9 DMG 1 Resolver Motor A Excitation Neg.
10 DMG 1 Resolver Motor A S1 Signal
11 DMG 1 Resolver Motor A S3 Signal
12 DMG 1 Resolver Motor A S2 Signal
13 DMG 1 Temperature Sensor Signal
14 DMG 1 Resolver Motor A S4 Signal
15 DMG 2 Resolver Motor B Excitation Pos.
16 DMG 2 Resolver Motor B Excitation Neg.
17 DMG 2 Resolver Motor B S1 Signal
18 DMG 2 Resolver Motor B S3 Signal
19 DMG 1 Temperature Sensor Ground
20 DMG 2 Resolver Motor B S2 Signal
21 DMG 2 Resolver Motor B S4 Signal
22 DMG 2 Temperature Sensor Signal
23 DMG 2 Temperature Sensor Ground
24 Empty

Figure 7



CONTROL UNIT CASE CONNECTOR (Y175)
Looking into TCM and Solenoid Assembly

1
2
3 IMS Terminal F (G - Escalade)
4 TCM Battery
5 Ground
6 Exterior Lights
7
8
9 Body Control Module
10 Data Communication
11 Data Communication
12 Ignition
13 Data Communication
14 Data Communication
15
16 Engine Control

Figure 8

GM 2ML70 TWO MODE HYBRID TRANSMISSION

ELECTRICAL CONNECTOR ID

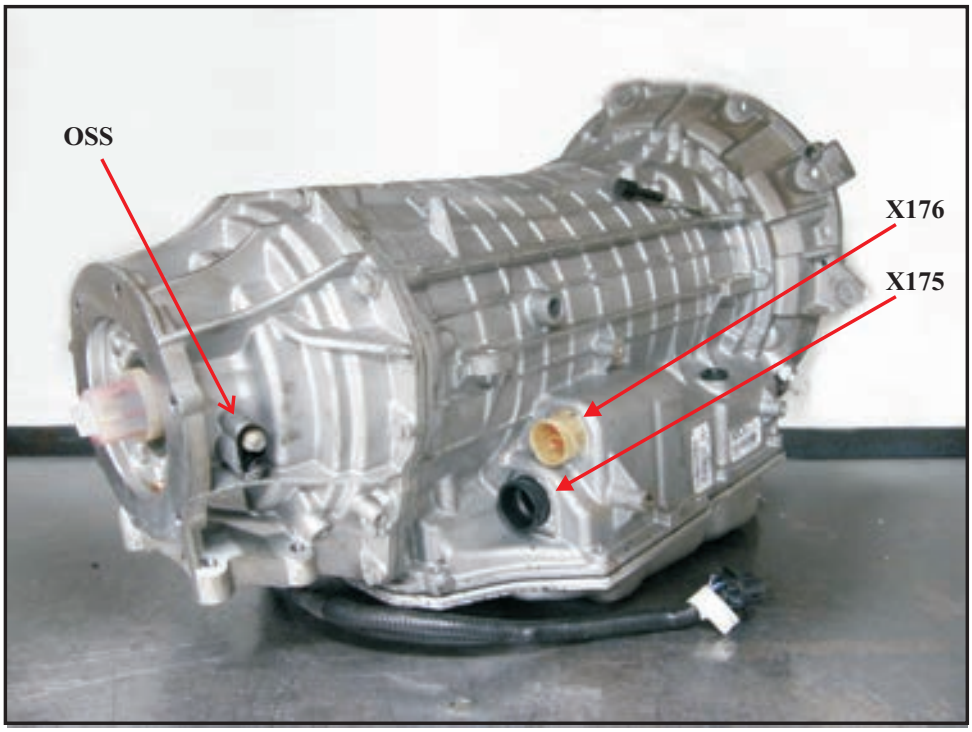


Figure 9

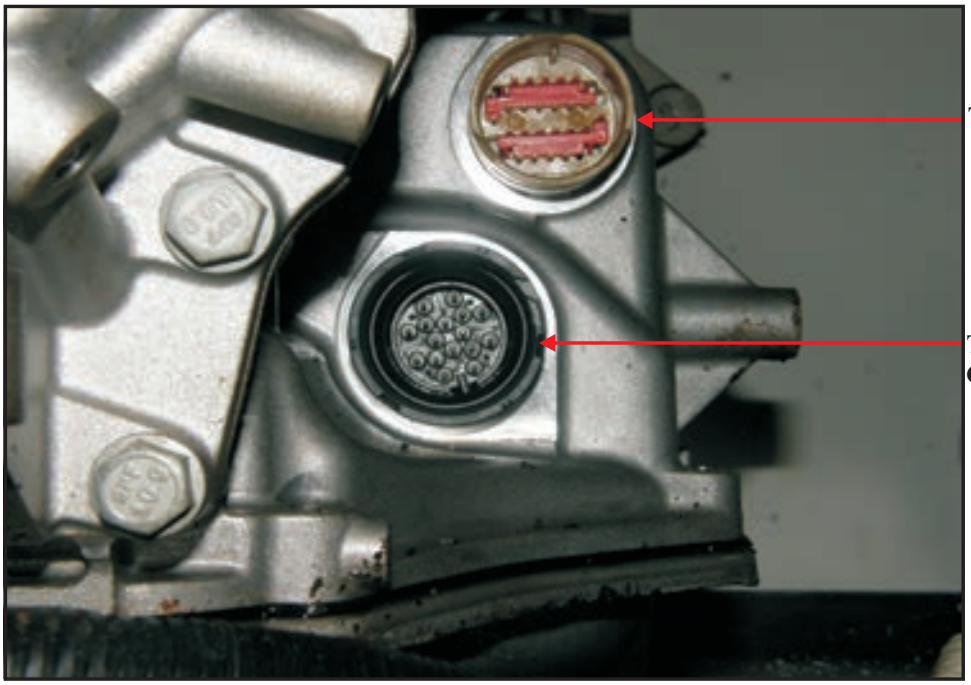


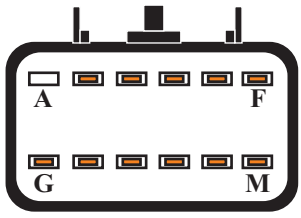
Figure 10

GM 2ML70 TWO MODE HYBRID TRANSMISSION

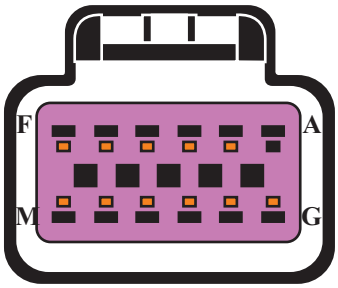
ELECTRICAL CONNECTOR ID

IMS POSITION SWITCH LOGIC TABLE

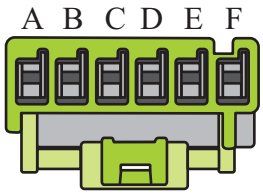
Gear Selector Position	Signal			
	A	B	C	P
PARK	LOW	HI	HI	LOW
Park/Reverse	LOW	LOW	HI	LOW
REVERSE	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
NEUTRAL	HI	LOW	HI	LOW
DRIVE 4	LOW	LOW	LOW	LOW
Drive4/Drive3	LOW	HI	LOW	LOW
DRIVE 3	LOW	HI	LOW	HI
Drive 3/Drive 2	HI	HI	LOW	HI
DRIVE 2	HI	HI	LOW	LOW
Open	HI	HI	HI	HI
Invalid	HI	HI	HI	LOW
Invalid	LOW	HI	HI	HI



IMS
Looking into the IMS
(Terminal **I** *not used)*



IMS
Looking into the internal harness connector



X1
Looking into internal harness connector to TCM

A Empty
B To TCM Connector X1 (Green) Terminal E - Signal C
C To TCM Connector X1 (Green) Terminal D - Signal B
D To TCM Connector X1 (Green) Terminal C - Signal A
E To TCM Connector X1 (Green) Terminal B - Signal P
F To TCM Connector X1 (Green) Terminal A - Ground
G To TCM Connector X1 (Green) Terminal F
H To Y176 Terminal 1
J To Y176 Terminal 2
K To Y176 Terminal 3
L To Y176 Terminal 4
M To Y176 Terminal 5

Figure 11

GM 2ML70 TWO MODE HYBRID TRANSMISSION

ELECTRICAL CONNECTOR ID

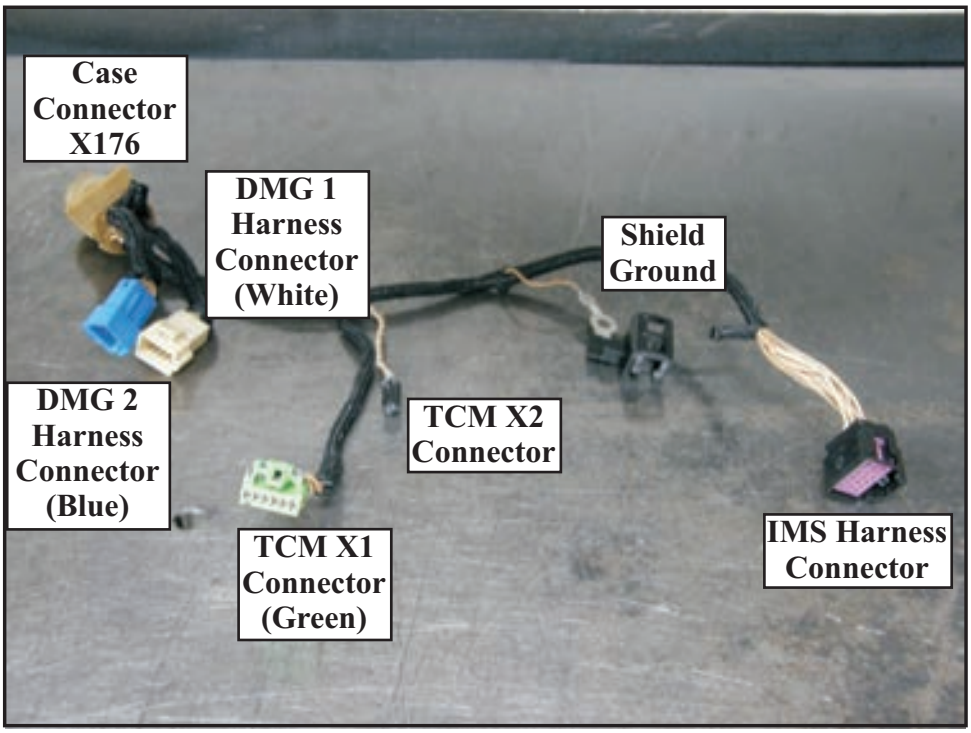
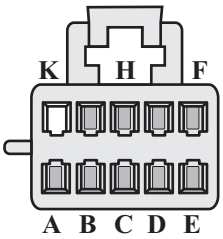
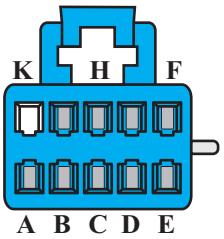


Figure 12



DMG 1
Looking into the Drive Motor Generator Position 1 Harness (White Connector)
(Terminal* I *not used)

A DMG 1 Resolver Motor A Excitation Neg.
B DMG 1 Resolver Motor A Excitation Pos.
C DMG 1 Resolver Motor A S1 Signal
D DMG 1 Resolver Motor A S2 Signal
E DMG 1 Resolver Motor A S3 Signal
F DMG 1 Resolver Motor A S4 Signal
G DMG 1 Temperature Sensor Signal
H DMG 1 Temperature Sensor Ground
J Shield Ground
K Empty



DMG 2
Looking into the Drive Motor Generator Position 2 Harness (Blue Connector)
(Terminal* I *not used)

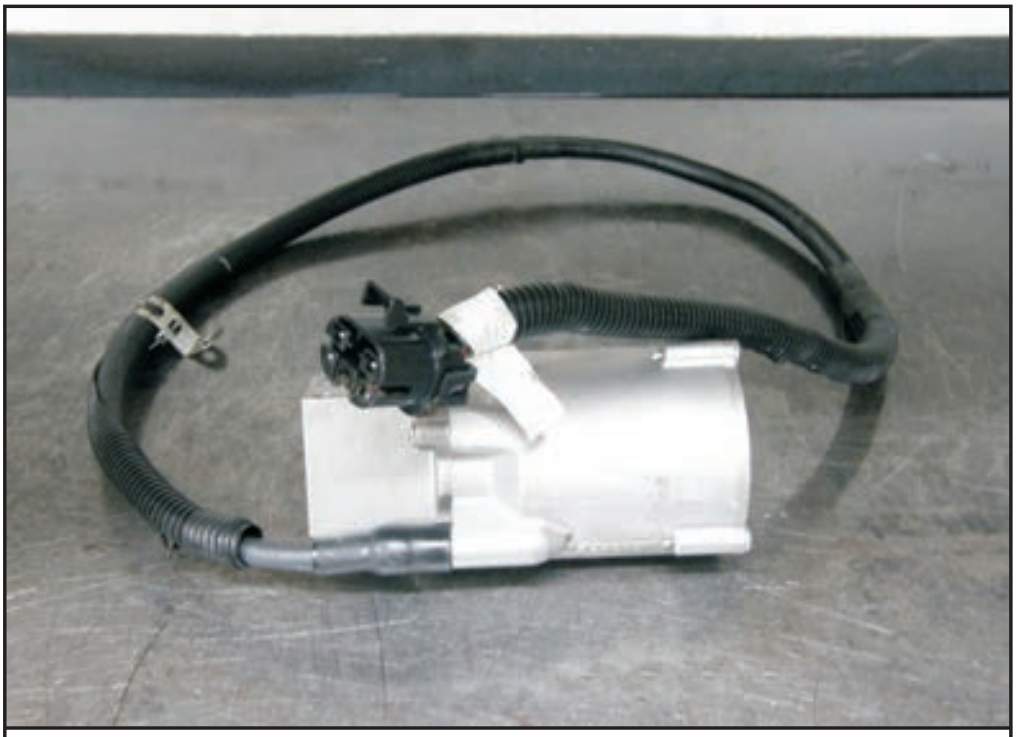
A DMG 2 Resolver Motor B Excitation Neg.
B DMG 2 Resolver Motor B Excitation Pos.
C DMG 2 Resolver Motor B S1 Signal
D DMG 2 Resolver Motor B S2 Signal
E DMG 2 Resolver Motor B S3 Signal
F DMG 2 Resolver Motor B S4 Signal
G DMG 2 Temperature Sensor Signal
H DMG 2 Temperature Sensor Ground
J Shield Ground
K Empty

Figure 13

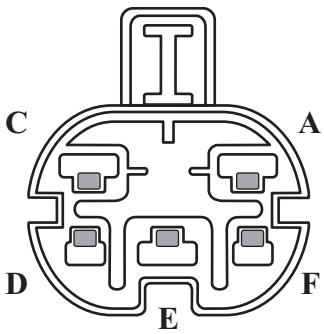
GM 2ML70 TWO MODE HYBRID TRANSMISSION

ELECTRICAL CONNECTOR ID

AUXILIARY FLUID PUMP



The Auxiliary Fluid Pump is a 3 Phase 12 Volt AC motor type that is turned on by the Auxiliary Fluid Pump Control Module (AFPCM) when the vehicle comes to a stop and the engine is off. It provides lubrication and keeps the Hybrid Low-1-2 Clutch applied in preparation for initial take off.



X2 (HP2)
LOOKING INTO AUXILIARY PUMP HARNESS

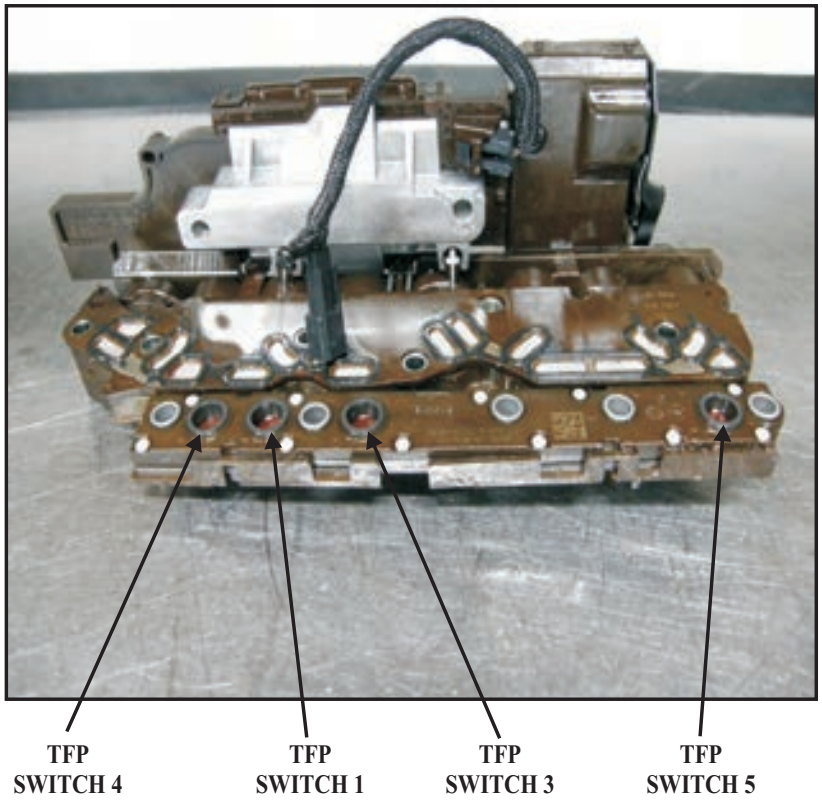
A	AC Voltage Phase A
C	AC Voltage Phase C
D	Not used
E	AC Voltage Phase B
F	Drain Wire

Figure 14

GM 2ML70 TWO MODE HYBRID TRANSMISSION

ELECTRICAL CONNECTOR ID

PRESSURE SWITCH LOGIC & ID



FLUID PRESSURE SWITCH LOGIC TABLE

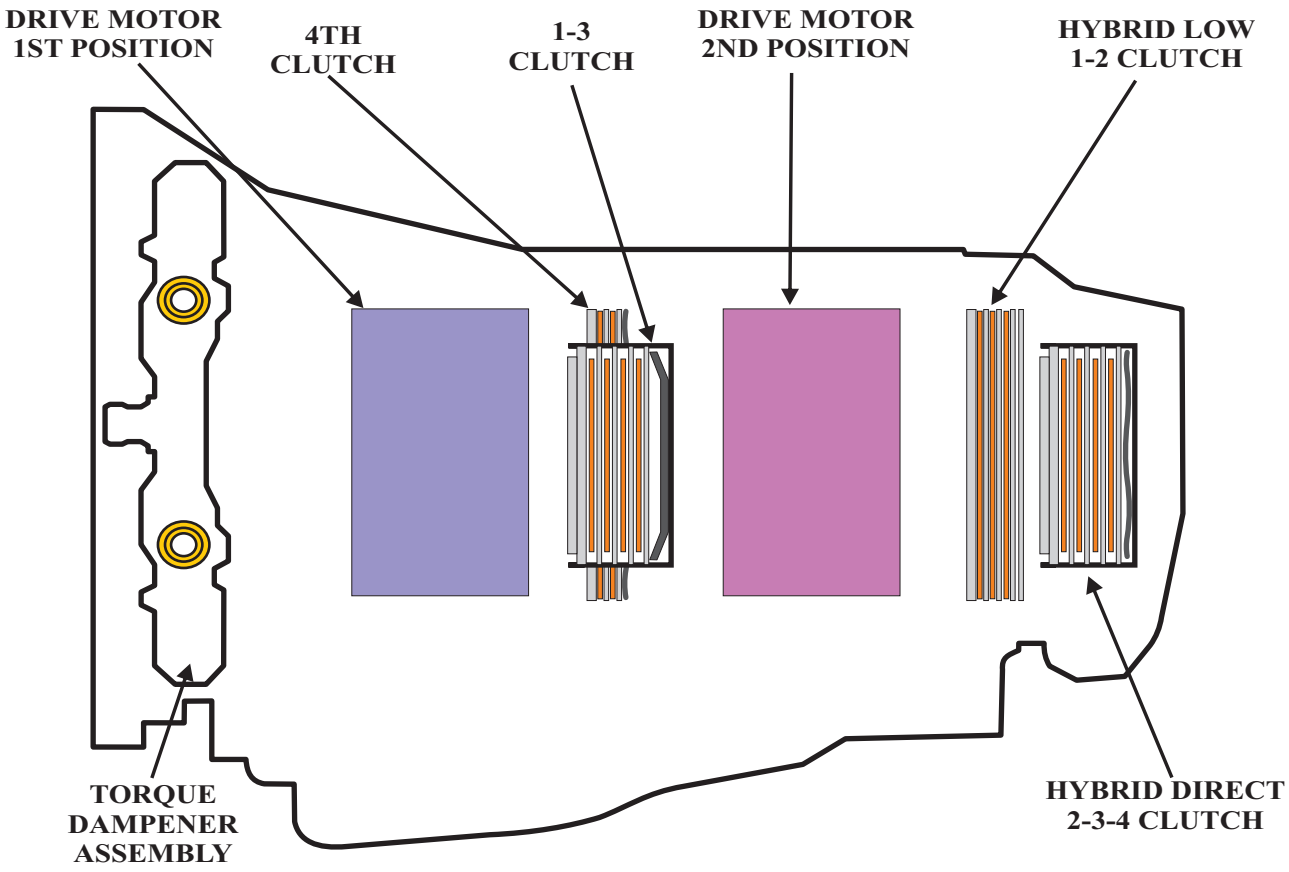
GEAR SELECTOR POSITION	SWITCH			
	1	3	4	5
PARK	1	0	1	0
EVT Mode Reverse	0	0	1	0
NEUTRAL	1	0	1	0
EVT Mode Low	0	0	1	0
DRIVE 1	0	1	1	0
DRIVE 2	0	0	0	0
DRIVE 3	1	0	1	1
DRIVE 4	0	0	0	1
EVT Mode High	1	1	1	1

