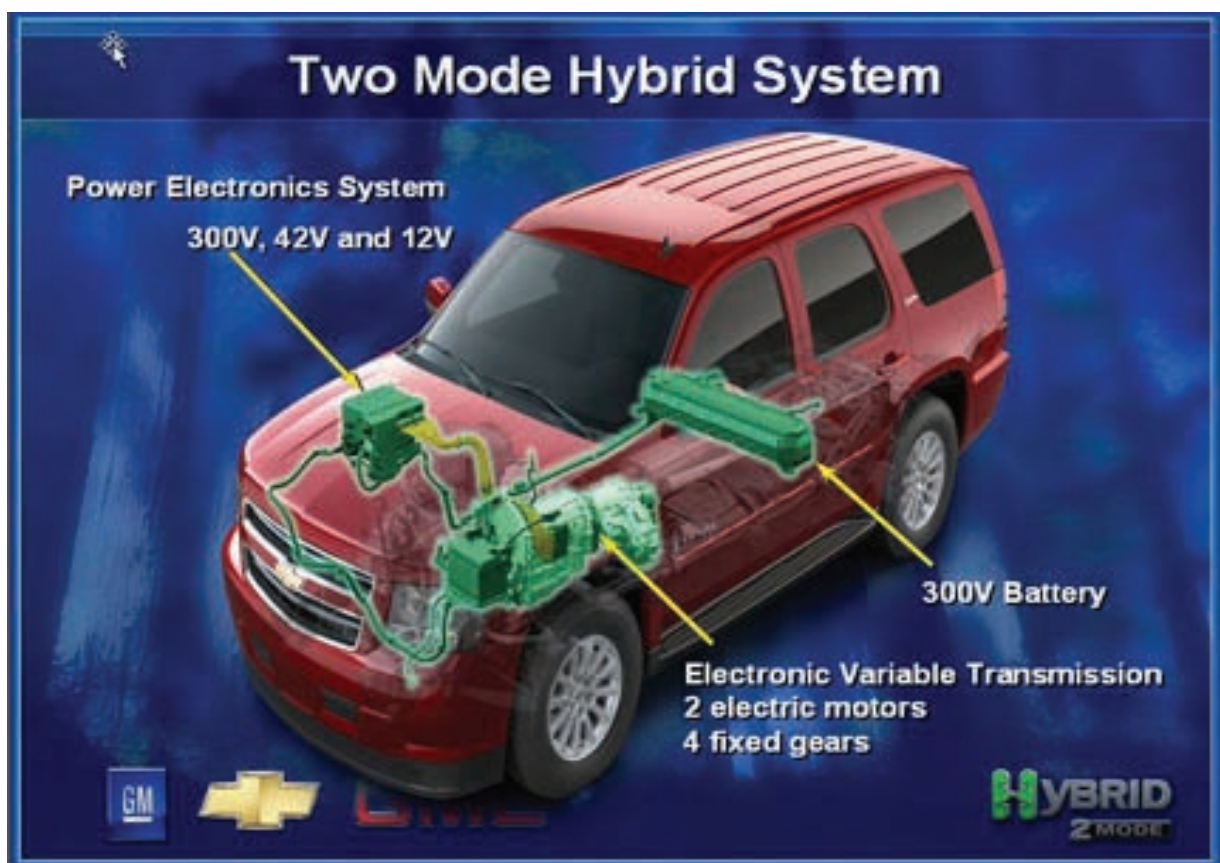


A New Kid on the Block: 2ML70 (RPO M99) 2-Mode, Part 1



by Steve Garrett



The next generation of transmissions to enter the marketplace has been introduced for the 2008 model year. Known as a 2-mode design, the transmission was designated as the 2ML70 (RPO M99), and was introduced on the Chevrolet Tahoe and GMC Yukon for 2008.

In 2009, it expanded into GM truck and additional SUV applications. The T-model transmission will be designated for rear wheel drive applications, the C-model will be an upscale rear wheel

drive application, while the F-model will be a front wheel drive application. In addition, the 2ML70 is also used by Dodge and BMW in some of their vehicles.

The 2-Mode design offers several advantages over conventional automatic transmissions, including substantial gains in performance, fuel economy, and significant reductions in emissions. Overall, fuel economy improvement for C/K trucks range between 25-40%.

In addition to the common trans-

mission functions, the 2ML70 also eliminates the need for an alternator and a starter for the vehicle.

