

# Troubleshooting Borg-Warner's 4405 Electronic Transfer Case



| Symptom Chart  |  |  |
|--|--|--|
| Condition  | Possible Source  | Action   |
| Vehicle Does Not Operate Properly in AUTO and 4WD HIGH Modes   | <ul style="list-style-type: none"> <li>• Circuitry</li> <li>• Mode switch.</li> <li>• Speed sensors.</li> <li>• Transfer case electric clutch.</li> <li>• Transfer case mechanism.</li> <li>• Generic electronic module (GEM).</li> <li>• DTC P1812.</li> <li>• DTC P1815.</li> <li>• DTC P1824.</li> <li>• DTC P1826.</li> <li>• DTC P1836.</li> <li>• DTC P1837.</li> <li>• DTC P1874.</li> <li>• DTC P1875.</li> <li>• DTC P0500.</li> </ul>  | <ul style="list-style-type: none"> <li>• GO to Pinpoint Test A.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Vehicle Does Not Shift Between A4WD/4WD High and 4WD Low Modes Properly but Operates Properly in Auto Mode</li> </ul> | <ul style="list-style-type: none"> <li>• Circuitry.</li> <li>• Mode switch.</li> <li>• Contact plate sensors A, B, C and/or D.</li> <li>• Transfer case shift motor.</li> <li>• Transfer case shift relay.</li> <li>• Transfer case mechanism.</li> <li>• Generic electronic module (GEM).</li> <li>• Digital transmission range (DTR) sensor.</li> <li>• Neutral safety switch.</li> <li>• Speed sensors.</li> <li>• Brake on/off (BOD) switch.</li> <li>• Vehicle speed sensor (VSS).</li> <li>• DTC B1483.</li> <li>• DTC B1485.</li> <li>• DTC B1812.</li> <li>• DTC B1815.</li> <li>• DTC B1820.</li> <li>• DTC B1822.</li> <li>• DTC B1828.</li> <li>• DTC B1830.</li> <li>• DTC B1836.</li> <li>• DTC B1837.</li> <li>• DTC B1838.</li> <li>• DTC B1846.</li> <li>• DTC B1850.</li> <li>• DTC B18S4.</li> <li>• DTC B1858.</li> <li>• DTC B1863.</li> <li>• DTC B1866.</li> <li>• DTC B1867.</li> <li>• DTC B1874.</li> <li>• DTC B1875.</li> <li>• DTC P0500.</li> </ul> | <ul style="list-style-type: none"> <li>• GO to Pinpoint Test B.</li> </ul> |
| <ul style="list-style-type: none"> <li>• 4x4 or 4x4 LOW Range Indicator Not Operating Properly</li> </ul>  | <ul style="list-style-type: none"> <li>• Circuitry.</li> <li>• Lamp.</li> <li>• Instrument Cluster.</li> <li>• Generic electronic module (GEM).</li> <li>• DTC P1804.</li> <li>• DTC P1806.</li> <li>• DTC P1808.</li> <li>• DTC P1810.</li> </ul>   | <ul style="list-style-type: none"> <li>• GO to Pinpoint Test C.</li> </ul> |

**Mike Weinberg**  
Contributing Editor

This is transfer-case season, and all the good citizens who have purchased 4WD vehicles usually migrate to their local transmission shop at this time with various complaints. Many of these problems will have nothing to do with a worn or damaged transfer case but are the result of not understanding the proper way to operate the equipment they own, or external faults such as low tire pressures, worn tires, mixed tire sizes and lack of use (driving a 4WD vehicle for eight months without engaging the 4WD unit for a few miles every 30 days).

It is very important for the transmission-repair technician to understand the proper operation of different 4WD systems and to check thoroughly all external problems before removing and taking apart a transfer case. As in engine-control systems and the late-model transmissions, transfer cases have become increasingly complex with more electronics and new designs of operation.

The Borg-Warner 4405 transfer case we will use here is a good example. Found in the 1995-and-up Ford Explorer, this unit has three 4x4 operating modes, is computer controlled and is shifted electronically. As is common today, a tremendous amount of diagnostic material is necessary to troubleshoot electronic problems with these units. Space here permits us to have only a general discussion of the theory of operations.

The computer, which is called a GEM (generic electronic module), can store 27 diagnostic trouble codes (DTCs). The service manual's pinpoint circuit tests to diagnose all these codes take up 86 pages. On top of that, the GEM has adaptive logic,

*continues page 46*

### 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 (BX/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 |
| P181S   | 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            |
| P18S8   | 763 (O/W)         | Transfer Case CONTACT PLATE "D" Circuit Open                            | Continuous            |
| P1863   | 162 (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 Hall Effect Sensor Power Circuit Failure                      | On-Demand             |
| P1815   | 774 (LG)          | Automatic Hall Effect Sensor Power Circuit Short to Power               | On-Demand, Continuous |

and removing the GEM connectors with the battery connected can create numerous false codes. Disconnecting the battery to work on this unit, although necessary, will cause the loss of the adaptive logic, and it will be necessary to drive the vehicle up to 10 miles for the computer to relearn this strategy.

