

Theory & Operation

INTRODUCTION

WARNING: On Prius, read service precautions before proceeding with service procedure. See SERVICE PRECAUTIONS .

NOTE: References to California models apply to California emission vehicles, which may be verified by underhood Emission Control label. California emissions may be available in other states.

This article covers basic description and operation of engine performance-related systems and components. Read this article before diagnosing vehicles or systems with which you are not completely familiar.

SERVICE PRECAUTIONS

PRIUS

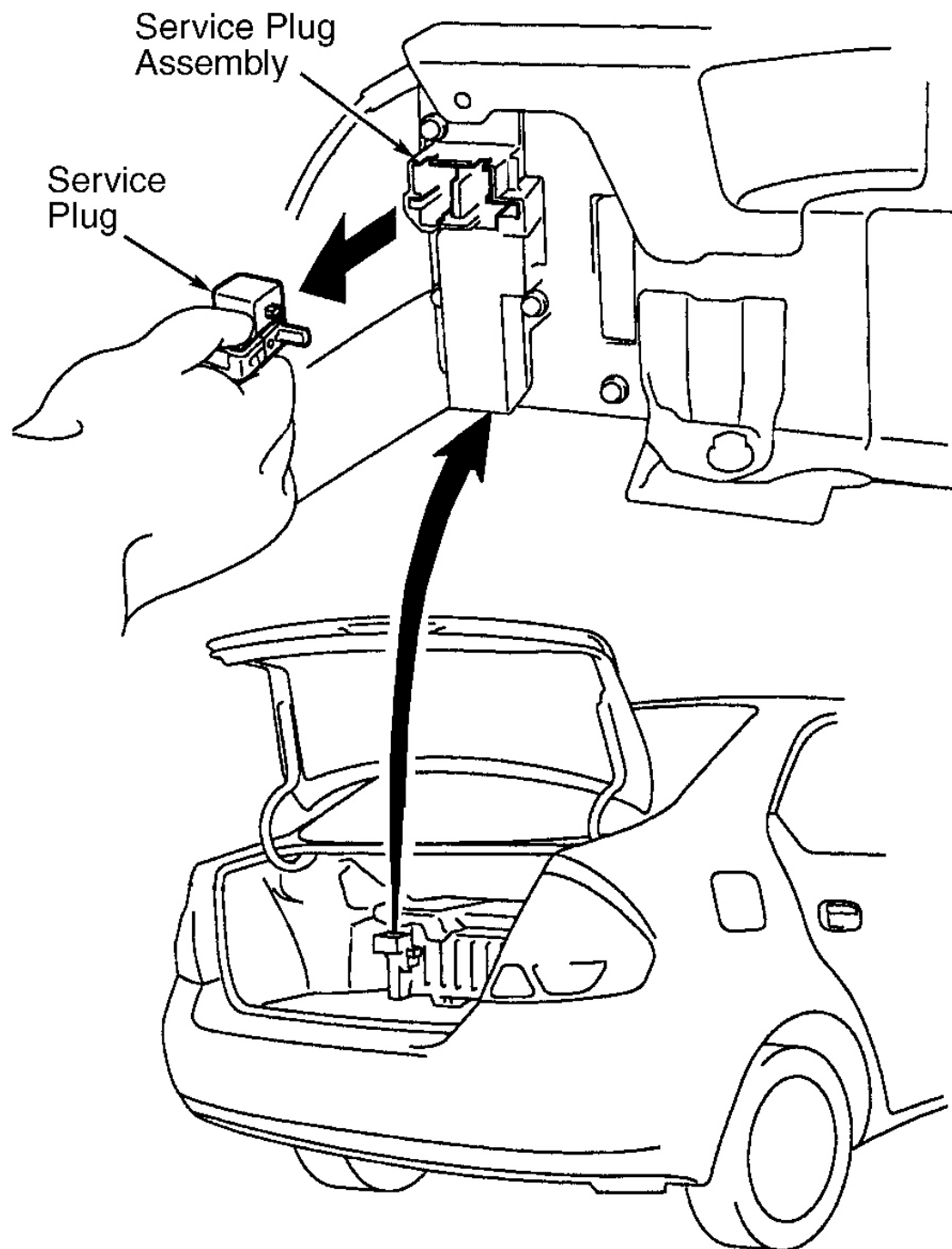
WARNING: When performing any inspection or service procedure on this vehicle, ensure following service precautions are followed to prevent personal injury or death due to the extremely high voltage.

The following service precautions must be followed:

- Ensure ignition is off and ignition key is removed from ignition before performing any inspection or service procedure in engine compartment, as engine may automatically start and shut off when ignition is on and READY light is illuminated. READY light is displayed just above the shift lever position indicator on instrument cluster at center of instrument panel.
- Read all service and warning labels in engine compartment before performing any procedures in engine compartment.
- All high-voltage wiring harness connectors contain Orange connectors. DO NOT touch any wiring harness that contains Orange connectors.
- High-voltage battery and other high-voltage components may be identified by HIGH VOLTAGE caution labels on them. DO NOT touch these components.
- If necessary to inspect or service high-voltage system, ensure ignition is off. Remove service plug and wait at least 5 minutes to ensure high voltage is fully discharged before touching any high-voltage wiring harness, connectors or components. Service plug is located on service plug assembly at driver's side front corner of trunk compartment, near high-voltage battery. See **Fig. 1** . Ensure service plug is stored in a location in which no one may install service plug while technician is working on the vehicle.
- If necessary to touch any high-voltage wiring harness, connectors or components, ensure service plug is removed and battery voltage or less exists at electrical connector. Use Toyota insulated gloves when touching any high-voltage wiring harness, connectors or components. Ensure insulated gloves are dry and

in good condition and that no holes exist in insulated gloves. Test by applying air to insulated glove before touching any high-voltage wiring harness, connectors or components.

- DO NOT wear any metal objects while working on vehicle which may accidentally drop and cause a short circuit.
- If any high-voltage wiring harness connector is disconnected, ensure terminal on wiring harness connector is wrapped with tape to prevent wiring harness connector from contacting any surface.
- If servicing high-voltage system, place sign on roof of vehicle to indicate to other technicians that high-voltage system is being serviced.



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Fig. 1: Locating Service Plug & Service Plug Assembly (Prius)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

AIR INDUCTION SYSTEMS

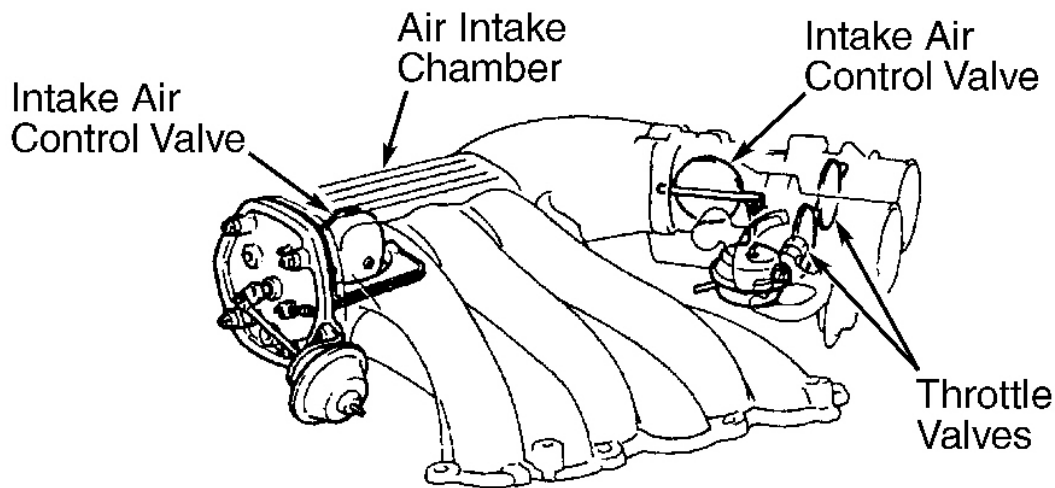
ACOUSTIC CONTROL INDUCTION SYSTEM

NOTE: Acoustic Control Induction System (ACIS) may also be referred to as Intake Air Control Valve (IACV) system.

Avalon, Highlander 3.0L V6 & Sienna

Acoustic Control Induction System (ACIS) is a variable induction system that improves engine performance by increasing the length of intake runners in the air intake chamber. In accordance with engine speed and throttle opening angle, ACIS controls the length of intake runners in air intake chamber in 3 stages by opening and closing the 2 intake air control valves located on end of air intake chamber and downstream of the throttle valves. See **Fig. 2** .

When engine is under a heavy load and vehicle speed is low, Engine Control Module (ECM) turns on both ACIS Vacuum Switching Valves (VSVs) resulting in vacuum being supplied from vacuum tank to both actuators for the intake air control valves. ACIS VSVs may also be referred to as intake air control valve VSVs. This results in both intake air control valves closing, enabling the air intake chamber, throttle bodies and air cleaner hose to function as an intake manifold. When engine is under a medium load and vehicle speed in the mid-range, ECM turns on ACIS VSV at the air intake chamber side and turns off ACIS VSV downstream of the throttle valves. As a result, the intake air control valve in the air intake chamber closes and intake air control valve downstream of the throttle valves opens, enabling air intake chamber to function as the intake manifold. When engine is idling, engine is under a light load or vehicle speed is high, ECM turns off both ACIS VSVs. This allows both intake air control valves to open, enabling air intake chamber to function as a normal air intake chamber. ECM uses an engine RPM input signal and throttle position sensor input signal for determining ACIS operation. Engine RPM input signal is provided by camshaft and crankshaft position sensors.

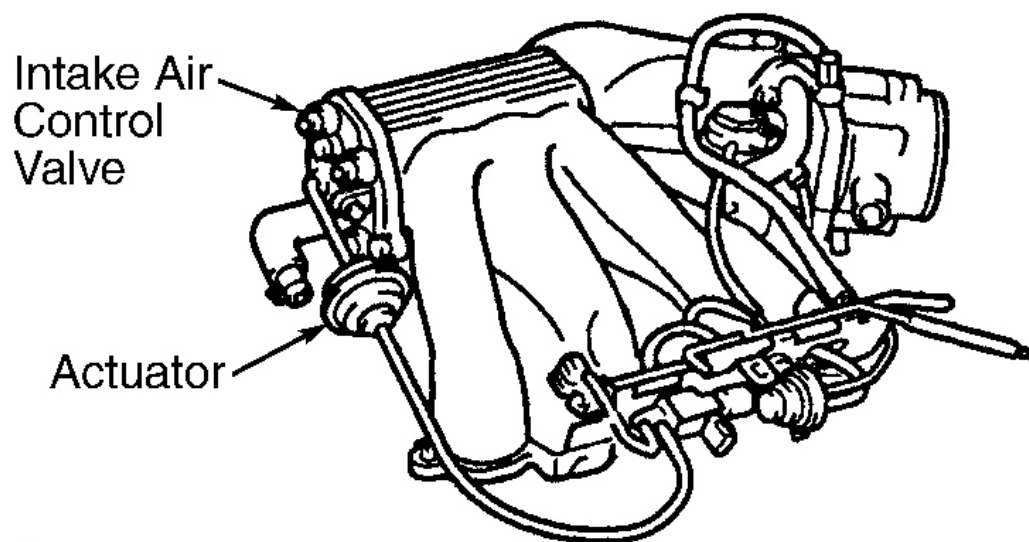


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Fig. 2: Locating Intake Air Control Valves (Avalon, Highlander 3.0L V6 & Sienna)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Camry 3.0L V6 & Camry Solara 3.0L V6

Acoustic Control Induction System (ACIS) is a variable induction system that improves engine performance by increasing the length of intake runners in the air intake chamber. In accordance with engine speed and throttle opening angle, ACIS controls the length of intake runners in air intake chamber in 2 stages. This is accomplished by opening and closing the intake air control valve located on end of air intake chamber. See **Fig. 3** and **Fig. 4**. ACIS is controlled by Engine Control Module (ECM). ECM controls ACIS Vacuum Switching Valve (VSV) which controls vacuum supply from vacuum tank to the actuator. Actuator operates intake air control valve in air intake chamber. ECM uses engine RPM input signal and throttle position sensor input signal for determining ACIS operation. Engine RPM input signal is provided by camshaft and crankshaft position sensors.

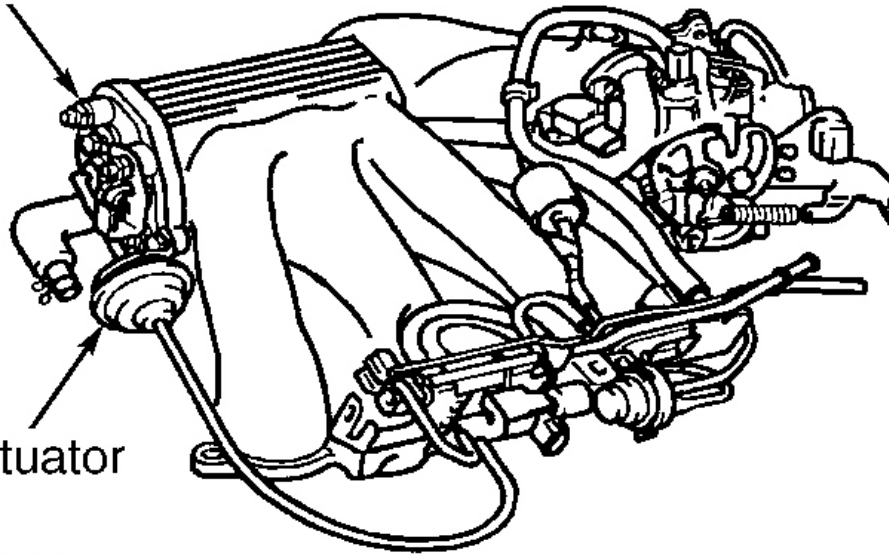


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Fig. 3: Locating Intake Air Control Valve (Camry 3.0L V6)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Intake Air
Control Valve

Actuator

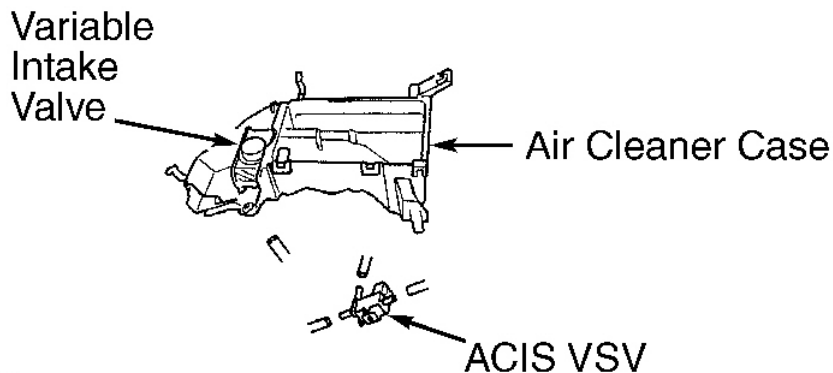
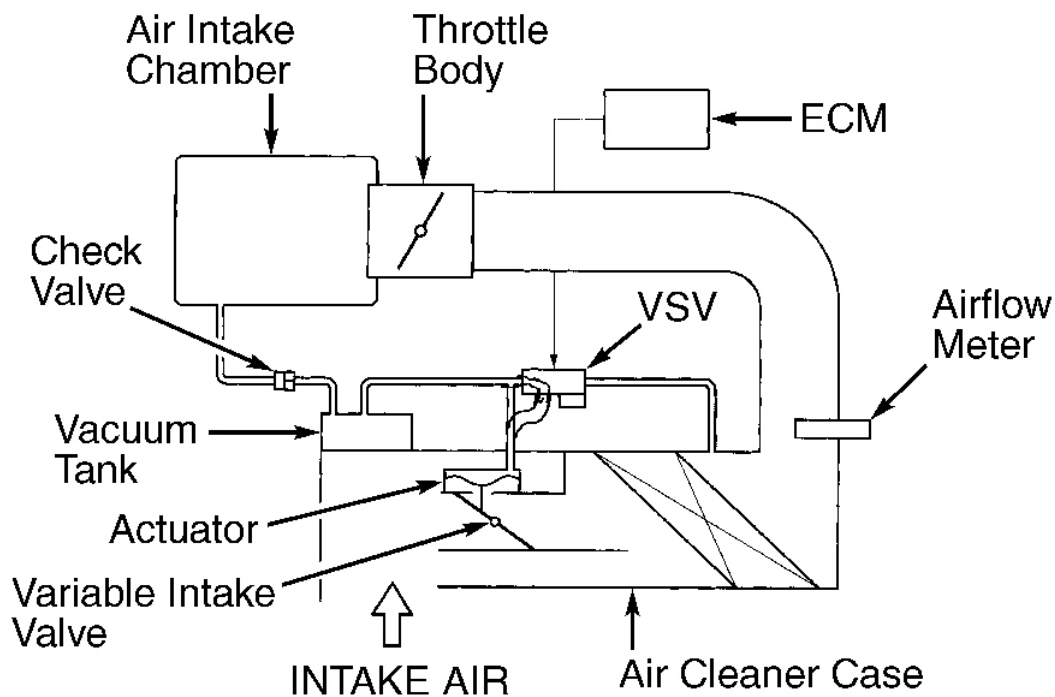


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Fig. 4: Locating Intake Air Control Valve (Camry Solara 3.0L V6)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Celica

Acoustic Control Induction System (ACIS) is a variable induction system that improves engine performance and reduces engine noise by dividing the air intake duct into 2 stages. When engine is operating in low-to-mid speed range, ACIS causes variable intake valve to close one side of the intake air duct. See **Fig. 5** . When engine is operating in the high-speed range, ACIS causes variable intake valve to open, allowing both sides of the intake air duct to supply intake air. Variable intake valve operation is controlled by a vacuum controlled actuator. See **Fig. 5** . Engine Control Module (ECM) controls the ACIS Vacuum Switching Valve (VSV) which controls vacuum supply from vacuum tank to the actuator. See **Fig. 5** . ECM uses engine RPM input signal and throttle position sensor input signal for determining ACIS operation. Engine RPM input signal is provided by camshaft and crankshaft position sensors.



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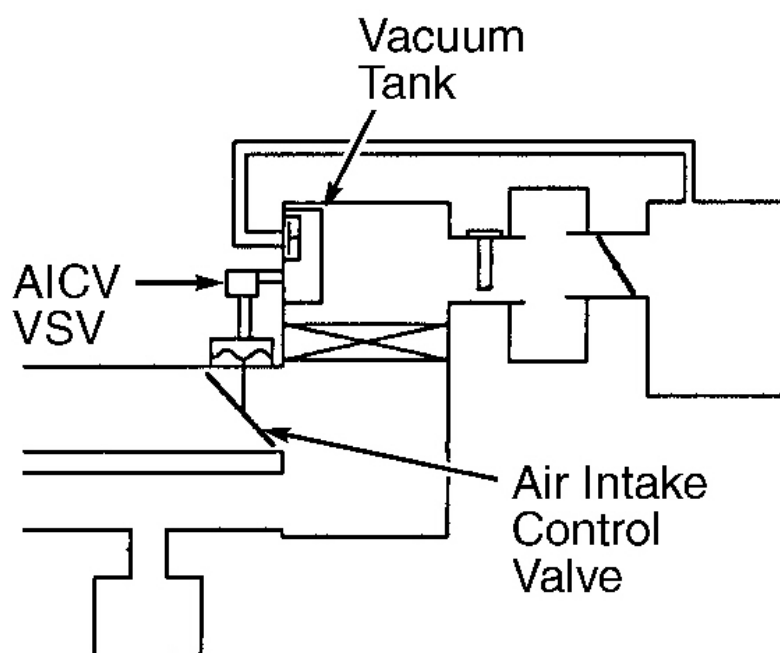
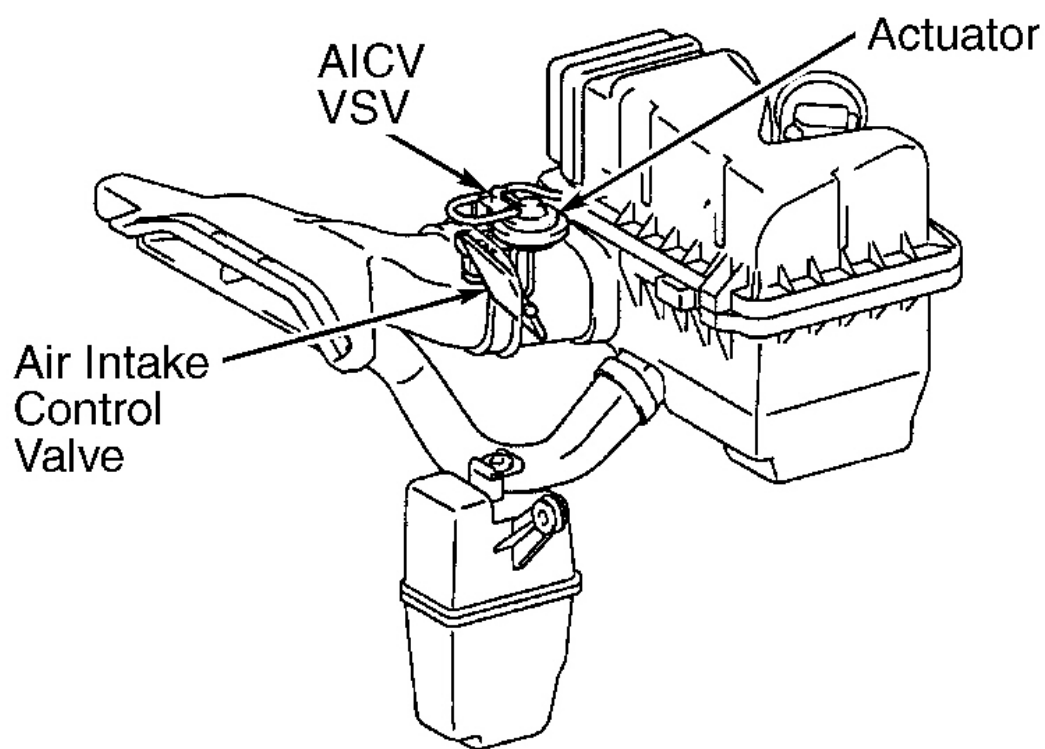
Fig. 5: Identifying Acoustic Control Induction System Components (Celica)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

AIR INTAKE CONTROL SYSTEM

Camry 3.0L V6

Air Intake Control System (AICS) reduces engine noise in low-speed ranges and increases engine performance in high-speed ranges by dividing air cleaner inlet into 2 stages. When engine is operating in low-to-mid speed

range, AICS operates air intake control valve to close one side of air cleaner inlet. See **Fig. 6** . When engine is operating in high-speed range, AICS operates air intake control valve to open both sides of air cleaner inlet to supply intake air. Air intake control valve operation is controlled by a vacuum controlled actuator. See **Fig. 6** . Engine Control Module (ECM) controls Air Intake Control Valve (AICV) Vacuum Switching Valve (VSV) which controls vacuum supply from vacuum tank to the actuator. See **Fig. 6** .



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Fig. 6: Locating Air Intake Control System Components (Camry 3.0L V6)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

ELECTRONIC THROTTLE CONTROL SYSTEM

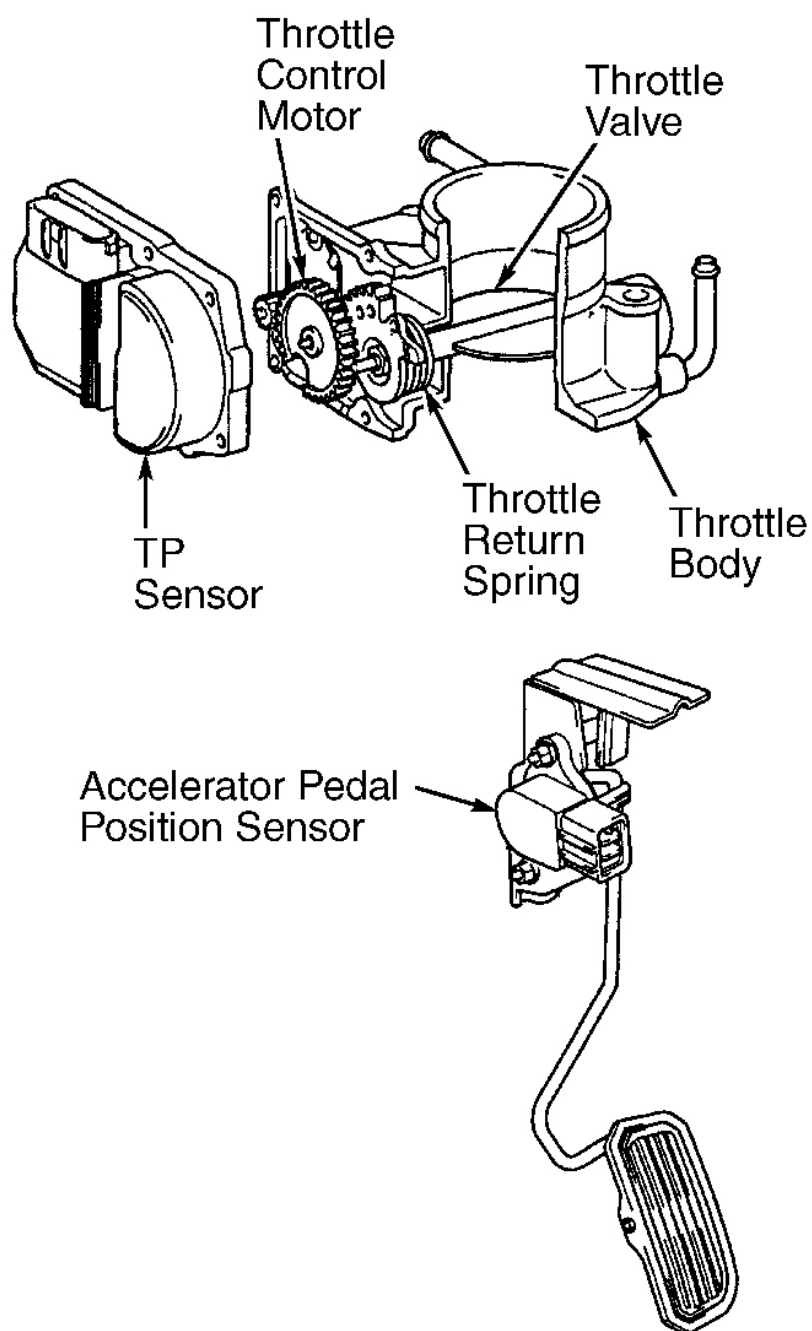
NOTE: Electronic Throttle Control System (ETCS) may also be referred to as Electronic Throttle Control System-Intelligent (ETCS-I or ETCS-i).

Camry 2.4L 4-Cyl. & Camry Solara 2.4L 4-Cyl.

Electronic Throttle Control System (ETCS) consists of throttle body, accelerator pedal position sensor, Throttle Position (TP) sensor, throttle control motor and Engine Control Module (ECM). ETCS uses the ECM to calculate throttle valve opening in the throttle body in relation to driving conditions. There is no accelerator cable used with the ETCS. ETCS controls idle speed and cruise control system operation. On A/T models, the throttle control is synchronized with the electronically controlled transaxle during shifting to reduce shift shock during transaxle shifting. On all models, accelerator pedal position sensor is mounted near accelerator pedal. See **Fig. 7** . Accelerator pedal position sensor consists of 2 internal sensors which deliver accelerator pedal position input signals to the ECM to indicate throttle valve opening. TP sensor consists of 2 internal sensors which deliver input signals to ECM. ECM uses various input signals for operating throttle control motor. Throttle control motor is mounted on side of throttle body and operates throttle valve. See **Fig. 7** .

ETCS consists of various fail-safe features. If malfunction occurs in either one of the 2 internal sensors in accelerator pedal position sensor, the ECM detects the abnormal voltage signal difference between the 2 sensor circuits and switches to the limp mode. In limp mode, the remaining sensor circuit is used to calculate accelerator pedal position. If malfunction occurs in both internal sensors in accelerator pedal position sensor, the ECM detects the abnormal voltage signal difference between the 2 sensors circuits and regards that accelerator pedal is released and continues throttle control in which the vehicle may be driven at idle speed. If malfunction occurs in either one of the 2 internal sensors in TP sensor, the ECM detects the abnormal voltage signal difference between the 2 sensor circuits and switches to limp mode in which voltage to throttle control motor is turned off and throttle control motor becomes inoperative. Throttle return spring will position throttle valve at a designated position in which the vehicle may be driven. If problem exists with throttle control motor, ECM will switch to limp mode in which voltage to throttle control motor is turned off and throttle control motor becomes inoperative. Throttle return spring will position throttle valve at a designated position in which the vehicle may be driven.

In the event of an ETCS malfunction, Malfunction Indicator Light (MIL) will be illuminated and Diagnostic Trouble Code (DTC) will be stored in ECM. MIL is displayed as an engine icon on instrument cluster on instrument panel. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs.



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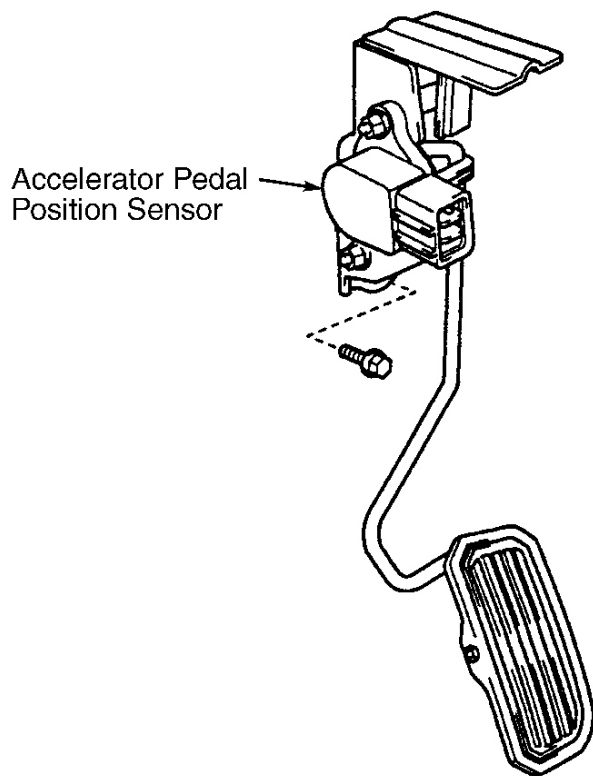
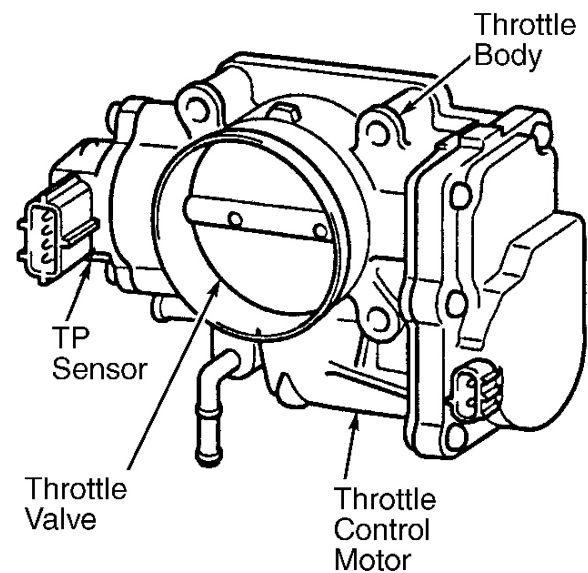
Fig. 7: Locating Electronic Throttle Control System Components On Throttle Body & Accelerator Pedal Position Sensor (Camry 2.4L 4-Cyl. & Camry Solara 2.4L 4-Cyl.)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Electronic Throttle Control System (ETCS) consists of throttle body, accelerator pedal position sensor, Throttle Position (TP) sensor, throttle control motor and Engine Control Module (ECM). ETCS uses the ECM to calculate throttle valve opening in the throttle body in relation to driving conditions. There is no accelerator cable used with the ETCS. ETCS controls idle speed and cruise control system operation. On A/T models, the throttle control is synchronized with the electronically controlled transaxle during shifting to reduce shift shock during transaxle shifting. On models with traction control, the throttle valve is closed by demand signal from skid control Electronic Control Unit (ECU) if an excessive amount of slippage is created by a driving wheel. On models with vehicle skid control, throttle valve opening is controlled in conjunction with coordinating control with the skid control ECU to provide operation of vehicle skid control system. On all applications, accelerator pedal position sensor is mounted near accelerator pedal. See **Fig. 8** . Accelerator pedal position sensor consists of 2 internal sensors which deliver accelerator pedal position signals to the ECM to indicate throttle valve opening. TP sensor consists of 2 internal sensors which delivers input signals to ECM. ECM uses various input signals for operating throttle control motor. Throttle control motor is mounted on side of throttle body and operates throttle valve. See **Fig. 8** .

ETCS consists of various fail-safe features. If malfunction occurs in either one of the 2 internal sensors in accelerator pedal position sensor, the ECM detects the abnormal voltage signal difference between the 2 sensor circuits and switches to the limp mode. In limp mode, the remaining sensor circuit is used to calculate accelerator pedal position. If malfunction occurs in both internal sensors in accelerator pedal position sensor, the ECM detects the abnormal voltage signal difference between the 2 sensors circuits and regards that accelerator pedal is released and continues throttle control in which the vehicle may be driven at idle speed. If malfunction occurs in either one of the 2 internal sensors in TP sensor, the ECM detects the abnormal voltage signal difference between the 2 sensor circuits and switches to limp mode in which voltage to throttle control motor is turned off and throttle control motor becomes inoperative. Throttle return spring will position throttle valve at a designated position in which the vehicle may be driven. If problem exists with throttle control motor, ECM will switch to limp mode in which voltage to throttle control motor is turned off and throttle control motor becomes inoperative. Throttle return spring will position throttle valve at a designated position in which the vehicle may be driven.

In the event of an ETCS malfunction, Malfunction Indicator Light (MIL) will be illuminated and Diagnostic Trouble Code (DTC) will be stored in ECM. MIL is displayed as an engine icon on instrument cluster on instrument panel. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs.



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Fig. 8: Locating Electronic Throttle Control System Components On Throttle Body & Accelerator Pedal Position Sensor (Camry 3.0L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Electronic Throttle Control System (ETCS) consists of throttle body, accelerator pedal position sensor, Throttle Position (TP) sensor, throttle control motor, magnetic clutch and Engine Control Module (ECM). ETCS uses ECM to calculate throttle valve opening in the throttle body in relation to driving conditions. ETCS controls operation of idle speed control system, cruise control system, traction control system (if equipped) and vehicle skid control system (if equipped). Accelerator pedal position sensor is mounted on throttle body and is integrated with throttle lever which attaches to the throttle cable. See **Fig. 9** . Accelerator pedal position sensor consists of 2 sensors which delivers input signals to the ECM. TP sensor delivers input signals to ECM to indicate throttle valve opening.

ECM uses these input signals to operate throttle control motor to obtain proper operating speeds in relation to accelerator pedal position and engine speed, obtain proper idle speed, and operate cruise control system, traction control system (if equipped) and vehicle skid control system (if equipped). Throttle control motor is mounted on side of throttle body and operates throttle valve on throttle body by use of a magnetic clutch.

In the event of an ETCS malfunction, Malfunction Indicator Light (MIL) will be illuminated and Diagnostic Trouble Code (DTC) will be stored in ECM. MIL is displayed as an engine icon on instrument cluster on instrument panel. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. If malfunction exists, magnetic clutch will be disengaged, allowing spring pressure to close the throttle valve. When magnetic clutch is disengaged, throttle control motor will not operate the throttle valve. If ETCS is shut off, accelerator pedal may be used to operate throttle valve for vehicle operation in limp mode by using limp mode lever on throttle body. See **Fig. 9** .

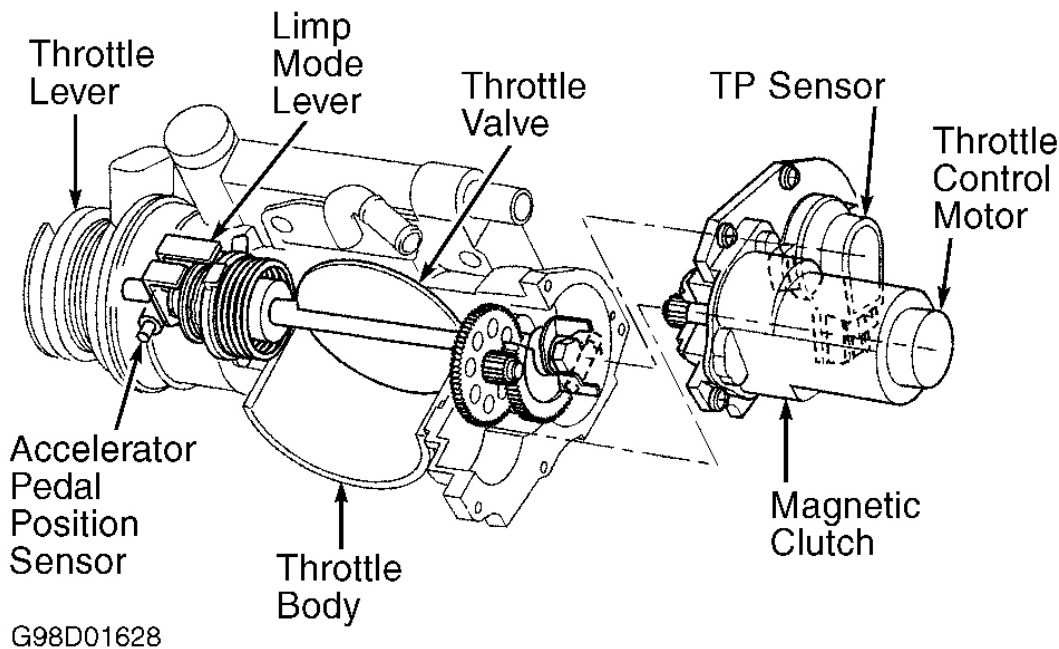


Fig. 9: Locating Electronic Throttle Control System Components On Throttle Body (Land Cruiser,

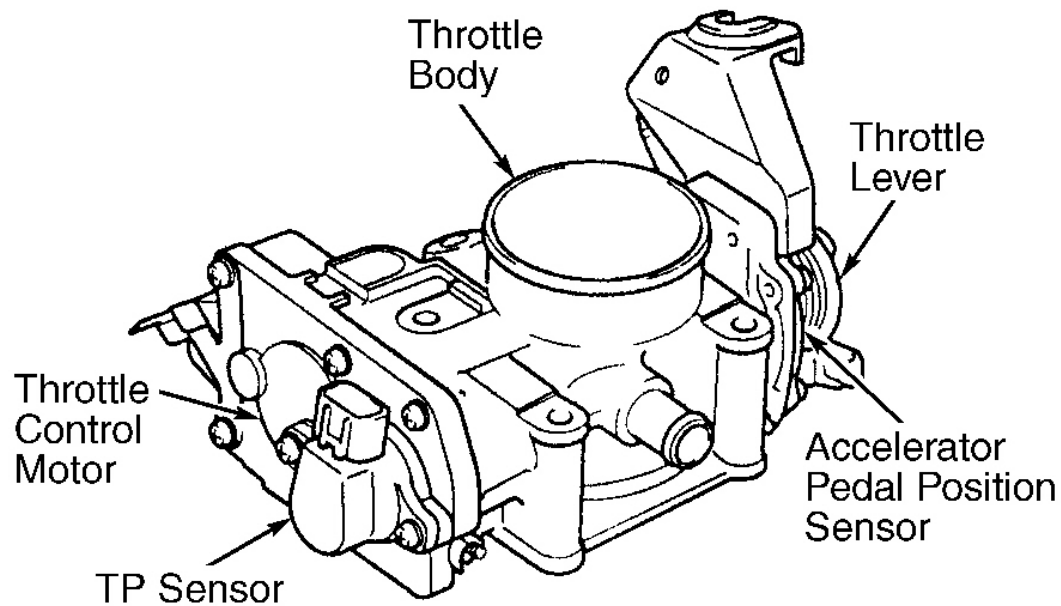
MR2 With Sequential Manual Transaxle & 4Runner

NOTE: On MR2 models, 2 types of manual transaxles are used. Standard type manual transaxle in which the driver operates the clutch and shifts the transaxle, and sequential manual transaxle, which is electronically controlled. Clutch is operated and transaxle is shifted hydraulically by moving shift lever forward or backward. Sequential manual transaxle may be identified by shift lever pattern which consists of "R", "N", "S" and "+" in place of the conventional type shift lever pattern and there is no clutch pedal.

On all models, Electronic Throttle Control System (ETCS) consists of throttle body, accelerator pedal position sensor, Throttle Position (TP) sensor, throttle control motor, magnetic clutch and Engine Control Module (ECM). ETCS uses ECM to calculate throttle valve opening in the throttle body in relation to driving conditions. ETCS controls idle speed and cruise control system operation. Accelerator pedal position sensor is mounted on throttle body and is integrated with throttle lever which attaches to the throttle cable. See **Fig. 10** and **Fig. 11** . Accelerator pedal position sensor consists of 2 sensors which deliver input signals to the ECM. TP sensor delivers input signals to ECM to indicate throttle valve opening.