Specifications

- Type: 2-Mode continuous electric ratio hybrid transmission; 4 fixed gear ratios; 2 electric motors provide infinite variable ratios, with engine on/off operational capability (Figure 1)

- Gear Ratios
1st — 3.69:1
2nd — 1.70:1
3rd — 1.00:1
4th — 0.73:1
EVT #1 — Infinity to 1.70:1
EVT #2 — 1.70 to 0.50:1
Reverse — Infinity to 1.70:1
- Maximum engine torque 380 lb-ft (515 Nm)
- Maximum engine power 369 bhp (275 kW)
- 2, 65kW electric motors (drive motor #1, drive motor #2); Y-wound, 3-phase, 300 volts, permanent magnet (figure 2)
- Motor cooling accomplished by transmission fluid circulation system
- Electric motor torque 242 lb-ft (320 Nm)
- 300-volt, 40-cell nickel-metal hydride battery (located under the 2nd row seats)
- 3 planetary gearsets
- 4 multiple disc clutches
- 2 shift solenoids used (on/off design); SS1,SS2
- 6 variable bleed solenoids; PCS, PCS2, PCS3, PCS4, PCS5, TCC (only 5 are used)
- A Bosch-built, 32-bit TCM (TEHCM) mounted inside the transmission on the valve body (referred to as the control solenoid valve assembly). TCM (TEHCM) incorporates solenoids, pressure switches, TFT and is bolted to the valve body using 6 bolts.
- Output speed sensor (2 Hall Effect sensors in one housing, capable of sensing both speed and direction)
- Electronic range selection (no manual valve)
- IMS (range position)
- Vane-style oil pump (3 selective slides and rotors)
- 12-volt AC auxiliary fluid pump
- 3-piece, die-cast aluminum case
- Wet weight 374 lbs (170 kg)
- Dexron VI required
- Fluid capacity
Fluid and filter — 11.5 quarts (10.88 liters)
Overhaul — 13 quarts (12.30 liters)
- Torque dampener 347mm (no torque converter)
- Pressure taps: Line, Aux pump

- Manufactured in the GMPT plant, Baltimore

External Components and Function

The 2 mode system requires several different control modules and sub-systems for operation, including:

Drive Motor Generator Control Module (DMGCM) — The DMGCM contains the APM (Accessory Power Module) and PIM (Power Inverter Module) fastened together as an assembly. Cooling for the assembly is provided by a separate cooling system.

The standalone cooling system requires Dexcool and uses a heat exchanger mounted in front of the vehicle and an electric coolant pump. The drive motor control module is connected to the poles of the drive motor battery. The high voltage system is controlled by a high current contactor relay, mounted in the drive motor generator battery assembly.

Power Inverter Module (PIM) — The Power Inverter Module converts high voltage DC to 3-phase, 300-volt AC. Six, high-voltage shielded cables connect the PIM to the two electric drive motors mounted in the trans-

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2-Mode RWD Hybrid Transmission

