



September 2026

Technicians Service Training

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Editor

"G" Jerry Truglia

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"Real World Fuel Systems Diagnosis"

In order to understand fuel injection, we are going to work our way up from the old mechanical systems to the ones on the road today.

Bosch CIS Fuel Injection (Pre-1996 Audis, BMWs, Mercedes, Volvo, and VWs)

In these systems, fuel delivery is done through a mixture control unit that consists of a fuel distributor, airflow sensor and fuel lines.

As the airflow sensor plate moves, the motion is transferred to the control plunger in the fuel distributor. When the throttle is depressed, the plate raises and fuel demand increases. This action lifts the plunger to deliver a higher volume of fuel to the engine that tries to match the air intake. Oxygen sensor voltage is then sent to the PCM and is used to control fuel delivery via a frequency valve on the electronic mechanical version only when the system is in closed loop.

To increase fuel delivery, fuel pressure is reduced in the lower part of the differential pressure valve. This allows for greater fuel flow to the injectors, allowing for a rich mixture. When pressure is increased the fuel delivery will be shortened, allowing for a leaner mixture.

(Con't on page 4)

What is TST?

TST is a group of dedicated technicians and instructors committed to the continuing education of our fellow technicians. We provide training seminars to technicians at a reasonable price. TST brings our members nationally known instructors and state of the art training.

Our Goal & Mission Statement

- *Keep our fellow technicians up to date with the latest technology.*
- *Provide training seminars for a reasonable price.*
- *Deliver information that the technician can use now.*
- *Keep technicians informed of information affecting our industry.*
- *Increase consumer awareness of what a good technician is.*

Why join TST?

TST membership includes special pricing on weekday night seminars and the occasional full Saturday seminar. With a \$99.00 yearly individual or shop \$299.00 membership, the simulcast are only \$20.00. **TST seminars are NOT sales or product seminars.** The instructors that TST brings in are all “hands-on” industry experts with up to date, cutting edge knowledge that you can use in your shop the next day. That’s 99 dollars for a seminar in which you are able to learn something useful, for fixing those tough jobs that we all see on a regular basis. Our instructors are masters at making the complex understandable. Membership also includes a newsletter full of real world technical articles, diagnostic case studies, and solutions to the kinds of problems you see in your bays each week.

The following are some of TST’s regular instructors:

Bernie Thompson of ATS

John Thornton of Autotrain Inc.

Wayne Colonna of ATSG

Jorge Menchu the “Labscope Guru,” AES Wave

John Anello of Auto Tech On Wheels

Mark Warren of World Pac / Motor Magazine

Brandon Steckler of CTI & Motor Age Magazine

Peter Meier of Motor Age Magazine

Ken Zanders of Illinois Air Team

"G" Jerry Truglia of A.T.T.S. Inc.

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"Real World Fuel Systems Diagnosis" (con't from p. 1)

This fuel system utilized poppet valve injectors, similar to the injectors that were used on many GM Vortex engines.



TBI Fuel Injection (PRE-1996 GM, CHRYSLER, FORD, Some ASIAN)

The throttle body assembly usually contains one or two injectors, a TPS (throttle position sensor), IAC (idle air control) motor, pressure regulator and a throttle plate. The throttle body injection system was introduced in order to provide a better fuel delivery system and replace the expensive electronic carburetor.

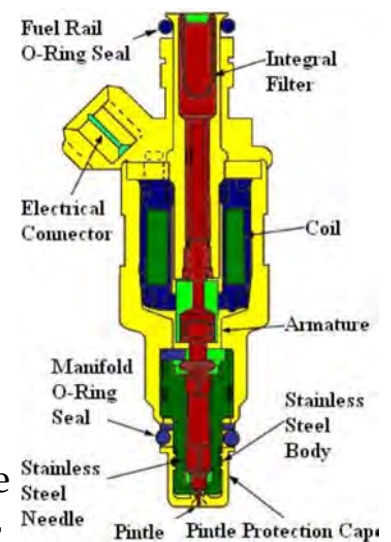


EFI Fuel Injection (Most 1996 and Newer Vehicles That You Are Most Likely Working On)

EFI systems utilize one injector per cylinder. Other names for EFI are Ported and or Sequential.

Different Fuel Injectors

EFI Three different types of EFI injectors that perform the same task. The different designs were for different motor application made by different companies.

