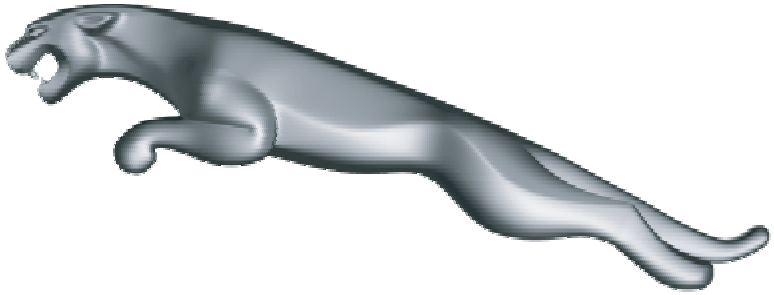

JAGUAR

ON-BOARD DIAGNOSTICS

Transaxle

Vehicle Coverage:

X-Type from 2001 model year onwards

1 Contents

2 Introduction

This document describes the On Board Diagnostic (OBD) monitoring strategy and malfunction criteria for the JATCO transaxle systems.

2.1 OBDII Systems

California OBDII applies to all gasoline engine vehicles up to 14,000 lbs. Gross Vehicle Weight Rating (GVWR) starting in the 1996 model year and all diesel engine vehicles up to 14,000 lbs. GVWR starting in the 1997 model year.

"Green States" are states in the Northeast that chose to adopt California emission regulations, starting in the 1998 model year. At this time, Massachusetts, New York, Vermont and Maine are Green States. Green States receive California certified vehicles for passenger cars and light trucks up to 6,000 lbs. GVWR.

The National Low Emissions Vehicle program (NLEV) requires compliance with California OBDII, including 0.020" evaporative system monitoring requirements. The NLEV program applies to passenger cars and light trucks up to 6,000 lbs. GVWR nationwide from 2001 model year through 2003 model year.

Federal OBD applies to all gasoline engine vehicles up to 8,500 lbs. GVWR starting in the 1996 model year and all diesel engine vehicles up to 8,500 lbs. GVWR starting in the 1997 model year.

OBDII system implementation and operation is described in the remainder of this document.

3 JATCO Automatic Transaxle System

3.1 Transaxle Overview

The X-Type is the first Jaguar vehicle to be installed with a transversely mounted automatic transaxle, which combines both automatic transmission and differential into one unit. The term transaxle, developed from the terms transmission and axle, is used to describe this type of arrangement.

The automatic transaxle with 5-speed lock-up provides a smooth and fast operation. The transaxle comprises a torque converter, shift solenoids, hydraulic valve body and pressure regulators. The Transmission Control Module (TCM) operates these components to control the flow of transaxle fluid, to hydraulically control, gearshift selection and shift quality.

The TCM processes the information it receives, relating to transaxle input and output speed, engine torque, transaxle fluid temperature, mode switch and gearshift selector position. This information is then used to decide which shift pattern to implement and which gear to select. Under normal conditions, shift determination is performed by monitoring the appropriate shift lines and determining the relationship of the vehicle speed and throttle opening to these lines. The shift lines are selected according to the shift pattern, present range selection and the gear position.

In the event of electrical failures the system has a failure management system to provide for a wide range of circumstances from individual signal loss to total loss of electrical power. Transaxle faults are indicated to the driver via the instrument cluster and a fail safe 'limp home' mode is entered where appropriate.

Gear selection is achieved using the J-gate gearshift selector. A mode switch operated by the driver is used to select between 'Normal' and 'Sport' modes. In 'Sport' mode the TCM will use higher engine revolutions, according to the unique shift map, than when in 'Normal' mode. The status of the mode switch is indicated to the driver by the illumination of a lamp in the switch when 'Sport' is selected.

3.2 Transaxle Control System

The signal interface between the Engine Control Module (ECM) and the TCM is transmitted via the Controller Area Network (CAN) communications network. The ECM supplies the TCM with powertrain: Configuration data; Status information; Control information; plus speed control status to enable the transaxle to operate the adjusted setting.

