

FUEL INJECTION SYSTEM - BOSCH AFC

1988 Toyota Celica

1988 FUEL INJECTION
Bosch AFC

Toyota; Camry, Celica, Corolla, Cressida, Land Cruiser, MR2,
Pickup, Supra, Van, 4Runner

DESCRIPTION

NOTE: For specifications on Throttle Position Sensor (TPS), idle speed and mixture, and fuel pump output volume, see appropriate article in TUNE-UP PROCEDURES section.

The Bosch AFC (L-Jetronic) fuel injection system is used on all models. However, variations may exist between model applications. This article covers the Bosch AFC system in general, with manufacturers' differences noted under SPECIAL FEATURES. For computer control information, see the appropriate article in 1988 COMPUTERIZED ENGINE CONTROLS section.

The Bosch Airflow Controlled (AFC) fuel injection system is an electronically controlled system operated by incoming airflow. Some vehicles are equipped with a potentiometer to measure incoming air flow, while other vehicles use a hot wire type airflow sensor.

The AFC fuel injection system also contains a feedback system which measures oxygen content of exhaust gases and maintains the air/fuel ratio at about 14.7:1.

The fuel injection system consists of an electric fuel pump, fuel pressure regulator, fuel damper, fuel injectors, cold start injector, Electronic Control Unit (ECU), and airflow meter. In addition, an air temperature sensor, throttle position sensor, coolant temperature sensor, oxygen sensor, catalytic converter, auxiliary air valve, idle speed control valve, throttle body, and electrical relays are used.

NOTE: Not all models use all components.

OPERATION

ELECTRIC FUEL PUMP(S)

Fuel under pressure from electric fuel pump flows through a fuel damper, fuel filter, injector fuel rail and fuel pressure regulator. Fuel pump(s) may be located on frame rail, in fuel tank or both. Electrical power for fuel pump operation during cranking mode is provided from starter relay via the fuel pump relay (if equipped) and ECU.

FUEL PRESSURE REGULATOR

The pressure regulator is a sealed unit which is divided by a diaphragm into 2 chambers (fuel and spring chambers). The fuel chamber receives fuel through the inlet side (both sides on Subaru 1.8L) from the injector fuel rail. The spring chamber is connected to intake manifold vacuum.

At idle, intake manifold vacuum is high. The diaphragm is pulled down by intake manifold vacuum. Any excessive fuel is returned to the fuel tank. As the throttle is depressed, intake manifold vacuum decreases. The regulator spring overcomes manifold vacuum increasing fuel pressure.

FUEL INJECTORS

A fuel rail links the fuel pressure regulator with the fuel injectors. Each cylinder is provided with a solenoid-operated injector which sprays fuel toward the back of each intake valve.

ELECTRONIC CONTROL UNIT (ECU)

All components of the control system are electrically connected to the ECU. The ECU is a pre-programmed computer which receives and interprets data from various sensors to calculate the amount of fuel required by the engine to maintain efficiency with minimum exhaust emissions. The oxygen sensor informs the ECU of oxygen content of exhaust gases and the ECU constantly adjusts the air/fuel ratio by controlling the injector "on" time.

An automatic function of the ECU is to provide fuel enrichment whenever engine is cranked, regardless of engine temperature. This is activated by a direct electrical connection from the starter circuit to the ECU (most models). The ECU is a sealed unit, and no service is required.

AIRFLOW METER

Hot Wire Type

The airflow meter continually measures temperature, amount, density, and speed of air entering engine intake system. The meter consists of a platinum wire filament located within intake air stream.

The wire filament is kept at a constant temperature above that of air entering engine regardless of composition of air entering engine. The airflow meter sends a temperature related signal to be processed by the ECU. See Fig. 1.

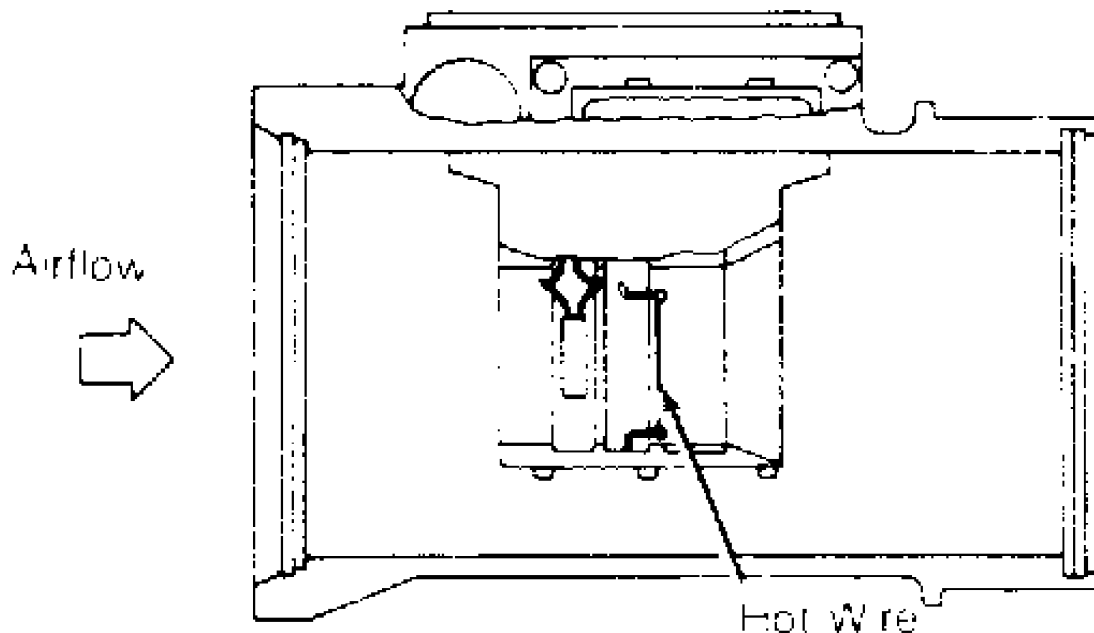
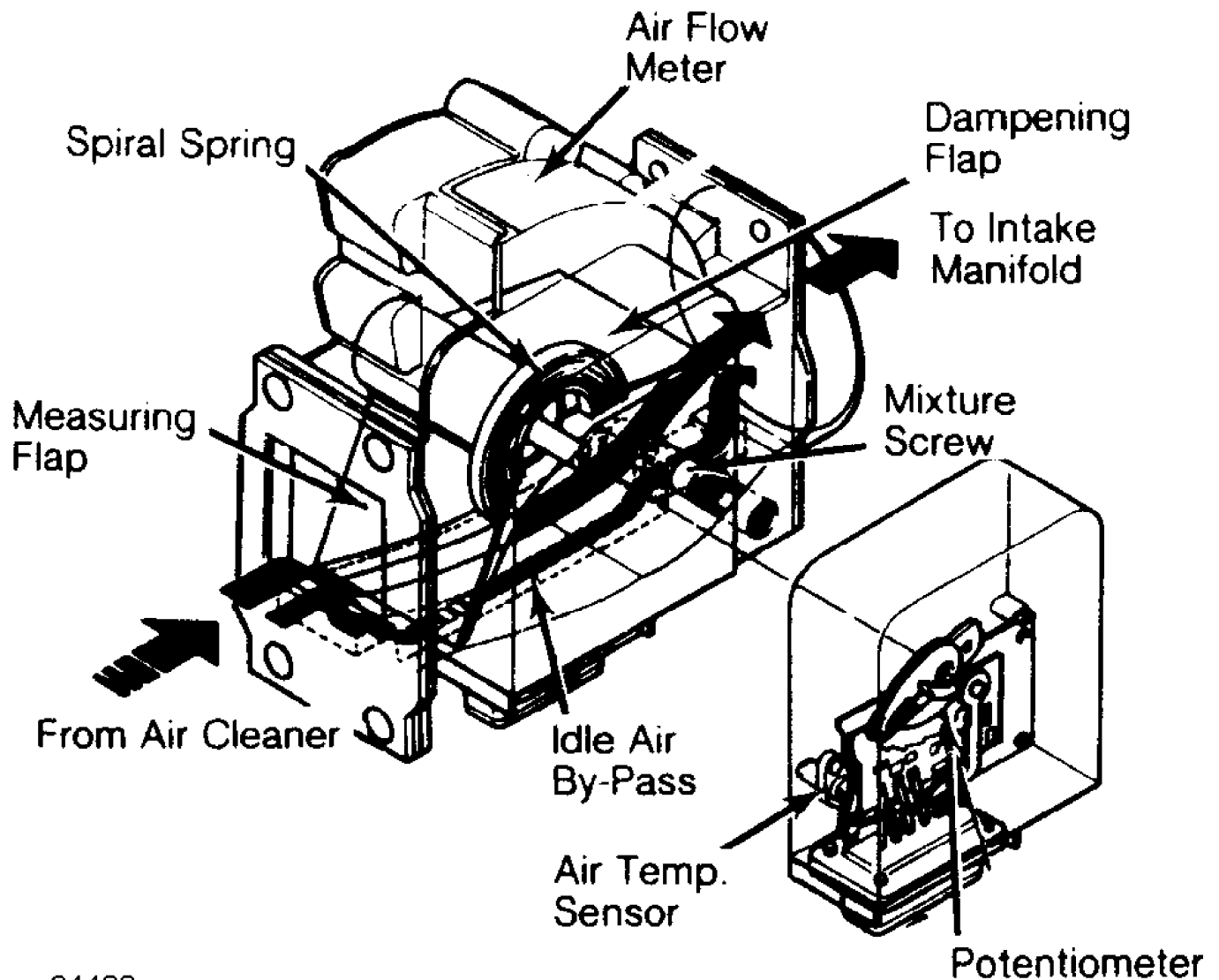


