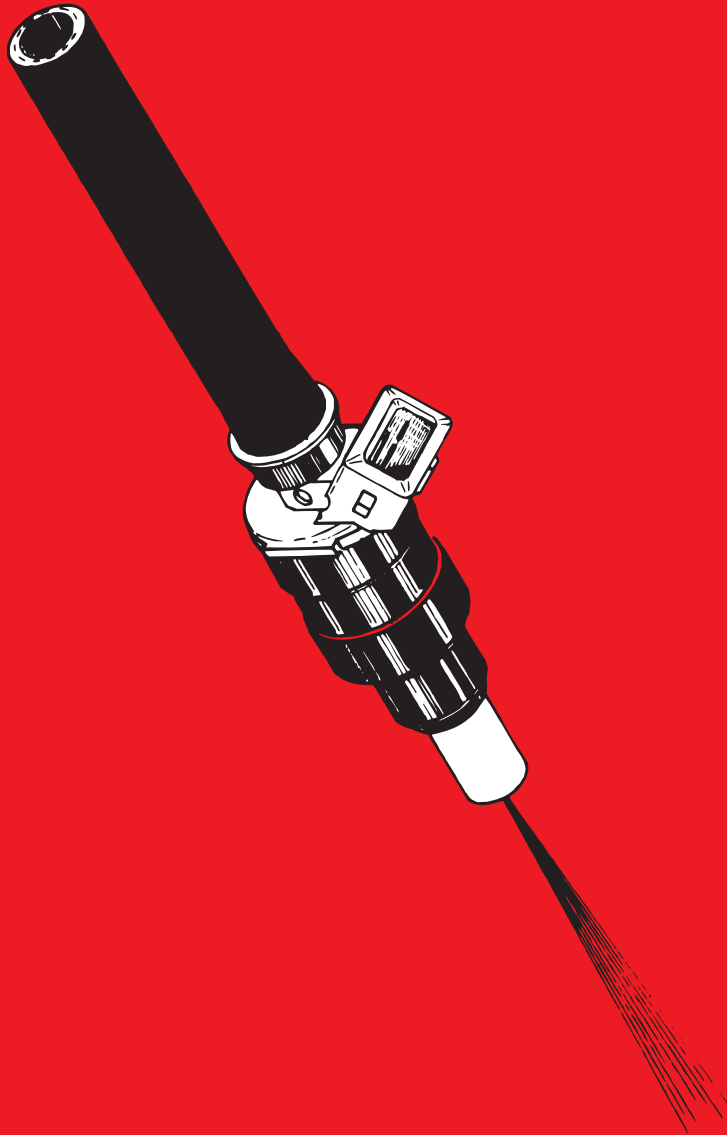


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**FIAT**

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*a mirafiori.com guide*

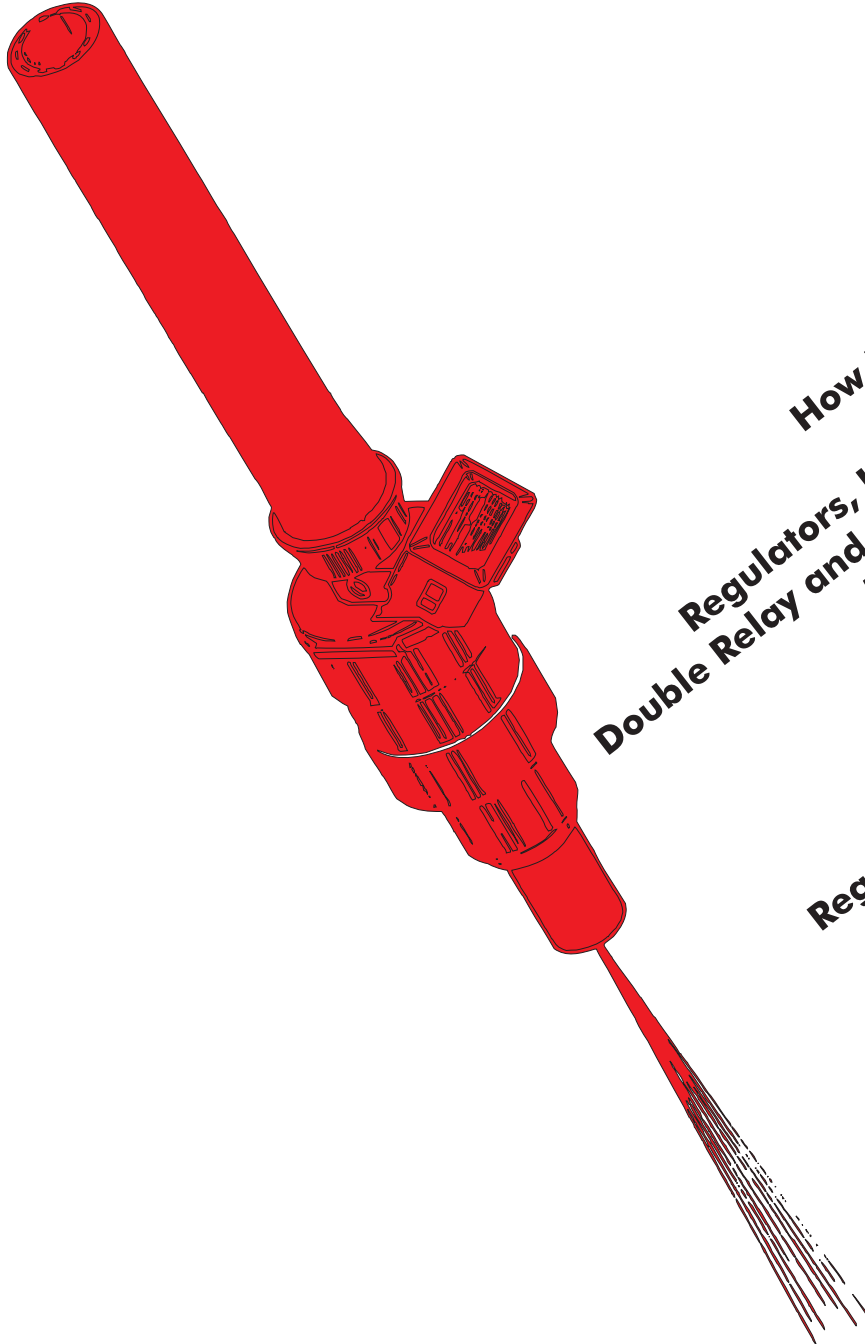


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**Bosch L-Jetronic Fuel Injection Guide**  
**FIAT Fuel Injected Engines " F irst Edition - July 2004**  
**Brad Artigue**

