

BOSCH AFC — JAPANESE MODELS

Datsun/Nissan 200SX, 280ZX, 280ZX Turbo, Maxima; Toyota Cressida, Supra

NOTE: The Bosch AFC Fuel Injection system is used on all models and variations may exist between model applications with the addition of auxiliary control systems. This article covers the Bosch AFC system in general, with manufacturer's differences noted.

DESCRIPTION

The Bosch Air Flow Controlled (AFC) fuel injection system is an electronically controlled system operated by incoming air flow. 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 (except Toyota models), fuel injectors, Electronic Control Unit (ECU) and air flow meter. In addition, an air temperature sensor, throttle switch, coolant temperature sensor (cylinder head temperature sensor on Datsun/Nissan models), oxygen sensor, catalytic converter, auxiliary air valve and electrical relays are used.

All models except 200SX and 280ZX Turbo are equipped with a cold start system which consists of an auxiliary air valve, cold start injector and thermo time switch. A dash pot is installed on the throttle chamber of 200SX models with automatic transmission to prevent engine stalls due to abrupt closing of throttle valve.

The electronic control system of 280ZX Turbo models controls emission control system, idle speed control system, fuel injection system, spark timing and fuel pump operation. Under normal service procedures, it is not necessary to adjust idle mixture, idle speed or ignition timing.

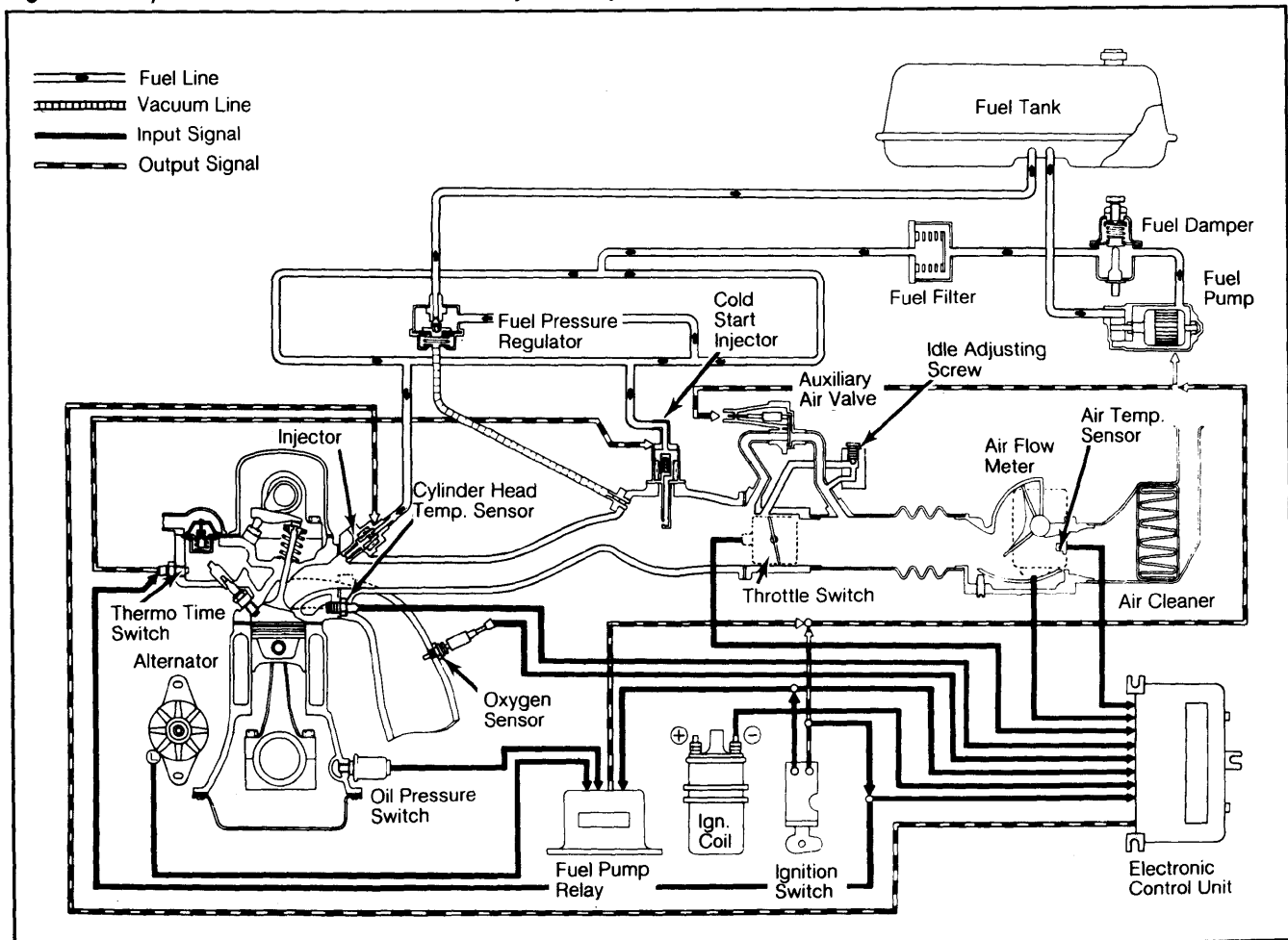
ELECTRIC FUEL PUMP

Fuel under pressure from electric fuel pump flows through a fuel damper (some models) and fuel filter to the fuel pressure regulator. Power for operation during cranking mode is provided from starter relay via the fuel pump relay and ECU.

After the engine has started, control of the fuel pump is by a fuel pump circuit in the air flow meter (Toyota models only). The first movement of the air flow meter measuring flap (about 5°) closes the fuel pump contacts and provides power to fuel pump after engine has started.

With engine stopped, no air flow is present, measuring flap closes and fuel pump contacts are opened

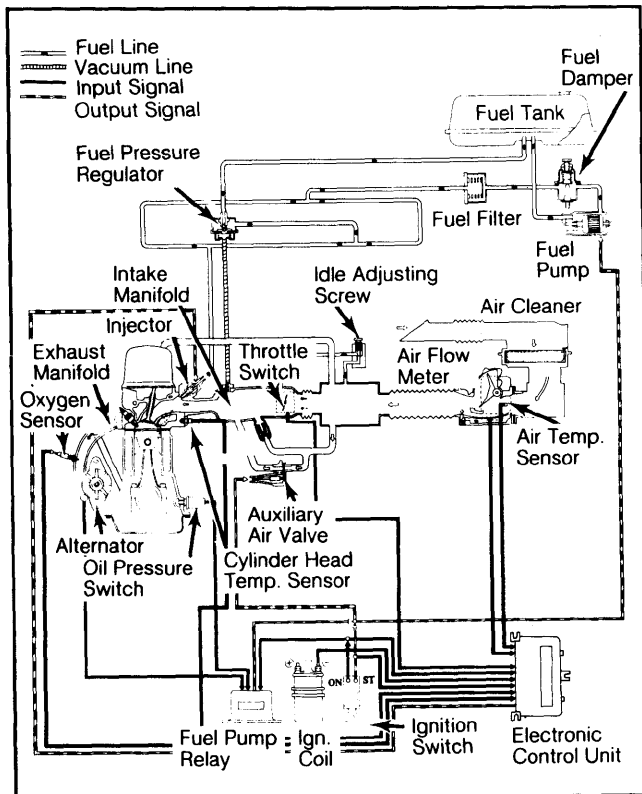
Fig. 1: Datsun/Nissan 280ZX and Maxima Fuel Injection System



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Fig. 2: Datsun/Nissan 200SX Fuel Injection System



to cut power to fuel pump. This method reduces the risk of fire in a collision.