0 = Closed *1 = Open*

Figure 15

GM 2ML70 TWO MODE HYBRID TRANSMISSION

CLUTCH AND MOTOR APPLICATION



RANGE	GEAR	RATIO	1-3 CLUTCH	4TH CLUTCH	HYB. LOW 1-2 CLUTCH	HYB. DIRECT 2-3-4 CLUTCH
PARK	P	——				
REV.	EVT R	3.692			APPLIED	
NEUT.	N	——				
DRIVE	EVT LOW	Infinity to 1.700			APPLIED	
	1ST	3.692	APPLIED		APPLIED	
	2ND	1.705			APPLIED	APPLIED
	3RD	1.000	APPLIED			APPLIED
	4TH	0.738		APPLIED		APPLIED
	EVT HIGH	1.700 to <0.738				APPLIED

Figure 16

GM 2ML70 TWO MODE HYBRID TRANSMISSION

TRANSMISSION OVERVIEW

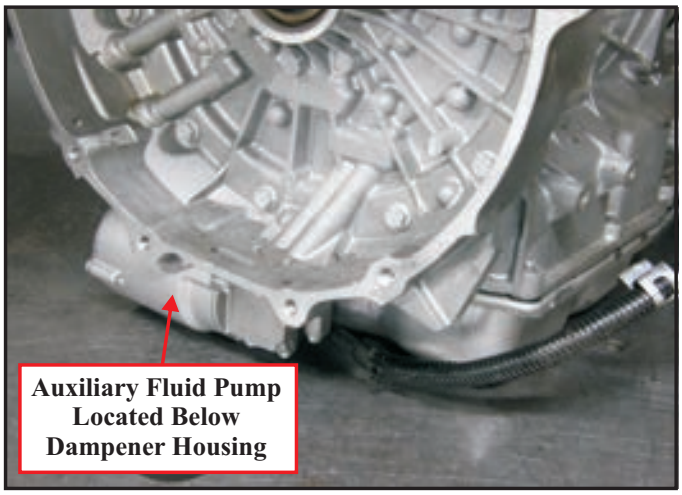


Figure 17

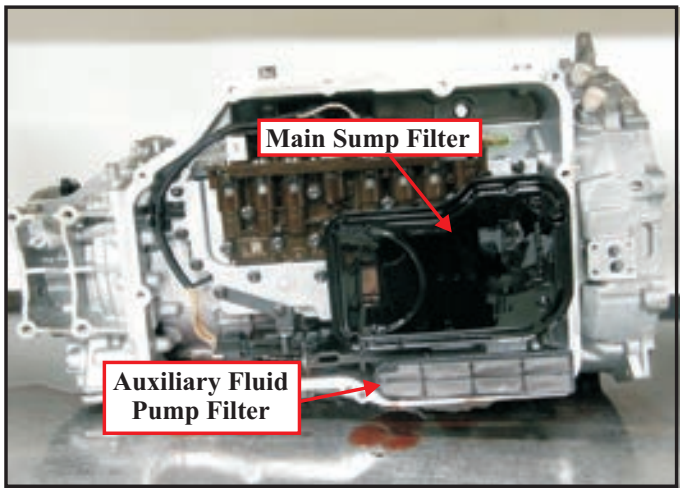


Figure 20

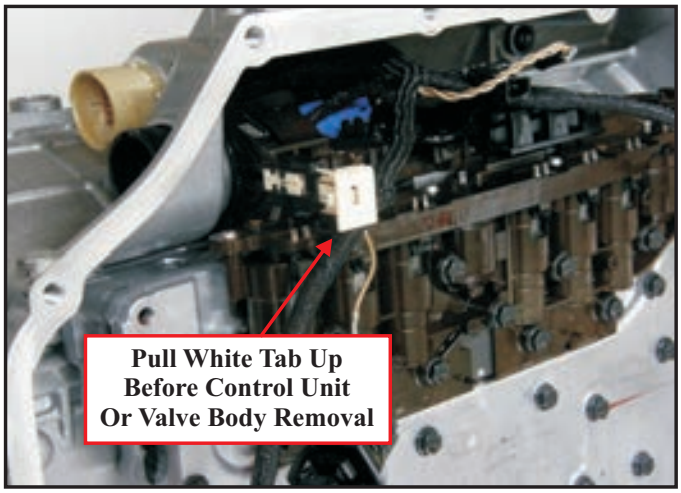


Figure 18

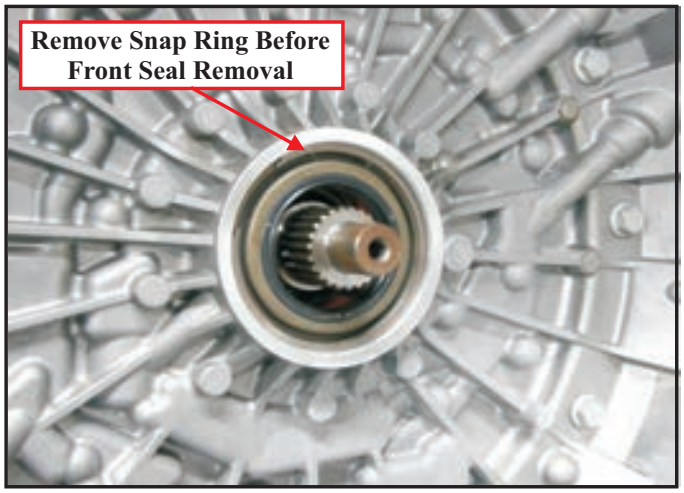


Figure 21

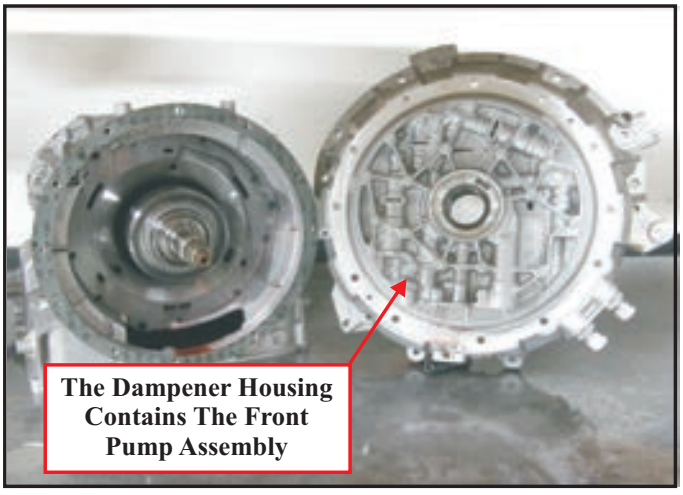


Figure 19

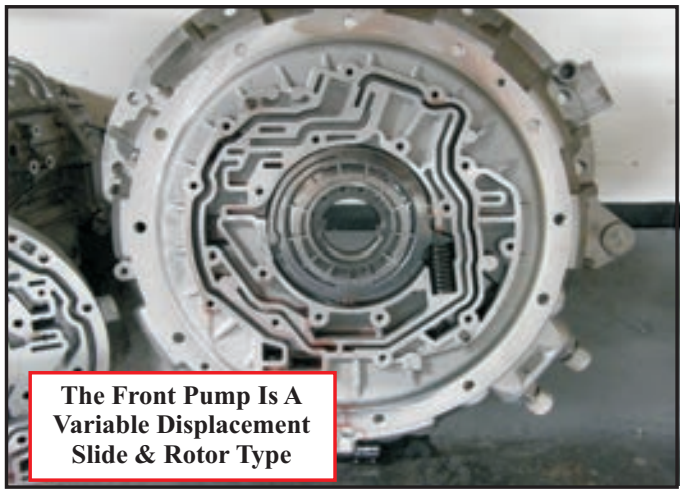


Figure 22

GM 2ML70 TWO MODE HYBRID TRANSMISSION

TRANSMISSION OVERVIEW

Figure 23

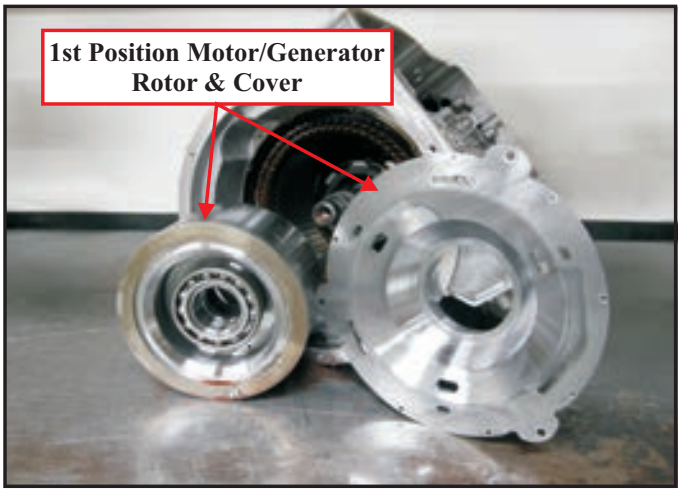


Figure 26

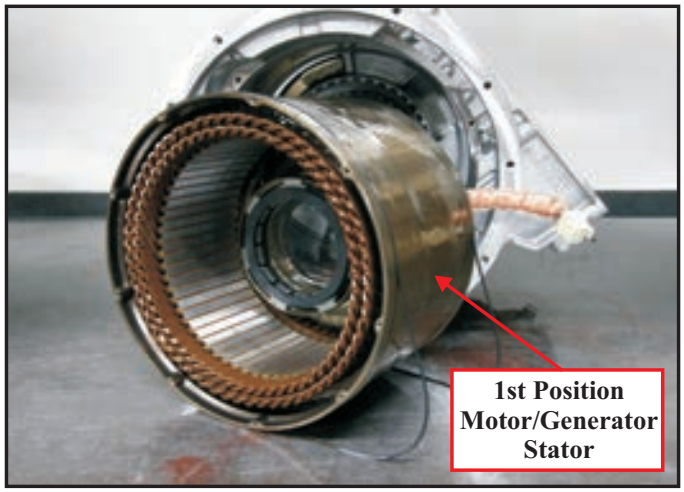


Figure 24

Figure 27

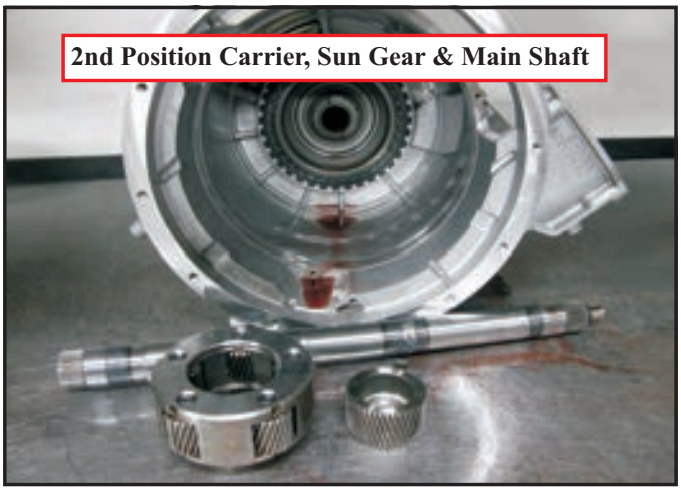


Figure 25

Figure 28

GM 2ML70 TWO MODE HYBRID TRANSMISSION

TRANSMISSION OVERVIEW

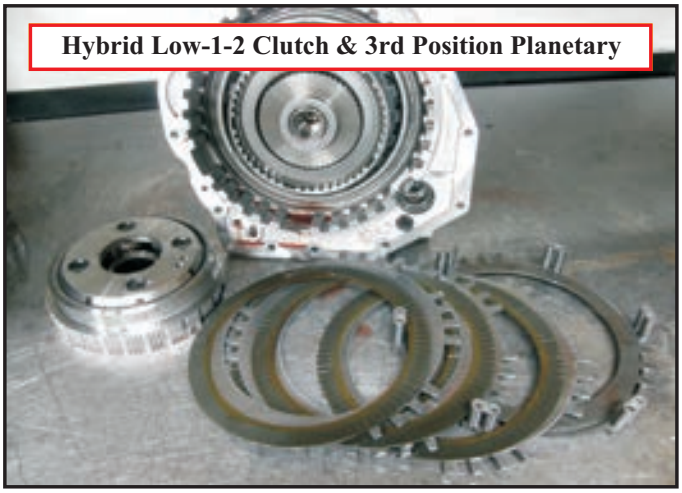


Figure 29

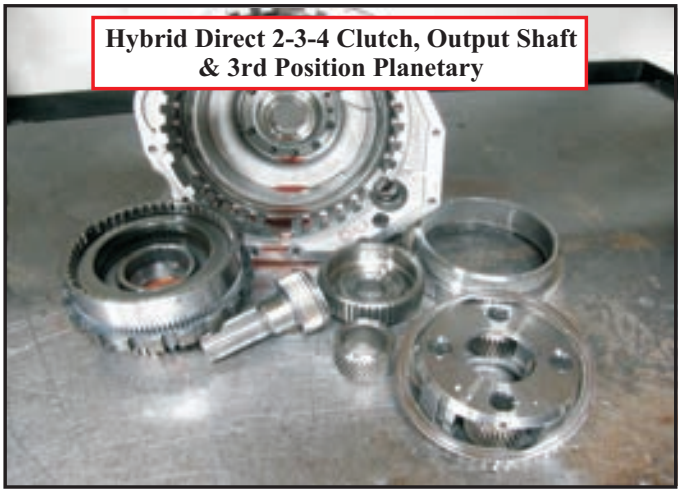


Figure 31

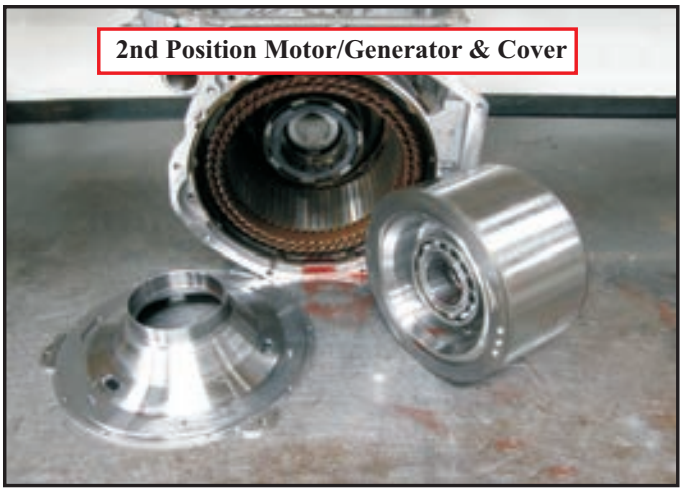
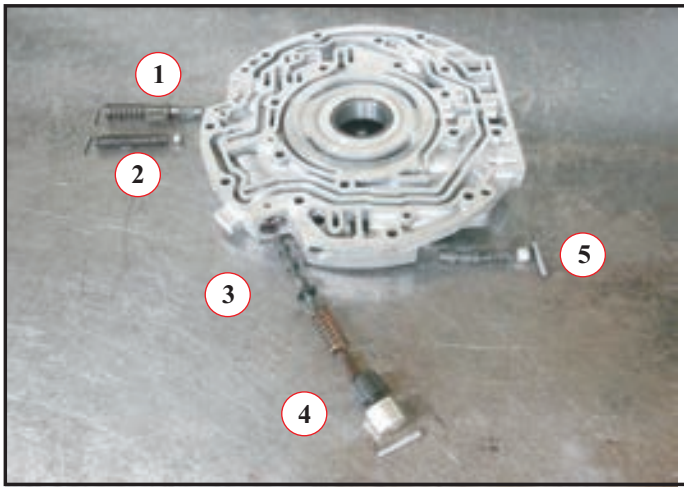


Figure 30

Figure 32



1. COOLER BYPASS VALVE
2. PRESSURE RELIEF VALVE
3. FLUID PUMP & AUX. FLUID PUMP VALVE
4. ISOLATOR VALVE
5. LUBE FLUID REGULATOR VALVE