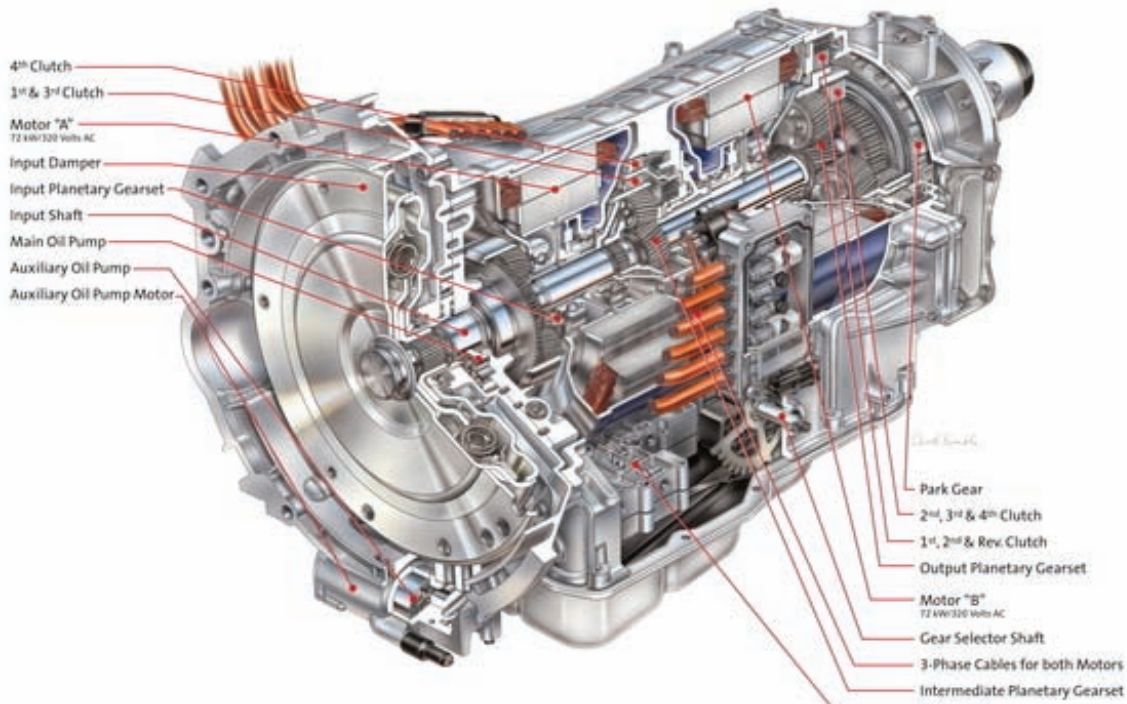


Figure 1

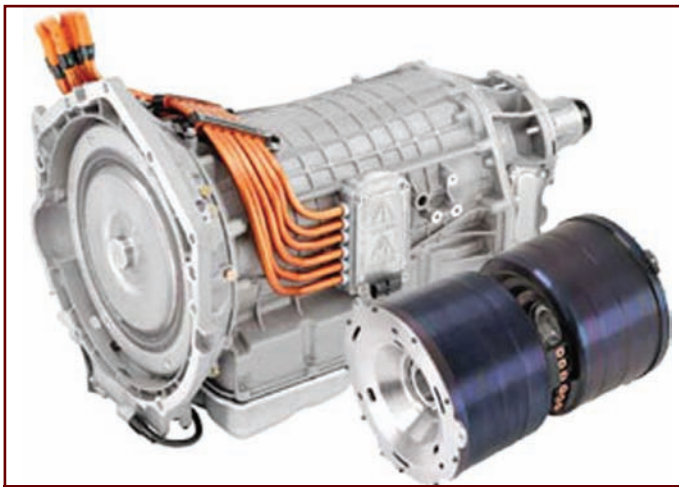


Figure 2

The front motor is used to start the engine and also reacts to torque input from the rear motor for EVT operation.

mission. The high voltage cables are orange for easy identification.

The PIM also contains the Hybrid Powertrain Control Module (HPCM) and two Motor Control Modules (MCM). The PIM, HPCM and the MCM are flashable.

Accessory Power Module (APM) — The Accessory Power Module converts high voltage DC to low voltage DC (14 volts) and intermediate voltage (42 volts). The system charges the standard vehicle battery and provides power for the 42-volt power steering system. The intermediate voltage cables are blue and shielded.

Hybrid Powertrain Control Module (HPCM) — The Hybrid Powertrain Control Module is the main controller for the hybrid transmission system. The HPCM determines which mode/motor will operate and controls features such as auto stop and regenerative braking. The HPCM operates together with the Battery Energy Control Module (BECM) and the Motor Control Module (MCM) to operate the two transmission electric motors.

Motor Control Module (MCM) — The Motor Control Module controls each of the transmission electric motors/generators. Each MCM con-

trols its respective IGBT driver circuit to control each motor separately. The MCM output is 3-phase, 300-volt AC to operate the motors. The MCM is located in the PIM.

Battery Energy Control Module (BECM) — The Battery Energy Control Module is located in the battery pack compartment under the 2nd row seats. The BECM controls the 40-cell drive motor generator battery. It contains two, high-voltage contactor relays, a high-voltage limiter relay, a battery fan relay, and the battery vent fan. The BECM monitors control the relays and fan, and monitors current,

voltage and battery temperature.

Auxiliary Fluid Pump Control Module (AFPCM) — The Auxiliary Fluid Pump Control Module is mounted in the engine compartment. It controls the auxiliary fluid pump based on commands from the Hybrid Powertrain Control Module (HPCM).

Hybrid Battery Pack — The battery pack is located under the 2nd row seat. The nickel-metal hydride battery pack consists of 40, 7.2-volt cells. The combined static output of the battery is 288 volts DC. The battery pack provides current for the motors and other vehicle systems.

Internal Components and Function

Drive Motors — The 2ML70 contains two, 300-volt, 3-phase, 65kW AC motor/generator assemblies (figure 2). The two permanent-magnet motors are mounted from each end of the transmission and are supported by the shafts/bushings and a support assembly. Three, high-voltage (orange) cables are attached to the transmission via rigid conduit around the transmission, which then transitions to flexible cable to attach the transmission to the Drive Motor Generator Control Module (DMGCM).

Transmission fluid is used for normal transmission operation and to cool the drive motors. The motors have a seal around each end of the assembly so transmission fluid can circulate around the motor.

The motors provide these functions:

- Engine cranking
- Battery charging
- Transmission reverse operation
- Two modes of electronic variable transmission (EVT) operation

The front motor is used to start the engine and also reacts to torque input from the rear motor for EVT operation. The rear motor drives the vehicle in reverse or when auto stop is activated and the vehicle is operating only on electrical power. Motor speed and torque is controlled by the Motor Control Module via motor position sensors mounted in the motors.

The Motor Control Module (MCM) monitors the speed, direction and angular position using resolver position sensors. The resolver position sensor contains a drive coil, two driven coils, and an irregularly-shaped rotor assembly. The rotor is attached to the drive motor shaft.

The Motor Control Module sends a 5-volt AC, 10kHz bias signal to the resolver drive coil. The Motor Control Module then monitors the output from the two driven coil assemblies. Since the rotor tooth offset varies, the Motor Control Module can determine the exact speed, angle and direction of

each motor.

Accessory Power Module — The auxiliary fluid pump is mounted to the front of the transmission assembly. The pump is a 12-volt, 3-phase AC motor which is controlled directly by an Auxiliary Fluid Pump Control Module via the Hybrid Powertrain Control Module (HPCM). The function of the pump is to provide pressurized fluid for lube, cooling and clutch operation when the vehicle is being operated in electric or auto stop modes.



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