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HEV Systems Technical eNewsletter

Extended HEV Systems Tip of the Month!

Yes.....it's winter, again. This means ice, snow, and the cold weather in many places in the world that brings the joys and frustrations of the winter season. This also means that the 12 volt auxiliary battery in your hybrid vehicle must be in top condition for the winter months. As a reminder, the 12 volt battery may (or may not) crank the engine but, it still needs to be in top condition to power all of the vehicle control modules. In the vehicles that do not use a 12 volt cranking motor, the 12 volt battery provides power to the hybrid and motor controllers that are used to energize/control the high voltage electric machines that crank the engine. Therefore, no 12 volt battery means no controllers power and no motor to crank the engine. Ensure that the hybrid 12 volt battery ready to go for the winter to keep the hybrids cranking!!

Introduction to GM 2-Mode Hybrid System
Conclusion - Part 3 for this Series

Have you read parts 1 and 2 of this series? If you would like to refer back, you can download the PDF's of the November (Part 2) and October (Part 1) eNewsletters.

Part 1 of this topic series (ref: Oct 2011 Newsletter) we covered the following aspects of the GM 2-Mode Hybrid System:

- Engine Cranking
- Components
- EVT Mode 1 Low
- EVT Mode 2 High
- Engine Auto-Stop and Start
- Fixed Gear Operation
- Regenerative Braking

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Diagnosing Hybrid Vehi Electric Machine (Transmission) Failures (P of 3-Part Series)

Our next Complimenta Webinar is on JANUARY 1 2012. Click on the butt above to register!

Did you miss this series? will be re-running all three again later in Spring 2012. on the webinar catalog abo register!

Part 2 of this series (ref: Nov 2011 Newsletter) we covered the following aspects of the GM 2-Mode Hybrid System:

- 2ML70 Transmission Specifications
- 2ML70 Transmission Overview
- Drive Motor - First Position (Motor “A”)
- Engine Starting
- Regenerative Braking
- 1-3 Clutch Assembly
    - 1-3 Clutch Apply
    - 1-3 Clutch Release
- 4th Clutch Assembly
    - 4th Clutch Apply
    - 4th Clutch Release

*In **Part 3** of this series we will concentrate on the Drive Motor and Design, Switch Assembly, Sensor Assembly as well as the aux fluid pump assembly.*

GM 2-Mode 2ML70 Hybrid Transmission

Drive Motor - Second Position (Motor “B”)

The drive (w/generator) motor assembly - 2nd position (see Figures 1 and 2) is located in the case assembly, between the center support assembly and the sun gear carrier assembly - 3rd position, and is splined to the sun gear shaft assembly - 3rd position. The drive (w/generator) motor assembly - 2nd position provides power input to the transmission, in order to drive the vehicle when the internal combustion engine is OFF (auto-stop). The drive (w/generator) motor assembly - 2nd position is commanded ON and driving when the transmission is in Reverse, EVT Mode Low, and EVT Mode High.

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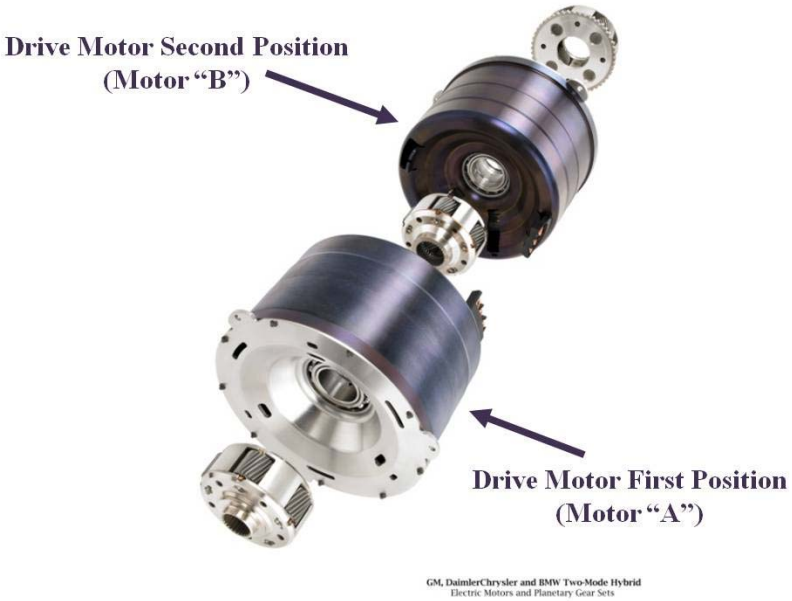