Figure 33

GM 2ML70 TWO MODE HYBRID TRANSMISSION

TRANSMISSION OVERVIEW

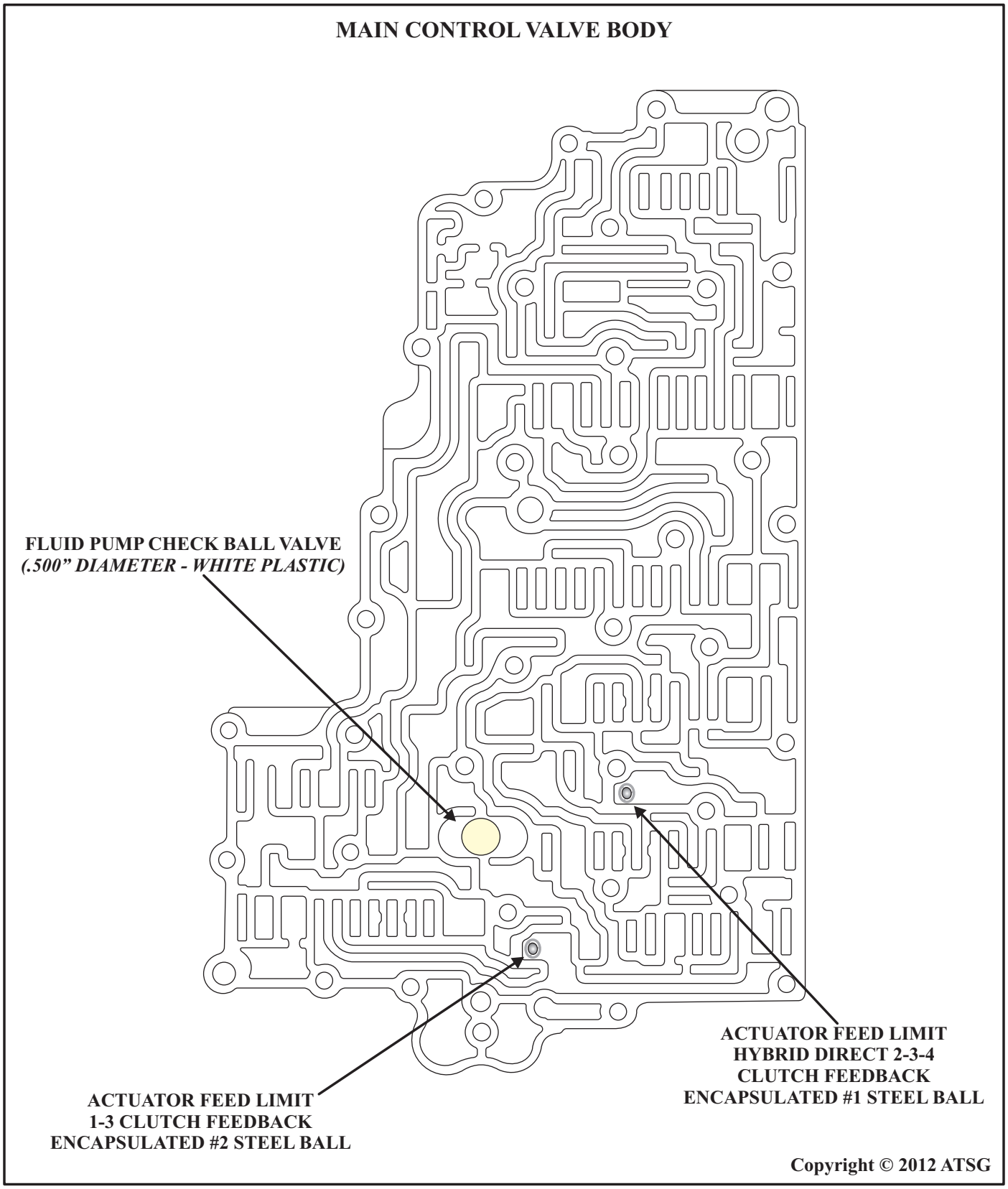
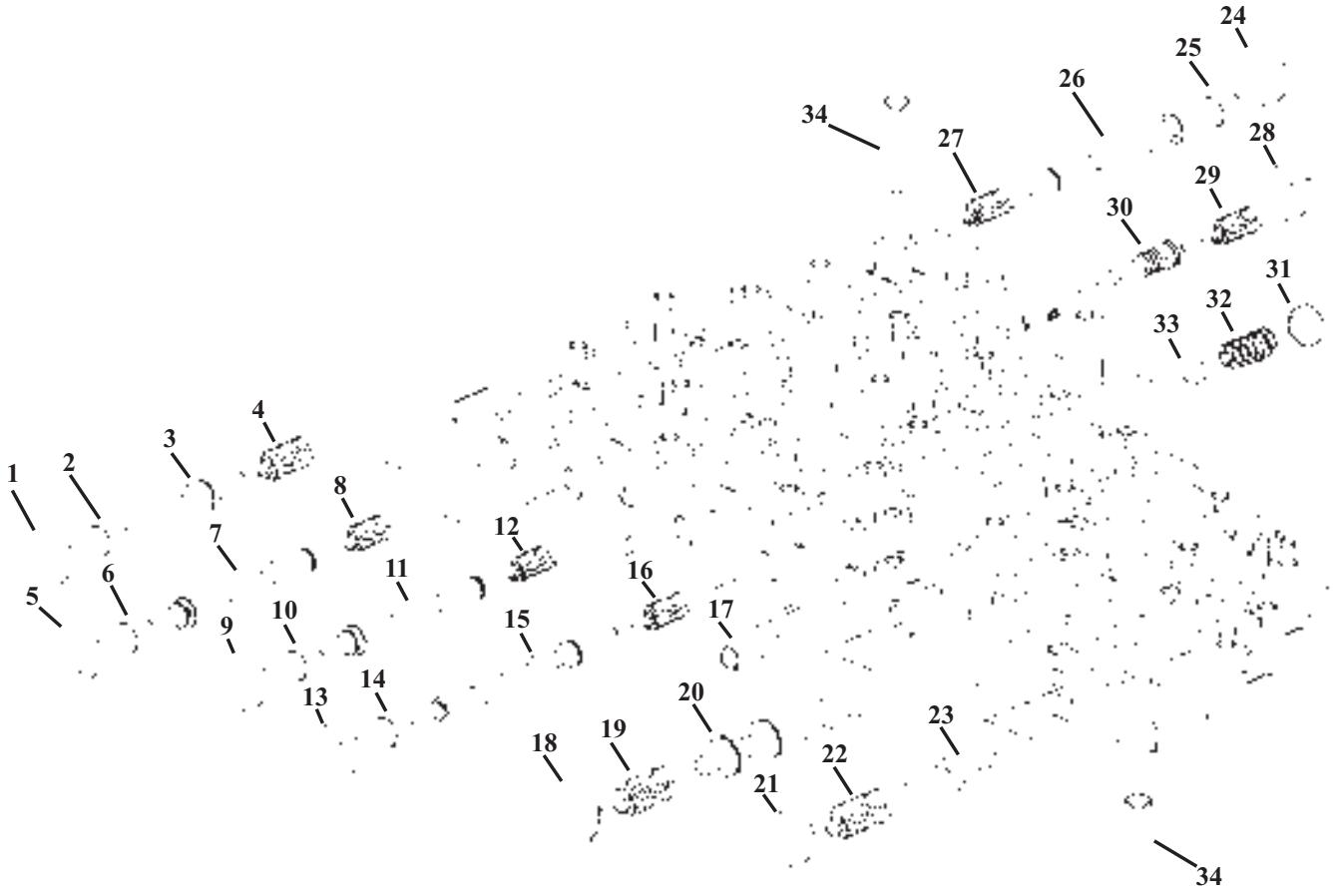


Figure 34

GM 2ML70 TWO MODE HYBRID TRANSMISSION

TRANSMISSION OVERVIEW

MAIN CONTROL VALVE BODY



1. Valve Retaining Clip
2. Valve Retaining Plug
3. Auxiliary Line Boost Valve
4. Auxiliary Line Boost Valve Spring
5. Valve Retaining Clip
6. Valve Retaining Plug
7. 1-3 Clutch Regulator Valve
8. 1-3 Clutch Regulator Valve Spring
9. Valve Retaining Clip
10. Valve Retaining Plug
11. Hybrid Direct 2-3-4 Clutch Regulator Valve
12. Hybrid Direct 2-3-4 Clutch Regulator Valve Spring
13. Valve Retaining Clip
14. Valve Retaining Plug
15. Shift Solenoid Valve - Mode A
16. Hybrid A/Trans Shift Solenoid Valve Spring
17. Control Valve Body Locating Pin
18. Valve Retaining Clip
19. Hybrid B/Trans Shift Solenoid Valve Spring
20. Shift Solenoid Valve - Mode B
21. Valve Retaining Clip
22. Actuator Feed Limit Valve Spring
23. Actuator Feed Limit Valve
24. Valve Retaining Clip
25. Valve Retaining Plug
26. Hybrid Low-1-2 Clutch Regulator Valve
27. Hybrid Low-1-2 Clutch Regulator Valve Spring
28. Valve Retaining Clip
29. Hybrid Low-1-2 Clutch Boost Valve Spring
30. Hybrid Low-1-2 Clutch Boost Valve
31. Clutch Piston Exhaust Blow Off Ball Valve Plug
32. Clutch Piston Exhaust Blow Off Ball Valve Plug Spring
33. Clutch Piston Exhaust Blow Off Ball Valve
34. Control Valve Body Locator Pin

Figure 35

GM 2ML70 TWO MODE HYBRID TRANSMISSION

TRANSMISSION OVERVIEW

PASSAGE IDENTIFICATION

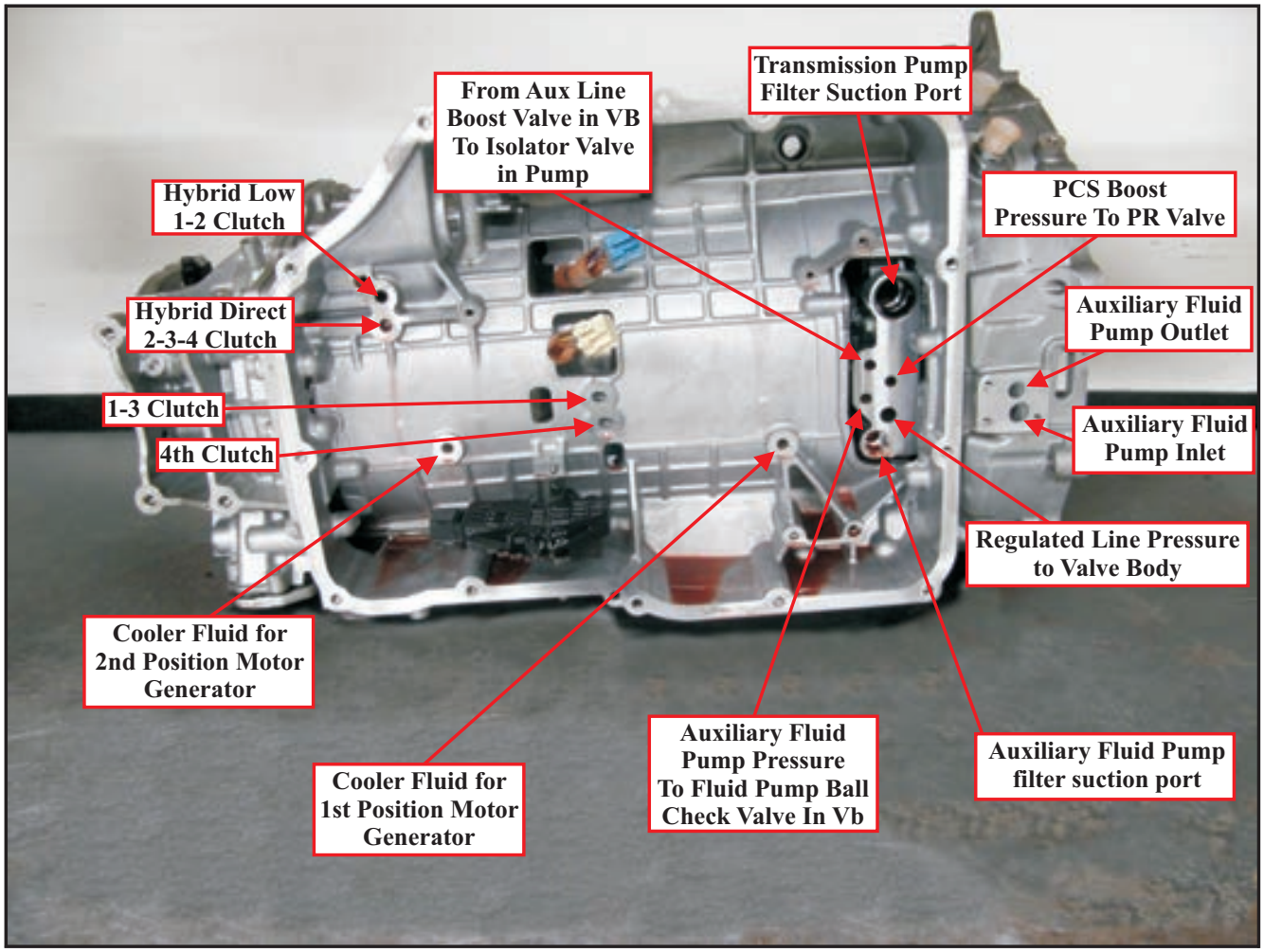


Figure 36

FORD ESCAPE HYBRID

PRELIMINARY INFORMATION

The Ford Escape Hybrid was offered for sale as a 2005 model. At the start of production for the 2006 model year the Mercury mariner was added. At the start of production for the 2008 model year Mazda acquired this same vehicle as the Tribute. The hybrid systems used in all three of these vehicles are identical.

Because Ford Motor Company designed the all wheel drive model with a separate PTU unit, the FWD and AWD transaxles are the same. The hybrid battery pack is one of the most powerful in the industry rated at 330 volts and is located under the cargo cover.

The transaxle is known as the eCVT or the P310 and has a dedicated cooling system that is separate from the engine cooling system. The hybrid cooling system uses a 12 volt electric pump to circulate the coolant.

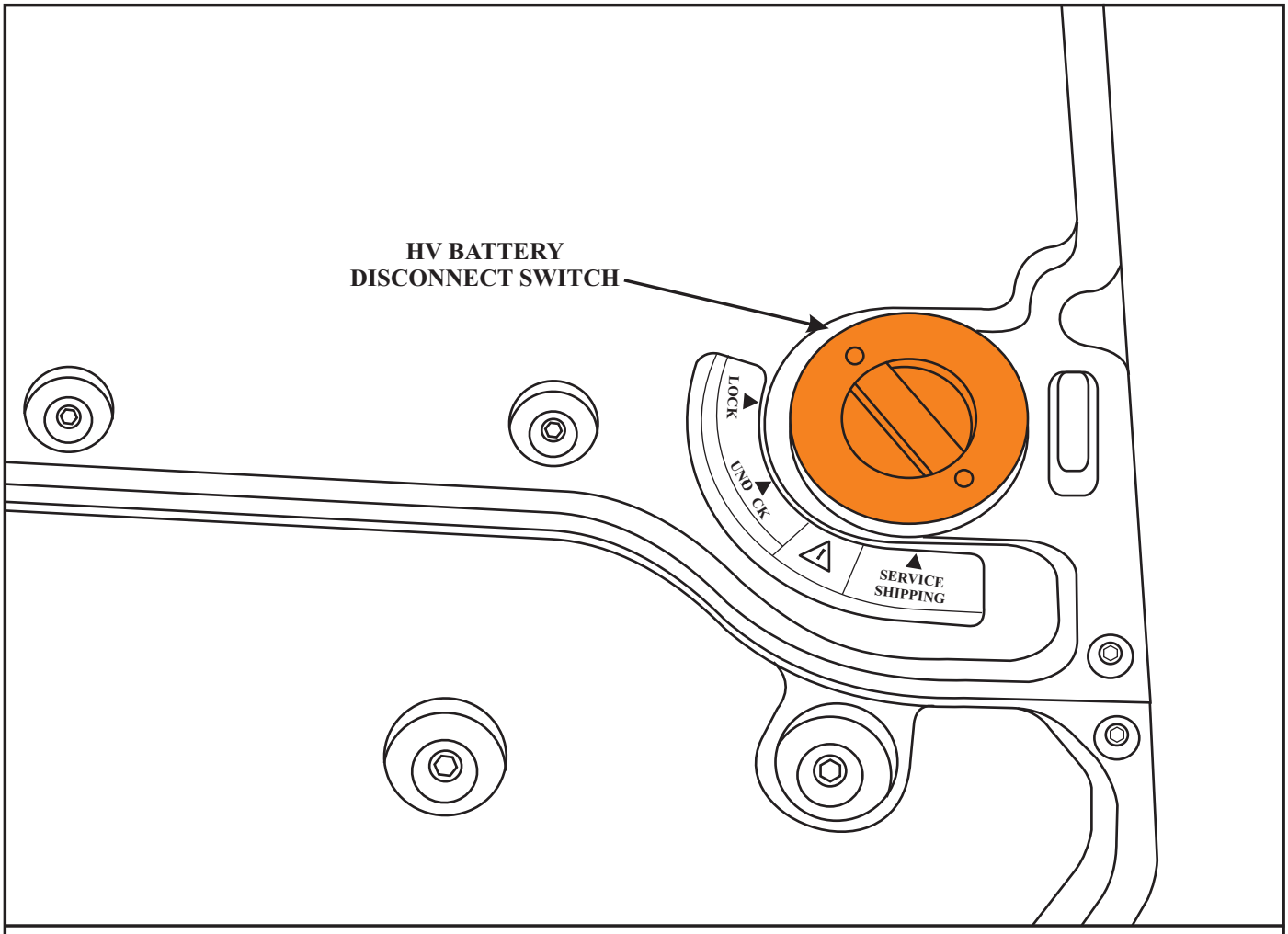
The P310 uses a Power Split Device (PSD) similar to the Toyota Prius to allow the transaxle to operate in its various driving modes. Unlike the Prius the P310 does not use a chain to connect the drive motors to the final drive. Instead, it is gear to gear. A four cylinder gasoline powered engine along with two 3 phase AC electric traction motors power the vehicle. The engine uses stop/start technology at which time the electric starter motor will start the engine if needed. The engine is a 2.3 Liter Atkinson Cycle design and can maintain a low RPM range while meeting the necessary torque requirements.

The vehicle can launch on electric power only. It also utilizes a regenerative braking system to recharge the hybrid battery pack and has electric assist steering which is functional when the ICE is off.

Power units, the Transmission Control Module (TCM), the DC to AC voltage inverter and the high voltage capacitors are all contained inside the transaxle. All other hybrid electronic controls are externally located.

FORD ESCAPE HYBRID

HYBRID BATTERY DISCONNECT SWITCH



To remove the battery disconnect switch in a Ford Escape or Mercury Mariner, remove the key from the ignition and place in a different safe location. Next, Locate the ORANGE HV Battery disconnect switch in the right rear corner of the cargo area. Next, rotate the cover to the "UNLOCK" position and pull it out. **DO NOT STICK YOUR HAND OR DROP ANYTHING IN THE HOLE, THE 336 VOLT BATTERY PACK IS BELOW THE OPENING!**
Next, replace the cover in the "SERVICE SHIPPING" location. Wait 5 to 15 minutes for the HV capacitors to discharge and then using your CAT III voltmeter and Class zero rated rubber gloves, check the HV circuits to make certain the voltage level is below 12 volts.

REMEMBER TO WEAR YOUR INSULATED GLOVES UNTIL YOU ARE SURE THERE IS LITTLE OR NO VOLTAGE ON THE HIGH VOLTAGE CIRCUITS!

CAUTION: EVEN THOUGH THE CAPACITORS ARE DISCHARGED, THE HYBRID BATTERY PACK IS ALWAYS LETHAL!

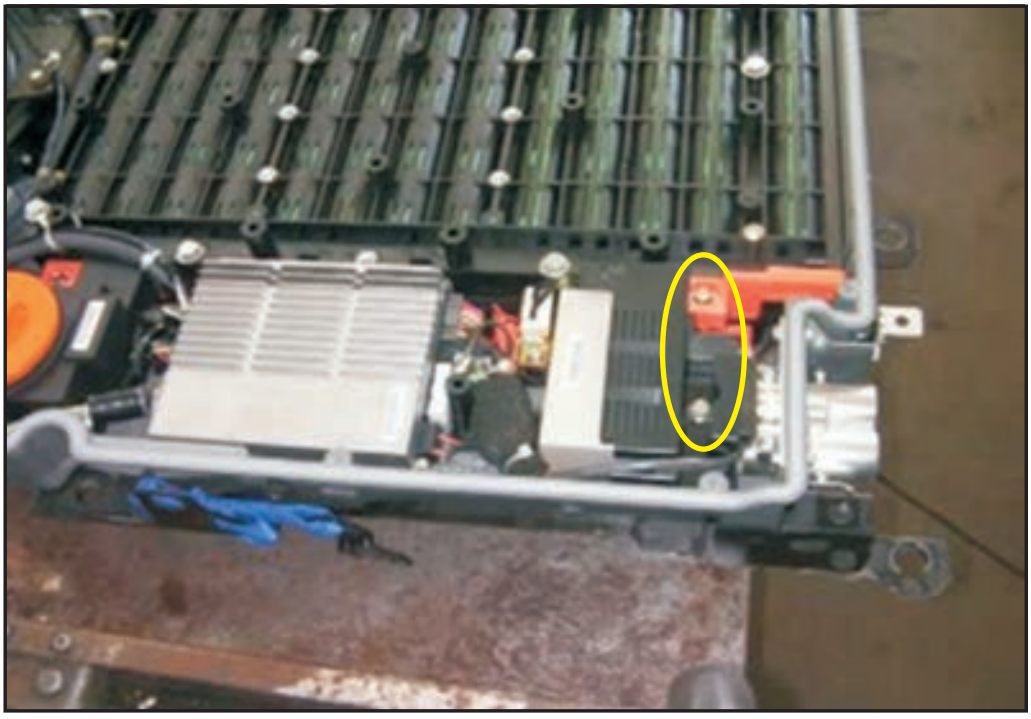
Figure 1

FORD ESCAPE HYBRID

HIGH VOLTAGE VERIFICATION

Remove the HV Traction Battery metal cover

Figure 2

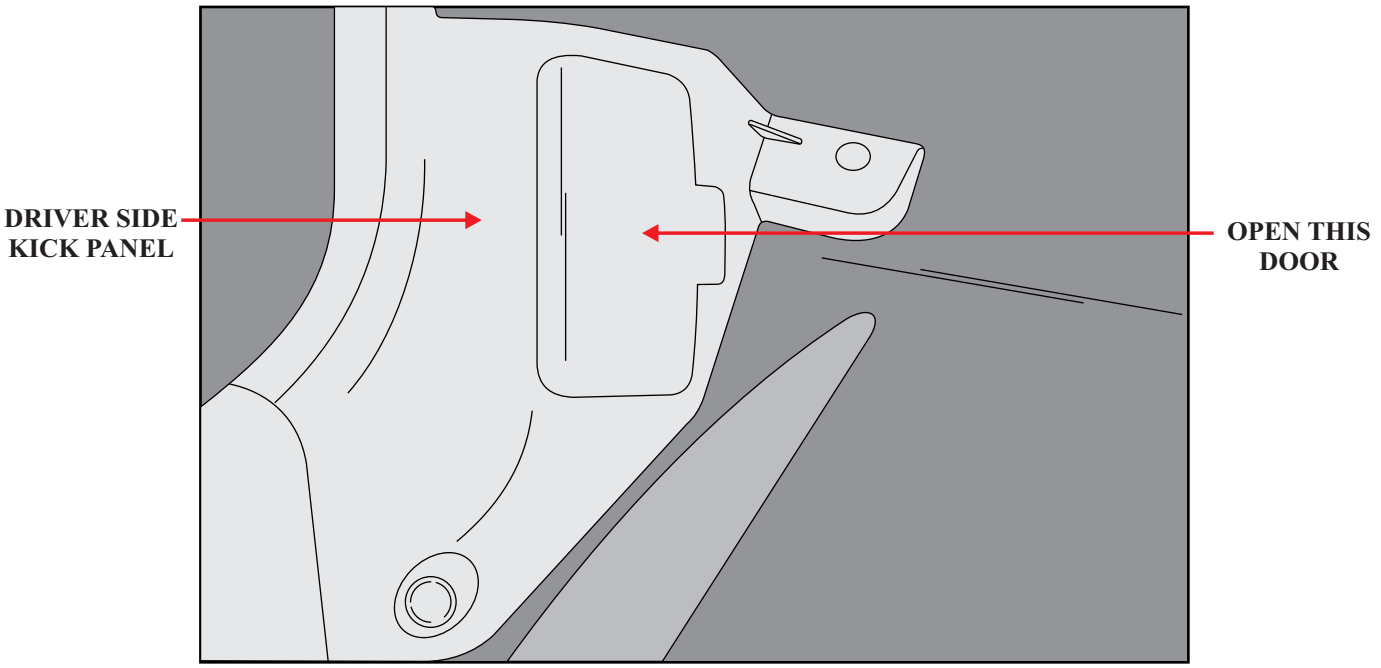


Once the hybrid battery disconnect switch has been turned off, it will be necessary to verify with class zero rated rubber gloves and a 1000 Volt, CAT III DVOM that the high voltage has dissipated. This is done at the HV Battery cable connection in the battery box as shown above.

