E - THEORY/OPERATION
Article Text
1991 Toyota MR2
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ARTICLE BEGINNING

1991 ENGINE PERFORMANCE
Toyota Theory & Operation

Camry, Celica, Corolla, Cressida,
Land Cruiser, MR2, Pickup, Previa,
Supra, Tercel, 4Runner

INTRODUCTION

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.

AIR INDUCTION SYSTEM

INTAKE AIR CONTROL SYSTEM

SUPRA (7M-GE)
ECU uses inputs from engine RPM and throttle position sensor to change amount of airflow into manifold runner. This is done to increase power in low speed range. ECU opens an air control valve through a vacuum switching valve.

VARIABLE INDUCTION SYSTEM

CELICA TURBO & MR2 TURBO
Each cylinder runner in the intake manifold is divided into 2 parts. An intake air control valve is installed in one passage on each cylinder runner. The opening and closing of this valve gives the best airflow possible, preventing low-speed performance loss and improved fuel economy. The intake control valves are vacuum actuated. The vacuum signal is controlled by the ECU through a vacuum switching valve.

TURBOCHARGERS

CELICA TURBO, MR2 TURBO & SUPRA TURBO
All systems are equipped with an air-cooled intercooler and use a wastegate system to control maximum boost pressure. On Celica and MR2, maximum boost pressure is controlled by a dual control wastegate actuator. One pressure signal is direct from downstream of the impeller wheel and one pressure signal is ECU controlled, through a vacuum switching valve, from upstream of the impeller wheel.
On Supra, wastegate valve is actuated by pressure signal from intake manifold. Celica and MR2 use a vane-type airflow meter and turbocharging pressure sensor to signal the ECU. On Supra, there is not a separate pressure sensor for the ECU. The Karman-Vortex mass airflow meter senses boost pressure for the ECU.

COMPUTERIZED ENGINE CONTROLS

TOYOTA COMPUTER CONTROL SYSTEM (TCCS)

Toyota Computer Control System (TCCS) is a computerized emission, ignition and fuel injection control system. TCCS lowers exhaust emissions while maintaining good fuel economy and driveability.

An Electronic Control Unit (ECU) governs TCCS based on input signals received from various input devices. ECU contains preprogrammed data to maintain optimum engine performance under all operating conditions.

ECU is also equipped with a self-diagnostic function. Trouble codes are set by the malfunction of engine sensors or circuits and stored in the ECU memory. A CHECK ENGINE light on the instrument panel will come on if a trouble code is stored.

CONTROL UNIT

Electronic Control Unit (ECU) is a microprocessor which controls all functions of TCCS. ECU receives signals from sensors, switches, and ignition and starting systems. ECU has constant source of battery power at BATT terminal. EFI main relay provides battery voltage to terminals +B and +B[I1] of ECU. EFI main relay is activated by turning on ignition switch.

Signals are processed by the ECU for controlling various functions. See OUTPUT SIGNALS in this article.

FAIL-SAFE SYSTEM

The ECU contains a fail-safe function that is used in case of sensor or switch failure. The fail-safe function uses preprogrammed engine values to provide a limp-in mode so the vehicle may be driven. If malfunction is serious enough, ECU may shut down engine.

ECU LOCATIONS TABLE

Model	Location
Camry, Celica, Corolla & Tercel	Bottom Center Of Dash, In Front Of Console
Cressida, Land Cruiser & Supra	Above Glove Box
MR2	Left Rear Of Engine Compartment
Pickup & 4Runner	Behind Right Kick Panel
Previa	Under Driver's Seat

POWER SUPPLY

EFI MAIN RELAY

EFI main relay provides battery voltage to terminals +B and +B1 of ECU. It also supplies current to circuit opening relay, engine

check connector and, depending on model application, idle speed control valve and oxygen sensor heater. EFI fuse supplies constant battery voltage to EFI main relay.

CIRCUIT OPENING RELAY

Circuit opening relay controls fuel pump circuit. ECU receives input signal at STA terminal when engine is cranking. This same starter signal is also applied to terminal STA of circuit opening relay. Starter signal energizes circuit opening relay during cranking, which in turn, activates fuel pump. On Camry, Corolla (4A-GE), Cressida, Land Cruiser, Pickup, Previa, Supra (7M-GE) and 4Runner, circuit opening relay is grounded through airflow meter when it senses airflow to engine. On Celica, Corolla (4A-FE), MR2, Supra (7M-GTE) and Tercel, circuit opening relay is grounded by ECU through FC terminal.

NOTE: Components are grouped into 2 categories. The first category covers INPUT DEVICES, which control or produce voltage signals monitored by the control unit. The second category covers OUTPUT SIGNALS, which are components controlled by the control unit.

INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine the input usage on a specific model, see appropriate wiring diagram in L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section. The available input signals include the following:

A/C SWITCH

When the air conditioner is turned on, the ECU monitors the signal that turns on the compressor clutch. ECU uses this signal for controlling idle speed during A/C operation.

AIRFLOW SENSOR

On all models except Supra Turbo, the airflow sensor in the airflow meter measures airflow volume. Airflow meter converts intake air readings into a voltage signal by means of a variable resistor (potentiometer). Signal is sent to ECU for controlling fuel injection duration and spark advance system. On Supra Turbo, the airflow volume is measured by a Karman-Vortex airflow meter. This input signal is sent to the ECU.

AIR TEMPERATURE SENSOR

Sensor is mounted in either airflow meter or air filter housing. Sensor measures incoming air temperature. Signal is sent to ECU for controlling fuel injection duration.

BATTERY SIGNAL

Battery voltage is always present at BATT terminal of ECU. When ignition switch is turned to ON position, voltage for ECU operation is applied through the EFI main relay to terminals +B and +B1.

BRAKE LIGHT SIGNAL
The brake light switch is used to detect when the vehicle is braking. This signal is sent to terminal STP of the ECU.

CAMSHAFT POSITION SENSOR (SUPRA TURBO)
This sensor sends crankshaft position and engine RPM signal to the ECU.

COOLANT TEMPERATURE SENSOR (CTS)
Monitors coolant temperature. CTS has a built-in thermistor whose resistance varies according to engine temperature. CTS signal is input to ECU at terminal THW. ECU uses sensor signal for controlling fuel injection duration, overdrive operation on electronically controlled transmissions, spark advance system, idle speed control system and EGR system.

COOLANT TEMPERATURE SWITCH (LAND CRUISER)
Switch turns on when coolant exceeds a specified temperature. Signal is used for fuel pressure control by the ECU. ECU receives signal from terminal TWS.

CRANKING SIGNAL
While the engine is cranking, the voltage applied the starter is also input to terminal STA of the ECU.

EGR GAS TEMPERATURE SENSOR (CALIF.)
Sensor determines EGR gas temperature and sends signal to ECU.

KNOCK SENSOR
Sensor monitors ignition knock conditions and sends a signal to the ECU. ECU will in turn retard engine timing until knocking stops.

NEUTRAL/START SWITCH
Switch is installed on A/T models to inform ECU of gear selection. Information is used by the ECU to allow starter operation and control engine idle.

OIL PRESSURE SWITCH SIGNAL (SUPRA TURBO)
Engine oil pressure is monitored by the ECU at the OIL terminal.

OXYGEN (O2) SENSOR (ZIRCONIA TYPE - CALIF.)
This oxygen sensor is installed in the exhaust system and monitors oxygen content of exhaust gases. Signal is sent to the ECU and is used for determining fuel injection duration. Some models are equipped with a second, sub-oxygen sensor downstream from the main oxygen sensor.
The oxygen sensor can be monitored at the engine check connector at terminal VF or VF1. The ECU sends out a special 5-volt signal on this wire so the number of cross-counts the ECU sees from

the O2 sensor can be read with an analog voltmeter.

OXYGEN (O2) SENSOR (TITANIA TYPE - FEDERAL)

This oxygen sensor is installed in the exhaust system and monitors oxygen content of exhaust gases. Signal is sent to the ECU and is used for determining fuel injection duration.

The oxygen sensor is supplied a potential one volt by the ECU on terminal Ox+. The signal returns to the ECU at terminal Ox. Through a comparator resistor, the ECU compares voltage drop at terminal Ox and a predetermined reference voltage. If the Ox voltage is greater than the reference voltage, the ECU judges the air/fuel ratio rich. If the Ox voltage is lower than the reference voltage, the ECU judges the air/fuel ratio lean.

RPM SIGNAL

On all models except Supra Turbo, crankshaft position and engine RPM are detected by pick-up coils in the distributor. On all models except 4-cylinder Pickup and 4Runner, and Tercel, crankshaft position is read by ECU at G1 terminal (and G2 on some models), and engine RPM is input to ECU terminal Ne.

On Pickup/4Runner (22R-E) and Tercel, a single pick-up coil is used in the distributor. ECU monitors pick-up coil signal at terminal Ne. On Supra Turbo models, crankshaft position and engine RPM are detected by the camshaft position sensor. Crankshaft position is input to ECU terminals G1 and G2, and engine RPM is input to terminal Ne.

SUB-OXYGEN SENSOR (CALIF.)

Sensor is used in conjunction with O2 sensor. Sensor monitors oxygen content of exhaust gases and sends signal to the ECU.

THROTTLE POSITION SENSOR (TPS)

Throttle Position Sensor (TPS) is mounted on throttle body. Sensor determines changes in throttle valve position and sends signals to the ECU. Signals are used for controlling fuel injection duration and idle speed control system.

TURBO PRESSURE SENSOR (CELICA TURBO)

Sensor monitors turbo pressure and sends signal to ECU.

VACUUM SENSOR (CELICA NON-TURBO,
COROLLA 4A-FE, MR2 5S-FE & TERCEL)

Sensor is also known as manifold absolute pressure (MAP) sensor. This sensor monitors engine vacuum for the ECU. ECU uses this signal to help control fuel injection pulse width.

VEHICLE SPEED SENSOR (VSS)

Sensor is used to monitor vehicle speed. Vehicle speed information is used by the ECU for fuel injection, air injection (Land Cruiser only), cruise control and electronic control of automatic transmission.

4WD SWITCH (LAND CRUISER, PICKUP & 4RUNNER)

Switch indicates 4WD operation and sends signal to ECU.

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 the system indicated after component.

The ECU receives input from data sensors and, depending on model application, controls the following components and subsystems:

A/C CUT CONTROL SYSTEM
See IDLE SPEED.

AIR INJECTION SOLENOID
See EMISSION SYSTEMS.

AIR SUCTION CONTROL SOLENOID
See EMISSION SYSTEMS.

CIRCUIT OPENING RELAY
See FUEL DELIVERY.

DASHPOT SYSTEM
See DASHPOT SYSTEM.

ELECTRONIC FUEL INJECTION
See FUEL CONTROL.

ELECTRONIC SPARK ADVANCE
See IGNITION SYSTEM.