ECM uses these input signals to operate throttle control motor to obtain proper operating speeds in relation to accelerator pedal position and engine speed, obtain proper idle speed, and provide cruise control operation. Throttle control motor is mounted on side of throttle body and operates throttle valve on throttle body by use of a magnetic clutch.

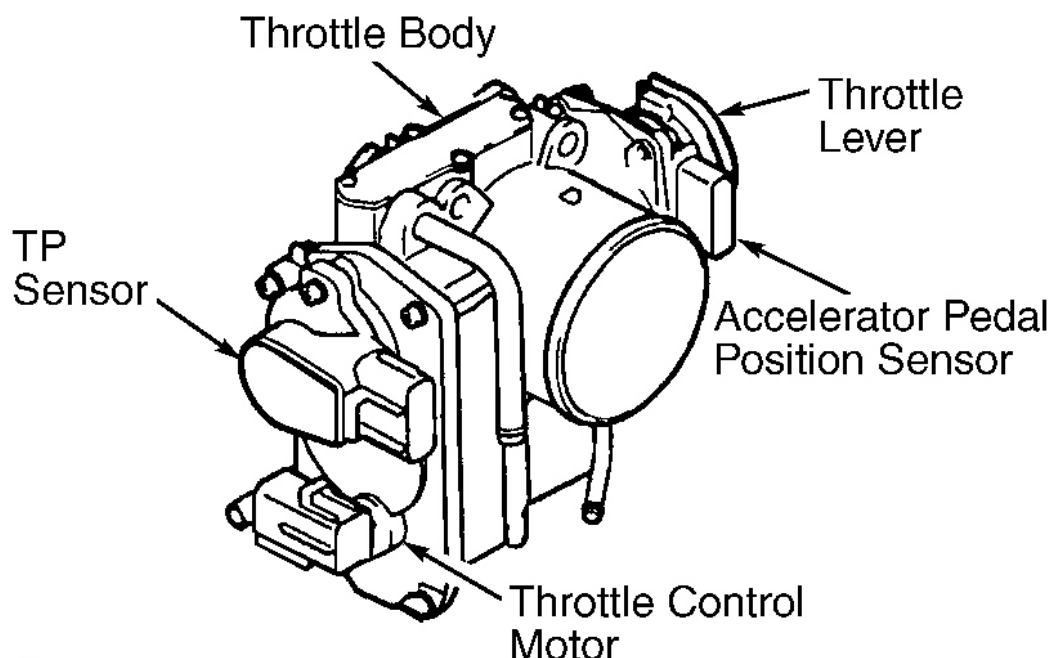
In the event of an ETCS malfunction, Malfunction Indicator Light (MIL) will be illuminated and Diagnostic Trouble Code (DTC) will be stored in ECM. MIL is displayed as an engine icon on instrument cluster on instrument panel. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. If malfunction exists, magnetic clutch will be disengaged, allowing spring pressure to close the throttle valve. When magnetic clutch is disengaged, throttle control motor will not operate the throttle valve. If ETCS is shut off, accelerator pedal may be used to operate throttle valve for vehicle operation.



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Fig. 10: Locating Electronic Throttle Control System Components On Throttle Body (MR2 With Sequential Manual Transaxle)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



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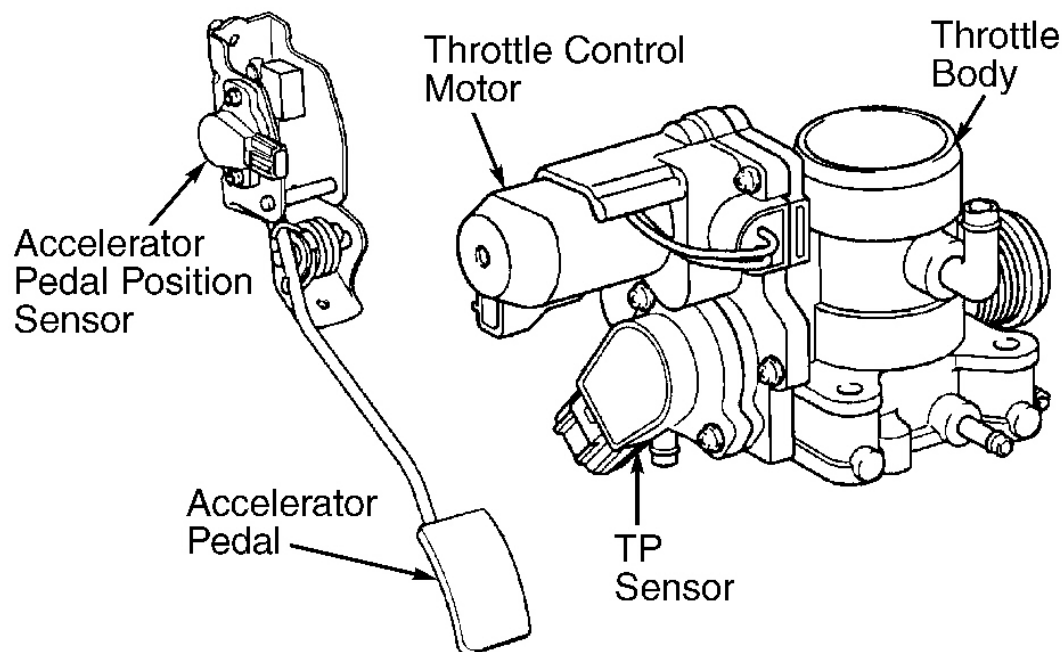
Fig. 11: Locating Electronic Throttle Control System Components On Throttle Body (4Runner)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Prius

Electronic Throttle Control System (ETCS) consists of throttle body, accelerator pedal position sensor, Throttle Position (TP) sensor, throttle control motor, Hybrid Vehicle (HV) control Electronic Control Unit (ECU) and Engine Control Module (ECM). Hybrid vehicle control ECU is referred to as HV ECU. ETCS uses ECM to calculate throttle valve opening in the throttle body in relation to driving conditions. ETCS controls idle speed and cruise control system operation. Accelerator pedal position sensor is mounted near accelerator pedal. See **Fig. 12** . Accelerator pedal position sensor consists of 2 internal sensors which deliver accelerator pedal position input signals to the HV ECU. HV ECU in turn delivers the input signals to ECM. TP sensor delivers input signals to ECM to indicate throttle valve opening.

ECM uses input signals to operate throttle control motor to obtain proper idle speed and provide cruise control operation. Throttle control motor is mounted on side of throttle body and operates throttle valve. See **Fig. 12** .

In the event of an ETCS malfunction, Malfunction Indicator Light (MIL) will be illuminated and Diagnostic Trouble Code (DTC) will be stored in ECM. MIL is displayed as an engine icon on instrument cluster at center of instrument panel. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. If malfunction exists, voltage to throttle control motor is turned off in which throttle control motor becomes inoperative, allowing spring pressure to close the throttle valve.



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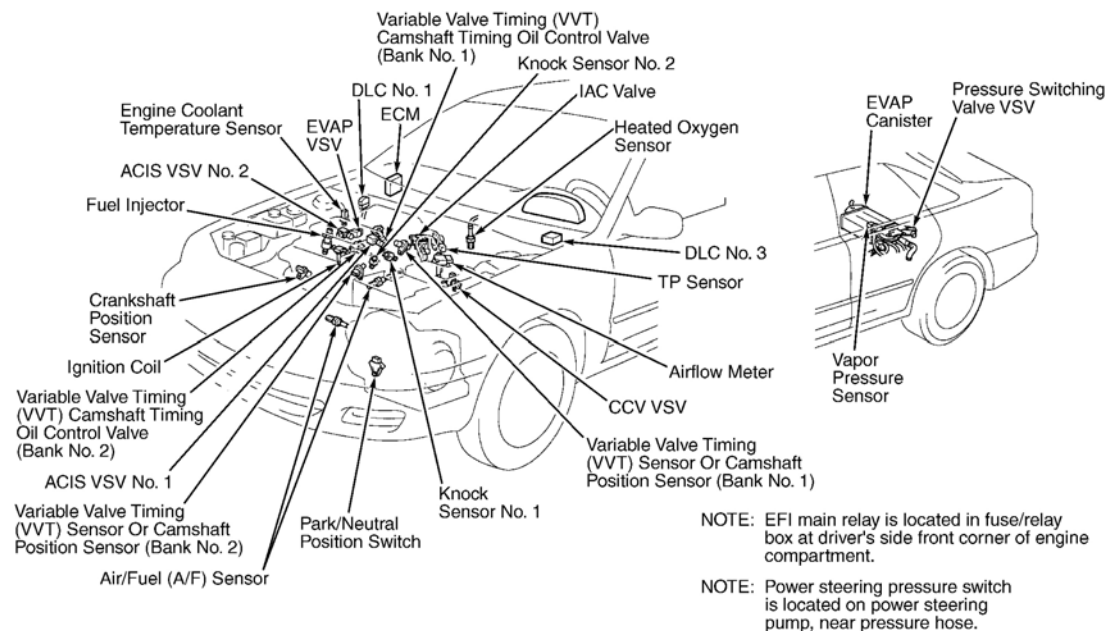
Fig. 12: Locating Electronic Throttle Control System Components On Throttle Body & Accelerator Pedal Position Sensor (Prius)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

COMPUTERIZED ENGINE CONTROLS

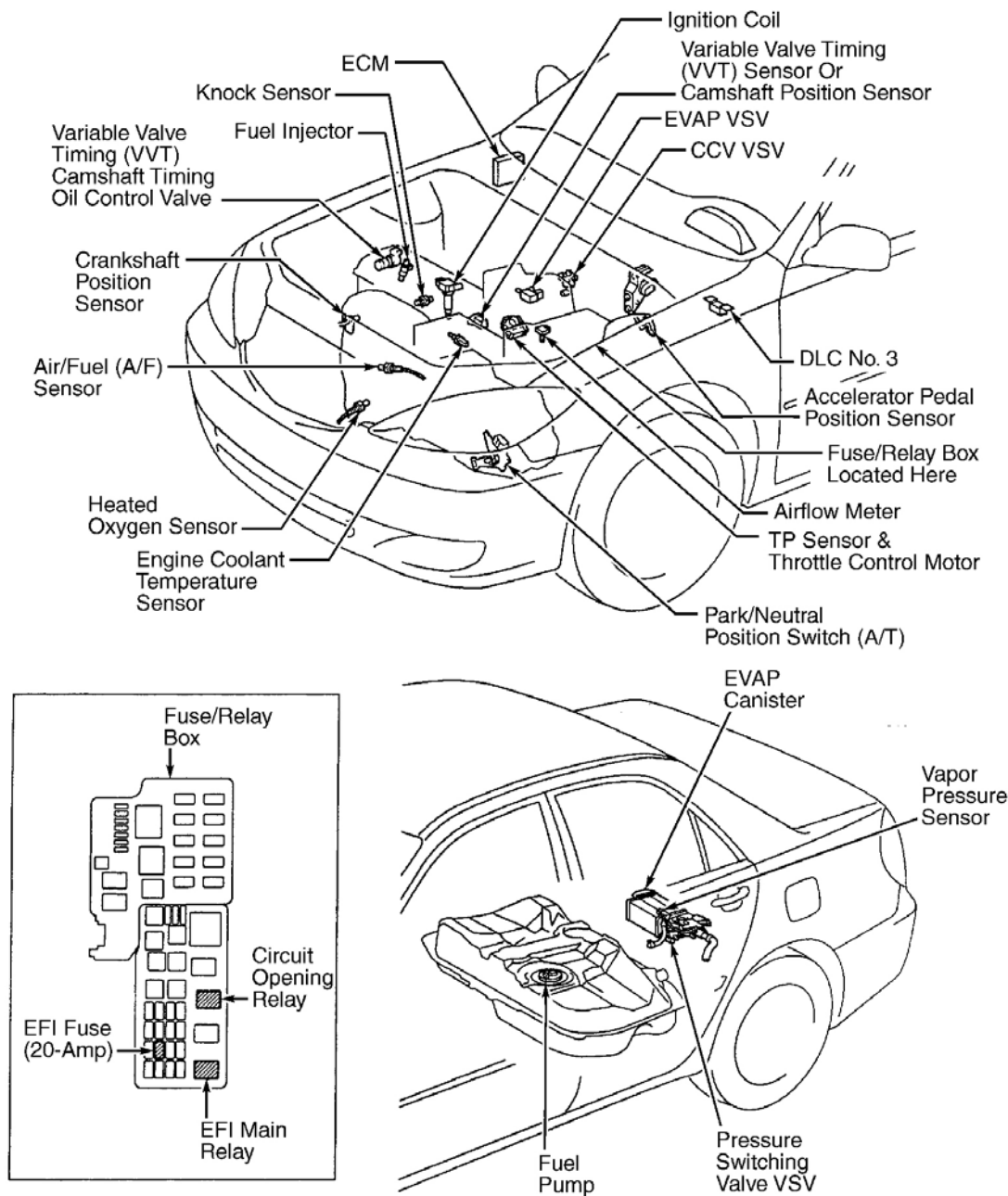
ENGINE CONTROL SYSTEM

Engine control system is a computerized emission, ignition and fuel injection control system. Engine control system lowers exhaust emissions while maintaining good fuel economy and driveability. Engine control system consists of various sensors, switches and control units. See **Fig. 13 -Fig. 33** . The Engine Control Module (ECM) controls engine control system based on input signals received from various input devices. ECM contains preprogrammed data to maintain optimum engine performance under all operating conditions.



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Fig. 13: Locating Engine Control System Components (Avalon)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

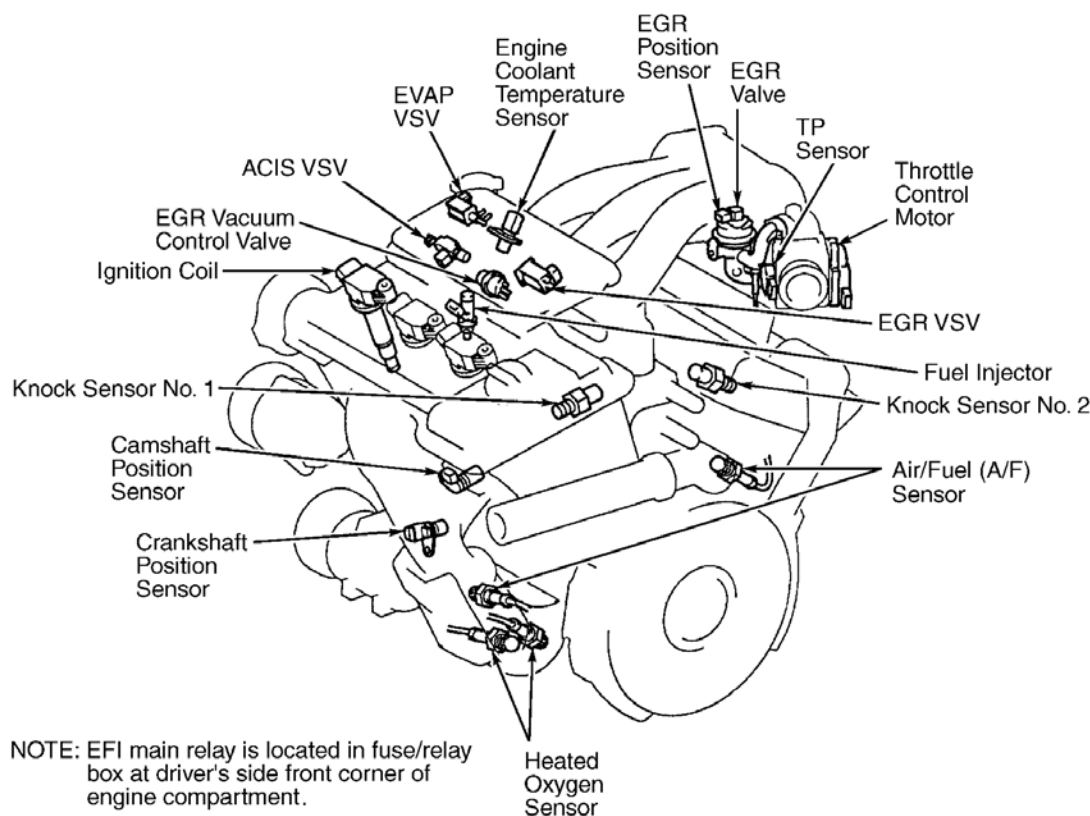
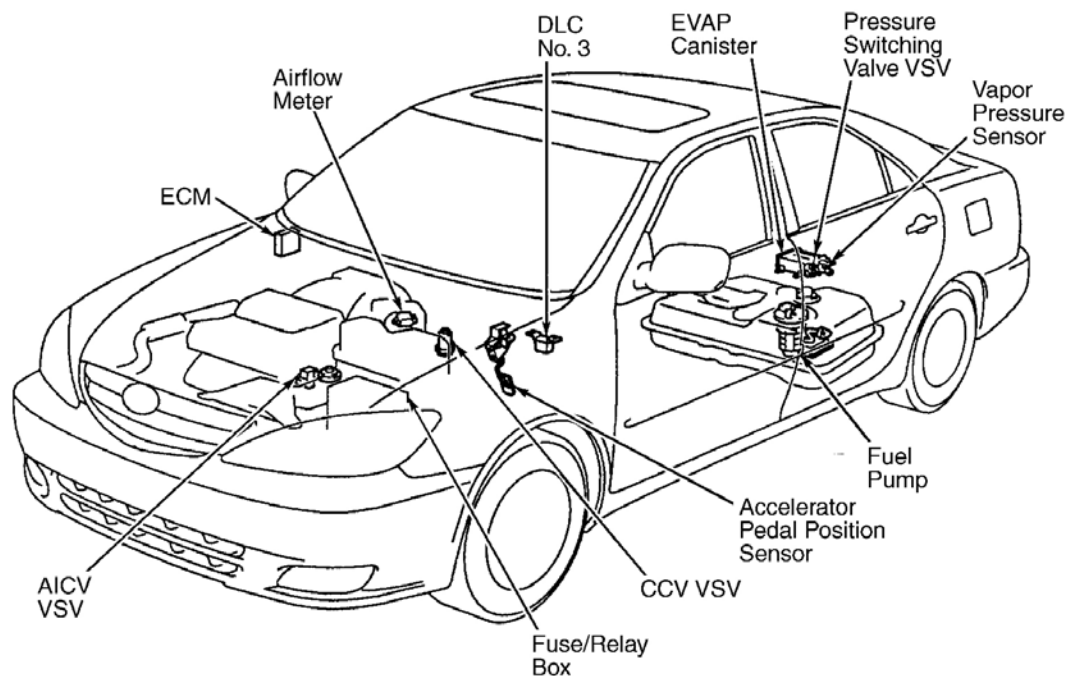


NOTE: Vehicle speed sensor is located on the transaxle.

NOTE: Power steering pressure switch is located on power steering pump, near pressure hose.

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Fig. 14: Locating Engine Control System Components (Camry 2.4L 4-Cyl.)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



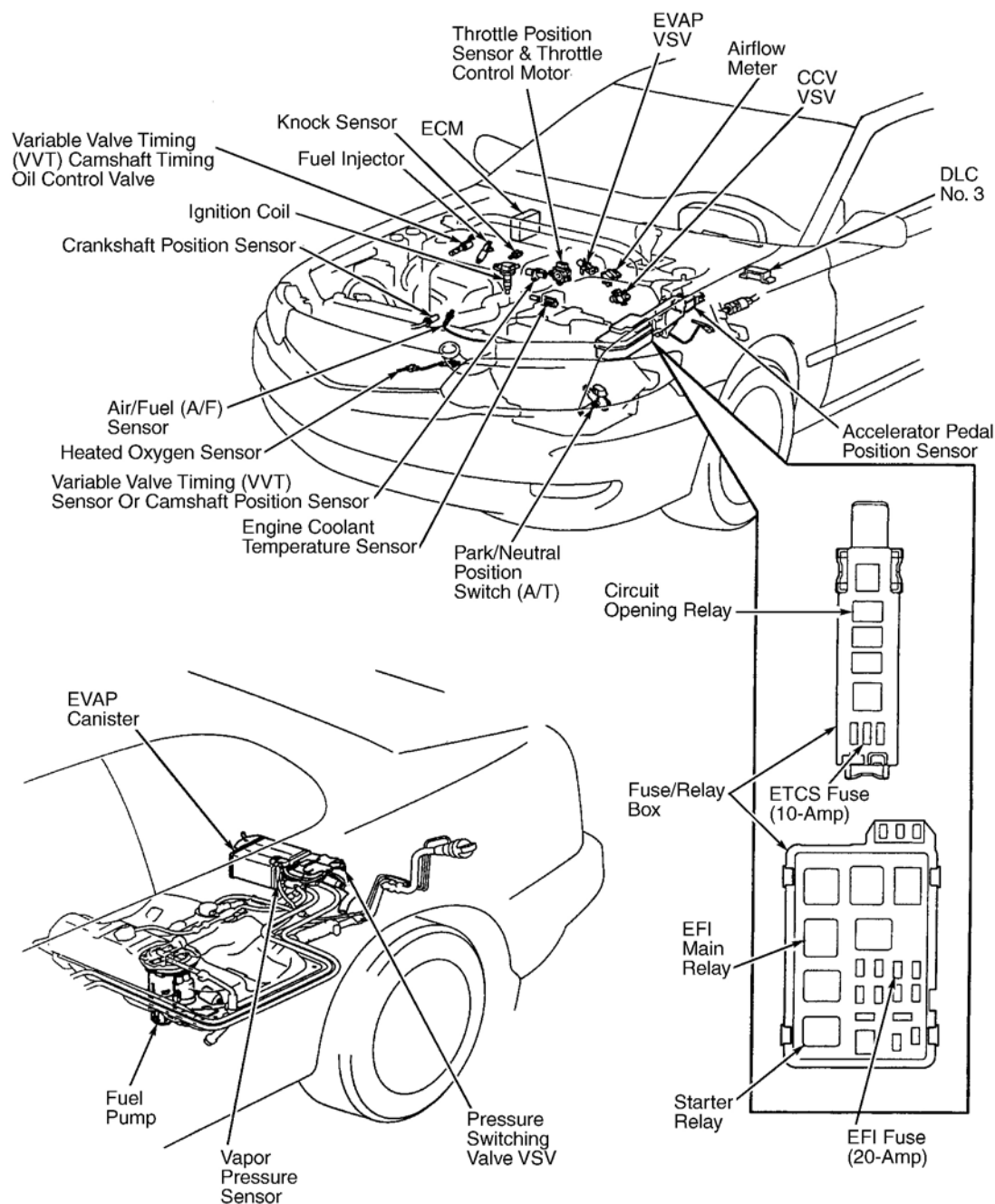
NOTE: EFI main relay is located in fuse/relay box at driver's side front corner of engine compartment.

NOTE: Power steering pressure switch is located on power steering pump, near pressure hose.

NOTE: On A/T models, park/neutral position switch is located on side of transaxle.

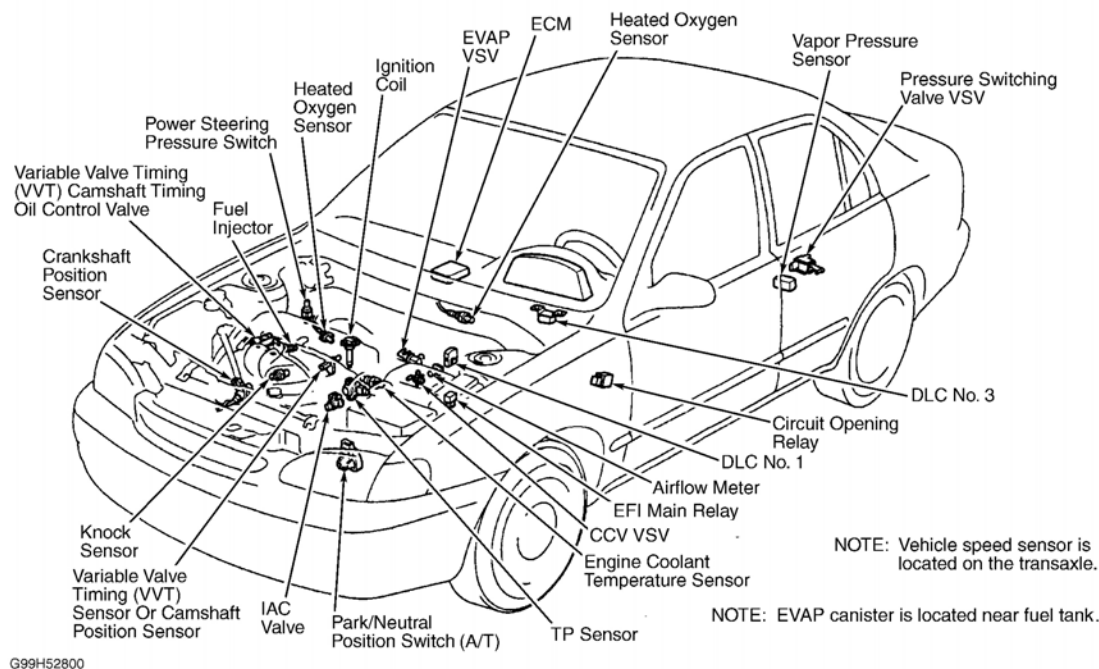
Fig. 15: Locating Engine Control System Components (Camry 3.0L V6)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



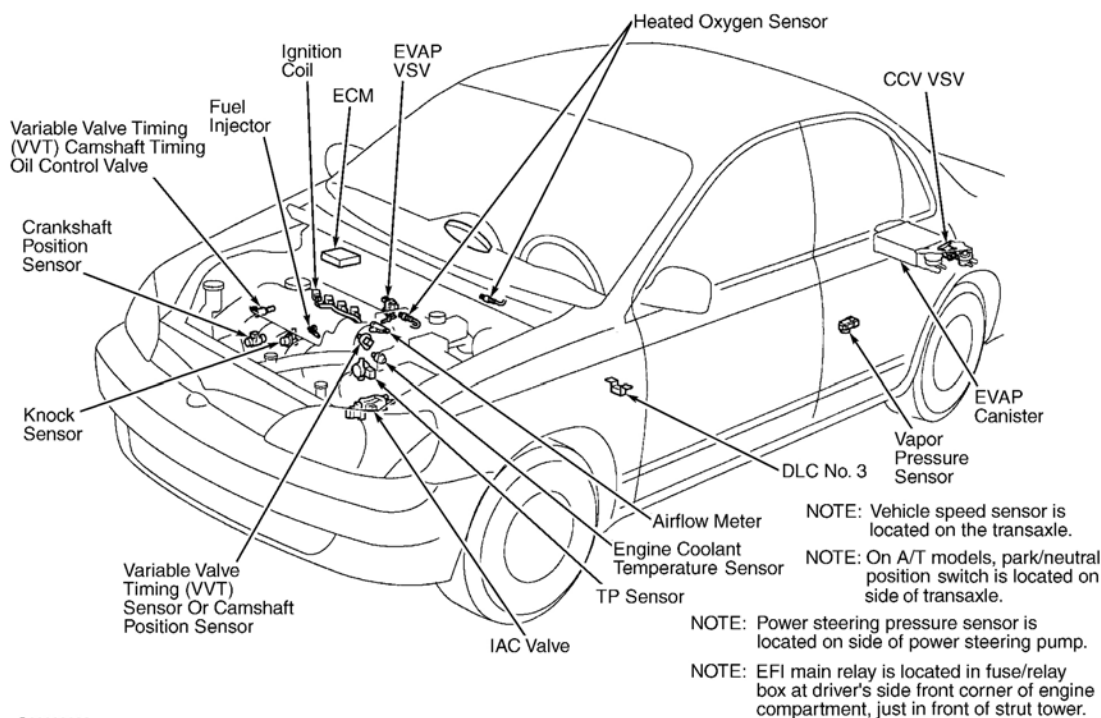
NOTE: Vehicle speed sensor is located on the transaxle.

NOTE: Power steering pressure switch is located on power steering pump, near pressure hose.



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Fig. 19: Locating Engine Control System Components (Corolla)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



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Fig. 20: Locating Engine Control System Components (ECHO)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

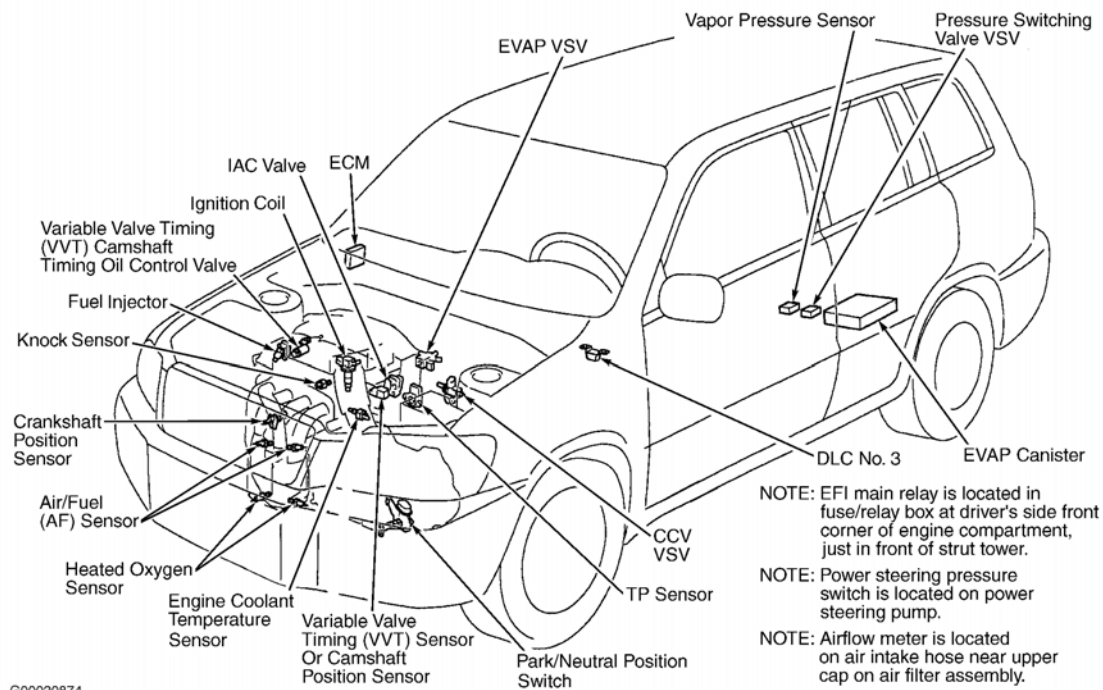


Fig. 21: Locating Engine Control System Components (Highlander 2.4L 4-Cyl.)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

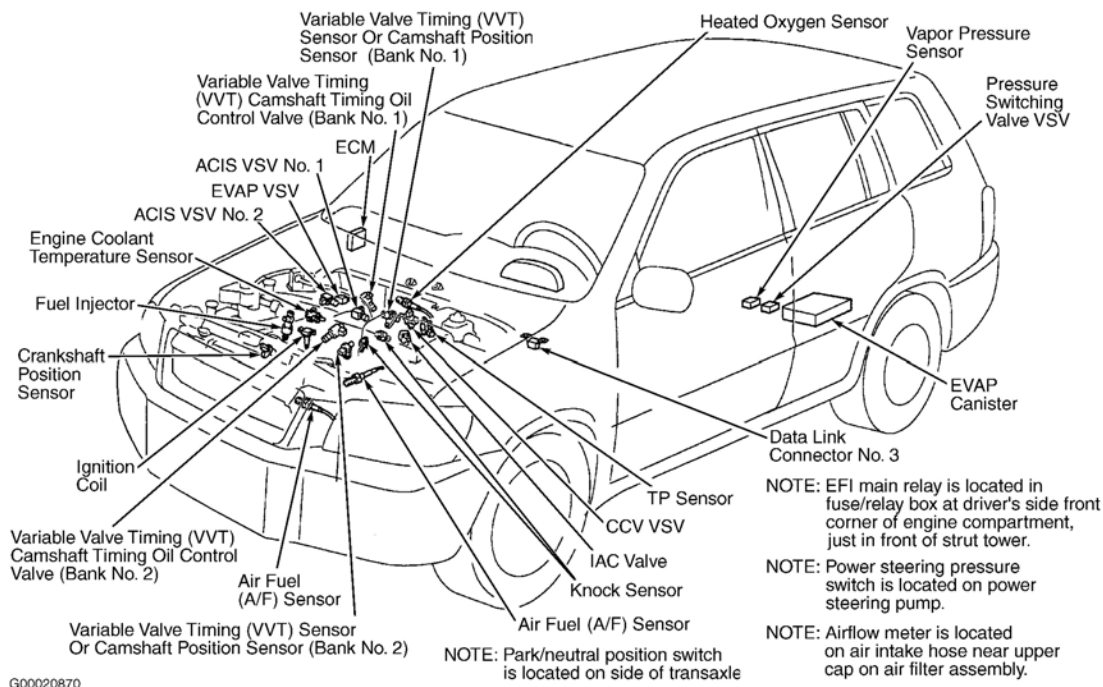


Fig. 22: Locating Engine Control System Components (Highlander 3.0L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

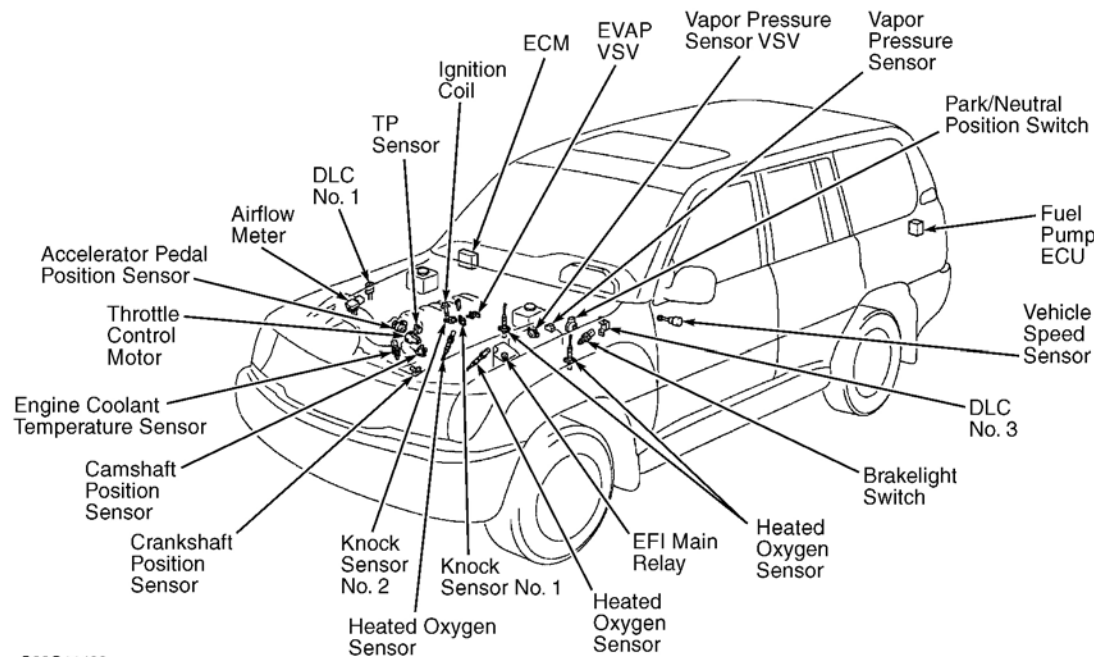
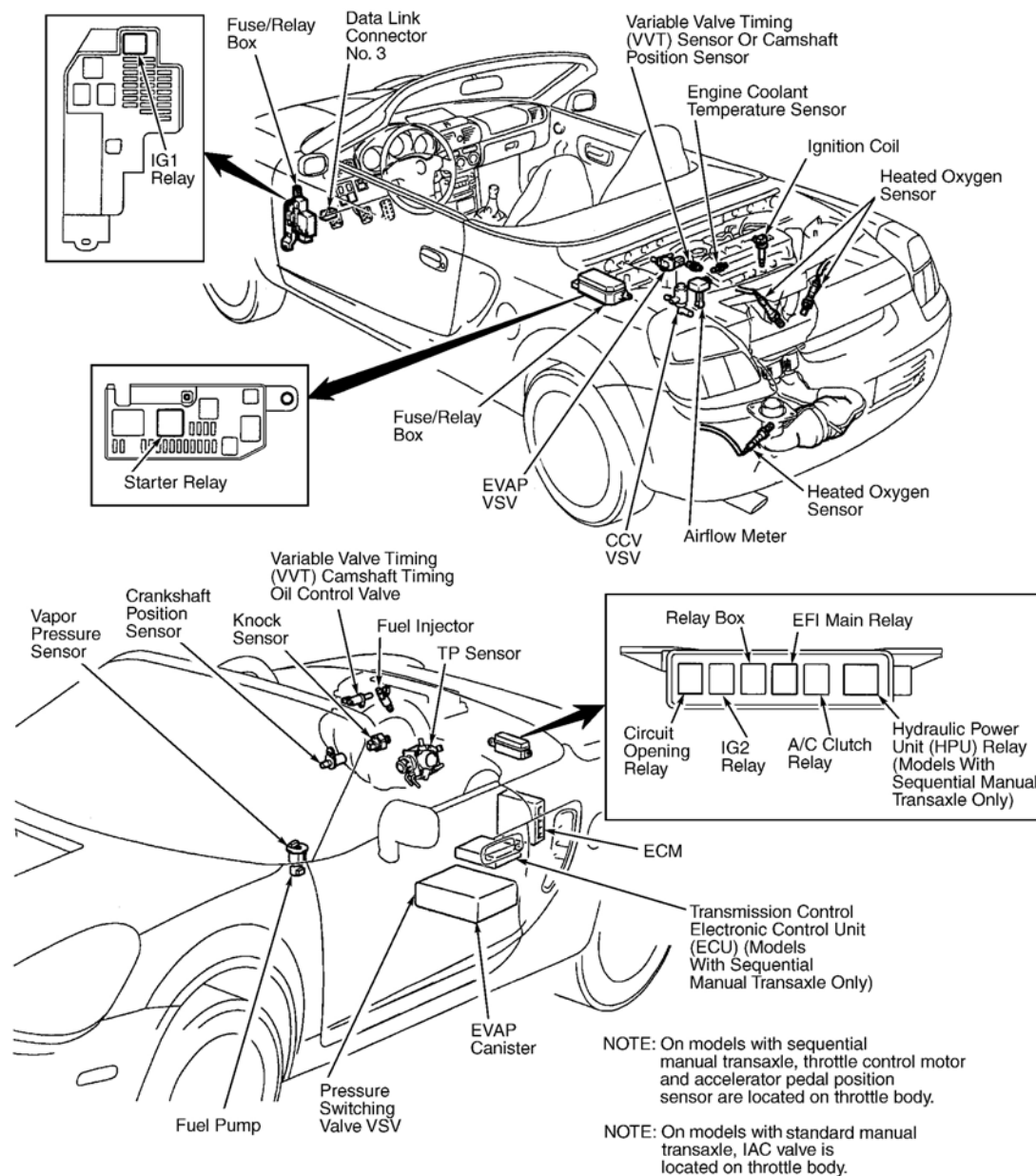
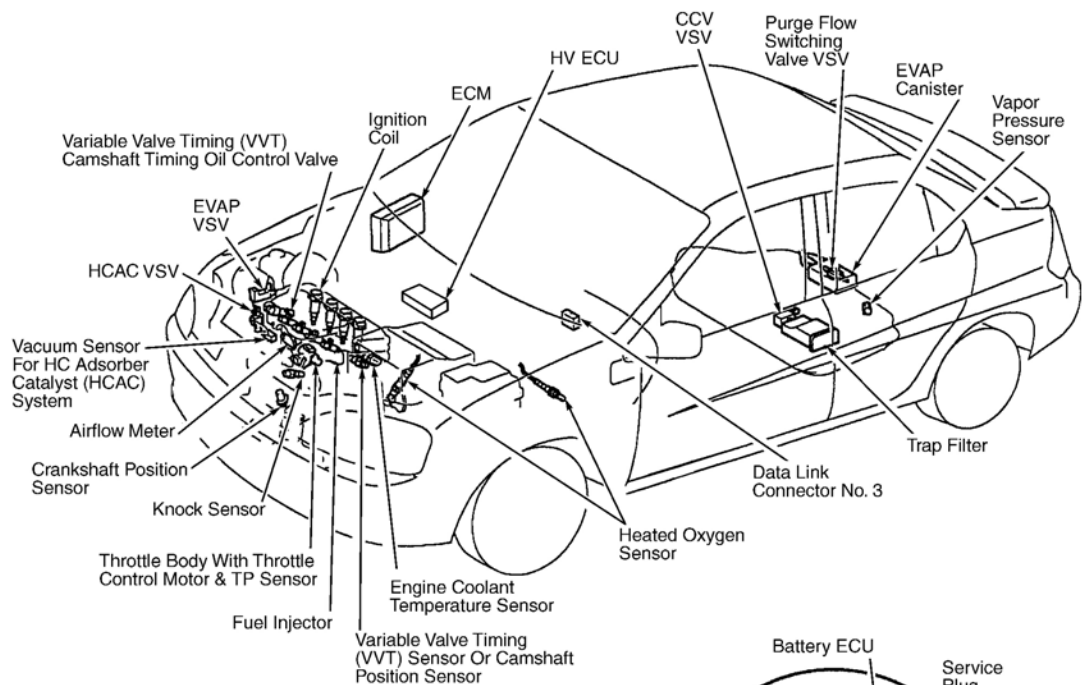


Fig. 23: Locating Engine Control System Components (Land Cruiser)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



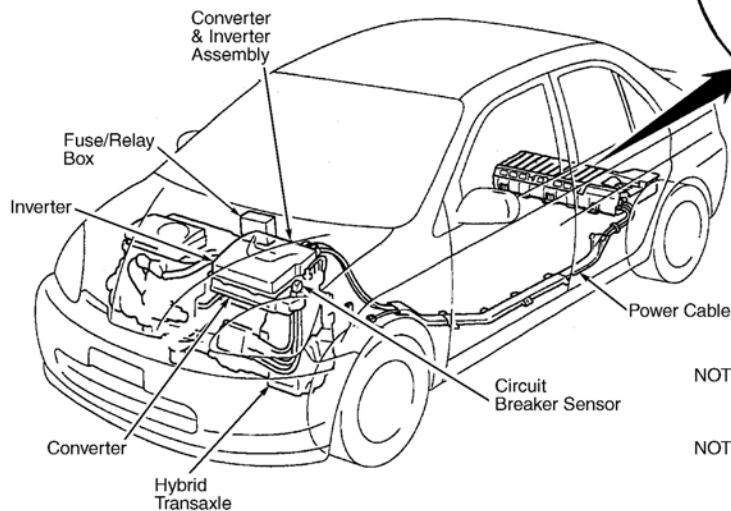
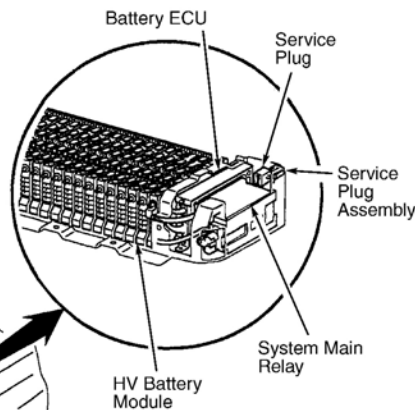
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Fig. 24: Locating Engine Control System Components (MR2)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



NOTE: Accelerator pedal position sensor is located near top of accelerator pedal.

