

Subject: Fuel pressure testing and fuel injection operating checks for all FI engines

Symptom: No start, hard starting, starts and dies

Source: General Motors service and training manuals

IMPORTANT:

In rare cases, hard starting or start-and-die symptoms can be caused by fuel with too high of an octane rating. See last page of this Reference for more information.



Risk of fire.

- **Wear safety goggles and protective clothing, user and bystander.**
- **Relieve fuel system pressure before opening lines and connections.**
- **Keep cigarettes, sparks, open flame, and other sources of ignition away from the vehicle.**
- **Keep a dry chemical (Class B) fire extinguisher rated for gasoline, chemical, and electrical fires in the work area.**

Fire can cause death or serious injury.

This Reference contains fuel pressure specifications and test methods for GM throttle body injection (TBI), port fuel injection (PFI), digital fuel injection (DFI), Central Multi-port fuel injection (CMFI), and Central Sequential fuel injection (CSFI) systems. It also provides other guidelines for checking:

- Fuel pump priming operation
- Pressure regulators, oil pressure switches, and relays
- Cold-start valves
- Injector pulse

The fuel system on some pickup and sport utility vehicles is a returnless on-demand type of system (Figure G083-1 on page G173). On these systems, the fuel pressure regulator is part of the fuel sender assembly, which eliminates the need of a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank because hot fuel returning from the engine is eliminated. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

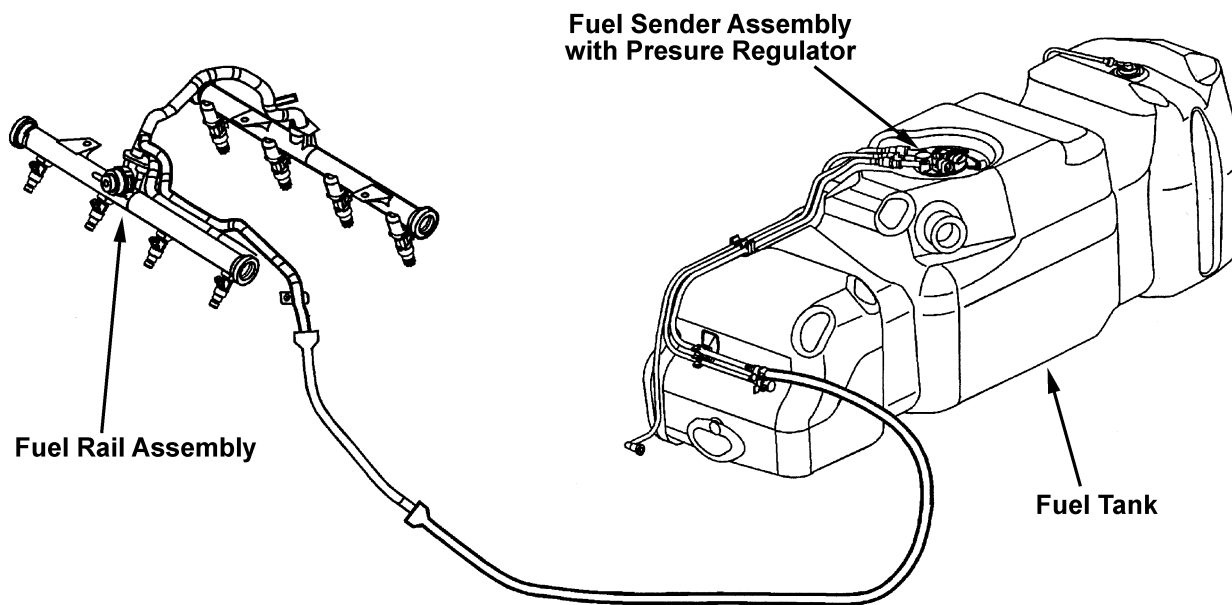


Figure G083-1 Typical returnless fuel system

Fuel System Type and Pressure Specifications

General Motors TBI systems are all low-pressure systems and generally are more trouble free than PFI systems. PFI, CMFI, and CSFI systems are all considered high-pressure systems. PFI, CMFI, and CSFI systems have all had problems with clogged injectors. See Reference G020 for more information. Specifications for TBI are listed in Table G083-1, specifications for PFI, CMFI, and CSFI are listed in Table G083-2 on page G174.