Figure 1.- Location of Motor "B"

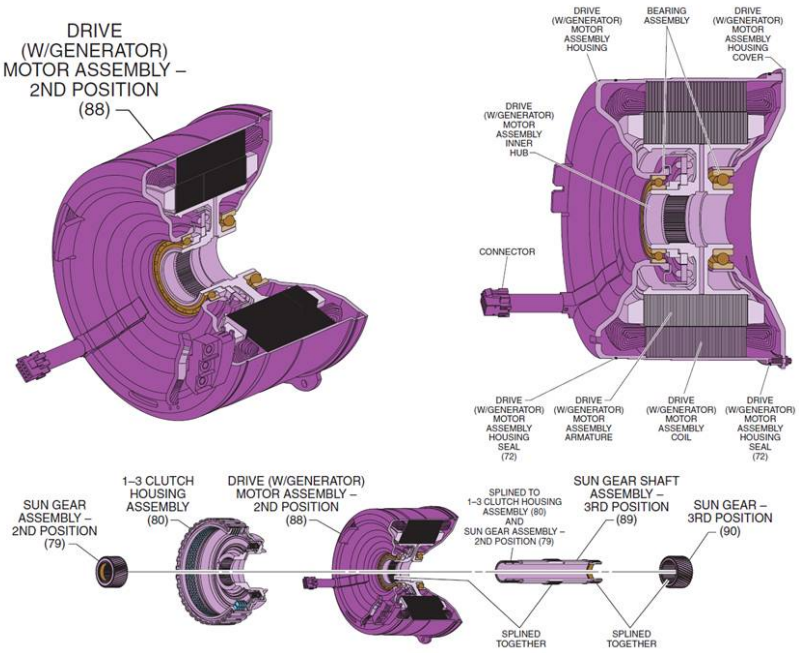


Figure 2.- Motor B Construction

Regenerative Braking

When the vehicle is coasting or braking the HPCM may operate the drive (w/generator) motor assembly - 2nd position in an electrical generation mode. Operating as an electrical generator, the drive (w/generator) motor assembly - 2nd position exerts a driveline load that helps to slow the vehicle. The electrical energy that the drive (w/generator) motor assembly - 2nd position creates is transferred by the drive motor generator TPIM to the drive motor generator battery assembly (high voltage battery). Constant communication between the HPCM and the electronic brake control module (EBCM) controls the blending of regenerative braking force with hydraulic braking force.

Reverse

A planetary gear set reverses the direction of power flow rotation when the internal gear is held stationary and power is applied to the sun gear. This causes the pinion gears to act as idler gears and drive the carrier assembly in the opposite direction. The 2ML70 2-Mode Hybrid transmission, however, uses the drive (w/generator) motor assembly - 2nd position to reverse direction, and a gear set is used only to achieve reduction.- Reverse direction of rotation occurs in EVT Mode Reverse when the drive (w/generator) motor assembly - 2nd position is commanded ON by the hybrid control module (HCM).- The drive (w/generator) motor assembly - 2nd position drives in the reverse direction (opposite of engine rotation), providing power to the sun gear - 3rd position through the sun gear shaft assembly - 3rd position, and thus driving the sun gear carrier assembly - 3rd position pinion gears. With the internal gear - 3rd position held stationary by the hybrid low, 1-2 clutch assembly, the sun gear carrier assembly - 3rd position pinion gears walk around the internal gear and drive the sun gear carrier assembly - 3rd position to provide an overall transmission reduction ratio of approximately 3.692:1.- See Figure 3