EGR CONTROL SOLENOID
See EMISSION SYSTEMS.

ELECTRONIC CONTROLLED TRANSMISSION (ECT)
See MISCELLANEOUS CONTROLS.

FUEL PRESSURE VACUUM SWITCHING VALVE
See FUEL DELIVERY.

FUEL PUMP
See FUEL DELIVERY.

IDLE SPEED CONTROL
See IDLE SPEED.

IDLE-UP SYSTEM
See IDLE SPEED.

INTAKE AIR CONTROL SYSTEM

See AIR INDUCTION SYSTEM.

O2 SENSOR HEATER
See FUEL CONTROL.

SELF-DIAGNOSTIC SYSTEM
See SELF-DIAGNOSTIC SYSTEM.

TURBOCHARGER VACUUM SWITCHING VALVE (VSV)
See AIR INDUCTION SYSTEM.

VARIABLE INDUCTION VACUUM SWITCHING VALVE (VSV)
See AIR INDUCTION SYSTEM.

FUEL SYSTEM

FUEL DELIVERY

CIRCUIT OPENING RELAY

The ECU receives an input signal at terminal STA when the engine is cranking. This same starter signal is also applied to terminal STA of the circuit opening relay.

The starter signal energizes the relay during cranking, turning on the fuel pump. On Camry, Corolla (4A-GE), Cressida, Land Cruiser, Pickup, Previa, Supra (7M-GE) and 4Runner, when the airflow meter senses airflow to the engine, the fuel pump switch in the airflow meter provides an alternate ground for the relay. On Celica, Corolla (4A-FE), Supra Turbo and Tercel, the ECU keeps the relay energized through ECU terminal FC while engine is running.

FUEL PUMP

All models use an electric fuel pump. Fuel pump is turned on by signal from the circuit opening relay, which in turn is controlled by the EFI main relay. Some models use a fuel pump relay. The fuel pump can be run with the engine off by turning on the ignition key and placing a jumper wire across terminals +B and FP of the engine check connector.

On Celica (3S-GTE), Cressida, MR2 (3S-GTE) and Supra models, fuel pump volume can be varied. Based on intake volume and engine RPM signal, the ECU signals the fuel pump relay to change fuel pump speed. If engine requires a large volume of fuel, fuel pump turns at high speed; when a small volume of fuel is required, pump turns at a slower speed.

FUEL PRESSURE REGULATOR

Mounted on the fuel rail, the pressure regulator maintains constant fuel pressure to the injectors. The pressure regulator is vacuum operated. As the throttle is depressed and manifold vacuum drops, the pressure regulator increases fuel pressure to maintain a constant flow to the injectors.

FUEL PRESSURE-UP SYSTEM (CAMRY 3S-FE, COROLLA 4A-GE,

LAND CRUISER, MR2 5S-FE, PICKUP, PREVIA, SUPRA TURBO, TERCEL & 4RUNNER)

The fuel pressure-up system increases fuel pressure slightly on hot restarts for improved starting and idle stability. The pressure rise is accomplished by cutting off the vacuum signal to the fuel pressure regulator. The ECU controls the vacuum signal through the Vacuum Switching Valve (VSV). Pressure rise lasts for about 90-180 seconds after hot restart.

FUEL PULSATION DAMPER

The fuel pulsation damper eliminates pressure surges in fuel line caused by opening and closing of injectors.

FUEL CONTROL

AIRFLOW METER

Mounted in the air induction system near the air cleaner, the airflow meter measures intake air volume.

On all models except Supra Turbo, a Bosch vane airflow meter converts intake air readings into a voltage signal by means of a variable resistor (potentiometer). When intake air volume is low, the voltage is high; when the air volume is high, the voltage signal is close to zero.

On Supra Turbo, a Karman-Vortex airflow meter is used to measure intake airflow and turbo boost pressure. Corolla (4A-FE) and Tercel do not use an airflow meter.

COLD START INJECTOR

This device delivers additional fuel for cold engine starting. Cold start injector (and cold start injector time switch) is fed current from ignition switch during cranking. ECU supplies voltage to injector, and a cold start injector time switch controls ground circuit for the cold start injector.

COLD START INJECTOR TIME SWITCH

This switch determines cold start injector on time for cold engine starting. Cold start injector ground circuit is controlled by cold start injector time switch.

DECELERATION FUEL-CUT SYSTEM

This system aids in controlling exhaust emissions and improving engine performance during prolonged periods of deceleration. The system cuts off fuel or reduces the amount of fuel in the mixture. Air/fuel ratio becomes lean during deceleration, thereby preventing afterburning and overheating.

EFI MAIN RELAY

The EFI main relay is activated by turning on the ignition switch. The EFI main relay provides battery voltage to terminals +B and +B1 of ECU.

FUEL-CUT SYSTEM

Controlled through input from the throttle position sensor,

the ECU will cut fuel delivery during closed throttle deceleration.

FUEL INJECTORS

Injectors are ECU actuated solenoids which deliver fuel to individual cylinders.

INJECTOR RESISTOR (CELICA TURBO, MR2 TURBO & SUPRA TURBO)

The injector resistor reduces current flow to the fuel injectors.

PORT FUEL INJECTION

Port fuel injected vehicles can operate in one of 2 injection modes, simultaneous or sequential. In simultaneous injection mode, fuel is injected into all 4 or 6 cylinders at the same time, or sometimes in pairs. In sequential injection mode, the injectors are triggered in spark plug firing order.

The ECU controls injection duration in accordance with engine conditions to provide efficient engine operation. Data on engine temperature, engine and vehicle speed, intake air volume, throttle position, exhaust oxygen content, and intake air temperature are used by ECU to modify injection pulse width.

OXYGEN SENSOR HEATER

On some models, the O2 sensor is equipped with a heating element. The ECU turns the heater on when intake air volume and coolant temperature are low, and warms O2 sensor to improve sensor performance.

IDLE SPEED

A/C CUT CONTROL SYSTEM (CELICA NON-TURBO, COROLLA, MR2 NON-TURBO & PREVIA)

A/C cut control system interrupts A/C compressor operation for a fixed period of time when the vehicle accelerates from low engine speed. ECU uses vehicle speed and throttle plate angle inputs to determine A/C cut control.

AUXILIARY AIR VALVE (CELICA 4A-FE, COROLLA, PICKUP 22R-E, TERCEL & 4RUNNER 22R-E)

Auxiliary air valve provides extra air to the intake manifold when the engine is cold. Valve is mounted on the throttle body and is fed coolant to determine engine operating temperature.

IDLE SPEED CONTROL (CAMRY, CELICA 3S-GTE & 5S-FE, CRESSIDA, LAND CRUISER, MR2, PREVIA & SUPRA)

The ECU is programmed with engine idle speed values. The Idle Speed Control (ISC) system gives a stable idle when the engine is cold and when idle speed has dropped due to electrical load. Such loads may be caused by air conditioner, high beams or rear window defogger. The ECU receives input and controls idle speed through ISC valve, located on air intake system.

IDLE-UP SYSTEM (CELICA 4A-FE, COROLLA & TERCEL)

The idle-up system uses an ECU controlled vacuum switching valve to increase and stabilize idle speed due to electrical loads. The vacuum switching valve allows extra intake air to by-pass the throttle valve.

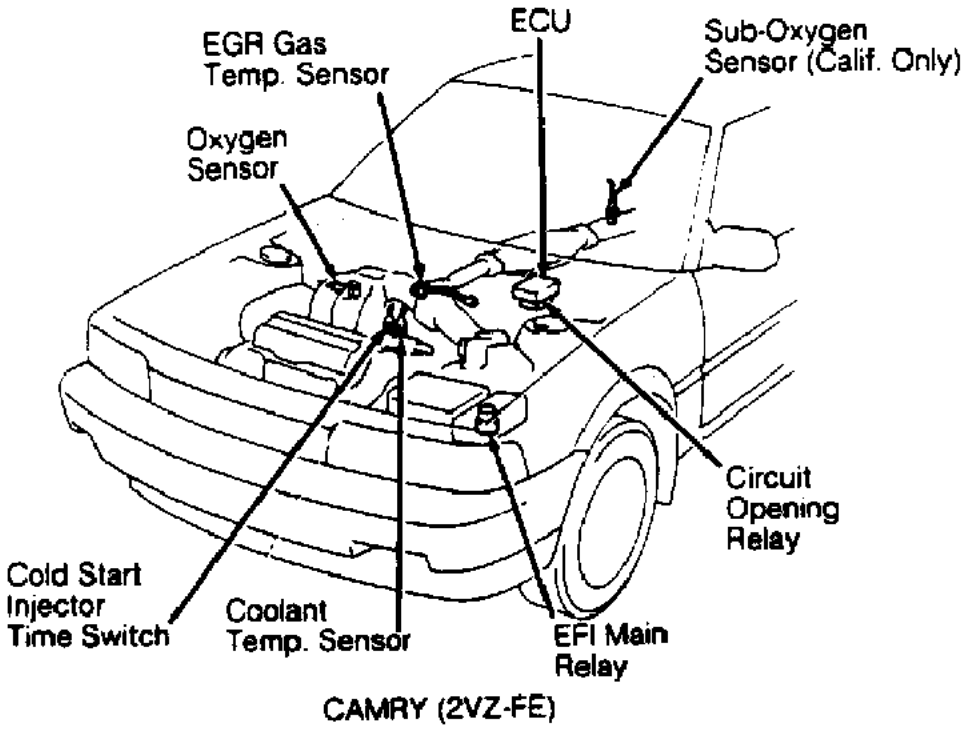


Fig. 1: Locating TCCS Components (Camry 2VZ-FE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

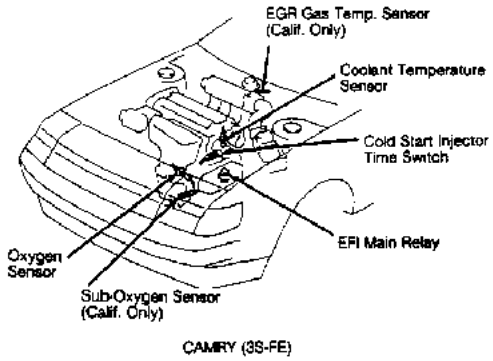


Fig. 2: Locating TCCS Components (Camry 3S-FE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