NOTE: Hybrid Vehicle Control Electronic Control Unit (HV ECU) is located below carpet on floor panel, just below passenger's side of instrument panel.

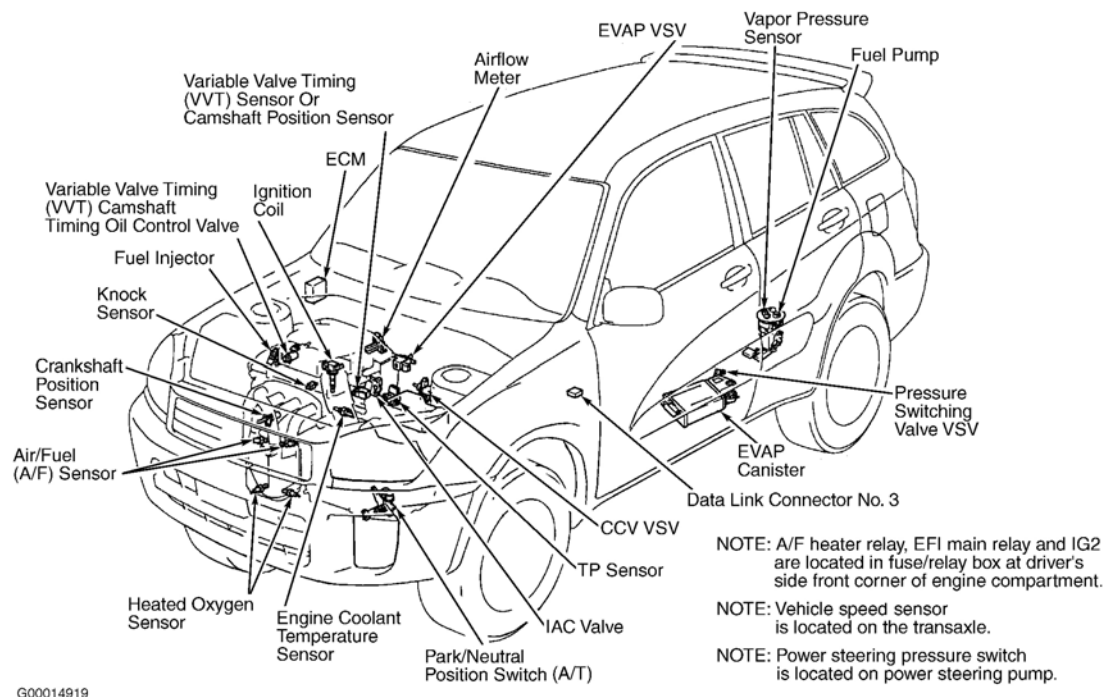


NOTE: EFI main relay is located in fuse/relay box at driver's side front corner of engine compartment.

NOTE: Park/neutral position switch is located on end of shift lever assembly and may also be referred to as shift position sensor.

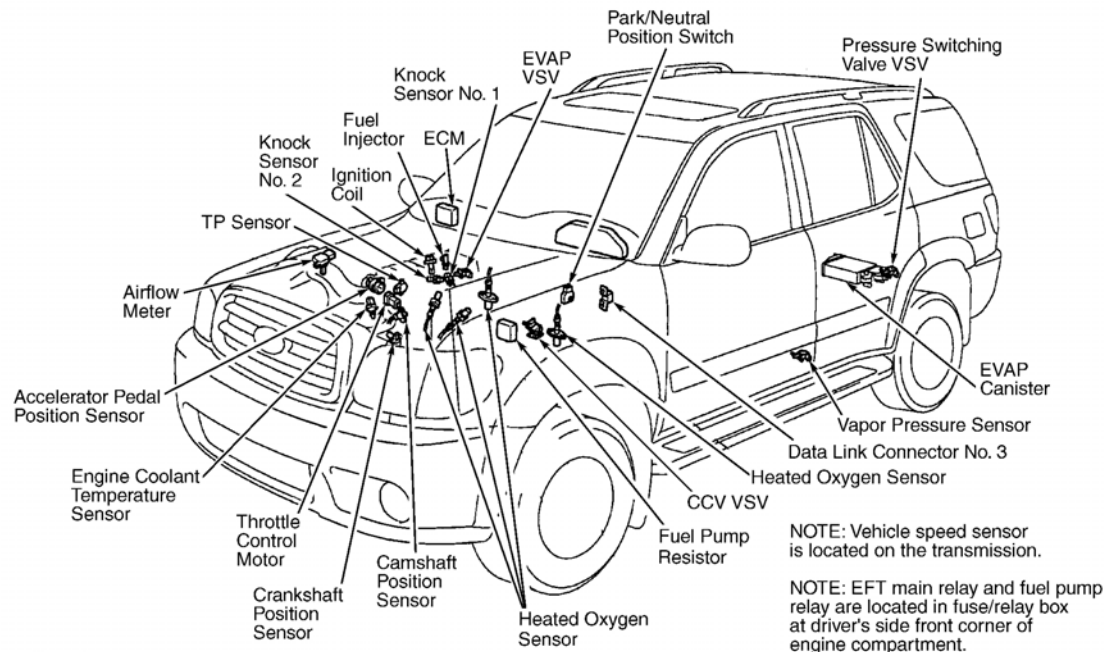
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Fig. 25: Locating Engine Control System Components (Prius)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G00014919

Fig. 26: Locating Engine Control System Components (RAV4)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



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Fig. 27: Locating Engine Control System Components (Sequoia)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

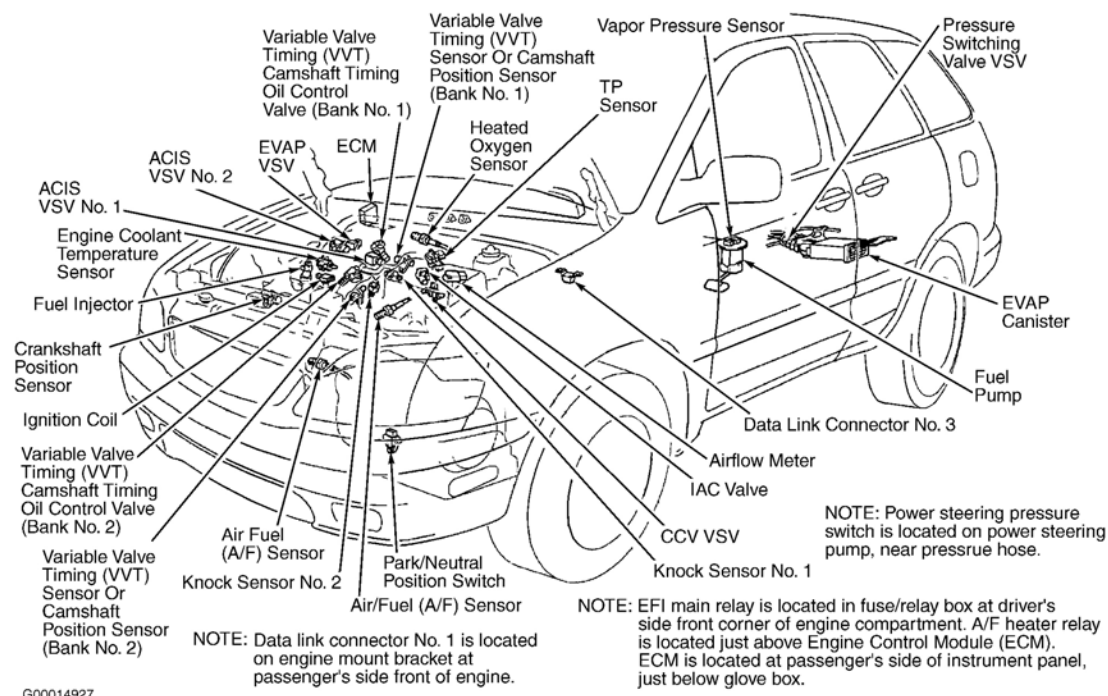
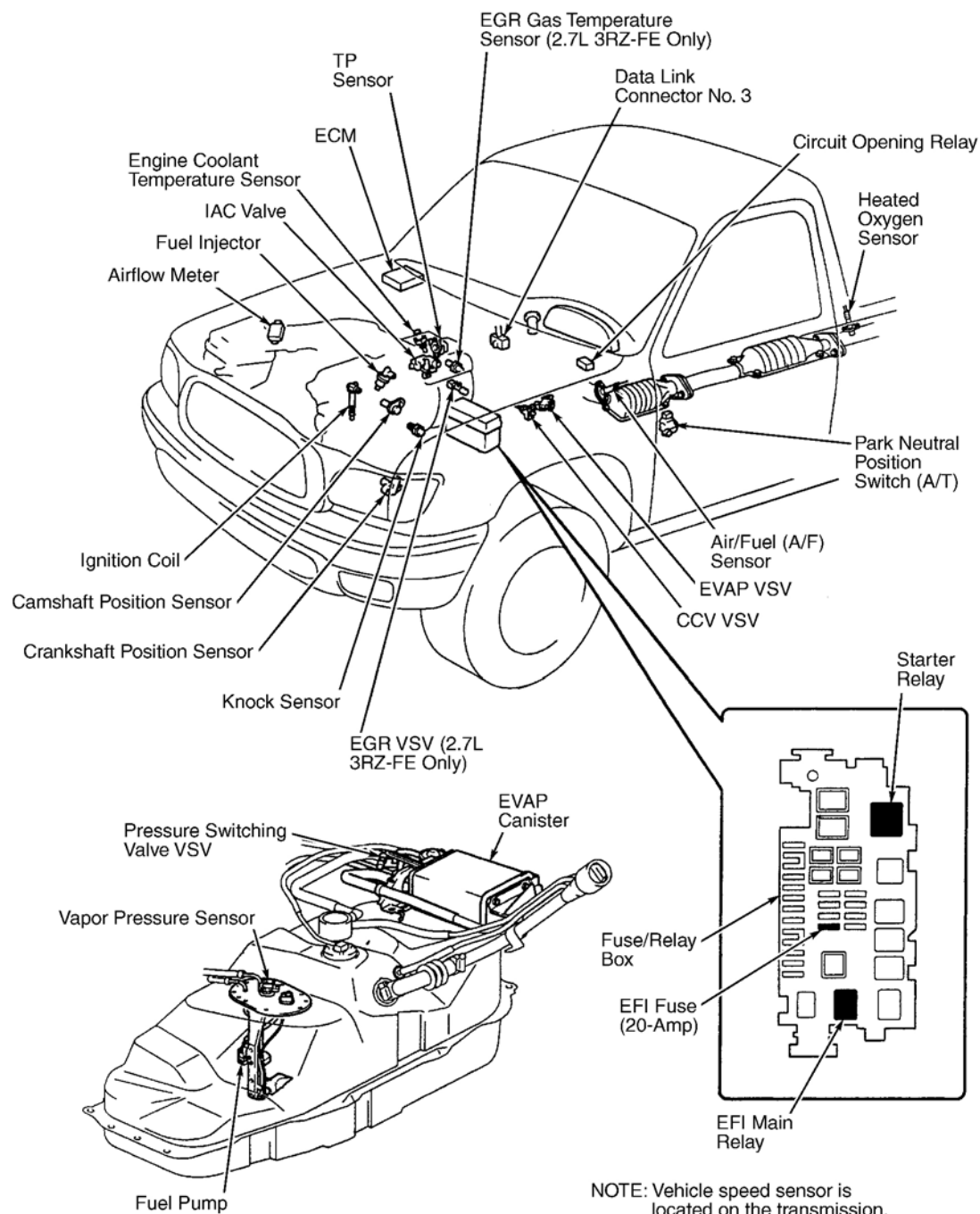
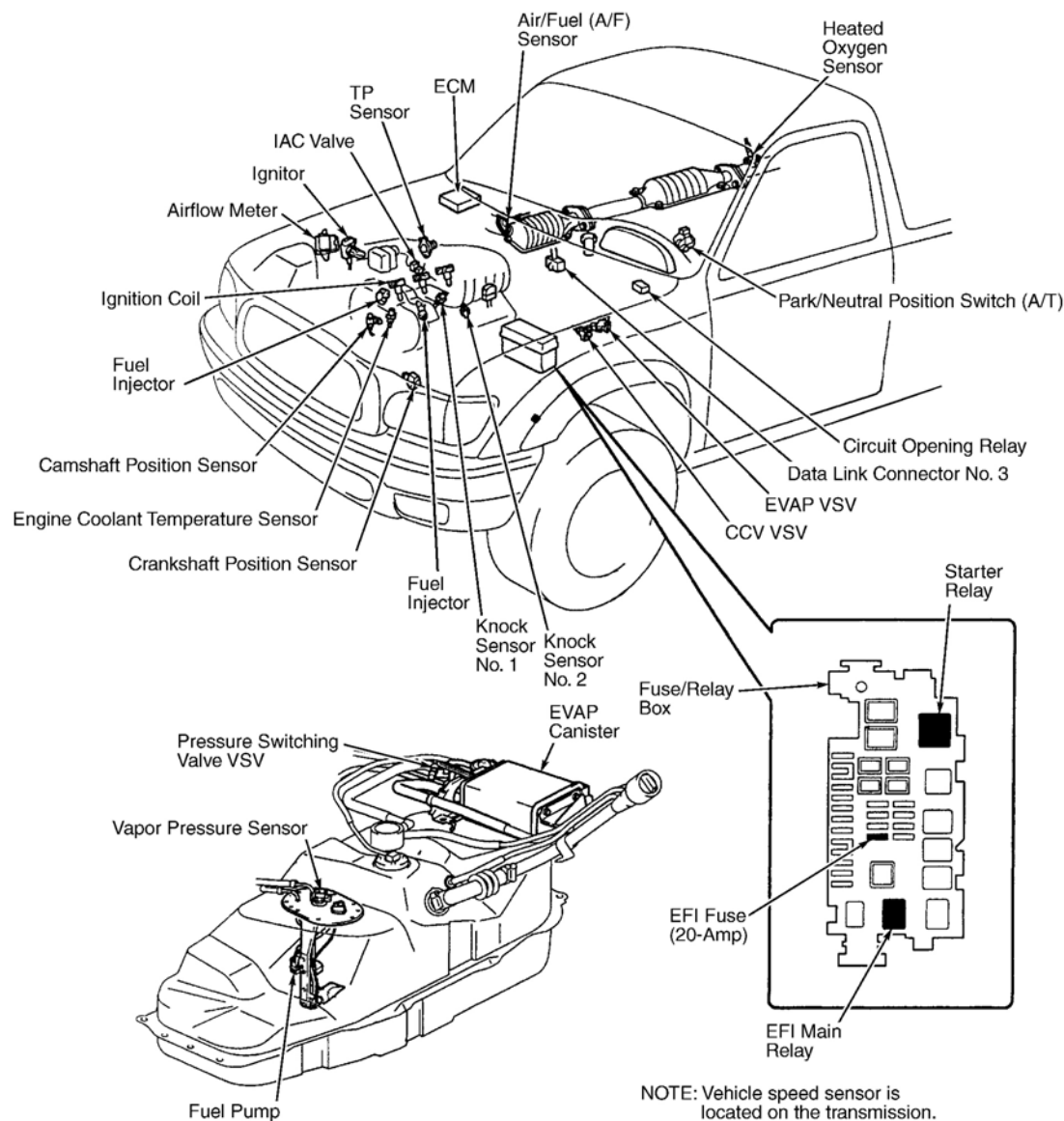


Fig. 28: Locating Engine Control System Components (Sienna)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



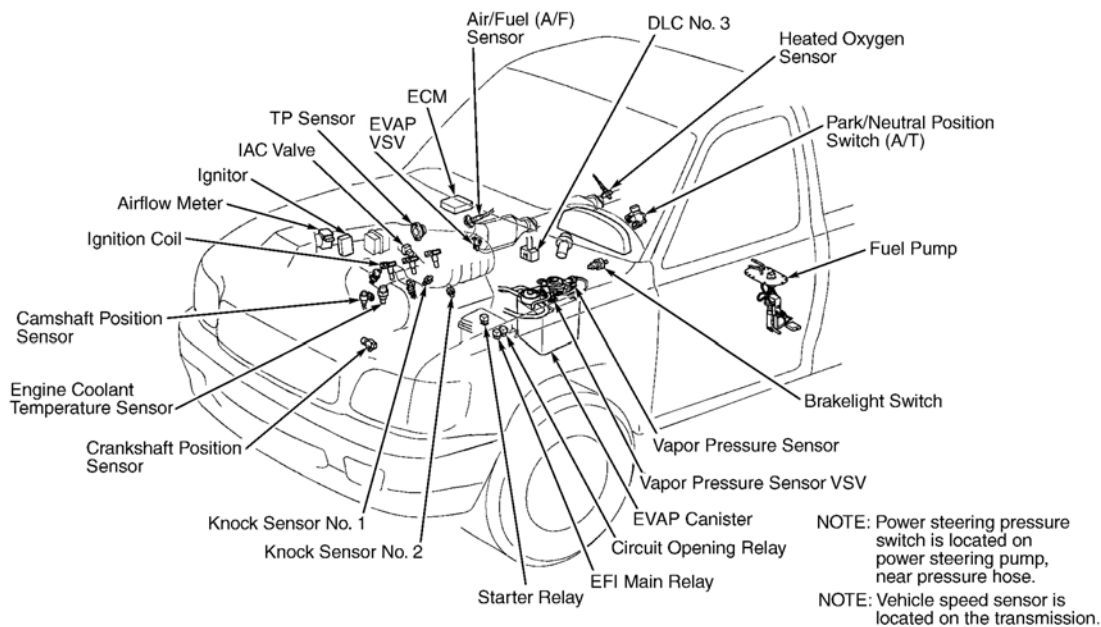
G00025401

Fig. 29: Locating Engine Control System Components (Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl.)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



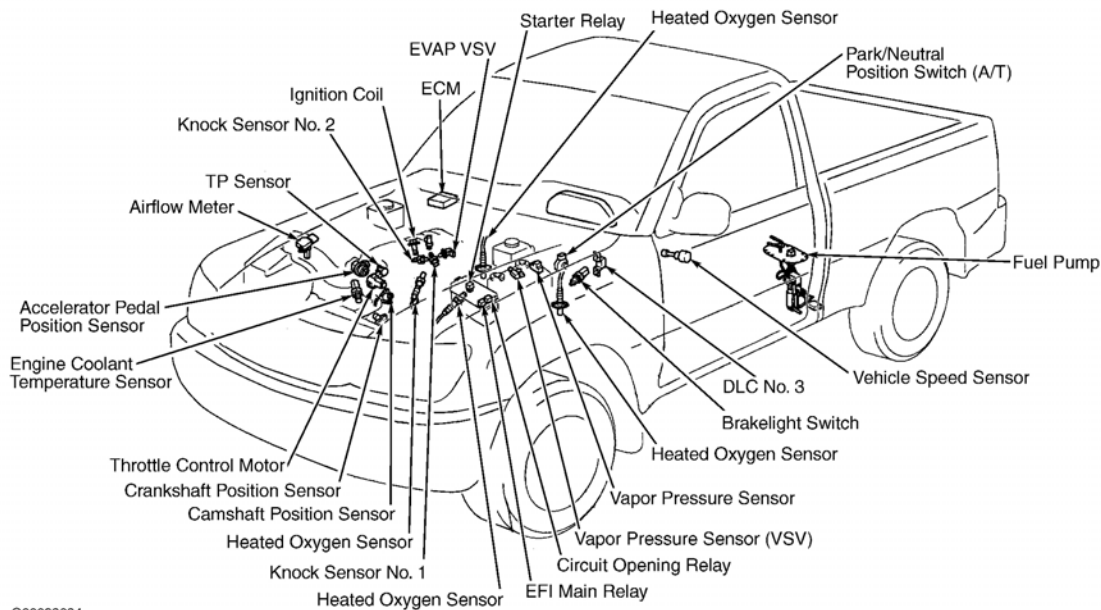
G00025405

Fig. 30: Locating Engine Control System Components (Tacoma 3.4L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



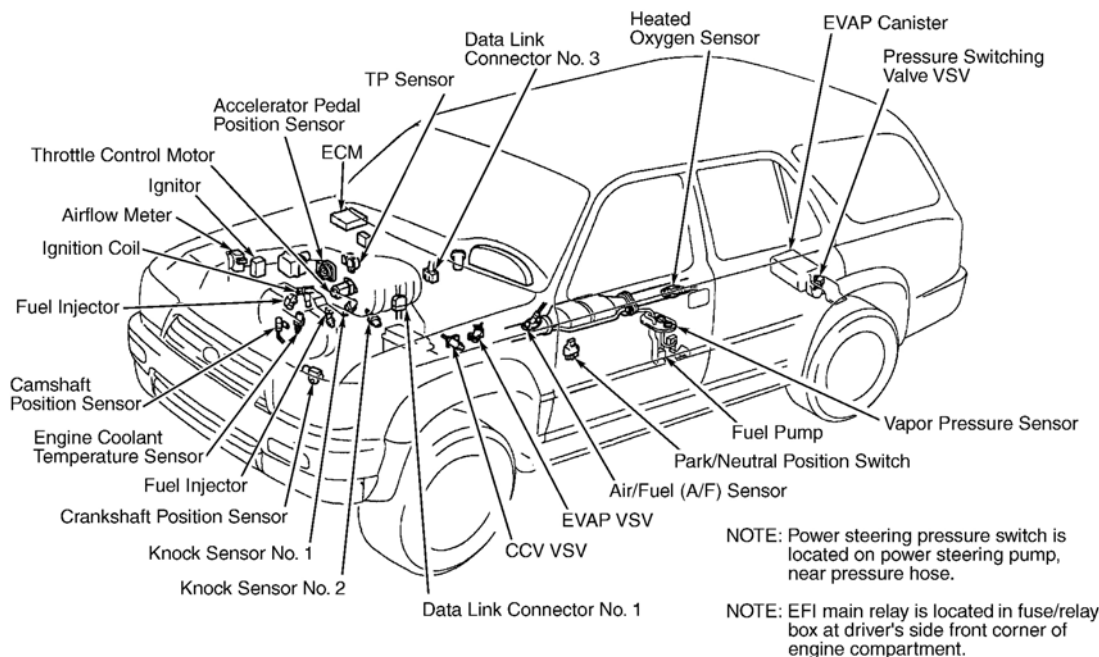
G00028707

Fig. 31: Locating Engine Control System Components (Tundra 3.4L V6)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G00028684

Fig. 32: Locating Engine Control System Components (Tundra 4.7L V8)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G00025402

Fig. 33: Locating Engine Control System Components (4Runner)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

ENGINE IMMOBILIZER SYSTEM

Avalon, Camry, Camry Solara, Highlander, Land Cruiser, MR2, RAV4, Sequoia, Sienna & 4Runner

Engine immobilizer system is a theft deterrent system that disables engine from starting. This is accomplished by not allowing fuel injector and ignition system operation unless ignition key identification code matches code stored in Engine Control Module (ECM). Engine immobilizer system may be standard equipment on some models or optional equipment on other models. Models equipped with engine immobilizer system may be identified by looking at the ignition key. On models equipped with engine immobilizer system, the top of the ignition key is thicker than a standard ignition key, as a transponder chip is incorporated into the top of the ignition key. Engine immobilizer system consists of ignition key with transponder chip, transponder key coil, transponder key amplifier and ECM. When ignition key is inserted into ignition lock cylinder, the ECM instructs transponder key coil on ignition lock cylinder to supply an electromagnetic energy that enables transponder chip to transmit an ignition key identification code signal.

Transponder key amplifier then amplifies ignition key identification code signal and delivers code signal to the ECM. ECM compares received ignition key identification code signal to code stored in the ECM. If ignition key identification code signal and code in the ECM match, ECM will allow fuel injector operation and ignition system operation. If ignition key identification code signal and code in the ECM do not match, ECM will not allow fuel injector operation and ignition system operation. For additional information on system operation and testing, see appropriate ENGINE IMMOBILIZER SYSTEMS article in ACCESSORIES & EQUIPMENT.

Engine immobilizer system may also be referred to as Hybrid Vehicle (HV) immobilizer system. Engine immobilizer system is a theft deterrent system that disables hybrid system and prevents engine from starting by not allowing fuel injector and ignition system operation unless ignition key identification code matches code stored in Hybrid Vehicle (HV) control Electronic Control Unit (ECU). Hybrid vehicle control ECU is referred to as HV ECU.

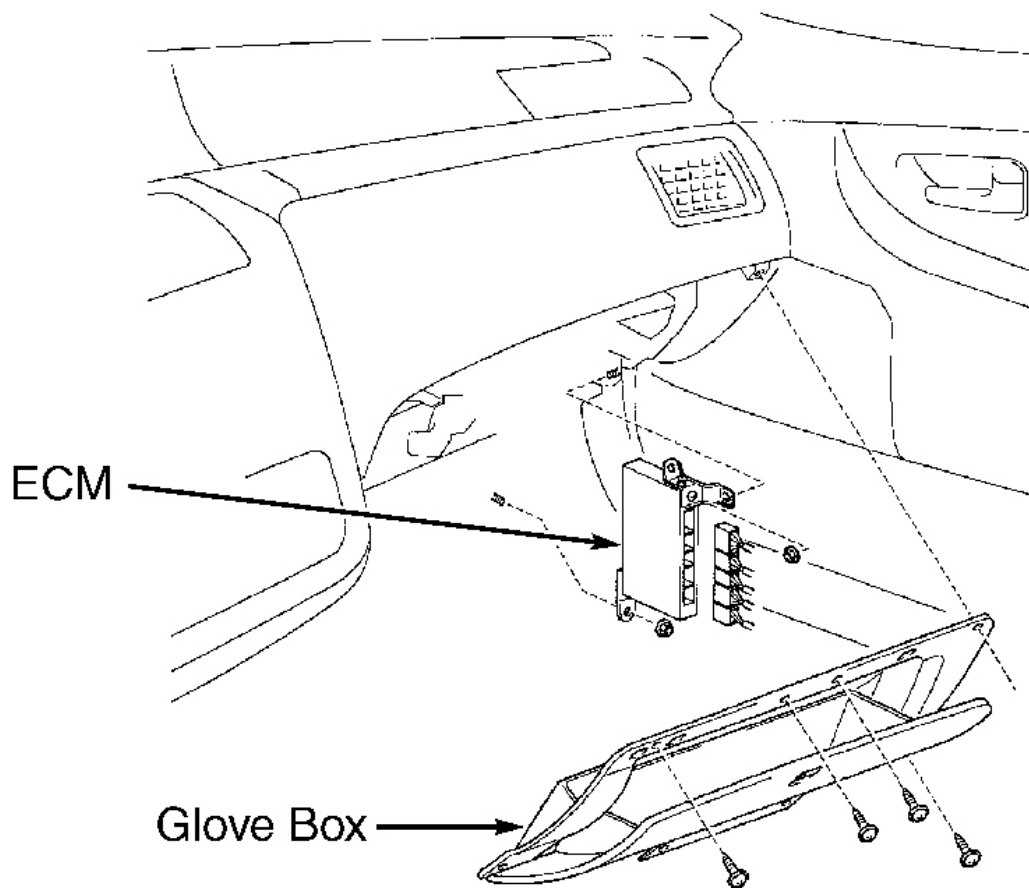
Engine immobilizer system consists of ignition key with transponder chip incorporated in top of ignition key, transponder key coil, transponder key ECU and HV ECU. When ignition is turned on, transponder key ECU checks if ignition key is registered and delivers the result to the HV ECU. When HV ECU confirms ignition key is registered, it transmits its own identification numbers to the transponder key ECU. The transponder ECU then calculates internally and delivers the calculated result back to the HV ECU. The HV ECU rechecks the calculated result against calculation stored in the HV ECU. If calculations are the same, the HV ECU allows hybrid system operation and allows the engine to start. If calculations are not the same, the HV ECU will not allow hybrid system operation and the engine to start. For additional information on system operation and testing, see appropriate ENGINE IMMOBILIZER SYSTEMS article in ACCESSORIES & EQUIPMENT.

ENGINE CONTROL MODULE

Engine Control Module (ECM) monitors and controls vehicle emissions, fuel system, ignition system and other various systems by using input signals from various input devices. ECM processes input signals from input devices and delivers output signals to various components for controlling system operation to achieve optimum engine performance for all operating conditions. See **INPUT DEVICES** and **OUTPUT SIGNALS** . ECM contains a fail-safe function which is used in case of sensor or switch failure. Fail-safe function uses preprogrammed values to provide a limp-in mode for minimal driveability. If a failure exists, ECM will inform the driver by illuminating the Malfunction Indicator Light (MIL).

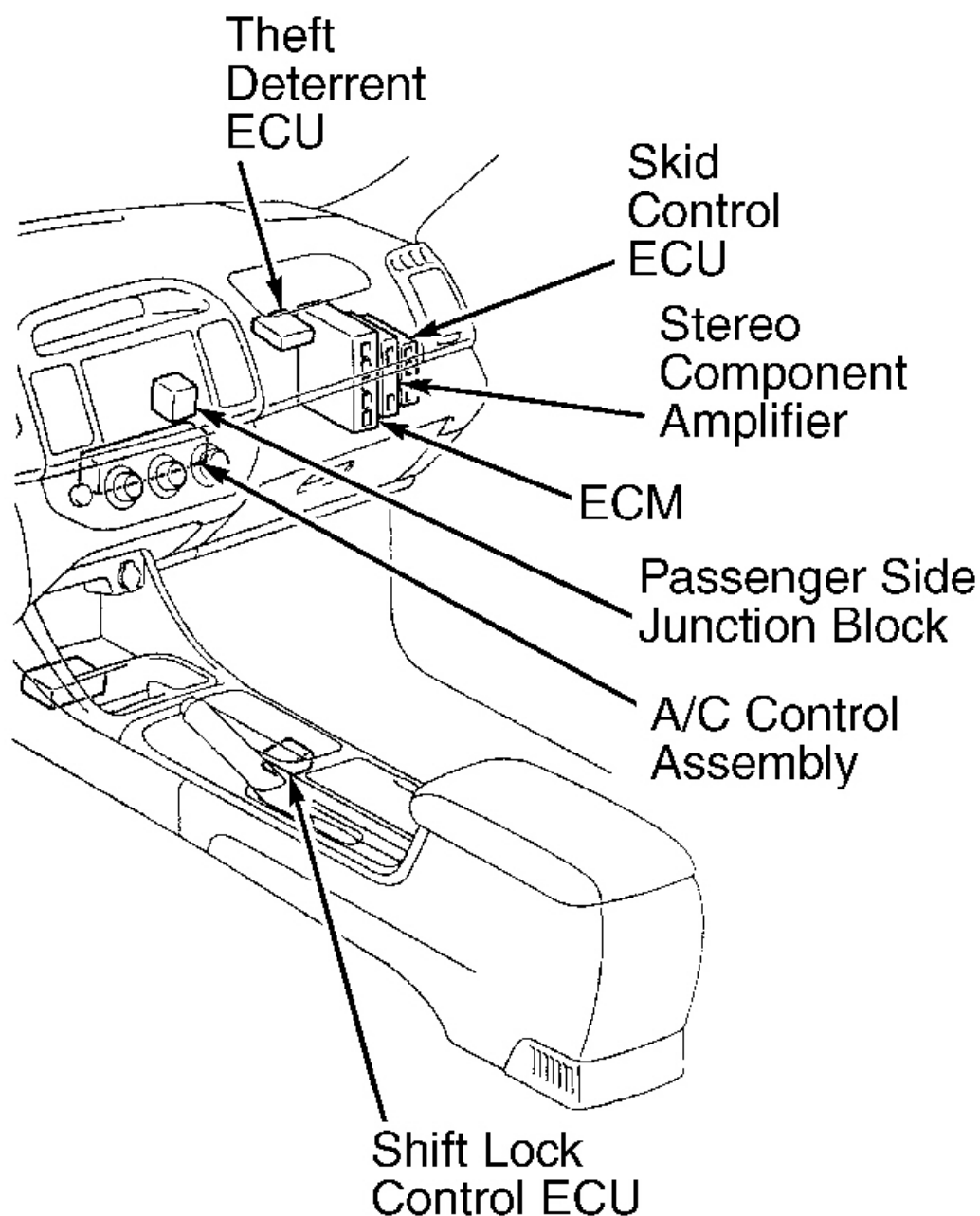
NOTE: **MIL may also be referred to as CHECK ENGINE light. MIL is displayed as an engine icon on instrument cluster on instrument panel.**

ECM contains a self-diagnostic system which may store a Diagnostic Trouble Code (DTC) if an electronic control system failure exists. DTC may be retrieved from ECM for system diagnosis by using Toyota hand-held tester or a scan tool. See **SELF-DIAGNOSTIC SYSTEMS** . For ECM location, see **Fig. 34 -Fig. 49** .