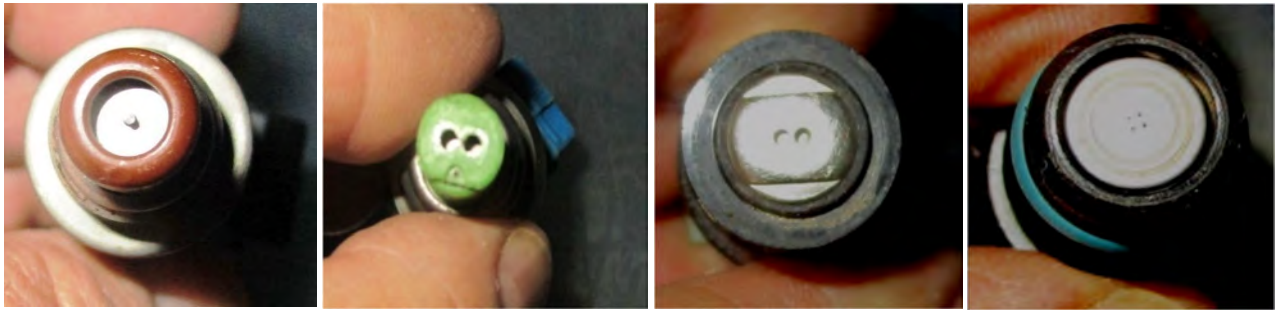


(Con't on page 5)

"Real World Fuel Systems Diagnosis" (con't from p. 4)

Different Fuel Injectors

There are different tips designs from a one pintel spray tip to a ball type (not pictured) 2 and 4 spray tips. The reason for these different tips is to atomize the fuel better. Some injectors also spray to one side, right or left.



In EFI systems that use a MAP sensor the computer is designed to calculate the amount of air entering the engine from the MAP and rpm input signals.

On a MAF system the calculation of air entering the engine is done as air flow through the MAF.

Fuel injectors receive a signal from the PCM based on information that was sent from sensors such as the HO2S, AF/WR, MAP, MAF, TPS, and ECT to name a few. The PCM determines the amount of time the injector will stay open, and this is measured in milliseconds (mS).

Remember that there may be other factors that allow extra fuel to be sprayed, such as an injector that does not fully seat in the closed position or from a high pressure from a defective fuel pressure regulator. Shorted injector ground wires are another problem that the computer cannot control that will hold an injector open to the point of hydrostatically locking an engine.

(Con't on page 6)

"Real World Fuel Systems Diagnosis" (con't from p. 5)

Pressure Regulators

The pressure regulator on MFI and SFI systems are similar to the regulator on TBI systems. A diaphragm and valve assembly are positioned in the center of the regulator, and a diaphragm spring seats the valve on the fuel outlet.

When fuel pressure reaches the regulator setting, the diaphragm moves against the spring tension and the valve opens. This action allows fuel to flow through the return line to the fuel tank. The fuel pressure drops slightly when the pressure regulator valve opens, and the spring closes the regulator valve. Under this condition, the fuel pressure increases and reopens the regulator valve.

A vacuum hose is connected from the intake manifold to the vacuum inlet on the pressure regulator.

This hose supplies vacuum to the area in which the diaphragm



spring is located. This vacuum works with the fuel pressure to move the diaphragm and open the valve. When the engine is running at idle speed, high manifold vacuum is supplied to the pressure regulator. Under this condition, fuel pressure opens the regulator valve. If the engine is operating at wide-open throttle, a very low manifold vacuum is supplied to the pressure regulator. When this condition is present, the vacuum does not help to open the regulator valve, and a higher fuel pressure is required to open the valve.

When the engine is idling, higher manifold vacuum is supplied to the injector tips, and the injectors are discharging fuel into this vacuum.

Under wide-open throttle conditions, the very low

(Con't on page 10)

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manifold vacuum is supplied to the injector tips. When this condition is present, the injectors are actually discharging fuel into a higher pressure compared to idle speed conditions, because the very low manifold vacuum is closer to a positive pressure. If the fuel pressure remained constant at idle and wide-open throttle conditions, the injectors would discharge less fuel into the higher pressure in the intake manifold at wide-open throttle. The increase in fuel pressure supplied by the pressure regulator at wide-open throttle maintains the same pressure drop across the injectors at idle speed and wide-open throttle. When this same pressure drop is maintained, the change in pressure at the injector tips does not affect the amount of fuel discharged by the injectors.

Pressure Transducer Regulators

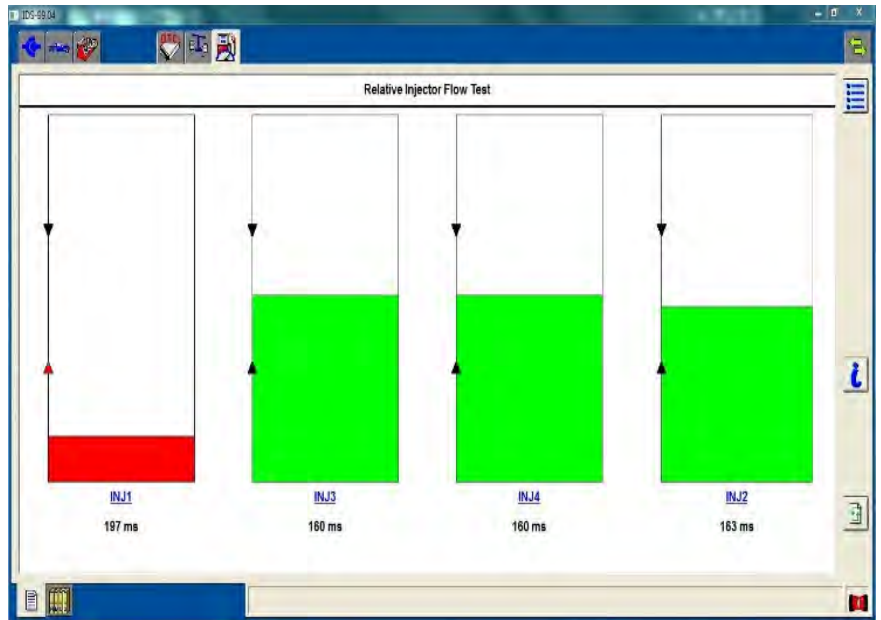
Many companies such as Ford motor company utilize an electronic fuel pressure regulator. The regulator works the same way as a conventional fuel pressure regulator with the exception that it can supply information that can be used by scan data to monitor fuel pressure drop per injector per cylinder.