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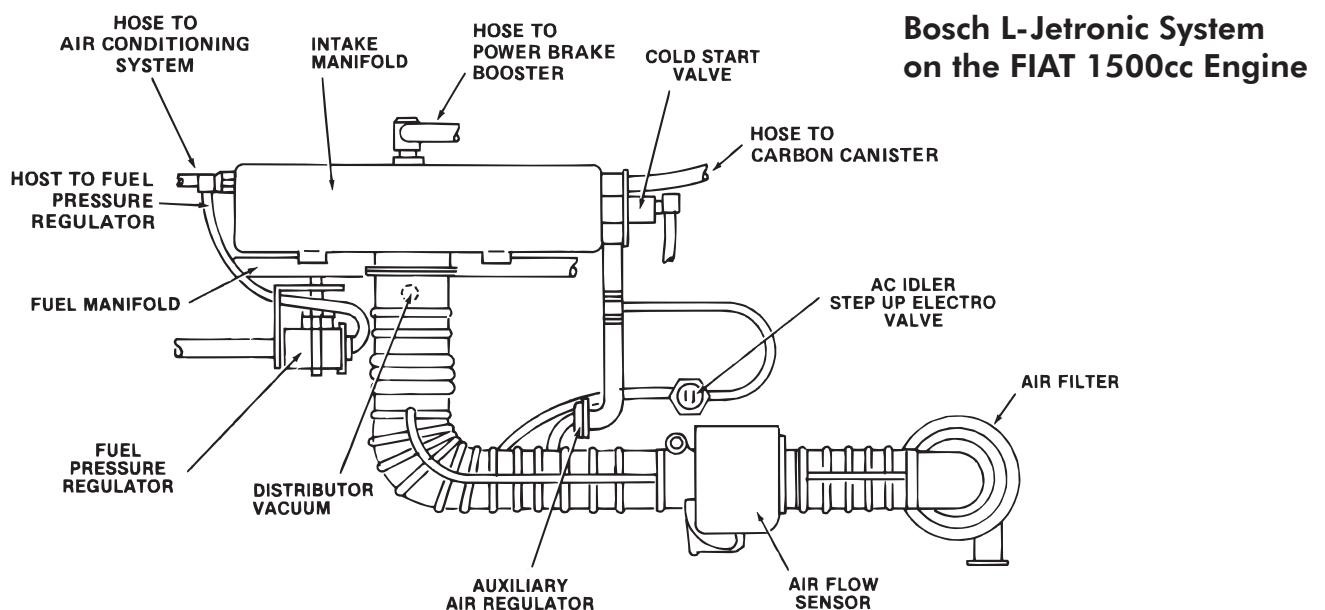
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# How L-Jetronic Works

In 1980 FIAT introduced a Bosch multiport fuel injection system in its vehicles. Introduced first on California-bound vehicles and, by 1981, on all U.S. vehicles, the Bosch system improved the performance, efficiency, reliability, and quality of engine operations. Solely responsible for a 23 horsepower increase on the 2 liter engines, this system, known as Bosch L-Jetronic, was popular not only on FIATs but on nearly every European car produced in the 1980's.

The L-Jetronic was the first mass-produced, fully electronic fuel injection system. Prior to L-Jetronic, mechanical fuel injection systems had proven that directly injecting atomized fuel into the cylinder resulted in better engine operation. Combining this direct injection theory with electronic sensors, valves, and meters - all controlled by a central computer - resulted in better operation than before.

The basic operation is straightforward. An engine is basically an air pump, drawing mixed fuel and air into the intake manifold, compressing it (followed by a spark-triggered explosion), and expelling it through the exhaust manifold. In a fuel injection system the entire operation is based on the amount of air entering the system. The engine pulls air through an air filter and into an air flow meter. The air flow meter measures the amount of air entering the system. Once measured, the air flows into a large hose that is connected to the intake manifold (a plenum). The intake manifold has a throttle plate that is connected to the driver's foot (the accelerator pedal). The position of this plate determines how much air is drawn into the manifold. Air is then passed into one of four barrels connecting the manifold to the cylinder head. A fuel injector is positioned each barrel and, as air passes through, fuel is sprayed for a specific amount of time into the air stream.

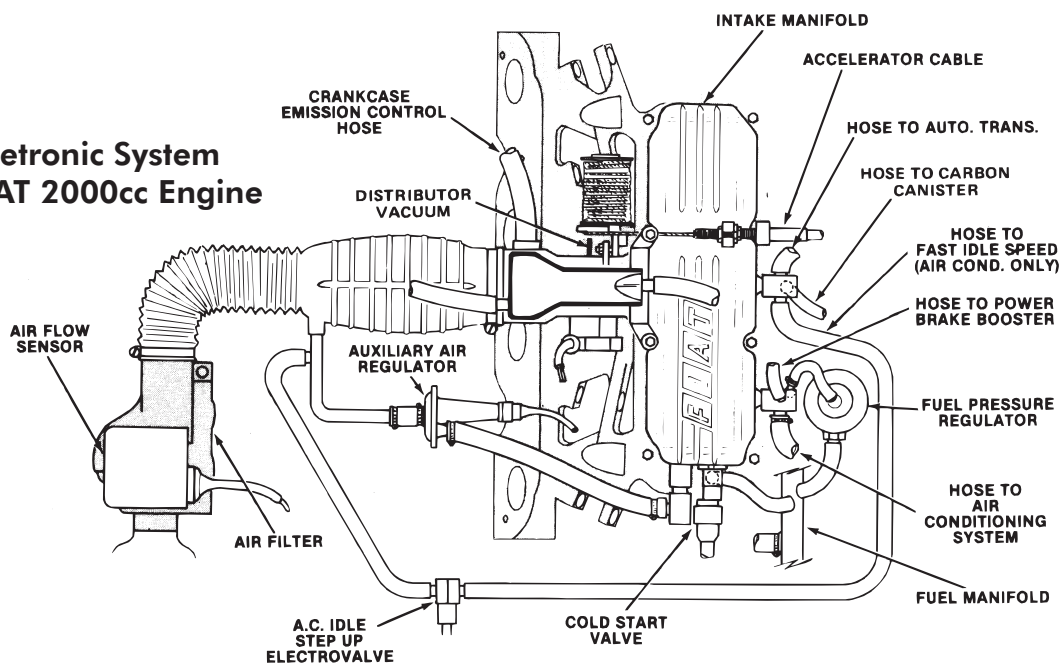


# How L-Jetronic Works

This basic operation is achievable without an electronic fuel injection system. What an electronic system offers is precise control over fuel delivery and air flow. Utilizing sensors that determine air and engine temperature, throttle position, exhaust gas content, and engine speed, an electronic system can precisely meter the input of air and fuel. The result is a smooth, efficient engine.

Electronic fuel injection is a system of electronic inputs and mechanical actions. On the FIAT system, the electronic inputs are water temperature, air temperature, engine speed, exhaust gases, and throttle position. Expanding upon the basic fuel injection operation described on the previous page, these inputs are gathered by sensors located in your engine compartment. They are very easy to locate - the water temperature sensors are located in the coolant "T" bolted to and in front of the cylinder head and underneath the intake manifold. The air temperature sensor is integrated into the air flow meter. The engine speed sensor is read from your coil and throttle position by a smallish black box (roughly triangular in shape) attached to the intake manifold and opposite your throttle spring. Finally, the exhaust sensor (or oxygen sensor) is located in your exhaust system, just below the collection point for all four cylinders. These inputs connect to your fuel injection computer, which is located in the interior of the car. As your car operates these sensors send continuous signals to the computer.