On Datsun/Nissan models, power for operation during cranking mode is provided by the ECU through the fuel pump relay. After the engine has started, control of the fuel pump is by the charging system and oil pressure switch. Power to fuel pump is stopped if alternator does not generate a charge and oil pressure decreases. This method reduces risk of fire in a collision.

FUEL PRESSURE REGULATOR

The pressure regulator consists of a sealed, spring loaded diaphragm with a connection for intake manifold vacuum. Fuel is provided to fuel injectors under approximately 36 psi (2.5 kg/cm²) pressure.

A connection for intake manifold vacuum provides a constant pressure differential which ensures that the amount of fuel injected is solely dependent upon injector "open" time. Excess fuel is returned to fuel tank. No service of pressure regulator is required.

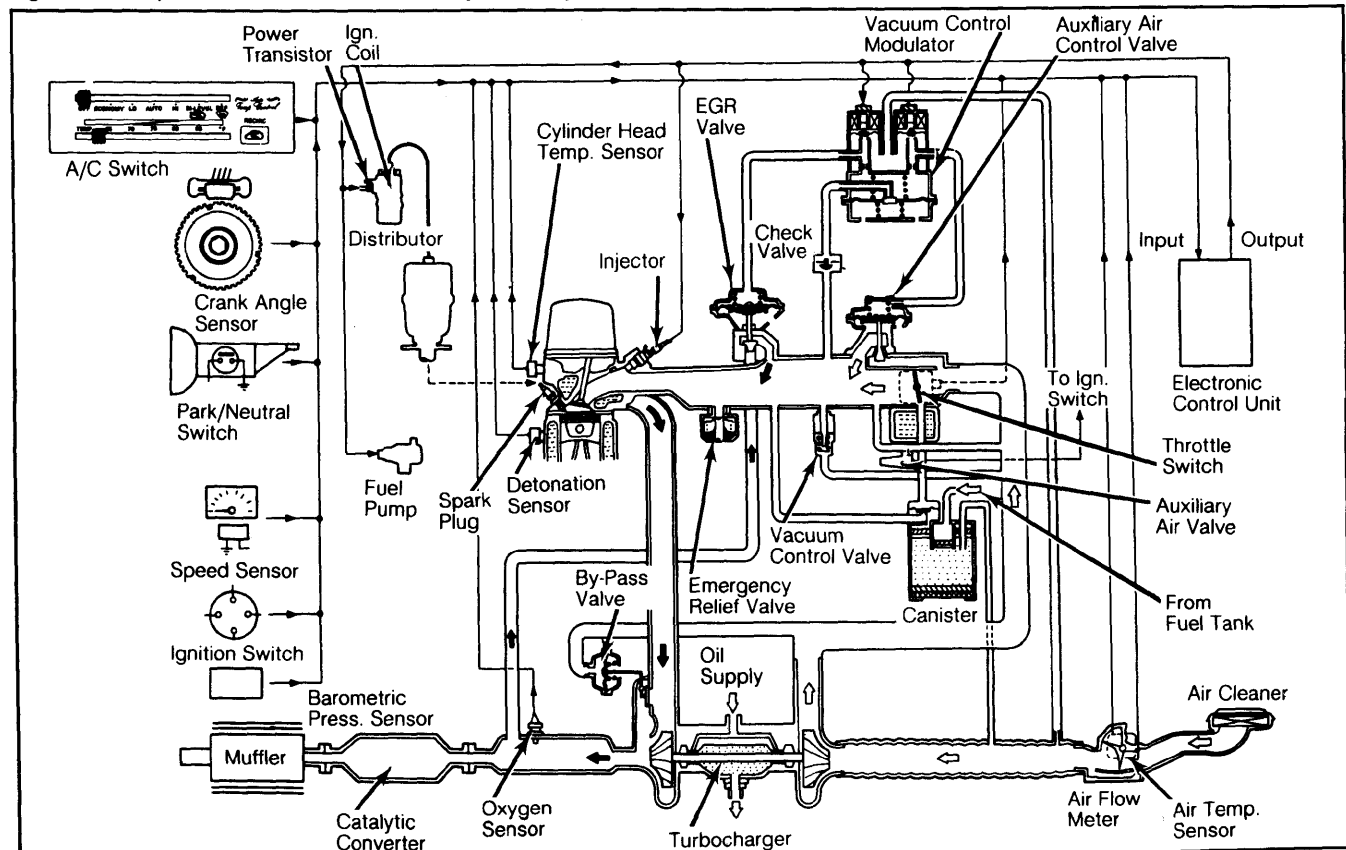
FUEL INJECTORS

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 back of each inlet valve.

Each injector is energized through the ignition coil and grounded through the ECU. The injectors have an operating voltage of 12 volts.

The ECU controls the injectors and the length of time they are open. The "open" time of the injector

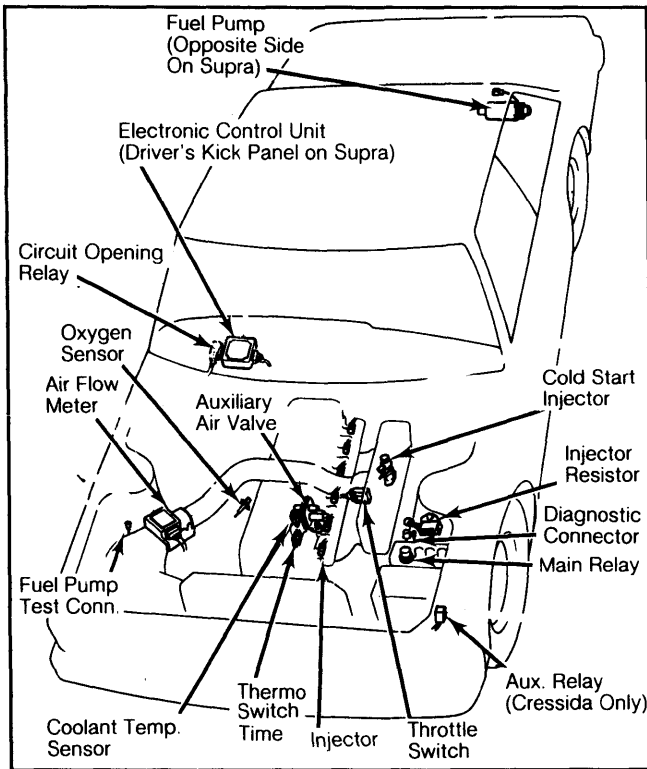
Fig. 3: Datsun/Nissan 280ZX Turbo Fuel Injection System



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governs the amount of fuel delivered. The injectors deliver 1/2 the amount of fuel required for 1 operating cycle, twice per cycle.