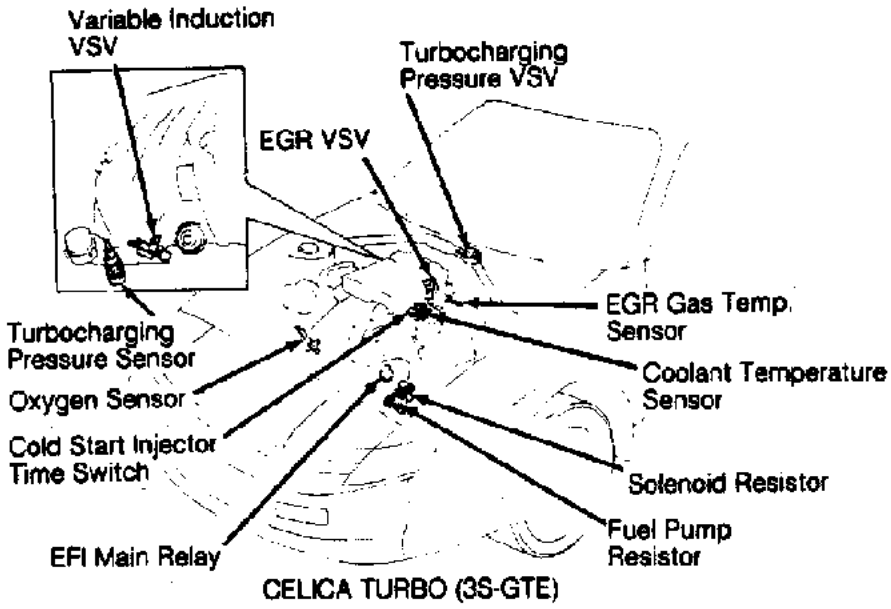


Fig. 3: Locating TCCS Components (Celica Turbo 3S-GTE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

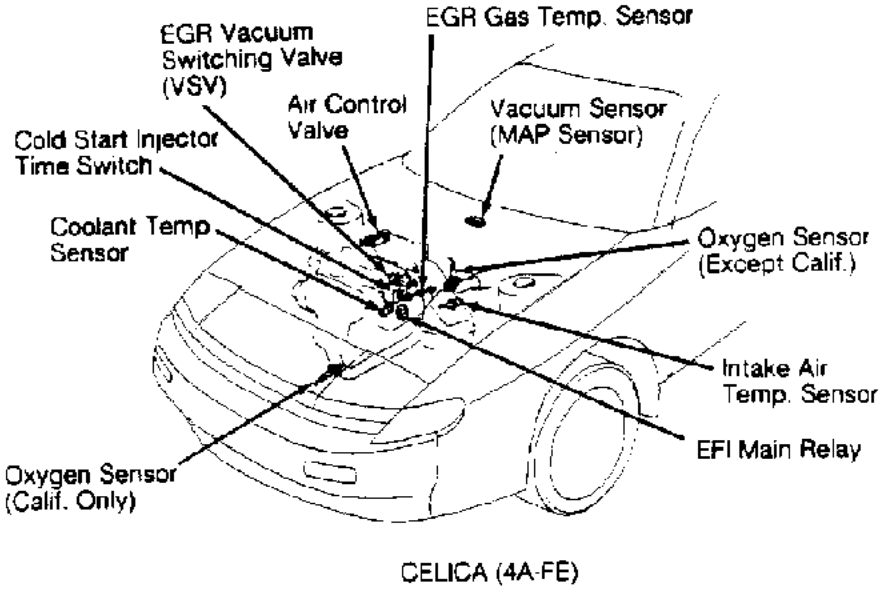


Fig. 4: Locating TCCS Components (Celica 4A-FE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

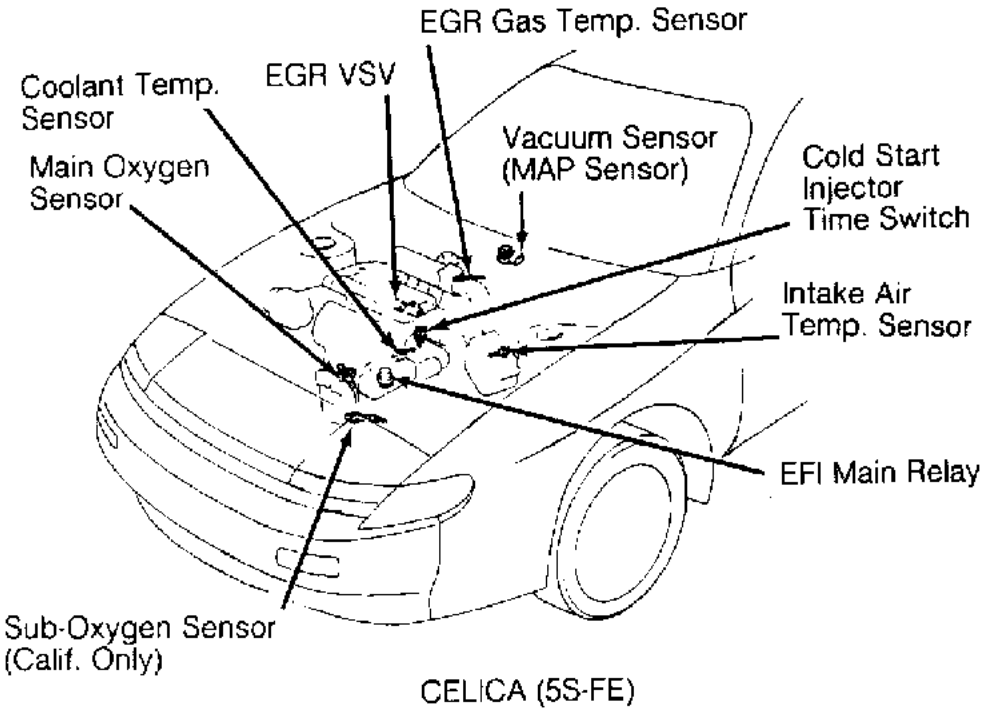


Fig. 5: Locating TCCS Components (Celica 5S-FE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

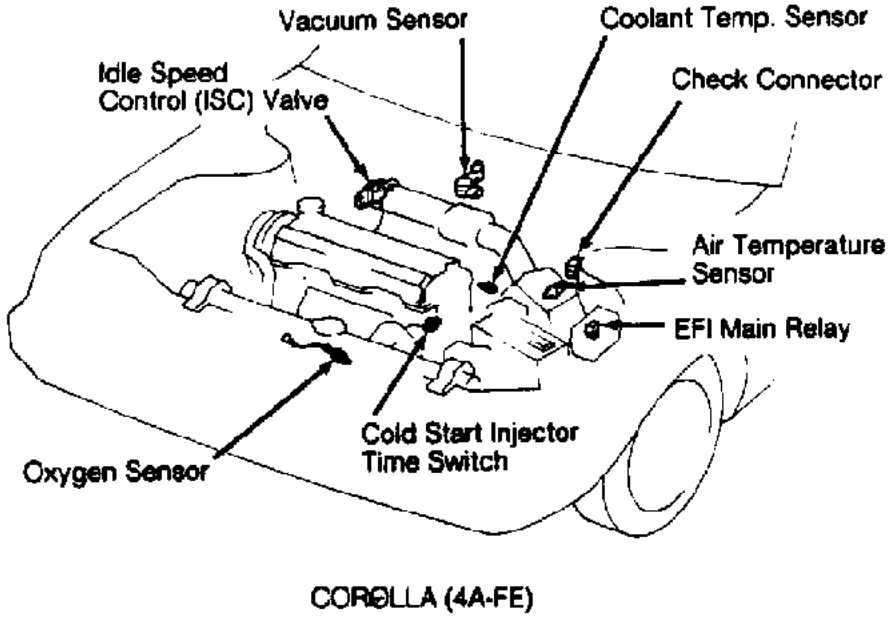


Fig. 6: Locating TCCS Components (Corolla 4A-FE - 1 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

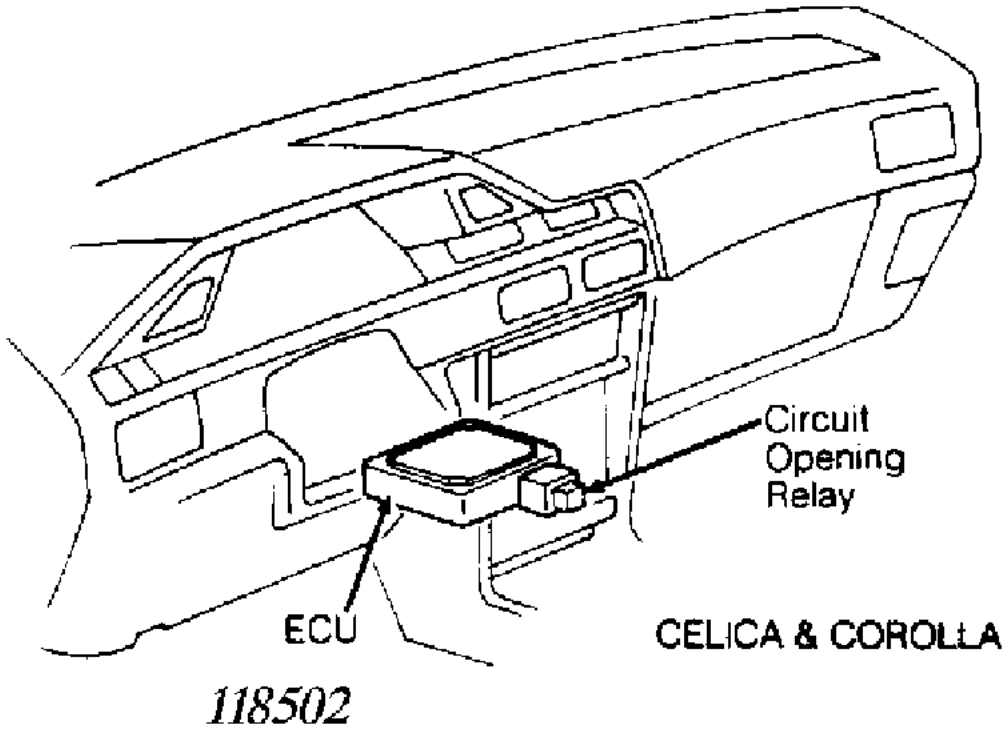


Fig. 7: Locating TCCS Components (Corolla 4A-FE - 2 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

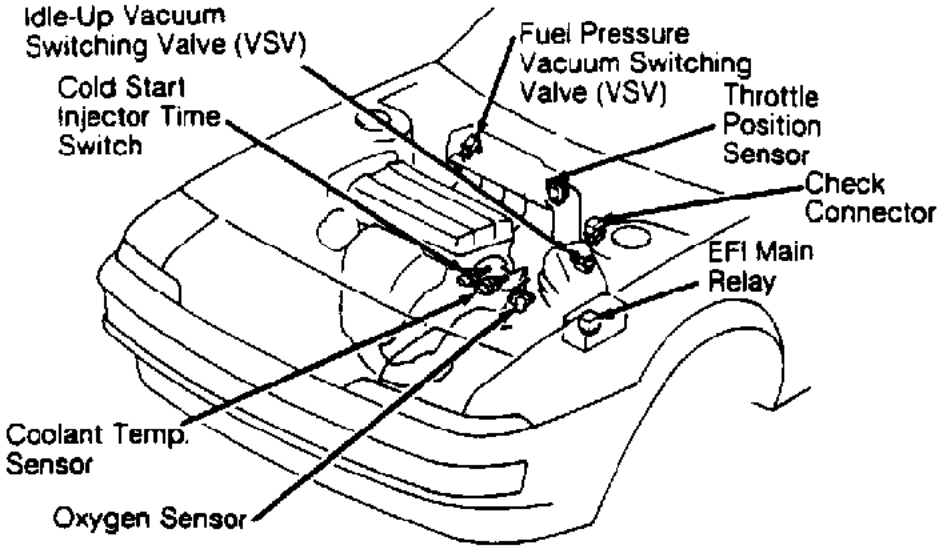


Fig. 8: Locating TCCS Components (Corolla 4A-GE - 1 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