G99D52806

Fig. 34: Locating Engine Control Module (Avalon)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G00025406

Fig. 35: Locating Engine Control Module (Camry)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

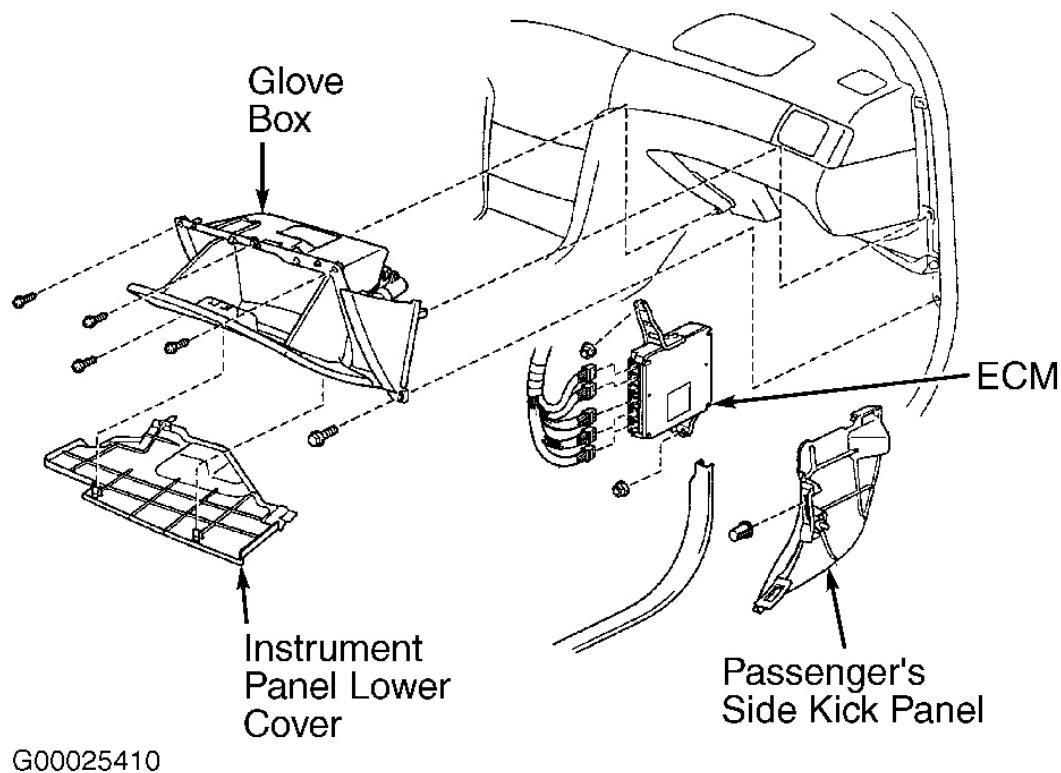
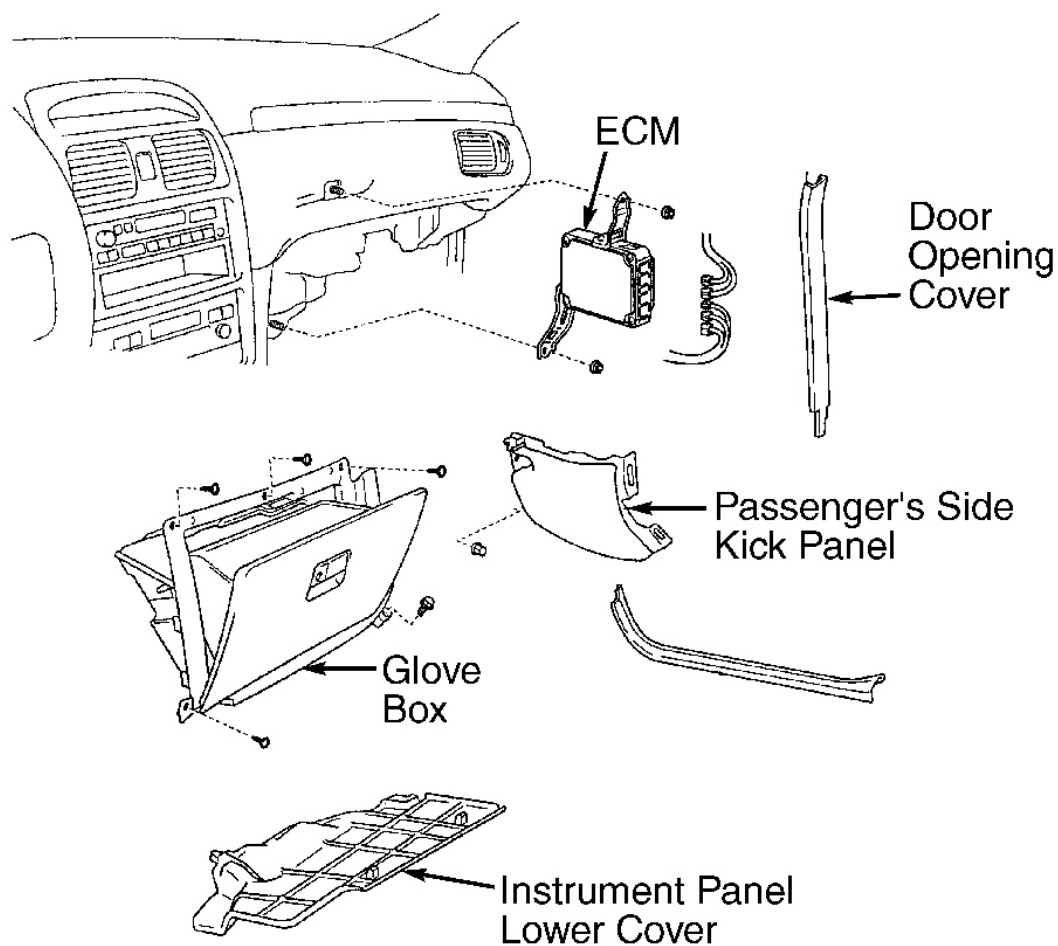
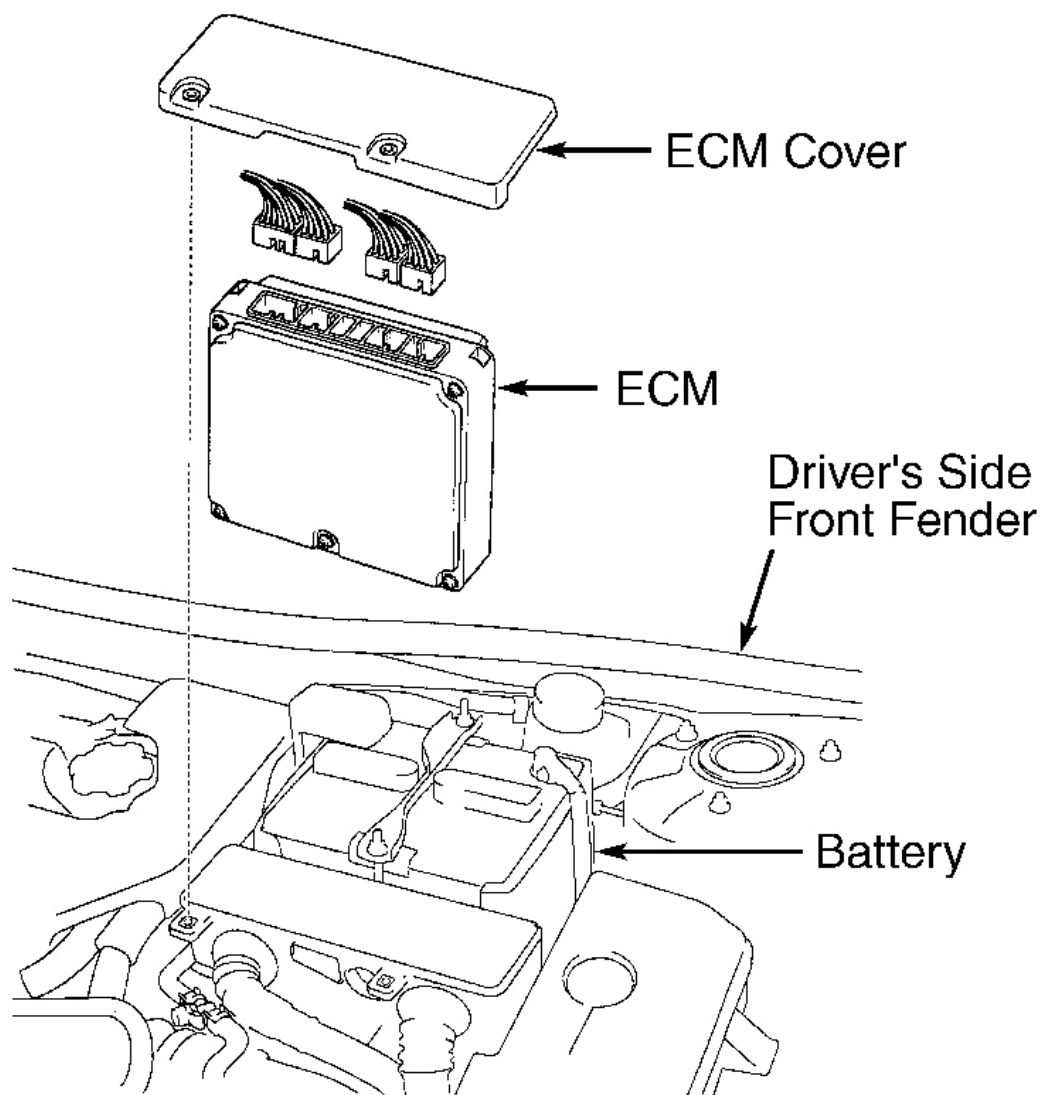


Fig. 36: Locating Engine Control Module (Camry Solara 2.4L 4-Cyl.)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



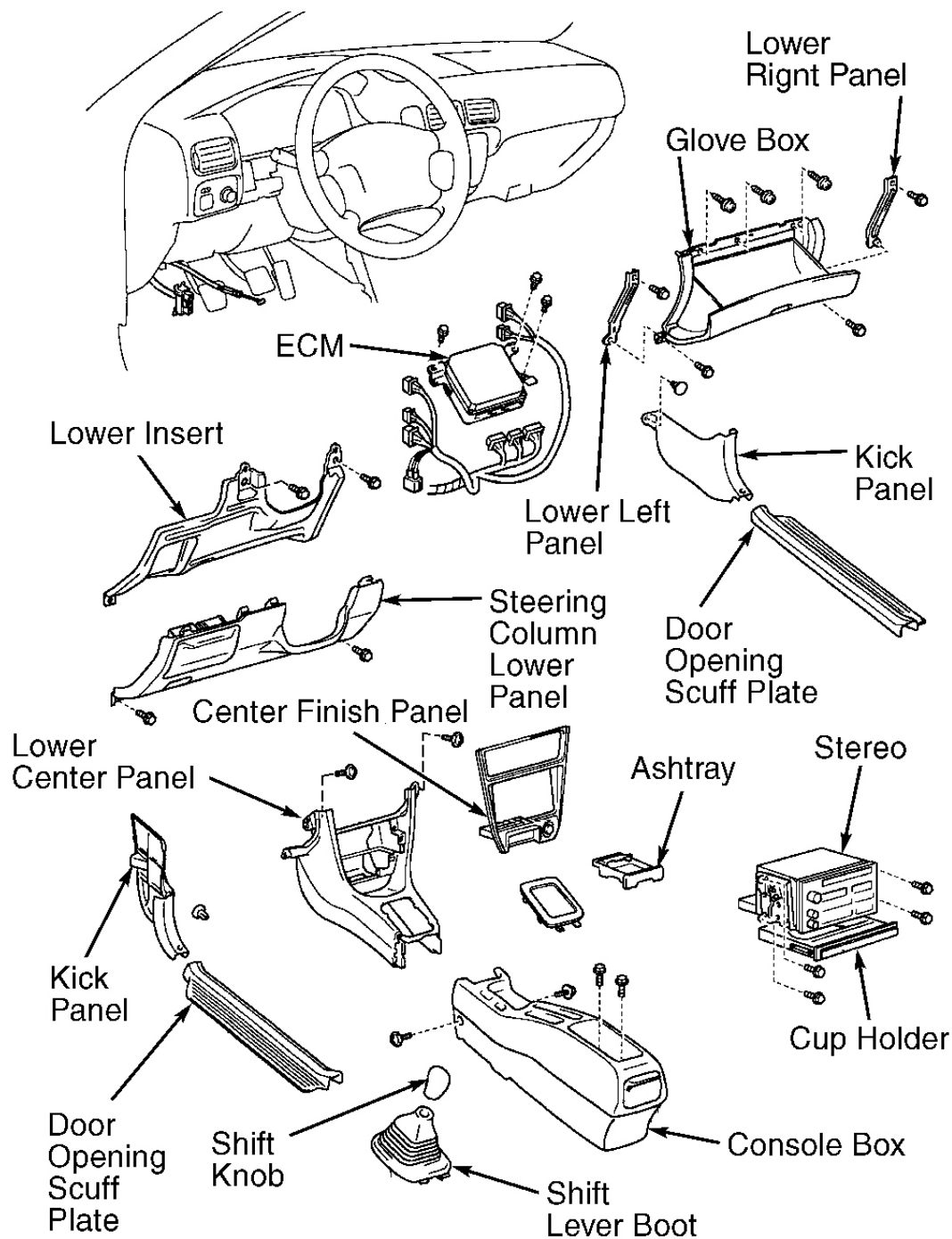
G00025414

Fig. 37: Locating Engine Control Module (Camry Solara 3.0L V6)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



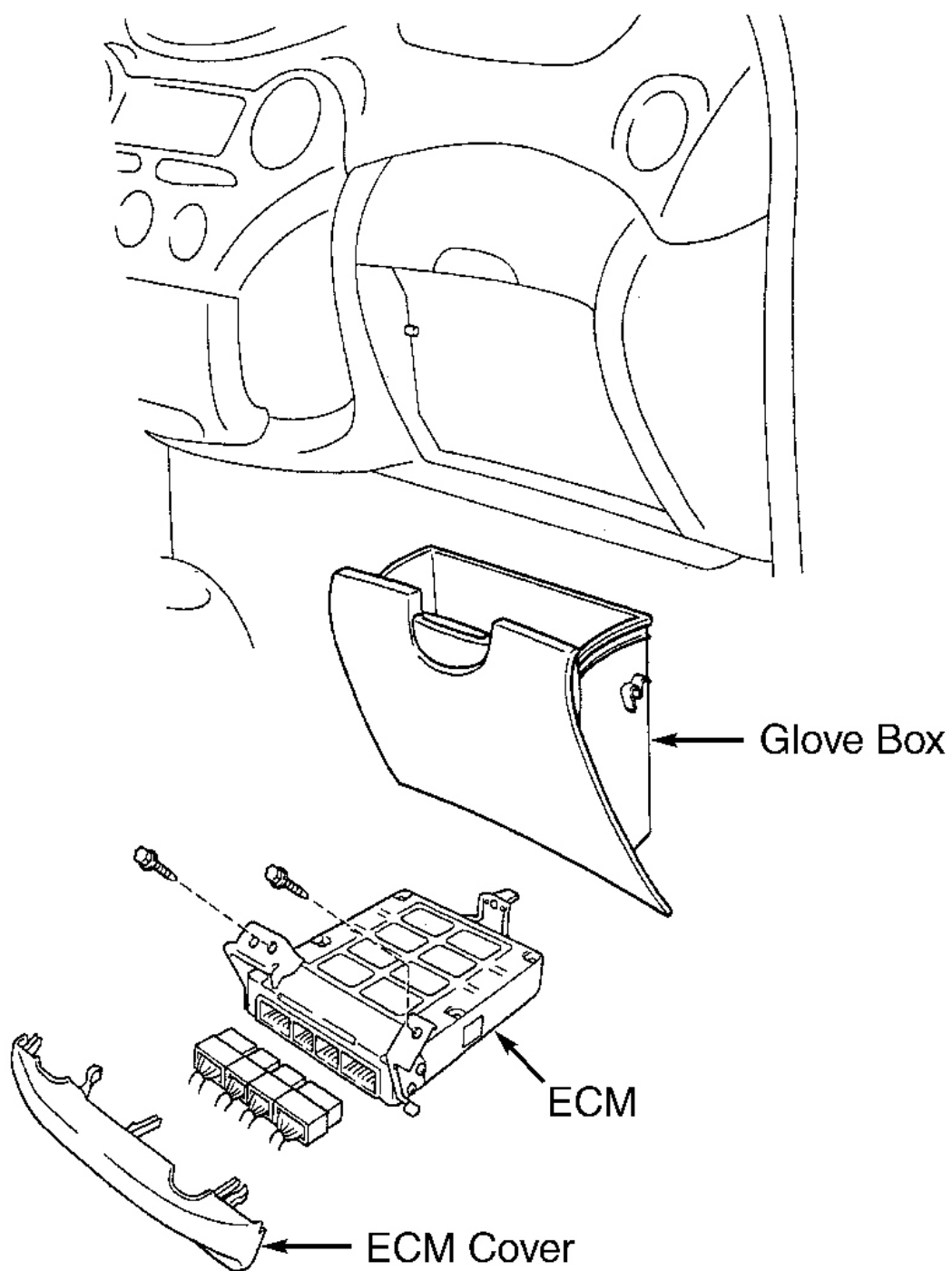
G99E52807

Fig. 38: Locating Engine Control Module (Celica)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



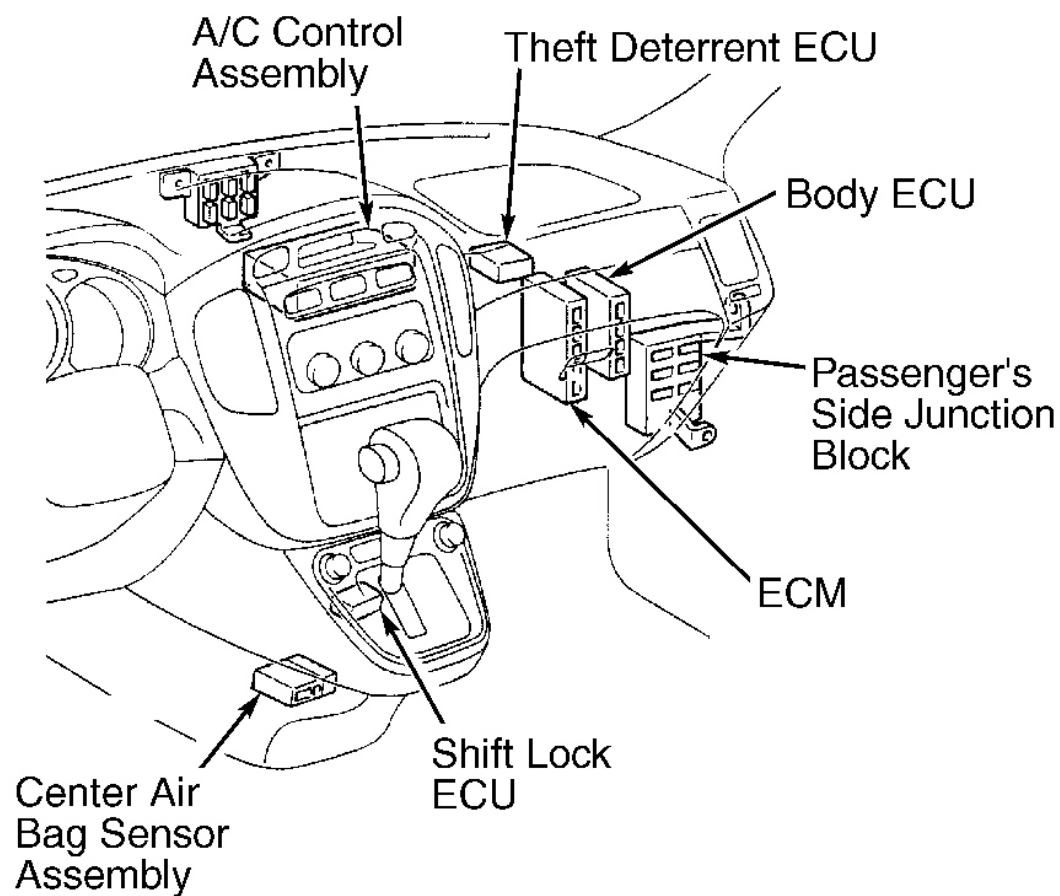
NOTE: ECM is located behind stereo and lower center panel.

Fig. 39: Locating Engine Control Module (Corolla)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



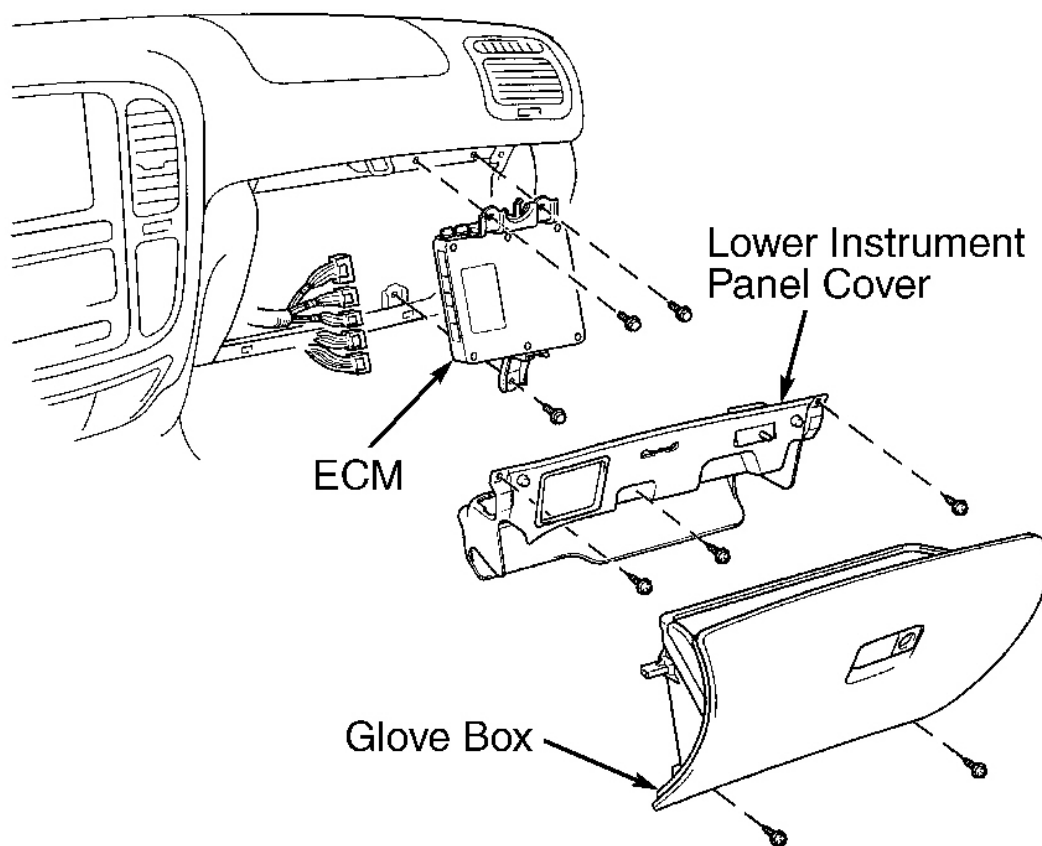
G99F52808

Fig. 40: Locating Engine Control Module (ECHO)



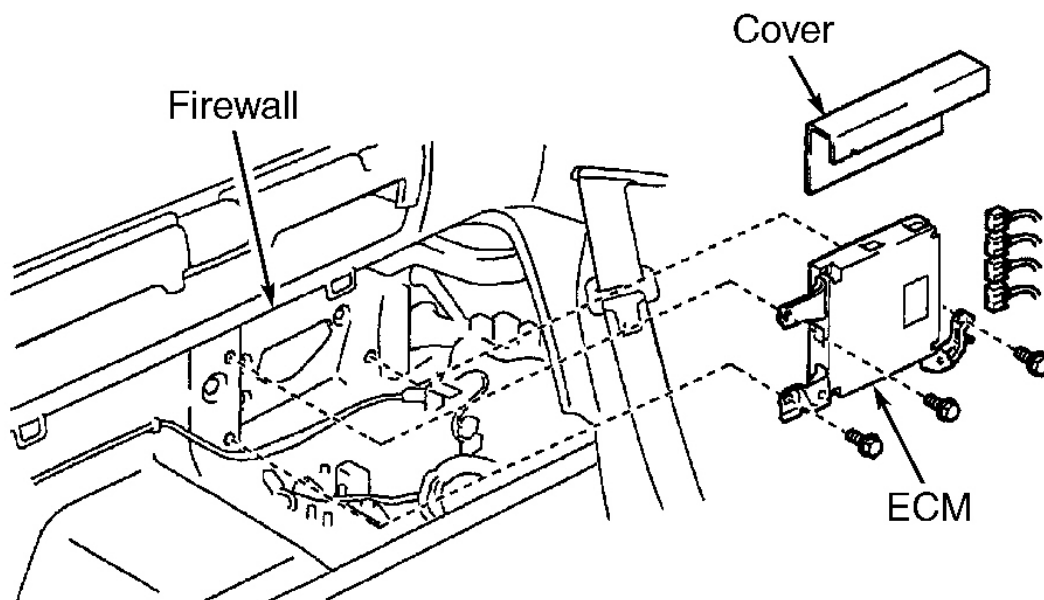
G00028711

Fig. 41: Locating Engine Control Module (Highlander)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99D08291

Fig. 42: Locating Engine Control Module (Land Cruiser)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



NOTE: ECM is located on driver's side of firewall behind driver's seat, luggage compartment lids and partition board.

G00028715

Fig. 43: Locating Engine Control Module (MR2)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

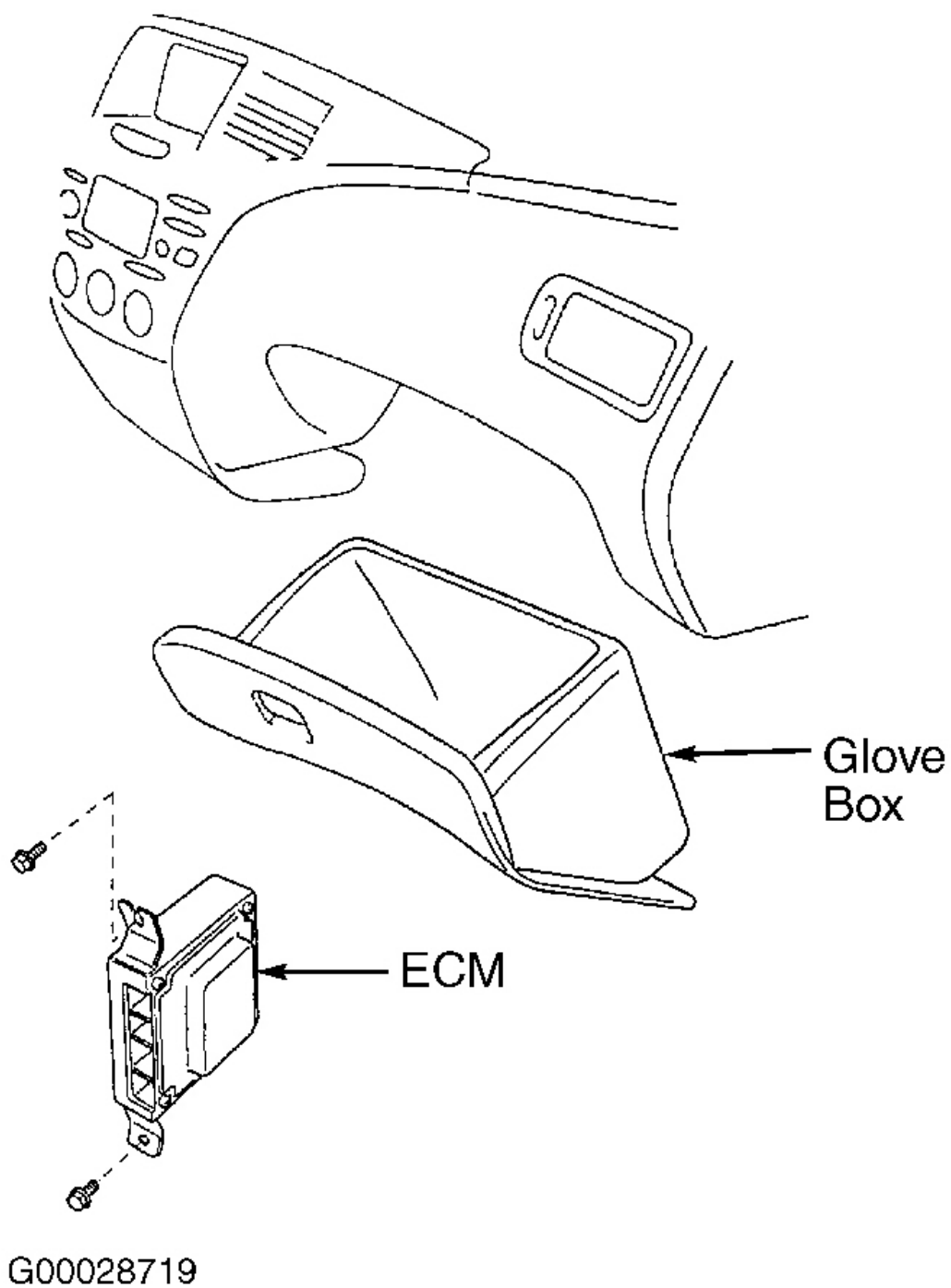
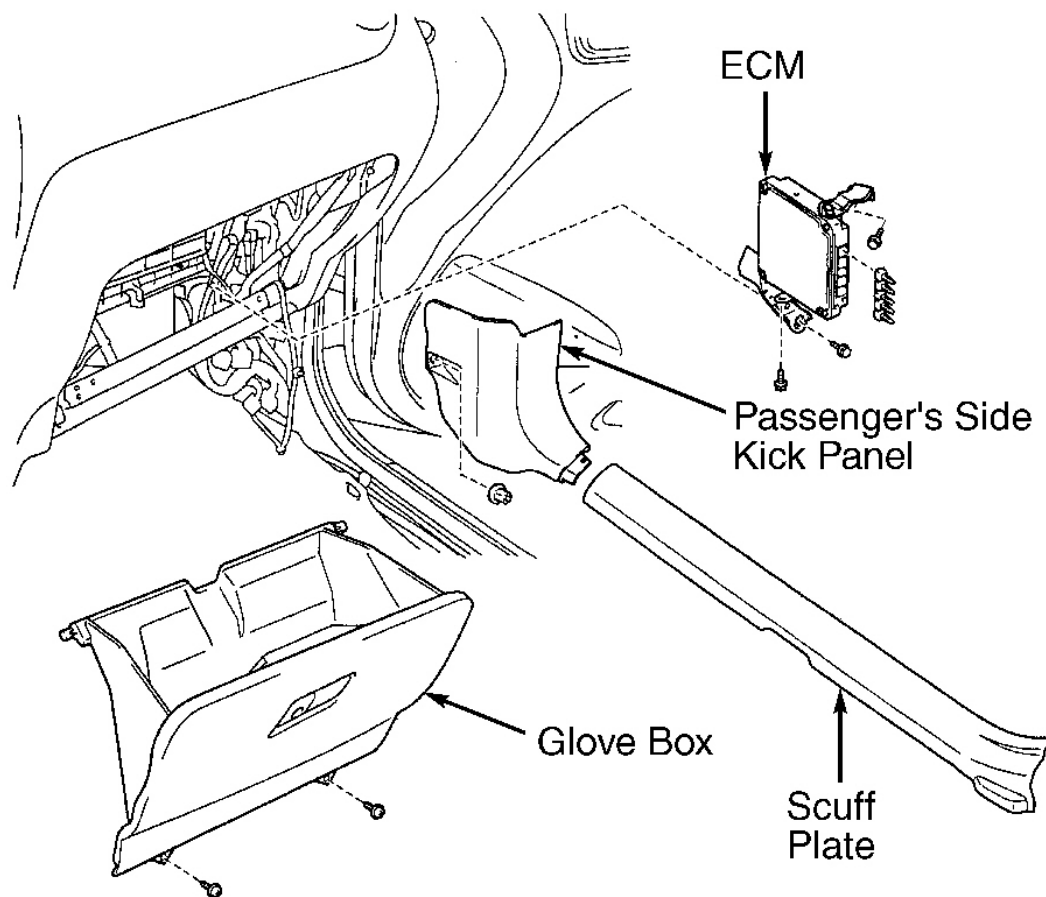
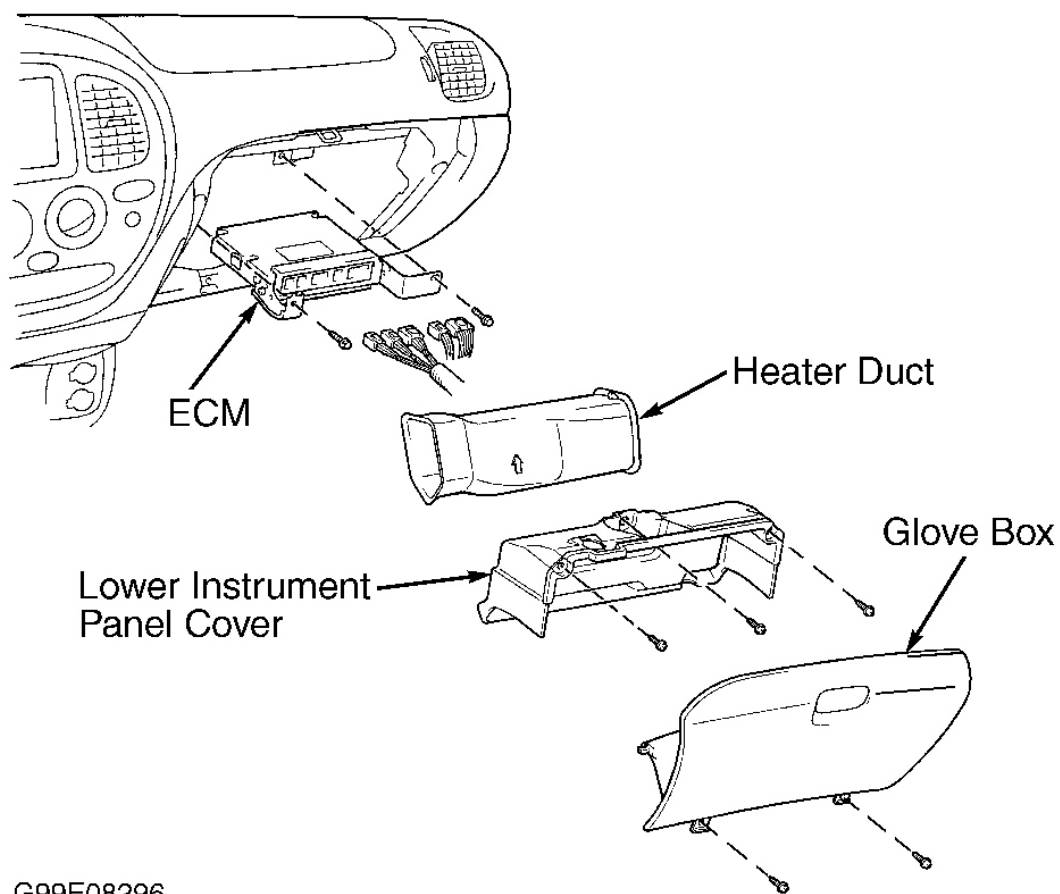


Fig. 44: Locating Engine Control Module (Prius)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



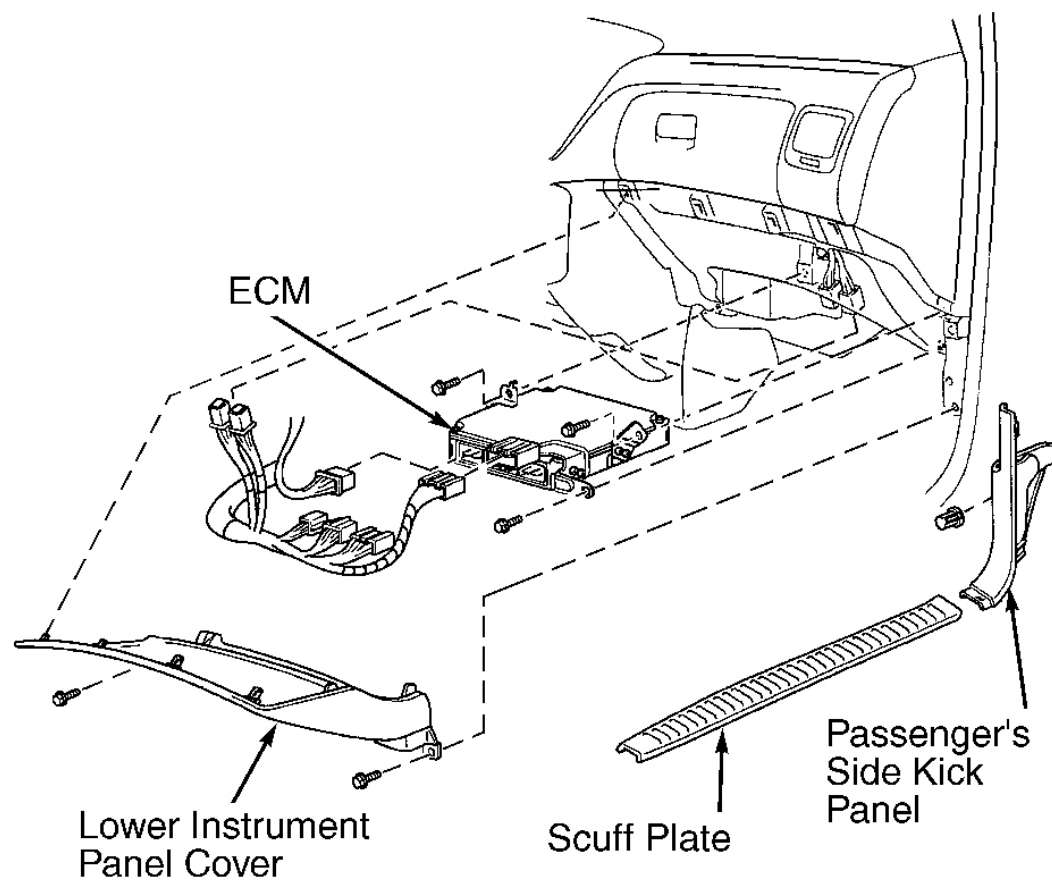
G00028723

Fig. 45: Locating Engine Control Module (RAV4)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99E08296

Fig. 46: Locating Engine Control Module (Sequoia & Tundra)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99H08293

Fig. 47: Locating Engine Control Module (Sienna)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

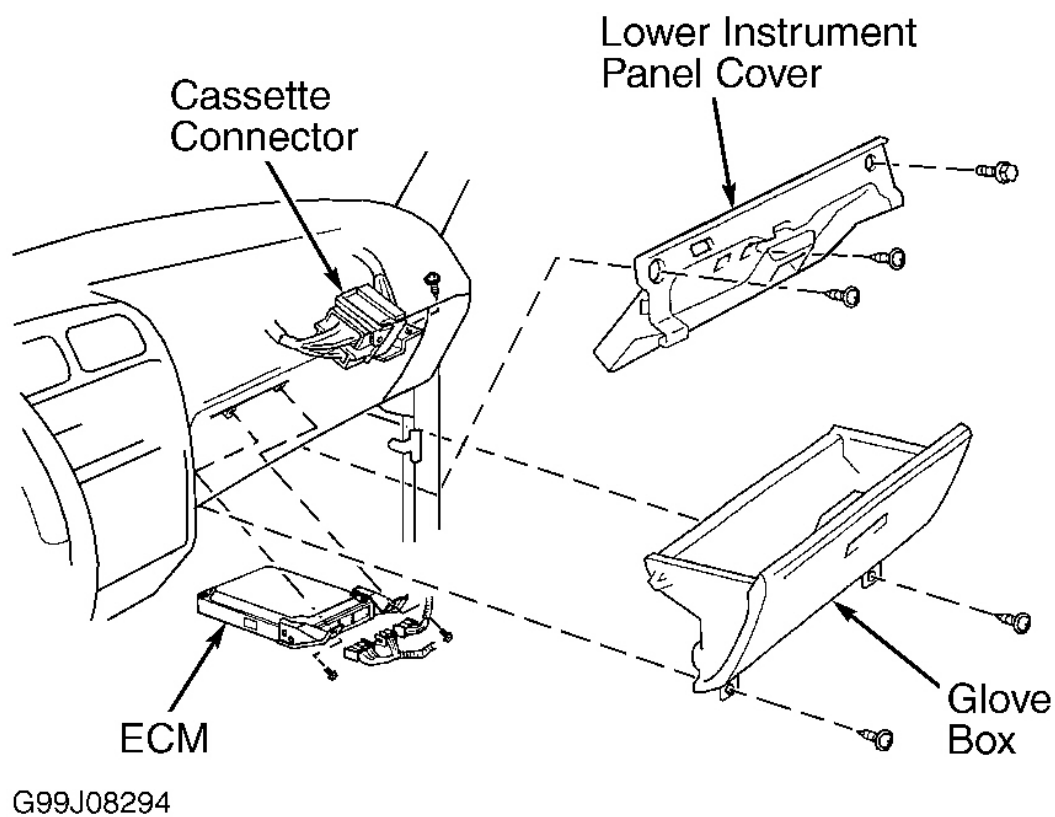


Fig. 48: Locating Engine Control Module (Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl., & 4Runner)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

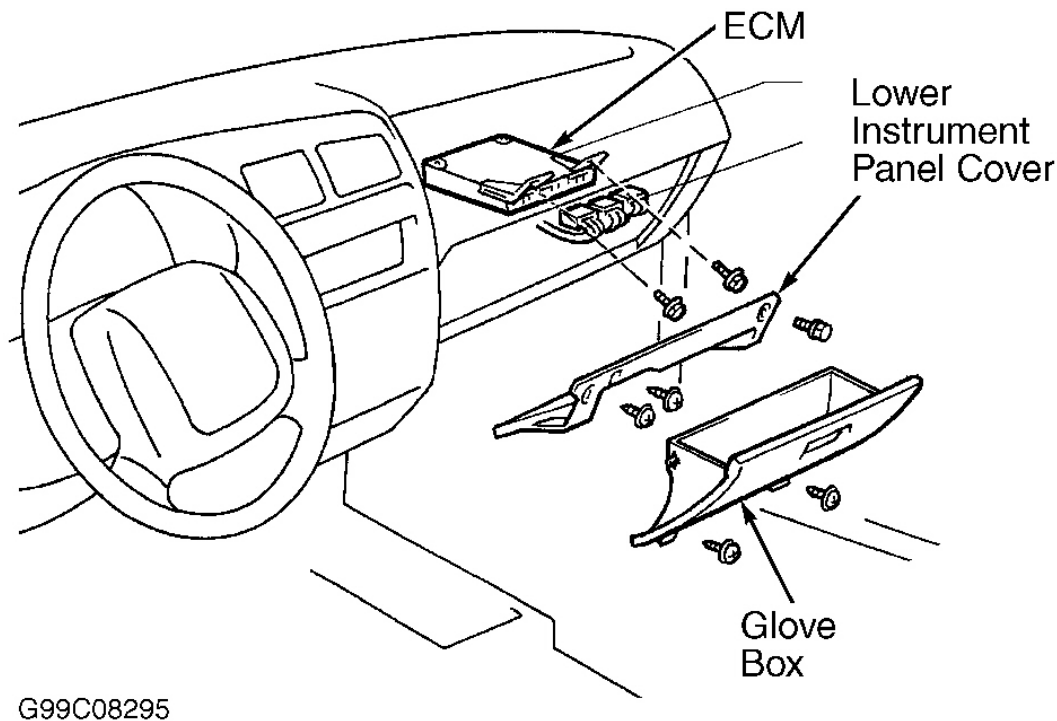


Fig. 49: Locating Engine Control Module (Tacoma 3.4L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

HYBRID VEHICLE CONTROL ELECTRONIC CONTROL UNIT

Prius

Hybrid Vehicle (HV) control Electronic Control Unit (ECU) is used for controlling the hybrid system which uses the gasoline engine along with AC electric motor for vehicle operation. Hybrid vehicle control ECU is referred to as HV ECU. The HV ECU is located below carpet on floor panel, just below passenger's side of instrument panel. HV ECU receives input information from various sensors and electronic control units and determines the torque and output power. HV ECU delivers the demand torque and target RPM to ECM. The ECM uses this input information for controlling throttle opening, fuel injection system, ignition timing and Variable Valve Timing (VVT) system. The ECM delivers the actual engine RPM to the HV ECU. When vehicle is stopped, the HV ECU may deliver an input signal to the ECM to indicate that vehicle is stopped. ECM uses this for reducing fuel consumption.

INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. Available input signals include the following:

Accelerator Pedal Position Sensor (Camry, Camry Solara 2.4L 4-Cyl., Land Cruiser, MR2 With Sequential Manual

Transaxle, Sequoia, Tundra 4.7L V8 & 4Runner)

Accelerator pedal position sensor is used with Electronic Throttle Control System (ETCS) for controlling of throttle operation. See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS for additional information.

Accelerator Pedal Position Sensor (Prius)

Accelerator pedal position sensor converts accelerator pedal angle into an electrical signal and delivers output signal to Hybrid Vehicle (HV) control Electronic Control Unit (ECU). Hybrid vehicle control ECU is referred to as HV ECU. The HV ECU communicates with the ECM for controlling the Electronic Throttle Control System (ETCS) for throttle operation. See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS for additional information.

A/C Compressor Lock Sensor (Camry)

A/C compressor lock sensor delivers 4 pulse input signals per engine revolution to Engine Control Module (ECM). If number ratio of A/C compressor speed divided by engine speed is smaller than a predetermined value, ECM delivers input signal to A/C amplifier and A/C amplifier will turn off A/C compressor. A/C lock sensor is located near front of A/C compressor.

A/C Compressor Lock Sensor (Camry Solara 2.4L 4-Cyl. With Manual A/C, Celica, Highlander, MR2 & RAV4)

A/C compressor lock sensor delivers a predetermined number of pulse input signals per engine revolution to Engine Control Module (ECM). If number ratio of A/C compressor speed divided by engine speed is smaller than a predetermined value, ECM will turn off A/C compressor. A/C lock sensor is located near front of A/C compressor.

A/C Evaporator Temperature Sensor (Camry 2.4L 4-Cyl. With Manual A/C & Camry Solara 2.4L 4-Cyl. With Manual A/C)

A/C evaporator temperature sensor may also be referred to as A/C thermistor. A/C evaporator temperature sensor detects temperature inside A/C cooling unit and delivers input signal to Engine Control Module (ECM). A/C evaporator temperature sensor is located inside A/C cooling unit, near A/C evaporator core.