Fig. 4: Toyota Fuel Injection System

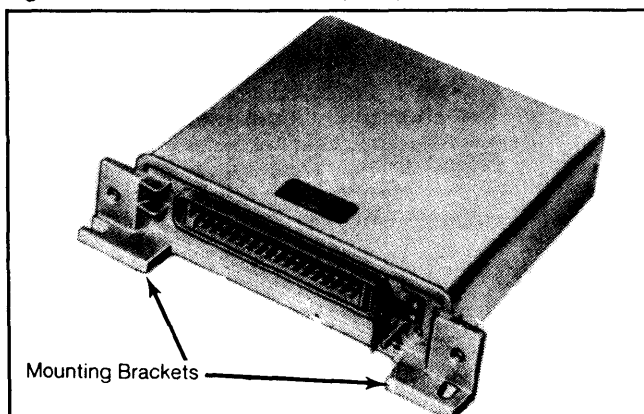


ELECTRONIC CONTROL UNIT (ECU)

All components of the control system are electrically connected to the ECU. See Fig. 5. 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 "open" 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

Fig. 5: Electronic Control Unit (ECU)



connection from the starter circuit to the ECU (most models). The ECU is a sealed unit; no service required.

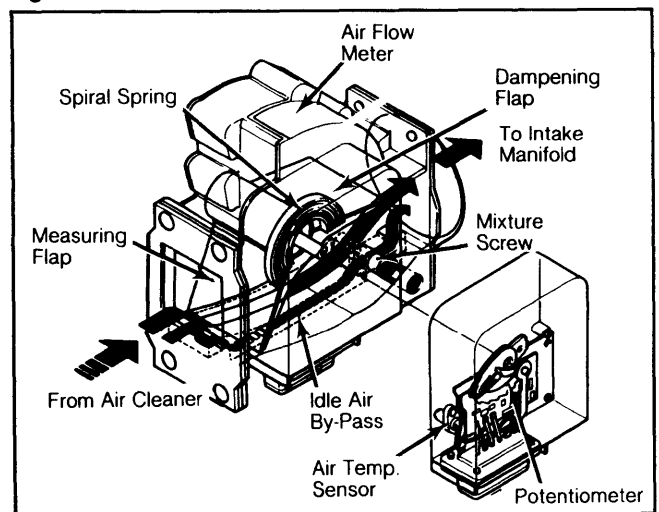
NOTE: The ECU of Datsun/Nissan 280ZX Turbo models controls all operations of the engine electronically (ignition timing, idle speed, etc.). The ECU on this model is referred to as the Electronic Concentrated Engine Control System (ECCS).

AIR FLOW METER

All engine air is drawn through the air flow meter. The meter is basically a tunnel with similarly shaped measuring flap and dampening flap (offset 90° on same casting). The measuring flap swings on an axis in air stream against pressure of a spiral spring and is connected to a potentiometer. The potentiometer transmits an electrical signal to inform the ECU of engine load. See Fig. 6.

In addition to monitoring the air flow, the meter also controls fuel pump operation (Toyota models) and idling. At idle, the measuring flap is almost closed due to spring pressure. An idle air by-pass receives air from main air flow through a small hole, the size of which is controlled by the idle mixture screw. This adjustable air by-pass influences CO levels at low engine speeds.

Fig. 6: Bosch AFC Air Flow Meter



AIR TEMPERATURE SENSOR

The air temperature sensor is an integral component of the air flow 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 non-serviceable.

THROTTLE SWITCH

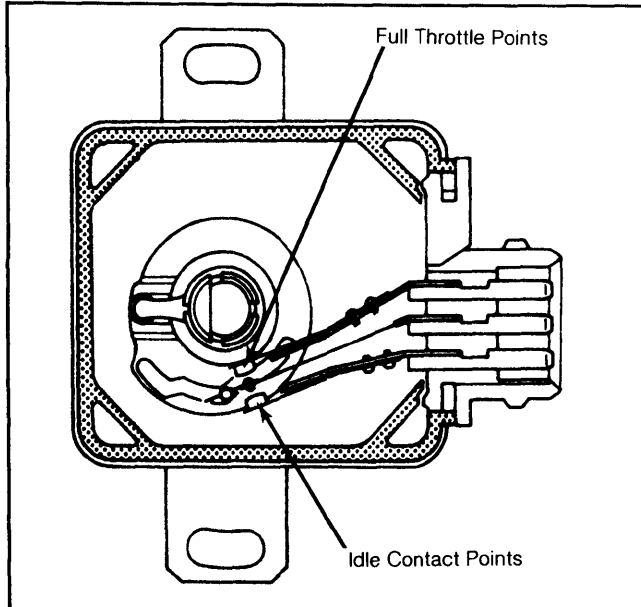
A contact type throttle switch is installed on the throttle chamber of all models. It converts throttle position into electrical signals to inform ECU of throttle position. Signals are sent to ECU when throttle is fully open or at idle. See Fig. 7. The potentiometer prevents loss of power during sudden acceleration/deceleration by signaling the ECU of necessary fuel enrichment requirements.

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NOTE: Datsun/Nissan 200SX models with automatic transmissions are also equipped with a dash pot to prevent abrupt closing of throttle valve.

Fig. 7: Contact Type Throttle Switch



COOLANT TEMPERATURE SENSOR

NOTE: Datsun/Nissan models use a cylinder head temperature sensor instead of coolant temperature sensor. Any reference made to coolant temperature sensor within this article also applies to Datsun/Nissan cylinder head temperature sensor.

This sensor provides ECU with engine temperature information relating to warm-up enrichment operation. 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 1 component for all relays or a combination of individual relays.

COLD START SYSTEM (Exc. 200SX & 280ZX Turbo)

The cold start system provides additional air and fuel during cold engine starts. The cold start system consists of an auxiliary air valve which provides additional air, cold start injector which delivers additional fuel and a thermo time switch which controls operation of the cold start system.