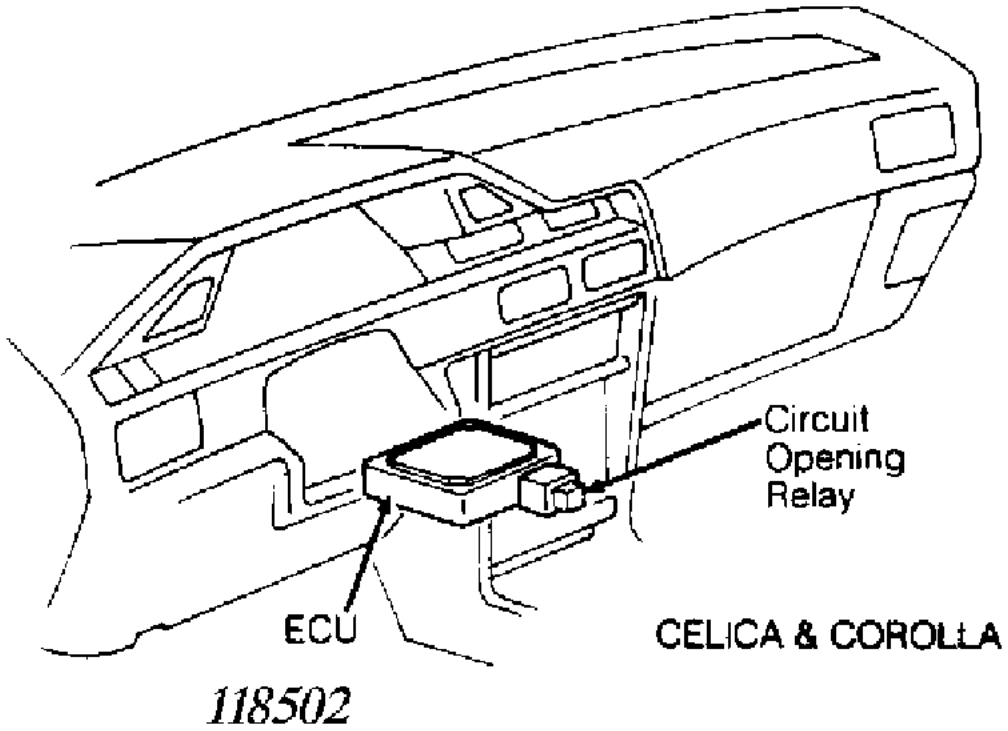


Fig. 9: Locating TCCS Components (Corolla 4A-GE - 2 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

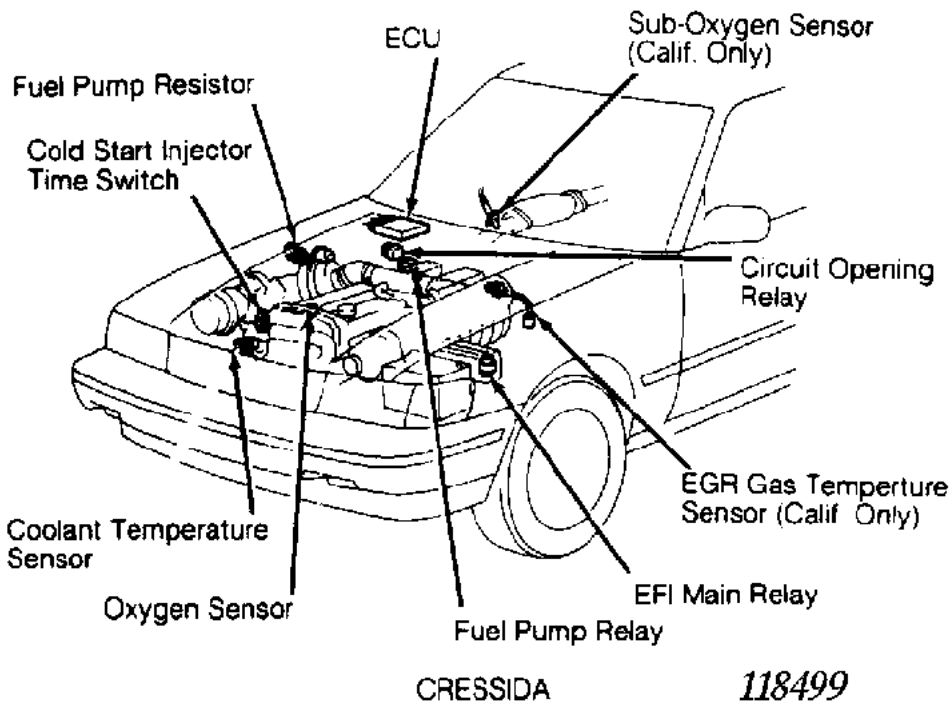


Fig. 10: Locating TCCS Components (Cressida)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

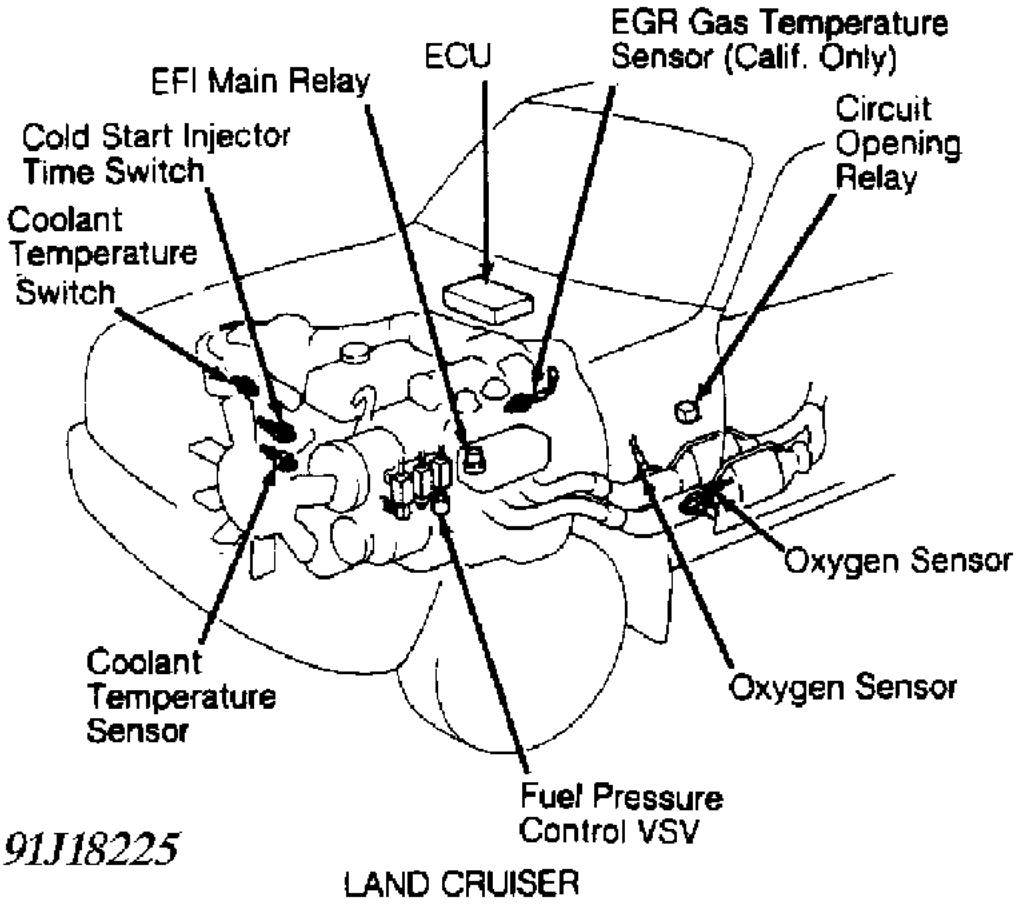


Fig. 11: Locating TCCS Components (Land Cruiser)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

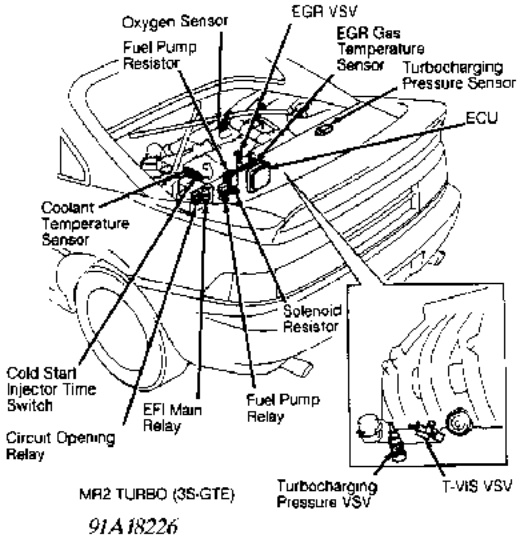


Fig. 12: Locating TCCS Components (MR2 Turbo 3S-GTE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