Fig. 1: Hot Wire Airflow Meter (Typical)

Potentiometer Type

This airflow meter uses a movable vane connected to a potentiometer. As air entering the engine moves the vane, the

potentiometer is moved informing the ECU on the amount of air entering the engine. Some potentiometer airflow meters use an air temperature sensor located inside the airflow meter air passage. See Fig. 2.



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Fig. 2: Potentiometer Airflow Meter (Typical)

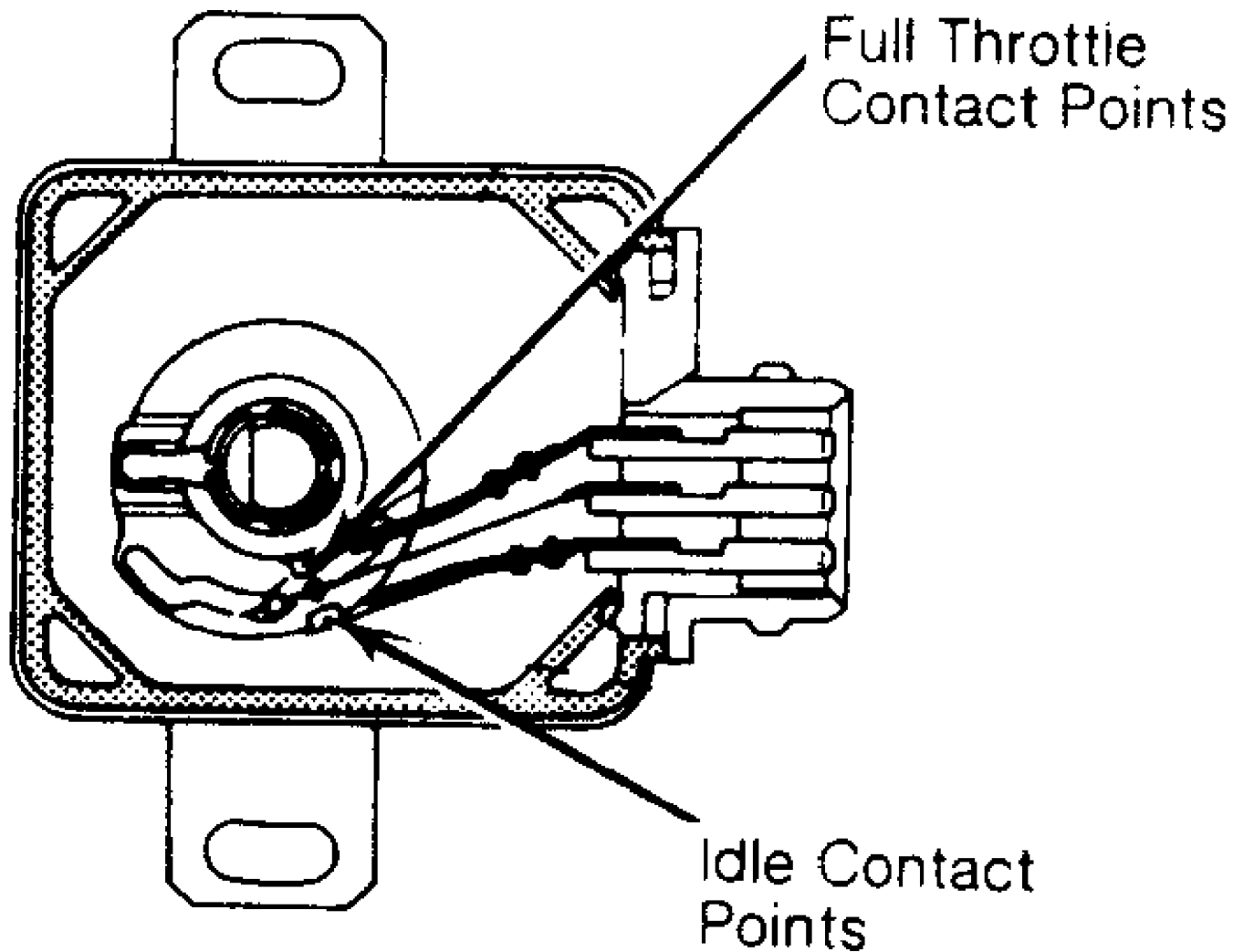
AIR TEMPERATURE SENSOR

The air temperature sensor is an integral component of the airflow meter which converts temperature of incoming air into electrical signals. These signals are received by the ECU and processed to adjust the amount of fuel delivered by the injectors. The air temperature sensor is not serviceable.

THROTTLE POSITION SENSOR (TPS)

A contact-type TPS is installed on the throttle chamber. It converts throttle position into electrical signals to inform ECU of throttle position. Signals are sent to ECU when throttle is fully open or at idle. See Fig. 3. Some models send a specific signal to ECU, depending on throttle angle. The open contacts prevent loss of power

during sudden acceleration/deceleration by signaling ECU of the required fuel enrichment.



34501

Fig. 3: Contact-Type Throttle Position Sensor (Typical)

COOLANT TEMPERATURE SENSOR

This sensor provides ECU with engine temperature information relating to warm-up enrichment operation. Some models use a dual-sensor element which also signals the ignition computer (if equipped).

During warm-up period after a cold engine start, additional fuel is required to maintain engine performance. As engine temperature increases, the ECU decreases fuel enrichment until engine reaches normal operating temperature.