The TCM supplies the ECM with transaxle control signals to provide: smooth operation during gear changes through reduction in engine torque; torque limiting to protect the transaxle from damage; Diagnostic Trouble Codes (DTC's) for storage and later interrogation.

Transaxle control is achieved using nine solenoids that respond to electrical input signals transmitted by the TCM, to regulate control valve operation. The control valves cause changes in the fluid-flow passages, which results in fluid pressure changes within the transaxle. These fluid pressure changes control transaxle operation.

3.2.1 Transaxle Control Functions

The following table defines the main transaxle control functions.

Item	Function
Gear change control.	Shifts the gear in range from '1st to 5th' according to the shift schedule set for each driving range and enables the selection of engine brake mode depending on range.
Line pressure control.	Required clutch and brake operating fluid pressure vary with selected transaxle speed. The line pressure control regulates these changing pressures. Finer control of fluid pressure change during gearshift assures smooth and comfortable ride.
Lock-up control.	The Torque Converter Clutch (TCC) are directly connected. The lock-up control regulates the TCC operation. Lock-up is possible in '1st to 5th gears' of the 'D, 4, 3 and 2 ranges'. This establishes lock-up control for speed control in a certain speed range to enhance fuel economy and quietness.
Timing solenoid control: a. reduction timing solenoid, b. Low clutch timing solenoid, c. 2, 4 brake timing solenoid	Controls the clutch and brake operational timing during start or gear change operation to enhance gear change response and to ease gear change shock. It also prevents erroneous shifting into 'R' when the vehicle is moving forward.
Torque-down control	Reduces the engine torque during gear changes reducing gear change shock. A control signal is sent from the TCM to the ECM.
Gear change timing control using Input Shaft Speed (ISS) sensor and intermediate shaft speed sensor.	Closely monitors automatic transaxle internal operating conditions using the ISS sensor and the intermediate shaft speed sensor. It optimizes lock-up control as well as brake and clutch operational timing during gear changes, therefore reducing gear change shock.
1. Abnormal signal control 2. Fail safe control	The TCM fail-safe mechanism functions whenever an abnormal input or output signal is detected. The mechanism redirects the control functions so running efficiency losses are minimized.
Reverse prohibition control	When 'R' is selected at the speed of 5mph or greater, the TCM sets the low-clutch timing solenoid 'ON' to drain the low and reverse brake pressure. This brings about 'N' range condition superseding, 'R' being selected.
Engine speed restriction	When in 'Neutral' or 'Park' the engine speed is restricted to 3000 RPM.

3.3 Inputs and Outputs

Inputs and outputs are directed to and from the TCM through hard-wired connections and the CAN and ISO 9141/2 (Serial Communication) data buses contained in the harness.

	Component/Signal	Function
Input signals	Vehicle speed sensor	Senses the parking gear rotational speed to determine vehicle speed.
	ISS sensor	Senses the turbine runner rotational speed to determine the input rotation power being delivered to the transaxle.
	Intermediate shaft speed sensor	Senses the rotational speed of the output gear of 4-speed gear train.
	Transmission rotary switch (range sensor)	Senses the position (range) of the selector lever.
	Sport mode switch	Senses which driving mode is selected among 'Sport'
	D/4 switch	Detects the selector lever position in 'D and/or 4' ranges.
Output signals	Shift solenoid A	Operates the shift valve 'A' in the control valve as part of gear change control.
	Shift solenoid B	Operates the shift valve 'B' in the control valve as part of gear change control.
	Shift solenoid C	Operates the shift valve 'C' in the control valve as part of gear change control.
	Line pressure control solenoid	Adjusts the pressure as part of the line pressure control.
	Low clutch timing solenoid	Adjusts roller clutch pressure as part of gear change and line pressure control.
	TCC solenoid	Operates the lock-up control valve.
	Reduction timing solenoid	Adjusts reduction brake pressure as part of gear change control.
	Torque-down request signal	The signal supplied to the ECM during gear change requests the reduction of engine torque.
	1. 2, 4 brake timing solenoid 2. 2, 4 brake duty solenoid	Adjusts pressure during the gear change to and from '2nd, 4th and 5th' gear
Communication	CAN	Provides communication between the TCM, ECM and diagnostic tester.