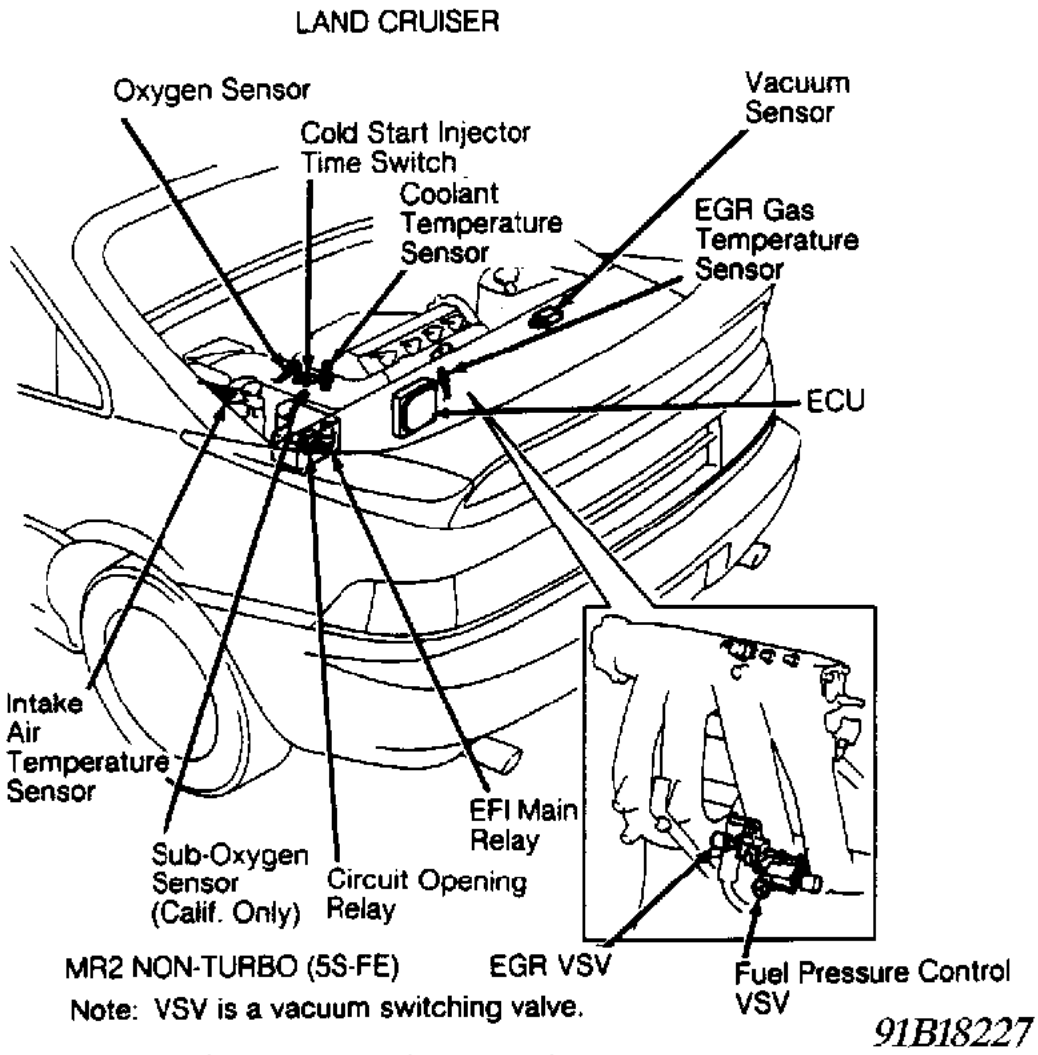
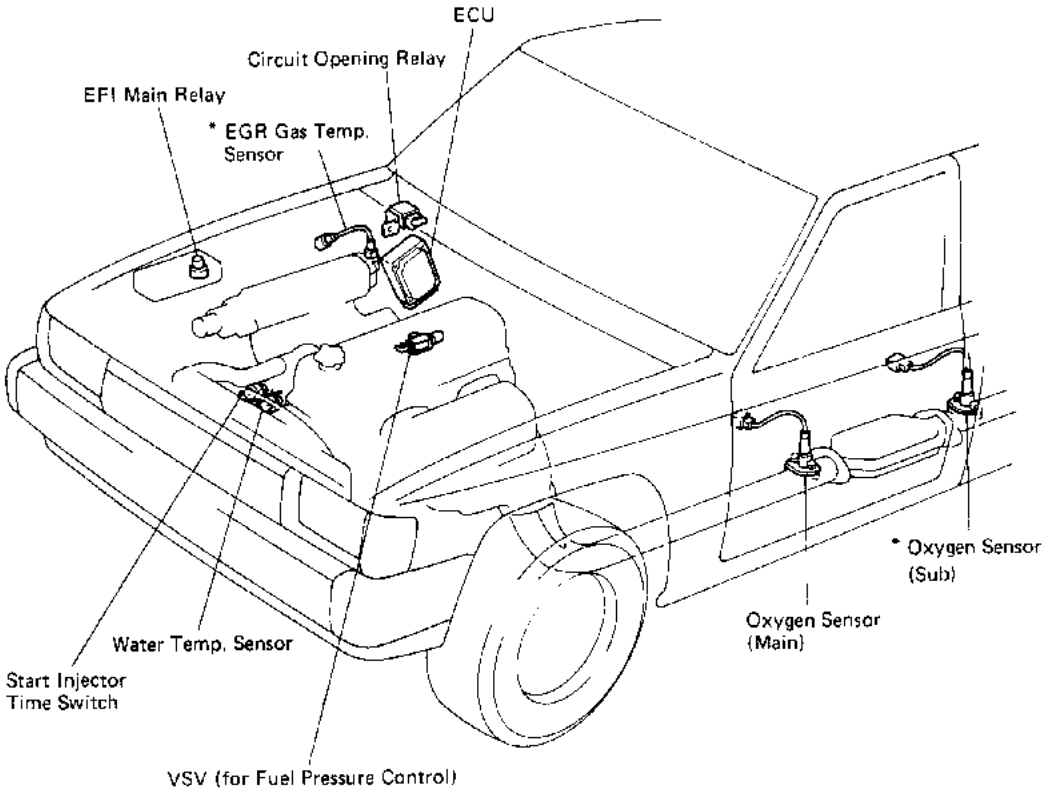
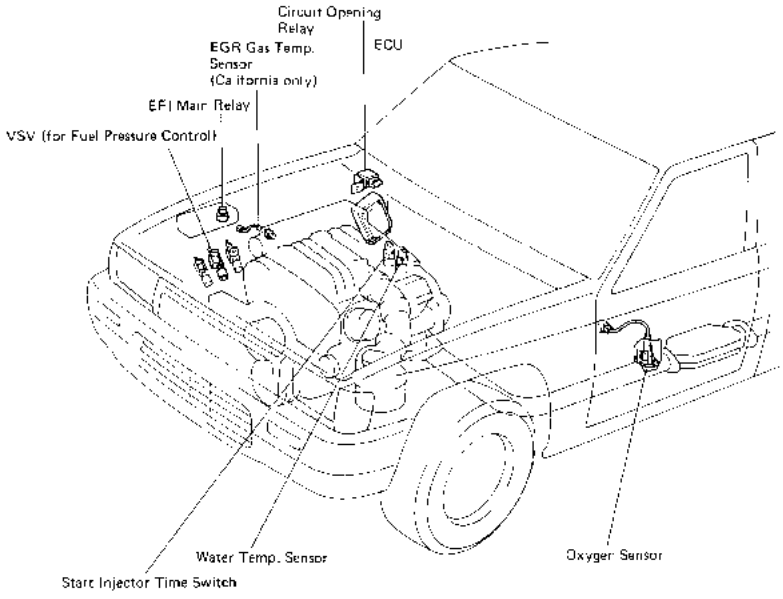


Fig. 13: Locating TCCS Components (MR2 Non-Turbo 5S-FE)
Courtesy of Toyota Motor Sales, U.S.A., Inc.



P/U 22 R E

Fig. 14: Locating TCCS Components (Pickup & 4Runner 22R-E)
Courtesy of Toyota Motor Sales, U.S.A., Inc.



(P/U 3VZ-E)

Fig. 15: Locating TCCS Components (Pickup & 4Runner 3VZ-E)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

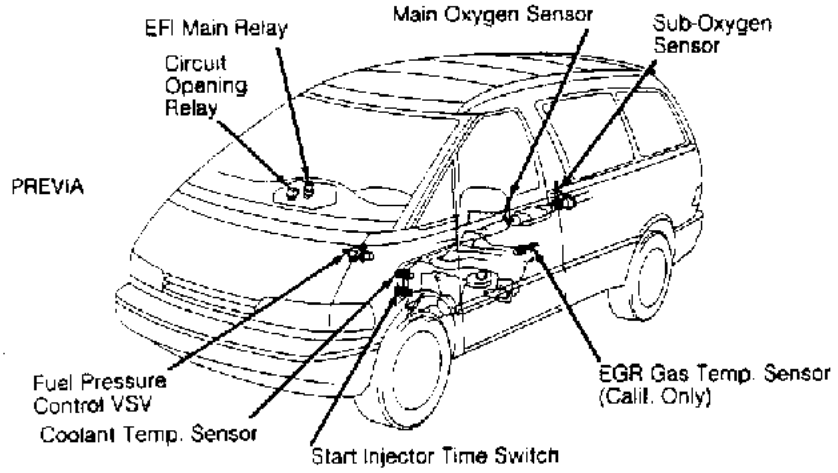


Fig. 16: Locating TCCS Components (Previa)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

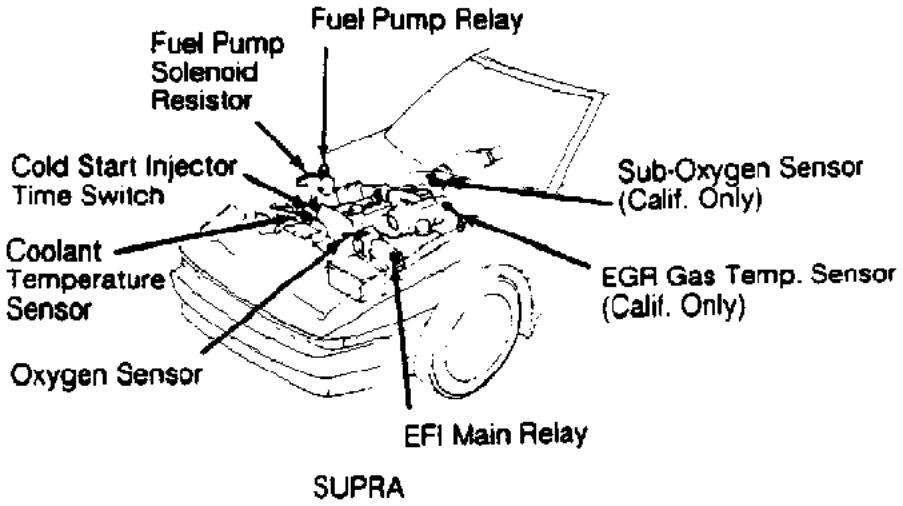


Fig. 17: Locating TCCS Components (Supra Non-Turbo - 1 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