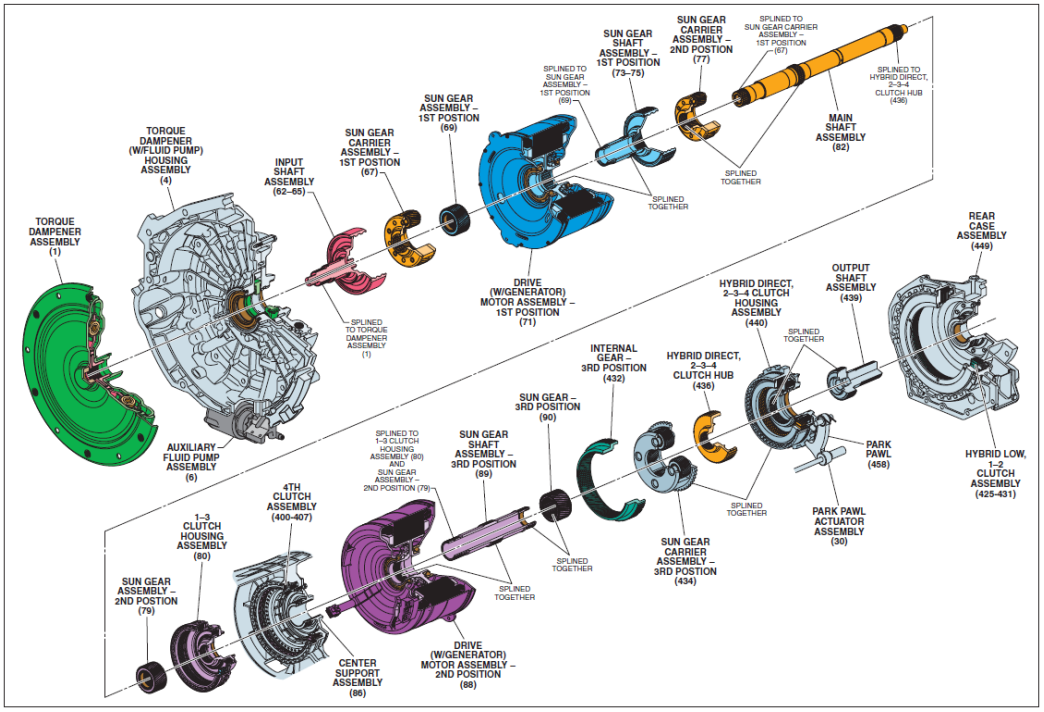
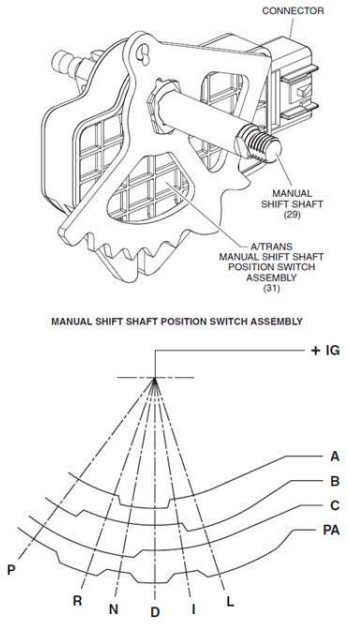


Figure 3.- Planetary Gear Set

Manual Shift Shaft Position Switch Assembly

The shaft position switch (manual shift shaft position switch assembly), also referred to as an Internal Mode Switch (IMS) as shown in (Figure 4), is a dual sliding contact switch attached to the manual shift shaft inside the transmission case. The nine outputs from the switch indicate which position is selected by the manual shift shaft.