3.4 Control Module Pin Numbering

The following table details the pin numbering for the TCM.

Pin	Circuit	Pin	Circuit	Pin	Circuit
001	Not used	019	Not used	037	Not used
002	Not used	020	Sensor ground	038	Power ground
003	2/4 Brake pressure control solenoid drive	021	Intermediate shaft speed sensor signal	039	Transmission Fluid Temperature (TFT) sensor signal
004	2/4 Brake timing solenoid drive	022	Not used	040	Not used
005	Output Shaft Speed (OSS) sensor signal	023	Not used	041	Not used
006	Battery power supply	024	ISS sensor signal	042	Sensor ground
007	Range sensor (position 2)	025	Range sensor (position N)	043	Not used
008	Range sensor (position 3)	026	Range sensor (position R)	044	Sensor ground
009	Power ground	027	Range sensor (position D)	045	D – 4 Switch
010	Reduction timing solenoid drive	028	Not used	046	Sensor ground
011	Not used	029	Not used	047	Mode switch
012	Serial communications (CAN – 1)	030	Range sensor (position P)	048	Not used
013	Serial communications (CAN – 2)	031	Not used	049	Not used
014	Shift solenoid B drive	032	Not used	050	Not used
015	Shift solenoid A drive	033	Serial communications (CAN + 1)	051	Not used
016	TCC pressure control solenoid drive	034	Serial communications (CAN + 2)	052	Shift solenoid C drive
017	Solenoid ground	035	Not used	053	Low clutch timing solenoid drive
018	Line pressure control solenoid drive	036	Ignition switched power supply	054	Ignition switched power supply

4 On Board Monitoring

When the ignition switch is set to position II (ignition ON) the transmission warning lamp comes on briefly and then goes off again.

When the TCM detects a fault, it stores the DTC and activates the transmission warning lamp. For faults detected in less critical inputs/outputs, the TCM substitutes the faulty input/output with a default value and continues the Normal mode of operation. This allows the vehicle to be driven normally, although gear change quality will be affected.

For certain faults, the TCM also disables the Sport mode.

For more serious faults, the TCM may adopt a `limp home' mode by disabling the shift and TCC solenoids. This allows the vehicle to be driven, but no gear changes will occur in the forward range. If the `limp home' mode is adopted while the vehicle is in motion the transmission is kept in fourth gear. If the vehicle is then brought to a halt, neutral selected and drive re-selected, or if the `limp home' mode is adopted while the vehicle is stationary, the transmission is kept in third gear.

Note: this document only details those codes that will cause the Malfunction Indicator Lamp (MIL) to illuminate.

4.1 Control Module Malfunctions

4.1.2 Electrically Erasable Programmable Read Only Memory Fault

The TCM can diagnose errors within the Electrically Erasable Programmable Read Only Memory (EEPROM). Diagnosis is only performed during TCM initialization. There is no fail-safe mechanism associated with this function as the EEPROM is mainly used for the storage of DTC's and transmission calibration adaptions. If a fault occurs, the TCM is able to perform default actions and inform the driver of the problem.

During TCM initialization, immediately following ignition on, the TCM calculates a new checksum for the EEPROM (fast memory). This is compared to the value already stored, if the two do not match then the failure is flagged.

4.1.3 Configuration Error

The TCM compares the configuration data stored within its own memory (EEPROM) to equivalent data transmitted on the Controlled Area Network (CAN) by the Engine Control Module (ECM) during the module initialization procedure. If the data does not match then the failure is flagged.

For both of the above failure conditions a DTC is logged immediately the failure is recognized.

Note: Unless specifically included in the tables below, Intake Air Temperature (IAT), Engine Coolant Temperature (ECT), vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Control Module Malfunctions								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
TCM Internal	P1603	EEPROM fault	Calculated checksum does not match stored checksum				Within 3s of ignition on	1 DTC
	P1601	Configuration error	Engine message does not equal the TCM configuration value.				Within 3s of ignition on	1 DTC

4.2 Communications Network Monitor

The TCM communicates other control modules throughout the vehicle using the CAN serial communications network. In addition to vehicle data (i.e. data about vehicle conditions e.g. vehicle speed) the network carries data specifically for error checking of the vehicle data messages. The TCM uses this data to confirm that the communications network is functioning correctly.