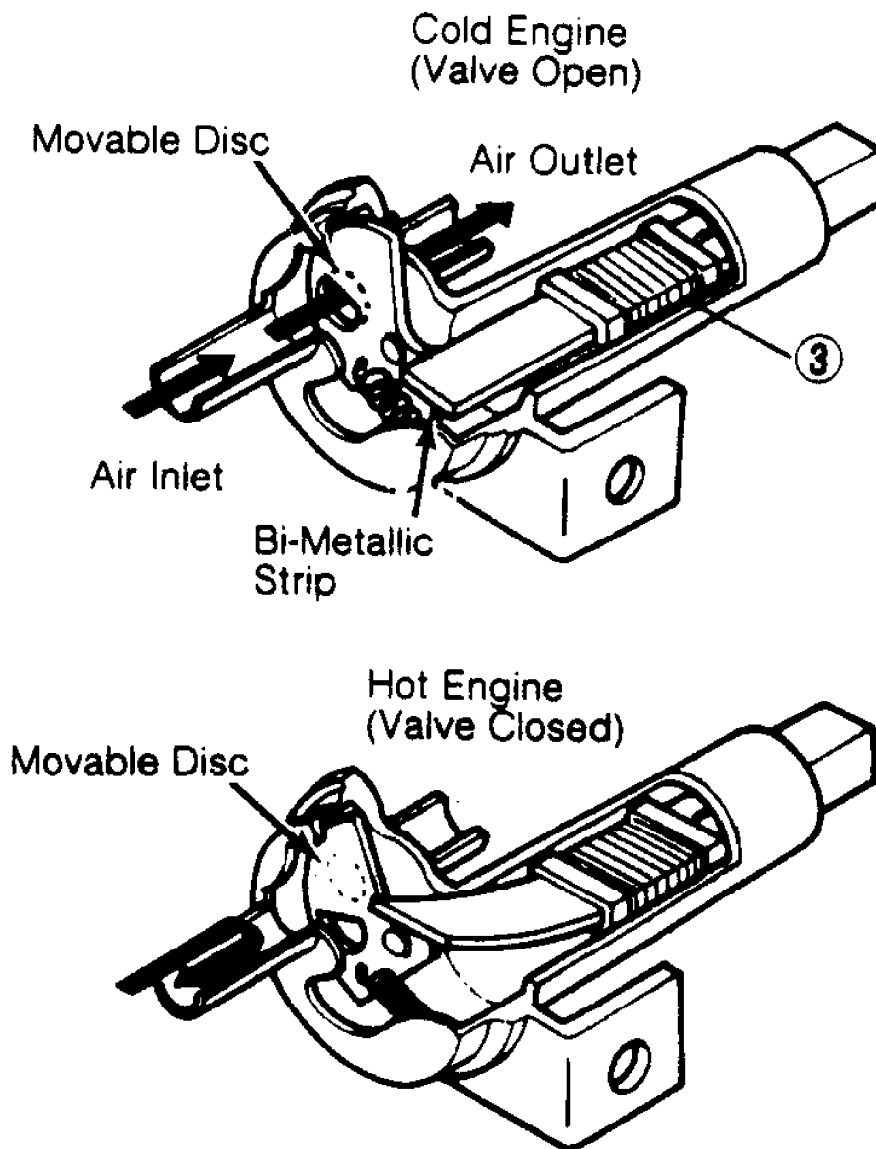
ELECTRICAL RELAYS

The various relays used with the electronic controls of the AFC injection system control power to injectors, fuel pump, ECU, and cold start system. The electrical relays may consist of one component for all relays or a combination of individual relays.

AUXILIARY AIR VALVE

Most models with Bosch AFC fuel injection use an Auxiliary Air Valve (AAV) to shorten engine warm-up time. The AAV supplies additional air into the intake system which increases engine RPM during a cold start.

The AAV consists of an electrically heated bi-metallic strip, movable disc, and air by-pass channel. The heater coil on the bi-metallic strip is energized by the fuel pump relay. Control of the valve is based upon engine temperature; the air by-pass channel is open when engine is cold and gradually closes as temperature rises. At predetermined temperatures, air by-pass channel is blocked and additional airflow stops. See Fig. 4.



34502
Fig. 4: Auxiliary Air Valve (Typical)

COLD START INJECTOR

Most models use a cold start injector which delivers

additional fuel, and a start injector time switch which controls operation of the cold start injector. The start injector time switch limits cold start injection to 1-12 seconds, depending upon engine coolant temperature. When engine coolant temperature rises above a specified point, bi-metallic contact breaks ground circuit of cold start injector and cold start enrichment is by-passed.

SPECIAL FEATURES

AIRFLOW METER

All models except Supra, use a potentiometer type airflow meter incorporating an air temperature sensor. Supra models use an airflow meter which has a lumimus diode and a photo transistor. The lumimus diode emits light which reflects off of a mirror to the photo transistor.

The airflow meter causes incoming air to swirl into a vortex. When air swirls, it vibrates a leaf spring which has the mirror attached to it. As the mirror moves, the photo transistor picks up the movement of reflected light. The airflow meter sends this signal to the ECU.

FUEL PULSATION DAMPER

All models except Celica, Corolla FX-16, MR2 and Supra turbo use a fuel pulsation damper. The function of the damper is to eliminate fuel pressure surges during vehicle operation.

TESTING

*** PLEASE READ THIS FIRST ***

NOTE: For testing of fuel system components not covered in this article, refer to appropriate article in 1988 COMPUTERIZED ENGINE CONTROLS section.

ELECTRONIC CONTROL UNIT (ECU)

Do not attempt to test ECU, as permanent damage could result. It is possible to check wires for continuity. The ECU should only be judged faulty after compression is checked, ignition system has been tested and found problem-free, and all other fuel injection components have been thoroughly tested (including wiring).

NOTE: AFC electrical systems can be checked by using Electronic Fuel Injection testers prescribed by the manufacturer. Instructions for use of testers must be followed carefully to prevent damage to system.

FUEL INJECTORS & RESISTORS

1) Connect tachometer to engine. Start engine and run at idle. Remove harness connector from injectors one at a time. Engine idle speed should drop 100-300 RPM as each injector is disconnected. If engine idle speed does not drop, check the wiring connector, injector resistance or injection signal from the computer.

2) Disconnect electrical connector from each injector. Measure injector resistance. See INJECTOR RESISTANCE SPECIFICATIONS table. If injector is not to specification, replace injector.

INJECTOR RESISTANCE SPECIFICATIONS TABLE

Application	Ohms
Camry	
4-Cyl.	1.6
V6	13.8
Celica	13.8
Celica All-Trac	2-4
Corolla (All Models)	13.8
Cressida	1.5-3
Land Cruiser	13.8
MR2	13.8
Pickup & 4Runner	
4-Cyl. (Non-Turbo)	1-2.5
4-Cyl. (Turbo)	1.1-2
V6	1.2-2.2
Supra	
Non-Turbo	1.8-3.4
Turbo	2.0-3.8
Van	1.1-2.2

FUEL PRESSURE

CAUTION: Constant fuel pressure is maintained in fuel lines and component parts at all times. Relieve pressure before attempting to open system for testing. Do not allow fuel to flow onto engine or electrical parts or allow an open flame in area while testing fuel system components.

Relieve fuel system pressure. Connect fuel pressure gauge in fuel system after fuel pressure regulator. Check fuel pressure at engine idle with fuel pressure regulator vacuum hose connected and disconnected. See FUEL PUMP PRESSURE SPECIFICATIONS table. Fuel system residual pressure should be 21 psi (1.5 kg/cm²) for 5 minutes on all models.

FUEL PUMP PRESSURE SPECIFICATIONS TABLE

Application	No Vacuum psi (kg/cm ²)	Vacuum psi (kg/cm ²)
Camry, Celica (3S-FE), Pickup & 4Runner (22-RE & V6)	38-44	33-37
Celica (3S-GE & All-Trac), Cressida, Pickup & 4Runner ..	33-38	27-31
Corolla, MR2 & Van	38-44	30-33
Land Cruiser	37-46	33-37
Supra	33-40	23-30

AIR TEMPERATURE SENSOR

Information not available from manufacture.

AIRFLOW METER

Disconnect airflow meter connector. Using an ohmmeter, measure resistance across meter terminals. On Supra Turbo models, an analog ohmmeter must be used. Supra Turbo models have a 5-terminal airflow meter connector. See Fig. 5. For airflow meter specifications, see AIRFLOW METER RESISTANCE table.