A/C Switch (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, MR2, RAV4, Sequoia, Sienna, Tacoma, Tundra & 4Runner)

When A/C is turned on, input signal is delivered to Engine Control Module (ECM). ECM may use input signal for controlling engine operation. Input signal may be delivered from A/C switch, A/C amplifier, A/C control assembly or A/C clutch depending on model application.

Air/Fuel Sensor (Avalon, Camry, Camry Solara 2.4L 4-Cyl., Camry Solara 3.0L V6 With A/T, Highlander, RAV4, Sienna, Tacoma, Tundra 3.4L V6 & 4Runner)

Air Fuel (A/F) sensor may also be referred to as A/F ratio sensor. Heated A/F sensor monitors exhaust gas oxygen content and delivers an input signal to Engine Control Module (ECM). ECM may use input signal to control fuel injection system. For A/F sensor location, see **A/F SENSOR LOCATION** table.

A/F SENSOR LOCATION

Application	Sensor Location
Avalon	One On Each Exhaust Manifold
Camry	
2.4L 4-Cyl.	On Exhaust Manifold, Above Catalytic Converter
3.0L V6	One On Each Exhaust Manifold
Camry Solara	
2.4L 4-Cyl.	On Exhaust Manifold, Above Catalytic Converter
3.0L V6 With A/T	One On Each Exhaust Manifold
Highlander	
2.4L 4-Cyl.	Two Sensors Are Used & Mounted On Exhaust Manifold, Above Catalytic Converters
3.0L V6	One On Each Exhaust Manifold
RAV4	Two Sensors Are Used & Mounted On Exhaust Manifold, Above Catalytic Converters
Sienna	One On Each Exhaust Manifold
Tacoma, Tundra 3.4L V6 & 4Runner	On Exhaust Pipe, In Front Of Catalytic Converter

Airflow Meter (All Models)

NOTE: **Airflow meter may also be referred to as Mass Airflow (MAF) meter.**

Airflow meter measures intake airflow volume. Input signal for airflow volume is sent from airflow meter to Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance), for controlling fuel injection system and oxygen sensor heater. Airflow meter also contains an intake air temperature sensor which is used to measure intake air temperature. See **INTAKE AIR TEMPERATURE SENSOR** .

Battery Signal (Avalon, Camry, Camry Solara, Celica, ECHO, Highlander, MR2, Prius, RAV4, Sienna, Tacoma, Tundra 3.4L V6 & 4Runner)

Battery voltage is always present at BATT terminal of Engine Control Module (ECM). When ignition is turned on, voltage for ECM operation is applied through EFI main relay to +B terminal on ECM. EFI main relay may also be referred to as EFI relay.

Battery Signal (Corolla)

Battery voltage is always present at BATT terminal of Engine Control Module (ECM). When ignition is turned on, voltage for ECM operation is applied through EFI main relay to +B terminal on ECM. EFI main relay may also be referred to as EFI relay or F-HTR relay.

Battery Signal (Land Cruiser)

Battery voltage is always present at BATT and +BM terminals of Engine Control Module (ECM). When

ignition is turned on, voltage for ECM operation is applied through EFI main relay to +B and +B1 terminals on ECM. EFI main relay may also be referred to as EFI relay or ECD relay. Voltage is applied to IGSW terminal on ECM through IGN fuse.

Battery Signal (Sequoia & Tundra 4.7L V8)

Battery voltage is always present at BATT and +BM terminals of Engine Control Module (ECM). When ignition is turned on, voltage for ECM operation is applied through EFI main relay to +B and +B1 terminals on ECM. EFI main relay may also be referred to as EFI relay. Voltage is applied to IGSW terminal on ECM through IGN fuse or IGN1 fuse.

Brakelight Signal (Avalon, Camry, Camry Solara 2.4L 4-Cyl., Camry Solara 3.0L V6 With A/T, Celica With A/T, Corolla With 4-Speed A/T, ECHO With A/T, Highlander, Land Cruiser, MR2, RAV4, Sequoia, Sienna, Tacoma, Tundra With A/T & 4Runner)

Brakelight switch delivers an input signal to STP terminal of Engine Control Module (ECM) to indicate when brakes are applied. Input signal is mainly used for controlling fuel cut-off engine speed, as fuel cut-off engine speed is slightly reduced when brakes are applied. Brakelight switch may also be referred to as stoplight switch.

Camshaft & Crankshaft Position Sensors (Avalon, Highlander 3.0L V6 & Sienna)

Camshaft position sensors and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensors may also be referred to Variable Valve Timing (VVT) sensors. Camshaft position sensors are located at flywheel end of each cylinder head, just below valve cover. Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance), and for controlling fuel injection system, engine idle speed control system, Acoustic Control Induction System (ACIS) and VVT system.

Camshaft & Crankshaft Position Sensors (Camry 2.4L 4-Cyl. & Camry Solara 2.4L 4-Cyl.)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensor may also be referred to as Variable Valve Timing (VVT) sensor. Camshaft position sensor is located on end of cylinder head at flywheel end of engine. Crankshaft position sensor is located on front of engine, near crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance), and for controlling fuel injection system and VVT system.

Camshaft & Crankshaft Position Sensors (Camry 3.0L V6 & Camry Solara 3.0L V6)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensor is located at flywheel end of front (radiator side) cylinder head, just below valve cover. Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance), and for controlling fuel injection system, engine idle speed control system, EGR system, heated oxygen sensor system and Acoustic Control Induction System (ACIS).

Camshaft & Crankshaft Position Sensors (Celica, Corolla, ECHO, Highlander 2.4L 4-Cyl., MR2, Prius & RAV4)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM).

Camshaft position sensor may also be referred to as Variable Valve Timing (VVT) sensor. On Celica, Corolla and MR2, camshaft position sensor is located just above intake manifold on cylinder head, at flywheel end of engine. On ECHO, Highlander, Prius and RAV4, camshaft position sensor is located on end of cylinder head at flywheel end of engine. On all models, crankshaft position sensor is located on front of engine, near crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance), and for controlling fuel injection system, engine idle speed control system and VVT system.

Camshaft & Crankshaft Position Sensors (Land Cruiser & Sequoia)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensor is located behind driver's side upper timing belt cover, near camshaft sprocket. Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance) and for controlling fuel injection system.

Camshaft & Crankshaft Position Sensors (Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl.)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensor is located at driver's side front corner of cylinder head, just in front of intake manifold. Crankshaft position sensor is located near crankshaft pulley, just above oil pan on driver's side of engine. ECM may use input signals for determining ignition timing (spark advance), and for controlling fuel injection system and heated oxygen sensor system.

Camshaft & Crankshaft Position Sensors (Tacoma 3.4L V6, Tundra 3.4L V6 & 4Runner)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensor is located behind upper timing belt cover, near passenger's side camshaft sprocket. Crankshaft position sensor is located at front of engine, just above crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance), and for controlling fuel injection system and heated oxygen sensor system.

Camshaft & Crankshaft Position Sensors (Tundra 4.7L V8)

Camshaft position sensor and crankshaft position sensor deliver input signals to Engine Control Module (ECM). Camshaft position sensor is located behind driver's side upper timing belt cover, near camshaft sprocket. Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. ECM may use input signals for determining ignition timing (spark advance) and for controlling fuel injection system.

Center Air Bag Sensor Assembly (Celica, Corolla, Highlander, MR2, RAV4, Sequoia & Sienna)

Center air bag sensor assembly delivers an input signal to Engine Control Module (ECM) if an airbag is deployed. If ECM detects that air bags are deployed, ECM will stop fuel pump operation by opening the circuit opening relay. This operation is referred to as fuel cut control. If fuel cut control has been activated, turning ignition switch from OFF position to ON position cancels the fuel cut control operation and fuel pump will operate. Center air bag sensor assembly may also be referred to as air bag sensor assembly.

Center Air Bag Sensor Assembly (Prius)

Center air bag sensor assembly delivers an input signal to Hybrid Vehicle (HV) control Electronic Control Unit

(ECU) if an airbag is deployed. Hybrid vehicle control ECU is referred to as HV ECU. The HV ECU then delivers input signal to Engine Control Module (ECM). If air bags are deployed, ECM will stop fuel pump operation by opening the circuit opening relay. This operation is referred to fuel cut control. If fuel cut control has been activated, turning ignition switch from OFF position to ON position cancels the fuel cut control operation and fuel pump will operate. Center air bag sensor assembly may also be referred to as air bag sensor assembly.

EGR Gas Temperature Sensor (Camry 3.0L V6, Camry Solara 3.0L V6 & Tacoma 2.7L 4-Cyl. 3RZ-FE)

EGR gas temperature sensor monitors EGR gas temperature and delivers an input signal to Engine Control Module (ECM). EGR gas temperature sensor is located near EGR valve.

EGR Position Sensor (Camry 3.0L V6 & Camry Solara 3.0L V6)

EGR position sensor monitors movement of EGR valve and delivers an input signal to Engine Control Module (ECM). ECM uses this input signal to obtain the correct amount of EGR valve opening in relation to the engine operation. EGR position sensor may also be referred to as EGR valve position sensor. EGR position sensor is mounted on EGR valve.

Electrical Load Signal (Avalon, Camry, Camry Solara, Corolla & Sienna)

An input signal is delivered to ELS and ELS2 terminals of Engine Control Module (ECM) to indicate when high electrical output is required. This signal is delivered when items such as headlights or rear window defroster are turned on. ECM may use input signal to maintain proper engine idle speed.

Electrical Load Signal (ECHO)

On vehicles equipped for cold areas, an input signal is delivered to ELS terminal of Engine Control Module (ECM) to indicate when high electrical output is required. This may occur when HTR SUB1 relay is energized to provide voltage to Positive Temperature Coefficient (PTC) heater. PTC heater is a small electrical heater located in the heater core. PTC heater will be turned on when engine coolant temperature is less than 176°F (80°C), engine speed is greater than 1050 RPM, generator power ratio is less than 95 percent and heater temperature control switch is positioned in maximum heat range. ECM may use input signal to maintain proper engine idle speed.

Electrical Load Signal (Land Cruiser, RAV4, Sequoia, Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl., & Tundra 4.7L V8)

An input signal is delivered to ELS terminal of Engine Control Module (ECM) to indicate when high electrical output is required. This signal is delivered when items such as rear window defroster or headlights are turned on. ECM may use input signal to maintain proper engine idle speed.

Engine Coolant Temperature Sensor (All Models)

Engine Coolant Temperature (ECT) sensor contains a built-in thermistor in which resistance varies according to engine coolant temperature. ECT delivers an input signal to THW terminal of Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance), and for controlling fuel injection system, engine idle speed control system, heated oxygen sensor system (if equipped), EGR system (if equipped) and operation of electronically controlled transaxles/transmissions (if equipped). For ECT sensor location, see

ENGINE COOLANT TEMPERATURE SENSOR under ENGINE SENSORS & SWITCHES in appropriate REMOVAL, OVERHAUL & INSTALLATION article.

Engine Cranking Signal (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, Land Cruiser, MR2, RAV4, Sequoia, Sienna, Tacoma, Tundra & 4Runner)

While engine is cranking and voltage is applied to the starter, an input signal is also delivered to STA or NSW terminal of Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance) and for controlling fuel injection system.

Heated Oxygen Sensor (All Models)

Heated oxygen sensor monitors exhaust gas oxygen content and delivers an input signal to Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance) and for controlling fuel injection system. Some models may be equipped with more than one heated oxygen sensor. A heater is used to warm oxygen sensor to improve heated oxygen sensor detection operation. Heater is controlled by ECM.

Intake Air Temperature Sensor (All Models)

Intake air temperature sensor is located in airflow meter. Intake air temperature sensor measures incoming intake air temperature and delivers an input signal to THA terminal of Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance) and for controlling fuel injection system.

Knock Sensor (Avalon, Camry 3.0L V6, Camry Solara 3.0L V6, Highlander 3.0L V6, Land Cruiser, Sequoia, Sienna & Tundra 4.7L V8)

Knock sensors No. 1 and 2 monitor ignition knock conditions and deliver input signals to KNKR and KNKL terminals of Engine Control Module (ECM). ECM may use input signals for determining ignition timing (spark advance) and for controlling fuel injection system. For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - V6 & V8 article.

Knock Sensor (Camry 2.4L 4-Cyl., Camry Solara 2.4L 4-Cyl., Celica, Corolla, ECHO, Highlander 2.4L 4-Cyl., MR2, Prius, RAV4 & Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl.)

Knock sensor monitors ignition knock conditions and delivers input signal to KNK1 terminal of Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance) and for controlling fuel injection system. For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - 4-CYLINDER article.

Knock Sensor (Tacoma 3.4L V6, Tundra 3.4L V6 & 4Runner)

Knock sensors No. 1 and 2 monitor ignition knock conditions and deliver input signals to KNK1 and KNK2 terminals of Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance) and for controlling fuel injection system. For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - V6 & V8 article.

Park/Neutral Position Switch (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, Land Cruiser,

RAV4, Sequoia, Sienna, Tacoma, Tundra & 4Runner)

Park/Neutral Position (PNP) switch is used only on A/T models. PNP switch delivers an input signal to Engine Control Module (ECM) to indicate transaxle or transmission gear position. ECM may use input signal to control engine idle speed and fuel injection system. PNP switch is located on side of transaxle or transmission.

Park/Neutral Position Switch (Prius)

Park/Neutral Position (PNP) switch is used only for the hybrid vehicle control system which controls the electric transaxle. PNP switch delivers an input signal to Hybrid Vehicle (HV) control Electronic Control Unit (ECU) to indicate transaxle gear position instead of the Engine Control Module (ECM) like all other models. Hybrid vehicle control ECU is referred to as HV ECU. The HV ECU uses input signal for controlling vehicle movement. PNP switch is located on end of shift lever assembly on steering column and may also be referred to as shift position sensor.

Power Steering Pressure Sensor (ECHO)

Power steering pressure sensor delivers an input signal to ECM to indicate power steering pressure. ECM may use input signal to control engine idle speed. Power steering pressure sensor may also be referred to as power steering oil pressure sensor. Power steering pressure sensor is located on side of power steering pump.

Power Steering Pressure Switch (Avalon, Camry, Camry Solara, Celica, Corolla, Highlander, RAV4, Sienna, Tacoma, Tundra 3.4L V6 & 4Runner)

Power steering pressure switch delivers an input signal to Engine Control Module (ECM) to indicate power steering pressure. ECM may use input signal to control engine idle speed. Power steering pressure switch may also be referred to as power steering oil pressure switch. Power steering pressure switch is located on power steering pump or near pressure hose at power steering pump.

Temperature Control Switch (ECHO)

On vehicles equipped for cold areas, temperature control switch operates a maximum hot switch which provides an input signal to Engine Control Module (ECM) for controlling Positive Temperature Coefficient (PTC) heater. PTC heater is a small electrical heater located in the heater core. Maximum hot switch may also be referred to as MAX HOT switch. For additional information on PTC heater, see **POSITIVE TEMPERATURE COEFFICIENT HEATER** under MISCELLANEOUS CONTROLS.

Throttle Position Sensor (Avalon, Camry Solara 3.0L V6, Celica, Corolla, ECHO, Highlander, MR2 With Standard Type Manual Transaxle, RAV4, Sienna, Tacoma & Tundra 3.4L V6)

Throttle Position (TP) sensor is located on throttle body. TP sensor delivers an input signal indicating throttle position to Engine Control Module (ECM). ECM may use input signal for determining ignition timing (spark advance), and for controlling fuel injection system, idle speed control system and various other systems.

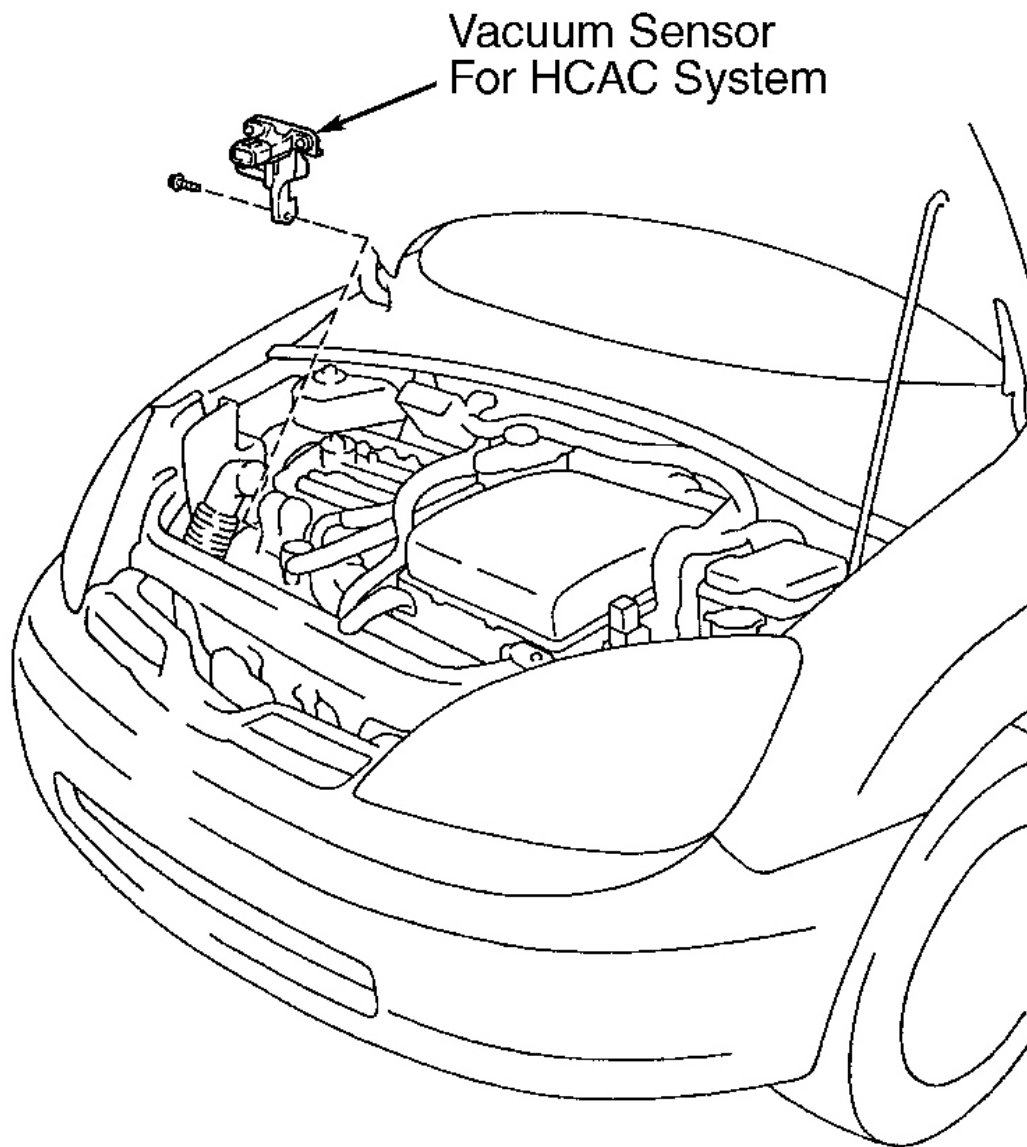
Throttle Position Sensor (Camry, Camry Solara 2.4L 4-Cyl., Land Cruiser, MR2 With Sequential Manual Transaxle, Prius, Sequoia, Tundra 4.7L V8 & 4Runner)

Throttle Position (TP) sensor is used with Electronic Throttle Control System (ETCS) for control of the throttle

operation. See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS for additional information.

Vacuum Sensor For Hydrocarbon Adsorber Catalyst System (Prius)

Vacuum sensor provides input signal to Engine Control Module (ECM). ECM uses input signal for controlling the Hydrocarbon Adsorber Catalyst (HCAC) system. For additional information on HCAC system, see **HYDROCARBON ADSORBER CATALYST SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS. Vacuum sensor is located at passenger's side front corner of the engine. See **Fig. 50** .



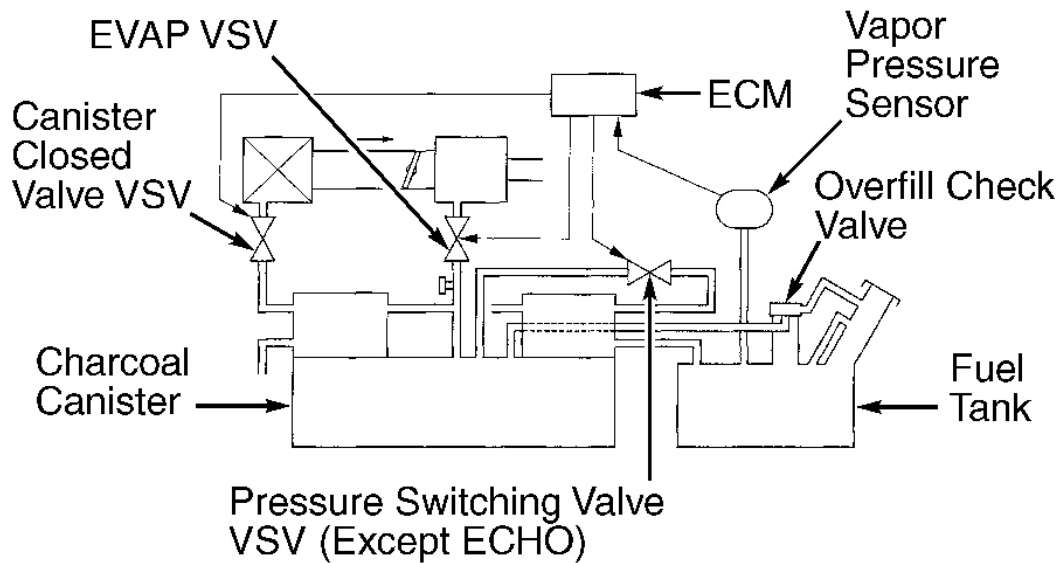
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Fig. 50: Locating Vacuum Sensor For HCAC System (Prius)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Vapor Pressure Sensor (Avalon, Camry, Camry Solara, Celica, Corolla, Highlander, MR2, RAV4, Sequoia, Sienna, Tacoma & 4Runner)

Vapor pressure sensor, pressure switching valve Vacuum Switching Valve (VSV) and canister closed valve Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in the EVAP system. See **Fig. 51** . EVAP system may also be referred to as fuel evaporative system. Engine Control Module (ECM)

determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. If a leak or abnormality exists, a Diagnostic Trouble Code (DTC) will be stored in the ECM. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Canister closed valve VSV may also be referred to as EVAP Canister Closed Valve Vacuum Switching Valve (EVAP-CCVVS) or Canister Closed Valve Vacuum Switching Valve (CCV VSV). Pressure switching valve VSV may also be referred to as EVAP Pressure Switching Valve Vacuum Switching Valve (EVAP-PSVVS). EVAP canister may also be referred to as charcoal canister.



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Fig. 51: Identifying Typical EVAP System Components (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, MR2, RAV4, Sequoia, Sienna, Tacoma & 4Runner)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

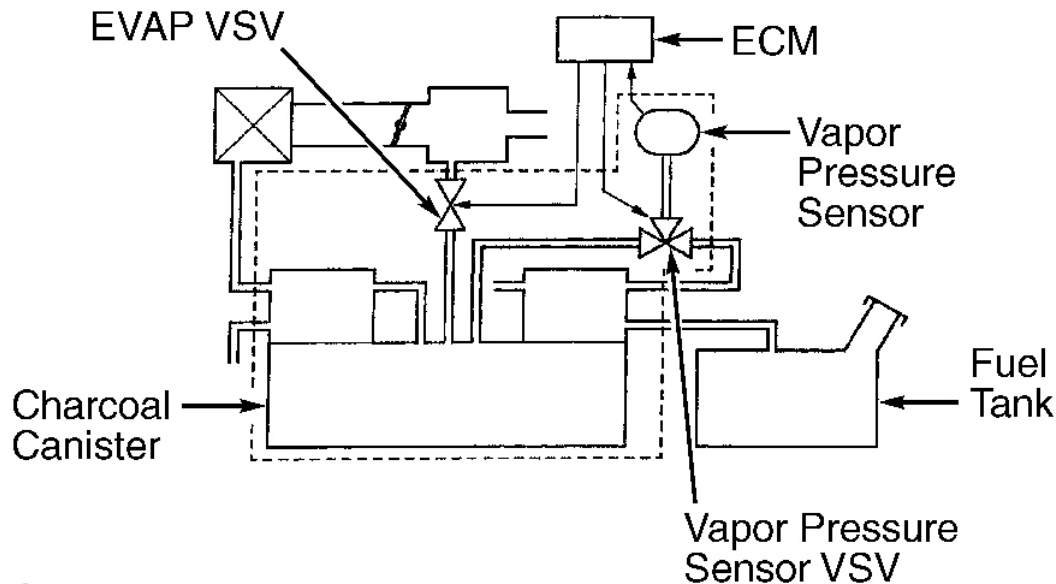
Vapor Pressure Sensor (ECHO)

Vapor pressure sensor and canister closed valve Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in the EVAP system. See **Fig. 51** . EVAP system may also be referred to as fuel evaporative system. Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. If a leak or abnormality exists, a DTC will be stored in the ECM. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Canister closed valve VSV may also be referred to as EVAP Canister Closed Valve Vacuum Switching Valve (EVAP-CCVVS) or Canister Closed Valve Vacuum Switching Valve (CCV VSV). EVAP canister may also be referred to as charcoal canister.

Vapor Pressure Sensor (Land Cruiser & Tundra)

Vapor pressure sensor and vapor pressure sensor Vacuum Switching Valve (VSV) are used to determine if a

leak or an abnormality exists in the EVAP system. See **Fig. 52** . Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. EVAP system may also be referred to as fuel evaporative system. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Vapor pressure sensor VSV may also be referred to as EVAP Vapor Pressure Sensor Vacuum Switching Valve (EVAP-VPSVSV).

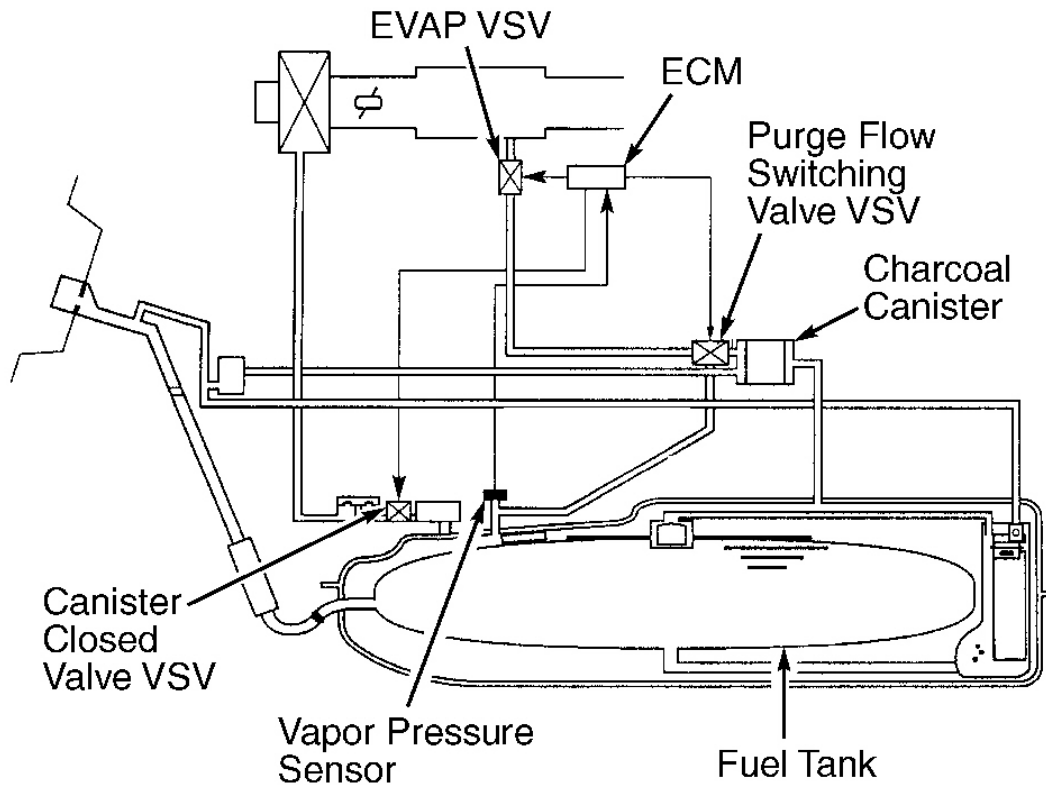


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Fig. 52: Identifying Typical EVAP System Components (Land Cruiser & Tundra)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Vapor Pressure Sensor (Prius)

Vapor pressure sensor, purge flow switching valve Vacuum Switching Valve (VSV) and canister closed valve Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in the EVAP system. See **Fig. 53** . EVAP system may also be referred to as fuel evaporative system. Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. If a leak or abnormality exists, a Diagnostic Trouble Code (DTC) will be stored in the ECM. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Canister closed valve VSV may also be referred to as EVAP Canister Closed Valve Vacuum Switching Valve (EVAP-CCVSV) or Canister Closed Valve Vacuum Switching Valve (CCV VSV). Purge flow switching valve VSV may also be referred to as EVAP Purge Flow Switching Valve Vacuum Switching Valve (EVAP-PFSVSV). EVAP canister may also be referred to as charcoal canister.



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Fig. 53: Identifying EVAP System Components (Prius)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Variable Valve Timing Sensor (Avalon, Highlander 3.0L V6 & Sienna)

See **CAMSHAFT & CRANKSHAFT POSITION SENSORS (AVALON, HIGHLANDER 3.0L V6 & SIENNA)** .

Variable Valve Timing Sensor (Camry 2.4L 4-Cyl. & Camry Solara 2.4L 4-Cyl.)

See **CAMSHAFT & CRANKSHAFT POSITION SENSORS (CAMRY 2.4L 4-CYL. & CAMRY SOLARA 2.4L 4-CYL.)** .

Variable Valve Timing Sensor (Celica, Corolla, ECHO, Highlander 2.4L 4-Cyl., MR2, Prius & RAV4)

See **CAMSHAFT & CRANKSHAFT POSITION SENSORS (CELICA, COROLLA, ECHO, HIGHLANDER 2.4L 4-CYL., MR2, PRIUS & RAV4)** .

Vehicle Speed Sensor (Avalon)

Wheel speed sensors on each wheel deliver an input signal to Anti-Lock Brake System (ABS) Electronic Control Unit (ECU). ABS ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transaxle and various other systems. On models with traction control, ABS ECU may also be referred to as ABS & BA (Brake Assist) & TRAC & Vehicle Skid Control (VSC) ECU. On models without traction control, ABS ECU may also be referred to as ABS actuator and ECU.

Vehicle Speed Sensor (Camry 2.4L 4-Cyl.)

Vehicle speed sensor is mounted near rear of transaxle. Vehicle speed sensor outputs a 4-pulse input signal for every revolution of the drive gear in transaxle to the instrument cluster where input signal is converted to a rectangular waveform and then sent to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transaxle (if equipped) and various other systems.

Vehicle Speed Sensor (Camry 3.0L V6)

Wheel speed sensors on each wheel deliver an input signal to skid control Electronic Control Unit (ECU). Skid control ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transaxle and various other systems.

Vehicle Speed Sensor (Camry Solara, Celica, Corolla, ECHO, Land Cruiser, RAV4, Sequoia, Tacoma & Tundra)

Vehicle speed sensor is mounted near rear of transaxle or transmission. Vehicle speed sensor outputs a 4-pulse input signal for every revolution of the drive gear in transaxle or transmission to the instrument cluster where input signal is converted to a rectangular waveform and then sent to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transaxle or transmission (if equipped) and various other systems.

Vehicle Speed Sensor (Highlander)

Wheel speed sensors on each wheel deliver an input signal to skid control Electronic Control Unit (ECU). Skid control ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transaxle and various other systems.

Vehicle Speed Sensor (MR2)

Wheel speed sensors on each wheel deliver an input signal to Anti-Lock Brake System (ABS) Electronic Control Unit (ECU). ABS ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then

sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM uses input signal for controlling fuel injection system, electronically controlled automatic transaxle and various other systems.

Vehicle Speed Sensor (Prius)

Wheel speed sensors on each wheel deliver an input signal to brake Electronic Control Unit (ECU) for the Anti-Lock Brake System (ABS). Brake ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system and vehicle operation.

Vehicle Speed Sensor (Sienna)

Wheel speed sensors on each wheel deliver an input signal to Anti-Lock Brake System (ABS) Electronic Control Unit (ECU). ABS ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transaxle and various other systems. On models with Vehicle Skid Control (VSC), ABS ECU may also be referred to as VSC ECU. On models without VSC, ABS ECU may also be referred to as ABS actuator and ECU.

Vehicle Speed Sensor (4Runner)

Wheel speed sensors on each wheel deliver an input signal to Vehicle Skid Control (VSC) Electronic Control Unit (ECU). VSC ECU converts input signals from wheel speed sensors to a 4-pulse input signal to the instrument cluster. Instrument cluster then converts 4-pulse input signal to a rectangular waveform and then sends input signal to Engine Control Module (ECM). ECM determines vehicle speed by using input signal. ECM may use input signal for controlling fuel injection system, electronically controlled automatic transmission and various other systems.

4WD Input (Land Cruiser, Sequoia, Tacoma, Tundra & 4Runner)

On 4WD models, Engine Control Module (ECM) receives an input signal from transfer L4 position switch and transfer neutral position switch to indicate transfer case position.

OUTPUT SIGNALS

NOTE: Vehicles are equipped with different combinations of computer-controlled components. Not all components listed below are used on every vehicle. For theory and operation on each output component, refer to system indicated after component.

Engine Control Module (ECM) receives input from data sensors and switches, depending on model application, to control following components and sub-systems:

Accelerator Pedal Position Sensor

See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS.

Acoustic Control Induction System

See **ACOUSTIC CONTROL INDUCTION SYSTEM** under AIR INDUCTION SYSTEMS.

Acoustic Control Induction System Vacuum Switching Valve

See **ACOUSTIC CONTROL INDUCTION SYSTEM** under AIR INDUCTION SYSTEMS.

Active Control Mount Vacuum Switching Valve

See **ACTIVE CONTROL ENGINE MOUNT** under MISCELLANEOUS CONTROLS.

A/C-Cut Control System

See **IDLE SPEED** under FUEL SYSTEMS.

A/F Heater Relay

See **FUEL DELIVERY** under FUEL SYSTEMS.

Air Intake Control Valve (AICV) Vacuum Switching Valve (VSV)

See **AIR INTAKE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS.

Canister Closed Valve Vacuum Switching Valve

See **FUEL EVAPORATIVE SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS.

Circuit Opening Relay

See **FUEL DELIVERY** under FUEL SYSTEMS.

EGR Vacuum Switching Valve

See **EXHAUST GAS RECIRCULATION CONTROL** under EMISSION SYSTEMS & SUB-SYSTEMS.

Electronically Controlled Transmission/Transaxle

See **TRANSMISSION/TRANSAXLE CONTROLS** under MISCELLANEOUS CONTROLS.

Electronic Spark Advance System

See **DISTRIBUTORLESS IGNITION SYSTEM** under IGNITION SYSTEMS.

EVAP Vacuum Switching Valve

See **FUEL EVAPORATIVE SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS.

Fuel Pump

See **FUEL DELIVERY** under FUEL SYSTEMS.

Fuel Pump Relay

See **FUEL DELIVERY** under FUEL SYSTEMS.

Hydrocarbon Adsorber Catalyst System Vacuum Switching Valve

See **HYDROCARBON ADSORBER CATALYST SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS.

HRT SUB1 Relay

See **POSITIVE TEMPERATURE COEFFICIENT HEATER** under MISCELLANEOUS CONTROLS.

Idle Speed Control System

See **IDLE SPEED** under FUEL SYSTEMS.

IG2 Relay

See **IG2 RELAY** under MISCELLANEOUS CONTROLS.

Pressure Switching Valve Vacuum Switching Valve

See **FUEL EVAPORATIVE SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS.

Purge Flow Switching Valve Vacuum Switching Valve

See **FUEL EVAPORATIVE SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS.

Self-Diagnostic System

See **SELF-DIAGNOSTIC SYSTEMS** .

Throttle Control Motor

See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS.

Vapor Pressure Sensor Vacuum Switching Valve

See **FUEL EVAPORATIVE SYSTEM** under EMISSION SYSTEMS & SUB-SYSTEMS.

Variable Valve Lift Oil Control Valve

Variable Valve Lift (VVL) oil control valve may also be referred to as Oil Control Valve (OCV). See **VARIABLE VALVE LIFT SYSTEM** .

Variable Valve Timing Camshaft Timing Oil Control Valve

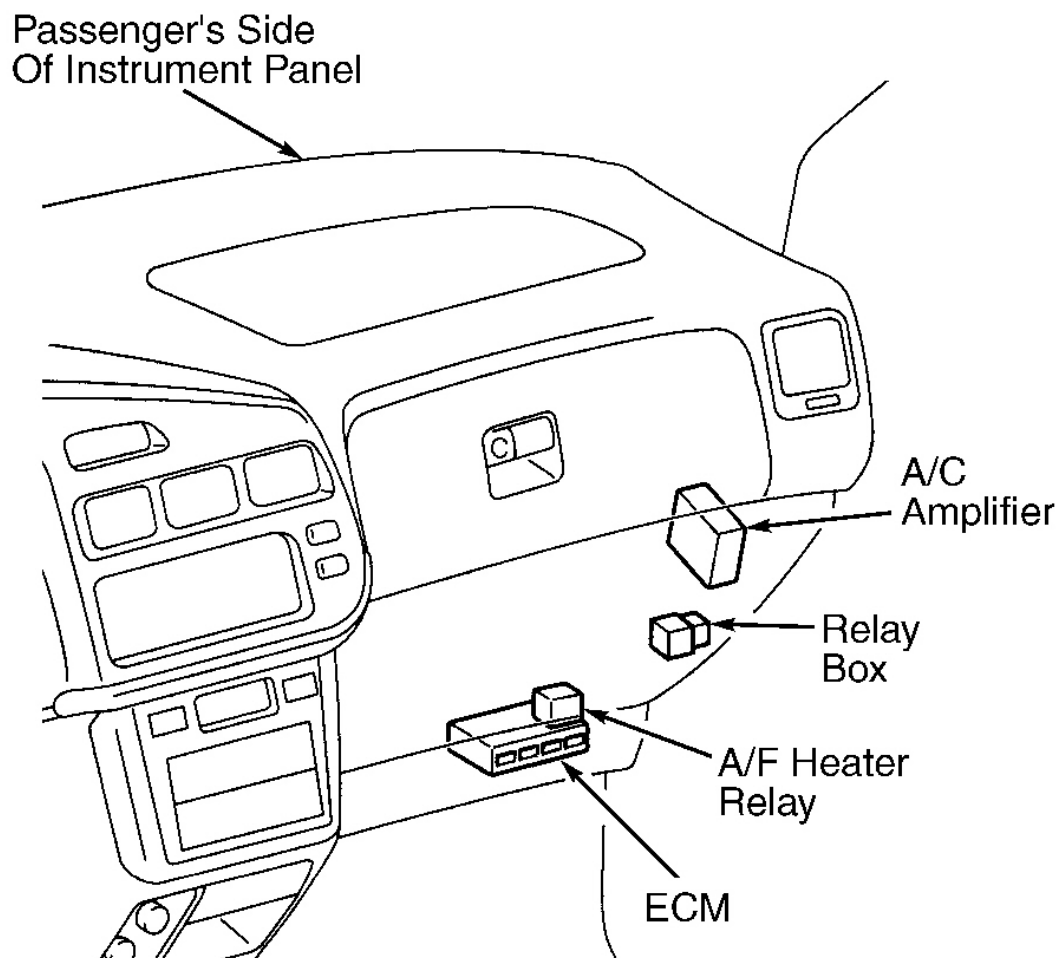
Variable Valve Timing (VVT) camshaft timing oil control valve may also be referred to as oil control valve or VVT Oil Control Valve (OCV). See **VARIABLE VALVE TIMING SYSTEM** .

FUEL SYSTEMS

FUEL DELIVERY

A/F Heater Relay (Avalon, Camry 3.0L V6, Camry Solara 3.0L V6 With A/T, Highlander & Sienna)

A/F heater relay may also be referred to as A/F HTR relay, A/F sensor relay or A/F relay. Constant battery voltage is supplied from battery, through A/F heater fuse to one side of A/F heater relay. A/F heater fuse may also be referred to as A/F fuse. A/F heater relay is energized by MREL terminal of Engine Control Module (ECM). When A/F heater relay is energized, A/F heater relay provides battery voltage to +B terminal at Air Fuel (A/F) sensors. For A/F heater relay location, see **A/F HEATER RELAY LOCATION** table.