If messages that are expected by the TCM are not being received (all modules transmit some data on a regular basis) or messages are proven to be repeatedly corrupt, then the TCM will register an appropriate network failure. If the failure is identified on two consecutive drive cycles then the appropriate DTC is logged

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Communications Network								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
CAN Link	P1642	Bus Malfunction	Bit, stuff, Cyclic redundancy check or form error.				> 0.500s	2 DTC
	P1797	No network token received from ECM node	Acknowledgement error No ECM message				1s	2 DTC

4.3 System Power Supply

System supply voltage is continuously monitored whilst the engine speed is greater than the threshold speed. The diagnostic monitors the TCM supply voltage for voltages greater than, or less than fixed thresholds.

If the engine speed is above its minimum threshold and the transmission is not in limp home because of another code then the supply voltage check continues. The voltage is checked against both upper and lower limits. If it exceeds either then a timer is started and the voltage rechecked. If at the end of the timer period the supply voltage is still outside its threshold then the fault is flagged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – System Power Supply								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
System Voltage	P1793	Ignition supply out of allowable range	Ignition supply checked	8 volts to 18 volts	Engine speed	> 420 RPM	1s	2 DTC

4.4 Transmission Range Switch

The transmission range sensor and inhibit switch is located on top of the transmission assembly on the end of the selector shaft. The sensor switches a ground signal to individual outputs depending on the selected transmission range (P, R, N, D, 2 and 3). Each output is connected to a discrete TCM input. In addition to the range sensor switches the sensor includes a separate inhibit switch to indicate when the vehicle is not in park or neutral. This switch provides a battery positive input to the ECM when park or neutral is selected.

The range sensor is monitored by the TCM for loss of signal and multiple gearshift positions selected at the same time (indicating a short circuit in the harness). The presence of a crank signal from the ECM is also checked when the vehicle is not in park or neutral. If any of the conditions persist for longer than a defined period then a failure judgement is made. If the failure is detected on two consecutive drive cycles, the DTC is logged.

The D to fourth hall effect switch is mounted in the transmission selector assembly. When the selector is moved across the gate to engage fourth or back from that side towards D the selector cable does not move. In order that this change of state is registered by the TCM, the D to fourth switch is incorporated.

The switch is monitored by the TCM for conflicts with the range sensor switches. If the D to fourth switch indicates fourth in any range selector switch position apart from D then a failure judgement is made. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Transmission Range/Position Switch								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Inhibitor switch (range sensor)	P0706		No signal Multiple signal No P, N signal at cranking				60s 0.500s 0.300s	2 DTC
D – 4 Switch	P1780	Conflicting signals	P, R, N or 2, 3 ranges				1s	2 DTC

4.5 Speed Sensors

There are three sensors installed in the transmission casing. They are all of the inductive type.

4.5.4 Output Shaft Speed Sensor Circuit

The OSS sensor detects the parking gear rotation speed. The TCM calculates the vehicle speed based on the parking gear rotation speed. The OSS sensor uses a magnetic coil. As the parking gear rotates the sensor detects a pulse signal according to the gear teeth rotation speed and then sends it to the TCM.

4.5.5 Input Shaft Speed Sensor Circuit

The ISS sensor detects the reverse clutch drum rotation speed. The reverse clutch drum is connected to the input shaft and rotates at the same speed. The TCM calculates the ISS to determine the input speed. The ISS sensor uses a magnetic coil. As the input shaft rotates, the sensor detects a pulse signal according to the gear teeth on the outside of the reverse clutch drum and sends it to the TCM.

4.5.6 Intermediate Shaft Speed Sensor Circuit

The intermediate shaft speed sensor detects the output gear rotation speed, which is calculated by the TCM. The intermediate shaft speed sensor uses a magnetic coil. As the output gear rotates the sensor detects a pulse signal according to the gear teeth rotation and sends it to the TCM.