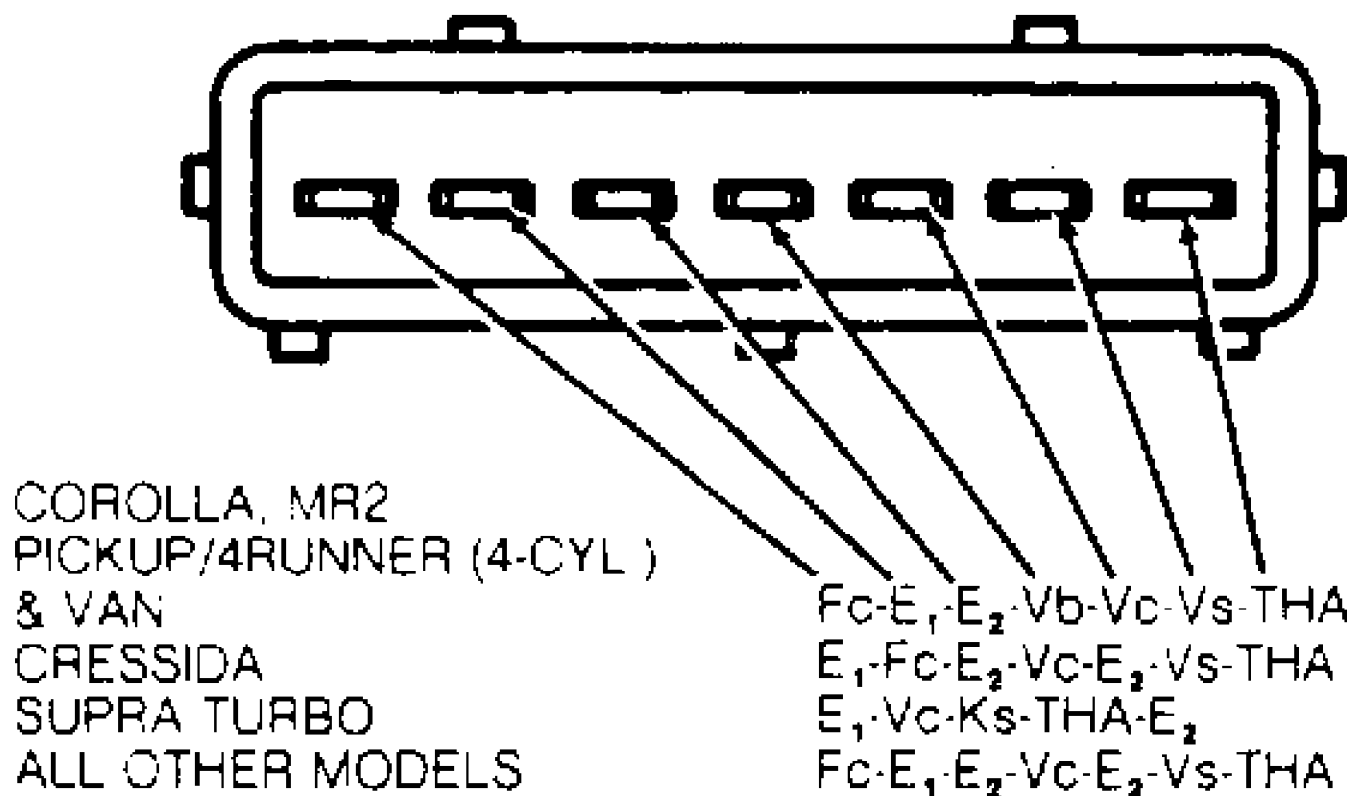


Fig. 5: Airflow Meter Terminal Identification
Courtesy of Toyota Motor Sales, U.S.A., Inc.

AIRFLOW METER RESISTANCE TABLE

Application Terminals	Ohms
Camry, Celica, Land Cruiser, Pickup & 4Runner & Supra Non-Turbo	
E2-Vc	200-400
E1-Fc	
Measuring Plate Fully Closed	Infinity
Measuring Plate Other Than Closed	0
E2-Vs	
Measuring Plate Fully Closed	200-600
Measuring Plate Fully Open	20-1200
Corolla	
E2-Vc	100-300
E2-Vb	200-400
E1-Fc	
Measuring Plate Fully Closed	Infinity
Measuring Plate Other Than Closed	0
E2-Vs	
Measuring Plate Fully Closed	20-400
Measuring Plate Fully Open	20-3000
Cressida, MR2 & Van	
E2-Vc	
Cressida	200-400
MR2 & Van	100-300
E2-Vb	
MR2 & Van	200-400

E1-Fc		
Measuring Plate Fully Closed	.....	Infinity
Measuring Plate Other Than Closed	.....	0
E2-Vs		
Cressida	.....	20-1200
MR2	.....	20-3000
Van	.....	20-1000
Supra Turbo		
Ks-E1	.....	Infinity
E1-Ks	.....	5000-10,000
Vc-E1	.....	10,000-15,000
E1-Vc	.....	5000-10,000
All Models		
E2-THA		
-4°F (20°C)	.....	10,000-20,000
32°F (0°C)	.....	4000-7000
68°F (20°C)	.....	2000-3000
104°F (40°C)	.....	900-1300
140°F (60°C)	.....	400-700

AUXILIARY AIR VALVE

Ensure engine is cold, then start engine. Pinch rubber hose between air valve and throttle chamber. Engine speed should decrease. After engine reaches operating temperature, pinch hose again. Engine speed should not decrease more than 50 RPM. If valve does not operate as outlined, replace auxiliary air valve.

ALTITUDE COMPENSATOR SENSOR

NOTE: Refer to appropriate article in 1988 COMPUTERIZED ENGINE CONTROLS section.

IDLE SPEED CONTROLLER (ISC) VALVE

NOTE: Refer to appropriate article in 1988 COMPUTERIZED ENGINE CONTROLS section.

COLD START INJECTOR

Disconnect cold start injector connector. Using an ohmmeter, measure resistance between injector terminals. See COLD START INJECTOR RESISTANCE table.

COLD START INJECTOR RESISTANCE TABLE

Application	Ohms
Camry, Celica (Non-Turbo), Land Cruiser, Pickup & 4Runner & Supra	2-4
Celica (Turbo), Corolla, Cressida & Van	3-5

THERMO TIME SWITCH

NOTE: Refer to appropriate article in 1988 COMPUTERIZED ENGINE CONTROLS section.

COOLANT TEMPERATURE SENSOR

Disconnect coolant temperature sensor connector. Using an ohmmeter, measure resistance between sensor terminals. See COOLANT TEMPERATURE SENSOR RESISTANCE table.

COOLANT TEMPERATURE SENSOR RESISTANCE TABLE

Temperature	Ohms
-4°F (-20°C)	10,000-20,000
32°F (0°C)	400-7000
68°F (20°C)	2000-3000
104°F (40°C)	900-1300
140°F (60°C)	400-700
176°F (80°C)	200-400

REMOVAL & INSTALLATION

* PLEASE READ THIS FIRST *

CAUTION: The fuel injection system maintains constant fuel pressure in fuel lines and component parts at all times. Always relieve fuel pressure before attempting to open system for testing or replacement of components. Do not allow fuel to flow onto engine or electrical parts. Do not allow open flame or sparks in area while servicing components. Disconnect negative battery cable before disconnecting any electrical component.

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation

Disconnect negative battery cable. Clear area for access to ECU. Disconnect electrical connector lock lever (if used) and carefully remove connector. Remove ECU retaining screws and remove ECU. To install, reverse removal procedure.

AIRFLOW METER

Removal & Installation

Disconnect negative battery cable. Disconnect air ducts and hoses connecting air cleaner and airflow meter. Remove air cleaner cover, if required. Remove airflow meter retaining bolts. Unplug airflow meter electrical connector and remove airflow meter. To install, reverse removal procedure.

THROTTLE POSITION SENSOR

Removal & Installation

1) Disconnect negative battery cable. Unplug TPS electrical connector. Remove 2 screws securing TPS to housing. Remove by slowly pulling sensor off throttle shaft.

2) To install, reverse removal procedure. Make sure sensor is aligned on throttle shaft and after replacement, perform TPS adjustment. See ADJUSTMENTS in this article.

COLD START INJECTOR

Removal & Installation

Disconnect negative battery cable and remove electrical connector from cold start injector. Relieve fuel system pressure and

remove fuel supply line from injector. Remove injector retaining bolts and remove injector. To install, reverse removal procedure.

AUXILIARY AIR VALVE

NOTE: Replacement of auxiliary air valve on Toyota models requires that immediate replacement be available or cooling system be drained to below level of valve.

Removal & Installation

Disconnect negative battery cable and remove electrical connector from air valve. Drain engine coolant, if required. Remove air hoses and coolant hoses (if equipped). Remove retaining bolts and remove air valve. To install, reverse removal procedure.

COOLANT TEMPERATURE SENSOR

NOTE: Replacement of temperature sensor requires immediate replacement be available or cooling system be drained below level of sensor.

Removal & Installation

Disconnect negative battery cable and remove electrical connector from coolant sensor. Drain engine coolant, if required. Remove sensor. To install, reverse removal procedure.

THERMO TIME SWITCH

NOTE: Thermo time switch removal should be done only when engine is cold. Removal of switch requires having replacement switch ready for immediate installation or cooling system be drained below level of switch.

Removal & Installation

Disconnect negative battery cable and electrical connector from switch. Drain cooling system as required. Remove switch. To install, reverse removal procedure.

FUEL PRESSURE REGULATOR

Removal & Installation

Disconnect negative battery cable and relieve fuel system pressure. Disconnect fuel lines and vacuum line at regulator. Remove pressure regulator. To install, reverse removal procedure.

FUEL INJECTORS

Removal

1) Release fuel system pressure and disconnect negative battery cable. Drain cooling system. Clear fuel rail and intake air chamber by disconnecting all air hoses, coolant hoses, vacuum hoses, and fuel hoses.

2) Remove EGR valve and pipe and intake air duct. Remove intake air chamber and support bracket. Disconnect fuel injection wiring harness from all connectors near fuel rail and place harness on top of engine.

3) Remove fuel rail retaining bolts. Remove fuel rail, injectors and fuel pressure regulator as an assembly.

4) Separate fuel injectors from fuel rail by pulling injectors. Discard sealing grommet and "O" ring. Remove insulators from injector holes in intake manifold.