SHAFT POSITION SWITCH LOGIC

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
Drive 4/Drive 3	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

HI = Ignition Voltage
LOW = 0 Volts

Figure 4.- Internal Mode Switch

Four outputs (A, B, C, P) are range selection inputs to the TCM which indicate the selected transmission gear range. Five outputs (R1, R2, D1, D2, S) are direction selection inputs to the HPCM through the transmission 24-way connector. The input voltage at the modules is high when the switch is open and low when the switch is closed to ground. The state of each input is available for display on the scan tool as IMS Range and IMS Direction. The IMS Range input parameters represented are transmission range signal A, signal B, signal C, and signal P (Parity). The IMS Direction input parameters represented are transmission direction signal R1, signal R2, signal D1, signal D2, and Signal Start.

An additional output, signal N (P/N Start), does not input the TCM, but rather goes directly to the Engine Control Module (ECM) to determine a Park/Neutral state and allow engine start. Routing Signal N to the ECM will allow the engine to be started with a dead TCM. Signal N is not a signal used by the TCM for shaft position switch logic.

Automatic Transmission Output Speed (A/T OSS) Sensor Assembly

The Output Speed Sensor (OSS) assembly (see Figure 5) has two internal Hall Effect type sensors, and is capable of sensing both speed and direction. The OSS is mounted outside the automatic transmission rear case assembly, and is connected to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the hybrid direct, 2-3-4 clutch housing assembly, and is triggered by machined teeth on the rear outer diameter of the housing.

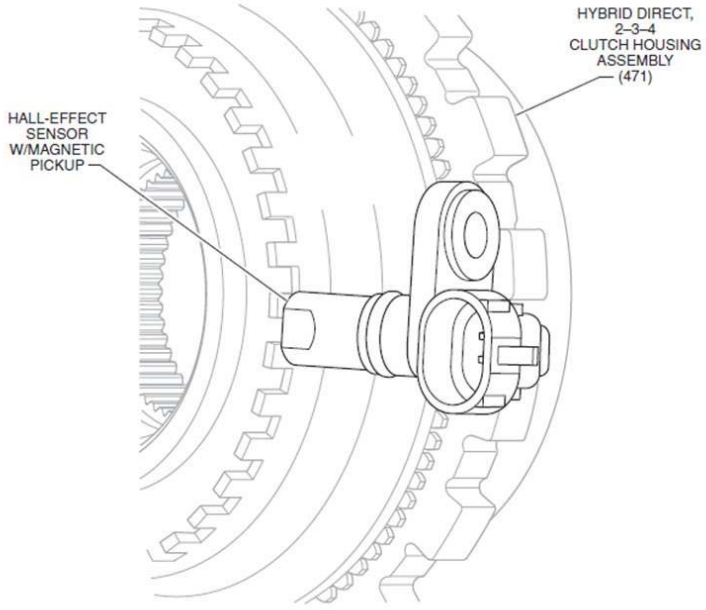


Figure 5.- Output Speed Sensor

The sensor receives 8.3-9.3 volts on the OSS supply voltage circuit from the TCM. As the hybrid direct, 2-3-4 clutch housing assembly rotates, the sensor produces a signal frequency based on the machined teeth and speed of the hybrid direct, 2-3-4 clutch housing assembly. The two sensor elements in the OSS assembly are spaced approximately half a tooth and will function as follows:

- When the vehicle is moving in a forward direction, sensor A detects a particular tooth before sensor B.
- When the vehicle is moving on a reverse direction, sensor B detects a particular tooth before sensor A.

If the TCM detects an improper signal from the transmission OSS, a DTC will be logged.

The electronics in the sensor combine the two signals and send a signal with a different pulse width. This signal is interpreted by the TCM for speed and direction, and is transmitted through the GM Local Area Network (GMLAN) circuits to the ECM and the HPCM. The ECM, HPCM, and TCM compare the OSS signal with the ABS wheel speed sensor signal. The HPCM also compares the output shaft direction with the drive (w/generator) motor assembly – 1st position and drive (w/generator) motor assembly – 2nd position direction. The TCM uses the OSS signal to determine forward or reverse direction, line pressure, transmission shift timing, vehicle speed and gear ratio.