The thermo time switch has a bi-metal contact surrounded by a heating coil which is energized during engine cranking. This switch limits cold start system to 1-12 seconds under extreme cold engine starts in relation to engine temperature. When engine temperature is above

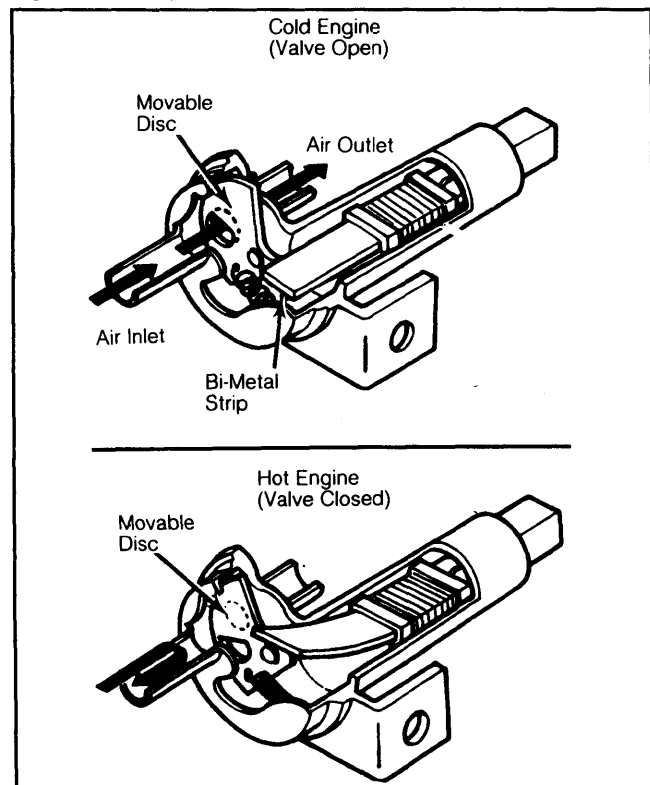
95°F (35°C), bi-metal contact breaks ground circuit of cold start injector and cold start enrichment is by-passed.

The auxiliary air valve provides additional air during cold engine starts and warm-up periods. The valve consists of an electrically heated bi-metal strip, movable disc and air by-pass channel. The heater coil on the bi-metal 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 air flow stops. See Fig. 8

NOTE: All models are equipped with an auxiliary air valve for engine warm-up.

Fig. 8: Auxiliary Air Valve



TESTING

NOTE: The Bosch AFC fuel injection system maintains constant fuel pressure in fuel lines and component parts at all times. Be sure to relieve pressure before attempting to open system at any point 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.

ELECTRONIC CONTROL UNIT (ECU)

Do not attempt to test ECU, 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

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components have been thoroughly tested (including wiring).

NOTE: The electrical system of the AFC system 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 PRESSURE

Datsun/Nissan

1) To release fuel system pressure on 280ZX Turbo models, start engine, disconnect fuel pump electrical connector in luggage compartment; after engine stalls, crank engine 2 or 3 times, turn ignition "OFF" and reconnect fuel pump.

2) On all other models, start engine, disconnect No. 2 fuel pump relay; after engine stalls, crank engine 2 or 3 times, turn ignition "OFF" and reconnect No. 2 fuel pump relay.

3) Remove fuel filter-to-fuel rail hose and connect a pressure gauge using a "T" fitting. Start engine and read fuel pressure at idle. If pressure is not as specified, replace pressure regulator.

4) Disconnect vacuum line from fuel pressure regulator and connect a hand vacuum pump. On 280ZX Turbo models, disconnect fuel pump connector and apply battery power. On all other models, disconnect alternator field plug and oil pressure sending unit lead wire.

5) On 280ZX models, leave ignition and engine off. On all other models, turn ignition "ON". As vacuum is applied to pressure regulator, pressure reading should decrease. If pressure and vacuum readings do not conform as shown in chart, replace fuel pressure regulator.

DATSUN/NISSAN FUEL PRESSURE SPECIFICATIONS

Condition In. Hg	Pressure psi (kg/cm ²)
Idle ¹	30(2.1)
0	36-37 (2.5-2.6)
5	33-35 (2.3-2.5)
10	31-32 (2.2-2.3)
15	29-30 (2.0-2.1)
20	26-28 (1.8-2.0)

¹ — Vacuum hose connected at pressure regulator.

Toyota

1) Disconnect battery ground cable and cold start injector electrical connector. Place container or shop rag under fuel rail at union bolt of cold start injector hose.

2) Remove union bolt and drain fuel rail. Remove cold start injector hose from union bolt and install fuel pressure gauge with hose to union bolt. Install gauge and bolt to fuel rail with a gasket on each side of gauge fitting.

3) Reconnect battery cable and start engine. Disconnect vacuum line from fuel pressure regulator and pinch line closed. Gauge reading should be 33-38 psi (2.3-2.7 kg/cm²). If pressure is too high, replace fuel pressure regulator; if too low check fuel system for leaks.

4) Reconnect vacuum line to pressure regulator. Pressure reading should decrease to 28 psi (2.0 kg/cm²) with engine at idle speed. If not, replace fuel

pressure regulator. Stop engine. If pressure drops quickly, check fuel pump, pressure regulator and/or injectors.

FUEL PUMP CIRCUIT

Datsun/Nissan

1) On 280ZX Turbo models, turn ignition "ON" and listen for fuel pump operation (pump operates for 5 seconds after ignition switch is turned on).

2) On all other models, turn ignition "ON", disconnect oil pressure switch electrical harness or alternator terminal "L"; fuel pump operation should be heard.

3) On all models, if fuel pump does not operate, check relays, fuel pump, alternator terminal "L" (if used) and oil pressure switch (if used).

Toyota

1) Turn ignition "ON". Remove cap from fuel pump test connector and, using a jumper wire, jump both terminals of connector.

2) Fuel pressure should be felt at cold start injector hose and noise of fuel returning to tank should be heard at fuel pressure regulator.

3) Remove jumper wire, install connector cap and turn ignition "OFF". If none of the above conditions were met, check fusible link, engine fuse, fuel injection fuse, circuit opening relay, fuel pump and all electrical connectors.

AIR TEMPERATURE SENSOR

1) With ignition "OFF", disconnect electrical connector at air flow meter. Connect an ohmmeter between terminals 30 and 33 (280ZX Turbo), terminals E₂ and THA (Toyota) or terminals 25 and 34 (all other models). Measure and record air temperature.

2) Ohmmeter readings should be as shown in chart. If not, check insulation resistance with ohmmeter between terminal 30 (280ZX Turbo), terminal THA (Toyota) or terminal 25 (all other models) and ground (use air flow meter as ground).

3) Infinity ohmmeter reading should be obtained. If values are not as specified, replace electrical harness or air flow meter assembly, as required.

TEMPERATURE/RESISTANCE RELATIONSHIP

Temperature °F (°C)	Resistance (Ohms)
Below 68 (20)	Above 2900
68 (20)	2100-2900
Above 68 (20)	Below 2100

AIR FLOW METER POTENTIOMETER

AIR FLOW METER RESISTANCE

Terminal No. Exc. Toyota	Toyota	Resistance (Ohms)
34 & 35	E ₂ & Vb	200-500
32 & 34 ¹	E ₁ & Fc	Exc. 0 or Infinity
33 & 34	E ₂ & Vc	100-400
.....	E ₂ & Vs	20-40
²	Infinity

¹ — Moving air flow measuring flap.

² — Between any terminal and air flow case (ground).

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Turn ignition switch off. Disconnect electrical connector from air flow meter and connect ohmmeter between terminals shown in table and note readings. If readings are not to specifications, replace air flow meter.