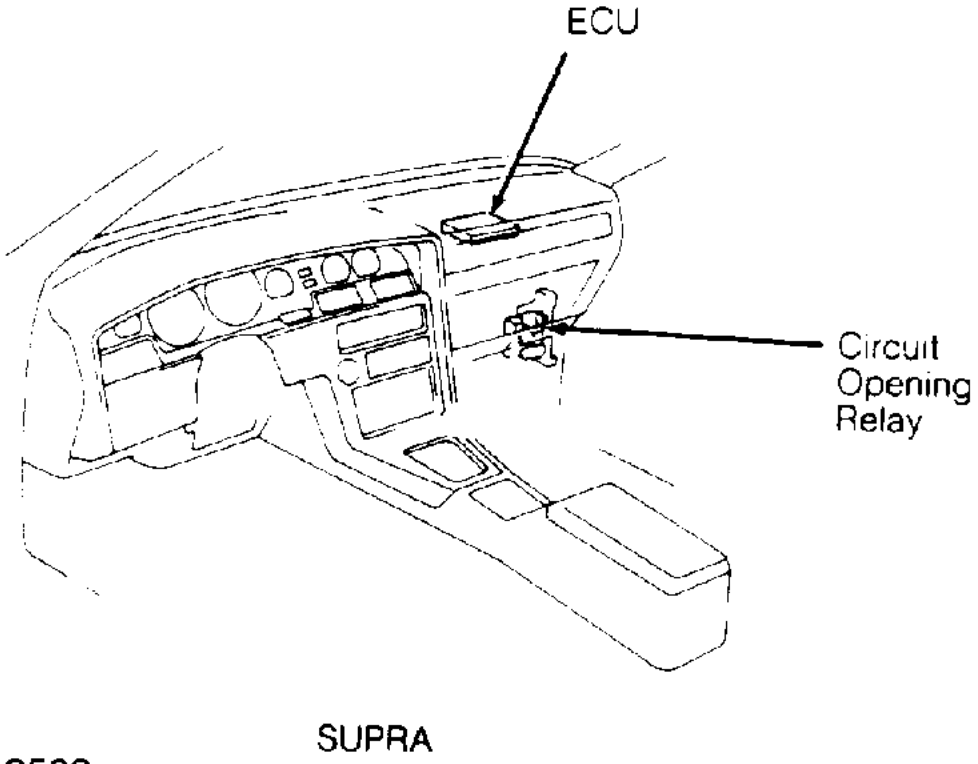


Fig. 18: Locating TCCS Components (Supra Non-Turbo - 2 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

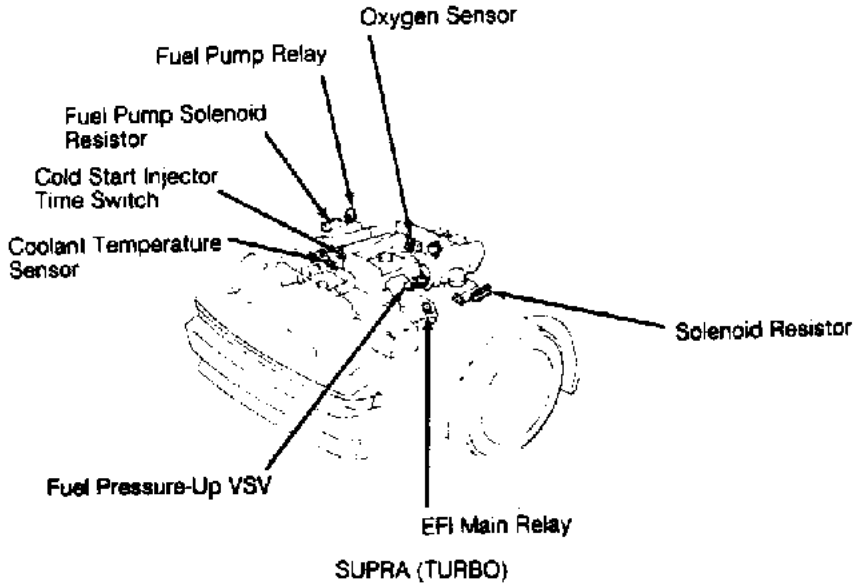


Fig. 19: Locating TCCS Components (Supra Turbo - 1 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

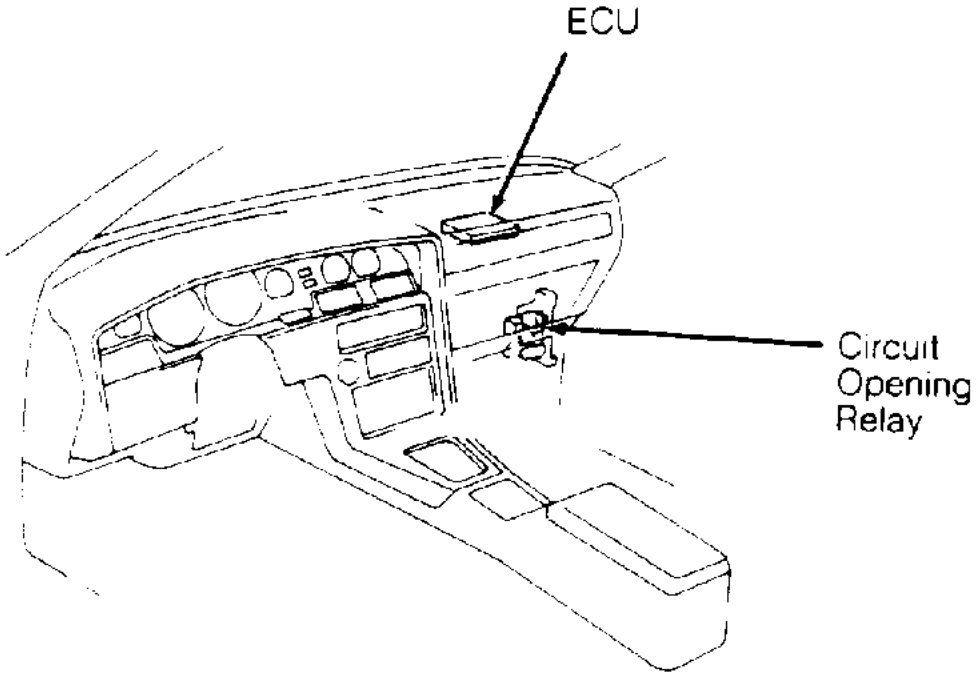


Fig. 20: Locating TCCS Components (Supra Turbo - 2 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

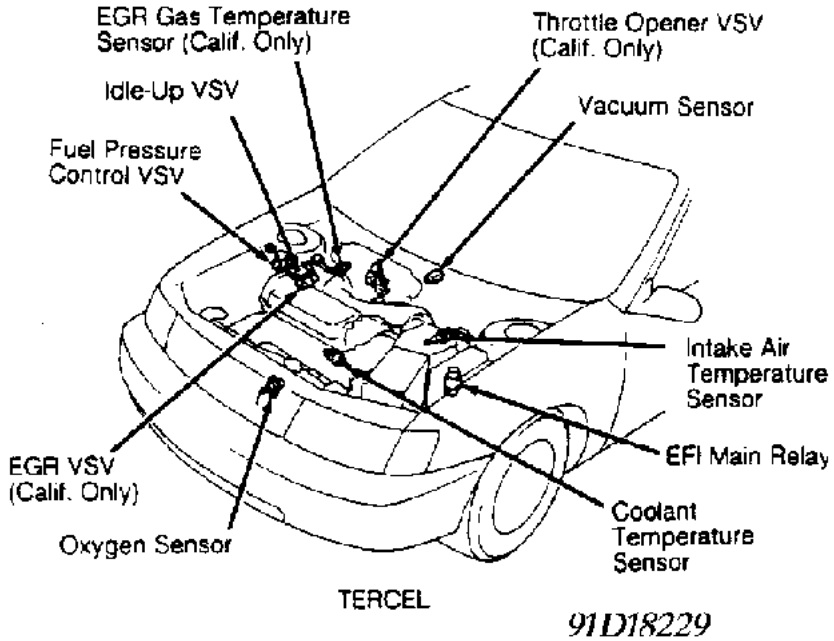


Fig. 21: Locating TCCS Components (Tercel - 1 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

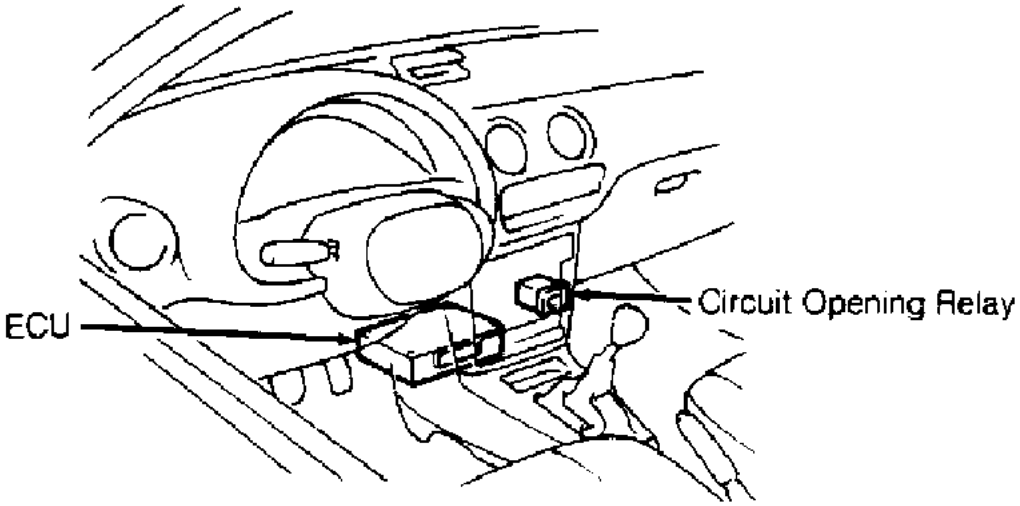


Fig. 22: Locating TCCS Components (Tercel - 2 of 2)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

IGNITION SYSTEM

ELECTRONIC SPARK ADVANCE (ESA)

EXCEPT SUPRA TURBO

The ESA system replaces conventional mechanical and vacuum advance. The ECU controls the ignition spark advance curve for every driving condition. Spark advance is based on the following inputs: coolant temperature sensor, O2 sensor, engine RPM, vehicle speed sensor, A/C switch, 4WD operation (Land Cruiser, Pickup and 4Runner), airflow meter and cranking (starter) signal. Integrated (coil in distributor) and remote coil ignition designs are used, depending on model.

On all models except Pickup (22R-E), Tercel and 4Runner (22R-E), crankshaft position and engine RPM are monitored by the ECU using permanent magnet pick-up coils in the distributor. Crankshaft position is read by ECU at G1 terminal (and G2 on some models), and engine RPM is input to ECU terminal Ne. See Fig. 23.

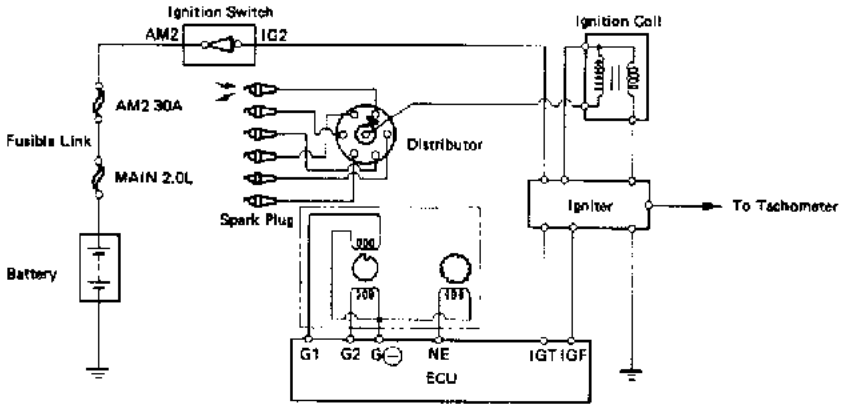
The ECU uses the Ne and G pick-up coil inputs to switch the primary ignition circuit on and off. Primary circuit is turned off when the ECU sends a signal to the ignitor on the IGT wire. At the same time, the ignitor sends an IGF signal to the ECU. The ECU feeds voltage to the IGF circuit. The ground for this voltage is momentarily cut when the primary circuit is turned off.