## Bosch L-Jetronic System on the FIAT 2000cc Engine

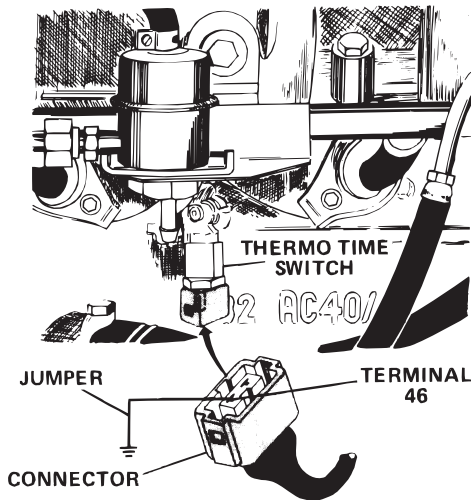


The fuel injection computer is tasked with making decisions based on these inputs. It is programmed to adjust the entire system for external and internal conditions. For example, if it is a cold day and your engine is cold, the water temperature sensor will tell the computer the engine is cold. The computer will adjust the air/fuel ratio as necessary to compensate for the cold exterior air. It also receives an input from the thermo-time switch, a temperature sensor that turns on the cold start valve, providing an even richer mixture while the engine is cold.

At this point you should have a general understanding of how electronic fuel injection works. The following sections will describe the fuel injection components as used on FIAT vehicles in some detail.

# Sensors

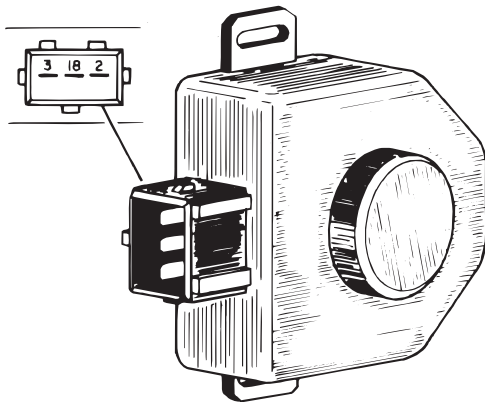
The Bosch L-Jetronic system has a variety of sensors designed to signal the ECU (electronic control unit) throughout engine operation. There are two water temperature sensors, one throttle position sensor, one exhaust sensor, and one air flow meter that all signal the ECU and must be operating correctly in order for your fuel injection system to remain efficient.



## Thermo-Time Switch

The thermo-time switch is located directly under the intake manifold between the #2 and #3 cylinder. It is screwed into the water passage that runs under the manifold and detects engine temperatures. When the engine is very cold the thermo-time switch turns on the cold start injector for a certain amount of time (enough to get the engine barely warm) then shuts it back off.

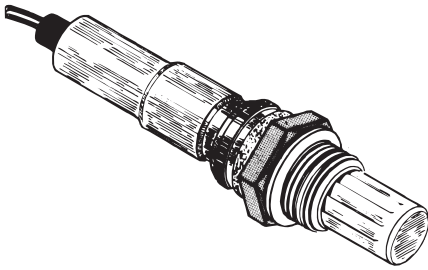
Failure of this switch will cause some difficulty in starting or a rich condition when driving at normal temperatures.



## Throttle Position Sensor

The throttle position sensor is located on the intake manifold on the opposite side of the big air hose from the throttle return spring. It rotates (internally) against a ceramic plate, the resistance of which is sent back to the ECU. The ECU uses this information to direct more (or less) fuel into the engine or shut off the injectors (during deceleration).

Failure or miscalibration of this sensor will cause the engine to run poorly at some or all speeds and will cause light puffing "backfires" while decelerating.



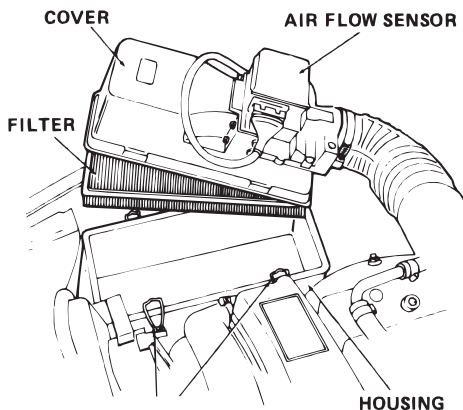
## Lambda Sensor (Oxygen Sensor)

The lambda sensor meters the presence of oxygen in the exhaust gases and reports the level of oxygen to the ECU. It is located in the exhaust system before the catalytic convertor.

Failure of this sensor will occur at approximately 30,000 miles or sooner on a poorly operating engine and will result in reduced efficiency. An engine that burns oil will ruin the sensor regularly.

**NOTE:** if you are tuning your fuel injection system you may want to buy two of these; one to ruin during tuning and another to use once you are finished.

## Air Flow Sensor



The air flow sensor is the point of entry for air into the fuel injection system. Any air leaks between this sensor and the engine will cause problems with your fuel injection system. Acting as both a sensor and a control device, the air flow sensor sends air volume information and air temperature to the ECU, which then instructs the air flow sensor to increase or decrease the volume of air passing into the system.

The air flow sensor is an expensive and complex device. It is, for lack of a better term, the carburetor in the fuel injection system. Failure of this sensor can cause a variety of performance problems including erratic idle, loss of power under load, bad air/fuel mixture, and even complete lack of vehicle operation.

The air filter resides in the housing below the air flow sensor and must be routinely changed (with a quality filter) for continued quality of operation. The air flow sensor is factory sealed and, should yours be under warranty, tampering will void the warranty.

## Water Temperature Sensor



The water temperature sensor is a hex-head brass component located in the cooling system pipes. On a 2000cc engine it is located in the coolant "T" in front of the head and between the cam drive wheels and the radiator. It should never be confused with the two water temperature sensors located in the cylinder head (between the spark plugs). Unlike the thermo-time switch, the water temperature sensor is continuously "on" throughout engine operation. It sends the engine temperature to the ECU which in turn instructs the air flow sensor to adjust the amount of air entering the engine.

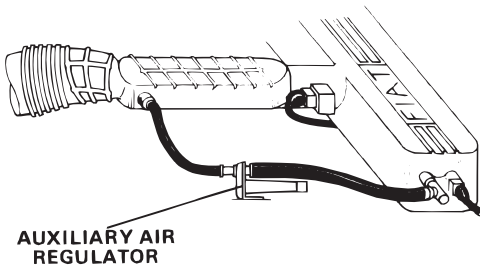
# Regulators, Injectors, and Pumps

The Bosch system is outfitted with several regulators and a fuel pump. Some vehicles have more regulators than others (such as A/C Electrovalves); the standard complement of equipment is discussed in this section.

