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5	Right hand CMP (camshaft position) intake sensor
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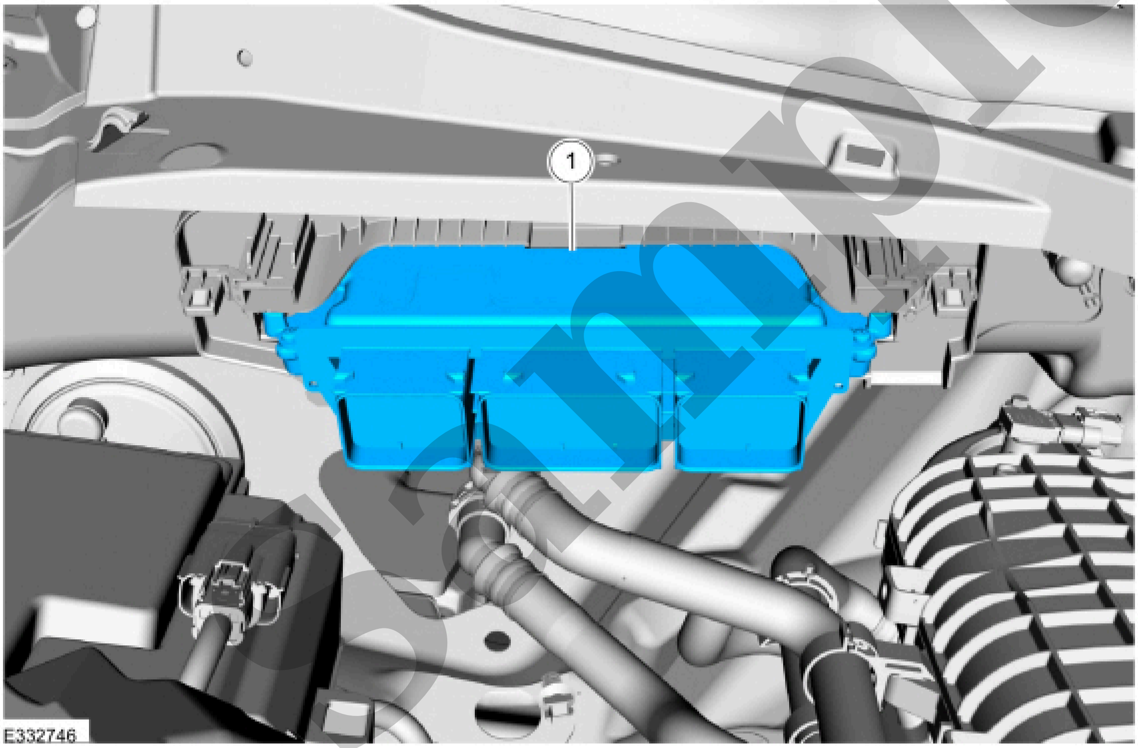
9	HO2S (heated oxygen sensor)
10	Catalyst monitor sensors

Powertrain Control Module (PCM)



Item	Description
1	PCM (powertrain control module)

Electronic Engine Controls - System Operation and Component Description

303-14B Electronic Engine Controls - 3.3L Duratec-V6	***2022 F-150***
Description and Operation	***Procedure revision date: 08/18/2021***

Electronic Engine Controls - System Operation and Component Description

System Operation

Auto Start Stop

The auto start stop system helps reduce fuel consumption and decrease emissions by automatically shutting down the engine when the vehicle stops and the engine is idling, usually within 1500 ms (1.5 seconds). To initiate the auto start stop operation on automatic transmission equipped vehicles on automatic transmission equipped vehicles, the vehicle gear selector must be in DRIVE when the vehicle comes to a stop and the brake pedal must be fully applied. The engine automatically restarts when the brake pedal is released, usually within 500 ms (0.5 seconds), or when a vehicle system requires a restart, for example to recharge the battery or to maintain interior comfort settings.

To initiate the auto start stop operation on manual transmission equipped vehicles, the gear selector must be in NEUTRAL, and the clutch pedal fully released. An auto start is initiated when the clutch pedal is pressed.