Table G083-1 TBI Fuel Pressure Specifications

Engine (Liters)	8th VIN	Year	Fuel Pressure (psi)	
			Key On engine Off*	At Idle
1.0	6	2000–02	23 to 31	13 to 20
1.3	2	2000–01	38.5 to 44	28.5 to 35
1.9	9	1991–94	26 to 31	26 to 31
2.5	R	1990–92	26 to 32	26 to 32
7.4	N	1994–97		
All Others	All Others	All	9 to 13	9 to 13

* Measure with the key on and engine off, or bypass the ignition and operate the pump through the fuel pump test connector.

Table G083-2 PFI Fuel Pressure Specifications (part 1 of 4)

Engine (Liters)	8th VIN	Year	Fuel Pressure (psi)	
			Key On engine Off	At Idle
1.6	6	2004–06	55 to 62	55 to 62
		2000–01	36 to 43	30 to 37
		1996–97	38 to 44	28 to 41
		1994–95	38 to 44	31 to 37
	Isuzu	1989–93	35 to 45	30 to 40
	T	2004	50 to 60	50 to 60
1.8	8	1998–2006	44 to 50	44 to 50
		1994–95	38 to 44	31 to 37
	J	1984–86	30 to 40	24 to 27
	L	2004–05	44 to 50	44 to 50
1.9	7	1991–98	38 to 44	31 to 36
2.0	P	2005	50 to 60	50 to 60
	C	2000–04	36 to 43	30 to 37
	H	1993–94	41 to 47	31 to 44
	M	1987–89	35 to 38	25 to 30
2.2	D	2003	50 to 60	50 to 60
	H	2003	55 to 62	55 to 62
	5	2000–02	55 to 62	45 to 90
	4	2001–02	53 to 59	43 to 56
		1992–99	41 to 47	31 to 44
	F	2002–06	50 to 60	50 to 60
2.4	T w/o EGR	1998–2001	52 to 58	42 to 55
	T w/EGR	1996–99	41 to 47	31 to 44
	T	2002	53 to 59	43 to 56
2.5	1	2001–03	39 to 45	30 to 37
2.6	M	2003	49 to 55	55 to 60
2.8	T	2005	55 to 60	55 to 60
	8	2004–05	50 to 70	50 to 70
	S, W, 9	1985–89	40.5 to 47	30.5 to 44
3.0	B	2003	53 to 59	53 to 59
	R	2002–03	39 to 49	39 to 49
		1997–2001	40 to 46	35 to 41
	L	1988	40 to 47	31 to 42
		1987	34 to 43	29 to 34
		1985–86	37 to 43	31 to 40
3.1	J	2000–05	52 to 59	42 to 56
	M	1996–99	41 to 47	31 to 44
	T flex-fuel	1992	48 to 55	38 to 52
	T, V, M	1988–95	40.5 to 47	30.5 to 44

Table G083-2 PFI Fuel Pressure Specifications (part 2 of 4)