## Auxiliary Air Regulator

Always a suspect when a FIAT is not idling properly, the Auxiliary Air Regulator is an electrovalve that, when signaled by the ECU, allows a metered amount of air to bypass the throttle plate and enter the intake manifold. The obvious result is faster idle.

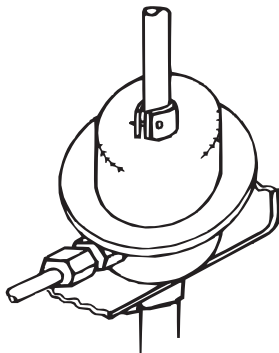
Failure of this device can cause the engine to idle too high or the engine to run lean.



## Fuel Pressure Regulator

The fuel pressure regulator receives fuel from the fuel pump and keeps the fuel pressure into the injectors constant. It is located on the fuel rail and connects (via the rail) to the injectors and fuel pump. A smaller vacuum hose connects this regulator to the intake manifold. Intake manifold pressure forces the regulator to increase or decrease fuel rail pressure.

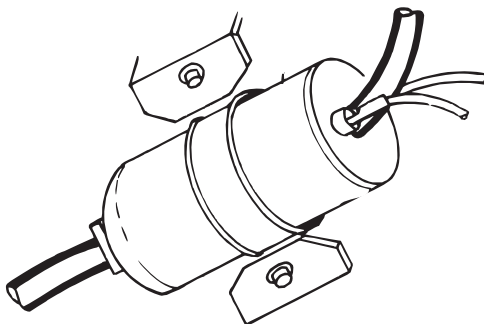
Failure of this device can cause fuel starvation or too much fuel in the system, effecting performance.



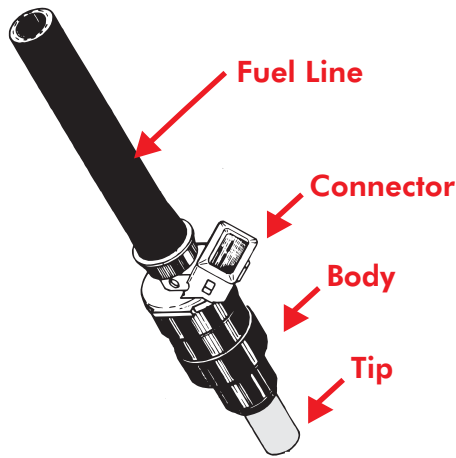
## Fuel Pump

Located under the car and near the fuel tank, the fuel pump works as described, pumping fuel through the fuel filter and the fuel rail and into the injectors.

Failure of the fuel pump can cause intermittent or total loss of power. Pumps are often noisy when failure is pending.



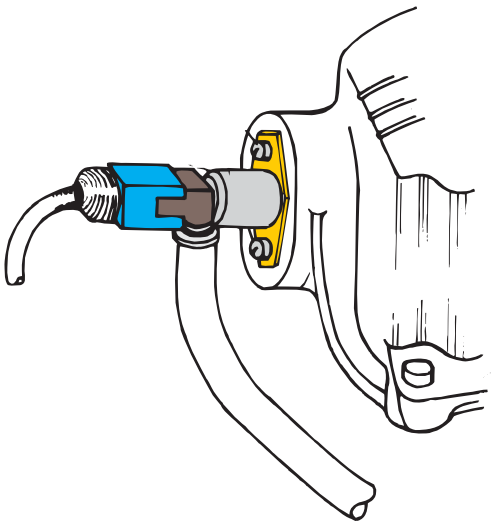
# Regulators, Injectors, and Pumps



## Fuel Injector

A fuel injector is an extremely simple electronic device. The ECU will send a small current to the injector (via the connector), opening the injector and allowing fuel from the fuel rail to spray through the tip and into the engine. The tip of the injector is an insulator, the injector itself is a small opening in the center of the tip. Injectors are seated in the manifold with large rubber isolators around the tip and the injector body, insulating the injector from vibration.

Like any electronic component subjected to heat and fuel, injectors fail over extended periods of time (20 years or so). Cars unused for very long periods of time may have varnished the injectors to the point of uselessness.



## Cold Start Injector

Upon receiving the "on" signal from the ECU, the cold start injector sprays fuel into the intake plenum, creating the rich fuel mixture required during cold starts. The duration of time in which the injector operates is determined by the thermo-time switch.

Failure of the cold start injector results in over-rich conditions when the engine is hot or rough idling / no start conditions when the engine is very cold.

This injector is usually the only component on the L-Jetronic harness with a blue connector.

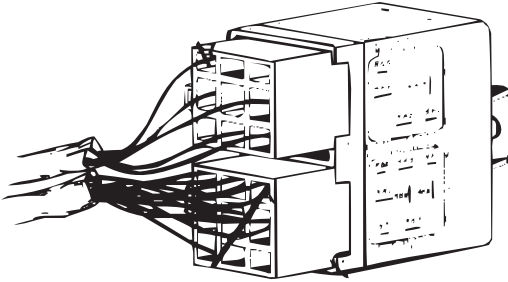


# Double Relay and Electronic Control Unit

## Double Relay

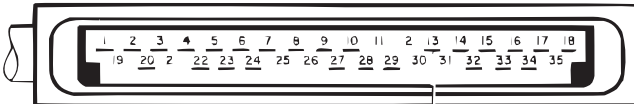
The double relay consists of two relays molded into a single container. It is located near the ECU. Signals from the ECU enter the relay and trigger higher voltage components.

A common problem is a double relay that is clicking rapidly during idling or deceleration. This is caused by the throttle position sensor being out of adjustment. Refer to the tune-up section of this document.