The auto start stop system is defaulted to an ON state when the engine is started. To switch the auto start stop system OFF, press the auto start stop switch located on the center console. To turn the auto start stop system ON, press the auto start stop switch again. The auto start stop system can only be deactivated during the current ignition cycle.

The IPC (instrument panel cluster) auto start stop indicator illuminates when an auto start stop system inhibit or disable condition is present.

During normal operation the auto start stop system may not stop the engine under the following conditions:

- The A/C (air conditioning) , heat or defrost settings are ON
- The battery has a low state of charge or is below approximately 5°C (41°F) or above 60°C (140°F)

correct range of values. Where feasible, inputs are checked for rationality and outputs are checked for correct functionality.

The CCM covers many components and circuits and tests them in various ways depending on the hardware, function, and type of signal. For example, analog inputs such as throttle position or engine coolant temperature are typically checked for opens, shorts, and out of range values. This type of monitoring is carried out continuously. Some digital inputs like brake switch or crankshaft position rely on rationality checks that are checking to see if the input value makes sense at the current engine operating conditions. These types of tests may require monitoring several components and can only be carried out under the appropriate test conditions.

Outputs such as coil drivers are checked for opens and shorts by monitoring a feedback circuit or smart driver associated with the output. Other outputs, such as relays, require additional feedback circuits to monitor the secondary side of the relay. Some outputs are also monitored for correct function by observing the reaction of the control system to a given change in the output command. An idle air control solenoid can be functionally tested by monitoring the idle RPM (revolutions per minute) relative to the target idle RPM (revolutions per minute) . Some tests can only be carried out under the appropriate test conditions. For example, the transmission shift solenoids can only be tested when the PCM (powertrain control module) commands a shift.

The following is an example of some of the input and output components monitored by the CCM. The component monitor may belong to the engine, ignition, transmission, air conditioning, or any other PCM (powertrain control module) supported subsystem.

- Inputs:
  - Air conditioning pressure (ACP) sensor, CMP (camshaft position) sensor, CKP (crankshaft position) sensor, CHT (cylinder head temperature) sensor, ECT (engine coolant temperature) sensor, fuel rail pressure temperature (FRPT) sensor, fuel tank pressure (FTP) sensor, IAT (intake air temperature) sensor, MAF (mass air flow) sensor (if equipped), TP (throttle position) sensor.
- Outputs:
  - EVAP (evaporative emission) purge valve, EVAP (evaporative emission) canister vent valve, fuel injector, fuel pump (FP), shift solenoid, torque converter clutch (TCC) solenoid, VCT (variable camshaft timing) actuator, wide open throttle A/C (air conditioning) cutout (WAC).
- The CCM is enabled after the engine starts and is running. A DTC (diagnostic trouble code) is stored in KAM (keep alive memory) and the MIL (malfunction indicator lamp) is illuminated after 2 driving cycles when a concern is detected. Many of the CCM tests are also carried out during an on demand self-test.

Computer Controlled Shutdown

The PCM (powertrain control module) controls the PCM (powertrain control module) power relay when the ignition is turned to the ON or START position, by grounding the PCMRC circuit. After the ignition is turned to

When a sensor input is determined to be out of limits by the PCM (powertrain control module) , an alternative strategy is initiated. The PCM (powertrain control module) substitutes a fixed value for the incorrect input and continues to monitor the suspect sensor input. If the suspect sensor begins to operate within limits, the PCM (powertrain control module) returns to the normal engine operational strategy.

Flash Electrically Erasable Programmable Read Only Memory (EEPROM)

The flash EEPROM is an integrated circuit within the PCM (powertrain control module) . This integrated circuit contains the software code required by the PCM (powertrain control module) to control the powertrain. One feature of the EEPROM is that it can be electrically erased and then reprogrammed through the DLC (data link connector) without removing the PCM (powertrain control module) from the vehicle.

Intermittent Diagnostic Techniques

Intermittent diagnostic techniques help find and isolate the root cause of intermittent concerns associated with the EEC (electronic engine control)) system. The information is organized to help find the concern and carry out the repair. The process of finding and isolating an intermittent concern starts with recreating a fault symptom, accumulating PCM (powertrain control module) data, and comparing that data to typical values, then analyzing the results. Refer to the scan tool manufacturer's instruction manual for the functions described below.