Installation

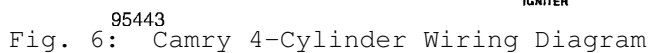
1) To install, reverse removal procedure. Install new insulators in injector holes in intake manifold. Install new grommets and "O" rings on fuel injectors.

2) Coat grommets and "O" rings with gasoline and push injectors onto fuel rail. Coat insulators and injector tips with gasoline prior to installation of injectors. Ensure injectors rotate freely.

ADJUSTMENTS

NOTE: For specifications on Throttle Position Sensor (TPS), idle speed and mixture, and fuel pump output volume, see appropriate article in TUNE-UP PROCEDURES section.

WIRING DIAGRAMS



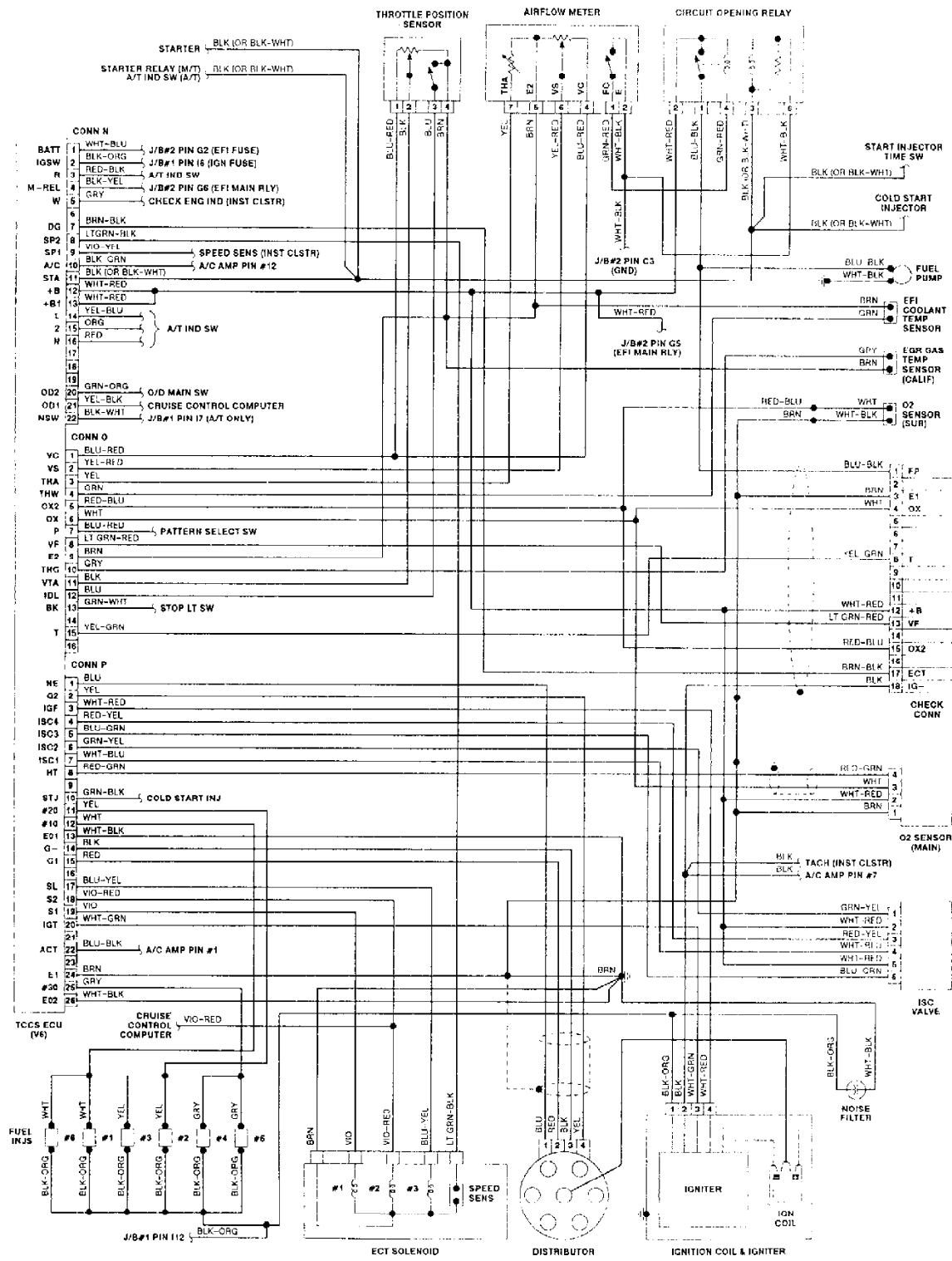


Fig. 7: Camry V6 Wiring Diagram

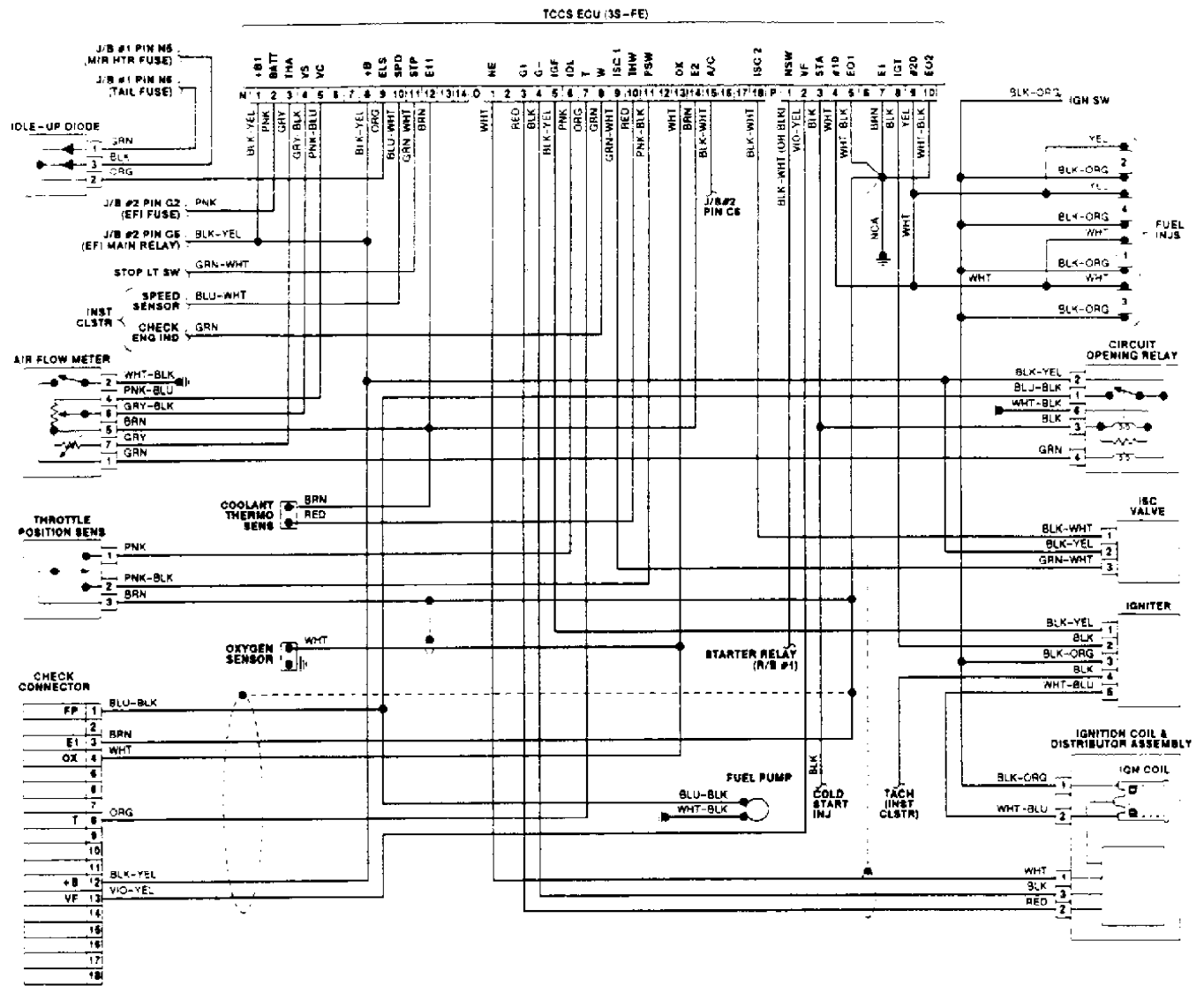


Fig. 8: Celica 3S-FE Engine Wiring Diagram

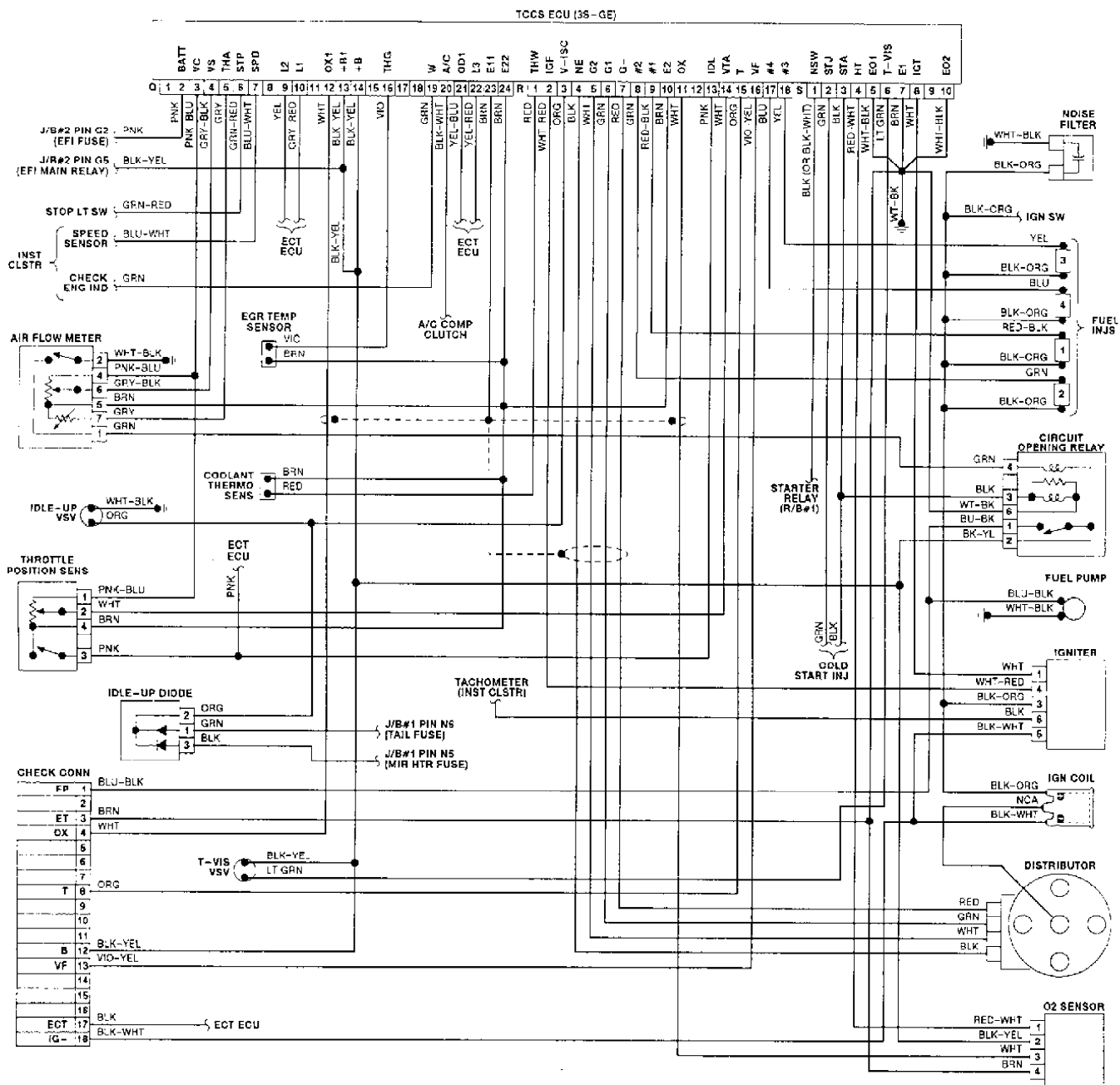


Fig. 9: Celica 3S-GE Engine Wiring Diagram

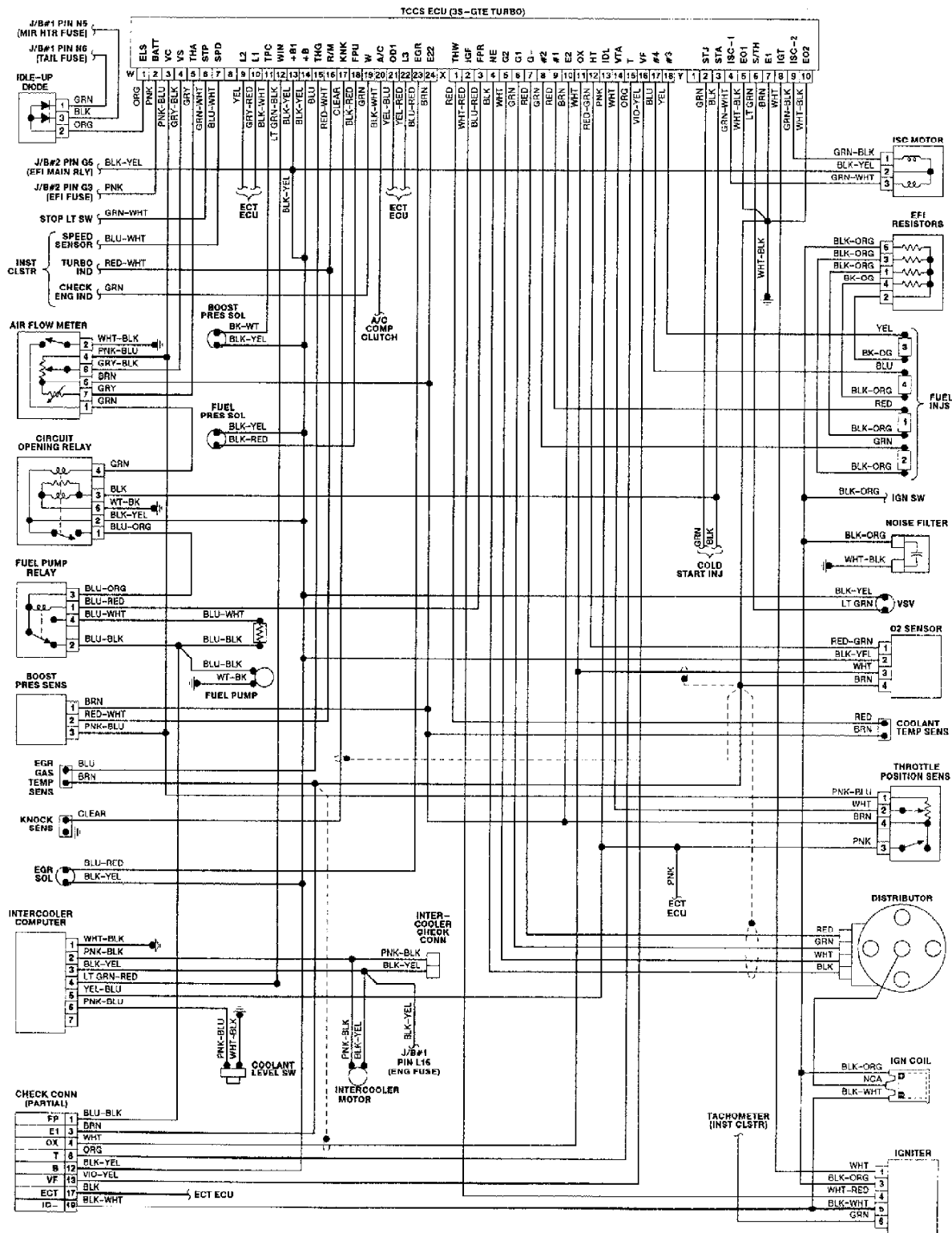
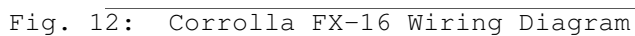
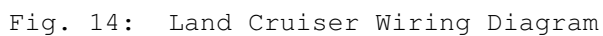
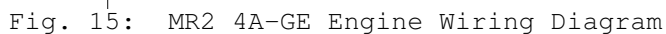