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Fig. 54: Locating A/F Heater Relay (Sienna)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

A/F Heater Relay (RAV4)

A/F heater relay may also be referred to as A/F HTR relay, A/F sensor relay or A/F relay. Constant battery voltage is supplied from battery, through A/F heater fuse to one side of A/F heater relay. A/F heater fuse may also be referred to as A/F fuse. When EFI main relay is energized, voltage is supplied to other side of A/F heater relay and A/F heater relay is energized. When A/F heater relay is energized, A/F heater relay provides battery voltage to +B terminal at Air Fuel (A/F) sensors. For A/F heater relay location, see **A/F HEATER RELAY LOCATION** table.

A/F HEATER RELAY LOCATION

Application	Location
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Avalon & Camry	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
Camry Solara	In Small Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment, In Front Of Battery
Highlander	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment, Just In Front Of Strut Tower
RAV4	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
Sienna	(1)
(1) Located near Engine Control Module (ECM) behind passenger's side of instrument panel and contains a 4-pin connector. See Fig. 54 .	

Circuit Opening Relay (Avalon)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied from ignition switch to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (Camry)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied through IG2 fuse to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (Camry Solara & Highlander)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied through IGN fuse to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (Celica, ECHO & Prius)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to both sides of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT**

OPENING RELAY LOCATION table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (Corolla)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to both sides of circuit opening relay. EFI main relay may also be referred to as EFI relay or F-HTR relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (MR2)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied from ignition switch to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (RAV4)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied to other side of circuit opening relay from IG2 fuse. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (Sequoia)

Circuit opening relay controls fuel pump circuit by supplying voltage to fuel pump relay. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied through IGN1 fuse to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump relay which supplies voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article. For operation of fuel pump relay, see **FUEL PUMP RELAY & FUEL PUMP RESISTOR (SEQUOIA & TUNDRA 4.7L V8)** .

Circuit Opening Relay (Sienna & Tacoma)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage

to one side of circuit opening relay. When ignition is turned on, voltage is supplied through IGN fuse to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

Circuit Opening Relay (Tundra 3.4L V6)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to both sides of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article

Circuit Opening Relay (Tundra 4.7L V8)

Circuit opening relay controls fuel pump circuit by supplying voltage to fuel pump relay. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied through IGN fuse to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump relay which supplies voltage for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article. For operation of fuel pump relay, see **FUEL PUMP RELAY & FUEL PUMP RESISTOR (SEQUOIA & TUNDRA 4.7L V8)** .

Circuit Opening Relay (4Runner)

Circuit opening relay controls fuel pump circuit. When EFI main relay is energized, it provides battery voltage to one side of circuit opening relay. When ignition is turned on, voltage is supplied through IGN fuse to other side of circuit opening relay. When proper input signals are delivered to Engine Control Module (ECM), circuit opening relay ground circuit is grounded at ECM terminal FC. Circuit opening relay then provides voltage to fuel pump for fuel pump operation. For circuit opening relay location, see **CIRCUIT OPENING RELAY LOCATION** table. Circuit opening relay may also be identified by appropriate illustration in appropriate SYSTEM & COMPONENT TESTING article.

CIRCUIT OPENING RELAY LOCATION ⁽¹⁾

Application	Location
Avalon	Top Corner Of Relay Box Behind Driver's Side Kick Panel
Camry & Camry Solara	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
Celica	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment, Just In Front Of Strut Tower
Corolla	Center Relay In Relay Box Behind Driver's Side Kick Panel

ECHO	In Fuse/Relay Box Behind Driver's Side Of Instrument Panel
Highlander	In Relay Box Just Above Driver's Side Kick Panel
MR2	In Relay Box On Firewall At Driver's Side Front Corner Of Engine Compartment
Prius & RAV4	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
Sequoia & Sienna	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
Tacoma	Behind Lower Instrument Panel Cover, Next To Driver's Side Of Steering Column
Tundra	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
4Runner	Below Right Corner Of Fuse/Relay Box, Behind Lower Instrument Panel Cover At Driver's Side Of Instrument Panel To Left Of Steering Column, Just Above Hood Release Lever
(1) Circuit opening relay may be marked as CIR OPN relay.	

EFI Main Relay (Avalon)

EFI main relay may also be referred to as EFI relay. EFI No. 1 fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, EFI No. 2 fuse, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Camry & Camry Solara)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Celica)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM, EFI No. 1 and 2 fuses, and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Corolla)

EFI main relay may also be referred to as EFI relay or F-HTR relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI fuse may also be referred to as F-HTR fuse. When ignition is turned on, voltage is supplied through IGN fuse to other side of EFI main relay. EFI main relay is then energized and provides battery voltage to circuit opening relay, +B terminal of Engine Control Module (ECM) and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (ECHO)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. When ignition is turned on, voltage is supplied to other side of EFI main relay. EFI main relay is then energized and provides battery voltage to circuit opening relay, +B terminal of Engine Control Module (ECM) and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Highlander)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Land Cruiser)

EFI main relay may also be referred to as EFI relay or ECD relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI fuse may also be referred to as ECD fuse. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to +B terminal of fuel pump Electronic Control Unit (ECU), +B and +B1 terminals of ECM and various other electrical components. For operation of fuel pump ECU and fuel pump switch, see **FUEL PUMP ELECTRONIC CONTROL UNIT & FUEL PUMP SWITCH (LAND CRUISER)** . For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (MR2)

EFI main relay may also be referred to as EFI relay. EFI No. 1 fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Prius)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (RAV4)

EFI main relay may also be referred to as EFI relay. EFI No. 2 fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, A/F heater relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN**

RELAY LOCATION table.

EFI Main Relay (Sequoia)

EFI main relay may also be referred to as EFI relay. EFI No. 1 fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to +B and +B1 terminals of ECM, circuit opening relay, EFI No. 2 fuse and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Sienna)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl.)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. When ignition is turned on, voltage is supplied through IGN fuse to other side of EFI main relay. EFI main relay is then energized and provides battery voltage to circuit opening relay, +B terminal of Engine Control Module (ECM) and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Tacoma 3.4L V6)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Tundra 3.4L V6)

EFI main relay may also be referred to as EFI relay. EFI No. 1 fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI Main Relay (Tundra 4.7L V8)

EFI main relay may also be referred to as EFI relay. EFI fuse No. 1 supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B and +B1 terminals of ECM, EFI fuse No. 2 and various other electrical components. For EFI main relay location, see

EFI MAIN RELAY LOCATION table.

EFI Main Relay (4Runner)

EFI main relay may also be referred to as EFI relay. EFI fuse supplies constant battery voltage to one side of EFI main relay. EFI main relay is energized by MREL terminal of Engine Control Module (ECM). When EFI main relay is energized, EFI main relay provides battery voltage to circuit opening relay, +B terminal of ECM and various other electrical components. For EFI main relay location, see **EFI MAIN RELAY LOCATION** table.

EFI MAIN RELAY LOCATION

Application	Location
Avalon, Camry & Camry Solara	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
Celica, Corolla, ECHO & Highlander	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment, Just In Front Of Strut Tower
Land Cruiser	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment
MR2	In Relay Box On Firewall At Driver's Side Front Corner Of Engine Compartment
Prius, RAV4, Sequoia, Sienna, Tacoma, Tundra & 4Runner	In Fuse/Relay Box At Driver's Side Front Corner Of Engine Compartment

Fuel Pump (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, MR2, Prius, RAV4, Sienna, Tacoma, Tundra 3.4L V6 & 4Runner)

Electric fuel pump is mounted in fuel tank. Fuel pump operates at one specified speed.

Fuel Pump (Land Cruiser)

Electric fuel pump is mounted in fuel tank. Fuel pump operating speed is varied by use of fuel pump Electronic Control Unit (ECU). For additional information, see **FUEL PUMP ELECTRONIC CONTROL UNIT & FUEL PUMP SWITCH (LAND CRUISER)** .

Fuel Pump (Sequoia & Tundra 4.7L V8)

Electric fuel pump is mounted in fuel tank. Fuel pump operating speed is controlled by operating condition of the engine such as: starting, idling, light load or heavy load. This is accomplished by use of fuel pump resistor and fuel pump relay. For operation of fuel pump relay and fuel pump resistor, see **FUEL PUMP RELAY & FUEL PUMP RESISTOR (SEQUOIA & TUNDRA 4.7L V8)** .

Fuel Pump Electronic Control Unit & Fuel Pump Switch (Land Cruiser)

Fuel pump operating speed is controlled by engine operating conditions such as: starting, idling, light load or heavy load. Engine Control Module (ECM) delivers an input signal from FPC terminal on ECM to FPC terminal on fuel pump Electronic Control Unit (ECU) in accordance with engine operating condition. Fuel

pump ECU uses this input signal to determine how much voltage should be delivered to fuel pump for varying fuel pump operating speed. When engine starts, or engine is under heavy load at high speeds, ECM delivers input signal of approximately 3.8 volts to fuel pump ECU. Fuel pump ECU then delivers approximately battery voltage to fuel pump and fuel pump operates at high speed. When engine is under heavy load at low speeds, ECM delivers an input signal of approximately 2.5 volts to fuel pump ECU. Fuel pump ECU then delivers approximately 10 volts to fuel pump and fuel pump operates at medium speed. When engine is idling or under light loads, ECM delivers an input signal of approximately 1.3 volts to fuel pump ECU. Fuel pump ECU then delivers approximately 8.5 volts to fuel pump and fuel pump operates at low speed. If a problem exists in fuel pump ECU or control circuit, Diagnostic Trouble Code (DTC) P1200 may be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. Fuel pump ECU is located behind inner panel, just behind driver's rear wheelwell. See **Fig. 55** .

Fuel pump switch is in the circuit between FPC terminal on ECM and FPC terminal on fuel pump ECU. Fuel pump switch may also be referred to as fuel pump inertia switch or fuel pump control switch. If vehicle is involved in a collision, fuel pump switch will shut off the fuel pump by opening this circuit, and not allowing any input signal to be delivered from ECM to fuel pump ECU. Fuel pump switch is located on driver's side of instrument panel. See **Fig. 56** . Fuel pump switch contains a reset switch which has an OFF and ON position. See **Fig. 56** . Continuity will exist between electrical terminals on fuel pump switch with reset switch in the ON position and no continuity in the OFF position. Reset switch must be in ON position for fuel pump operation.

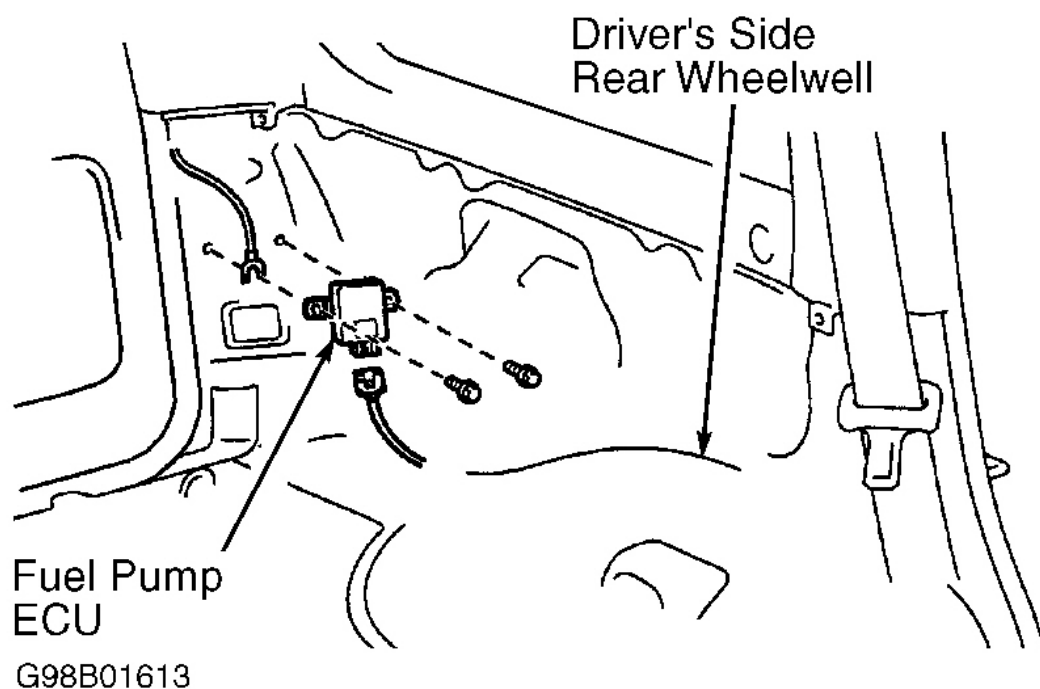


Fig. 55: Locating Fuel Pump Electronic Control Unit (Land Cruiser)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

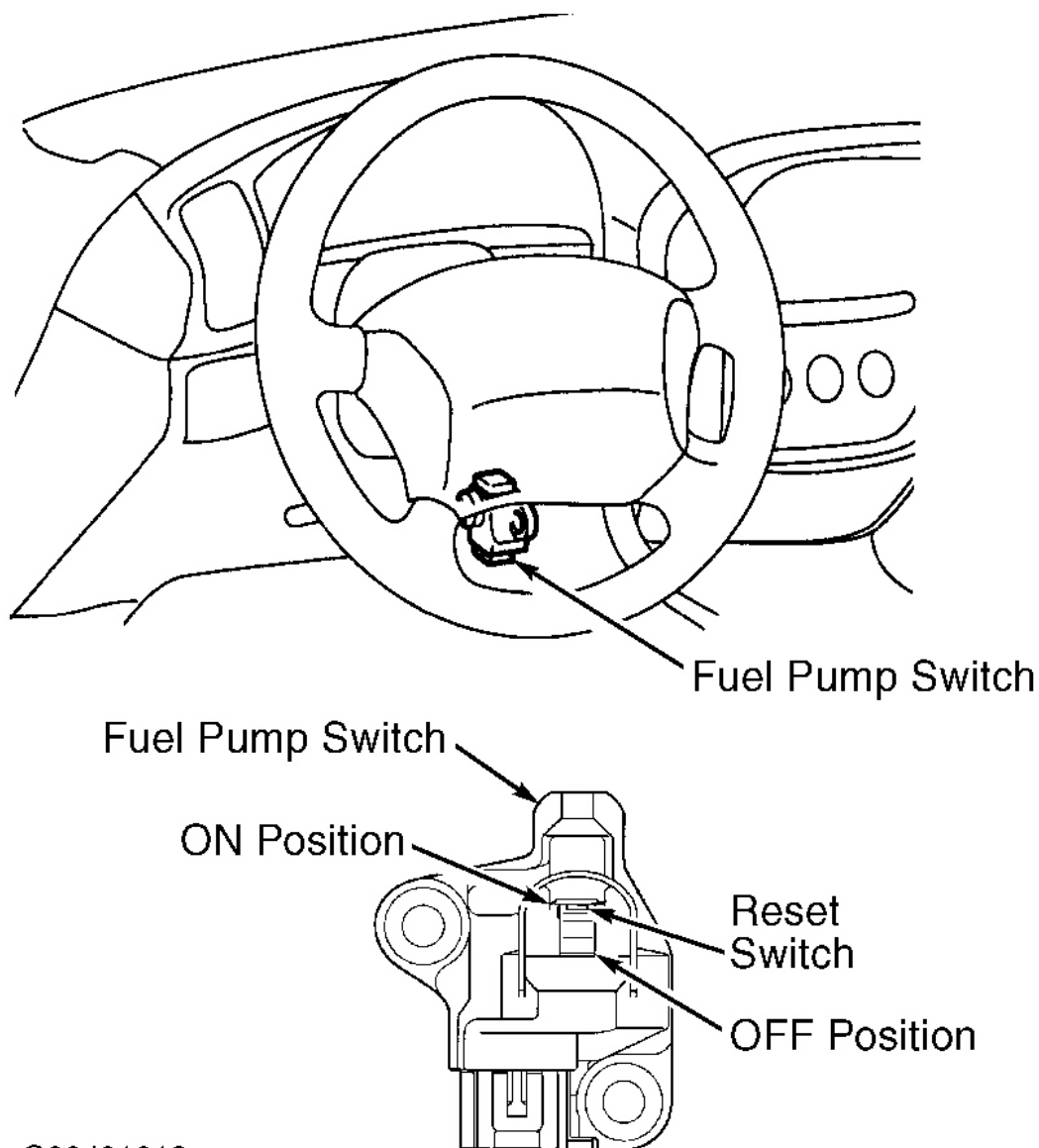


Fig. 56: Locating Fuel Pump Switch & Identifying Reset Switch Positions (Land Cruiser)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Fuel Pump Relay & Fuel Pump Resistor (Sequoia & Tundra 4.7L V8)

Fuel pump operating speed is controlled by operating condition of the engine such as; starting, idling, light load or heavy load. When engine is cranking and start signal is received at Engine Control Module (ECM), the ECM energizes circuit opening relay and voltage is applied to both sides of fuel pump relay. Fuel pump relay contacts are closed on one side and voltage is applied directly to fuel pump in which fuel pump operates at high speed.

After engine starts during idling or light loads, fuel pump relay is energized by FPR terminal of ECM and contacts in fuel pump relay close to other side of relay. Voltage is then supplied to fuel pump by going from fuel pump relay through fuel pump resistor. Fuel pump now operates at low speed. Fuel pump relay is located in fuse/relay box at driver's side front corner of engine compartment. Fuel pump resistor is located at driver's side front corner of engine compartment, near end of fuse/relay box. See **Fig. 57** .

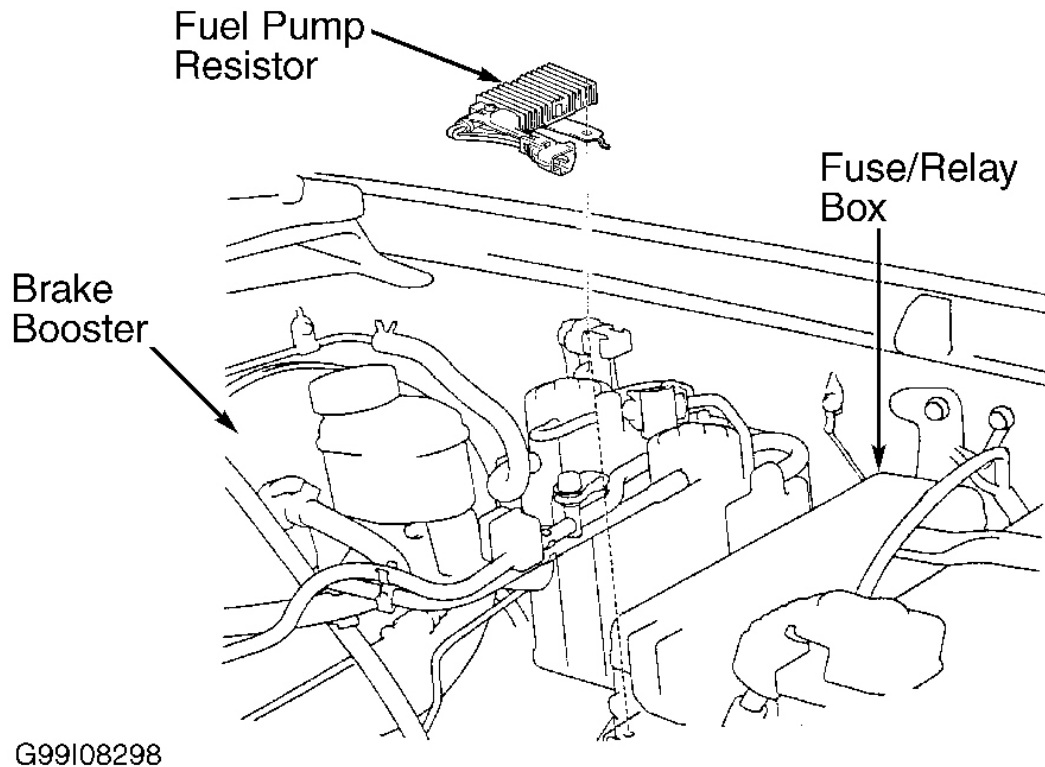


Fig. 57: Locating Fuel Pump Resistor (Sequoia & Tundra 4.7L V8)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Fuel Pressure Regulator (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, MR2, Prius, RAV4 & Sienna)

Fuel system is a returnless type system with fuel pressure regulator mounted on fuel pump in the fuel tank. Fuel pressure regulator maintains constant fuel pressure to the fuel injectors.

Fuel Pressure Regulator (Land Cruiser, Sequoia, Tacoma & Tundra)

Fuel pressure regulator is mounted on the fuel rail and maintains constant fuel pressure to fuel injectors.

IG2 Relay (Avalon, Celica, MR2, Prius & RAV4)

See **IG2 RELAY** under MISCELLANEOUS CONTROLS.

FUEL CONTROL

Fuel Cut System (All Models)

Controlled through input signals, Engine Control Module (ECM) will shut off fuel delivery momentarily during closed throttle deceleration.

Fuel Injectors

Fuel injectors are electrically operated solenoids which deliver fuel to individual cylinders. Engine Control Module (ECM) controls fuel injector duration based on various input signals to determine air/fuel mixture.

IDLE SPEED

A/C-Cut Control System (Corolla, Highlander, MR2, Prius & RAV4)

Engine Control Module (ECM) uses various input signals for controlling A/C-cut control system. A/C-cut control system interrupts A/C compressor operation for a fixed period of time when vehicle accelerates from low engine speed.

Dashpot (Tacoma 3.4L V6 With M/T)

Dashpot is mounted on throttle body and is used to allow engine to slowly return to specified RPM after throttle is released.

Idle Speed Control System (Avalon, Camry Solara 3.0L V6, Celica, Corolla, ECHO, Highlander, MR2 With Standard Type Manual Transaxle, RAV4, Sienna, Tacoma & Tundra 3.4L V6)

Idle speed control system may also be referred to as idle air control system. Engine Control Module (ECM) is programmed with engine idle speed values. Idle speed control system provides a stable idle speed when engine is cold, or idle speed decreases due to electrical load etc. ECM uses various input signals to maintain proper idle speed by controlling Idle Air Control (IAC) valve.

Throttle Control Motor (Camry, Camry Solara 2.4L 4-Cyl., Land Cruiser, Prius, Sequoia, Tundra 4.7L V8 & 4Runner)

Throttle control motor is used with Electronic Throttle Control System (ETCS) for controlling throttle operation and idle speed. See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS for additional information.

Throttle Control Motor (MR2 With Sequential Manual Transaxle)

There are 2 types of manual transaxles used for this model. Standard type manual transaxle in which the driver operates the clutch and shifts the transaxle, and the sequential manual transaxle, which is electronically controlled and the clutch is operated and transaxle is shifted hydraulically by moving the shift lever forward or backward. Sequential manual transaxle may be identified by the shift lever pattern which consists of "R", "N", "S" and "+" in place of the conventional type shift lever pattern and there is no clutch pedal. Models with _____

sequential manual transaxle use throttle control motor with Electronic Throttle Control System (ETCS) for controlling throttle operation and idle speed. See **ELECTRONIC THROTTLE CONTROL SYSTEM** under AIR INDUCTION SYSTEMS for additional information.

Throttle Opener (Avalon, Camry Solara 3.0L V6, Sienna, Tacoma & Tundra 3.4L V6)

Throttle opener, mounted on throttle body, is vacuum controlled and allows engine to return to specified RPM after throttle is released.

IGNITION SYSTEMS

DISTRIBUTORLESS IGNITION SYSTEM

NOTE: **Distributorless ignition system may also be referred to as Electronic Spark Advance (ESA) system.**

Avalon, Highlander 3.0L V6 & Sienna

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing (spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signals.

Conventional distributor and pick-up coil have been replaced by 2 camshaft position sensors and crankshaft position sensor. Camshaft position sensors may also be referred to as Variable Valve Timing (VVT) sensors. Camshaft position sensors and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on input signals from camshaft position sensors and actual crankshaft position, and engine speed by crankshaft position sensor input signals. Camshaft position sensors are located at flywheel end of each cylinder head, just below valve cover. See **Fig. 13** , **Fig. 22** and **Fig. 28** . Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. See **Fig. 13** , **Fig. 22** and **Fig. 28** . For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - V6 & V8 article.

The ECM uses 6 ignition primary control signals to the ignitors for the ignition coils. DIS uses 6 ignition coils with internal ignitors, one ignition coil for each cylinder. See **Fig. 58** . Cylinder No. 1 is front cylinder on right side of engine when viewed from flywheel end of engine. Cylinder No. 2 is front cylinder on left side of engine when viewed from flywheel end of engine. Cylinders No. 1, 3 and 5 are on right side of engine. Cylinders No. 2, 4 and 6 are on left side of engine. ECM monitors IGF circuit at ignitor to ensure ignition coils have fired.

NOTE: **On Avalon, IG2 relay provides voltage to ignition coils. For additional information on IG2 relay, see IG2 RELAY under MISCELLANEOUS CONTROLS.**

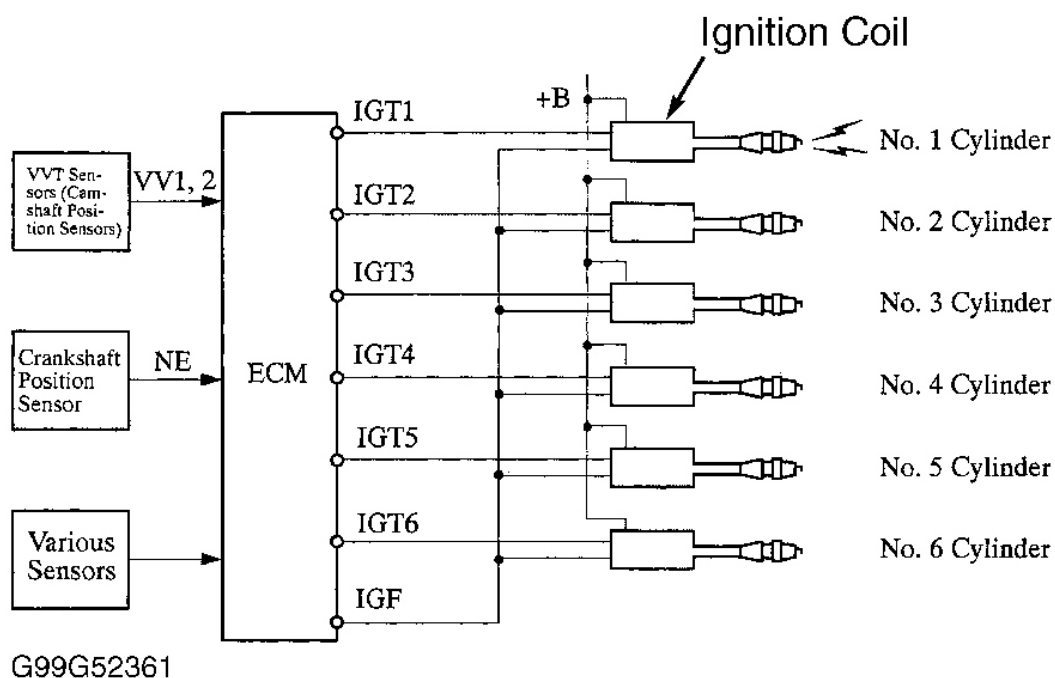


Fig. 58: Distributorless Ignition System Schematic (Avalon, Highlander 3.0L V6 & Sienna)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Camry 2.4L 4-Cyl., Camry Solara 2.4L 4-Cyl., Celica, Corolla, ECHO, Highlander 2.4L 4-Cyl., MR2, Prius & RAV4

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing (spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signal.

Conventional distributor and pick-up coil have been replaced by camshaft position sensor and crankshaft position sensor. Camshaft position sensor may also be referred to as Variable Valve Timing (VVT) sensor. Camshaft position sensor and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on camshaft position sensor input signals and actual crankshaft position, and engine speed by crankshaft position sensor input signals. On Camry, Camry Solara, ECHO, Highlander, Prius and RAV4, camshaft position sensor is located on end of cylinder head at flywheel end of engine. See **Fig. 14** , **Fig. 16** , **Fig. 20** , **Fig. 21** , **Fig. 25** and **Fig. 26** . On Celica, Corolla and MR2, camshaft position sensor is located just above intake manifold on cylinder head, at flywheel end of engine. See **Fig. 18** , **Fig. 19** and **Fig. 24** . On all models, crankshaft position sensor is located on front of engine, near crankshaft pulley. See **Fig. 14** -**Fig. 26** . For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - 4-CYLINDER article.

ECM uses 4 ignition primary control signals to ignitors for ignition coils. DIS uses 4 ignition coils with internal ignitors, one ignition coil for each cylinder. See **Fig. 59** . Cylinder No. 1 is front cylinder at timing chain end of engine and cylinder No. 4 is rear cylinder at flywheel end of engine. ECM monitors IGF circuit at ignitor to

ensure ignition coils have fired.

NOTE: On Celica, MR2, Prius and RAV4, IG2 relay provides voltage to ignition coils. For additional information on IG2 relay, see IG2 RELAY under MISCELLANEOUS CONTROLS.

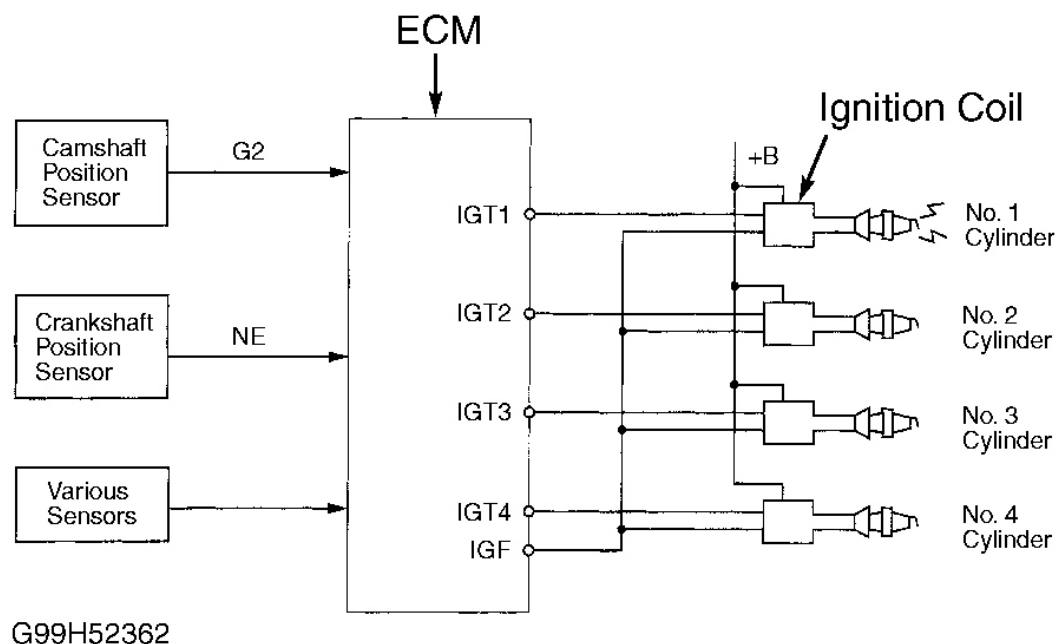


Fig. 59: Typical Distributorless Ignition System Schematic (Camry 2.4L 4-Cyl., Camry Solara 2.4L 4-Cyl., Celica, Corolla, ECHO, Highlander 2.4L 4-Cyl., MR2, Prius, RAV4 & Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl.)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Camry 3.0L V6

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing (spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signals.

Conventional distributor and pick-up coil have been replaced by camshaft position sensor and crankshaft position sensor. Camshaft position sensor and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on input signals from camshaft position sensor and actual crankshaft position, and engine speed by crankshaft position sensor input signals. Camshaft position sensor is located at flywheel end of front (radiator side) cylinder head, just below valve cover. See **Fig. 15** . Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. See **Fig. 15** . For knock sensor location, see **KNOCK SENSOR** under **ENGINE SENSORS & SWITCHES** in **REMOVAL, OVERHAUL &**

The ECM uses 6 ignition primary control signals to the ignitors for the ignition coils. DIS uses 6 ignition coils with internal ignitors, one ignition coil for each cylinder. See **Fig. 60** . Cylinder No. 1 is front cylinder on right side of engine when viewed from flywheel end of engine. Cylinder No. 2 is front cylinder on left side of engine when viewed from flywheel end of engine. Cylinders No. 1, 3 and 5 are on right side of engine. Cylinders No. 2, 4 and 6 are on left side of engine. ECM monitors IGF circuit at ignitor to ensure ignition coils have fired.

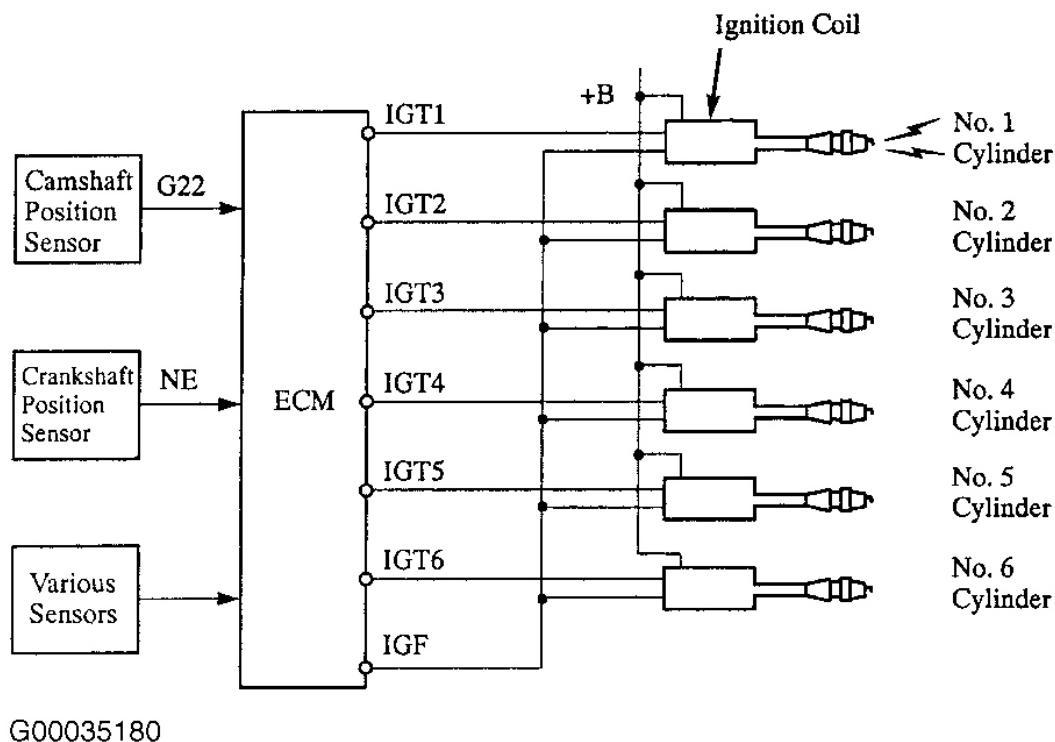


Fig. 60: Distributorless Ignition System Schematic (Camry 3.0L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Camry Solara 3.0L V6

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing (spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signals.

Conventional distributor and pick-up coil have been replaced by camshaft position sensor and crankshaft position sensor. Camshaft position sensor and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on camshaft position sensor input signals and actual crankshaft position, and engine speed by crankshaft position sensor input signals. Camshaft position sensor is located at flywheel end of front (radiator side) cylinder head, just below valve cover. See **Fig. 17** . Crankshaft position

sensor is located at front of crankshaft, near crankshaft pulley. See **Fig. 17** . For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - V6 & V8 article.

ECM uses 3 ignition primary control signals to ignitor for ignition coils. DIS uses 3 ignition coils which fire 2 cylinders simultaneously using same ignition coil. See **Fig. 61** . Cylinder No. 1 is front cylinder on right side of engine when viewed from flywheel end of engine. Cylinder No. 2 is front cylinder on left side of engine when viewed from flywheel end of engine. Cylinders No. 1, 3 and 5 are on right side of engine. Cylinders No. 2, 4 and 6 are on left side of engine.

One ignition coil is mounted on top of spark plug on cylinders No. 2, 4 and 6. Spark plug wires are routed from ignition coils on top of spark plugs to spark plugs on remaining cylinders. ECM monitors IGF circuit at ignitor to ensure ignition coils have fired.

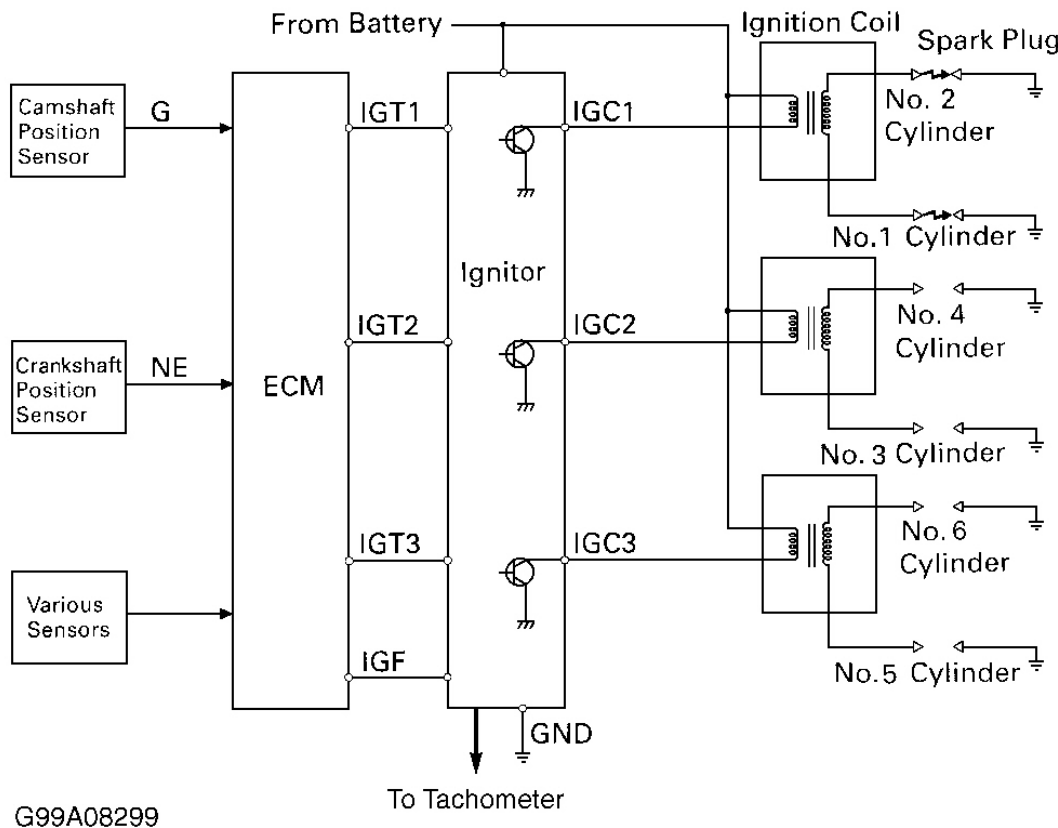


Fig. 61: Distributorless Ignition System Schematic (Camry Solara 3.0L V6)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Land Cruiser, Sequoia & Tundra 4.7L V8

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing

(spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signals.

Conventional distributor and pick-up coil have been replaced by camshaft position sensor and crankshaft position sensor. Camshaft position sensor and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on camshaft position sensor input signals and actual crankshaft position, and engine speed by crankshaft position sensor input signals. Camshaft position sensor is located behind driver's side upper timing belt cover, near camshaft sprocket. See **Fig. 23** , **Fig. 27** and **Fig. 32** . Crankshaft position sensor is located at front of crankshaft, near crankshaft pulley. See **Fig. 23** , **Fig. 27** and **Fig. 32** . For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - V6 & V8 article.

The ECM uses 8 ignition primary control signals to ignitors for ignition coils. DIS uses 8 ignition coils with internal ignitors, one ignition coil for each cylinder. See **Fig. 62** . Cylinder No. 1 is front cylinder on left side of engine when viewed from flywheel end of engine. Cylinder No. 2 is front cylinder on right side of engine when viewed from flywheel end of engine. Cylinders No. 1, 3, 5 and 7 are on left side of engine. Cylinders No. 2, 4, 6 and 8 are on right side of engine. The ECM monitors IGF circuit at ignitor to ensure ignition coils have fired.