Before proceeding, be sure that:

- Customary mechanical system tests and inspections do not reveal a concern. Mechanical component conditions can make a PCM (powertrain control module) system react abnormally.
- TSB (Technical Service Bulletin) and OASIS (Online Automotive Service Information System) messages, if available, are reviewed.
- Quick Test and associated diagnostic subroutines have been completed without finding a concern, and the symptom is still present.

Recreating the Fault

Recreating the concern is the first step in isolating the cause of the intermittent symptom. If freeze frame data is available, it may help in recreating the conditions at the time of a MIL (malfunction indicator lamp) DTC (diagnostic trouble code) . Listed below are some of the conditions for recreating the concern:

CONDITIONS TO RECREATE FAULT

Engine Type Conditions	Non-Engine Type Conditions
Engine Temperature	Ambient Temperature
Engine RPM	Moisture Conditions

International Standards Organization (ISO) 14229 Diagnostic Trouble Code (DTC) Descriptions

The ISO 14229 is a global, diagnostic communication standard. The ISO 14229 is a set of standard diagnostic messages that can be used to diagnose any vehicle module in use and at the assembly plant. The ISO 14229 is similar to the Society of Automotive Engineers (SAE) J2190 diagnostic communication standard that was used by all original equipment manufacturers (OEMs) for previous communication protocols.

The ISO 14229 changes the way PIDs, DTCs, and OSC (output state control) is processed internally in the PCM (powertrain control module) and in the scan tool software. Most of the changes are to make data transfer between electronic modules more efficient, and the amount and type of information that is available for each DTC (diagnostic trouble code) . This information may be helpful in diagnosing driveability concerns.

Historical Diagnostic Trouble Codes (DTCs)

Historical DTCs use bit 5 (the DTC (diagnostic trouble code) test failed at least once since last code clear) to indicate that a DTC (diagnostic trouble code) is no longer confirmed or pending, but has failed at least once since the last time the DTCs were cleared. The bit 5 is designed to eventually age out and clear in 80 drive cycles (255 in the future). The scan tool does not allow a technician to retrieve historical DTCs unless there are no active DTCs present. This information, in conjunction with manufacturer freeze frame and snapshot data, may be useful in diagnosing a noticeable fault that did not progress to MIL (malfunction indicator lamp) status, or an extended amount of time has occurred before diagnosis, and the confirmed DTC (diagnostic trouble code) has cleared.

DTC Structure

Like all digital signals, DTCs are sent to the scan tool as a series of 1s and 0s. Each DTC (diagnostic trouble code) is made up of 2 data bytes, each consisting of 8 bits that can be set to 1 or 0. In order to display the DTCs in the conventional format, the data is decoded by the scan tool to display each set of 4 bits as a hexadecimal number (0 to F). For example, P0420 Catalyst System Efficiency Below Threshold (Bank 1).

DTC Byte 1		DTC Byte 2	
0000	0100	0010	0000
P0	4	2	0

The table below shows how to decode the bits into hex digits.

Binary Bit Pattern	Hex Digit	Binary Bit Pattern	Hex Digit
0000	0	1000	8
0001	1	1001	9

P0	4	2	0	0	0	F	9

All ISO 14229 DTCs are 4 bytes long instead of 3 or 2 bytes long. Additionally, the status byte for ISO 14229 DTCs is defined differently than the status byte for previous applications with 3 byte DTCs.

Failure Type Byte

The failure type byte is designed to describe the specific failure associated with the basic DTC (diagnostic trouble code) . For example, a failure type byte of 1C means circuit voltage out of range, 73 means actuator stuck closed. When combined with a basic component DTC, it allows one basic DTC (diagnostic trouble code) to describe many types of failures.