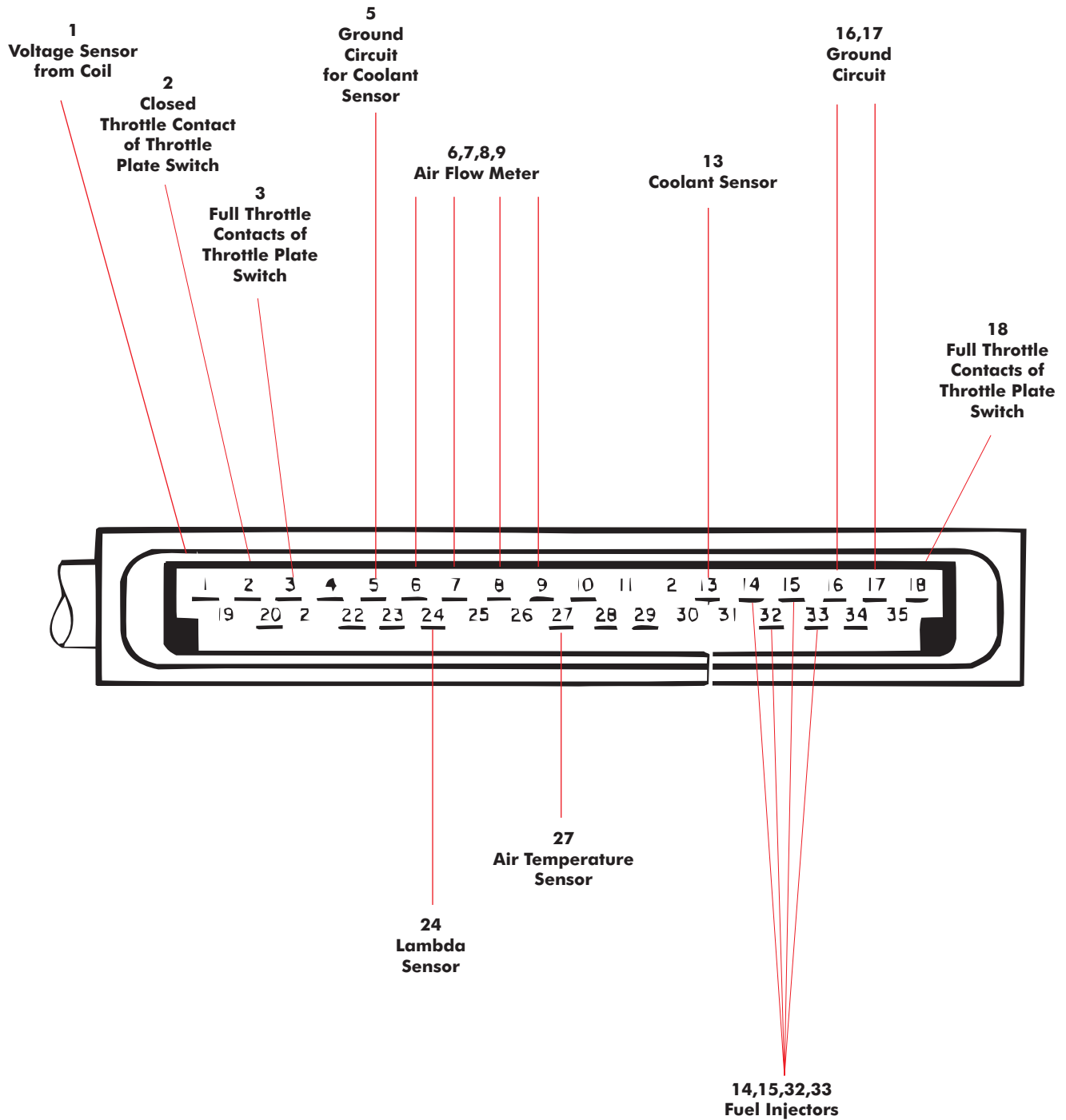


## ECU

The ECU is a black box located under the glove box. It is not a serviceable component. The connector on the ECU is used to test many of the sensors in the FI system.

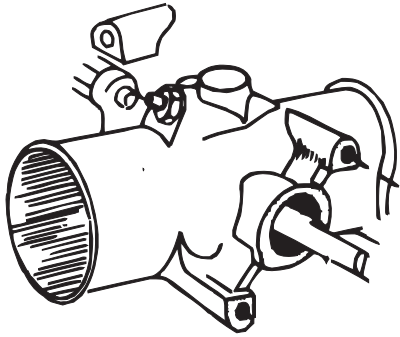


# Double Relay and Electronic Control Unit



# Mechanical Components

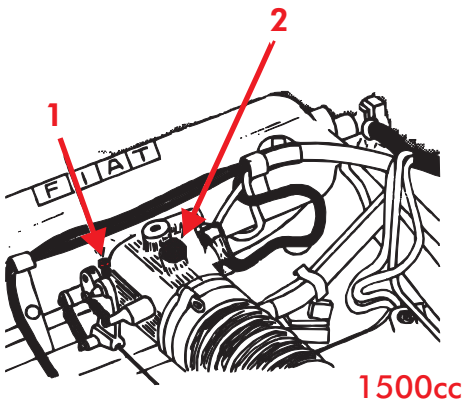
The system is not fully electronic; the systems that actually draw air into the plenum are mechanical. Activated by foot pressure on the gas pedal or by air bypass valves, these components allow the car to idle and accelerate.



## Throttle Plate

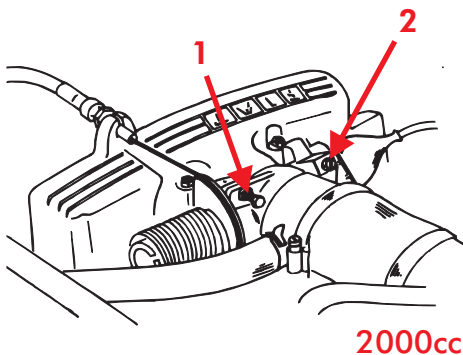
The throttle plate regulates the amount of air allowed into the intake manifold from the air flow sensor. The input signal is from the driver's foot as the throttle plate is directly connected to the accelerator pedal. Movement of this plate is tracked by the throttle position sensor and reported to the ECU.

Failure of the throttle plate is unlikely but it can stick. Cleaning the air intake assembly with a good spray cleaner will alleviate the problem.