Engine (Liters)	8th VIN	Year	Fuel Pressure (psi)	
			Key On engine Off	At Idle
3.2	N	2003–04	49 to 55	55 to 60
3.3	N	1990–93	40 to 47	31 to 44
		1989	40 to 44	32 to 46
3.4	E	2000–05	52 to 59	42 to 56
		1996–99	41 to 47	31 to 44
	X	1997	40.5 to 47	30.5 to 44
		1996	48 to 55	38 to 52
		1991–95	40.5 to 47	30.5 to 44
	S	1993–95	40.5 to 47	30.5 to 44
3.5	L	2005	50 to 60	50 to 60
	6	2004–05	50 to 75	50 to 75
	8	2004–06	50 to 60	50 to 60
	H	1999–2002	41 to 47	31 to 44
3.6	7	2004–06	55 to 60	55 to 60
3.8	2	2005	56 to 62	56 to 62
	4		56 to 62	56 to 62
	1	2005	53 to 59	43 to 56
		2003–04	48 to 54	38 to 51
		2002	53 to 59	43 to 56
		2001	48 to 54	38 to 51
		K (RWD)	2002	48 to 54
	K (FWD)	2001–05	53 to 59	43 to 56
	1, K	1995–2000	48 to 55	38 to 52
	1	1992–95	40 to 47	31 to 49
	C, L	1988–95	40 to 47	35 to 43
	3	1988	34 to 40	25 to 35
	3, 7	1987	34 to 43	29 to 34
4.0	C	1999–2003	41 to 47	31 to 44
		1996–98	48 to 55	38 to 52
		1995	41 to 47	31 to 44
4.2	S	2002–03	48 to 54	48 to 54
	S	2004–06	50 to 57	50 to 57

Table G083-2 PFI Fuel Pressure Specifications (part 3 of 4)

Engine (Liters)	8th VIN	Year	Fuel Pressure (psi)	
			Key On engine Off	At Idle
4.3 V6	F	2005	50 to 60	50 to 60
	X	2002–06	55 to 62	45 to 59
		1996–2001	60 to 66	55 to 64
	W	2003	55 to 62	45 to 59
		2002	60 to 66	60 to 66
		1996–2001	60 to 66	55 to 64
		1995	54 to 61	53 to 56
1992–94		54 to 60	53 to 56	
4.3 V8	W	1993–96	54 to 65	44 to 60
4.5	5	1990–93	40 to 50	32 to 38
4.6	A	2004–06	55 to 60	55 to 60
	9, Y	2000–05	41 to 47	31 to 44
		1996–99	48 to 55	38 to 52
		1993–95	41 to 47	31 to 44
4.8	V	2005–60	55 to 62	55 to 62
		2003–04	55 to 62	45 to 59
		1999–2002	55 to 62	45 to 52
4.9	B	1991–95	40 to 50	32 to 38
5.0	M	2002	60 to 66	50 to 63
		1996–2001	60 to 66	55 to 64
	F	1985–93	40.5 to 47	30.5 to 44
5.3	B	2005	55 to 62	55 to 62
	C			
	M			
	T			
	Z flex-fuel			
	P	2003–05	55 to 62	55 to 62
	Z flex-fuel	2002–04	48 to 54	38 to 51
	T	2002–06	55 to 62	45 to 59
1999–2001		55 to 62	45 to 52	
5.7	G	2001–03	55 to 62	55 to 62
		1997–2000	55 to 61	55 to 61
	R	2001–02	60 to 66	50 to 63
		1996–2000	60 to 66	55 to 64
	S	2001–05	55 to 62	55 to 62
	5, P	1992–97	41 to 47	31 to 44
	J	1990–95	48 to 55	38 to 52
	8	1986–92	40.5 to 47	30.5 to 44
1985		34 to 39	24 to 36	

Table G083-2 PFI Fuel Pressure Specifications (part 4 of 4)

Engine (Liters)	8th VIN	Year	Fuel Pressure (psi)	
			Key On engine Off	At Idle
6.0	H	2005	55 to 62	55 to 62
	N	2005–06		
	U			
	U	1999–2004	55 to 62	45 to 52
	N	2003–04	55 to 62	45 to 56
2002		55 to 62	45 to 59	
7.4	J	1996–2000	55 to 62	NA
8.1	G	2005–06	56 to 62	56 to 62
		2001–03	55 to 62	45 to 59

Testing System Pressure

Refer to Figure G083-2 and Figure G083-3 for system pressure test locations.