Fig. 10: Celica 3S-GTE Engine Wiring Diagram







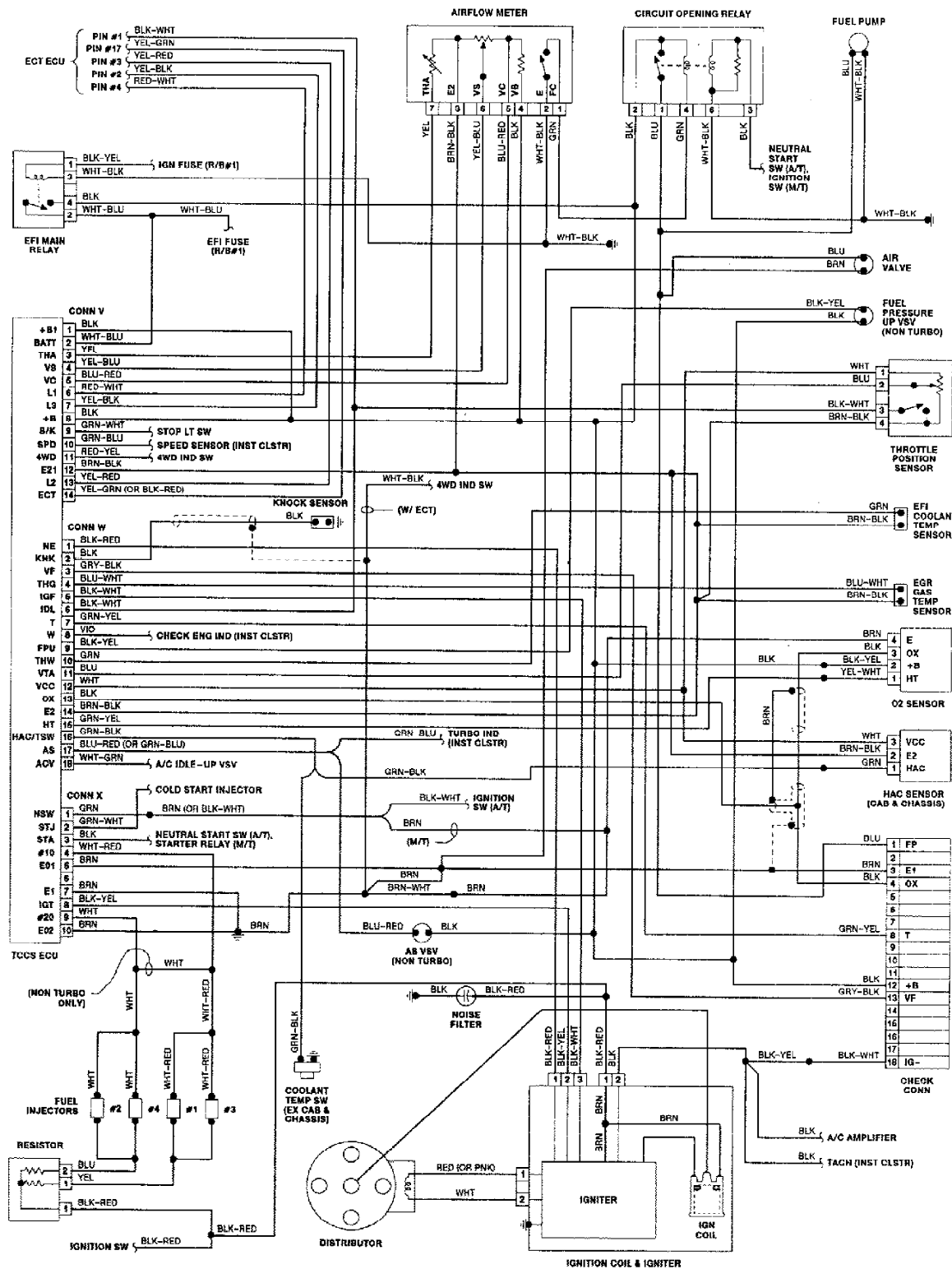


Fig. 16: Pickup & 4Runner 4-Cylinder Wiring Diagram



Fig. 17: Pickup & 4Runner V6 Wiring Diagram

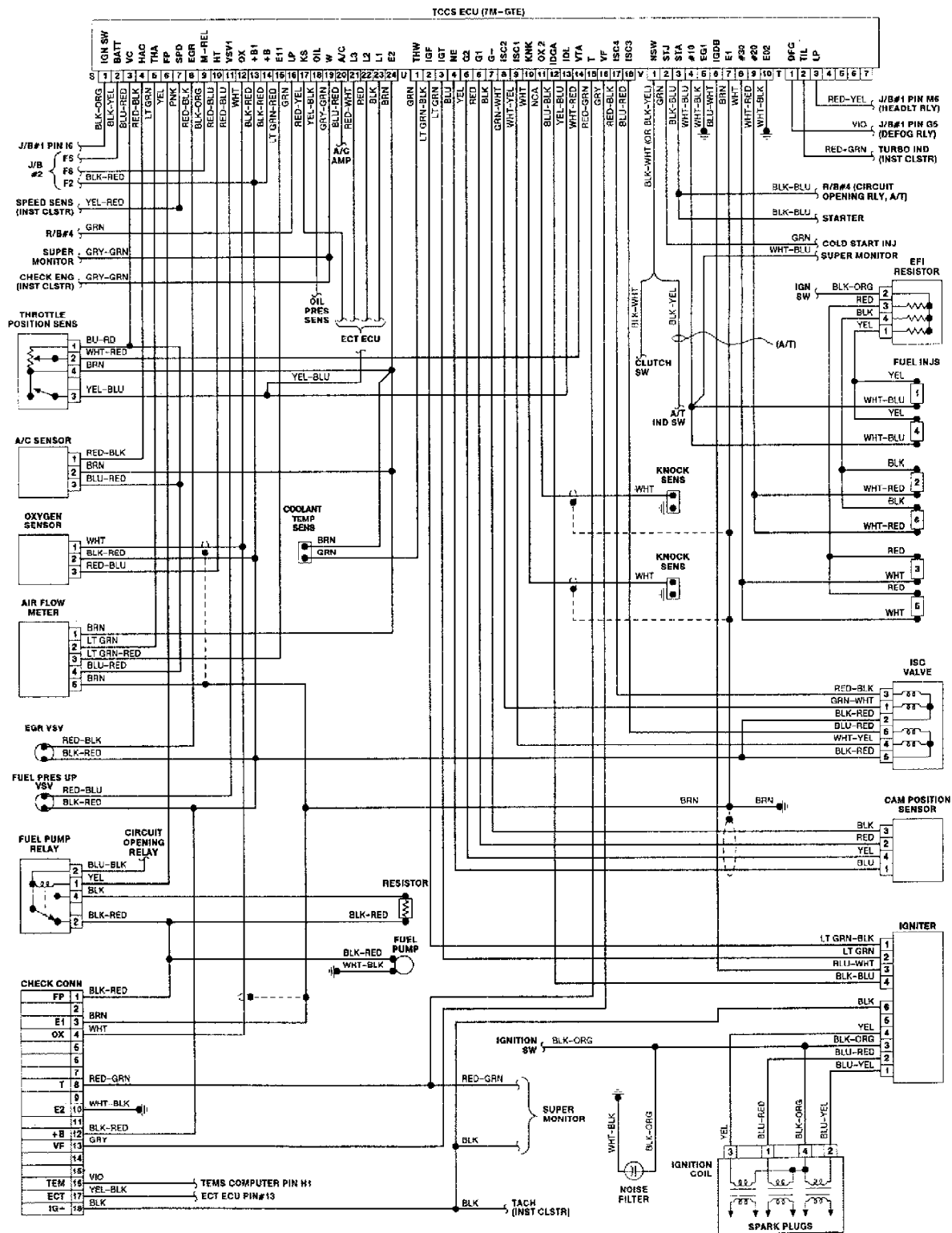


Fig. 19: Supra 7M-GTE Engine Wiring Diagram