DTC Byte 1		DTC Byte 2		Failure Type Byte		Status Byte	
0000	0100	0010	0000	0001	1100	1010	1111
P0	1	1	0	1	C	A	F

For example, P0110:1C-AF means IAT (intake air temperature) sensor circuit voltage out of range. The base DTC (diagnostic trouble code) , P0110, means IAT (intake air temperature) sensor circuit, while the failure type byte 1C means circuit voltage out of range. This DTC (diagnostic trouble code) structure was designed to allow manufacturers to more precisely identify different kinds of faults without always having to define new DTC (diagnostic trouble code) numbers.

The PCM (powertrain control module) does not use failure type bytes and always sends a failure type byte of 00 (no sub type information). This is because OBD (on-board diagnostic) II regulations require manufacturers to use 2 byte DTCs for generic scan tool communications. Additionally, the OBD (on-board diagnostic) II regulations require the 2 byte DTCs to be very specific, so there is no additional information that the failure type byte could provide.

A list of failure type bytes is defined by SAE J2012 but is not described here because the PCM (powertrain control module) does not use the failure type byte.

Status Byte

The status byte is designed to provide additional information about the DTC (diagnostic trouble code) , such as when the DTC (diagnostic trouble code) failed, when the DTC (diagnostic trouble code) was last evaluated, and if any warning indication has been requested. Each of the 8 bits in the status byte has a precise meaning that is defined in ISO 14229.

The protocol is that bit 7 is the most significant and left most bit, while bit 0 is the least significant and right most bit.

- 1 - The DTC (diagnostic trouble code) test failed on the current monitoring cycle

Bit 0

- 0 - The DTC (diagnostic trouble code) is not failed at the time of request
- 1 - The DTC (diagnostic trouble code) is failed at the time of request

For DTCs that illuminate the MIL (malfunction indicator lamp) , a confirmed DTC (diagnostic trouble code) means the PCM (powertrain control module) has stored a DTC (diagnostic trouble code) and has illuminated the MIL (malfunction indicator lamp) . If the fault has corrected itself, the MIL (malfunction indicator lamp) may no longer be illuminated but the DTC (diagnostic trouble code) still shows a confirmed status for 40 warm up cycles at which time the DTC (diagnostic trouble code) is erased.

For DTCs that do not illuminate the MIL (malfunction indicator lamp) , a confirmed DTC (diagnostic trouble code) means the PCM (powertrain control module) has stored a DTC (diagnostic trouble code) . If the fault has corrected itself, the DTC (diagnostic trouble code) still shows a confirmed status for 40 warm up cycles at which time the DTC (diagnostic trouble code) is erased.

To determine if a test has completed and passed, such as after a repair, information can be combined from 2 bits as follows:

If bit 6 is 0 (the DTC (diagnostic trouble code) test completed this monitoring cycle), and bit 1 is 0 (the DTC (diagnostic trouble code) test has not failed on the current monitoring cycle), then the DTC (diagnostic trouble code) has been evaluated at least once this drive cycle and was a pass.

If bit 6 is 0 (the DTC (diagnostic trouble code) test completed this monitoring cycle) and bit 0 is 0 (the DTC (diagnostic trouble code) test is not failed at the time of request), then the most recent test result for that DTC (diagnostic trouble code) was a pass.

The status byte bits can be decoded as a 2 digit hexadecimal number, and displayed as the last 2 digits of the DTC (diagnostic trouble code) , for example for DTC (diagnostic trouble code) P0110:1C-AF, AF represents the status byte info.

Status Byte							
A equals 1010				F equals 1111			
Bit 7 equals 1	Bit 6 equals 0	Bit 5 equals 1	Bit 4 equals 0	Bit 3 equals 1	Bit 2 equals 1	Bit 1 equals 1	Bit 0 equals 1

Malfunction Indicator Lamp (MIL)

The MIL (malfunction indicator lamp) notifies the driver the PCM (powertrain control module) has confirmed an OBD (on-board diagnostic) emission related component or system concern. When this occurs, an OBD (on-

For the EVAP (evaporative emission) system monitor to run, the ambient air temperature must be between 4.4 to 37.8°C (40 to 100°F), and the altitude below 2,438 meters (8,000 feet). If the OBD (on-board diagnostic) monitors must be completed in these conditions, the PCM (powertrain control module) must detect them once (twice on some applications) before the EVAP (evaporative emission) system monitor can be bypassed and OBD (on-board diagnostic) monitors readied. The EVAP (evaporative emission) Monitor Bypass procedure is described in the following drive cycle.