4.5.7 Speed Sensor Monitors

The sensors are monitored by comparing the output from each sensor with the other two speed sensor outputs and both ECM engine speed and Anti-lock Braking System (ABS) vehicle speed. The speed sensor signals are also checked against a minimum speed threshold that should be achieved when the conditions indicated by other speed sensors are present.

When the entry conditions for the particular monitor have been met, including the minimum vehicle speed attained. The sensor is checked against its minimum threshold. If the value is below this threshold then the monitor checks for the next range sensor signal input. If after the next range sensor signal input the speed sensor value is still below its minimum threshold then the failure is flagged and the appropriate DTC logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Output Speed Sensor Circuit								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
OSS sensor	P0720	Minimum OSS	Minimum OSS	< 150 RPM	Vehicle Speed No Vehicle or ABS speed failure.	> 12.4 mph	1 transmission range sensor input signal	2 DTC
ISS sensor	P0715	ISS sensor faults	Minimum ISS	< 600 RPM	Engine Speed Vehicle Speed No vehicle speed failure	> 1500 RPM > 24.8 mph	1 transmission range sensor input signal	2 DTC
Intermediate shaft speed sensor	P0791	Minimum intermediate shaft speed	Minimum intermediate shaft speed	< 400 RPM	Engine speed Vehicle speed No vehicle speed failure	> 1500 RPM > 24.8 mph	1 transmission range sensor input signal	2 DTC

4.6 Transmission Fluid Temperature Sensor

The TFT sensor is installed in the transmission case, it constantly monitors the fluid temperature. The sensor resistance varies with automatic TFT change. The TCM detects the automatic TFT according to the voltage produced by the TFT sensor.

The sensor monitor checks to ensure that the TFT is within its upper and lower limits. When the vehicle speed exceeds 12.4 mph (indicating that the transmission is functioning), the temperature is checked against its upper and lower limits. If the fluid temperature is outside the limits, a timer is started. If at the end of the timed period the TFT is still outside of its threshold values then the failure is flagged. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Transmission Fluid Temperature Sensor	
Temperature (ºC)	Resistance (KOhms)
-40	54.90
-20	16.70
0	6.02
20	2.50
40	1.16
60	0.59
80	0.33
100	0.19
120	0.12
140	0.08

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation –Transmission Fluid Temperature Sensor								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
TFT sensor	P0710		Minimum/Maximum Temperature	> -30ºC < 155ºC	Vehicle speed	> 12.4 mph	180s	2 DTC

4.7 Torque Converter Clutch

There is always an amount of slip between the impeller and turbine in a torque converter. This contributes to a reduction in fuel economy during high speed cruising. To eliminate the slip the torque converter uses a lock up mechanism. The lock up mechanism is attached to the turbine and controls a Torque Converter Clutch (TCC), which is integral with the torque converter. The lock up mechanism comprises a TCC solenoid valve, a TCC control valve and a TCC.

Control is provided by the TCM, which operates the lock up solenoid, controlling the TCC engagement and release according to the schedule programmed into memory and the vehicle conditions.

The TCC solenoid is one of three duty solenoids, these being the line pressure control duty solenoid, TCC solenoid and the 2/4 brake duty solenoid.

The duty solenoids repeatedly turn on/off in 50Hz cycles, this opens and closes the fluid pressure circuits. The ratio of the on to off time (duty cycle) can be varied to adjust the fluid pressure.

The monitor for this type of solenoid is common, when the appropriate entry conditions have been met. The duty cycle is repeatedly sampled and compared with the preceding sample. If seven consecutive samples have the same value then a failure is flagged and the appropriate DTC logged.