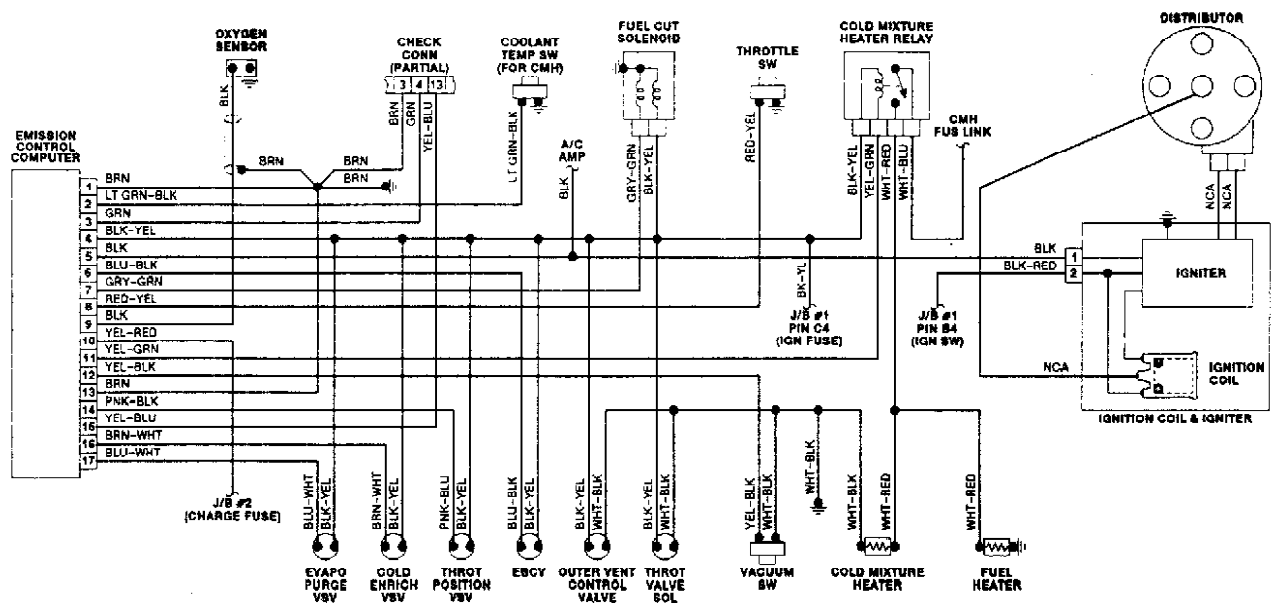


Fig. 20: Tercel Sedan Wiring Diagram
Courtesy of Toyota Motor Sales, U.S.A., Inc.

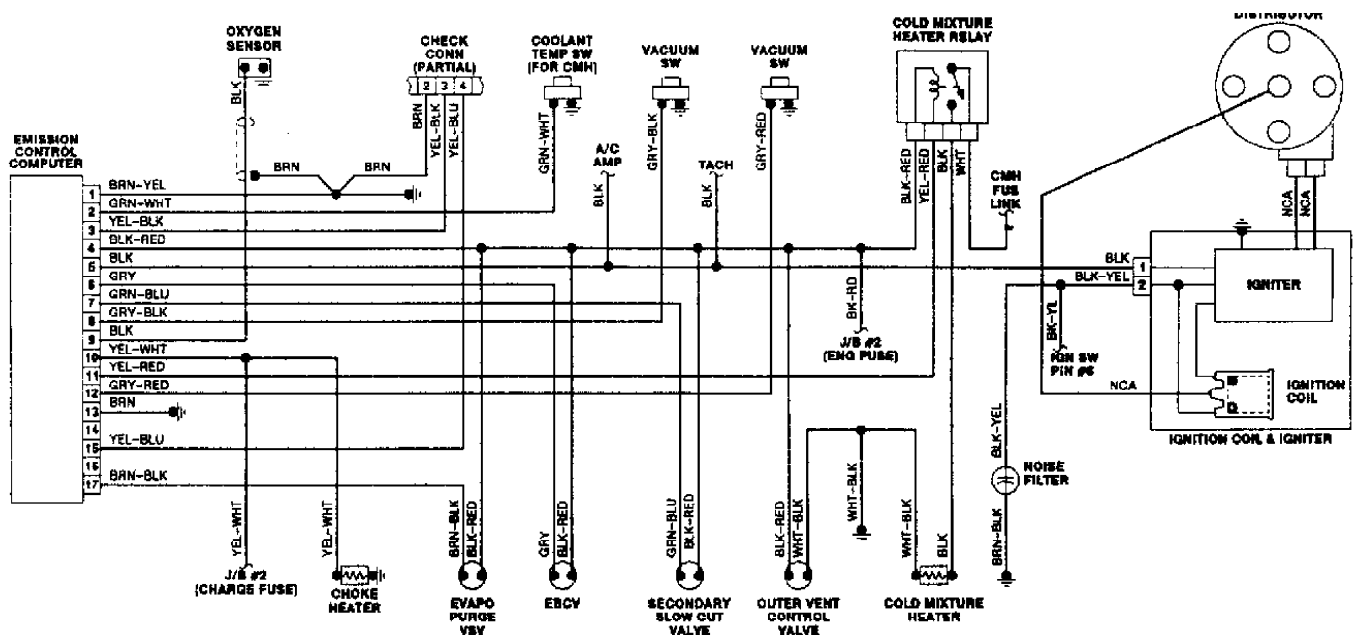


Fig. 21: Tercel Wagon Wiring Diagram
Courtesy of Toyota Motor Sales, U.S.A., Inc.

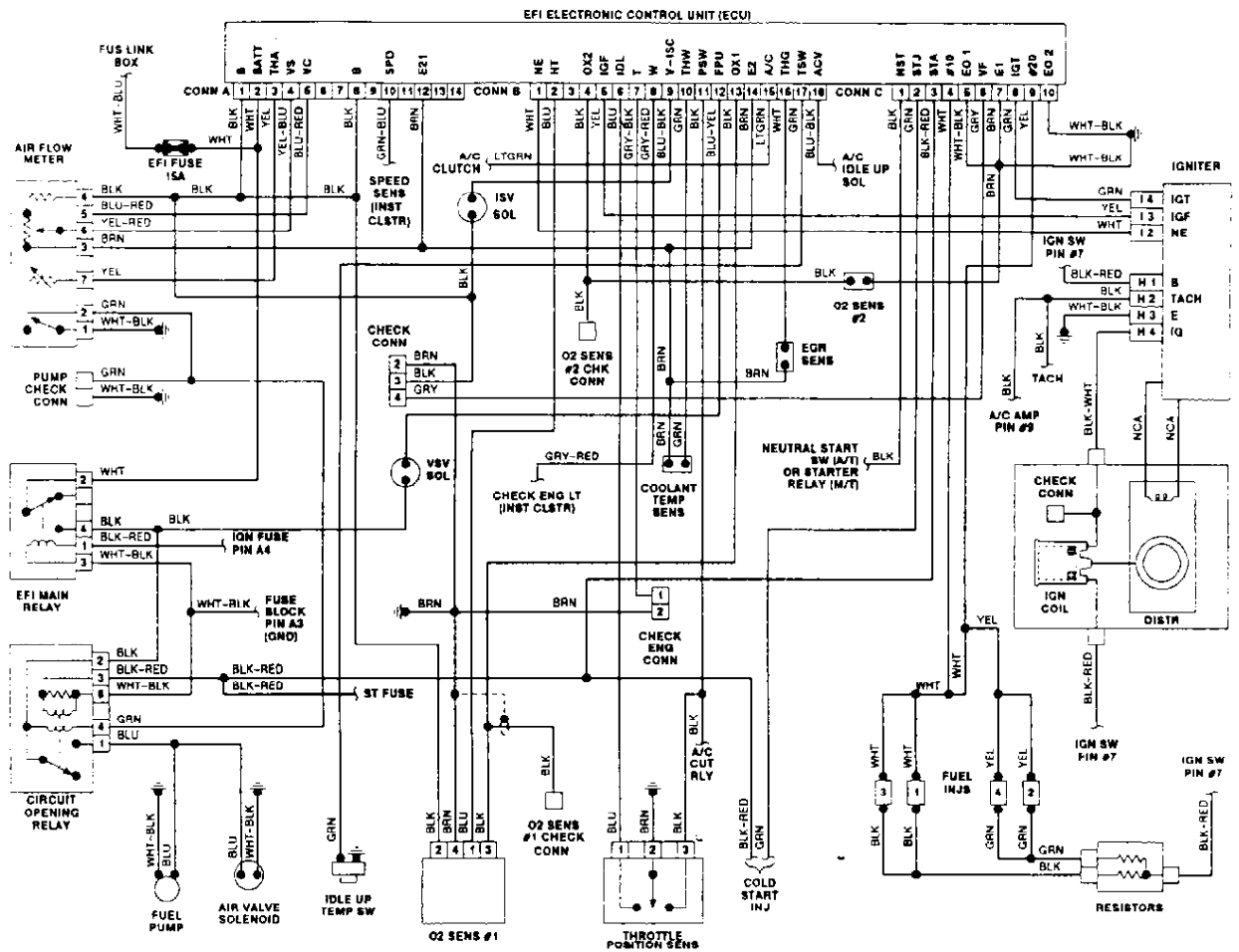


Fig. 22: Van Wiring Diagram