(Con't on page 11)

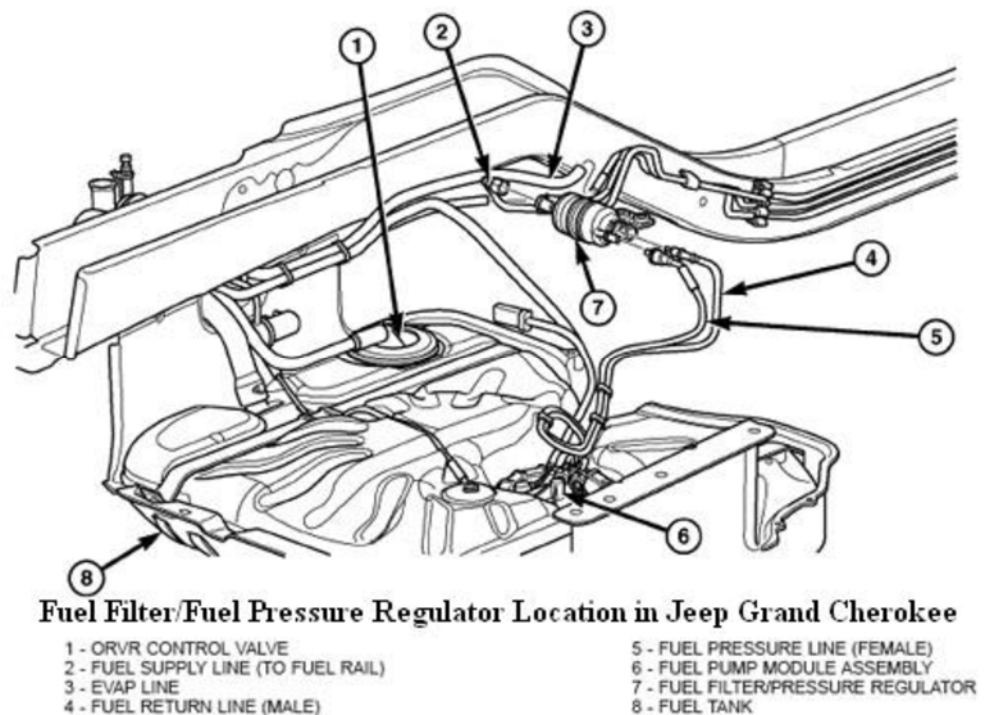
"Real World Fuel Systems Diagnosis" (con't from p. 10)

The scan tool screen capture to the right is from the Ford IDS factory scan tool. In this capture off a GDI engine, one injector in cylinder number one is diagnosed using the electronic pressure transducer via the IDS data. Rather than performing any manual testing, this test can be done with a few clicks on the scan tool.



Returnless Fuel System Pressure Regulators

Many late model vehicles utilize a returnless fuel system. One of the first companies to use the returnless system was Chrysler.



Fuel Filter/Fuel Pressure Regulator Location in Jeep Grand Cherokee

(Con't on page 12)

"Real World Fuel Systems Diagnosis" (con't from p. 11)

Chrysler calls their returnless system SFI. In these systems, the fuel pressure regulator and filter are mounted on the top of the assembly that contains the fuel pump and fuel gauge sending unit. The complete unit is installed in the tank and is sold as a one piece unit. Down the road many manufactures will sell the complete fuel tank and assembly as one. Fuel enters the filter through the fuel supply tube in the center of the regulator and filter assembly. Fuel pressure is applied against the regulator seat washer, which is seated by the seat control spring. At the specified regulator pressure, the seat is forced downward against the spring, and fuel flows past the seat into the cavity around the seat control spring. Fuel returns from this cavity to the fuel tank. When the pressure drops slightly, the seat closes again. With the returnless fuel system, only the fuel needed by the engine is filtered, allowing for longer fuel filter replacement intervals.

In fact, BMW and Toyota Prius bladder style tanks are currently sold this way. What's a bladder tank? Well it's a reinforced rubberized bag that is installed in the fuel tank to control vapor pressures. The tanks are similar to what is used in aircrafts and it is expected that many vehicles in the future will be using them.



*Article by
"G" Jerry Truglia
TST Founder- President - ASE Master Technician*

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