It should be obvious to anyone by now that without the service manual you will find out quickly how

Columbus felt on his journey to discover the Americas. For those really stubborn souls who like to experiment, I'll be politically incorrect: I don't care if you are Thomas Edison; without the proper manual you ain't fixing these units!

### GEM Primary Identification (PID) Reference Chart

| PID       | Circuit   | Circuit Description                         | Expected Values      |
|-----------|---|---|----------------------|
| VSS - GEM | 679(GY/BK)                                      | Vehicle Speed Input                         | 000-255 k/hr         |
| CLTCHSW   | 463 (R/W)                                       | Transmission Clutch Interlock Switch        | ENGAGED, NOT ENGAGED |
| NTRL - SW | 463 (R/W)                                       | Neutral Safety Switch Input                 | NTRL, not NTRL       |
| MTR - CCW | 339 (GY)  | Transmission Transfer LO to HI Motor Output | ON—, OFF—, OFF O-G   |
| MTR - CW  | 513 (BR/PK)                                     | LO to HI Shift Relay Coil Status            | OFF—                 |
| 4WDCLCH   | 275 (Y)   | 4WD Electronic Clutch Output Status         | ON—, OFF—, OFF O-G   |
| 4WDLW     | 784 (LB/BK)                                     | 4WD Low Indicator Status                    | ON—, OFF—            |
| 4WDHIGH   | 783 (GY)  | 4WD High Indicator Status                   | ON—, OFF—            |
| PLATE - A | 771 (P/Y)                                       | Transfer Case Contact Plate Switch A        | OPEN, CLOSED         |
| PLATE - B | 770 (W)   | Transfer Case Contact Plate Switch B        | OPEN, CLOSED         |
| PLATE - C | 764 (BR/W)                                      | Transfer Case Contact Plate Switch C        | OPEN, CLOSED         |
| PLATE - D | 763 (O/W)                                       | Transfer Case Contact Plate Switch D        | OPEN, CLOSED         |
| BOO - GEM | 511 (LG)  | Brake On/Off (BOO) Switch Input             | ON, OFF              |
| IGN - GEM | 1000 (R/BK),<br>1002<br>(BK/PK),<br>1003 (GY/Y) | Ignition Switch Status                      | START, RUN, OFF, ACC |
| HALLPWR   | 774 (LG)  | Hall Effect Speed Sensor Power              | ON—, OFF—            |
| 4WDCLST   | —   | FWD Clutch PWM Output Status                | ON—, OFF—            |
| TRA - RSP | 772 (LB)  | Rear Shaft Speed                            | 255 mph              |
| TRA - FSP | 236 (BK/LG)                                     | Front Shaft Speed                           | 0-225 mph            |
| PLATEPW   | 762 (Y/W)                                       | Contact Plate Ground Output                 | ON—, OFF—            |

### Operation

The Borg-Warner 4405 transfer case has three 4WD operational modes. A4WD is a full-time 4WD system in which the GEM regulates the torque split between the front and rear axles by varying the duty

cycle of the clutch in the transfer case. Hall-effect sensors on the front and rear output shafts allow the GEM to compare shaft speeds and increase the duty cycle on the transfer-case clutch from 4% torque to the front axle to 98% until the



shaft speeds are equal. At minimum clutch duty cycle, there should be no tire scrub or wheel hop during turns.

The A4WD computer inputs come from the 4WD Mode Switch, the transmission range sensor, the vehicle speed sensor (VSS), the front and rear driveshaft speed sensors, and the electric shift motor position sensor. GEM outputs are made to the transfer-case clutch through a solid-state relay that provides a pulse-width-modulated signal, which is grounded when the relay is on and shows battery voltage when the relay is off. The A4WD indicator provides the second GEM output. This circuit will be activated when grounded and show an open when deactivated.

4x4 High is the second transfer-case mode, and shifts between A4WD and 4x4 High can be made at any speed. 4x4 High range should be used on snow- or ice-covered roads, and A4WD may be used on dry pavement at highway speeds. 4x4 Low range is the third operating mode and provides gear reduction for off-road use at very slow speeds. In order for a shift to 4x4 Low range to take place, the computer must see that the transmission is in neutral, the brake is applied and road speed is under 3 mph.

It should be clear that because of the sensitivity of the electronics in modern transfer cases, many external factors (tires and wheels, for example) can affect the proper operation. A wonderful, time-saving habit to get into is to check tire pressure and tire and wheel sizes, and measure tire tread depth after you road-test one of these vehicles. A 0.060-inch difference in tread depth can create noise in the transfer case, wheel hop, tire scrub and driveline windup. You read it right - 0.060 inch. Another quick way to locate noise problems is to check noise in each gear. If the noise is present in some gears and

not in others, look at the transmission. If the noise is present in all gears, check the transfer case and differentials as likely suspects.

Once upon a time you could repair transmissions with some special tools, a pressure gauge and a vacuum gauge. In this era you need the tools, a good volt/ohmmeter, a good scan tool and a library of service manuals. Life is hard, but all the research has been done for us and we need only

to open the book to have a road map. Life is impossible if you don't take advantage of the available information. **TD**

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