

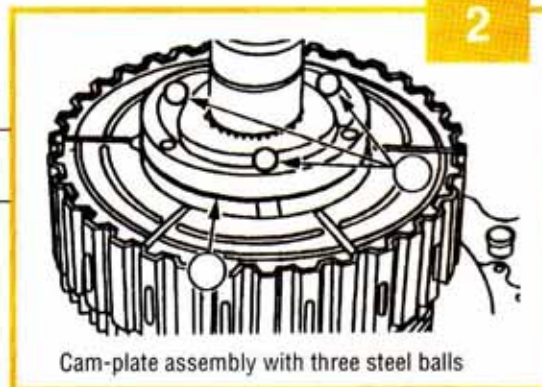


A New Design Level In Borg-Warner Transfer Cases

By Mike Weinberg
Contributing Editor

Most people will tell you that there is no such thing as a "sure thing." However, the one sure thing is change. With the constant advancement of technology as new designs are created and new, more-sophisticated models are brought to market, our industry is moving and changing at a phenomenal rate. No part of our business seems to be undergoing more change than transfer cases. As more people buy or lease sport/utility vehicles, transfer cases reach new levels of technology.

New from Borg-Warner is the Torque on Demand transfer case or TOD. There are two transfer-case models using this design, the 44-05 and the 44-06. The 44-05 is found in '97 Explorer models except for those with V-8 engines, which use the 44-04 all-wheel-drive transfer case. The 44-06 is found in the Ford Bronco and Expedition models. Both units employ Torque on Demand design but have some differences. This article will be devoted to the 44-05 unit.



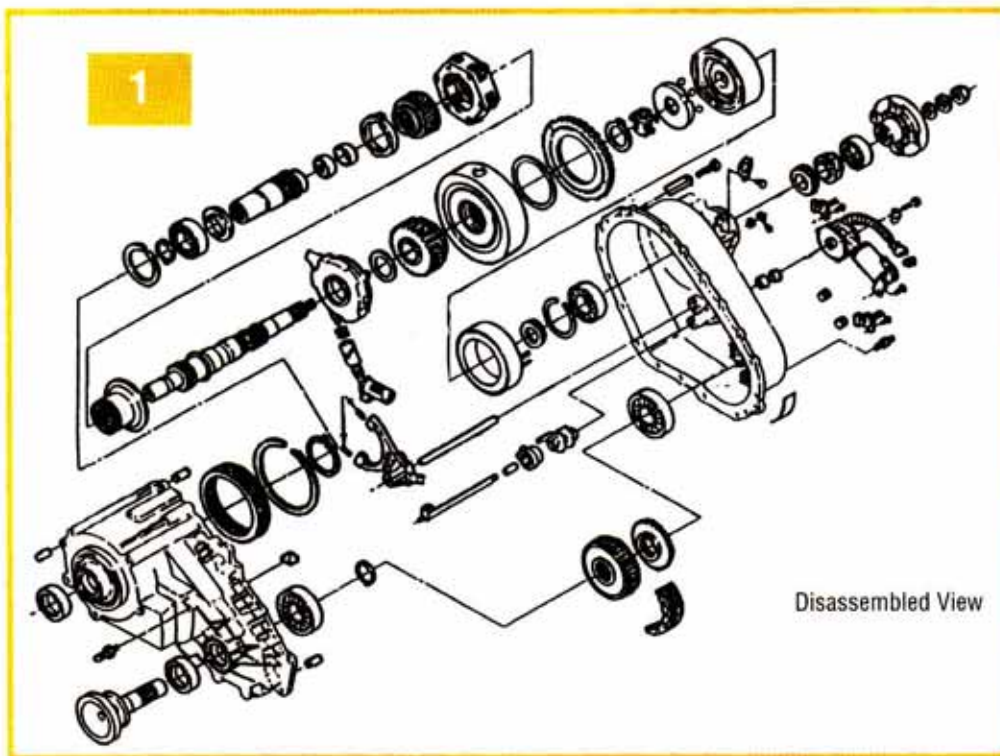
Cam-plate assembly with three steel balls

The 44-05 Torque on Demand unit is an electronically shifted computer-controlled transfer case. The dashboard control has a three-position switch that allows the driver to choose A4WD (automatic four-wheel drive), 4WD High and 4WD Low modes.

Automatic 4WD

When the vehicle is started in this mode the electromagnetic clutch is turned on and the clutch pack locks up and spins the front output shaft to allow the front axle to lock up. The computer or GEM (generic electronic module) now commands the electromagnetic clutch to go to minimum duty cycle (similar to a pulse-width-modulated solenoid). This is the slowest speed at which the clutch is cycled on and off. In this mode the small speed differences between front and rear axles during cornering are imperceptible, and the vehicle feels as if it is in two-wheel drive. Front and rear output-shaft speed sensors monitor any rear-axle slippage, and the GEM will increase the duty cycle from 4% to as much as 98%. This adds torque to the front wheels until rear slippage stops. When shaft speeds equalize, the duty cycle to the EMC returns to minimum values.