The ECU watches the IGF signal and can tell if the primary was switched on and off. After sending a command to turn off the primary circuit on the IGT wire, the ECU monitors the IGF circuit to ensure primary switching occurred. Normal cranking or running IGT

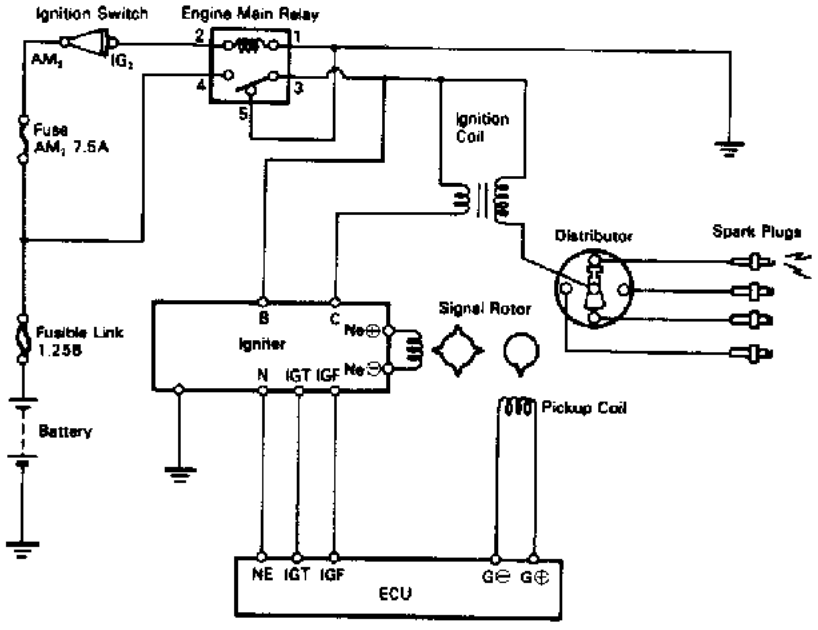
voltage is 0.60-1.70 volts.

NOTE: The TCCS system uses the input signal on the IGF line to fire the injectors. If this line is open or shorted to ground, the injectors will not fire.

On Pickup (22R-E), Tercel and 4Runner (22R-E), a single pick-up coil is used in the distributor. Ignition system operation is similar to other models except there are no G signals. The ECU monitors the pick-up coil signal at Ne terminal.



6-CYLINDER & V6



4-CYLINDER

Fig. 23: Ignition System Schematics (Typical)
118527 Courtesy of Toyota Motor Sales, U.S.A. Inc.

SUPRA TURBO
Supra Turbo models are equipped with a distributorless

ignition system. Companion cylinders No. 1 and 6, 2 and 5, and 3 and 4 are fired together. One cylinder in each pair is on compression stroke while the other is on the exhaust stroke. Since the spark for one cylinder in each pair is fired on exhaust stroke, this is commonly known as the waste-spark method of ignition distribution.

The conventional distributor and pick-up coil have been replaced by a camshaft position sensor. See Fig. 24. Crankshaft position and engine RPM are detected by 3 pick-up coils in the camshaft position sensor. The ECU uses the crankshaft (G1 and G2 coils) and RPM (Ne coil) signals to control the 3 coils. Toyota refers to the 3 ignition primary control signals for the 3 coils as IGT, IGDA and IGDB signals.

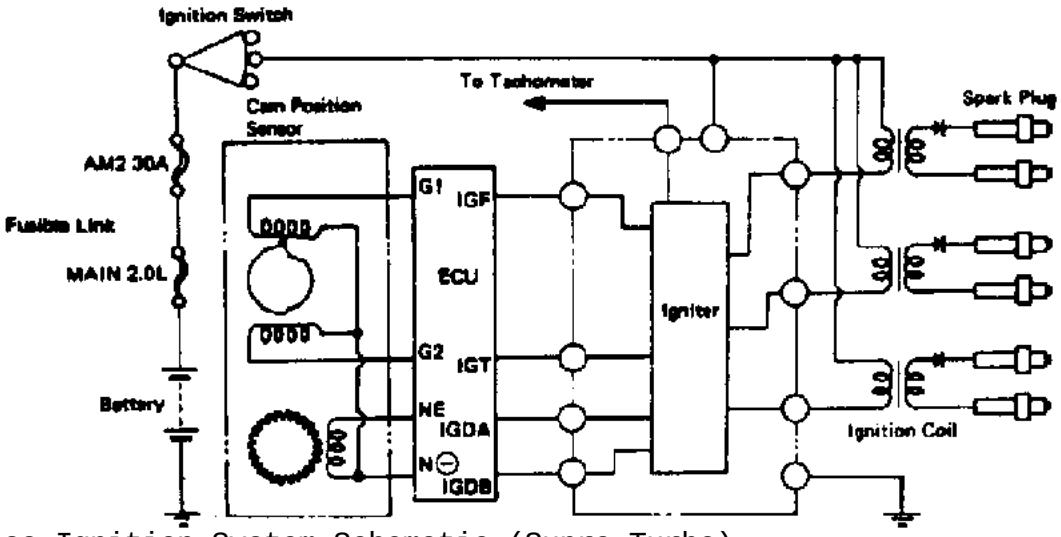


Fig. 24: Distributorless Ignition System Schematic (Supra Turbo)
Courtesy of Toyota Motor Sales, U.S.A. Inc.

EMISSION SYSTEMS

AIR INJECTION

AIR PUMP SYSTEM (LAND CRUISER)

This model is equipped with an Air Injection System (AIS). The AIS is designed to reduce hydrocarbons (HC) and carbon monoxide (CO) emissions by injecting air into the exhaust manifold. See Fig. 25.

Fresh air is drawn from the air cleaner and compressed by the air pump. Using a solenoid and air suction valve, this compressed air is injected into the exhaust manifold or exhausted into the atmosphere as determined by the Electronic Control Unit (ECU). The ECU receives various valve signals, depending on engine operating conditions, to determine compressed airflow. AIS components and operating parameters vary between models. For specific system operating parameters and testing of system or components, see AIR INJECTION SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in I - SYS/COMP TESTS article in the ENGINE PERFORMANCE Section.

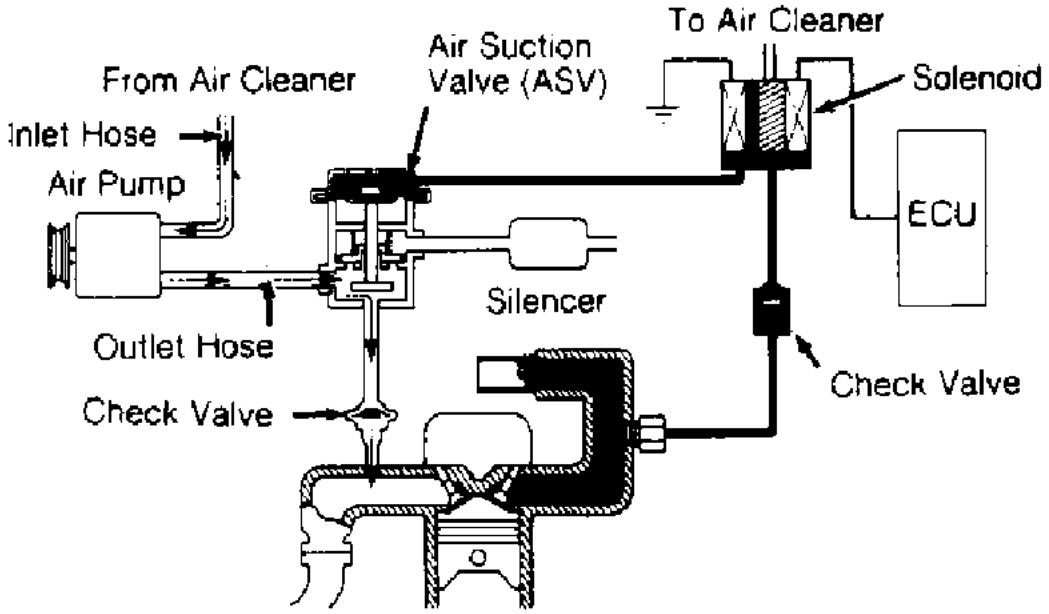


Fig. 25: Air Injection System (Typical)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

AIR SUCTION (AS) SYSTEM (PICKUP & 4RUNNER)

The AS system uses exhaust gas pulses to draw air into the exhaust manifold or catalytic converter to reduce hydrocarbons (HC) and carbon monoxide (CO) emissions. The AS system works by drawing air through the air filter and reed valve into the exhaust manifold or catalytic converter. See Fig. 26. Based on coolant temperature, engine RPM, throttle valve position, and vehicle speed sensor inputs, fresh air flow into the exhaust manifold can be turned on or off by the ECU through Air Suction Valve (ASV) and Vacuum Switching Valve (VSV).

AS system components and operating parameters vary between models. For specific system operating parameters and testing of system or components, see AIR INJECTION SYSTEM under EMISSION SYSTEMS & SUB-SYSTEMS in I - SYS/COMP TESTS article in the ENGINE PERFORMANCE Section.

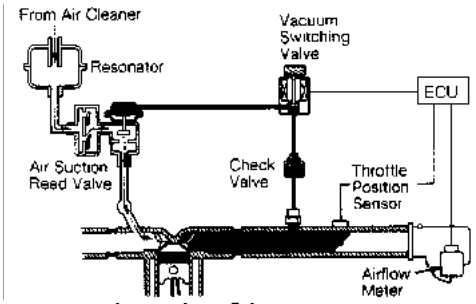


Fig. 26: Air Suction System (Typical)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

CRANKCASE VENTILATION

The Positive Crankcase Ventilation (PCV) system is designed to prevent contaminating hydrocarbons (HC), created in the crankcase, from escaping into the atmosphere.

Crankcase vapors are routed from the crankcase through a vacuum controlled fixed orifice or PCV valve, into the intake manifold. When vapors reach the intake manifold, they are mixed with air/fuel and burned in the combustion process. See Figs. 27 and 28.

The PCV system provides primary control by metering the flow of blow-by vapors, according to manifold vacuum. When manifold vacuum is high (at idle) the PCV restricts the flow to maintain a smooth idle condition.