AUXILIARY AIR VALVE

Start cold 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 (not more than 150 RPM on Toyota). If valve does not operate as outlined, replace auxiliary air valve.

THERMO TIME SWITCH

Datsun/Nissan (Exc. 200SX & 280ZX Turbo)

Disconnect negative battery cable and switch connector. Connect ohmmeter between terminal 45 and switch body (ground). Reading should be 40-70 ohms. Connect ohmmeter between terminal 46 and ground. At coolant temperature below 57°F (14°C), reading should be 0 ohms; above 77°F (25°C), reading should be infinity; between 57-77°F (14-25°C), reading should be infinity. If readings are not as specified, replace thermo time switch.

Toyota

Disconnect negative battery cable and switch connector. Connect ohmmeter between both terminals; reading should be 20-40 ohms at coolant temperature below 95°F (35°C) and 40-60 ohms at temperature above 95°F (35°C). Measure resistance between terminal STA and switch body (ground); reading should be 20-80 ohms. If readings are not as specified, replace thermo time switch.

COLD START INJECTOR

(Exc. 200SX & 280ZX Turbo)

Disconnect negative battery cable and cold start injector connector. Remove cold start injector (with fuel supply connected) and place over glass container. Connect battery power to injector terminals (use injector harness connector on Toyota). Fuel should spray from injector. If not, replace cold start injector.

COOLANT TEMPERATURE SENSOR

Warm engine to normal operating temperature and stop engine. Using a thermometer, measure temperature of coolant. Disconnect negative battery cable and sensor electrical connector. Connect ohmmeter leads to both terminals of sensor. Readings should be as shown in chart for corresponding temperature. If not, replace coolant temperature sensor.

COOLANT TEMPERATURE SENSOR RESISTANCE

Temperature °F (°C)	Resistance (Ohms)
14 (10)	7,000-11,500
68 (20)	2,100-2,900
122 (50)	700-1,000

REMOVAL & INSTALLATION

NOTE: The Bosch AFC fuel injection system maintains constant fuel pressure in fuel lines and component parts at all times. Be sure to relieve pressure before attempting to open

system at any point for removal or installation of components. Do not allow fuel to flow onto engine or electrical parts and do not allow open flame or sparks in area while servicing fuel system components. Always disconnect negative battery cable before disconnecting any electrical component.

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation

Disconnect negative battery cable. On Cressida models, ECU is located behind glove compartment; on all other models, ECU is located behind kick panel on driver's side. 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.

AIR FLOW METER

Removal & Installation

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

THROTTLE SWITCH

Removal & Installation

Disconnect negative battery cable. Disconnect throttle switch electrical connector. Remove 2 screws securing throttle switch to housing. Remove switch by slowly pulling switch off throttle shaft. To install, reverse removal procedure and note the following: Make sure switch is aligned on throttle shaft and after replacement, perform throttle switch adjustment. See *Adjustments in this article*.

COLD START INJECTOR

(Exc. 200SX & 280ZX Turbo)

Removal & Installation

Disconnect negative battery cable and remove electrical connector from cold start injector. Release 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 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

Removal & Installation

Disconnect negative battery cable and remove electrical connector from coolant sensor (cylinder head

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sensor on Datsun/Nissan models). Drain engine coolant, if required. Remove sensor. To install, reverse removal procedure, using suitable sealer on Toyota sensor.

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

THERMO TIME SWITCH

(Exc. 200SX & 280ZX Turbo)

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, using suitable sealer on switch threads.

FUEL PRESSURE REGULATOR

NOTE: Fuel pressure regulator removal for Toyota models requires removal of fuel rail. See Fuel Injector removal in this article.

Removal & Installation

Disconnect negative battery cable and relieve fuel system pressure. Disconnect fuel lines and vacuum line at regulator. Remove pressure regulator mounting bolts and separate regulator from bracket, if installed. Remove pressure regulator. To install, reverse removal procedure.

FUEL INJECTORS

Removal (Datsun/Nissan)

1) Release fuel system pressure and disconnect negative battery cable. Disconnect electrical connectors from cold start injector and fuel injectors. Disconnect fuel injection wiring harness from clip on fuel rail.

2) Clear fuel rail and injectors by disconnecting all air, vacuum, fuel supply and fuel return lines. Remove cold start injector fuel rail and fuel injector retaining bolts.

3) Remove fuel rail, cold start injector and fuel injectors as an assembly. Remove fuel supply hose retaining clip from cold start injector and each fuel injector and remove injectors.

4) To replace injector fuel supply hose, cut hose with soldering iron just enough to remove hose. Do not touch any part of injector with soldering iron, or mount injector in a vise.

Installation (Datsun/Nissan)

To install, reverse removal procedures and note the following: Coat inside of new fuel hose with gasoline and slide onto injector.

Removal (Toyota)

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 (Toyota)

To install, reverse removal procedure and note the following: Install new insulators in injector holes in intake manifold. Install new grommets and "O" rings on fuel injectors.

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

ALL IDLE ADJUSTMENTS

See appropriate TUNE-UP SERVICE PROCEDURES article.

THROTTLE SWITCH

Datsun/Nissan

1) With engine running at specified idle RPM, disconnect throttle switch electrical connector. Connect ohmmeter leads to terminals 18 and 25 (280ZX Turbo) or 29 and 30 (all others) of throttle switch.

NOTE: Do not connect ohmmeter leads to electrical connector of harness or damage to ohmmeter may result.

2) With engine operating at idle, 0 ohms should register on ohmmeter. Loosen throttle switch retaining screws and increase engine speed to 900 RPM.

3) Adjust position of throttle switch so that ohmmeter reading changes from 0 ohms to infinity reading. If ohmmeter registers correctly, proceed to step 5). If readings are not correct, proceed with next step.

4) Turn engine off and set clearance between throttle valve shaft lever and stopper screw to .012" (0.3 mm). Adjust throttle switch position until ohmmeter reading goes from 0 ohms to infinity. If switch does not perform as described, replace throttle valve switch.

5) To check full throttle contact, stop engine and disconnect negative battery cable. Connect ohmmeter between terminals 24 and 30 (except 280ZX Turbo).

6) Continuity should not exist when throttle valve is in idle position. Depress accelerator to full throttle position; continuity should exist. If not, replace throttle switch.

Toyota

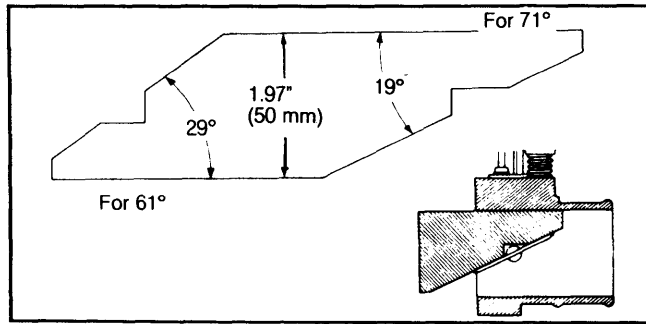
1) Construct an angle gauge as shown in Fig. 9. Insert angle gauge in throttle body to obtain a 61° or 71° throttle valve angle. Check continuity between each terminal of switch (IDL-TL, IDL-PSW and PSW-TL).