To check system pressure:

1. Remove the fuel pump fuse and start the engine. Let it run until it stalls to remove fuel in the lines and relieve pressure.
2. Crank the engine for about 3 seconds to relieve all pressure; then turn the ignition off and reinstall the fuel pump fuse.
3. Connect a fuel pressure gauge (Snap-on® MT3370A, or equivalent) with a suitable fuel pressure test adapter as follows:

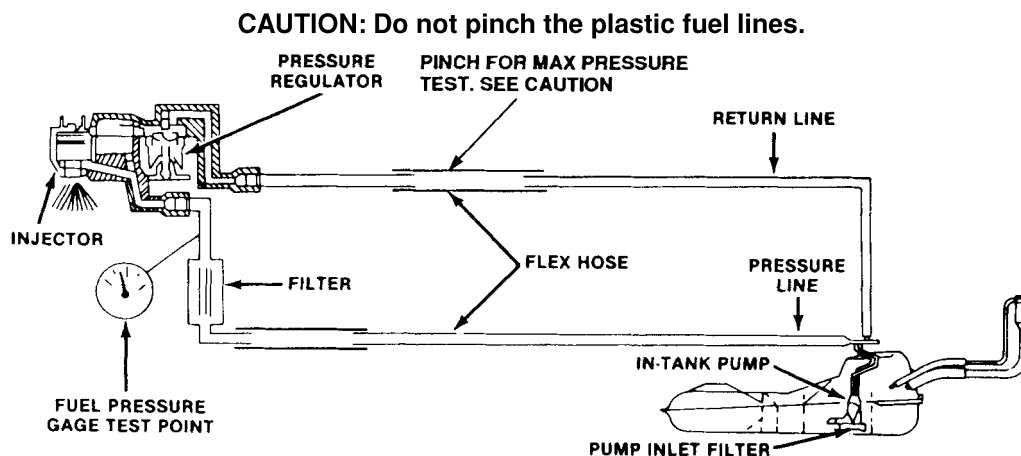


Figure G083-2 Typical TBI system

CAUTION: Do not pinch the plastic fuel lines.

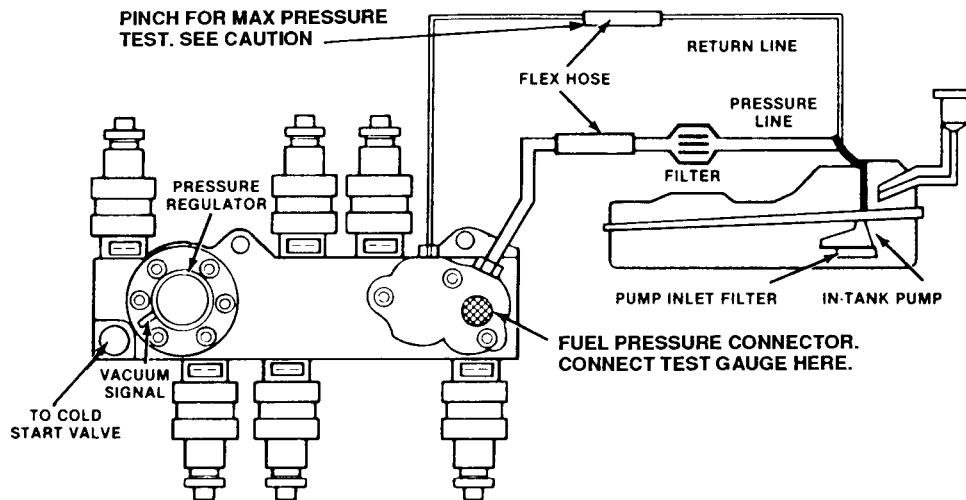


Figure G083-3 Typical PFI system

- a. **For TBI systems**—Connect the gauge between the fuel filter and the inlet to the throttle body (Figure G083-2). On some engines it is easiest to remove the filter and tee the gauge into the line in its place. If you do this, however, a pressure test does not pinpoint a clogged filter. You must test the filter separately.
- b. **For PFI and Cadillac throttle body DFI systems**—Connect the gauge to the test port (Schraeder valve) on the fuel rail or throttle body.
- c. **For CMFI and CSFI systems**—Connect the gauge to the Schraeder valve test port on the fuel pressure line at the rear of the intake manifold.