## Accelerator Linkage Stop Screw (1) Idle Speed Adjustment Screw (2)

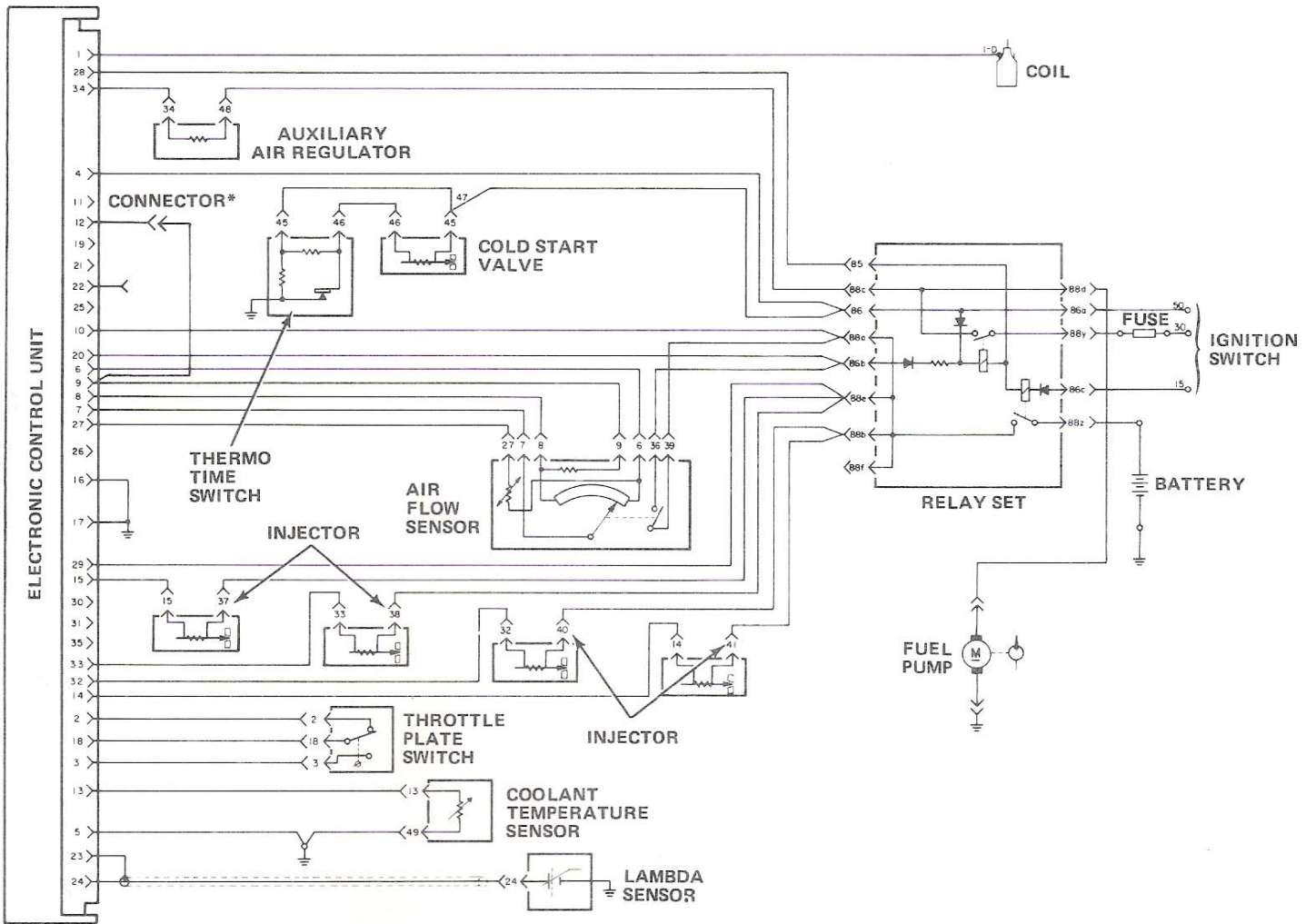
The accelerator linkage stop screw sets the "at rest" position of the throttle plate. It should be adjusted so that, with the idle speed adjustment screw fully turned in, the engine idles at 700 to 750 RPM.



The idle speed adjustment screw allows air to bypass the throttle plate, increasing engine speed. It is normally set so that the engine can idle at 850 to 900 RPM.

More details on this adjustment are provided in another section. Failure of either device is very rare; missing the idle speed adjustment screw causes the engine to idle at a non-adjustable, high RPM.

# Electrical Diagram

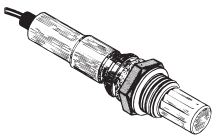


# Lambda

One goal of the fuel injection system is to achieve 14.7 pounds of air for every pound of fuel. This ratio of 14.7:1 is known as the "stoichiometric air ratio" and is abbreviated with the Greek letter lambda. Your fuel injection system constantly adjusts the amount of fuel sprayed by each injector to reach the stoichiometric air ratio - a.k.a. "lambda 1.0" or just "lambda". It is at lambda that the engine achieves a combination of performance and low emissions.

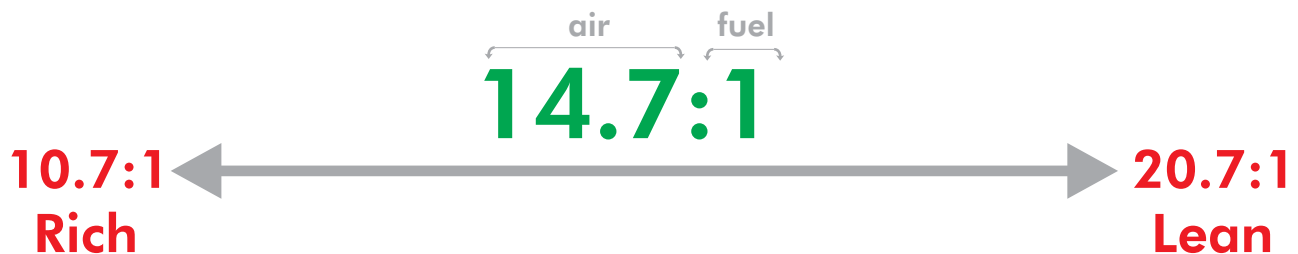
When your engine has an air/fuel ratio less than lambda the engine is running rich. This increases the level of carbon monoxide emissions (CO), fouls spark plugs, and leaves carbon deposits on your valves. On the other extreme, an air/fuel ratio greater than lambda indicates a lean running engine. Lean running can result in misfires, knocking, high levels of unburned hydrocarbons (HC) in the exhaust, and (in extreme cases) melting of engine parts.

Oxygen sensors are often called Lambda sensors for the very reasons stated above. The oxygen sensor in your FIAT does one thing - detects the amount of unburned oxygen in the fuel. Unburned oxygen is the best indication of a rich or lean mixture. The oxygen sensor sends an electrical current (in Volts) back to the computer. Lambda is approximately 465 mV. Lower voltages equate to a lean mixture (high oxygen) and higher voltages equate to a rich mixture (lack of oxygen). The oxygen sensor is also inefficient when cold, it begins to operate efficiently at about 600 degrees fahrenheit, and is positioned at the very hot collection point of the exhaust manifold.



An interesting activity is to connect a voltmeter to the oxygen sensor lead and watch the ratios change. The changes are constant - under hard acceleration and wide-open operation the sensor will read very high; under nominal operation it will cycle between 100mV and 1000mV as the computer constantly strives for an average around 465 mV (lambda).

Obviously lambda is very difficult to achieve with a bad oxygen sensor. FIATs have a sensor replacement reminder (a mechanical box under the dashboard) that many owners have disconnected. The box is very easy to reset (easier than disconnecting) and useful - oxygen sensors last 30,000 miles at best.



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# The Fuel Injection Tune Up

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Those of you who read my guide on carburetion, intake, and exhaust are familiar with my approach to getting the most out of your engine. The first step is understanding how it all works (which I hope the previous sections of this guide explained). The second step is to get everything working exactly as it was designed to. The third step is to tweak it - or not - and achieve what consider optimal performance.

Most FIAT owners I've spoken with are looking for optimal performance in their car. Regardless of how performance is defined, many owners share perception that their Spider (or Brava, X1/9, or whatever) is performing under its capability and - this is the important part- that the car never really had great performance to begin with. Let's take the latter statement first - it is flat out wrong. Anyone who has driven a new or properly tuned FIAT knows that the fuel injected engines performed quite well. The former statement - the one about the vehicle's capability - is a relative term. For example, a tired engine won't perform very well regardless of how well it is tuned.