Figure 3

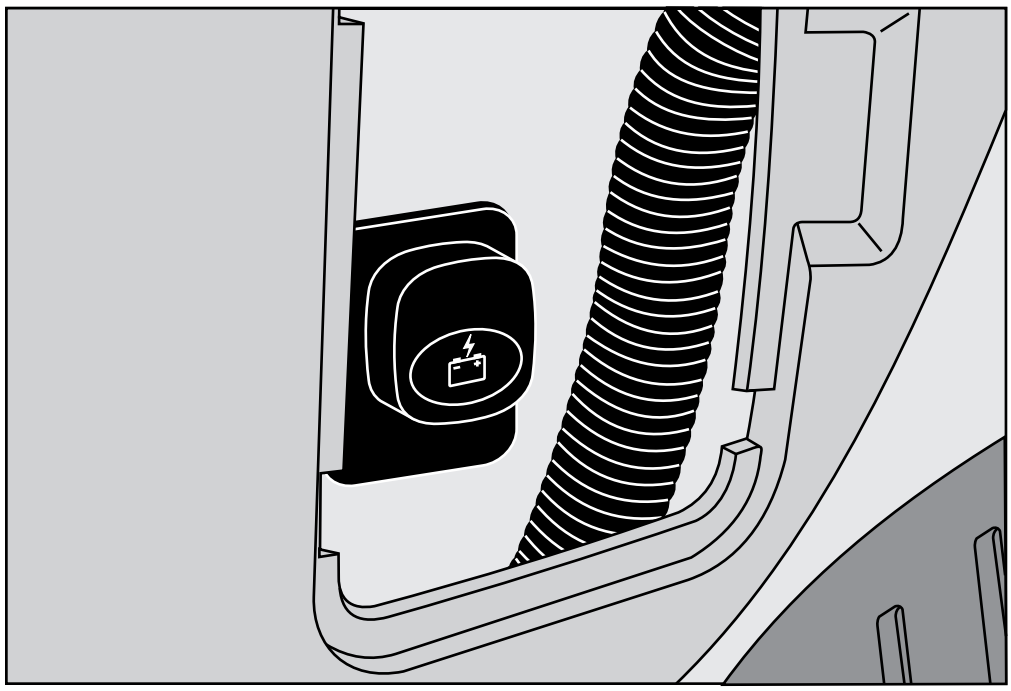
FORD ESCAPE HYBRID

HV BATTERY CHARGING SWITCH



Should the HV Traction Battery develop a state of charge that's too low to start the ICE, locate the cover in the driver's kick panel and remove it.

Figure 4

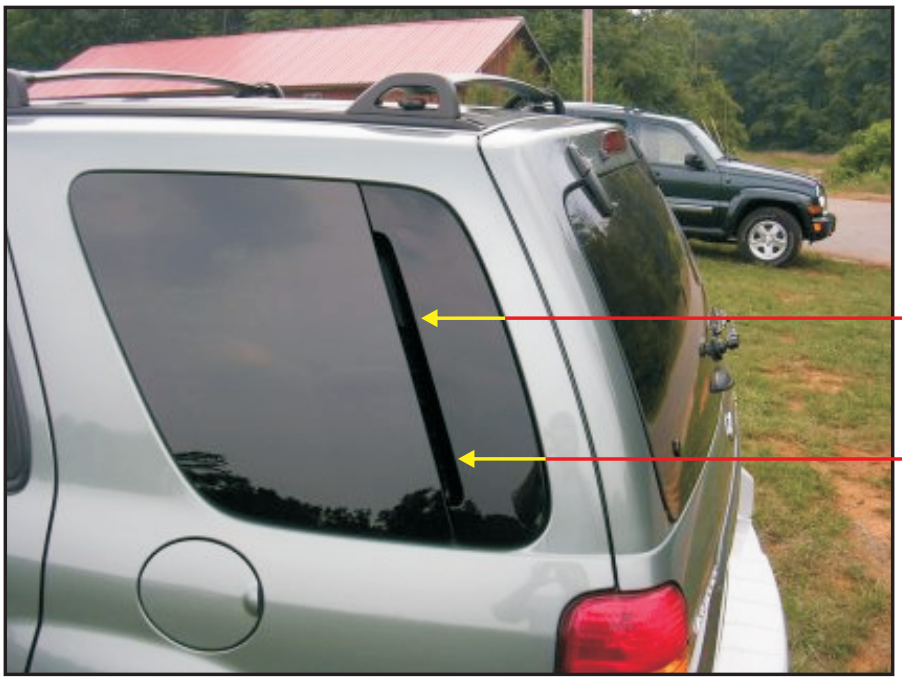


Behind the door is a Battery Charge Switch. Pull the knob out and wait 8 minutes for the vehicles 12 volt battery to provide just enough power to start the ICE, let the vehicle run long enough to charge both batteries. There is an 8 minute timer that will shut the switch off. This was eliminated in 2009.

Figure 5

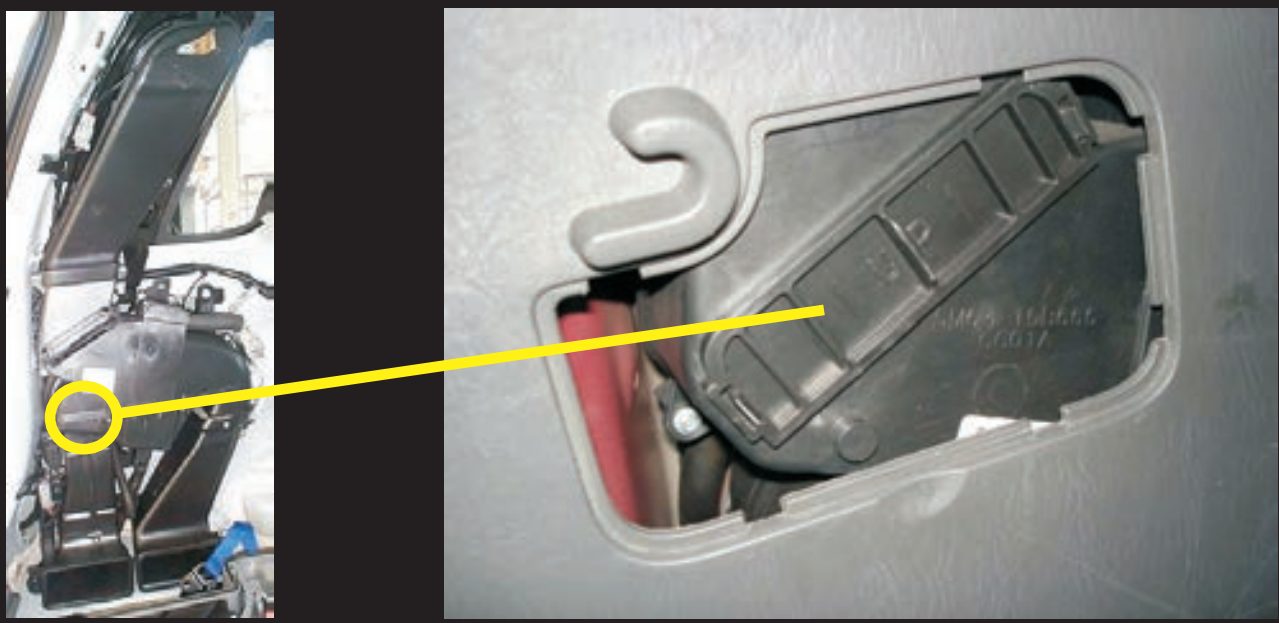
FORD ESCAPE HYBRID

HYBRID SERVICING



The High Voltage Traction Battery is cooled by fans as the fresh air is drawn in through the rear quarter window vent. Battery fumes are exhausted through the bottom half of the window vent.

Figure 6

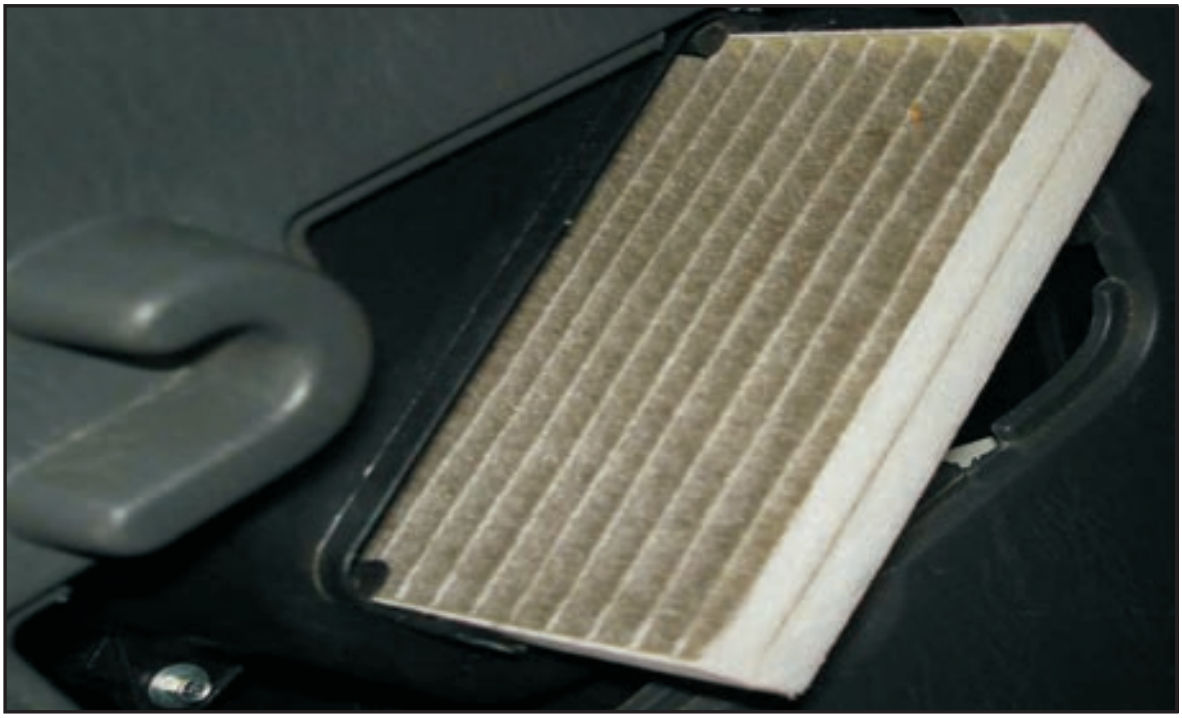


The intake and exhaust duct work is located in the cargo area on the drivers side. There is a small removable panel on the intake side of the duct work.

Figure 7

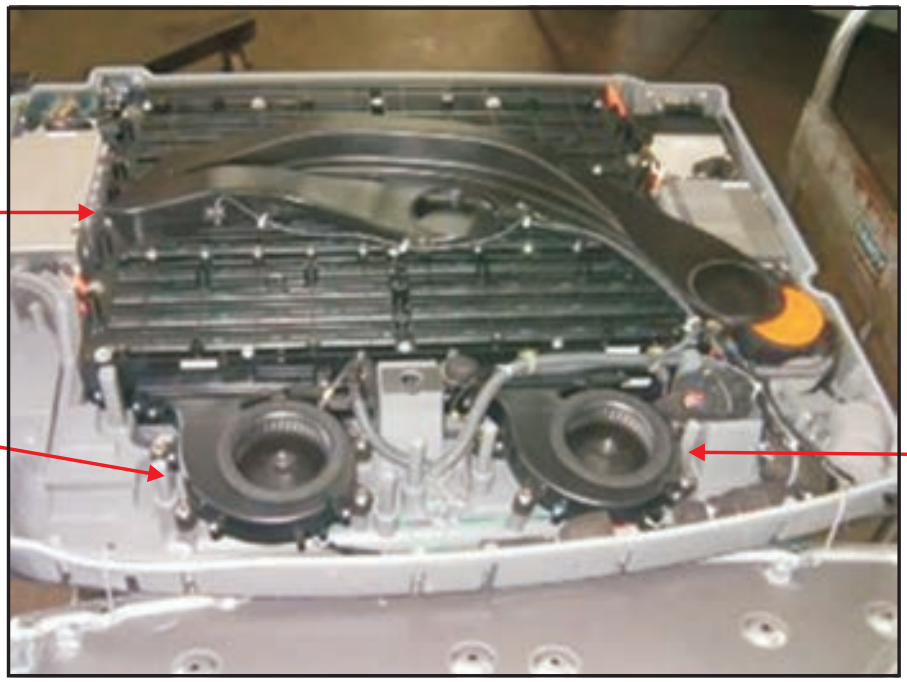
FORD ESCAPE HYBRID

HYBRID SERVICING



Located behind that removable panel is a filter that will need to periodically be replaced.

Figure 8

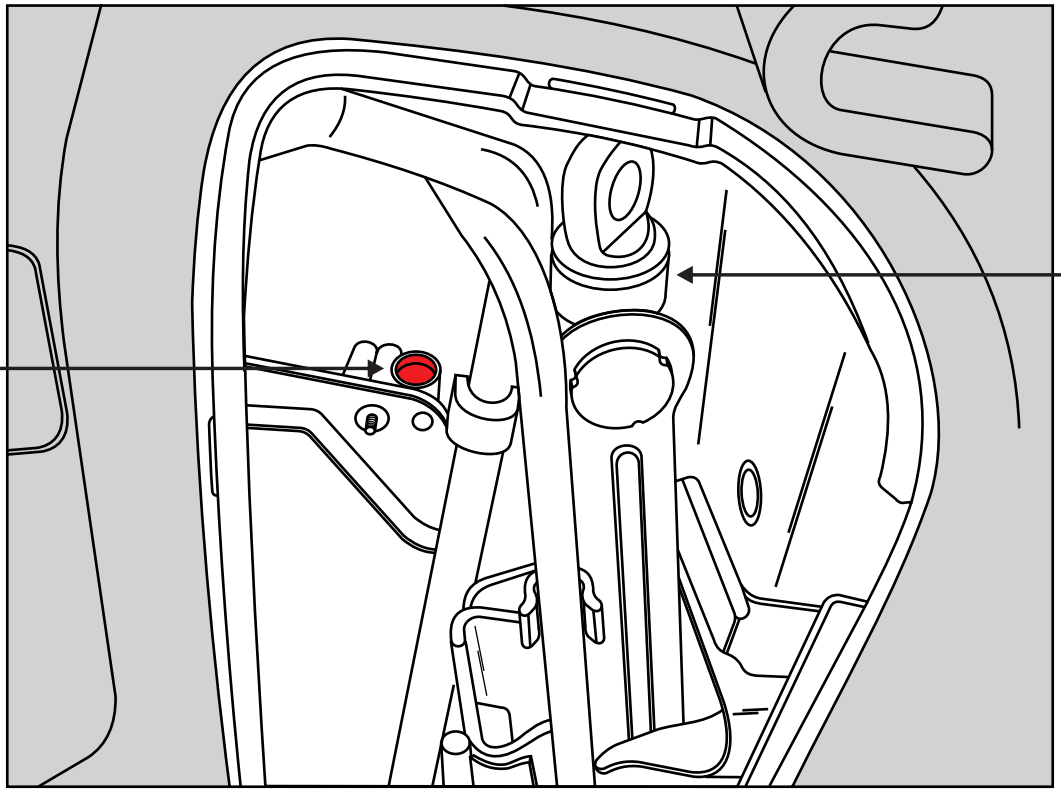


The High Voltage Traction Battery uses two cooling fans which require periodic cleaning. The fan duct work is connected to the ducts that lead to and from the window vent.

Figure 9

FORD ESCAPE HYBRID

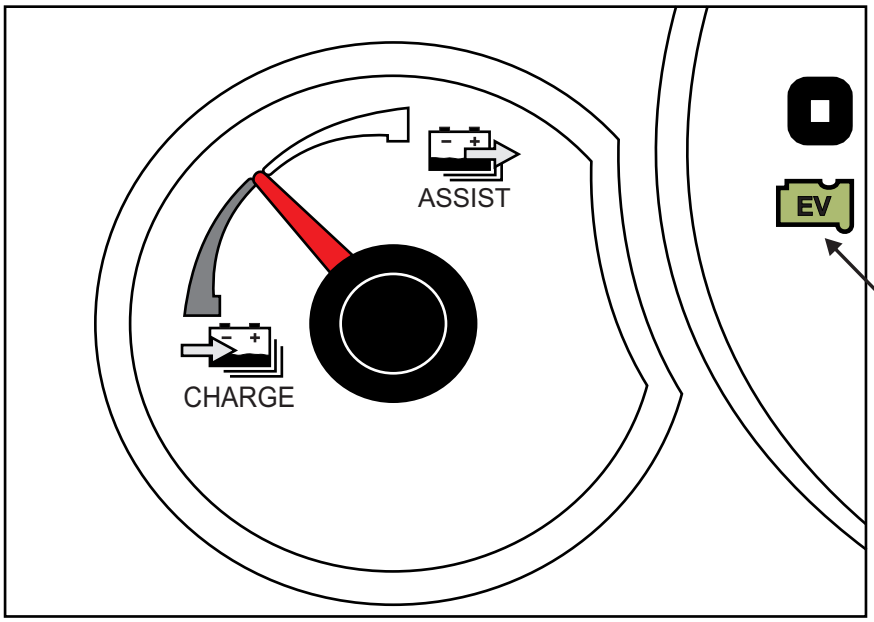
HYBRID INERTIA SWITCH & ASSIST CHARGE GAUGE



Behind a panel located in the passenger rear side of the cargo area is the hybrid system Inertia Switch. This switch shuts down the hybrid system in case of a collision. It is located next to the tire jack, if the jack is not secured after use, it can fall on the inertia switch and stop the vehicle from moving.