2) At 61° throttle opening, ohmmeter reading should show no continuity between any terminals. At 71° throttle opening, continuity should exist between terminals PSW and TL only. If not, proceed to step 3). If readings are correct, throttle switch is properly adjusted.

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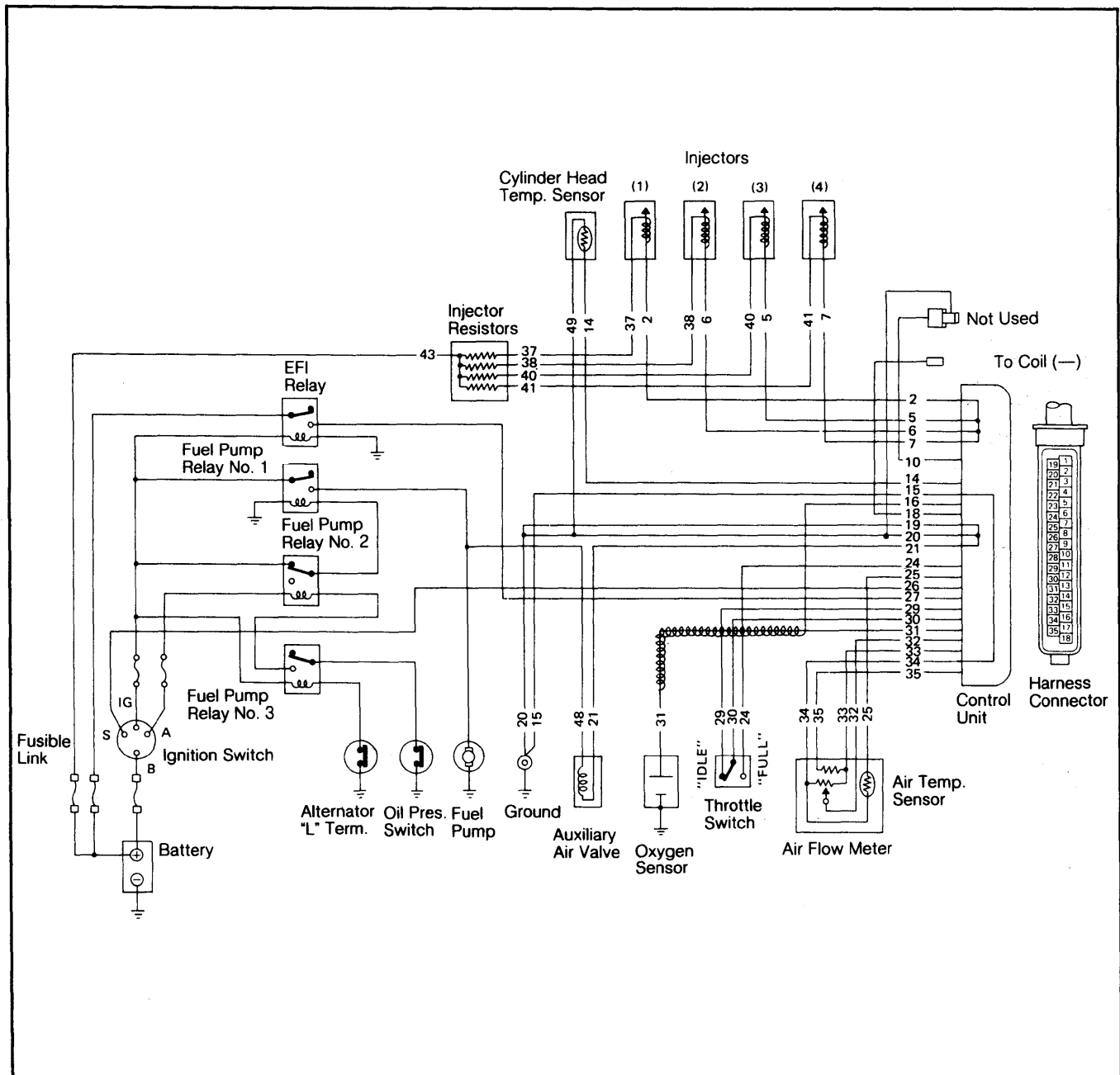
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Fig. 9: Toyota Throttle Switch Checking Gauge



Construct angle gauge to dimensions shown.

Fig. 10: Datsun/Nissan 200SX Fuel Injection Wiring Diagram



3) To adjust throttle switch, loosen retaining screws and insert a .020" (.52 mm) feeler gauge between throttle stop screw and lever.

4) Connect ohmmeter to terminals IDL and TL. Continuity should be registered. Gradually turn throttle switch counterclockwise until ohmmeter deflects and tighten screws. Remove feeler gauge.

5) To recheck, insert a .017" (.44 mm) feeler gauge between throttle stop and lever. Ohmmeter should register continuity. Remove feeler gauge and insert a .026" (.66 mm) feeler gauge. Ohmmeter should not register continuity.

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Fig. 11: Datsun/Nissan Maxima Fuel Injection Wiring Diagram