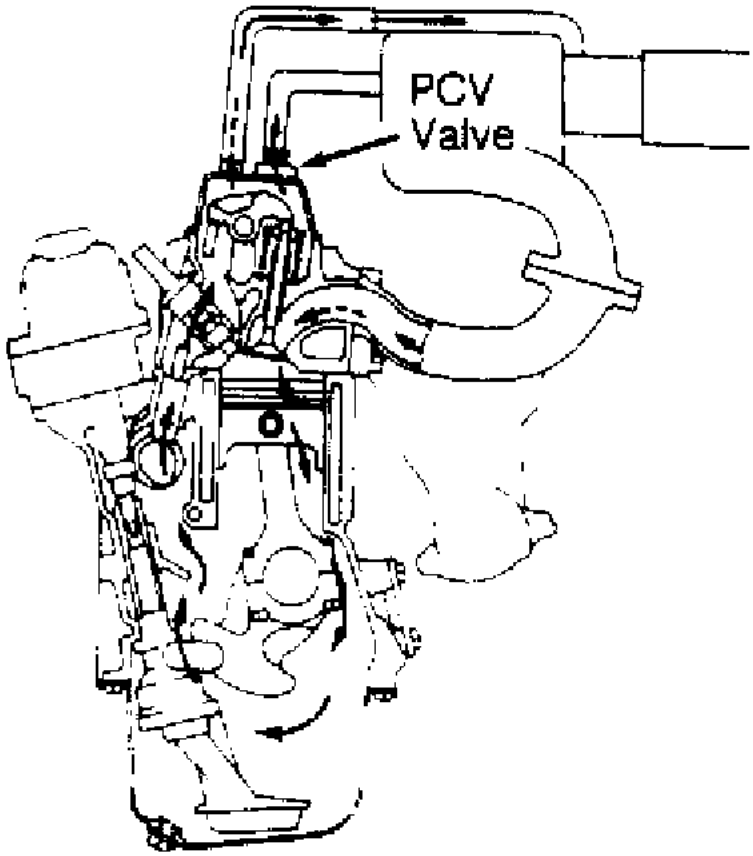


Fig. 27: PCV System (Typical)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

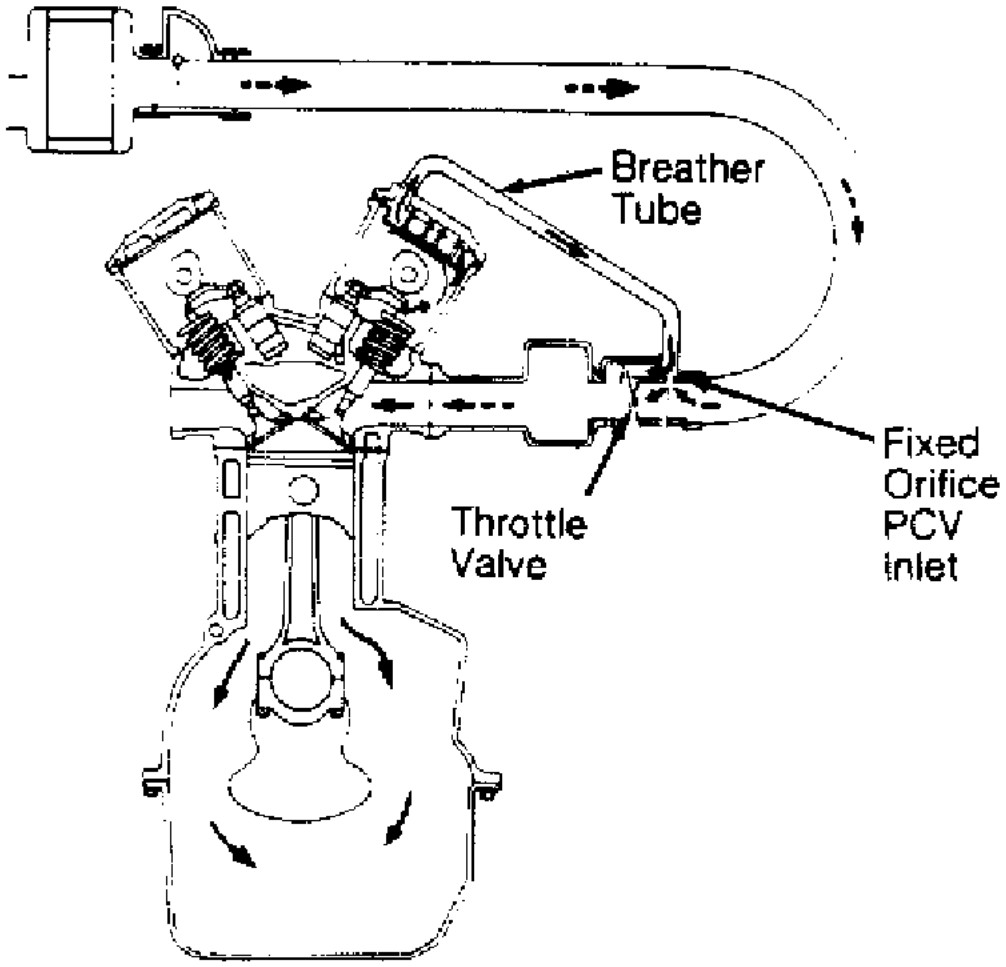


Fig. 28: Fixed Orifice PCV System (Typical)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

DASHPOT SYSTEM

This system controls exhaust emissions during deceleration by holding throttle plate at an above-idle position during deceleration. This aids in complete burning of the air/fuel mixture.

On most EFI models, the system consists of the ECU and throttle position sensor. The ECU adjusts the fuel injection duration depending on engine RPM. On Camry (2VZ-FE), Celica (4A-FE), Corolla (4A-FE) and Land Cruiser, throttle plate is held above idle on deceleration by a vacuum actuated dashpot.

EGR SYSTEM

The Exhaust Gas Recirculation (EGR) system is used to reduce oxides of nitrogen (NOx) emissions by lowering combustion temperatures. Recycling metered amounts of exhaust gas back into the intake system lowers peak combustion temperatures. See Fig. 29.

Each system has a vacuum-operated EGR valve and a vacuum modulator. A check valve, EGR cooler and computer controlled solenoid

may also be used. Temperature sensing devices control EGR operation. Temperature sensing devices used may include a Vacuum Switching Valve (VSV), a Bimetallic Vacuum Switching Valve (BVSV), a Thermostatic Vacuum Switching Valve (TVSV), a Vacuum Control Valve (VCV) or a combination of these valves.

When engine is below operating temperature, no exhaust gas recirculation is obtained. Increase in engine temperature allows control valves to regulate vacuum to EGR valve for exhaust gas recirculation. Vacuum modulator is used to regulate exhaust backpressure and balance atmospheric pressure and vacuum to allow EGR operation at heavy throttle. The EGR cooler, used on Cressida and Supra models, assists in reducing exhaust gas temperature before entering combustion chamber.

On all models except Camry, Pickup (22R-E) and 4Runner (22R-E), the ECU helps control EGR operation. Based on inputs from the coolant temperature sensor, engine RPM, throttle position sensor, and brake light switch, the ECU controls vacuum supply to the EGR valve. The ECU controls vacuum through a vacuum switching valve.

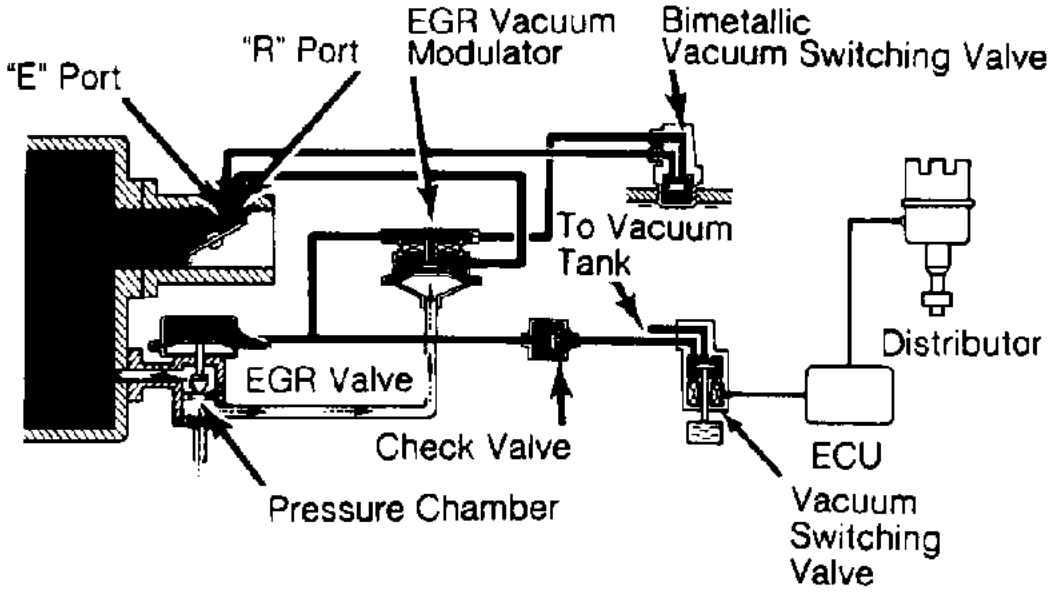


Fig. 29: EGR System (Typical)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

EVAPORATIVE EMISSION SYSTEM (EVAP)

Purpose of EVAP system is to prevent the escape of gasoline vapors (hydrocarbons) from the fuel tank into the atmosphere. To reduce hydrocarbon (HC) emissions, evaporated fuel from the fuel tank is routed through the charcoal canister into the intake manifold for combustion in the cylinders. Various model and engine types will have different evaporative emission system components and operating parameters. For specific EVAP system operating parameters and testing of system or components on various models, see FUEL EVAPORATION under

EMISSION SYSTEMS & SUB-SYSTEMS in I - SYS/COMP TESTS article in the ENGINE PERFORMANCE Section.

SELF-DIAGNOSTIC SYSTEM

The ECU is equipped with a self-diagnostic system which detects system failures or abnormalities. When malfunction occurs, the CHECK ENGINE light on instrument panel is activated.

By analyzing various input signals, the ECU detects system malfunctions related to various operating parameters. The CHECK ENGINE light will go out when malfunction clears; however, the ECU stores trouble codes associated with the detected failure until the diagnostic system is cleared. For additional information, see G - TESTS W/CODES article in the ENGINE PERFORMANCE Section.

MISCELLANEOUS CONTROLS

TRANSMISSION CONTROLS

ELECTRONICALLY CONTROLLED TRANSMISSION (ECT)

On Camry 4-Cylinder and Supra with separate control unit for the ECT, the engine ECU will transmit a signal to the transmission control unit to control overdrive engagement. The ECU uses input from the coolant temperature sensor to prevent a shift into overdrive when the engine is cold.

All other models do not have a separate control unit for the transmission, all shift functions are controlled by the engine ECU.

END OF ARTICLE