The performance of the clutch is monitored by comparing the ISS and engine speed. If the level of slip detected, when the clutch is locked, exceeds expected levels then a failure is registered. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Torque Converter Clutch								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Torque converter clutch solenoid	P0743		Previous value equals current value	7 times			Continuous	2 DTC
Torque converter clutch	P0740		Minimum slip revolutions in lock up region		Lock up duty No CAN driver error No ECM off bus failure No vehicle speed error No ISS failure	> 95%	10s	2 DTC

4.8 Line Pressure Control Duty Solenoid

The line pressure control duty solenoid is used to control the transmission fluid pressure within the valve block ensuring smooth transmission shifting across all vehicle driving conditions.

The line pressure control duty solenoid is one of three duty solenoids, these being the line pressure control duty solenoid, TCC solenoid and the 2/4 brake duty solenoid.

The duty solenoids repeatedly turn on/off in 50Hz cycles, this opens and closes the fluid pressure circuits. The ratio of the on to off time (duty cycle) can be varied to adjust the fluid pressure.

The monitor for this type of solenoid is common, when the appropriate entry conditions have been met. The duty cycle is repeatedly sampled and compared with the preceding sample. If seven consecutive samples have the same value then a failure is flagged. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Torque Converter Clutch Solenoid								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Line pressure control duty solenoid	P0748		Previous value equals current value	7 times			Continuous	2 DTC

4.9 Shift Solenoids

Shift solenoids A,B and C are three of the six on/off solenoids, these being the shift solenoids A, B, C, low clutch solenoid, reduction timing solenoid and the 2-4 brake timing solenoid.

The on/off solenoids close the pressure circuit in response to current flow. Each solenoid has an internal coil. Current passes through coil and actuates the needle valve. The needle valve then opens and closes the fluid pressure circuits.

The solenoids are monitored by comparing the commanded to the actual condition of the solenoids. If the any of the solenoids do not react to an on command on more than three occasions then a failure is registered. The state of the solenoid is checked by analyzing the voltage on the drive circuit at the time the solenoid engages. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Shift Solenoids								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Shift solenoid A	P0753		On / Off condition	3 times			Continuous	2 DTC
Shift solenoid B	P0758		On / Off condition	3 times			Continuous	2 DTC
Shift solenoid C	P0763		On / Off condition	3 times			Continuous	2 DTC

4.10 2-4 Brake Solenoid

The 2-4 brake duty solenoid is one of 3 duty solenoids, these being the line pressure control duty solenoid, TCC solenoid and the 2-4 brake duty solenoid.

The duty solenoids repeatedly turn on/off in 50Hz cycles, this opens and closes the fluid pressure circuits. The ratio of the on to off time (duty cycle) can be varied to adjust the fluid pressure.

The monitor for this type of solenoid is common, when the appropriate entry conditions have been met. The duty cycle is repeatedly sampled and compared with the preceding sample. If 7 consecutive samples have the same value then a failure is flagged and the appropriate DTC logged.

The 2-4 brake timing solenoid is one of 6 on/off solenoids, these being the shift solenoids A, B, C, low clutch solenoid, reduction timing solenoid and the 2-4 brake timing solenoid.

The on/off solenoids close the pressure circuit in response to current flow. Each solenoid has an internal coil. Current passes through coil and actuates the needle valve. The needle valve then opens and closes the fluid pressure circuits.

The solenoid is monitored by comparing the commanded to the actual condition of the solenoid. If the solenoid does not react to an on command on more than three occasions then a failure is registered. The state of the solenoid is checked by analyzing the voltage on the drive circuit at the time the solenoid engages. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – 2-4 Brake Solenoid								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
2-4 brake duty solenoid	P0778		Previous value equals current value	7 times			Continuous	2 DTC
2-4 brake timing solenoid	P1747		On / Off condition	3 times			Continuous	2 DTC

4.11 Low Clutch Solenoid

The low clutch solenoid is one of 6 on/off solenoids, these being the shift solenoids A, B, C, low clutch solenoid, reduction timing solenoid and the 2-4 brake timing solenoid.

The on/off solenoids close the pressure circuit in response to current flow. Each solenoid has an internal coil. Current passes through coil and actuates the needle valve. The needle valve then opens and closes the fluid pressure circuits.