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Diagnostic Trouble Code (DTC) Reference Chart

DTC	Circuit	Description	Test Mode
B1342	N/A	ECU is Defective	On-Demand, Continuous
P1483	307 (BK/Y)	Brake Pedal Input Circuit Open or Short to Ground	Continuous
P1485	307 (BK/Y)	Brake Pedal Input Short to Power	On-Demand, Continuous
P1804	210 (LB)	4WD High Indicator Circuit Open or Short to Ground	On-Demand, Continuous
P1806	210 (LB)	4WD High Indicator Short to Power	On-Demand, Continuous
P1808	975 (BR/Y)	4WD Low Indicator Circuit Open or Short to Ground	On-Demand, Continuous
P1810	975 (BR/Y)	4WD Low Indicator Short to Power	On-Demand, Continuous
P1812	780 (DB) 682 (DB)	4WD Mode Select Switch Circuit Open	On-Demand, Continuous
P1815	783 (G)	4WD Mode Select Switch Circuit Short to Ground	On-Demand, Continuous
P1820	782 (BR/W)	Transfer Case LO to HI Shift Relay Coil Circuit Open or Short to Ground	On-Demand, Continuous
P1822	782 (BR/W)	Transfer Case LO to HI Shift Relay Coil Short to Power	Continuous
P1824	779 (BR)	4WD Electric Clutch Relay Circuit Open or Short to Ground	On-Demand, Continuous
P1826	779 (BR)	4WD Electric Clutch Relay Short to Power	Continuous
P1828	781 (O/LB)	Transfer Case HI to LO Shift Relay Coil Circuit Open or Short to Ground	On-Demand, Continuous
P1830	781 (O/LB)	Transfer Case HI to LO Shift Relay Coil Short to Power	Continuous
P1836	772 (LB)	Transfer Case Front Shaft Speed Sensor Circuit Failure	Continuous
P1837	236 (BK/LG)	Transfer Case Rear Shaft Speed Sensor Circuit Failure	Continuous
P1838	777 (Y) 778 (O)	Transfer Case Shift Motor Circuit Failure	Continuous
P1846	771 (P/Y)	Transfer Case CONTACT PLATE "A" Circuit Open	Continuous
P1850	770 (W)	Transfer Case CONTACT PLATE "B" Circuit Open	Continuous
P1854	764 (BR/W)	Transfer Case CONTACT PLATE "C" Circuit Open	Continuous
P1858	763 (O/W)	Transfer Case CONTACT PLATE "D" Circuit Open	Continuous
P1863	762 (Y/W)	Transfer Case CONTACT PLATE Power Circuit Open	On-Demand
P1866	N/A	Transfer Case System Concern	Continuous
P1867	N/A	Transfer Case Contact Plate General Circuit Failure	Continuous
P1874	774 (LG)	Automatic Hail Effect Sensor Power Circuit Failure	On-Demand
P1875	774 (LG)	Automatic Hail Effect Sensor Power Circuit Short to Power	On-Demand, Continuous

4WD High

The driver can shift from A4WD to 4WD High at any time. In 4WD High mode the duty cycle is increased until lockup is achieved and torque is split equally between front and rear axles.

4WD Low

The driver is restricted from shifting into the Low range by the GEM design parameters. The vehicle transmission must be in Neutral, the brake must be applied and the vehicle speed must be under 5 kilometers per hour. If these conditions are met, the EMC will lock the driveshafts at maximum duty cycle and the electronic shift motor will rotate the cam to move the low-range shift fork and reduction collar to lock the planetary carrier to the input shaft. With input torque

passing the sun gear and front planet, a 2.48-1 reduction ratio is achieved. This mode is for off-road use only and not for driving on dry or hard pavement.

Electronic Operations

GEM – The generic electronic module is the computer that controls the operation of the 44-05 transfer case.

4WD Mode Switch – is a 3-position switch that permits the driver to choose among A4WD, 4WD High and 4WD Low ranges.

VSS – Vehicle-speed sensor mounted on the rear output shaft of the transfer case informs the GEM of vehicle road speed.

Front and rear output-shaft speed sensors – placed on the transfer case to monitor front and rear output-shaft

Up To Standards

speeds and allow the GEM to command the proper clutch duty cycle in A4WD.

Shift-motor sensor plates – part of the electronic shift motor, input the shift position of the transfer-case shift components to the GEM.

DTR – Digital transmission-range sensor tells the GEM when the transmission is in neutral.

Electronic shift motor – shifts the transfer case throughout its ranges.

4X4 shift-motor relay – a module containing two relays that the GEM uses to operate the electronic shift motor.

Solid-state clutch relay – activates the electromagnetic clutch inside the transfer case.

Note: This system uses adaptive logic. As with early Chrysler 604 units, a battery disconnect will cause the vehicle to lose its adaptive strategy. It may take as much as a 10-mile road test for the unit to relearn the strategy. Do not disconnect the GEM for repairs without first disconnecting the battery or else the GEM may acquire a number of false diagnostic codes, making diagnosis more difficult than it needs to be.

Mechanical Operations – Torque on Demand

The electromagnetic clutch pack is a new design for us to work on. The clutch pack is not hydraulically applied but mechanically locked by the electronic coil. Removing the electronic coil and coil housing exposes a cam-plate assembly and three steel balls (Figure 2). The cam-plate assembly or ball ramp is precision machined so that when the duty cycle of the coil is increased, the balls move farther up the ramp and lock the clutch pack. As duty cycle is decreased the balls come back down the ramp, releasing clutch pressure. The duty cycle can run from very slow to 10 times per second at full lockup. The condition of the balls and the ball ramp is critical to proper clutch operation, and any galling, damage or wear to the ramps will require replacement. The ramp is designed with a taper of 0.002" to 0.004" so that the outside of the ramp makes

contact first during clutch application. In trying to clean up any wear on the cam plate, make sure not to change the angles machined into the piece.

As with anything new, obtaining the service manual is important in order to understand how the technology works and what the assembly specs are. The manual for this unit has 84 pages of electronic diagnostics, pinpoint tests and diagnostic trouble codes (See Figure 3). Change keeps us perpetual students, but the good news

is we don't have to do it alone. The books are available, the research done. As we learn, we improve upon the factory technique and create our own time-saving steps. This is what keeps us coming back for more. **TD**

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