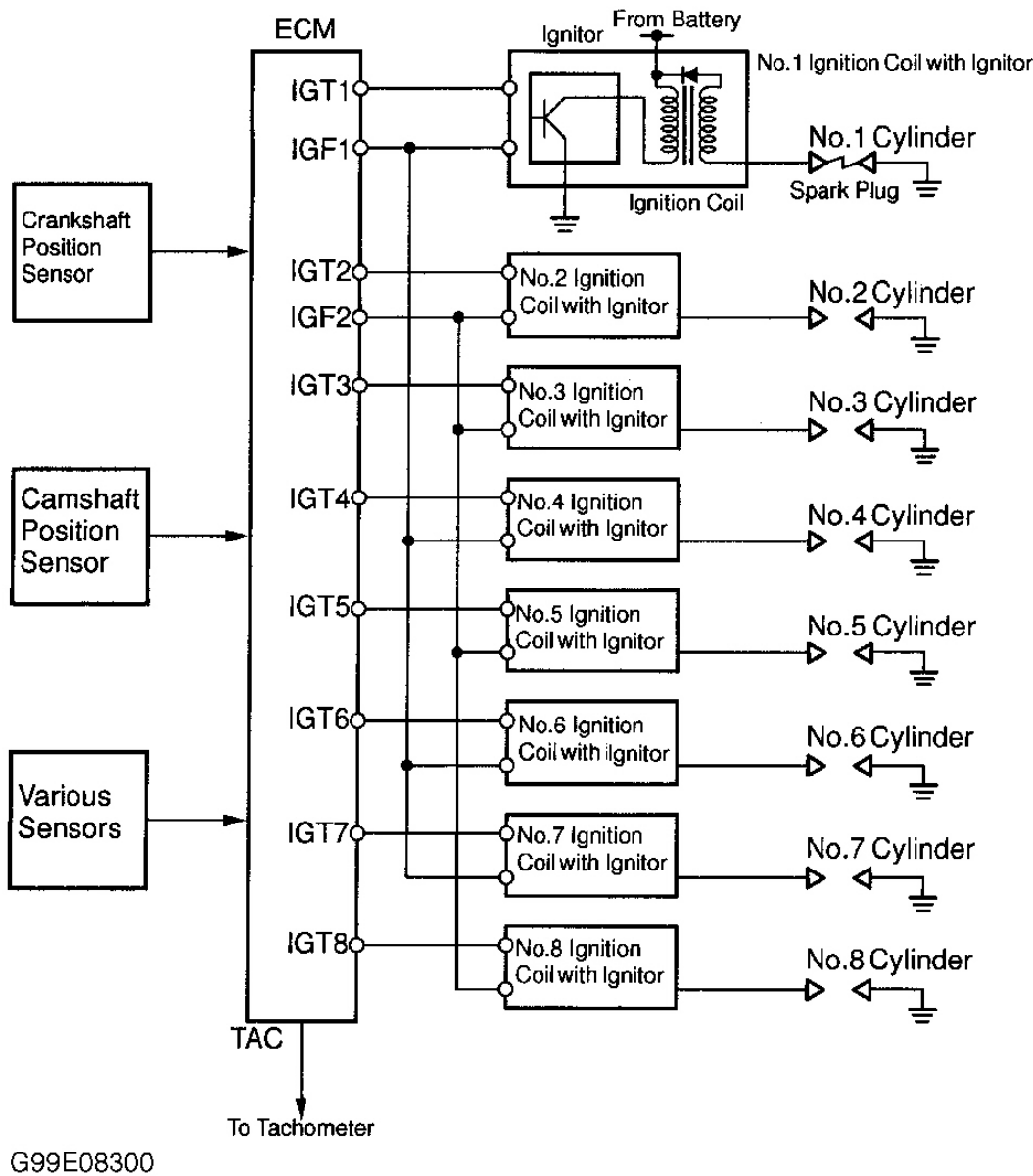


Fig. 62: Distributorless Ignition System Schematic (Land Cruiser, Sequoia & Tundra 4.7L V8)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Tacoma 2.4L 4-Cyl. & 2.7L 4-Cyl.

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing (spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signal.

Conventional distributor and pick-up coil have been replaced by camshaft position sensor and crankshaft position sensor. Camshaft position sensor and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on camshaft position sensor input signals and actual crankshaft position, and engine speed by crankshaft position sensor input signals. Camshaft position sensor is located at driver's side front corner of cylinder head, just in front of intake manifold. See **Fig. 29** . Crankshaft position sensor is located near crankshaft pulley, just above oil pan on driver's side of engine. See **Fig. 29** . For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - 4-CYLINDER article.

ECM uses 4 ignition primary control signals to ignitors for ignition coils. DIS uses 4 ignition coils with internal ignitors, one ignition coil for each cylinder. See **Fig. 59** . Cylinder No. 1 is front cylinder at timing chain end of engine and cylinder No. 4 is rear cylinder at flywheel end of engine. ECM monitors IGF circuit at ignitor to ensure ignition coils have fired.

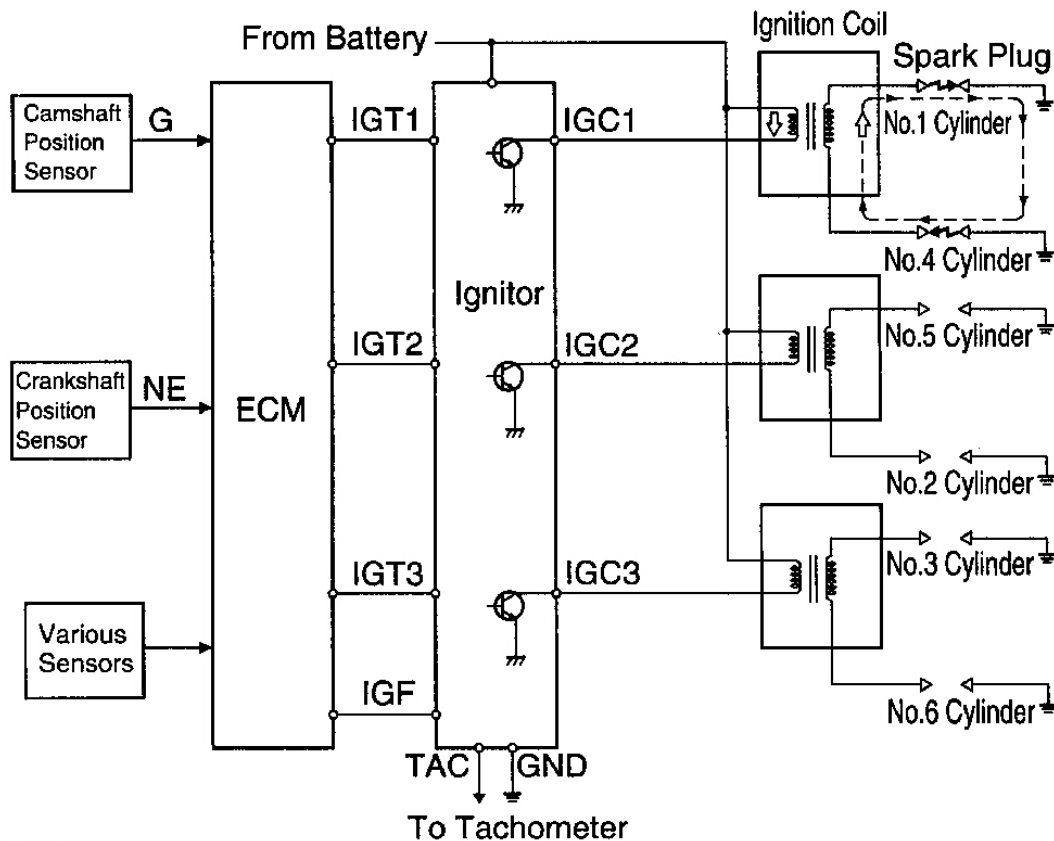
Tacoma 3.4L V6, Tundra 3.4L V6 & 4Runner

Distributorless Ignition System (DIS) uses Engine Control Module (ECM) for determining ignition timing (spark advance). ECM may determine ignition timing (spark advance) based on various input signals, engine RPM and knock sensor input signals.

Conventional distributor and pick-up coil have been replaced by camshaft position sensor and crankshaft position sensor. Camshaft position sensor and crankshaft position sensor deliver input signals to ECM. ECM detects standard crankshaft position based on camshaft position sensor input signals and actual crankshaft position, and engine speed by crankshaft position sensor input signals. Camshaft position sensor is located behind upper timing belt cover, near passenger's side camshaft sprocket. See **Fig. 30** , **Fig. 31** and **Fig. 33** . Crankshaft position sensor is located at front of engine, just above crankshaft pulley. See **Fig. 30** , **Fig. 31** and **Fig. 33** . For knock sensor location, see KNOCK SENSOR under ENGINE SENSORS & SWITCHES in REMOVAL, OVERHAUL & INSTALLATION - V6 & V8 article.

ECM uses 3 ignition primary control signals to ignitor for ignition coils. See **Fig. 63** . DIS uses 3 ignition coils which fire 2 cylinders simultaneously using same ignition coil. Cylinders No. 1 and 4 fire together, 2 and 5 fire together, and 3 and 6 fire together. Cylinder No. 1 is front cylinder on right side of engine when viewed from flywheel end of engine. Cylinder No. 2 is front cylinder on left side of engine when viewed from flywheel end of engine. Cylinders No. 1, 3 and 5 are on right side of engine. Cylinders No. 2, 4 and 6 are on left side of engine.

One ignition coil is mounted on top of spark plug on cylinder No. 1 with spark plug wire going to cylinder No. 4 spark plug. One ignition coil is mounted on top of spark plug on cylinder No. 3 with spark plug wire going to cylinder No. 6 spark plug. One ignition coil is mounted on top of spark plug on cylinder No. 5 with spark plug wire going to cylinder No. 2 spark plug. ECM monitors IGF circuit at ignitor to ensure ignition coils have fired.



G95I31318

Fig. 63: Distributorless Ignition System Schematic (Tacoma 3.4L V6, Tundra 3.4L V6 & 4Runner)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

EMISSION SYSTEMS & SUB-SYSTEMS

EXHAUST GAS RECIRCULATION CONTROL

Camry 3.0L V6 & Camry Solara 3.0L V6

Exhaust Gas Recirculation (EGR) system reduces oxides of nitrogen (NO_x) emissions by lowering combustion temperatures. Combustion temperatures are lowered by recycling metered amount of exhaust gases back into intake system.

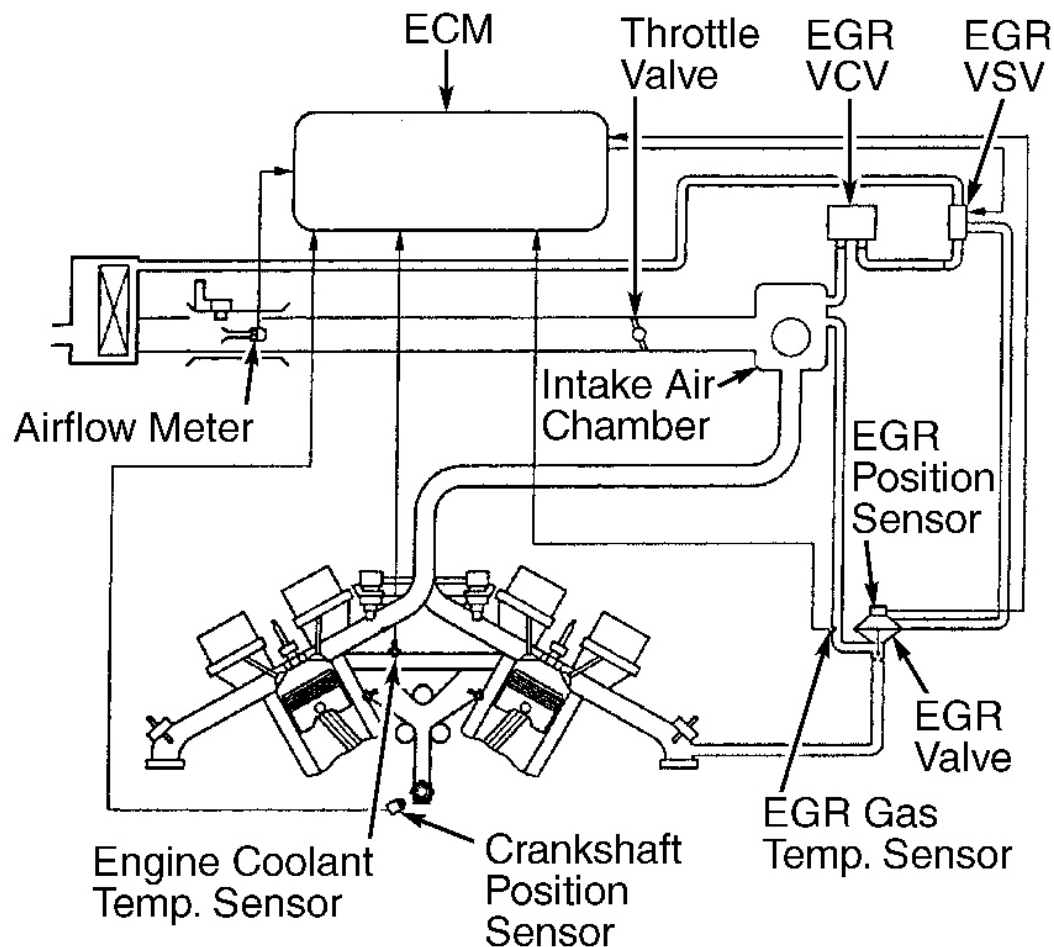
EGR system contains a vacuum-operated EGR valve, EGR position sensor, EGR Vacuum Switching Valve (VSV) EGR Vacuum Control Valve (VCV) and EGR gas temperature sensor which is screwed into lower side of EGR valve. See **Fig. 64**.

Amount of EGR operation is regulated by EGR VSV which is controlled by Engine Control Module (ECM).

EGR position sensor monitors movement of EGR valve and delivers an input signal to the ECM. The ECM uses this input signal to obtain the correct amount of EGR valve opening in relation to engine operation. ECM may shut off EGR system if any of the following conditions exist:

- Engine Is Not At Normal Operating Temperature
- During Deceleration With Throttle Closed
- During Light Engine Load
- Engine Is Idling
- Engine Speed Is Greater Than 4000 RPM

The ECM uses various input signals for controlling EGR system operation. For EGR system and component testing, see EXHAUST GAS RECIRCULATION SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in SYSTEM & COMPONENT TESTING - V6 & V8 article.



G00035184

Fig. 64: Identifying EGR System Components (Camry 3.0L V6 & Camry Solara 3.0L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

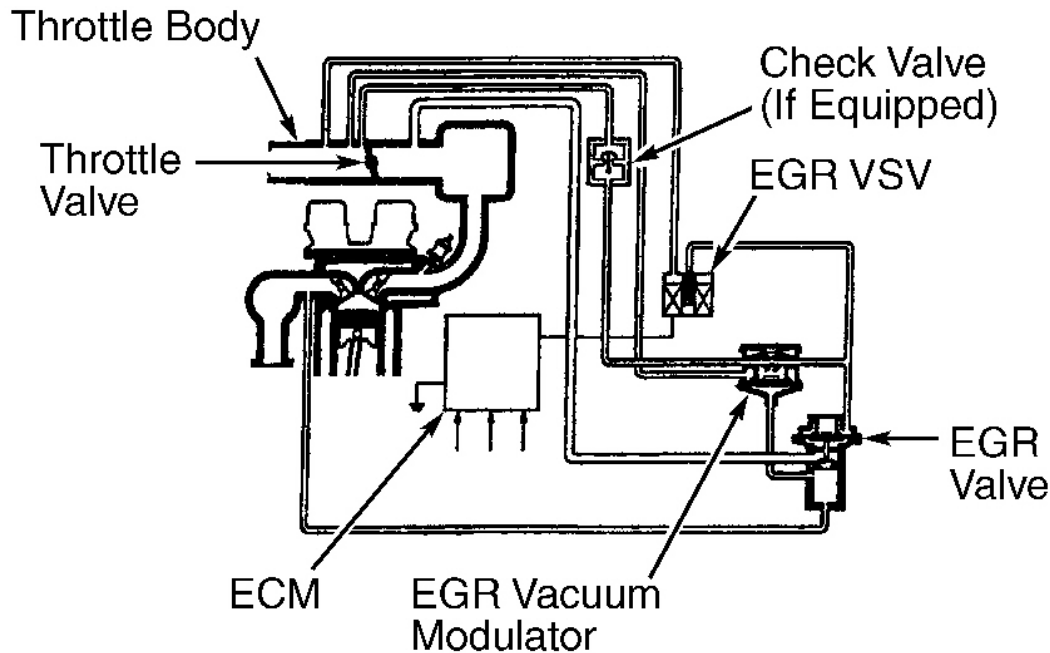
Tacoma 2.7L 4-Cyl. 3RZ-FE

Exhaust Gas Recirculation (EGR) system reduces oxides of nitrogen (NO_x) emissions by lowering combustion temperatures. Combustion temperatures are lowered by recycling metered amount of exhaust gases back into intake system. EGR system contains a vacuum-operated EGR valve, EGR vacuum modulator and EGR Vacuum Switching Valve (VSV). See **Fig. 65** . Amount of EGR operation is regulated by EGR vacuum modulator according to engine load. EGR valve operation is controlled by EGR VSV which is controlled by Engine Control Module (ECM). If ECM turns on EGR VSV, this causes EGR valve to close and shut off the exhaust gas. ECM may shut off EGR system if any of the following conditions exist:

- Engine Is Not At Normal Operating Temperature

- During Deceleration With Throttle Closed
- During Light Engine Load
- Engine Is At High Speed

The ECM uses various input signals for controlling EGR system operation. For EGR system and component testing, see EXHAUST GAS RECIRCULATION SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in SYSTEM & COMPONENT TESTING - 4-CYLINDER article.



G00035188

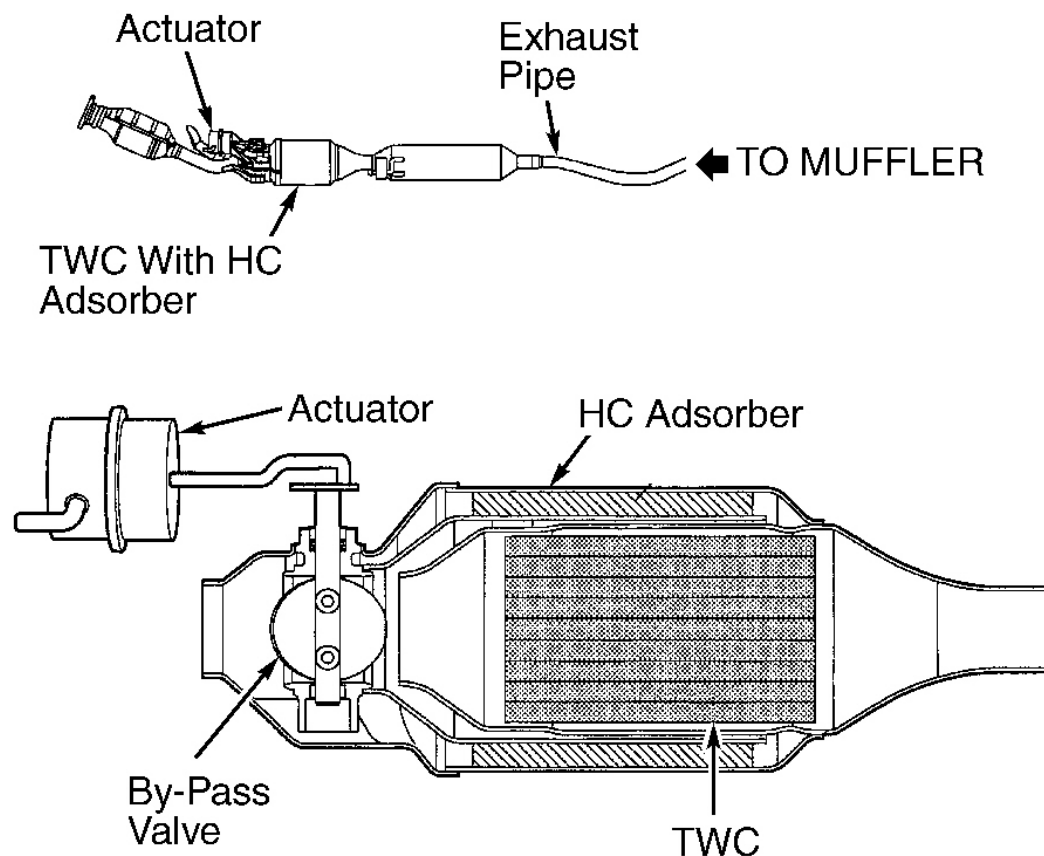
Fig. 65: Identifying EGR System Components (Tacoma 2.7L 4-Cyl. 3RZ-FE)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

HYDROCARBON ADSORBER CATALYST SYSTEM

Prius

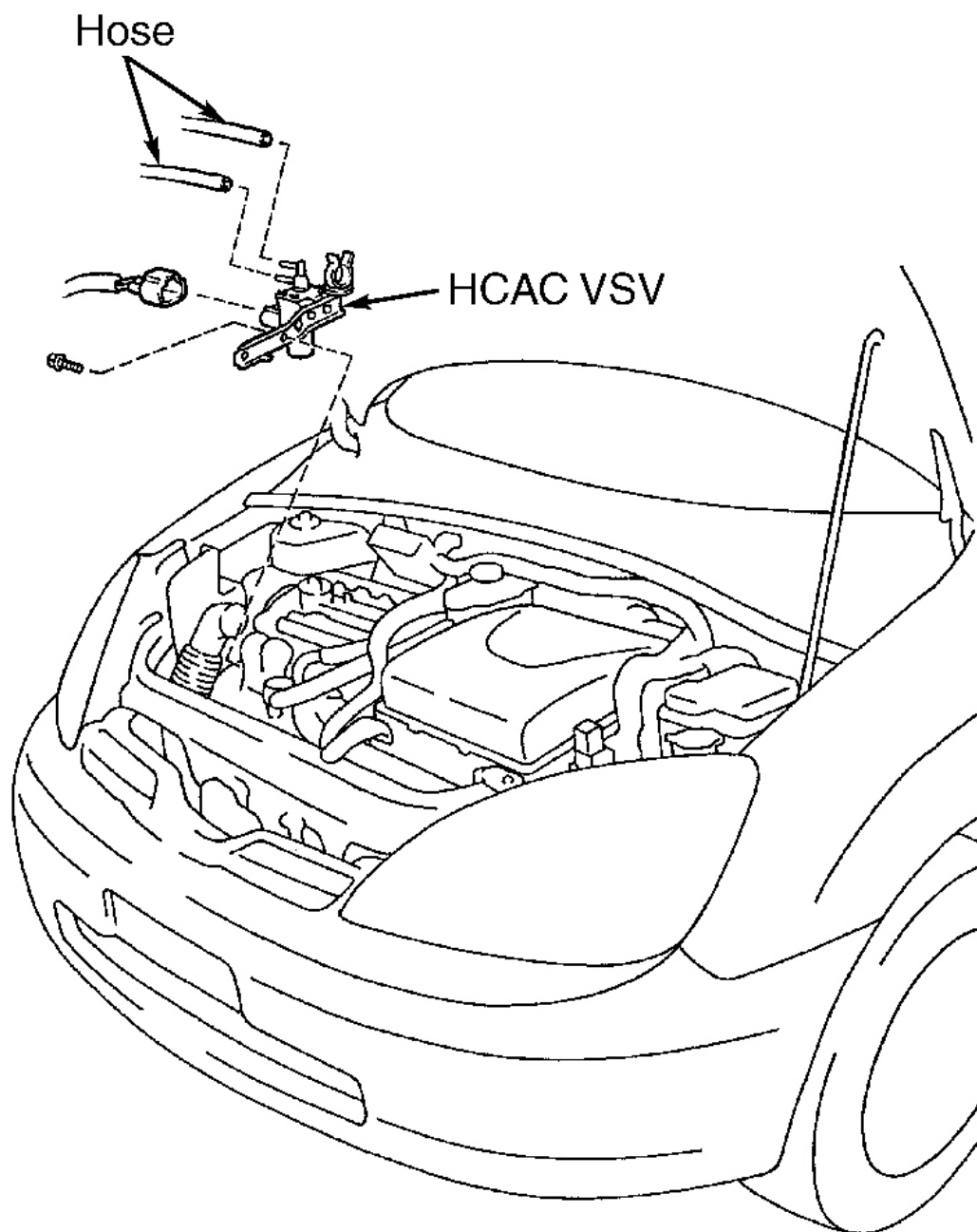
Hydrocarbon Adsorber Catalyst (HCAC) system is used to improve emissions when three-way catalytic converter temperature is low. HCAC system consists of HCAC Vacuum Switching Valve (VSV), actuator, by-pass valve and Three-Way Catalytic Converter (TWC) with Hydrocarbon (HC) adsorber. Actuator and by-pass valve are located at front of TWC on exhaust pipe. See **Fig. 66** . HCAC VSV is located on bracket bolted to timing chain end of engine and uses a Brown electrical connector with Black and Black/White wires. See **Fig. 67** .

Before engine is started, by-pass valve is open. When engine starts, Engine Control Module (ECM) delivers an output signal to HCAC VSV. HCAC VSV opens, allowing vacuum to be applied to actuator which causes the by-pass valve to close. When by-pass valve closes, exhaust gases pass into the HC adsorber, where the gases are stored until the temperature of front TWC increases. This prevents hydrocarbons from being delivered from vehicle when TWC temperature is low. After TWC becomes warm, the HCAC VSV closes and vacuum to by-pass valve is shut off, causing by-pass valve to open. When rear TWC becomes warm, exhaust emissions are cleaned by the TWC. The HCAC VSV may also be operated during a deceleration condition when HC adsorber is warm in order to scavenge the hydrocarbons that remain in the HC adsorber.



G00020823

Fig. 66: Locating Actuator, By-Pass Valve & HC Adsorber (Prius)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G00020827

Fig. 67: Locating HCAC VSV (Prius)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

FUEL EVAPORATIVE SYSTEM

NOTE: Fuel evaporative system is referred to as Evaporative Emission (EVAP) system.

Avalon, Camry, Camry Solara, Celica, Corolla, Highlander, MR2, RAV4, Sequoia, Sienna, Tacoma & 4Runner

EVAP system prevents fuel tank gasoline vapors from escaping into the atmosphere. Fuel tank gasoline vapors are routed through EVAP canister, then into air cleaner and intake manifold for combustion in the cylinders. Vapor pressure sensor, pressure switching valve Vacuum Switching Valve (VSV) and canister closed valve Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in EVAP system. See **Fig. 51** . Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Canister closed valve VSV may also be referred to as EVAP Canister Closed Valve Vacuum Switching Valve (EVAP-CCVSV). Pressure switching valve VSV may also be referred to as EVAP Pressure Switching Valve Vacuum Switching Valve (EVAP-PSVSV). EVAP canister may also be referred to as charcoal canister. If a leak or an abnormality exists in EVAP system, a Diagnostic Trouble Code (DTC) will be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. EVAP Vacuum Switching Valve (VSV) is used to control EVAP system. ECM operates EVAP VSV which controls vacuum flow for EVAP operation. For EVAP system and component testing, see FUEL EVAPORATIVE SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in appropriate SYSTEM & COMPONENT TESTING article.

ECHO

EVAP system prevents fuel tank gasoline vapors from escaping into the atmosphere. Fuel tank gasoline vapors are routed through EVAP canister, then into air cleaner and intake manifold for combustion in the cylinders. Vapor pressure sensor and canister closed valve Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in EVAP system. See **Fig. 51** . Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Canister closed valve VSV may also be referred to as EVAP Canister Closed Valve Vacuum Switching Valve (EVAP-CCVSV). EVAP canister may also be referred to as charcoal canister. If a leak or an abnormality exists in EVAP system, a Diagnostic Trouble Code (DTC) will be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieving of DTCs. EVAP Vacuum Switching Valve (VSV) is used to control EVAP system. ECM operates EVAP VSV which controls vacuum flow for EVAP operation. For EVAP system and component testing, see FUEL EVAPORATIVE SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in appropriate SYSTEM & COMPONENT TESTING article.

Land Cruiser & Tundra

EVAP system prevents fuel tank gasoline vapors from escaping into the atmosphere. Fuel tank gasoline vapors are routed through EVAP canister, then into air cleaner and intake manifold for combustion in the cylinders. Vapor pressure sensor and vapor pressure sensor Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in EVAP system. See **Fig. 52** . Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Vapor pressure sensor VSV may also be referred to as EVAP Vapor Pressure Sensor Vacuum Switching Valve (EVAP-VPSVSV). EVAP canister may also be referred to as charcoal canister. If a leak or an abnormality exists in EVAP system, a Diagnostic Trouble Code (DTC) will be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in

appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. EVAP Vacuum Switching Valve (VSV) is used to control EVAP system. ECM operates EVAP VSV which controls vacuum flow for EVAP operation. For EVAP system and component testing, see FUEL EVAPORATIVE SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in appropriate SYSTEM & COMPONENT TESTING article.

Prius

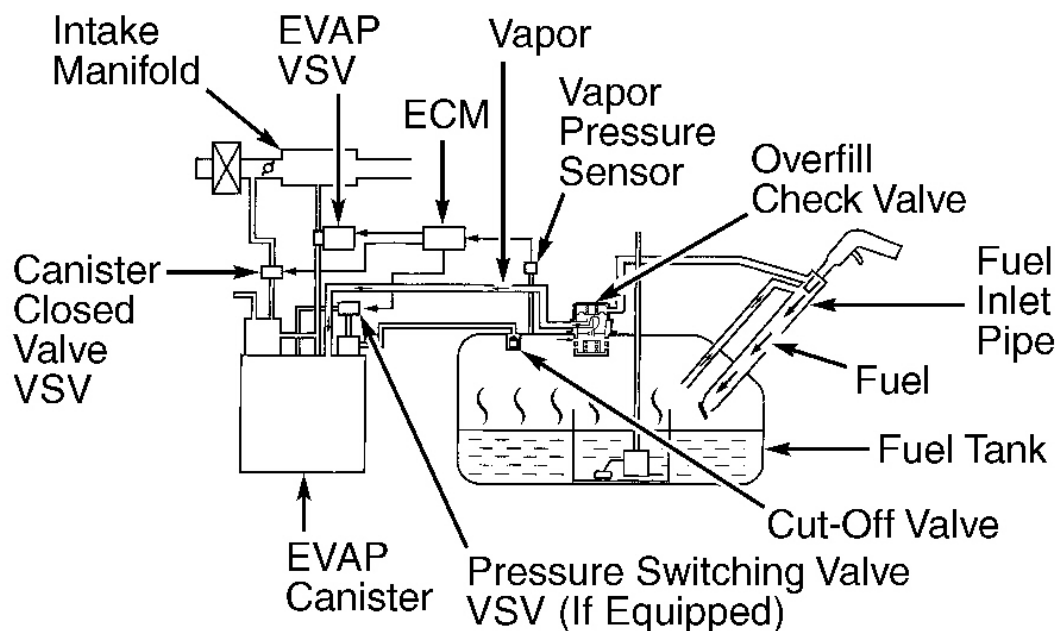
EVAP system prevents fuel tank gasoline vapors from escaping into the atmosphere. Fuel tank gasoline vapors are routed through EVAP canister, then into air cleaner and intake manifold for combustion in the cylinders. Vapor pressure sensor, purge flow switching valve Vacuum Switching Valve (VSV) and canister closed valve Vacuum Switching Valve (VSV) are used to determine if a leak or an abnormality exists in the EVAP system. See **Fig. 53** . Engine Control Module (ECM) determines if a leak or an abnormality exists in EVAP system by using input signal from vapor pressure sensor. Vapor pressure sensor may also be referred to as EVAP vapor pressure sensor. Canister closed valve VSV may also be referred to as EVAP Canister Closed Valve Vacuum Switching Valve (EVAP-CCVVSV) or Canister Closed Valve Vacuum Switching Valve (CCV VSV). Purge flow switching valve VSV may also be referred to as EVAP Purge Flow Switching Valve Vacuum Switching Valve (EVAP-PFSVVSV). EVAP canister may also be referred to as charcoal canister. If a leak or an abnormality exists in EVAP system, a Diagnostic Trouble Code (DTC) will be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieval of DTCs. EVAP Vacuum Switching Valve (VSV) is used to control EVAP system. ECM operates EVAP VSV which controls vacuum flow for EVAP operation. For EVAP system and component testing, see FUEL EVAPORATIVE SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in appropriate SYSTEM & COMPONENT TESTING article.

ON-BOARD REFILLING VAPOR RECOVERY SYSTEM

Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, MR2, Prius, RAV4, Sequoia, Sienna, Tacoma & 4Runner

On-board Refilling Vapor Recovery (ORVR) system is used to recover fuel vapors into EVAP canister that are generated during refueling. ORVR system consists of fuel inlet pipe, overfill check valve and EVAP canister. See **Fig. 68** .

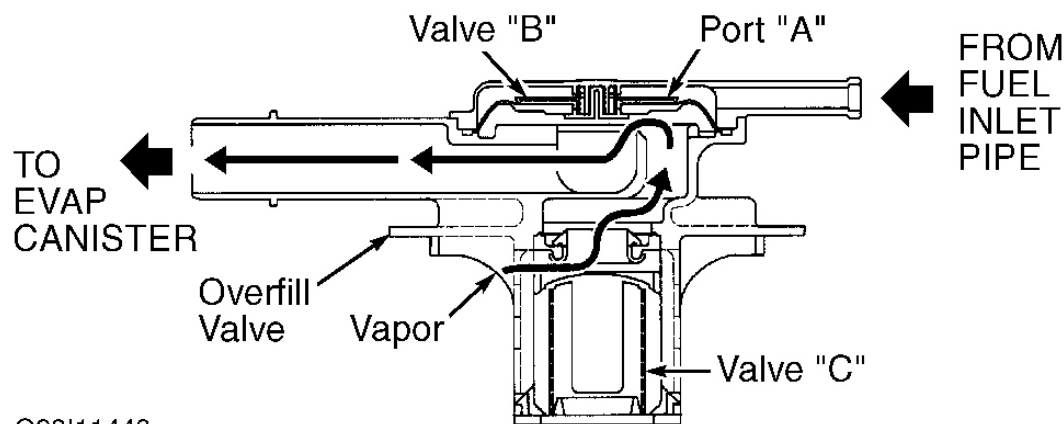
When fuel tank cap is removed, atmospheric pressure is applied to port "A" on overfill check valve. See **Fig. 69** . Overfill check valve may also be referred to as ORVR-OCKV, fuel tank overfill check valve or fill check valve. When fuel flows into fuel inlet pipe and fuel tank, the pressure in fuel tank increases. Increased pressure in fuel tank causes valve "B" on overfill valve to open, allowing fuel vapors to flow into EVAP canister. When fuel tank is full, valve "C" closes, shutting off vapor flow to EVAP canister.



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Fig. 68: Identifying Typical On-board Refilling Vapor Recovery System Components (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, MR2, Prius, RAV4, Sequoia, Sienna, Tacoma & 4Runner)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G98I11443

Fig. 69: Locating Port & Valves On Overfill Valve, & Identifying Vapor Flow (Avalon, Camry, Camry Solara, Celica, Corolla, ECHO, Highlander, MR2, Prius, RAV4, Sequoia, Sienna, Tacoma & 4Runner)

POSITIVE CRANKCASE VENTILATION

Positive Crankcase Ventilation (PCV) system prevents crankcase vapors from escaping into the atmosphere. Crankcase vapors are routed from crankcase through a vacuum-controlled PCV valve, then delivered back into the cylinders. PCV system provides primary control of crankcase blow-by vapors, according to manifold vacuum. When manifold vacuum is high (at idle), PCV restricts vapor flow to maintain a smooth idle condition.

SELF-DIAGNOSTIC SYSTEMS

Engine Control Module (ECM) is equipped with a self-diagnostic system. By analyzing various input signals, ECM detects system malfunctions related to various operating parameters. When malfunction of various engine sensors, switches or circuits occurs, a Diagnostic Trouble Code (DTC) may be stored in the ECM memory. DTC may be retrieved for system diagnosis. For additional information on self-diagnostic system, see SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieving of DTCs.

MALFUNCTION INDICATOR LIGHT

All vehicles are equipped with a Malfunction Indicator Light (MIL). MIL may also be referred to as CHECK ENGINE light and is displayed as an engine icon on instrument cluster. MIL will momentarily illuminate when ignition is first turned on to do a bulb check. MIL may illuminate when systems related to emission controls are malfunctioning during normal vehicle operation. For additional information on MIL operation, see SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article.

VARIABLE VALVE LIFT SYSTEM

NOTE: Variable Valve Lift (VVL) system may also be referred to as Variable Valve Timing Lift Intelligent (VVTI or VVTI-i) system.

CELICA (1.8L 2ZZ-GE)

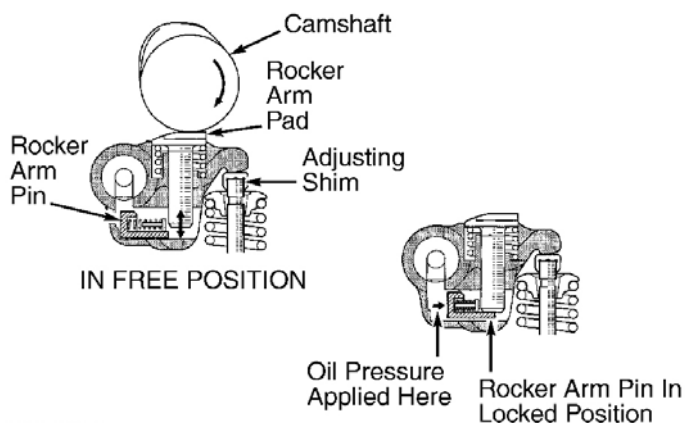
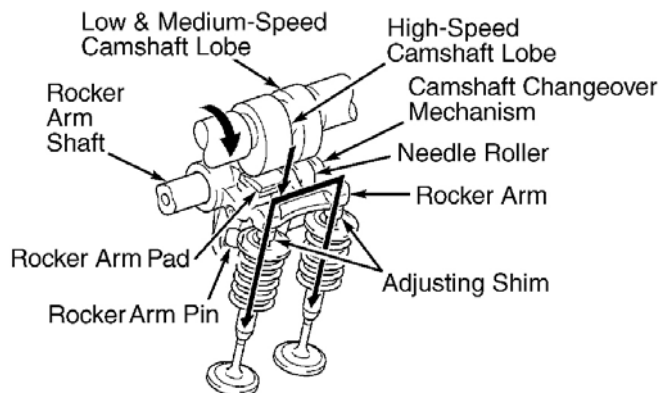
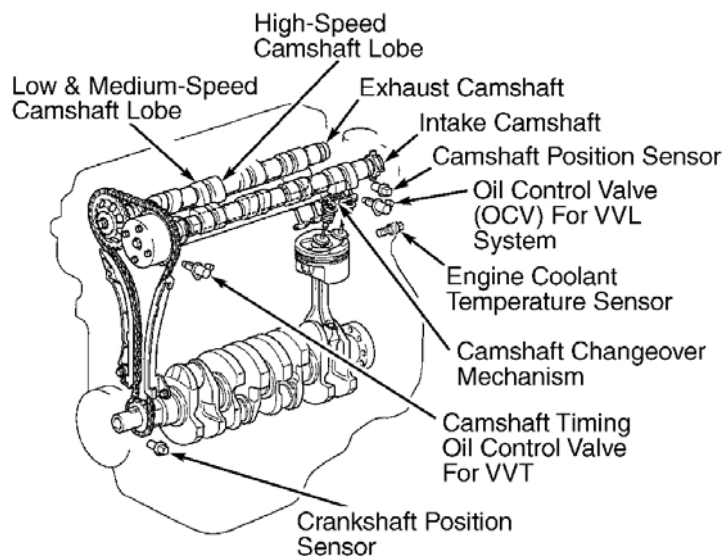
Variable Valve Lift (VVL) system controls amount of intake and exhaust valve lift while engine is operating at high speeds to provide improved engine performance and fuel economy. VVL system consists of camshaft timing Oil Control Valve (OCV), camshaft changeover mechanism, camshaft position sensor, crankshaft position sensor, engine coolant temperature sensor, camshafts with low-and-medium-speed camshaft lobes and high-speed camshaft lobes, Engine Control Module (ECM) and associated wiring. See **Fig. 70**.

NOTE: OCV for VVL system may also be referred to as camshaft timing oil control valve (VVL) or Variable Valve Lift (VVL) oil control valve.