Figure 10

ASSIST/CHARGE GAUGE

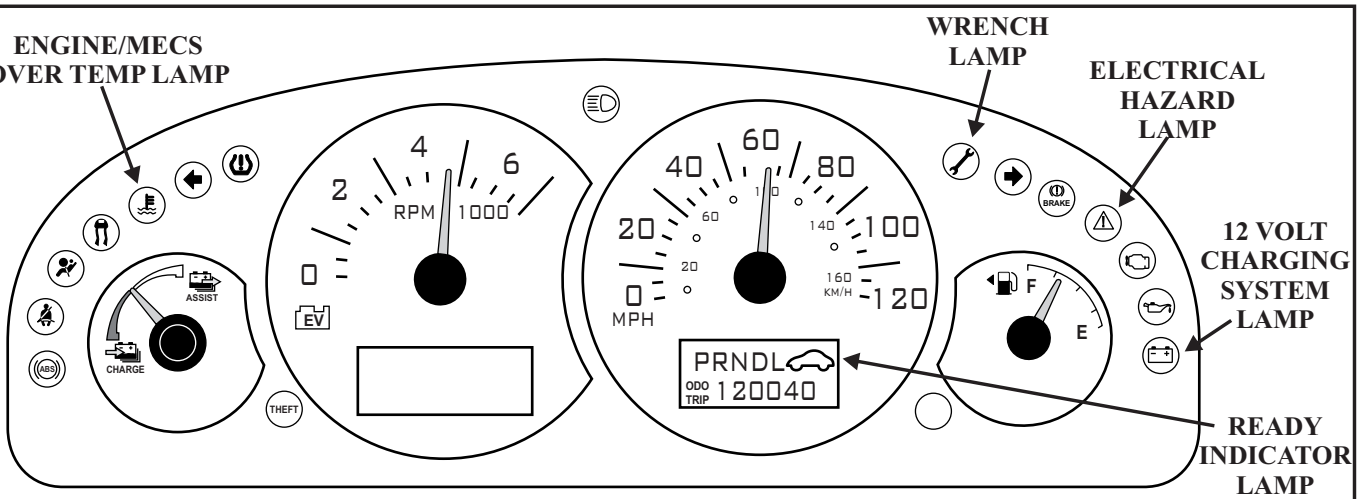


The Charge/Assist Gauge indicates when the HV Traction Battery is powering the vehicle or being recharged.

Figure 11

FORD ESCAPE HYBRID

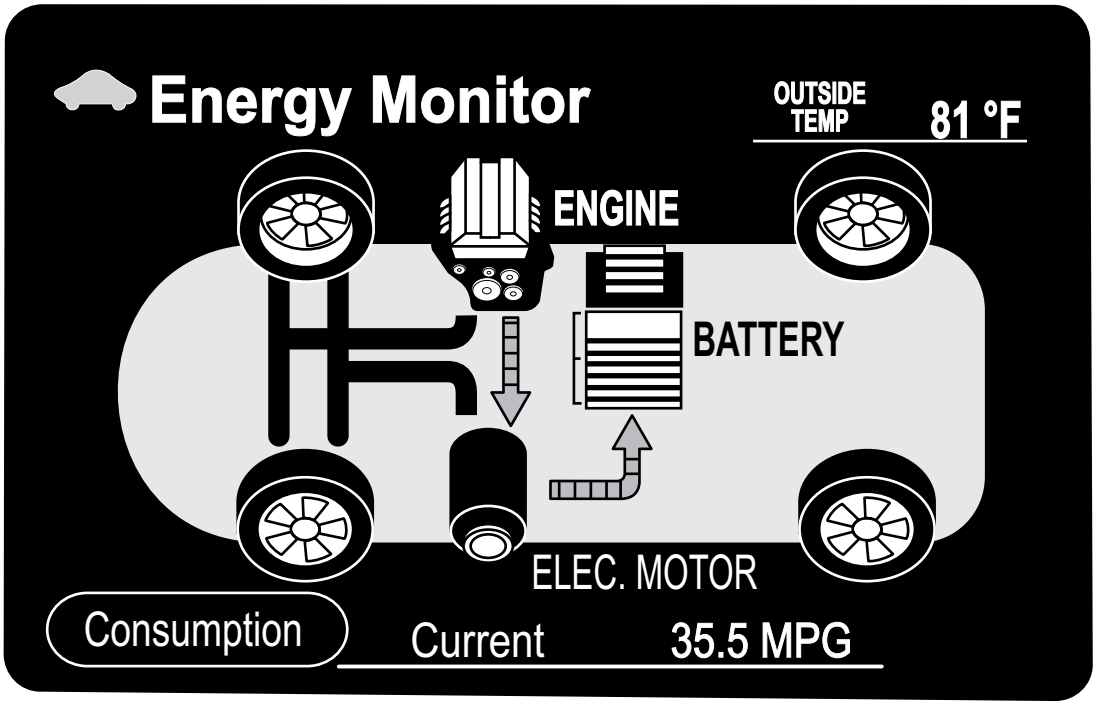
HYBRID WARNING LAMPS & MONITOR



The "Wrench" Lamp illuminates when a malfunction has occurred. The "Triangle" Lamp illuminates when a serious malfunction in the hybrid system occurs. If the "BATTERY" Lamp is illuminated, this means the 12 volt system has a malfunction. When the "READY" Indicator Lamp is illuminated, this indicates that the vehicle is ready to drive even though the ICE may not be running. When the "Engine/MECS Over Temp" Lamp is illuminated, there is an over heating condition in the ICE or the hybrid cooling system.

Figure 12

HYBRID MONITOR



The hybrid monitor indicates what state of drivabilty the hybrid system is operating in.

Figure 13

FORD ESCAPE HYBRID

DRIVING MODES

The Ford Escape Hybrid can exhibit a variety of driving modes as well as a failsafe mode. Theses driving modes are controlled by the Vehicle System Controller System (VSC) which consists of the Powertrain Control Module (PCM), the Transaxle Control Module (TCM), and the Traction Battery Control Module (TBCM) which communicate over a CAN Bus network. The PCM contains the VSC program and is responsible for controlling the hybrid system as well as the failsafe and code storage operations. Hardware used consists of a traction motor battery, two traction motors located inside the transaxle and a power split device. These are the most common components seen in series parallel hybrid systems. All of which produce the following driving modes:

ELECTRIC MODE

The hybrid electric system operates in electric mode when the vehicle is propelled by the electric power stored in the high voltage traction battery pack. Torque is supplied by the traction motor, the generator motor or a combination of both. As long as demand is not too great, the vehicle will drive in EV Mode without the use of the gas engine. Electric mode is also used for reverse movement because the engine can only deliver torque in a forward direction.

POSITIVE SPLIT MODE

In this mode the internal combustion engine is running and powering the generator motor which produces high voltage electricity. The power from the engine is split between the path through the generator motor and the path to the drive wheels. The electricity produced by the generator motor charges the HV Traction Battery or powers the Traction Motor through the Power Split Device. In this mode the traction motor can operate as a motor or as a generator to make up the difference between engine power and desired power at the drive wheels.

CREEP MODE

The hybrid electric system delivers torque to the drive wheels to mimic the creep normally found on vehicles equipped with a torque converter. The Powertrain Control Module commands a predetermined amount of torque to be delivered to the drive wheels through the transaxle. This torque is delivered from the ICE, the Traction Motor or the Generator Motor. The maximum creep speed in forward or reverse is approximately 4 MPH (6 km/h).

NEGATIVE SPLIT MODE

In this mode the ICE is running but the generator motor is reducing engine speed. This mode is never preferred but occurs when all of the following vehicle conditions are met: The engine is running, vehicle speed is high, the high voltage traction battery is charged and reducing engine throttle is not desired.

NEUTRAL GEAR MODE

The hybrid electric system operates in this mode when the driver selects NEUTRAL. In neutral gear the electronically controlled transaxle does not deliver any positive or negative torque to the drive wheels. The neutral gear actually consists of two neutral operating states:

1. Active neutral activated above 6 MPH (10 km/h).
2. Passive neutral activated below 6 MPH (10 km/h).

In active neutral, the generator motor is permitted to start and stop the ICE as needed to maintain the HV Traction Battery charge and provide HVAC operation.

FORD ESCAPE HYBRID

DRIVING MODES

NEUTRAL GEAR MODE *continued*

In passive neutral, the engine must remain in the state it was when the mode was entered and is not permitted to change state, (start or stop). If the engine is running when entering passive neutral, the speed control of the engine is transferred from the generator motor to the engine itself. The engine controlling its own speed in passive neutral is described as "Secondary Idle". The vehicle cannot be started in passive neutral, but can be started in active neutral.

ENGINE CRANKING MODE

The electronically controlled transaxle provides the engine cranking function to start or restart the ICE. When the PCM requests the engine cranking mode, the generator motor rapidly accelerates the engine speed up to about 1,000 RPM for about 0.3 seconds. When the engine speed reaches a calibrated speed the PCM commands the delivery of the fuel and spark at the appropriate times.

LIMITED OPERATING STRATEGY (LOS)

For some hybrid electric system malfunctions the PCM may initiate one or more of the LOS modes. The objective of the LOS modes is to manage vehicle operation after one or more of the following systems are disabled due to a malfunction: Engine, Transaxle, Traction battery or Regenerative brake system. Some LOS modes limit the vehicle capability to a limp home condition. Other LOS modes fully disable the vehicle. The PCM initiates the appropriate LOS mode depending on the severity of the malfunction that was detected.

When the PCM detects system faults for which the LOS mode is initiated, it stores a corresponding DTC. The root cause of the malfunction that initiated the LOS mode may be in a different subsystem or component than indicated by the DTC. Therefore, these DTCs should be considered LOS or FMEM only and are always accompanied by other more detailed circuit DTCs. The circuit DTCs should always be used to diagnose the problem before LOS or FMEM DTCs. LOS or FMEM DTCs do not mean that the subsystem or component they describe actually failed, but indicate the subsystem or component that is affected by the LOS mode.

NORMAL POWER DOWN SEQUENCE

The PCM must conduct a normal power down sequence. When ever the key is turned to the off or ACC position, modules that are powered up by the RUN circuit immediately shut down. However the PCM, TCM and TBCM stay on until the power down sequence is complete. The PCM keeps the TCM alive by controlling the Power Sustain Relay (PSR) which provides power to the TCM. The TBCM is powered directly from the 12 volt battery which permits wake-up function when the vehicle is off.

During the power down sequence the PCM shuts the engine off. Requests the TCM to disable the high voltage invertors. Disables the DC/DC converter. Requests the TBCM to open the high voltage contractors Requests the TCM to discharge the high voltage inverter capacitors and Opens the power sustain relay. If the power down sequence does not execute correctly, it is considered an abnormal shut down, which may result in the PCM, TCM and the TBCM storing DTCs.

POWER UP SEQUENCE

The PCM must conduct a power up sequence every time the key is turned from the OFF to the START position. The power up sequence is carried out only with the electronically controlled transaxle gear selector in the PARK position. During the power up sequence the PCM initializes and begins CAN communications with the TCM and the TBCM.

FORD ESCAPE HYBRID

DRIVING MODES

POWER UP SEQUENCE *continued*

It also Checks for TCM error status, requests the TBCM to close the high voltage contractors, enables the DC/DC converter and Starts the ICE. If the malfunction is detected during the power up sequence, the PCM may initiate LOS mode and store DTCs.

REGENERATIVE BRAKING

The regenerative braking is a software strategy and is controlled by the PCM, the TCM and the TBCM. Regenerative braking is the ability to capture and store a portion of the energy that would be lost as heat during a braking event. When the driver uses the brakes, the PCM determines how much negative torque (braking force) the traction motor should provide in addition to the friction brakes. Depending on the high voltage traction battery state of charge, the amount of negative torque provided by the traction motor can vary between 0 and 100 percent. The traction motor then becomes a generator, which causes the energy to flow into the high voltage traction battery. The PCM strategy smoothly blends regenerative and friction brake effort to make the dual brake operation transparent to the driver.

TORQUE MONITOR

The torque monitor resides within the PCM as both software and as a redundant safety processor. The torque monitor detects certain computer faults of the PCM. The torque monitor also detects if the overall powertrain torque delivered to the drive wheels is excessive to what the driver is requesting. The torque monitor detects 3 gross errors that are present for a specified time period which are:

1. Unintended vehicle motion when the powertrain accelerates the vehicle when it should not or provides movement in the wrong direction.
2. Excess acceleration when the vehicle accelerates at a greater rate than the driver of speed control requests.
3. Excess powertrain deceleration when the powertrain braking exceeds driver demand.

When any of the gross errors are detected, the torque monitor communicates it to the PCM, which initiates appropriate action such as LOS mode. The torque monitor requested LOS mode can be cleared when the malfunction is no longer present and the key is cycled to the OFF position for about 10 seconds.

TORQUE DETERMINATION & ENERGY MANAGEMENT

The PCM is responsible for torque determination and energy management functions. The PCM monitors gear selector position, brake pedal position and accelerator pedal position. The PCM then makes a torque command determination. Positive torque is perceived as vehicle acceleration and negative torque is perceived as braking. Based on the amount of torque requested by the driver, the PCM decides which power source has to deliver the torque to meet the driver demand while the powertrain system is running most efficiently.

FORD ESCAPE HYBRID

DRIVING MODES

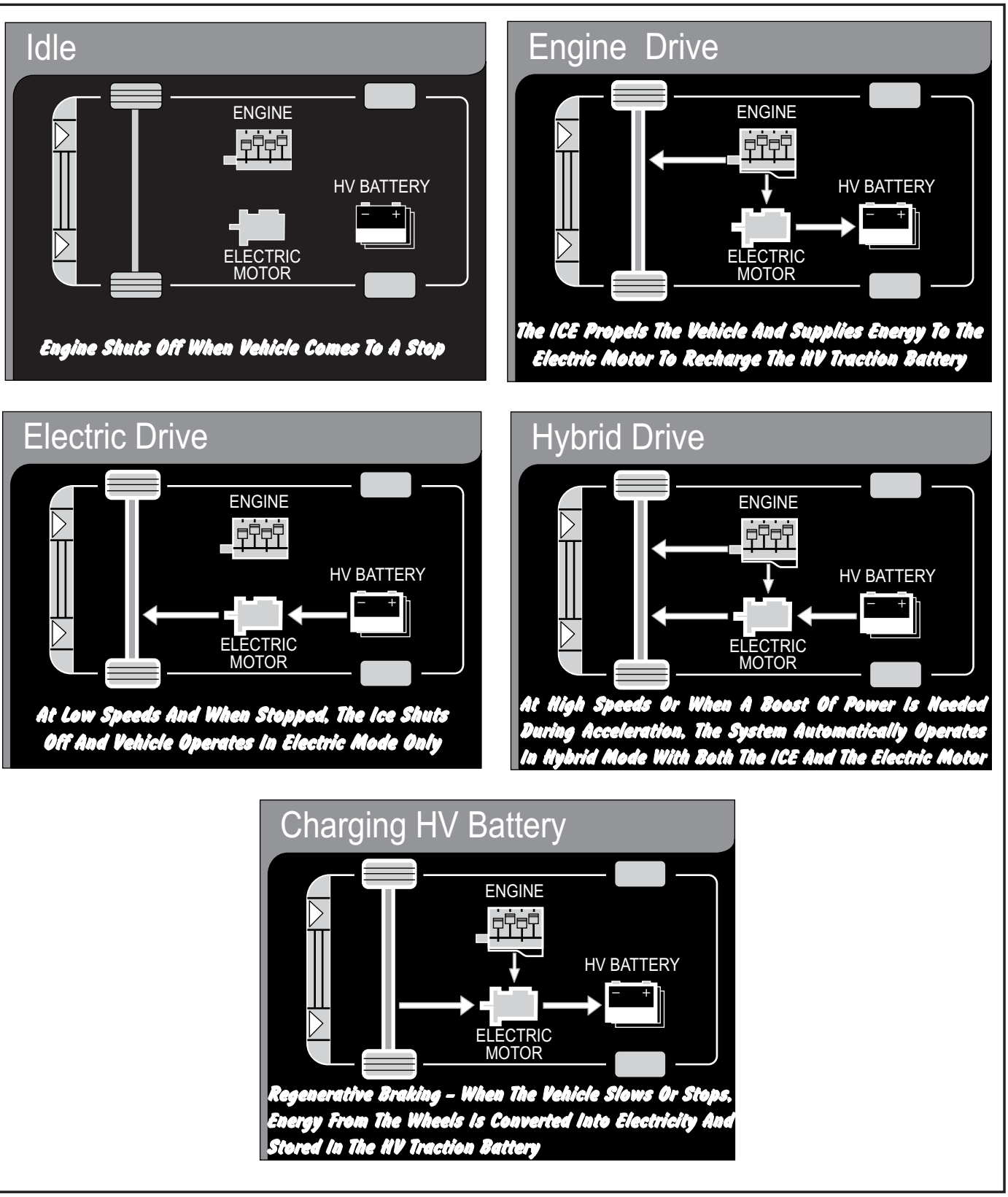
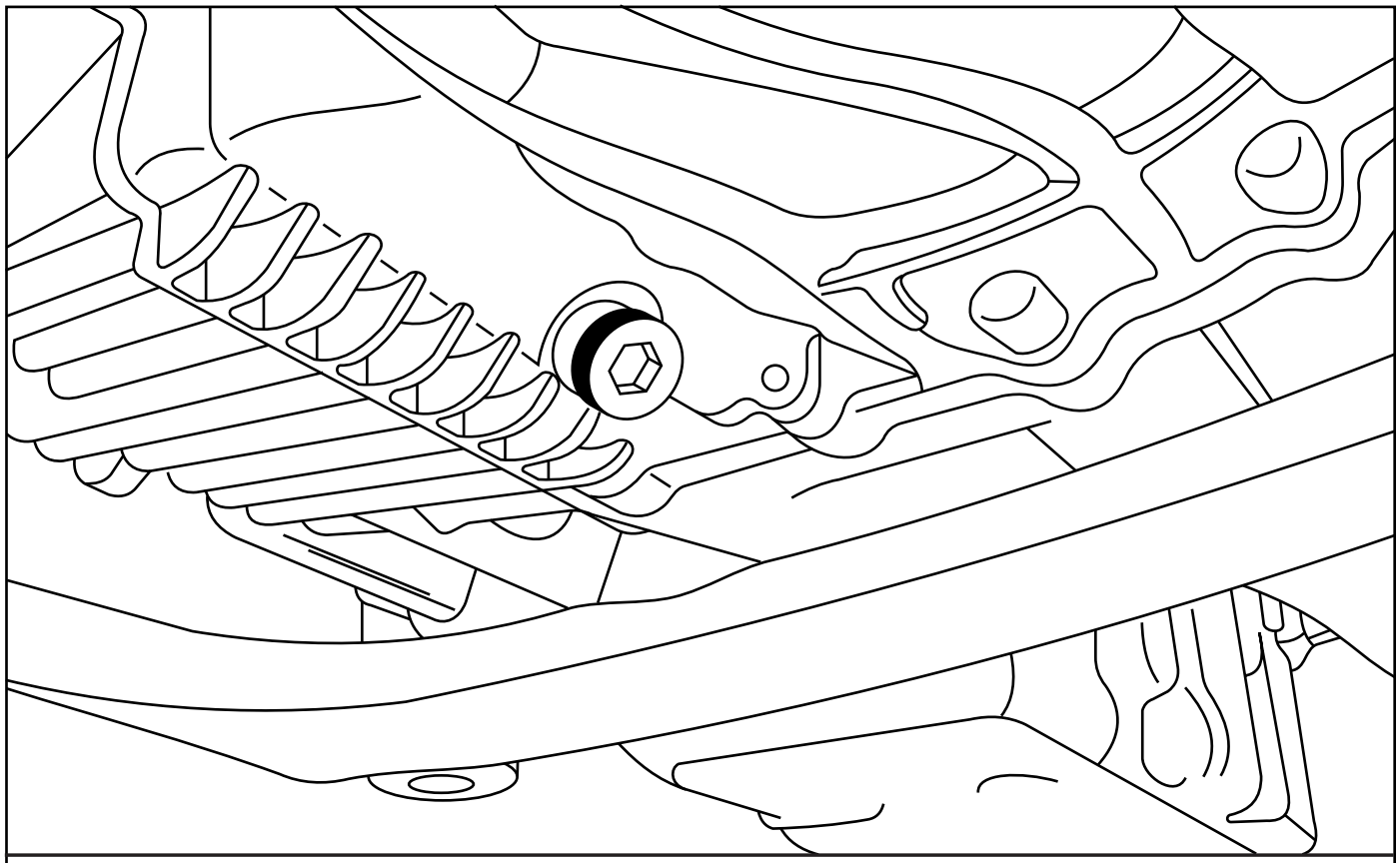