Use a scan tool to carry out the OBD (on-board diagnostic) drive cycle. Refer to the scan tool manufacturer's instruction manual for each described function.

Drive Cycle Recommendations

NOTICE

Strict observance of posted speed limits and attention to driving conditions are mandatory when proceeding through the following drive cycles. Failure to follow these instructions may result in personal injury.

A. Most OBD (on-board diagnostic) monitors complete more readily using a steady foot driving style during cruise or acceleration modes. Operating the throttle in a smooth fashion minimizes the time required for monitor completion.

B. The fuel tank level should be between 1/2 and 3/4 full with 3/4 full being the most desirable.

C. The EVAP (evaporative emission) purge flow monitor can operate only during the first 30 minutes of engine operation. When executing the procedure for this monitor, stay in part throttle mode and drive in a smooth fashion to minimize fuel slosh.

D. The EVAP (evaporative emission) 0.508 mm (0.020 inch) leak check monitor runs after the ignition is turned OFF. The vehicle must be driven to complete the EVAP (evaporative emission) purge flow monitor to increase the temperature of the fuel in the fuel tank.

E. When bypassing the EVAP (evaporative emission) engine soak times, the PCM (powertrain control module) must remain powered (ignition ON) after clearing the continuous DTC (diagnostic trouble code) s and relearning emission diagnostic information.

For best results, follow each of the following steps as accurately as possible:

OBD (on-board diagnostic) Monitor Exercised	Drive Cycle Procedure	Purpose of Drive Cycle Procedure

	between 15 and 85%, and for fuel tanks over 25 gallons FLI must be between 30 and 85%.	is between 4.4 to 37.8°C (40 to 100°F).
Catalyst	7. Drive in stop and go traffic conditions. Decelerate at closed throttle and then moderately accelerate from each stop. Include 5 different constant cruise speeds, ranging from 40 to 72 km/h (25 to 45 mph) over a 10 minute period.	Executes the catalyst monitor.
EGR (exhaust gas recirculation)	8. From a stop, idle for 30 seconds, accelerate to 72 km/h (45 mph) at 1/2 to 3/4 throttle, cruise at steady throttle for 1 minute. Repeat idle, acceleration and cruise 3 times.	Executes the EGR (exhaust gas recirculation) monitor.
CCM (Engine)	9. Bring the vehicle to a stop. Idle with the transmission in drive (neutral for M/T) for 2 minutes.	Executes the idle air control portion of the comprehensive component monitor (CCM).
CCM (Transmission)	10. For M/T, accelerate from 0 to 80 km/h (0 to 50 mph), and continue to step 11. For A/T, from a stop and in overdrive, moderately accelerate to 80 km/h (50 mph) and cruise for greater than 15 seconds. Stop the vehicle and repeat without overdrive to 64 km/h (40 mph) cruising for greater than 30 seconds. While at 64 km/h (40 mph), activate the overdrive, accelerate to 80 km/h (50 mph) and cruise for greater than 15 seconds. Stop for at least 20 seconds and repeat step 10 five times.	Executes the transmission portion of the CCM.
Misfire, Fuel And Deceleration Fuel Shut Off Rear HO2S (heated oxygen sensor) Monitors	11. From a stop, accelerate to 104 km/h (65 mph), hold steady throttle for 5 seconds, then decelerate at closed throttle to 64 km/h (40 mph) (no brakes), accelerate from 64 km/h (40 mph) to 104 km/h (65 mph), hold steady throttle for 5 seconds, repeat deceleration 5 times.	Allows learning for the misfire monitor, and completion of the deceleration fuel shut off rear HO2S (heated oxygen sensor) monitor.
Readiness Check	12. Access the On Board System Readiness (OBD (on-board diagnostic) monitor status) function on the scan tool. Determine whether all non-continuous monitors	Determines if any monitor has not completed.