When engine is operating in low-to-medium-speed range, low-and-medium-speed camshaft lobes operate to move the valves by using needle roller and rocker arm on camshaft changeover mechanism. See **Fig. 70**. The high-speed camshaft lobes also push downward on the rocker arm pad, but because rocker arm pad moves freely, this movement of high-speed camshaft lobes does not cause the rocker arm to move the valves. When engine coolant temperature is greater than 140°F (60°C) with engine speed greater than 6000 RPM, the ECM

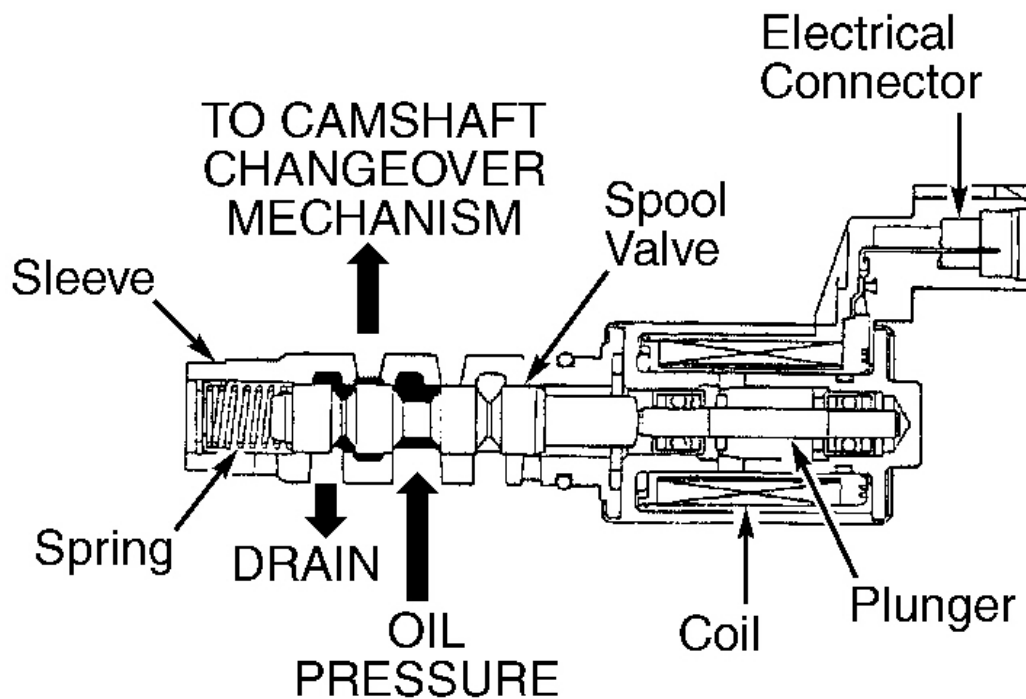
operates oil control valve for VVL system to allow oil pressure to be applied to the rocker arm pin. See **Fig. 70** . When oil pressure is applied to rocker arm pin, rocker arm pin is pushed to the locked position. This prevents rocker arm pad from moving freely, this changes operation from low-and-medium-speed camshaft lobes to the high-speed camshaft lobes. This provides more valve lift for improved engine performance and fuel economy.

Oil control valve for VVT is an electrically controlled valve that receives oil pressure from the oil pump. See **Fig. 71** . When engine is operating in low-to-medium-speed range, ECM operates oil control valve to move spool valve to open position. This allows oil pressure to drain instead of being applied to rocker arm pin for use of high-speed camshaft lobes. When engine coolant temperature is greater than 140°F (60°C) with engine speed greater than 6000 RPM, ECM operates oil control valve to move spool valve to the closed position. This allows oil pressure to be applied to rocker arm pin for use of the high-speed camshaft lobes. The ECM uses input signals for engine speed, intake air volume, throttle position and engine coolant temperature to determine operation of oil control valve for VVT. If a problem exists in the VVL system, a Diagnostic Trouble Code (DTC) may be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieving of DTCs.



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Fig. 70: Locating Variable Valve Lift System Components (Celica 1.8L 2ZZ-GE)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99D52814

Fig. 71: Cross-Sectional View Of Oil Control Valve For Variable Valve Lift System (Celica 1.8L 2ZZ-GE)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

VARIABLE VALVE TIMING SYSTEM

NOTE: Variable Valve Timing (VVT) system may also be referred to as Variable Valve Timing Intelligent (VVT-I or VVT-i) system.

AVALON, HIGHLANDER 3.0L V6 & SIENNA

Variable Valve Timing (VVT) system controls intake camshaft valve timing to provide improved engine performance and fuel economy, and reduce exhaust emissions. VVT system consists of 2 camshaft timing oil control valves, variable valve timing controller on each intake camshaft, crankshaft position sensor, engine coolant temperature sensor, Engine Control Module (ECM), variable valve timing sensors and associated wiring. See [Fig. 72](#).

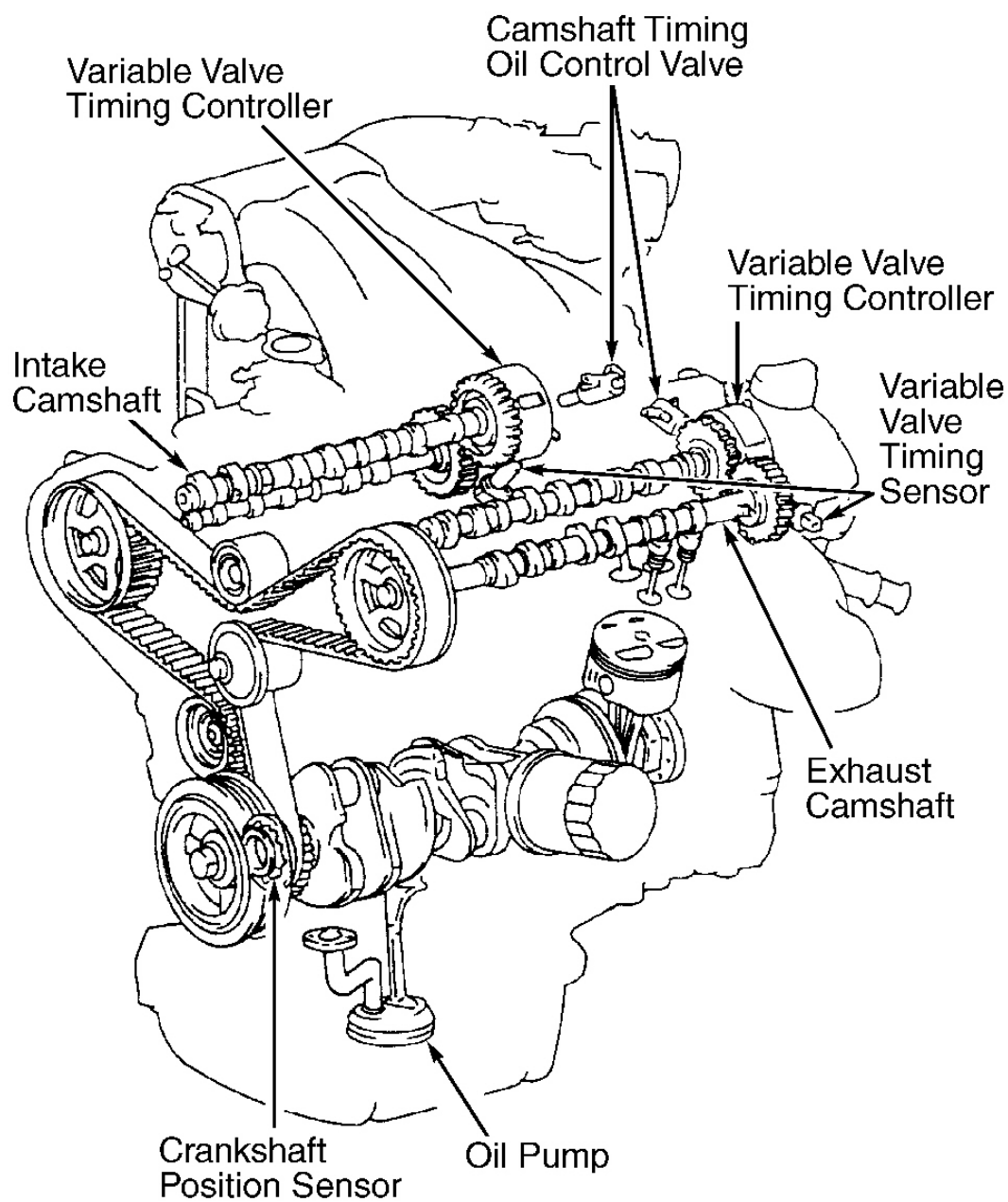
NOTE: Camshaft timing oil control valve may also be referred to as VVT camshaft timing oil control valve, camshaft timing oil control valve VVT, oil control valve

for VVT or VVT Oil Control Valve (OCV). Variable valve timing controller may also be referred to as variable valve timing actuator or VVT controller.

Exhaust camshaft is driven by the timing belt and intake camshaft is driven by gear on the end of exhaust camshaft. Intake camshaft drive gear is integrated with the variable valve timing controller to vary intake camshaft valve timing. Variable valve timing controller consists of a housing driven from the exhaust camshaft and a vane that is fixed on the intake camshaft. See **Fig. 73** . Oil pressure may be delivered from the advance or retard side of intake camshaft to the variable valve timing controller. This oil pressure causes variable valve timing controller to rotate intake camshaft and change the valve timing. When engine is stopped, intake camshaft will be placed in the most retarded state, to improve low speed stability. At this time, a lock pin secures the housing and the vane inside variable valve timing controller. After the engine starts, lock pin is released by oil pressure.

Camshaft timing oil control valve is an electrically controlled valve that receives oil pressure from the oil pump. See **Fig. 74** . The ECM uses input signals for engine speed, intake air volume, throttle position and engine coolant temperature to determine operation of camshaft timing oil control valve. The ECM also uses input signals from variable valve timing sensors and crankshaft position sensor for determining the actual intake camshaft valve timing. Variable valve timing sensors may also be referred to as camshaft position sensors. The ECM operates camshaft timing oil control valve by controlling position of spool valve. This determines which side of variable valve timing controller the oil pressure will be applied on for advancing or retarding the valve timing by rotating the intake camshaft. See **Fig. 74** . When engine is stopped, camshaft timing oil control valve is in the retarded state.

When engine is idling, intake camshaft valve timing is set at the standard or hold position to stabilize the idle and obtain better fuel economy. During light engine load, intake camshaft valve timing remains retarded to provide stable engine operation. During medium engine load, intake camshaft valve timing is advanced to provide increased performance, fuel economy and improved emission control. During heavy engine load in low-to-medium-speed range, intake camshaft valve timing is advanced to provide increased torque. During heavy engine load in high-speed range, intake camshaft valve timing is retarded to provide improved high-speed range operation and better fuel economy. During cold temperatures, intake camshaft valve timing remains at the standard or hold position to stabilize fast idle speed and obtain better fuel economy. When engine is started or stopped, intake camshaft valve timing is set at retarded position to improve engine starting. If a problem exists in the VVT system, a Diagnostic Trouble Code (DTC) may be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieving of DTCs.



G99E50538

Fig. 72: Locating Variable Valve Timing System Components (Avalon, Highlander 3.0L V6 & Sienna)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

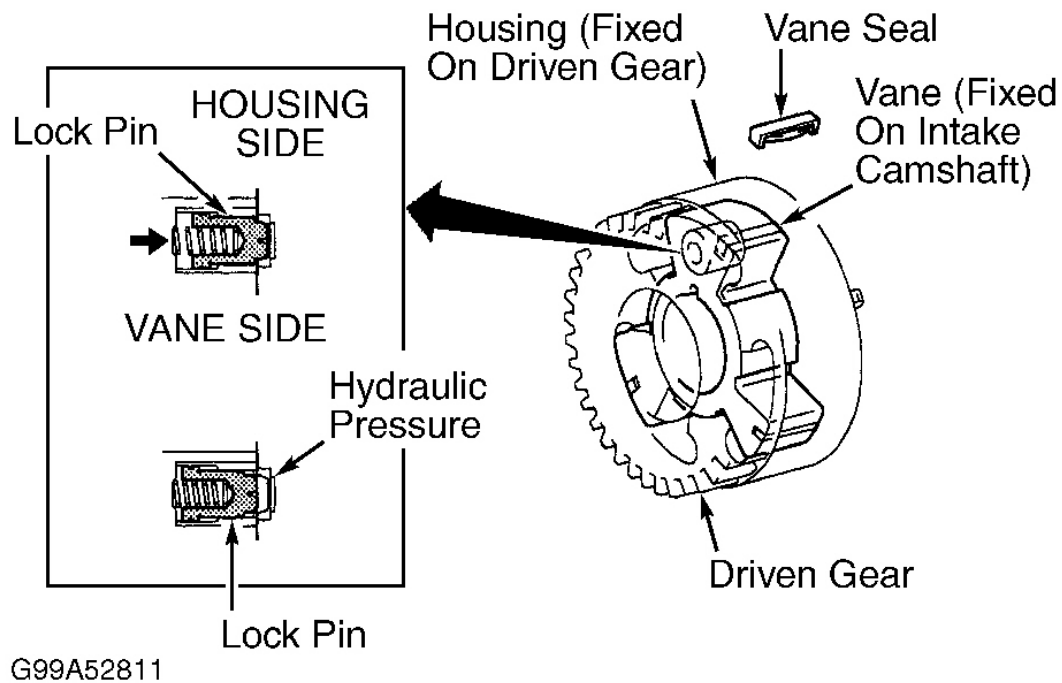
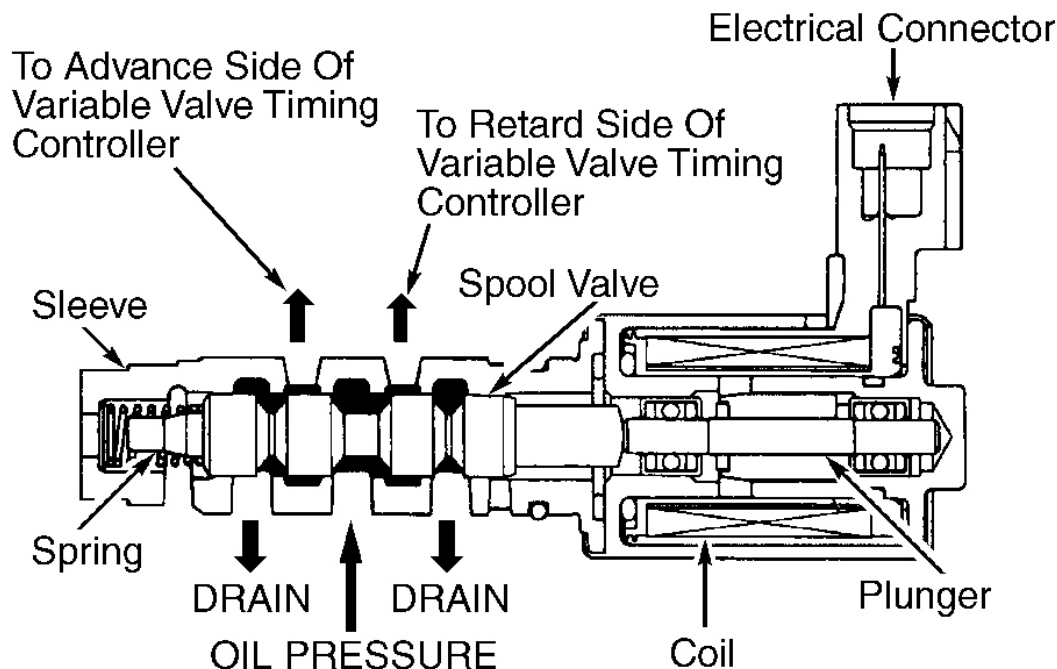


Fig. 73: Identifying Variable Valve Timing Controller Components (Avalon, Highlander 3.0L V6 & Sienna)

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99G52809

Fig. 74: Cross-Sectional View Of Typical Camshaft Timing Oil Control Valve (Avalon, Camry 2.4L 4-Cyl., Camry Solara 2.4L 4-Cyl., Celica, Corolla, ECHO, Highlander, MR2, Prius, RAV4 & Sienna)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

CAMRY 2.4L 4-CYL., CAMRY SOLARA 2.4L 4-CYL., CELICA, COROLLA, ECHO, HIGHLANDER 2.4L 4-CYL., MR2, PRIUS & RAV4

Variable Valve Timing (VVT) system controls intake camshaft valve timing to provide improved engine performance, fuel economy, and reduced exhaust emissions. VVT system consists of camshaft timing oil control valve, variable valve timing controller on intake camshaft, crankshaft position sensor, Engine Control Module (ECM), camshaft position sensor and associated wiring. See **Fig. 75 -Fig. 77** .

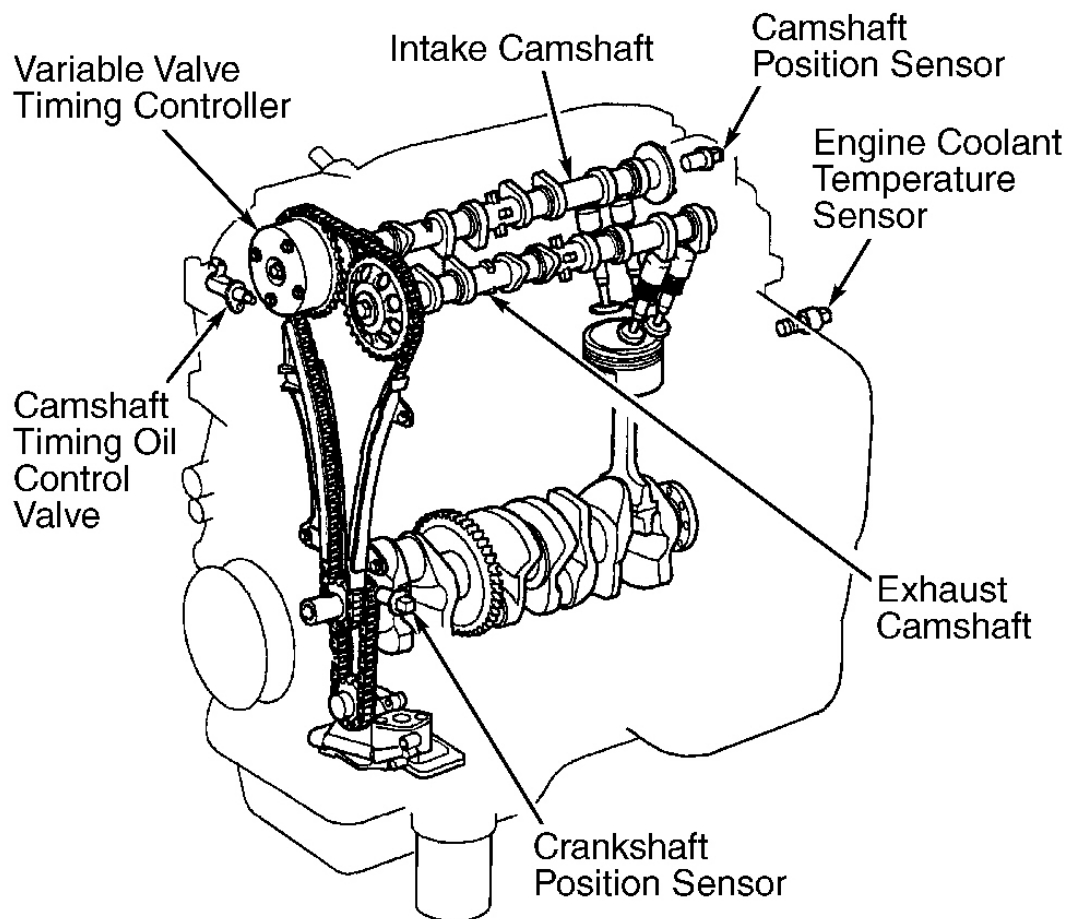
NOTE: Camshaft timing oil control valve may also be referred to as oil control valve for VVT, VVT Oil Control Valve (OCV) or camshaft timing oil control valve VVT. Variable valve timing controller may also be referred to as variable valve timing actuator or VVT controller.

Intake and exhaust camshaft are driven by a timing chain and drive gear on each camshaft. Intake camshaft drive gear is integrated with the variable valve timing controller to vary intake camshaft valve timing. Variable valve timing controller consists of a housing which is driven from the timing chain and a vane that is fixed on the intake camshaft. See **Fig. 78** . Oil pressure may be delivered from advance or retard side of intake camshaft to the variable valve timing controller. This oil pressure causes variable valve timing controller to rotate,

causing intake camshaft to rotate and change the valve timing. When engine is stopped, to improve stability, intake camshaft remains in the most retarded state. When no oil pressure is applied to variable valve timing controller immediately after engine is started, lock pin prevents movement of variable valve timing controller to prevent a knocking noise. Once engine is started and oil pressure exists at variable valve timing controller, lock pin is released by the oil pressure.

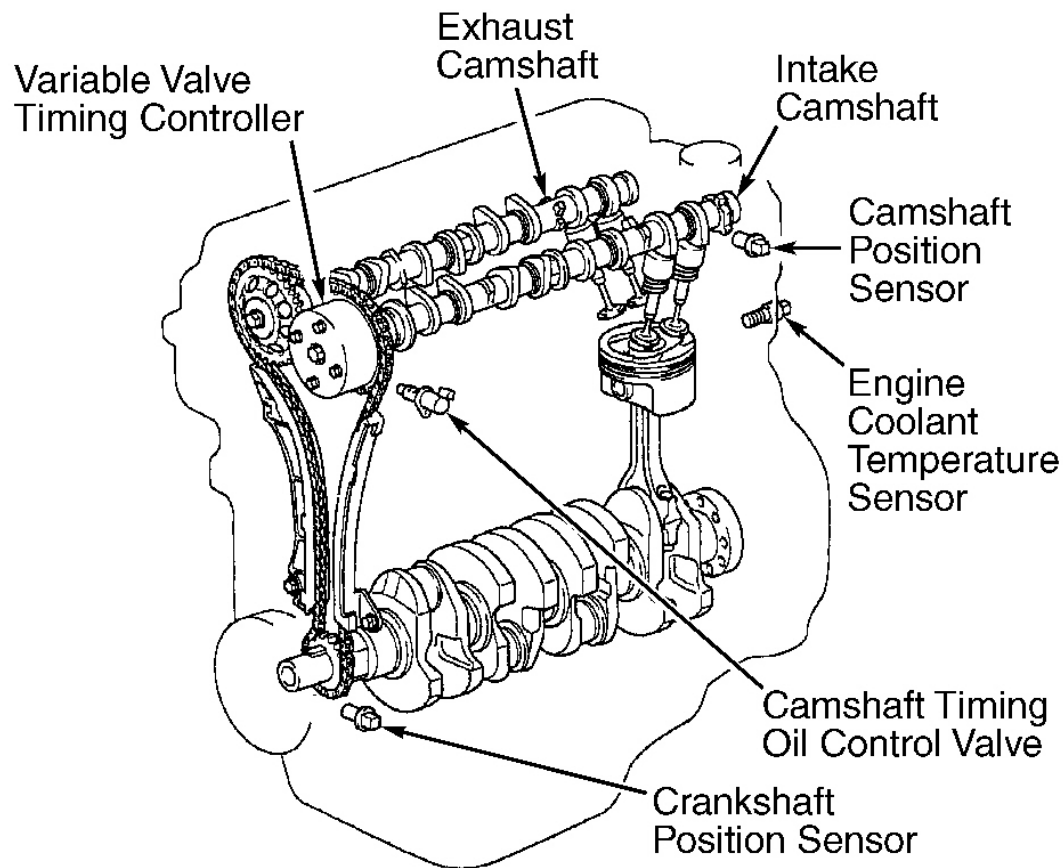
Camshaft timing oil control valve is an electrically controlled valve that receives oil pressure from the oil pump. See **Fig. 74** . The ECM uses input signals for engine speed, intake air volume, throttle position and engine coolant temperature to determine operation of camshaft timing oil control valve. The ECM also uses input signals from camshaft position sensor and crankshaft position sensor for determining the actual intake camshaft valve timing. Camshaft position sensor may also be referred to as variable valve timing sensor. The ECM operates camshaft timing oil control valve by controlling position of spool valve. This determines which side of variable valve timing controller the oil pressure will be applied to for advancing or retarding the valve timing by rotating the intake camshaft. See **Fig. 74** . When engine is stopped, camshaft timing oil control valve is in the retarded state.

When engine is idling, intake camshaft valve timing remains at the standard or hold position to stabilize the idle and obtain better fuel economy. During light engine load, intake camshaft valve timing remains retarded to provide stable engine operation. During medium engine load, intake camshaft valve timing is advanced to provide increased performance, fuel economy and improved emission control. During heavy engine load in low-to-medium-speed range, intake camshaft valve timing is advanced to provide increased torque. During heavy engine load in high-speed range, intake camshaft valve timing is retarded to provide improved high-speed range operation and better fuel economy. During cold temperatures, intake camshaft valve timing is set at the standard or hold position to stabilize fast idle speed and obtain better fuel economy. When engine is started or stopped, intake camshaft valve timing is remains at retarded position to improve engine starting. If a problem exists in the VVT system, a Diagnostic Trouble Code (DTC) may be stored in ECM. See TESTING PROCEDURE under SELF-DIAGNOSTIC SYSTEM in appropriate SELF-DIAGNOSTICS article for retrieving of DTCs.



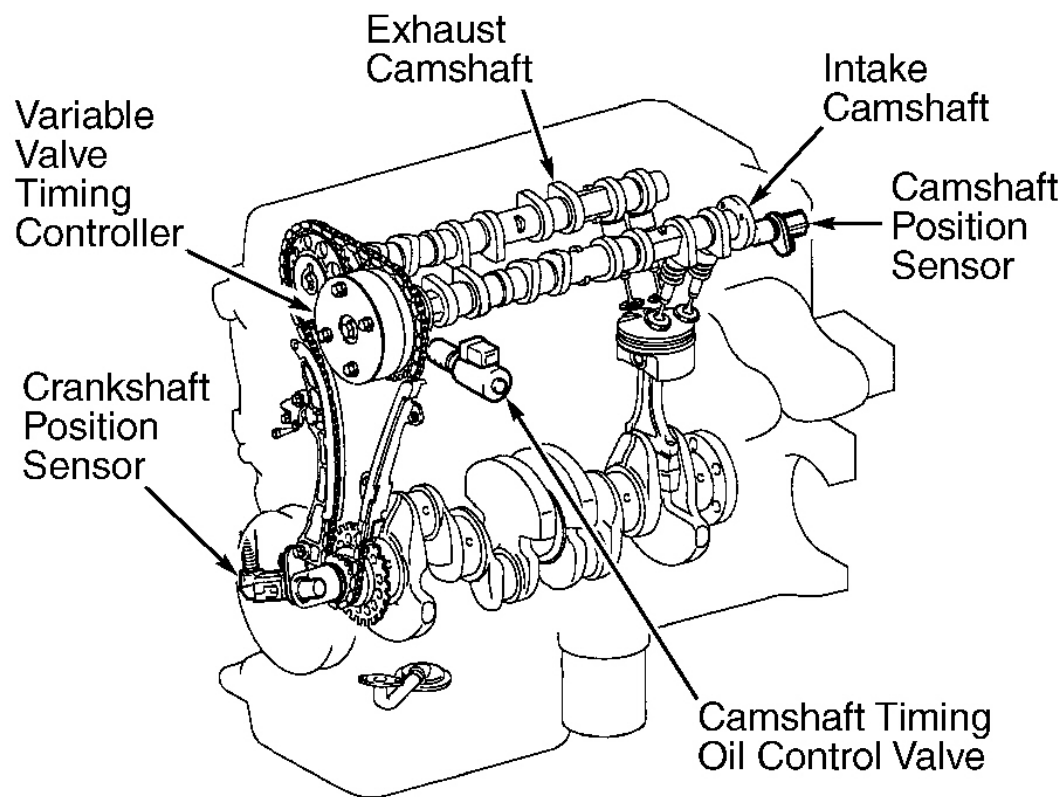
G00020831

Fig. 75: Locating Variable Valve Timing System Components (Camry 2.4L 4-Cyl., Camry Solara 2.4L 4-Cyl., Highlander 2.4L 4-Cyl. & RAV4)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



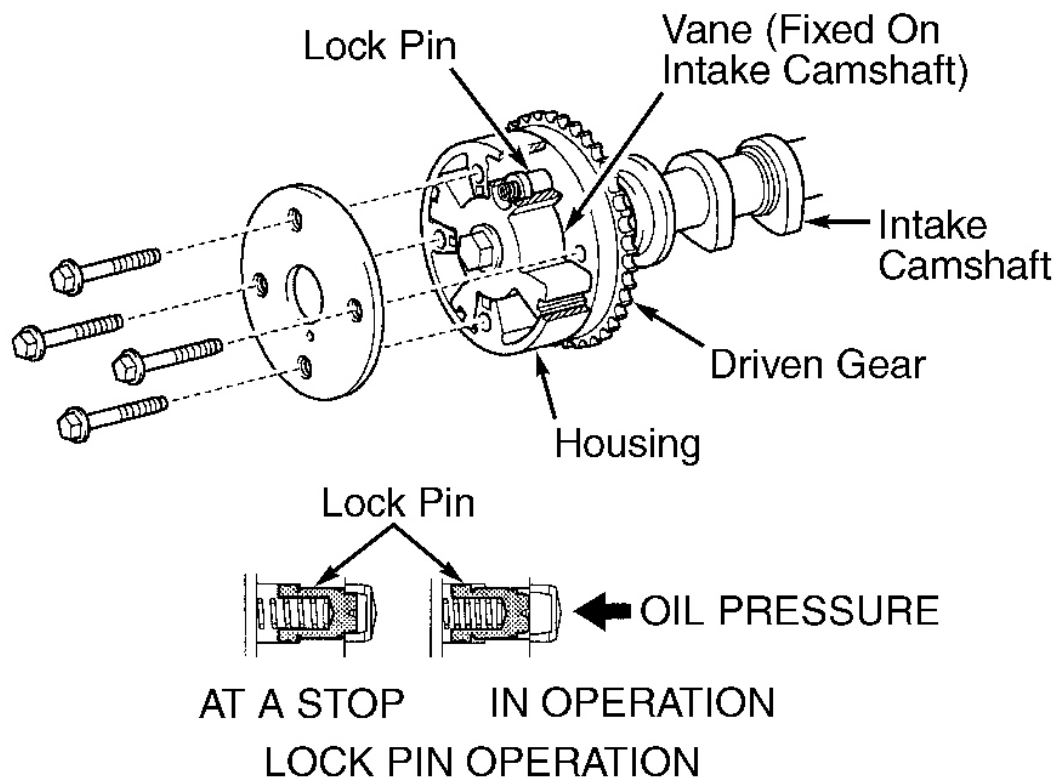
G99J52810

Fig. 76: Locating Variable Valve Timing System Components (Celica, Corolla & MR2)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99E52815

Fig. 77: Locating Variable Valve Timing System Components (ECHO & Prius)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



G99B52812

Fig. 78: Identifying Variable Valve Timing Controller Components (Camry 2.4L 4-Cyl., Camry Solara 2.4L 4-Cyl., Celica, Corolla, ECHO, Highlander 2.4L 4-Cyl., MR2, Prius & RAV4)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

MISCELLANEOUS CONTROLS

NOTE: Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.

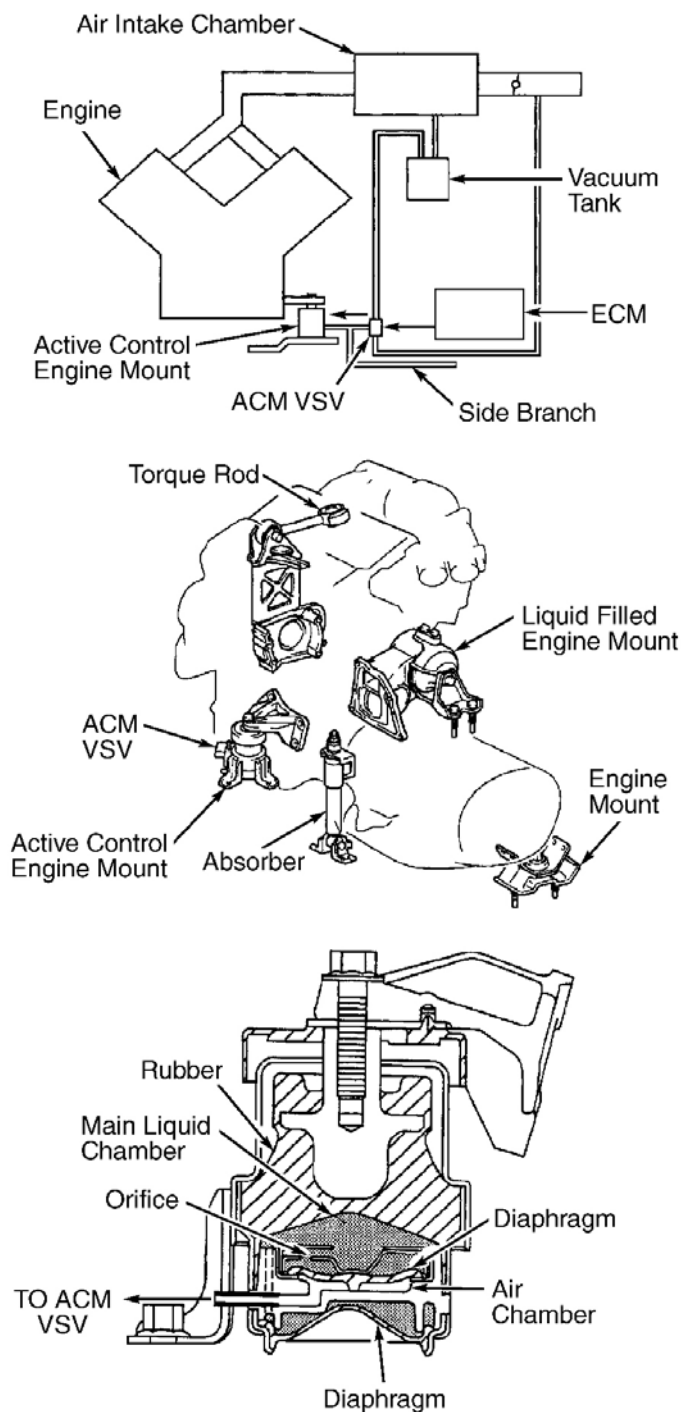
ACTIVE CONTROL ENGINE MOUNT

Avalon & Highlander 3.0L V6

Active control engine mount is used to reduce engine vibration and noise when engine is idling. Active control engine mount consists of vacuum tank, active control engine mount, Engine Control Module (ECM) and Active Control Mount (ACM) Vacuum Switching Valve (VSV). See **Fig. 79**.

Operating range of active control engine mount is during idling when engine speed is less than 900 RPM. ACM VSV receives vacuum supply from the vacuum tank. Signals that are synchronized to engine speed are

delivered from the ECM to the ACM VSV. Engine vacuum is used to vary the pressure in active control engine mount. As a result, the diaphragm in active control engine mount vibrates and uses the liquid in the main liquid chamber to control engine mount vibration. The force of the vibration in the active control engine mount is regulated by the orifice and the side branch which vents out to the atmosphere. Vibration of active control engine mount acts to cancel out the engine vibration during idle to reduce engine vibration and noise.



G00032695

Fig. 79: Identifying Typical Active Control Engine Mount Components (Avalon & Highlander 3.0L V6)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: IG2 relay may also be referred to as ignition relay.

Avalon

IG2 fuse supplies constant battery voltage to one side of IG2 relay. When ignition is turned on, voltage is supplied from ignition switch to other side of IG2 relay to energize the IG2 relay. When IG2 relay is energized, it provides battery voltage to fuel injectors and ignition coils. IG2 relay is located in fuse/relay box at driver's side front corner of engine compartment.

Celica

IG2 fuse supplies constant battery voltage to one side of IG2 relay. When ignition is turned on, voltage is supplied from ignition switch to other side of IG2 relay to energize the IG2 relay. When IG2 relay is energized, it provides battery voltage to fuel injectors and ignition coils. IG2 relay is located in fuse/relay box at driver's side front corner of engine compartment, just in front of strut tower.

MR2

IG2 fuse supplies constant battery voltage to one side of IG2 relay. When ignition is turned on, voltage is supplied from ignition switch to other side of IG2 relay to energize the IG2 relay. When IG2 relay is energized, it provides battery voltage to fuel injectors, ignition coils and IGSW terminal of Engine Control Module (ECM). IG2 relay is located in relay box on firewall at driver's side front corner of engine compartment.

Prius

AM2 fuse supplies constant battery voltage to one side of IG2 relay. When ignition is turned on, voltage is supplied from ignition switch to other side of IG2 relay to energize the IG2 relay. When IG2 relay is energized, it provides battery voltage to fuel injectors and ignition coils. IG2 relay is located in fuse/relay box at driver's side front corner of engine compartment.

RAV4

IGN fuse supplies constant battery voltage to one side of IG2 relay. When ignition is turned on, voltage is supplied from ignition switch, through IG2 fuse and to other side of IG2 relay to energize the IG2 relay. When IG2 relay is energized, it provides battery voltage to fuel injectors and ignition coils. IG2 relay is located in relay box at driver's side front corner of engine compartment, just in front of strut tower.

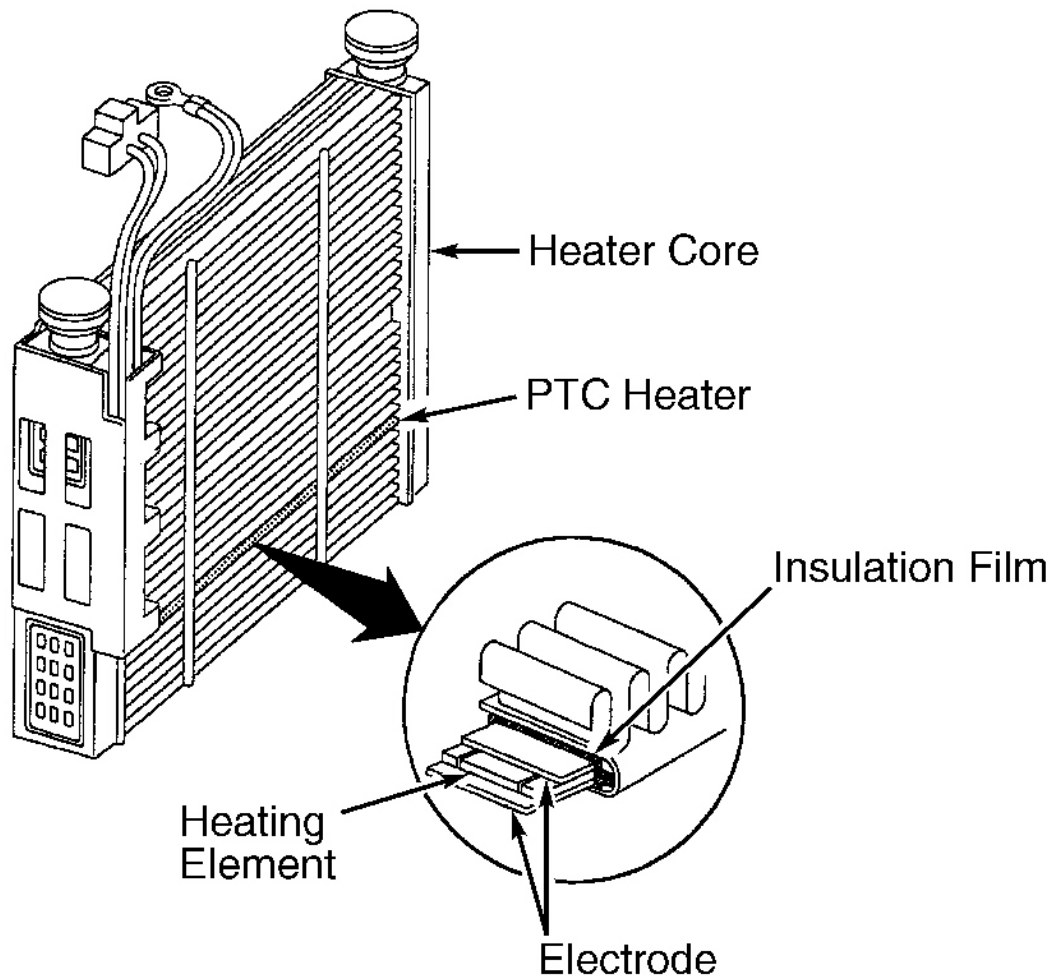
POSITIVE TEMPERATURE COEFFICIENT HEATER

ECHO

Positive Temperature Coefficient (PTC) heater is a small electrical heater located in the heater core and is used on vehicles equipped for cold areas. See **Fig. 80** . PTC heater may be turned on if all of the following conditions exist: temperature control switch is at MAX HOT position, engine speed is more than 1050 RPM, engine coolant temperature is less than 176°F (80°C) and generator power ratio is less than 95 percent. PTC heater may also be turned on and off depending on generator power ratio.

Temperature control switch operates a maximum hot switch, which provides an input signal to Engine Control Module (ECM) for controlling PTC heater operation. Maximum hot switch may also be referred to as MAX HOT switch.

HTR SUB1 relay is used for supplying battery voltage to PTC heater. HTR SUB1 relay may also be referred to as heater sub relay. HTR SUB1 fuse supplies battery voltage to one side of HTR SUB1 relay. When ignition is turned on, voltage is supplied from ignition switch, through ECU-IG fuse and to other side of HTR SUB1 relay. When PTC amplifier completes ground circuit for HTR SUB1 relay, HTR SUB1 relay then provides battery voltage to PTC heater for PTC heater operation. HTR SUB1 relay is located in fuse/relay box at driver's side front corner of engine compartment, just in front of strut tower.



G99A52365

Fig. 80: Locating Positive Temperature Coefficient Heater (ECHO)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

TRANSMISSION/TRANSAXLE CONTROLS

NOTE: Only electronically controlled automatic transmissions or transaxles are covered. Some models have automatic transmissions or transaxles which are not electronically controlled.

Electronically Controlled Transmission/Transaxle

Engine Control Module (ECM) uses input signals for controlling automatic transmission or transaxle operation.