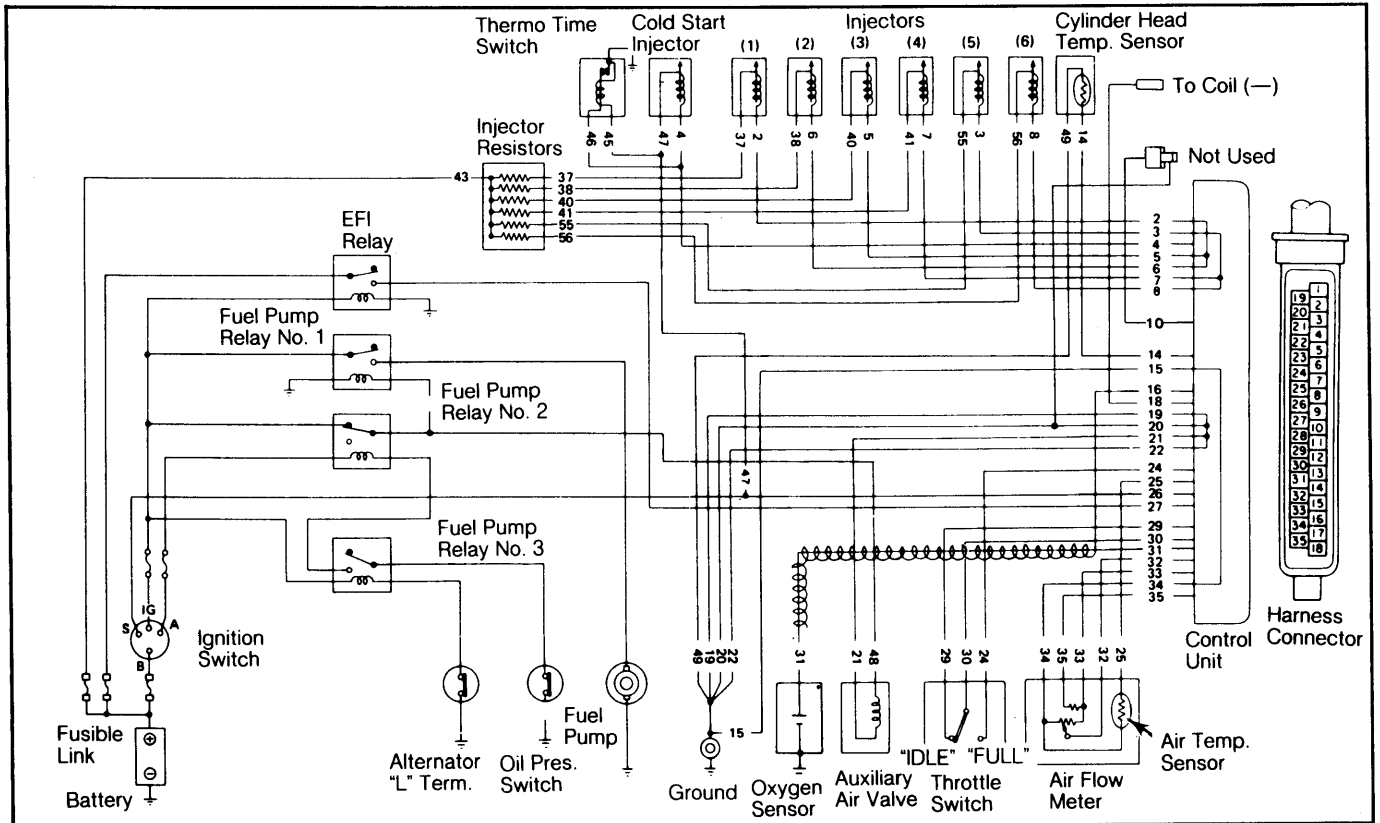
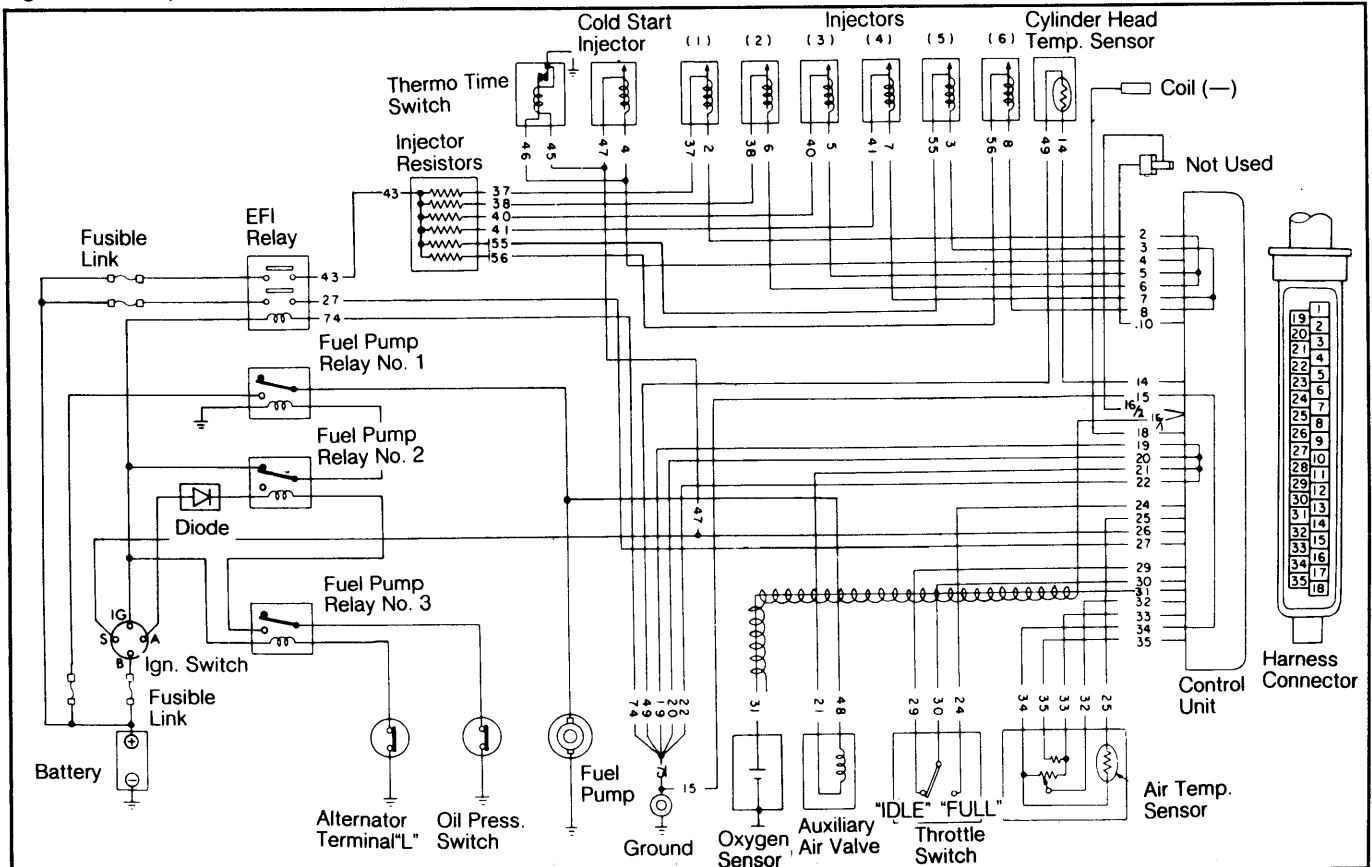