Figure 14

FORD ESCAPE HYBRID

HYBRID FLUID SERVICE

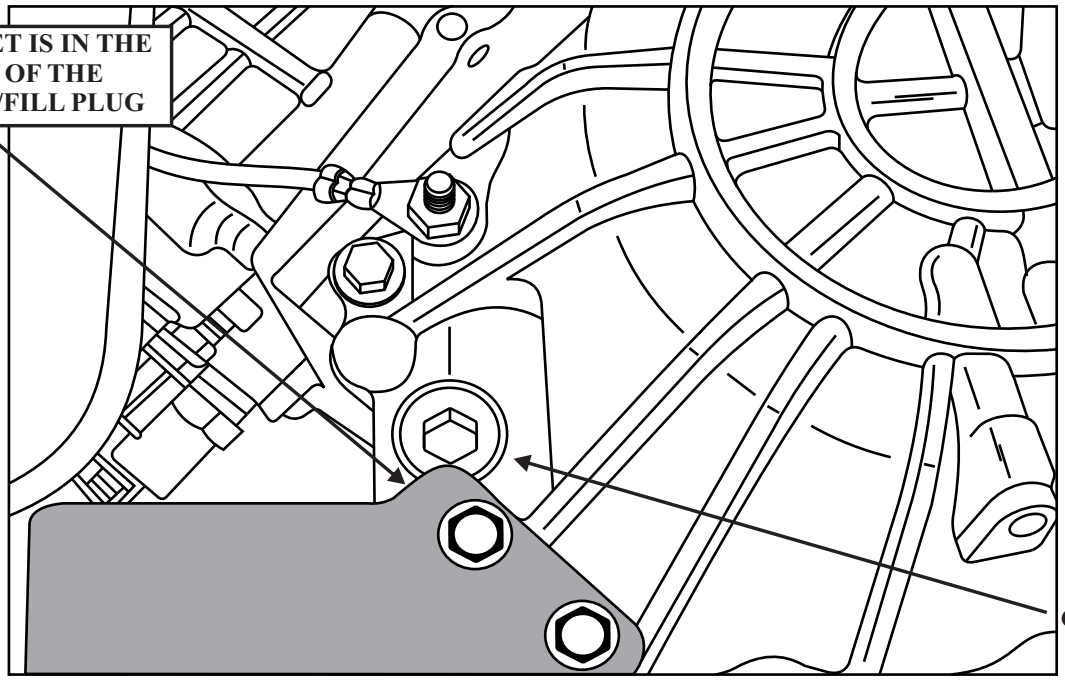


Remove the splash guard and the ATF drain plug. Once the drain plug is installed, tighten to 30 Lb. Ft.

Figure 15

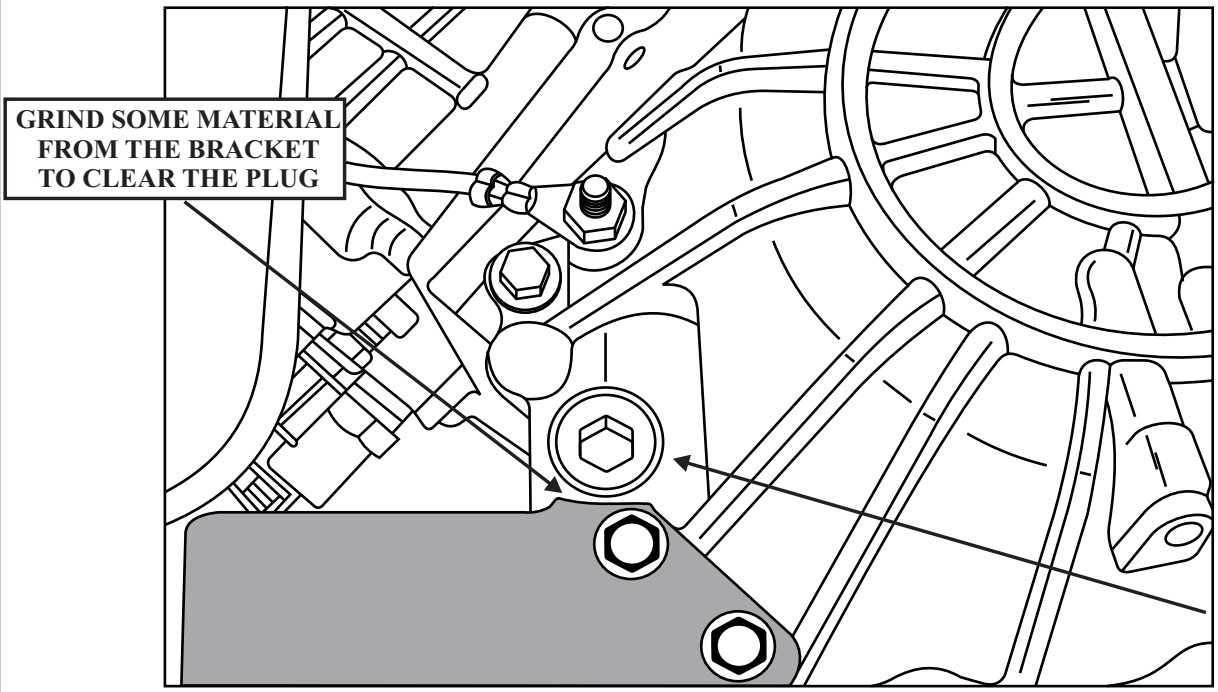
FORD ESCAPE HYBRID

HYBRID FLUID SERVICE



The ATF Check/Fill Plug is located at the rear of the transaxle. When the Check/Fill Plug is removed for the first time the support bracket will be in the way.

Figure 16



A modification will have to be made to the support bracket to allow for easy access to the Check/Fill Plug. Grind a small amount of material from the bracket in order to clear the Check/Fill Plug and fill with **4.3 Qts (4.5L) of Mercon® LV ATF fluid.**

Figure 17

FORD ESCAPE HYBRID

COOLANT SERVICE

Drain the Motor Electronics Cooling System (MECS) to remove the coolant from the hybrid system. Removal of the MECS cooling hoses from the transaxle will drain the system.

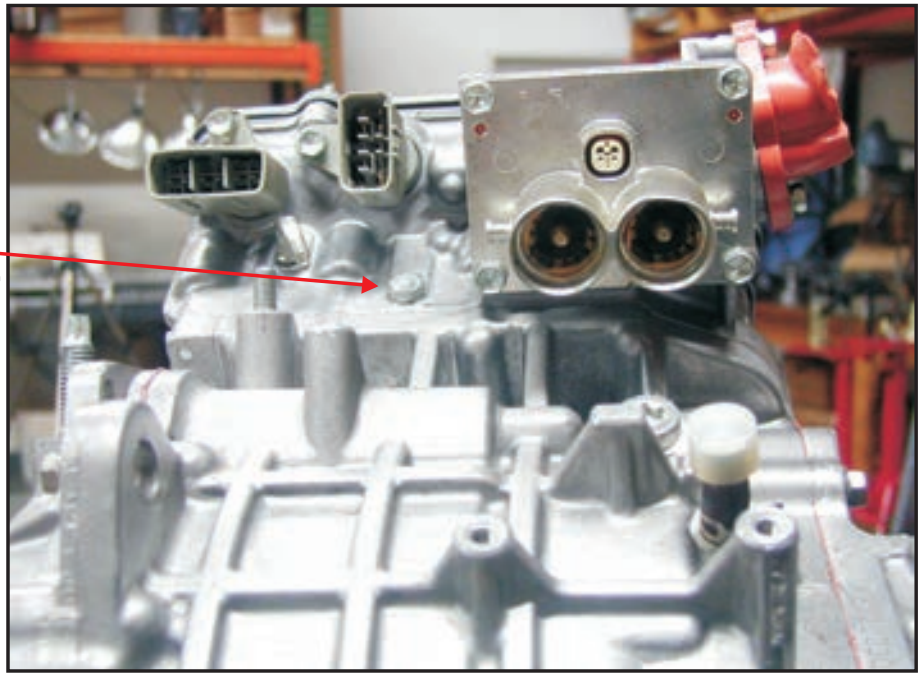
Figure 18

The hybrid coolant system is filled through the ***Inverter*** Degas Bottle shown above. Coolant dry fill is **3.7 Qts. (3.5L) of Motorcraft Premium Gold Engine Coolant.**

Figure 19

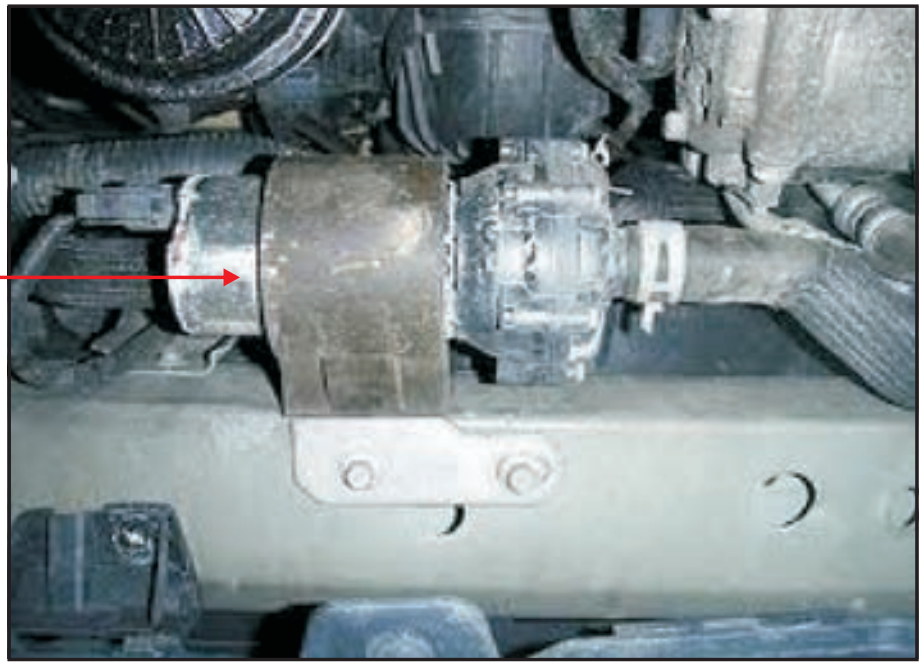
FORD ESCAPE HYBRID

COOLANT SERVICE



Remove the chrome bleeder bolt located on the transaxle below the low voltage connector to purge the air from the MECS cooling system.

Figure 20



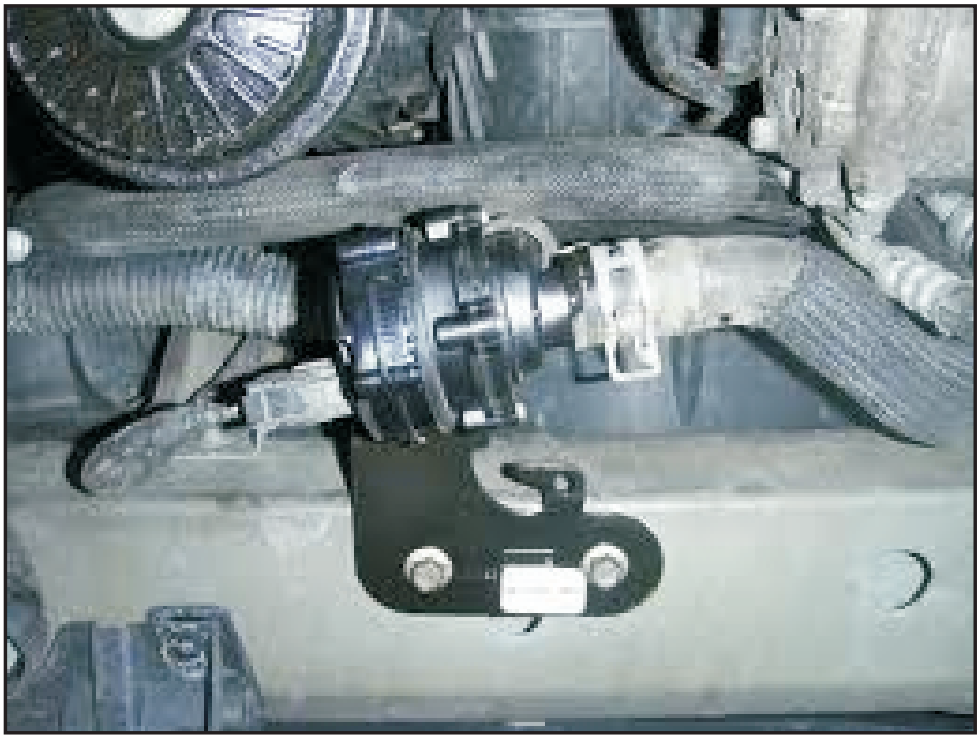
The Motor Electronic Coolant System (MECS) pump is powered by the 12 volt system. This pump should be updated if the original one is still in service due to a high failure rate. The pump is located in front of the MECS radiator at the center of the vehicle.

Figure 21

FORD ESCAPE HYBRID

COOLANT SERVICE

Figure 22

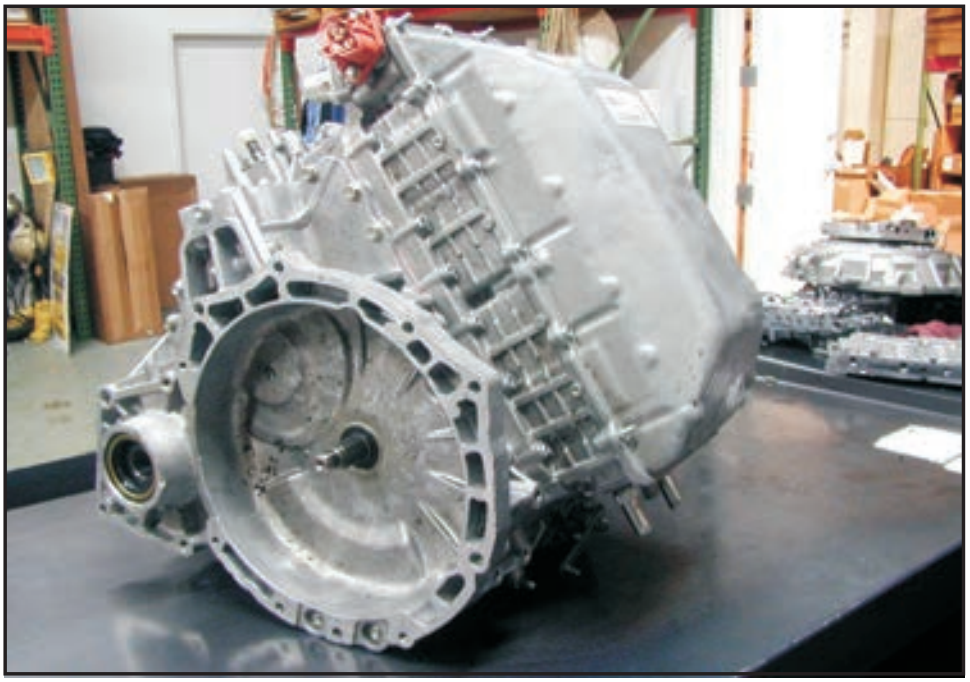


The current design MECS pump is a bolt in replacement for the previous design pump.

Figure 23

FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



The P310 eCVT transaxle is a massive unit weighing in at 287 pounds. It uses a damper plate assembly instead of a torque converter between the transaxle and the engine.

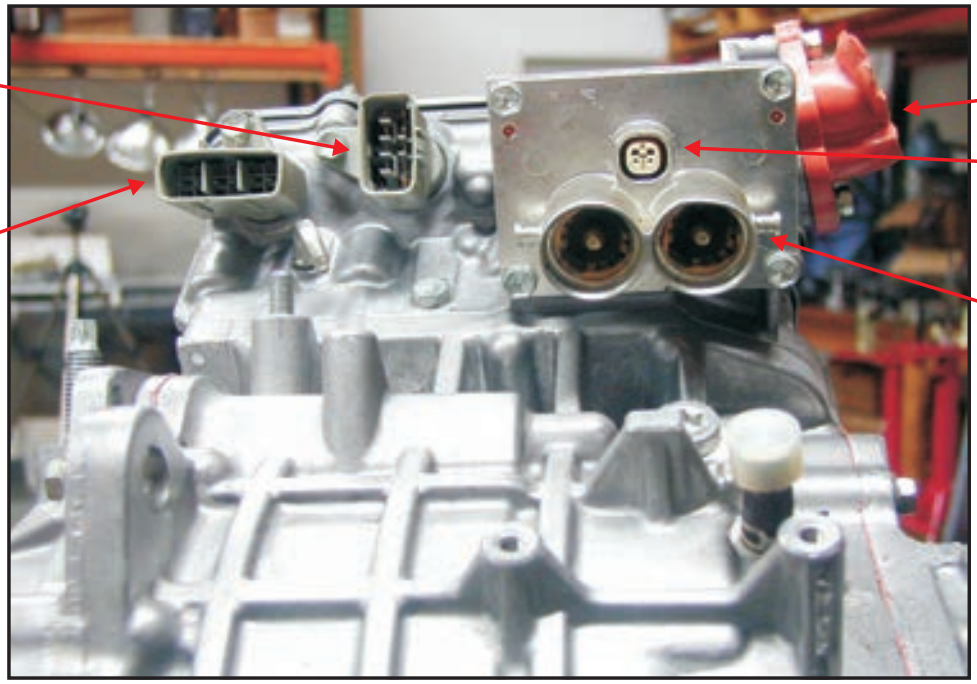
Figure 24

There is a high voltage warning tag on the transaxle top cover because the DC to AC Inverter as well as the Motor Control Modules are located underneath the cover.

Figure 25

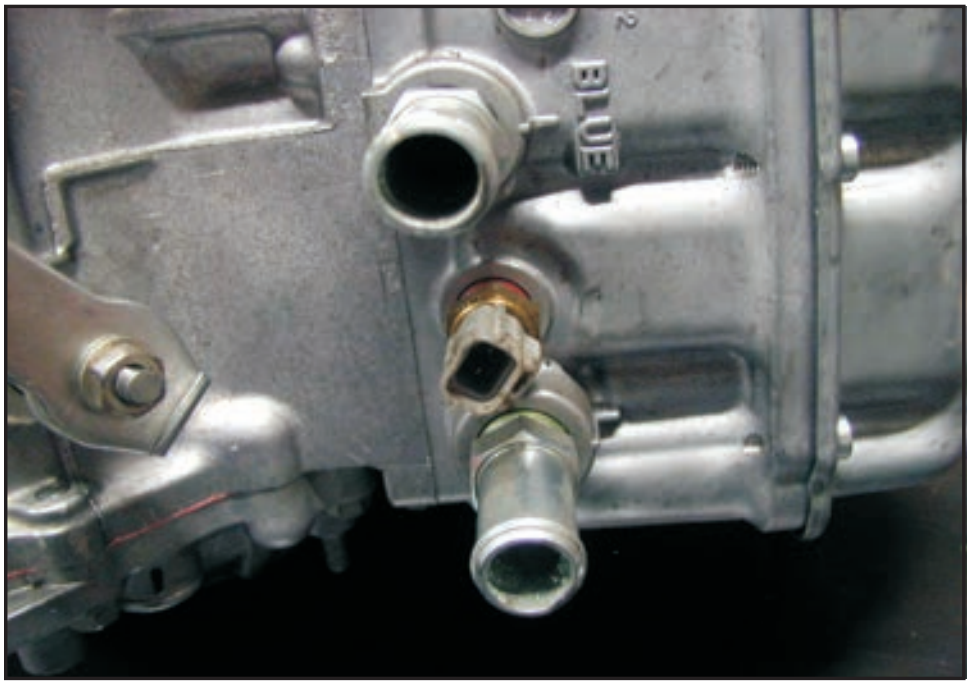
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



These are most of the connectors that have to be disconnected for transaxle removal which are the TCM, MECS and HV cables.