The solenoid is monitored by comparing the commanded to the actual condition of the solenoid. If the solenoid does not react to an on command on more than three occasions then a failure is registered. The state of the solenoid is checked by analyzing the voltage on the drive circuit at the time the solenoid engages. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Low Clutch Solenoid								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Low clutch solenoid	P1745		On/off condition	3 times			Continuous	2 DTC

4.12 Reduction Timing Solenoid

The reduction timing solenoid is one of 6 on/off solenoids, these being the shift solenoids A, B, C, low clutch solenoid, reduction timing solenoid and the 2-4 brake timing solenoid.

The on/off solenoids close the pressure circuit in response to current flow. Each solenoid has an internal coil. Current passes through coil and actuates the needle valve. The needle valve then opens and closes the fluid pressure circuits.

The solenoid is monitored by comparing the commanded to the actual condition of the solenoid. If the solenoid does not react to an on command on more than three occasions then a failure is registered. The state of the solenoid is checked by analyzing the voltage on the drive circuit at the time the solenoid engages. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Reduction Timing Solenoid								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Reduction timing solenoid	P1746		On/off condition	3 times			Continuous	2 DTC

4.13 Solenoid Ground Supply

All of the transmission solenoids are supplied with a common ground signal from the TCM. The ground signal is continually monitored by checking for small fluctuations in ground voltage as the solenoids switch on and off. If no fluctuation is detected on 7 occasions (during solenoid activation/deactivation) then a ground circuit failure is registered. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Solenoid Ground Supply								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Solenoid supply ground return	P1710		Previous value equals current value	7 times			Continuous	2 DTC

4.14 Transmission System Mechanical

The objective behind gear monitoring is to detect non-electrical errors that are caused by slipping clutches or by the mechanical failure of actuators. When the transmission is not shifting, verification checks are check the OSS in relation to the ISS. Failure results in a default gear being selected. When the TCM detects that both the OSS and ISS are above the thresholds required for the transmission to shift and the transmission is not shifting, the differences in speeds of the shafts (input and output) are calculated and a transmission slip speed calculated (taking into account the current gear). If the slip speed exceeds the threshold then a failure judgement is made. If the failure is detected on two consecutive drive cycles, the DTC is logged.

Note: Unless specifically included in the tables below, IAT, ECT, vehicle speed and time after start up are not critical to enable these monitors.

Electronic Transmission Operation – Transmission System Mechanical								
Strategy	DTCs	Description	Malfunction Criteria	Value	Secondary parameter	Enable Conditions	Time Required	MIL
Gear monitoring 1st	P0731	Gear monitoring 1st Ratio slip calculated using ISS and OSS	Calculated slip outside allowable range	> 181 RPM	D, 4, 3, 2 range signal in gear 1 (not shifting) OSS ISS	 > 500 RPM > 1000 RPM	1 transmission range sensor input signal	2 DTC
Gear monitoring 2nd	P0732	Gear monitoring 2nd Ratio slip calculated using ISS and OSS	Calculated slip outside allowable range	> 181 RPM	D, 4, 3, 2 range signal in gear 2(not shifting) OSS ISS	 > 500 RPM > 1000 RPM	1 transmission range sensor input signal	2 DTC
Gear monitoring 3rd	P0733	Gear monitoring 3rd Ratio slip calculated using ISS and OSS	Calculated slip outside allowable range	> 181 RPM	D, 4, 3, 2 range signal in gear 3 (not shifting) OSS ISS	 > 500 RPM > 1000 RPM	1 transmission range sensor input signal	2 DTC
Gear monitoring 4th	P0734	Gear monitoring 4th Ratio slip calculated using ISS and OSS	Calculated slip outside allowable range	> 181 RPM	D, 4, 3, 2 range signal in gear 4 (not shifting) OSS ISS	 > 500 RPM > 1000 RPM	1 transmission range sensor input signal	2 DTC
Gear monitoring 5th	P0735	Gear monitoring 5th Ratio slip calculated using ISS and OSS	Calculated slip outside allowable range	> 181 RPM	D, 4, 3, 2 range signal in gear 5 (not shifting) OSS ISS	 > 500 RPM > 1000 RPM	1 transmission range sensor input signal	2 DTC