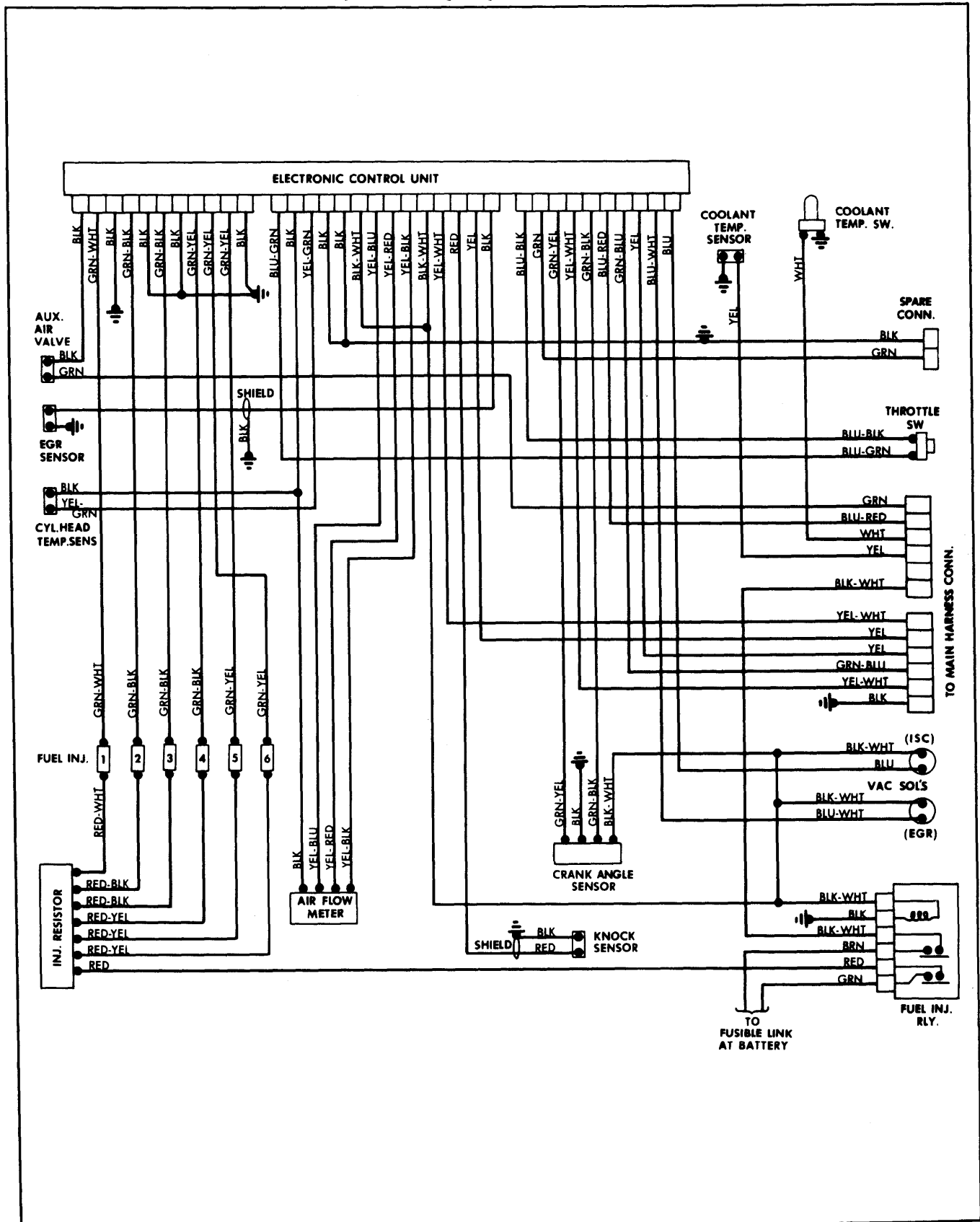
Fig. 12: Datsun/Nissan 280ZX (Except Turbo) Fuel Injection Wiring Diagram



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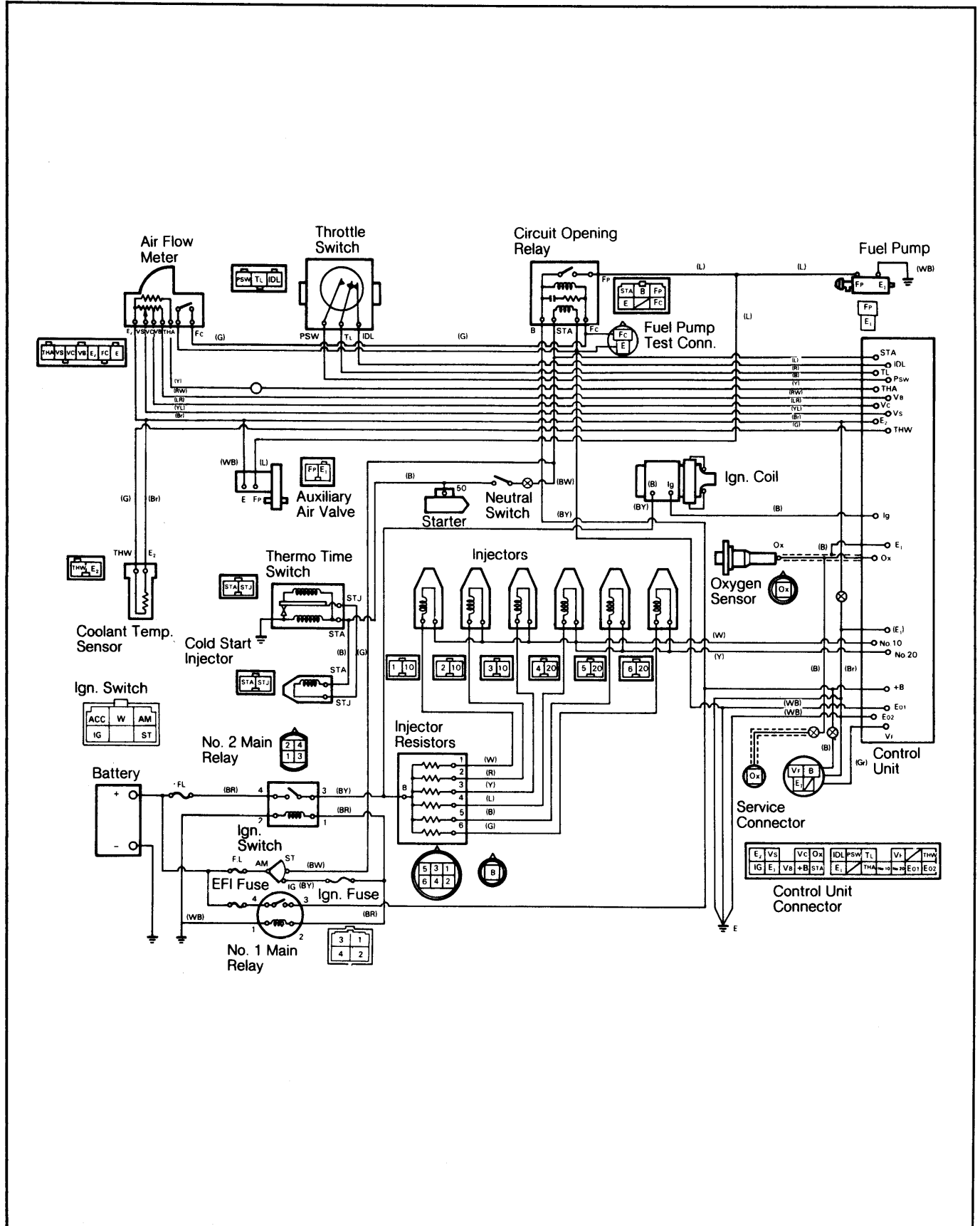
Fig. 13: Datsun/Nissan 280ZX Turbo Fuel Injection Wiring Diagram



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Fig. 14: Toyota Cressida Fuel Injection Wiring Diagram



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Fig. 15: Toyota Supra Fuel Injection Wiring Diagram