To further confuse you I'll leave you with a final thought before delving into how to get your engine tuned up. That is: you have no idea if your engine is under performing if your engine is not set up properly. If you've decided that you like 15 degrees advance at TDC then you're not set up properly. If you've decided to disconnect the oxygen sensor because "that's emissions control equipment" (I love that, by the way, because it's so wrong) then your not set up properly. If your vacuum advance diaphragm is simply a gateway for air entering the intake manifold, you're not set up properly. Getting the picture here?

The goal of this section is to get your fuel injection system and engine set to the proper specifications so that you can judge what is really wrong and what to start tweaking. I may as well say it now - be prepared to spend some amount of money on sensors, fuel injectors, air and fuel hose, a gasket or two, distributor parts, and spark plugs. Hopefully no one ever told you that working on cars was free or cheap!

Checklist for your tune up:

1. Change the oil with the correct grade for your climate zone. This usually results in 15W40, 20W50, or 10W40. Check your owner's manual.
2. Flush the cooling system and refill it properly.
3. Replace the air cleaner filter (the maintenance interval is 30,000 miles but FIAT recommends 15,000 miles).
4. Install new spark plugs and gap them appropriately. Get the correct plug for your engine (don't get fancy here and don't waste money on platinum plugs until after the car is set up). Install new spark plug wires if necessary. Brittle or cheap wires can arc, causing the fuel injection system to have all kinds of bad electrical interference and loads of bad spark.
5. Install a new distributor cap, rotor, pickup, and vacuum advance diaphragm if necessary. The first three are standard tune-up parts; the advance diaphragm is important because your car just won't accelerate correctly if it is bad. To diagnose it, start the engine and look down at the diaphragm's rod. Have someone tap the gas - the rod should move (advancing the distributor). If it does not, replace it.
6. How old is your oxygen sensor? Don't know? Replace it.
7. Set the engine timing to the exact spot appropriate for your model year. On most FIATs this is 10 degrees BTDC.

# The Fuel Injection Tune Up

## 1. Check the valve lash and adjust as necessary.

Out of spec valve lash can make an engine run rough and noisy. Check the valve lash, adjust it, and replace the cam cover gaskets if necessary. On the fuel injected Spider you may have to remove the intake plenum lid to get the intake side cam cover off the car. If you do, replace the plenum gasket as well and clean out the plenum with carburetor cleaner.

Note: a plenum full of fuel varnish is getting fuel sprayed back into it. In other words, something is or was wrong with the operation of the engine. Engines suck air from the plenum, not into it.

## 2. Start the car and warm the engine.

In order to properly tune the system you must operate the engine at 190 degrees. In FIAT terms this means start the car and let it run through two fan cycles. If your engine does not run then you might want to work through the troubleshooting section of this guide before you try and tune the engine.

## 3. Once the engine is warm, note how it sounds and operates.

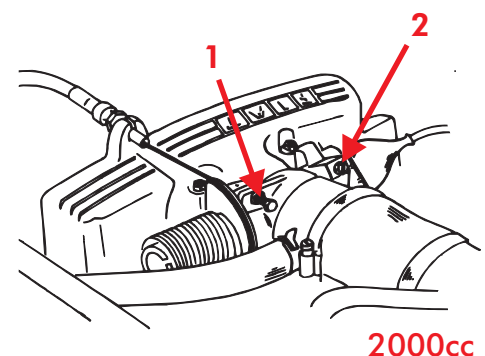
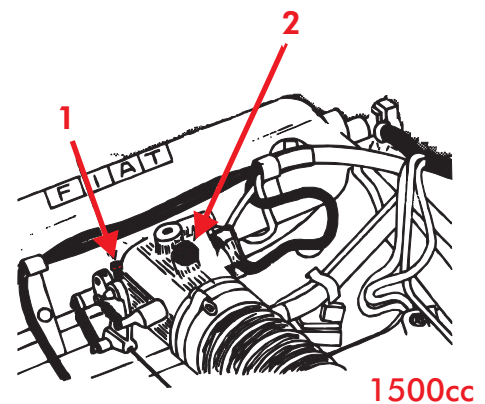
This isn't lambda zen or something like that. Make notes on the idle RPM, engine misfires, the smell of gas, the sound of leaking air, clacking of valves, etc. This is your opportunity to identify what you may need to address as you work through these procedures.

## 4. Set the idle speed according to the factory procedure.

The procedure is:

- A. Run the engine to normal operating temperature (step 2 above).
- B. On cars with automatic transmissions, set the parking brake, block the wheels, and put the transmission in "D".
- C. Completely seat the idle speed screw (2).
- D. Loosen the accelerator linkage stop screw retaining nut and adjust the stop screw (1) to achieve 800 to 900 RPM on manual transmissions and 700 to 800 RPM on automatic transmissions.
- E. Lock the accelerator stop screw with the retaining nut.
- F. Use the idle speed screw (1) to set idle at 850 to 900 RPM on manual transmissions and 700 to 800 RPM on automatic transmissions.

Note: if idle speed cannot be reached using this procedure, fully remove the idle speed screw (2) and clean the orifice and the screw itself using a high pressure spray cleaner (carburetor cleaner is fine).



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# The Fuel Injection Tune Up

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## 5. Throttle Position Sensor Adjustment

The throttle position sensor tells the ECU to turn off the injectors during deceleration. It also tells the ECU when the throttle is fully open, allowing the full flow of the injectors.

- A. Unplug the throttle plate switch. Note the connector blades (on the plate switch, not the connector itself) are marked 3 18 and 2 .
- B. Connect an ohmmeter between terminals 2 and 18 of the switch.
- C. Loosen the two screws holding the switch in place.
- D. Rotate the switch clockwise until the ohmmeter indicates a closed circuit.
- E. Tighten the two screws.
- F. Reconnect the switch.

## 6. Test the vehicle and determine what to do next.

A. Run the engine and drive the car. Note irregularities (puffs, misses, smells, etc.). Stop the engine and pull the spark plugs.

B. Considerations for moving forward:

- Missing and puffing: Check all of the air hoses for tightness and leaks. Any suspect hoses should be replaced. Air leaks are a primary cause of poor performance in fuel injected systems.

- Fuel smell: check the hoses leading from the fuel rail into the injectors and to and from the fuel tank and cold start injector. Hoses are 7.5mm - NOT 8mm - and can be purchased at Alfa Romeo, BMW, VW, and Porsche dealers. Also replace both seals!

- Black plugs? Check the ignition timing and ignition components and be sure the throttle plate is opening fully. Other causes are leaky injectors, a bad cold start valve, a bad air flow sensor, or a bad coolant temperature sensor resistance. Refer to the next section.

- White plugs? How white? L-jetronic systems typically run slightly lean and plugs have a whitish-brown color. An air leak is the most common cause or the failure of one of the FI sensors. Air leaks can occur in the injector seals as well - if you are unsure of the age it may be worthwhile to replace the seals. Refer to the next section and check the sensors for proper operation.