Automatic Transmission Auxiliary Fluid Pump Assembly

The auxiliary fluid pump assembly, attached to the bottom of the torque dampener housing assembly, is driven by a 3-phase, 12 volt AC motor (see Figure 6). The motor is controlled by a dedicated auxiliary pump control module that is mounted in the left-front side of engine compartment (see Figure 7). Control of the auxiliary pump is managed by the HPCM, which communicates directly with the auxiliary pump control module.

Figure 6.- Auxiliary Fluid Pump and Location

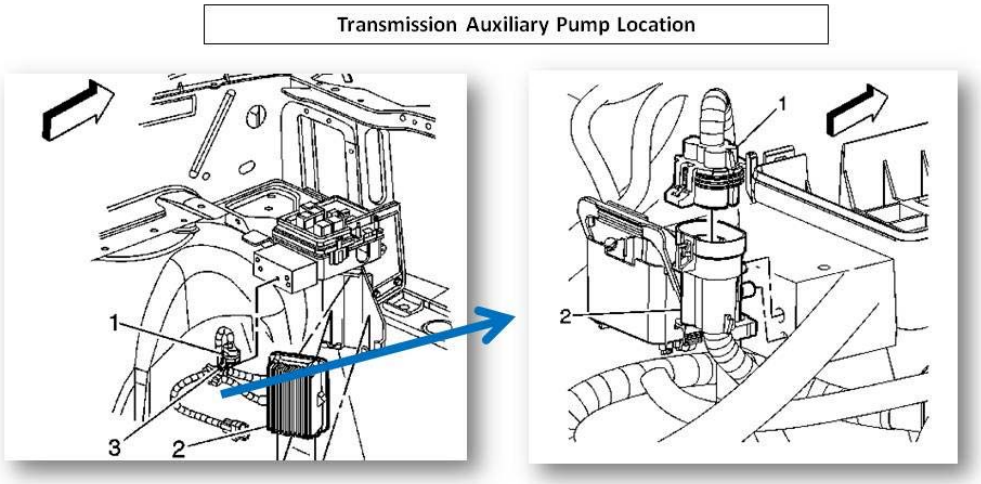


Figure 7.- Auxiliary Pump Control Module Location

The purpose of the auxiliary fluid pump is to provide hydraulic fluid pressure to the transmission for lubrication, cooling and clutch application during Auto Stop when the ICE is OFF and the main engine driven transmission fluid pump is not operating. The auxiliary pump control module varies the speed of the auxiliary

fluid pump in proportion to accelerator position to provide the fluid pressure appropriate for vehicle operating conditions. The auxiliary fluid pump is commanded ON when electric-only propulsion is active, such as when the vehicle is operating in electric launch or stopped at a traffic light.

The control solenoid (w/body and TCM) valve assembly (see Figure 8) bolts directly to the control valve upper body assembly inside the transmission. The control solenoid valve assembly utilizes a lead frame system to connect the components to the TCM. There are no wires used for these components.

