Introducing Ford’s Intelligent All-Wheel Drive System:

During the past three years, while not working on the ATRA Technical HotLine, I’ve been researching four-wheel drive and all-wheel drive systems for upcoming seminars and EXPOs. In the March 2009 issue of GEARS Magazine, I introduced Chrysler’s Interactive Torque Management System (ITM 3e). In this issue we’ll take a look at Ford’s new Intelligent All-Wheel Drive System.

Ford’s new all-wheel drive systems are referred to as an Intelligent All-Wheel Drive System or I-AWD, and are found in the Ford AWD Escape (figure 1), Ford AWD Five Hundred (figure 2), Ford AWD Freestyle (figure 3) or the Ford AWD Flex (figure 4), to name a few. These AWD systems are always active, require no input from the driver, and don’t have a mode-select switch. These systems combine transparent, all-surface operation and are capable of handling all road conditions, including street and highway driving, as well as off-road and winter driving.

The I-AWD system continuously monitors vehicle conditions and automatically adjusts the torque distribution between the front and rear wheels. During normal operation, most of the torque from the transmission is sent to the front wheels. If the system detects wheel slip between the front and rear wheels, or if you operate the vehicle under heavy throttle conditions, the I-AWD system will increase the torque to the rear wheels to prevent or control wheel slip.
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Ford’s I-AWD system consists of these components:

- Transfer case or Power Take-Off Unit (depending on application)
- Rear driveshaft
- Electronic on-demand coupler device
- Rear axle
- Coupler device control module, known as the 4WD Control Module (4WDCM)
- Differential Electronic Module (DEM) or an Intelligent Torque Control Coupler (ITCC) module, depending on application (figure 5).

The Heart of the I-AWD system

The heart of the Intelligent AWD system is the transfer case or power take-off unit (PTO) and an electronically controlled, on-demand coupler. The transfer case or PTO is a one-speed gearbox that attaches to the transaxle. The transfer case or PTO directs power to the rear driveshaft through a helical gear coupled to the transaxle differential case, a helical idler gear, a helical ring gear assembly, and a pinion set (figure 6).

The rear driveshaft transfers power to the electronic on-demand coupler, located on the rear differential, which in turn transfers the power through the rear differential to the rear wheels.

The on-demand coupling unit is attached to the rear axle, between the differential gear and the driveshaft. The on-demand coupler consists of mechanical and hydraulic sections that are driven by the driveshaft (figure 7).

The Brains of the I-AWD System

Depending on the application, the I-AWD System is controlled by the 4WDCM (Ford Flex), the ITCC module (Ford Escape) or the Differential Electronic Module (DEM) (Ford Five Hundred and Freestyle). The main purpose of the 4WDCM, the DEM or the ITCC module is to control the AWD function by distributing torque between the front and rear axles.

The I-AWD system isn’t sensitive to tire size differences between all four wheels and isn’t sensitive to being towed with one axle raised off the ground. The I-AWD system uses a CAN BUS system to communicate with the powertrain control module (PCM) and the ABS/ESP control module (ABS), and uses inputs from each of these systems to control the AWD system (figure 8).

Diagnosing Ford’s I-AWD System

Diagnosing the new Intelligent AWD system is pretty straightforward. Simply connect a compatible scan tool to the DLC connector and check for codes in the PCM and the ABS control module. Document all codes received from each of these modules.

Before starting your diagnosis of
the AWD system, be sure to correct all codes in the other modules. PCM and ABS problems can and will interfere with the AWD system operation. After you’ve corrected any codes in the other modules, access the 4WDCM, DEM or ITCC module and retrieve codes from the AWD system. The following list of codes is what you might find in the 4WDCM, the ITCC module, or the DEM.

**Codes for the Differential Electronic Module**
- P0562 – System voltage low
- P0563 – System voltage high
- P0602 – PCM programming error
- P0606 – ECU short or open circuit
- P0932 – Hydraulic pressure sensor circuit
- P0937 – Hydraulic oil temperature sensor circuit
- P0939 – Hydraulic oil temperature sensor circuit low
- P0940 – Hydraulic oil temperature sensor circuit high
- P0960 – PCS A control circuit open
- P0961 – PCS A control circuit range performance
- P0962 – PCS A control circuit low
- P1886 – Oil pressure pump performance
- U0001 – High speed CAM communication fault
- U0121 – Lost communication with ABS module
- U2050 – No valid application for DEM

**Codes for the 4WD Control Module and ITCC Module**
- B1317 – Battery voltage high
- B1318 – Battery voltage low
- B1342 – ECU defective
- P1635 – Tire or axle out of range
- P1824 – 4WD clutch relay circuit failure
- P1825 – 4WD clutch relay circuit open
- U0100 – Loss of communication with PCM
- U0121 – Loss of communication with ABS
- U0401 – Invalid data received from PCM
- U0415 – Invalid data received from ABS
- U1990 – CAN communication bus fault

**I-AWD System Code Diagnosis for the DEM**

**P0562 – System voltage is low.** Check battery and charging system voltage. Verify all power and ground voltages are correct at the DEM connector. If system voltage is within specification, replace the DEM.