Figure 26



Located between the MECS coolant pipes is the Hybrid System Temperature Sensor

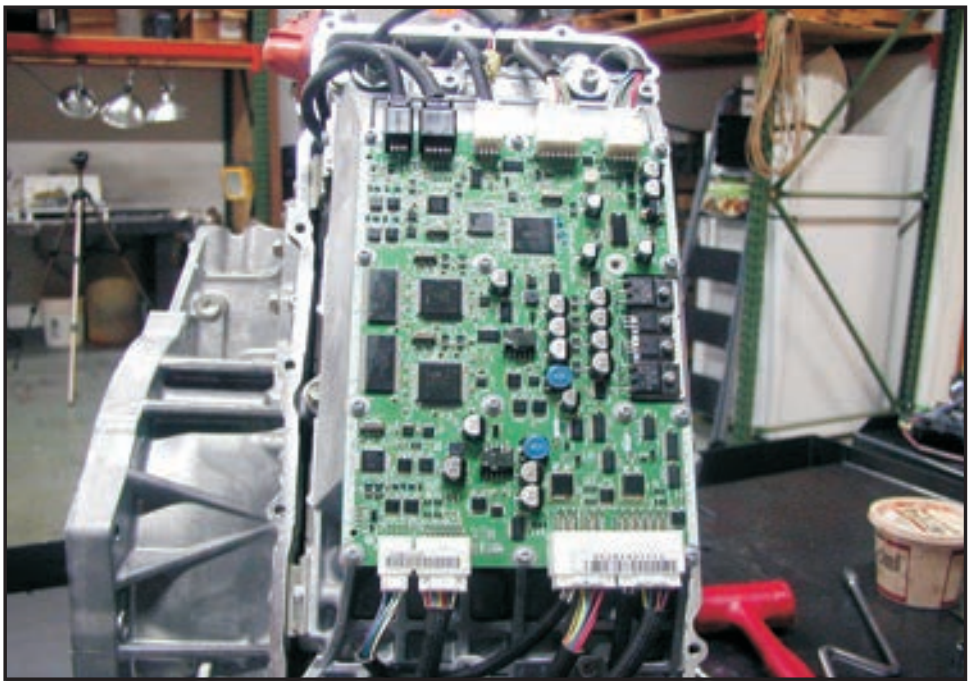
Figure 27

FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE

The top cover is ready to be removed, it has been damaged due to improper handling. This must be avoided due to what lies underneath this cover.

Figure 28

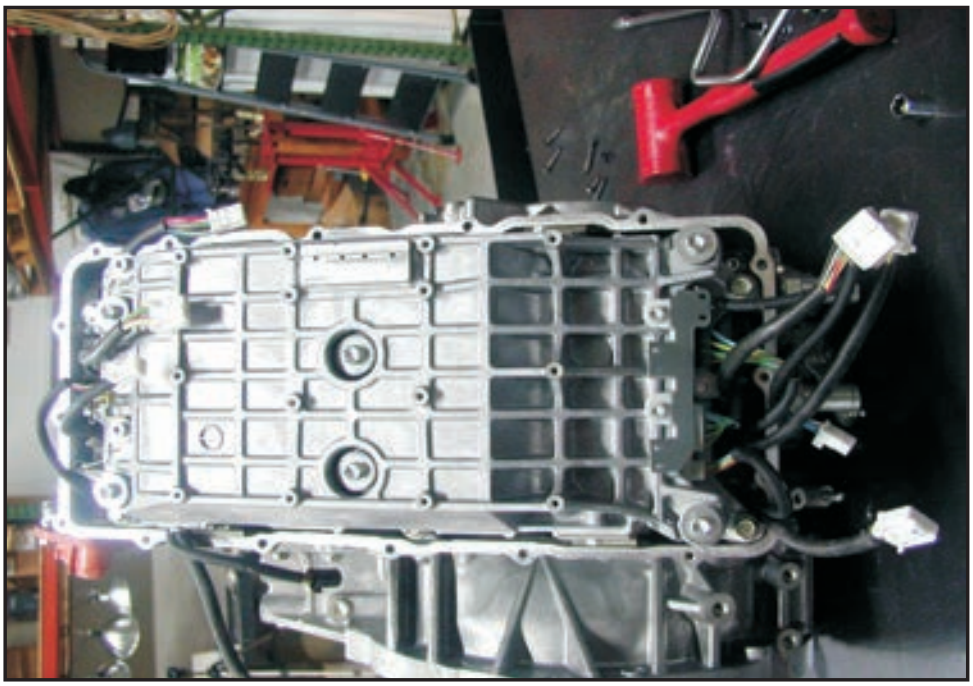


Below the top cover is the DC to AC inverter, care must be taken not to damage this due to mishandling. A ground strap should be worn to avoid electrical damage from static electricity.

Figure 29

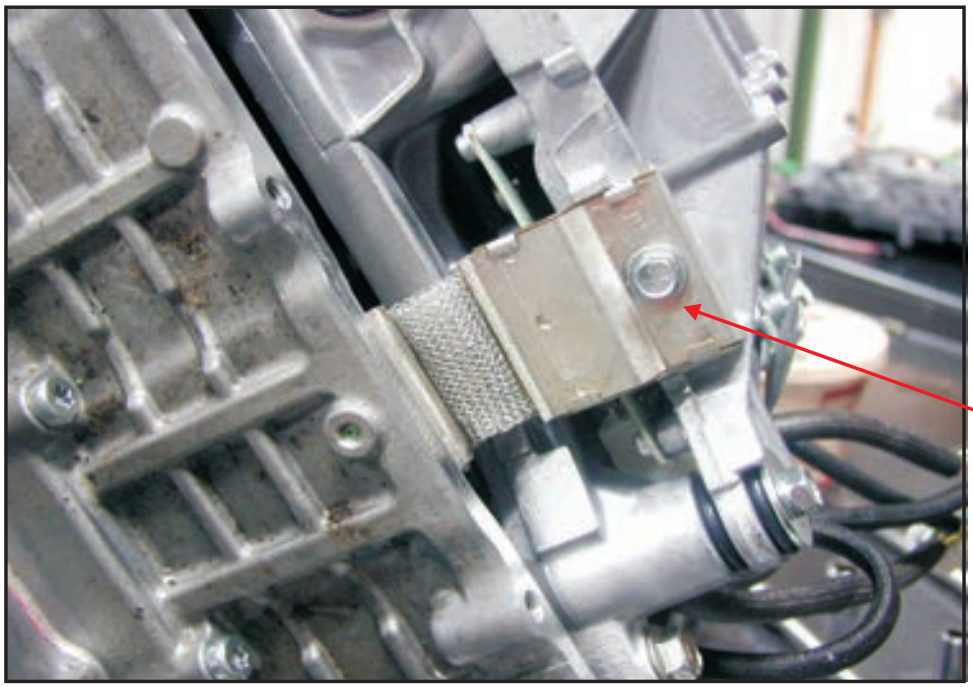
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



Once the inverter has been removed this cast aluminum cover is next. All the bolts are mounted in rubber grommets, make certain during assembly they are all in place.

Figure 30

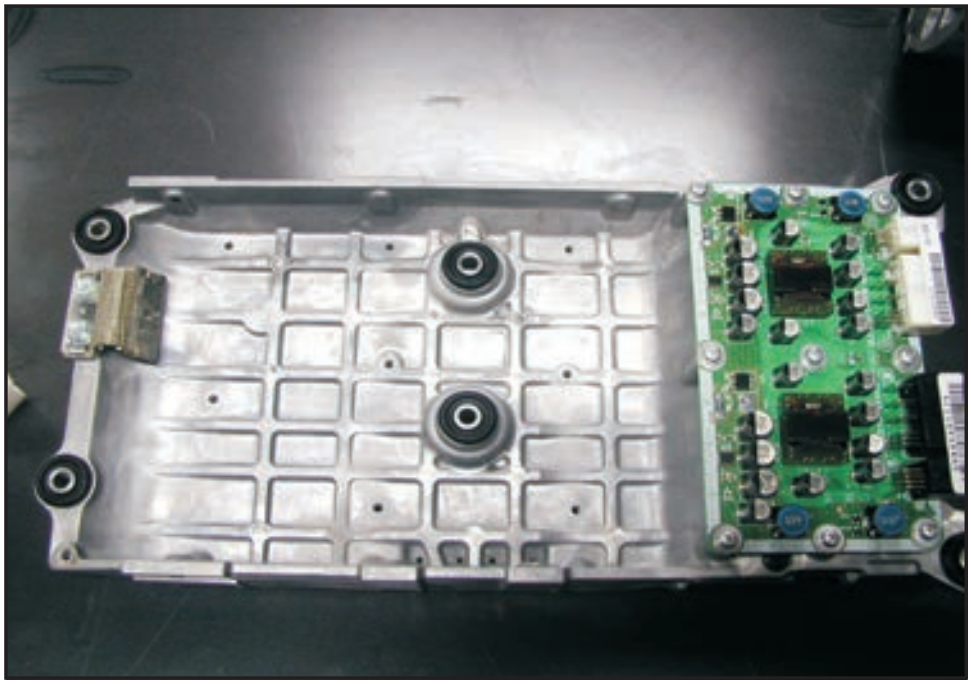


Be sure to disconnect all six ground straps before the cover is removed and make certain they are all reattached during assembly, there are two on each side and one on each end.

Figure 31

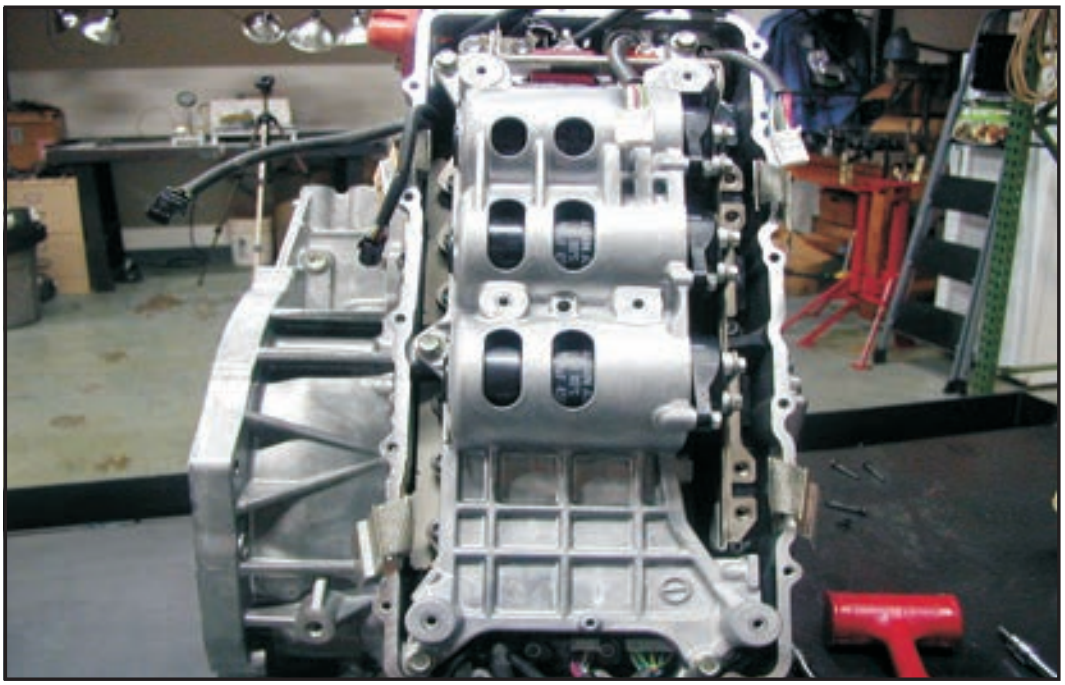
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



Handle this cover with the same care as the inverter because the TCM is located on the under side.

Figure 32

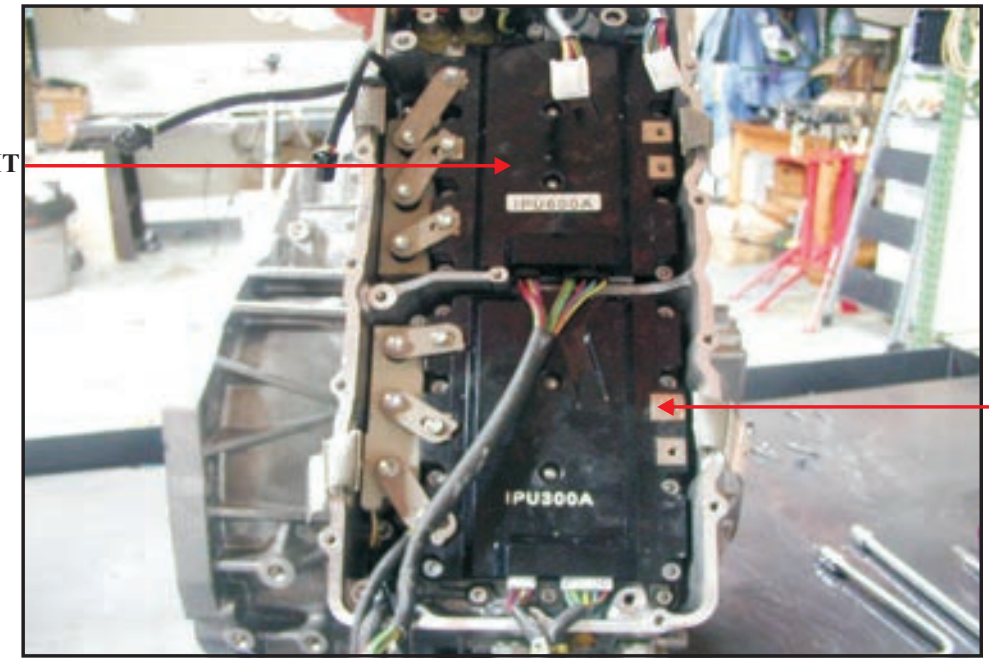


Once the TCM cover is removed, the capacitor pack can be removed. There are three capacitors rated at 450 volts and 125 amps each, they will not fall out of the cover when it is removed.

Figure 33

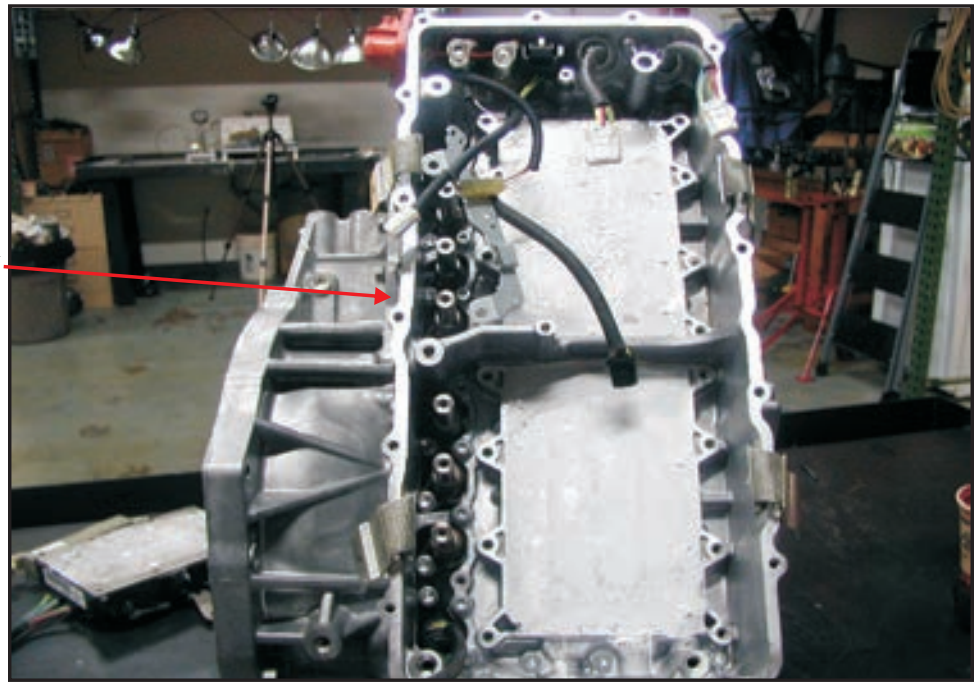
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



Underneath the capacitor pack is where the Generator Control Unit (GCU) is located. It is rated at 300 Amps. Next to the GCU is the Motor Control Unit (MCU). It is rated at 600 Amps. These two modules control the operation of the Generator Motor and the Traction Motor which is the larger of the two.

Figure 34

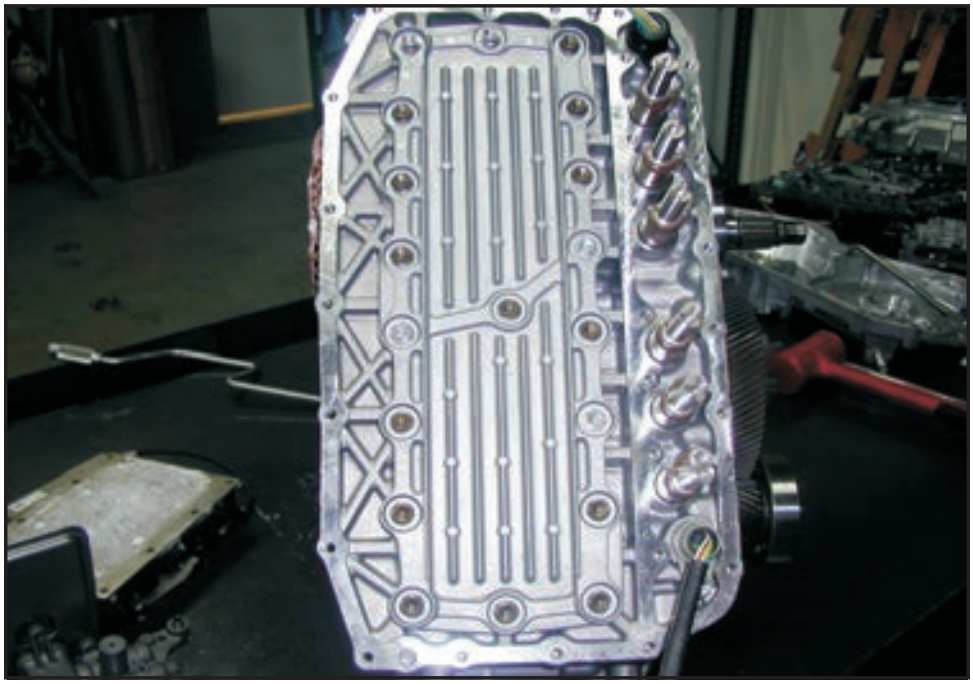


Do not remove the GCU and MCU modules unless necessary, it disturbs the heat resistant insulating material underneath them. This entire section of the case can be removed with the modules intact.

Figure 35

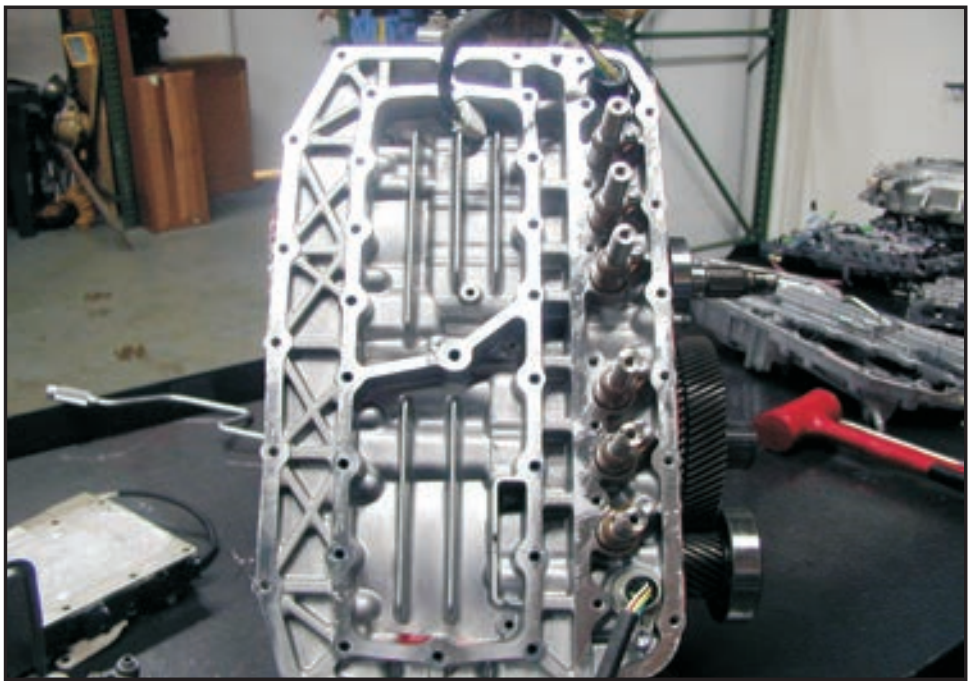
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



Once the module assembly is removed this cast aluminum plate will be visible. It covers the transaxle cooling chambers.