## Tuned up?

If your vehicle is performing well and your spark plugs are whitish-brown then you are probably well tuned. The fuel injection system results in smooth acceleration and deceleration without puffs or pops. In the next section we'll look at how to test your sensors to make sure they are all working well.

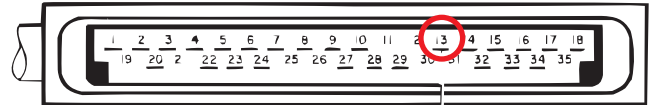


# Sensor Testing

## Coolant Temperature Sensor Resistance

The coolant sensor is tested on the ECU connector. Unplug the ECU and connect an ohmmeter between terminals 13 and ground (vehicle body). The meter should read:

7,000 to 12,000 OHMS	at	14 degrees F
2,000 to 3,000 OHMS	at	68 degrees F
250 to 400 OHMS	at	176 degrees F



If the reading is 0 or less replace the sensor. If the reading is infinity check the wires leading to the sensor for a break. If the wires are good, replace the sensor.

## Thermo Time Switch

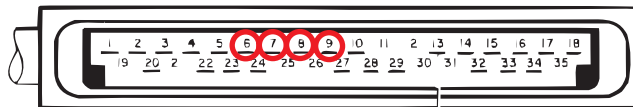
The engine must be completely cold to conduct this test. It is easier to perform this test when the ambient air temperature is less than 80 degrees. Disconnect connector from cold start valve. Install a test light or voltmeter to the connector. Operate the starter and note that the thermo time switch should be on for 1 to 8 seconds while the engine is colder than 95 degrees F. Above 95 degrees the sensor will not trip.

## Cold Start Valve

The engine must be completely cold to conduct this test. It is easier to perform this test when the ambient air temperature is less than 80 degrees. Unbolt the cold start valve from the intake plenum and place the tip in a container. Operate the starter. The valve should spray for 1-8 seconds or while the engine coolant is under 95 degrees F. The valve should have a fine misting spray, not a drip. If the valve fails to shut off or never sprays replace the valve.

## Air Flow Sensor

The air flow sensor flap should move freely and return quickly to the closed position. The sensor must be clean. The air flow sensor is tested on the ECU connector. Unplug the ECU connector and connect an ohmmeter between terminal 6 and terminal 8. Resistance should be no more than 600 OHMS. Connect an ohmmeter between terminals 7 and 8. Resistance should be no more than 1200 OHMS. Connect an ohmmeter between terminals 8 and 9. Resistance should be no more than 350 OHMS.



## Oxygen Sensor

Connect a voltmeter to the oxygen sensor and ground. The changes are constant - under hard acceleration and wide-open operation the sensor will read very high; under nominal operation it will cycle between 100mV and 1000mV.

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# ***Regulator, Injector, and Pump Testing***

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## **Auxiliary Air Regulator**

The auxiliary air regulator voltage can be tested by connecting a test light or volt meter to the connector poles. Voltage will be apparent when the engine is running. If voltage is not apparent replace the double relay.

The air regulator may be suspect if the vehicle is idling poorly and all idle-related tests have been completed successfully. The regulator hose can be pinched off for testing. When off the regulator will not allow air to pass through it.

## **Fuel Pump and Pressure Regulator**

The fuel pump should never be noisy. Voltage at the pump terminals should be approximately 12V; terminals are prone to getting dirty and cleaning them may improve connectivity. Terminals should have rubber boots over them; if not, consider covering connections with electrical tape or silicone.

Fuel pump operation can be tested by opening the fuel system in the engine compartment. You should consult a factory shop manual for this procedure. Fuel feed pressure is 36 +/- 3 psi with the fuel pressure regulator disconnected. Pressure is 28 psi with the regulator connected.

## **Injector Fuel Delivery**

Injectors can be tested by removing the injector and placing the nozzle in a glass container. Operate the engine and check that the fuel spray is a mist. There should be no drips. Injectors pulse during normal operation (see the injector voltage test).

## **Injector Voltage**

You can test the injector voltage pulse with a voltmeter or test light. Disconnect an injector plug and connect to each plug in the connector. Operate the starter (the car may or may not start) and note that voltage should pulse - making the light flicker weakly or the voltage to fluctuate. If there is no fluctuation then the ECU may be bad.

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# Performance Considerations

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The L-Jetronic system is not highly customizable. As a rule, modifications to the combustion characteristics of the engine (such as radical camshaft modifications) create difficulties with the system. However, some modifications do improve performance.

## Air Flow Meter Modifications

There is little that can be done to the air flow meter to improve performance. The meter has a flap that is tensioned by a spring. The spring tension is set by a geared wheel held in place by a metal rod. By manipulating the geared wheel and tightening the tension one can fool the ECU into a slightly richer condition. If you are considering this modification keep these things in mind: 1) A minor change is all that is required. Radical shifts in the spring tension result in over-rich conditions. 2) Mark the original position of the spring before moving the wheel. 3) This will void the AFM warranty.

## Compression Increases

My favorite fuel injected Spider had all standard engine components except for the pistons. I installed a set of 8.9:1 CR Kolbenschmidt pistons and was impressed at two things. First, there was no effect on the fuel injection system's operation. The car still ran smooth, passed emissions, and had good fuel economy. Second, the performance was dramatically improved. Acceleration was wonderful and response was much better than the stock 8.1:1 pistons.

My second favorite fuel injected Spider had the 8.1:1 pistons but an 1800cc cylinder head with stock valves. The head was surfaced slightly (enough to get some minor dings off the mating surface). Like the piston swap mentioned above the acceleration was much better. The 1800cc head is not as efficient at speed; therefore the overall experience at speed was the same as a stock car.

## Light Components

By lightening engine components - namely the cam shaft pulleys, flywheel and clutch, and connecting rods - the engine can wind up faster and respond to changes quickly. This offers a great performance boost across all areas of engine components and does not affect the fuel injection system.

## Camshaft Changes

I have had limited success implementing cams more radical than 40/80 in a fuel injected engine. Frankly the mild performance change from stock to 40/80 wasn't worth the cost of the cams. The 40/80 did not affect the fuel injection system except that fuel economy dropped slightly.

## Ignition Timing

I do not profess that 10 degrees BTDC is the right timing for your engine. In fact I doubt that the timing indicator on your 20+ year old car is actually at 10 degrees BTDC and is probably off by a few degrees. I like to set an engine timing by ear. I find that the correct tuning is the point where the engine runs fastest without any puffs during operation. On one of my cars this resulted in 13 degrees BTDC, in another it resulted in 8 degrees BTDC. Different engines, different heads, different timing.

## Marelliplex and Mechanical Advance Distributors

The engine with the Kolbenschmidts (mentioned above) also had a Marelliplex, a rather rare mechanical advance replacement for the electronic distributor. I noted no difference in quality of operation.