**P0563 – System voltage is high.** Check battery and charging system voltage. Verify all power and ground voltages are correct at the DEM connector. If system voltage is within specification, replace the DEM.

**P0602 – PCM programming error.** Attempt to clear code P0602. If code P0602 returns, verify all power and ground voltages are correct at the DEM connector. If voltages are within specification, replace the DEM.

**P0606 – ECU short or open circuit.** Attempt to clear code P0606. If code P0606 returns, verify all power and ground voltages are correct at the DEM connector. If voltages are within specification, replace the DEM.

**P0932 – Hydraulic pressure sensor circuit.** Check rear axle oil temperature sensor circuit. If circuit is okay, suspect a faulty rear axle oil temperature sensor.

**P0937 – Hydraulic oil temperature sensor circuit.** Check rear axle oil temperature sensor circuit. If circuit is okay, suspect a faulty rear axle oil temperature sensor.

**P0939 – Hydraulic oil temperature sensor circuit low.** Check rear axle oil temperature sensor circuit. If circuit is okay, suspect a faulty rear axle oil temperature sensor.

**P0940 – Hydraulic oil temperature sensor circuit high.** Check rear axle oil temperature sensor circuit. If circuit is okay, suspect a faulty rear axle oil temperature sensor.

**P0960 – Pressure control solenoid A circuit open.** Check ABS wheel sensor PIDs to verify the ABS module is transmitting the correct wheel speed to the DEM. Check for leaks from the active on-demand coupler. If no leaks...
are found, check the PCS A circuit. If the PCS A circuit is okay, replace the DEM.

**P0961 – Pressure control solenoid A circuit performance.** Check ABS wheel sensor data to verify the ABS module is transmitting the correct wheel speed to the DEM. Check for leaks from the active on-demand coupler. If no leaks are found, check the PCS A circuit. If the PCS A circuit is okay, replace the DEM.

**P0961 – Pressure control solenoid A circuit low.** Check ABS wheel sensor data to verify the ABS module is transmitting the correct wheel speed to the DEM. Check for leaks from the active on-demand coupler. If no leaks are found, check the PCS A circuit. If the PCS A circuit is okay, replace the DEM.

**P1889 – Oil pressure pump performance.** Install a new active on-demand coupler oil pump. If code returns, install updated DEM kit #4C016, available from your local Ford dealer.

**U0001 – High speed CAN communication error.** Check high speed CAN bus system wiring and connections. Repair as needed.

**U0121 – Loss of communication with ABS module.** Check CAN communication system. Check wiring and connections. Check ABS module power and grounds. If CAN system and ABS module power and grounds are okay, suspect a faulty ABS module.
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U2050 – No valid application for DEM. Reconfigure the DEM using As-Built data.

I-AWD System Code Diagnosis for the 4WDCM and ITCC Module

1317 – Battery voltage high. Check battery and charging system operation. Repair as needed.

B1318 – Battery voltage low. Check battery and charging system operation. Repair as needed.

B1342 – ECU defective. Attempt to clear code B1342. If code B1342 returns,
Figure 12: Ford Five Hundred I-AWD system wiring schematic

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check the 4WDCM power and ground circuits. If the 4WDCM power and ground circuits are good, replace the 4WDCM.

P1635 – Tire or axle out of acceptable range. Check for correct tire sizes and tire pressure. Check ABS system for wheel speed sensor fault. If wheel speed sensor fault exists, repair as needed.

P1824 – 4WD clutch relay circuit failure. Check 4WD clutch relay circuit. Check active on-demand coupler circuits. If the coupler circuits check out okay, suspect a faulty active on-demand coupler or a faulty 4WDCM.

P1825 – 4WD clutch relay circuit open. Check 4WD clutch relay circuit. Check active on-demand coupler circuits. If the coupler circuits check out okay, suspect a faulty active on-demand coupler or a faulty 4WDCM.

U0100 – Loss of communication with PCM. Check the CAN communication system. Check PCM power and ground circuits. If the CAN communication system and the PCM power and ground circuits are okay, suspect a faulty PCM.

U0121 – Loss of communication with ABS. Check the CAN communication system. Check ABS module power and ground circuits. If the CAN communication system and the ABS module power and ground circuits are okay, suspect a faulty ABS module.

U0401 – Invalid data received from PCM. Check data coming from PCM. Check for data being out of range. Repair as needed.

U0415 – Invalid data received from ABS module. Check data coming from ABS module. Check for data being out of range. Repair as needed.

U1900 – CAN communication bus fault. Check CAN communication system, wiring and connections. Repair as needed.

I’ve included figures 9, 10, 11, 12, 13 and 14, to help you with your diagnosis. Refer to the appropriate service manual for your specific vehicle’s diagnostic routines.

Well, there you have it: a closer look at Ford’s new Intelligent All-Wheel Drive system. With a basic understanding of how Ford’s I-AWD system operates and a quick look at the diagnostic routines for this system, you should have no problem keeping those trannys rolling.

Figure 13: Ford Escape I-AWD system wiring schematic
Figure 14: Ford Flex I-AWD system wiring schematic
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