Figure 36

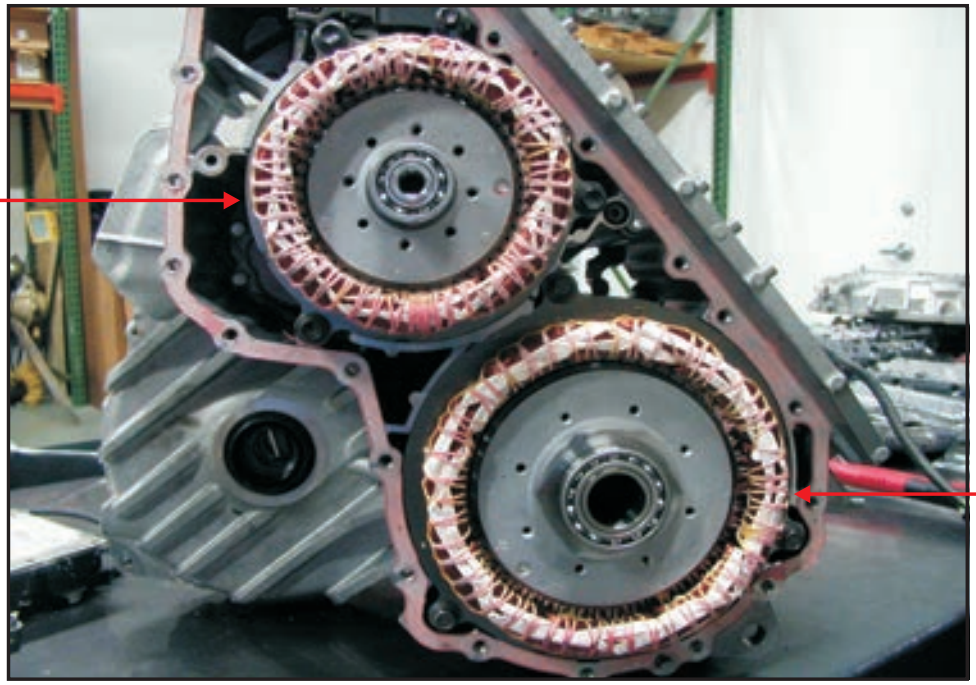


Coolant is circulated by the MECS pump which keeps the GCU and the MCU from overheating.

Figure 37

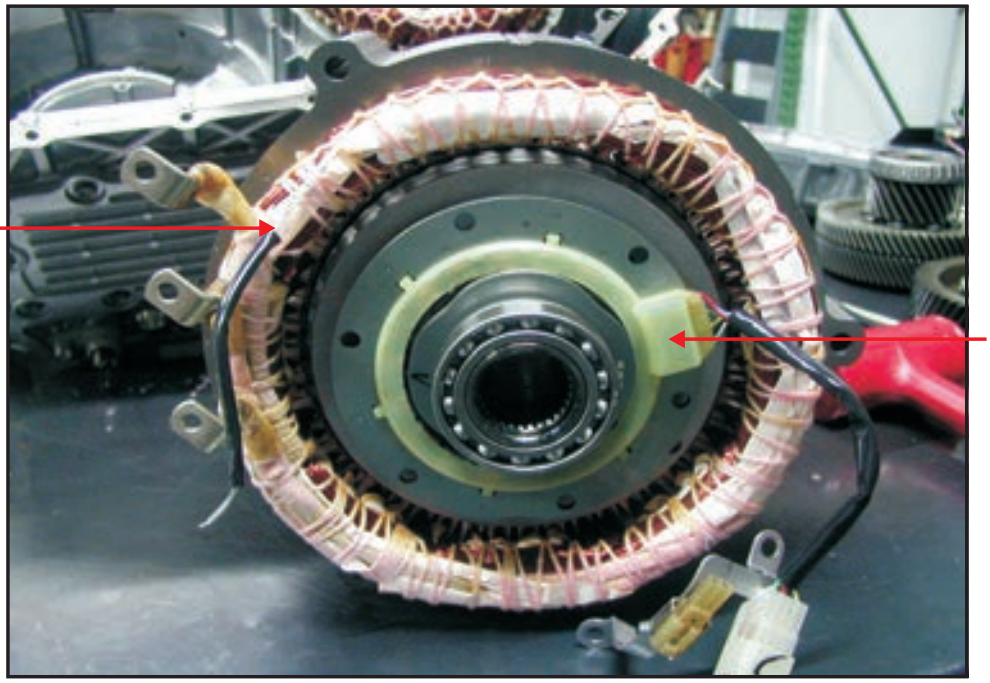
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



With the rear cover removed the Generator Motor and the Traction Motor are accessible. The Traction Motor is the larger of the two and propels the vehicle when it is in EV Mode.

Figure 38

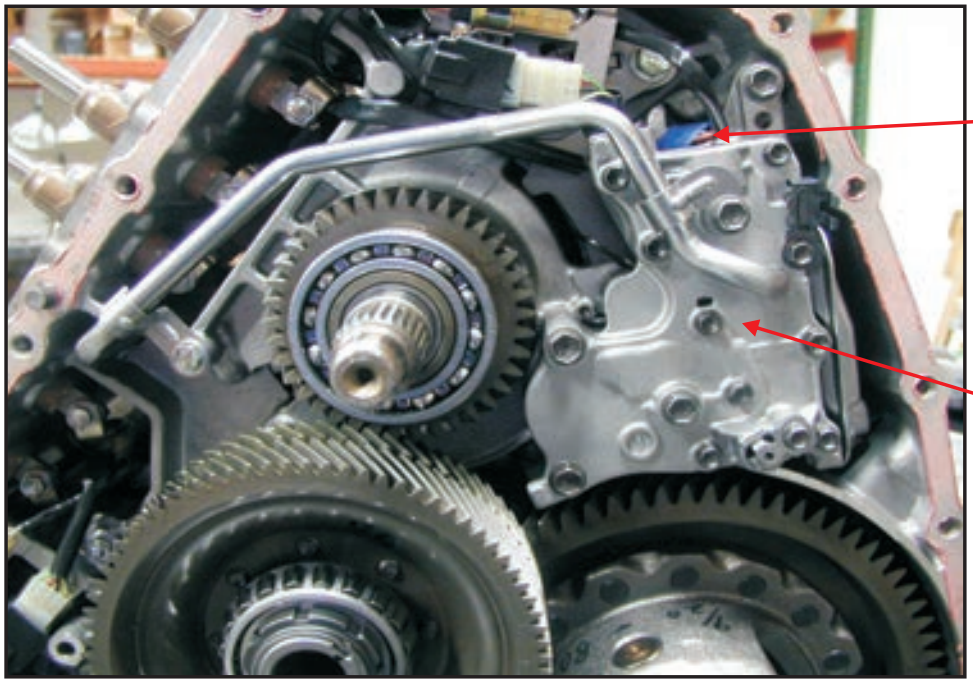


Both the Generator and Traction Motors have rotor support bearings on both sides. Each motor has its own RPM Sensor and Temperature Sensor.

Figure 39

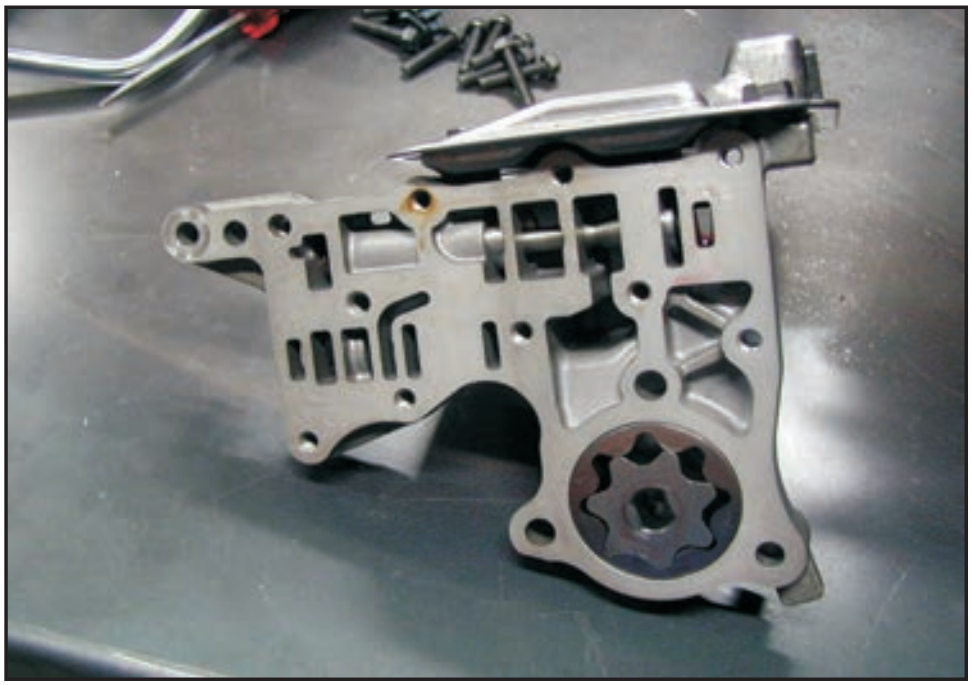
FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



With the bell housing removed, the lubrication pump is visible. It provides lube oil to the gears and bearings and also helps to keep the electric motors cool. The blue connector seen above is the ATF Temp Sensor.

Figure 40

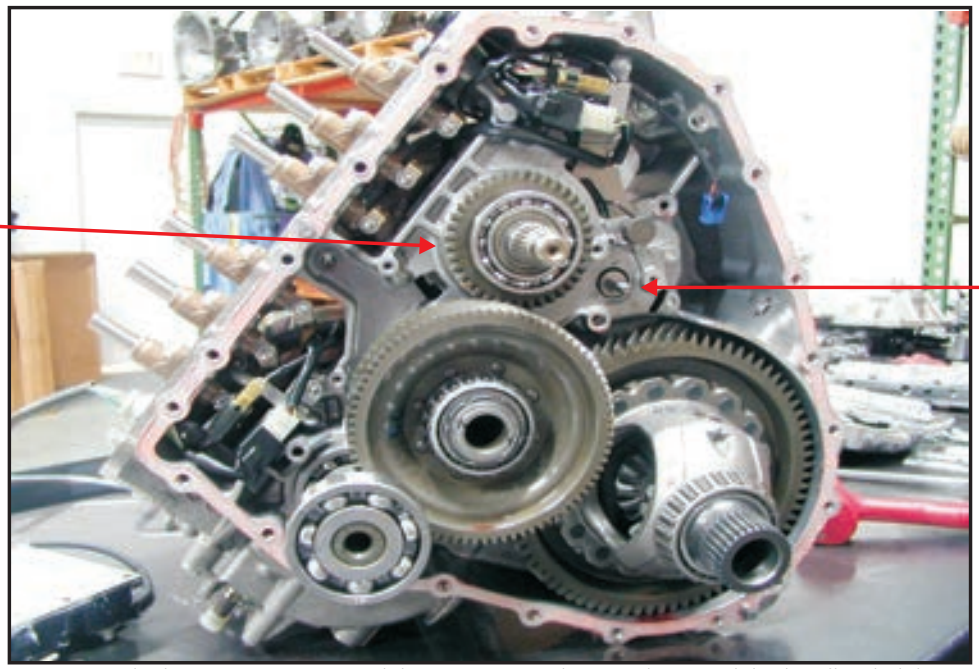


The lubrication pump is a simple gerotor style, with a pressure regulating valve. The sump filter is bolted to the pump and is readily available.

Figure 41

FORD ESCAPE HYBRID

P310 eCVT TRANSAXLE



The P310 eCVT transaxle is a gear to gear drive as seen above along with the final drive components. Behind the gear and shaft in the upper part of the photo is where the power split device can be found. The lubrication pump drive is driven off the power split device either by the engine or the traction motor.

Figure 42

In the transmission case where the Generator Motor and the Traction Motor bearings are located, there are end play shims that must be installed in their proper locations. Measure each one during disassembly so the correct thickness shim goes in the correct location.

Figure 43

FORD/MAZDA 4F27E/FN4A-EL
INTERMITTENT P0721 OUTPUT SPEED SENSOR FAULT

COMPLAINT: After overhaul, Ford/Mazda vehicles equipped with the 4F27E/FN4A-EL transmission may exhibit a complaint of a intermittent P0721 Output Speed Sensor Fault, with no drive-ability complaints. See Figure 1 for Output Speed Sensor Location.

CAUSE: The cause may be that during the overhaul process, one or more of the tabs on the 1st design Output speed sensor reluctor was bent, causing an inconsistent air gap, resulting in a P0721 trouble code. ***Note: There are two versions of this reluctor, the 1st design as shown in Figure 2, with individual tabs and the second design that is made of solid material. The 1st design with the tabs can be easily distorted, and the second design is made of soft material, and if the face of the reluctor is marred, the OSS signal to the PCM may be erratic causing the P0721 to set.***

CORRECTION: To correct this condition, be careful when handling the differential assembly, especially when loading parts into a cleaning machine as this is typically where the problem occurs. Carefully try to straighten the tabs or if it is the 2nd design, the surface may be straightened with a small file, although if it can not be repaired , it may require replacing.

OUTPUT SPEED SENSOR LOCATION

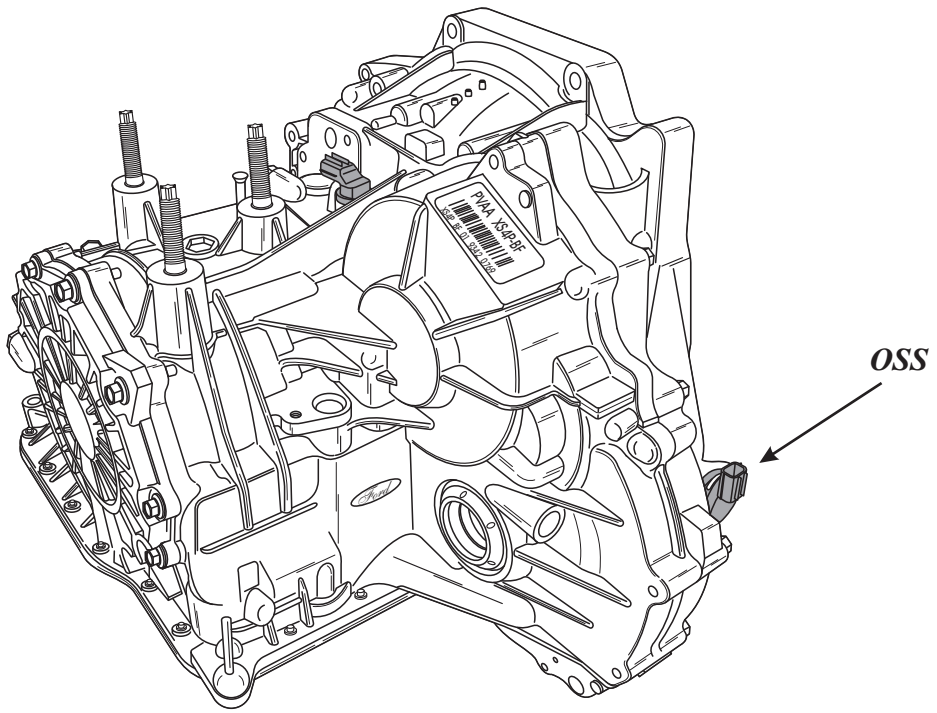
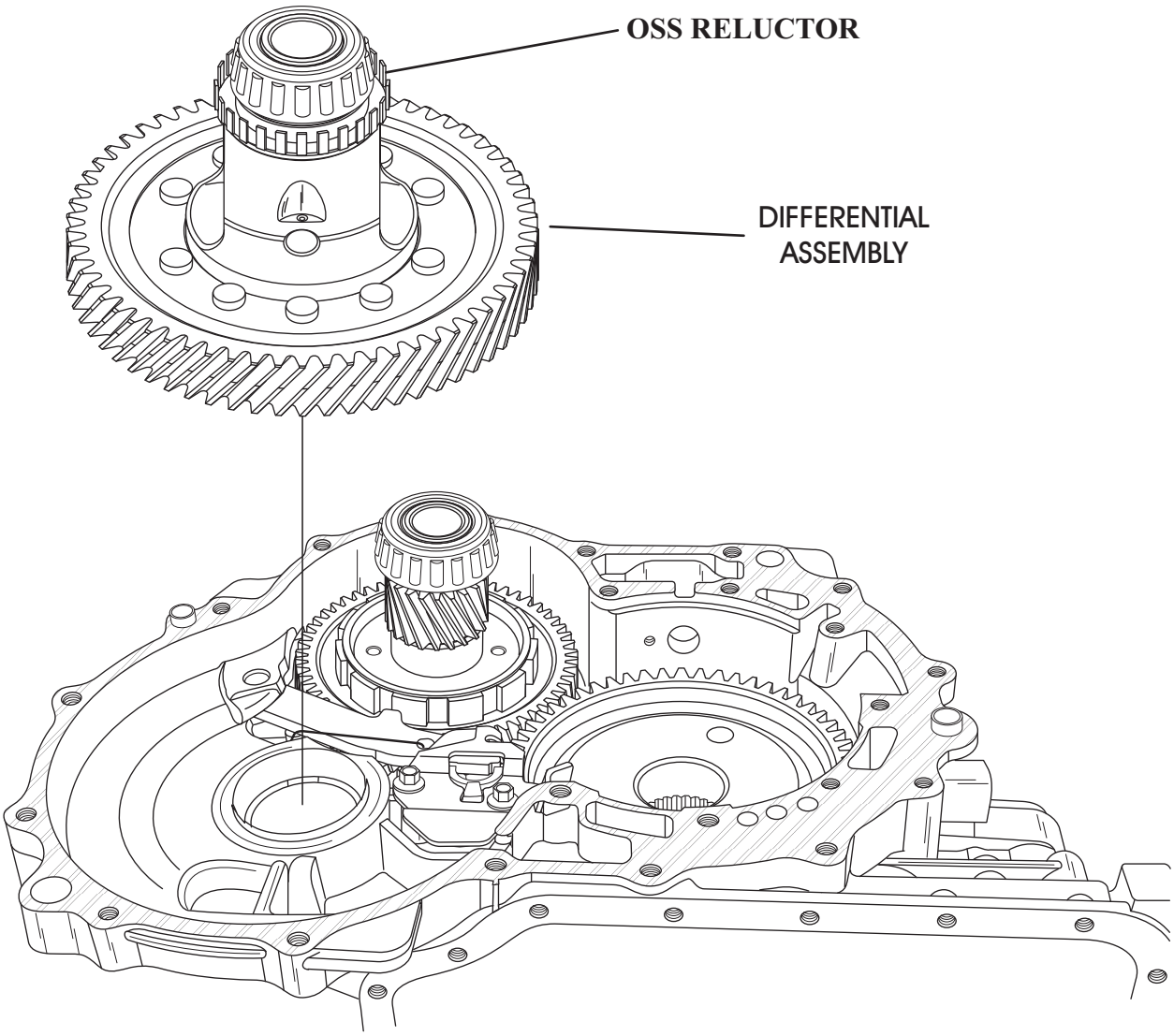


Figure 1

OUTPUT SPEED SENSOR RELUCTOR



The Output Speed Sensor reluctor is made from thin material and is easily bent, which can cause an insufficient air gap which could cause a intermittent P0721.
Note: the illustration shown above is of the 1st design, the second design is made of solid material although it is very soft. A marred surface can also cause the same code.

Figure 2

TeckPak
104

Transtec IBC

Life BC