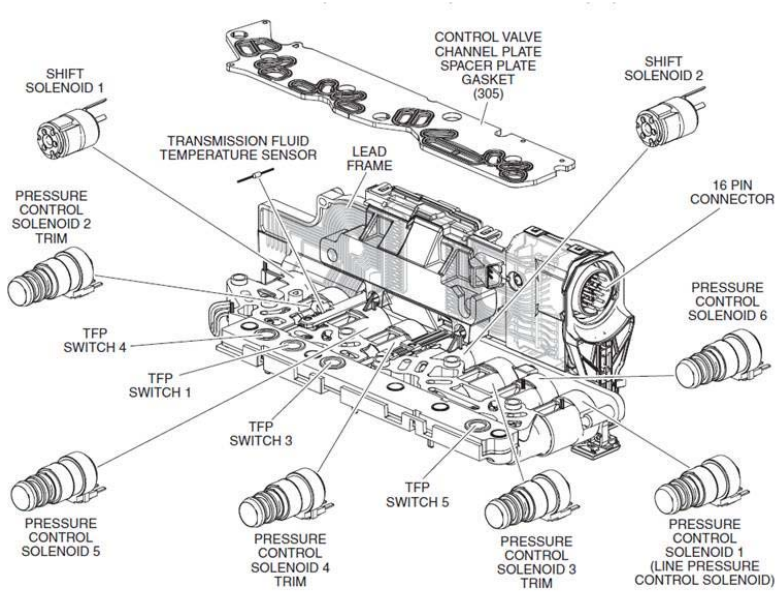
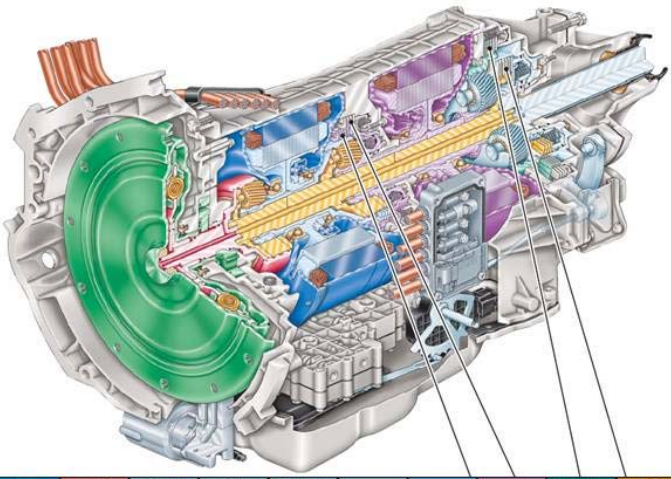


Figure 8.- Valve Body Control Solenoids and TCM Assembly

The control solenoid valve assembly connects to the engine harness 16-way connector via a pass-thru sleeve. All fluid passages to the switches and solenoids are protected from debris by a serviceable filter plate (control valve channel plate spacer plate gasket). In addition to these components, there are two temperature sensors (TCM Temperature Sensor and the Power Up Temperature Sensor) located inside the TCM. These components are diagnosed separately, but are serviced as an assembly.

To illustrate a summary of Transmission solenoid and clutch application for each gear application, a solenoid and clutch range chart is used to communicate these applications (see Figure 9). By reviewing this chart and coupling this information with the electric machine and planetary gear set operation, a complete understanding of the 2ML70 transmission can be acquired.



RANGE	GEAR	RATIO	SHIFT SOLENOID 1	SHIFT SOLENOID 2	LINE PC SOL 1 N.H.	PC SOL 2 TRIM N.H.	PC SOL 3 TRIM N.H.	PC SOL 4 TRIM N.L.	PC SOL 5 N.L.	1-3 CLUTCH	4TH CLUTCH	HYB. LOW, 1-2 CLUTCH	HYB. DIR., 2-3-4 CLUTCH
PARK	P	—	OFF	OFF	ON	OFF	OFF	OFF	OFF				
REV	EVT R	3.692	OFF	OFF	ON	OFF	ON	OFF	OFF			APPLIED	
NEU	N	—	OFF	OFF	ON	OFF	OFF	OFF	OFF				
D	EVT Low	Infinity to 1.700	OFF	OFF	ON/OFF*	OFF	ON	OFF	ON/OFF*			APPLIED	
	1st	3.692	ON	OFF	ON	OFF	ON	ON	OFF	APPLIED		APPLIED	
	2nd	1.705	ON	OFF	ON	ON	ON	OFF	OFF			APPLIED	APPLIED
	3rd	1.000	ON	ON	ON	ON	OFF	ON	OFF	APPLIED			APPLIED
	4th	0.738	ON	ON	ON	ON	ON	OFF	OFF		APPLIED		APPLIED
	EVT High	1.700 to < 0.738	OFF	ON	ON	ON	OFF	OFF	OFF				APPLIED

Figure 9.- Solenoid and Clutch Range Chart

Next Month: *"Voltage vs. hp vs. Torque: It's All About Relationships"*

Until next time remember - knowledge is ***POWER***

AR&D Tech Team

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