NOTE:

Some vehicles, such as the 1990–93 Geo Storm and 1991–93 models with a 2.3L engine, may not have Schraeder valve test ports. Install an adapter with a test port (Figure G083-4) to test. The 1991–93 2.3L engine uses “quick release” fuel line connectors. A special tool set (Snap-on® F1H9055 or equivalent) is needed.

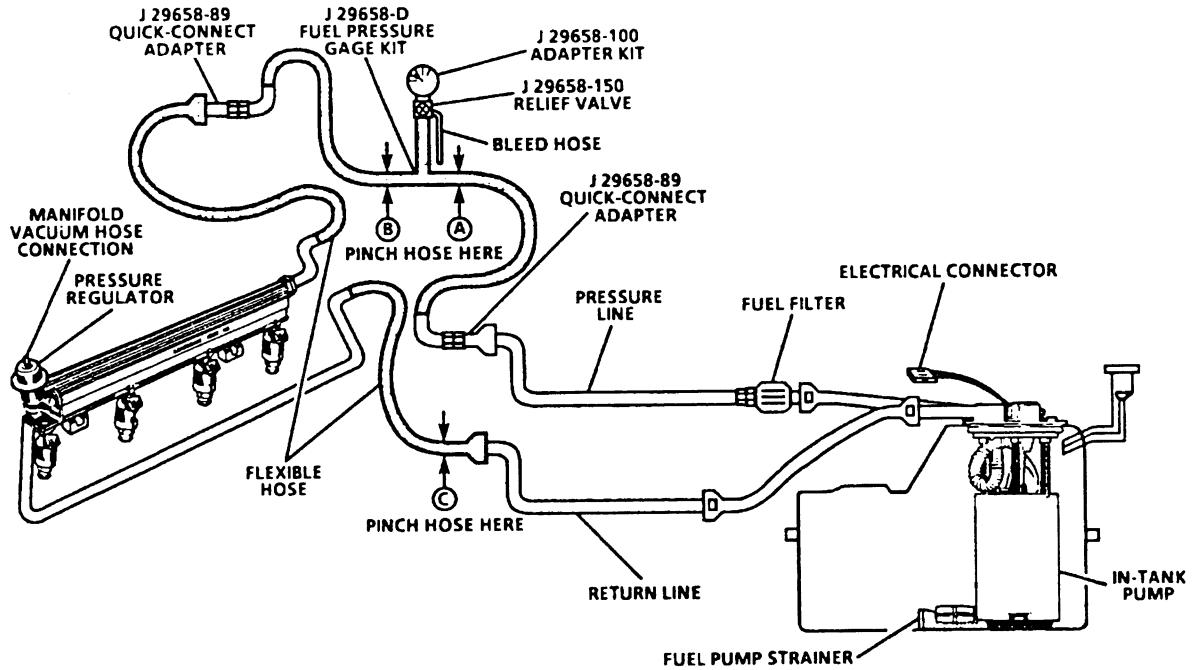


Figure G083-4 Typical gauge installation on vehicles without Schraeder valve

4. Check pressure as follows:
 - a. Turn the ignition on to pressurize the system, you may have to cycle the ignition two or three times to get full system pressure. Vehicles with a fuel pump test terminal provide an alternative. Locate the fuel pump test connector in the engine compartment, or the 12-pin ALDL connector. Apply battery voltage to terminal G (Figure G083-5) for about 5 or 6 seconds to pressurize the system. Compare results to specifications.
 - b. Start the engine and let it idle. Read the gauge and compare results to specifications. Fuel pressure is generally 5 to 10 psi below key-on, engine-off pressure.
 - c. If pressure does not meet specifications in the tests above, measure the fuel pump current to pinpoint the faulty fuel system component using the following procedure.

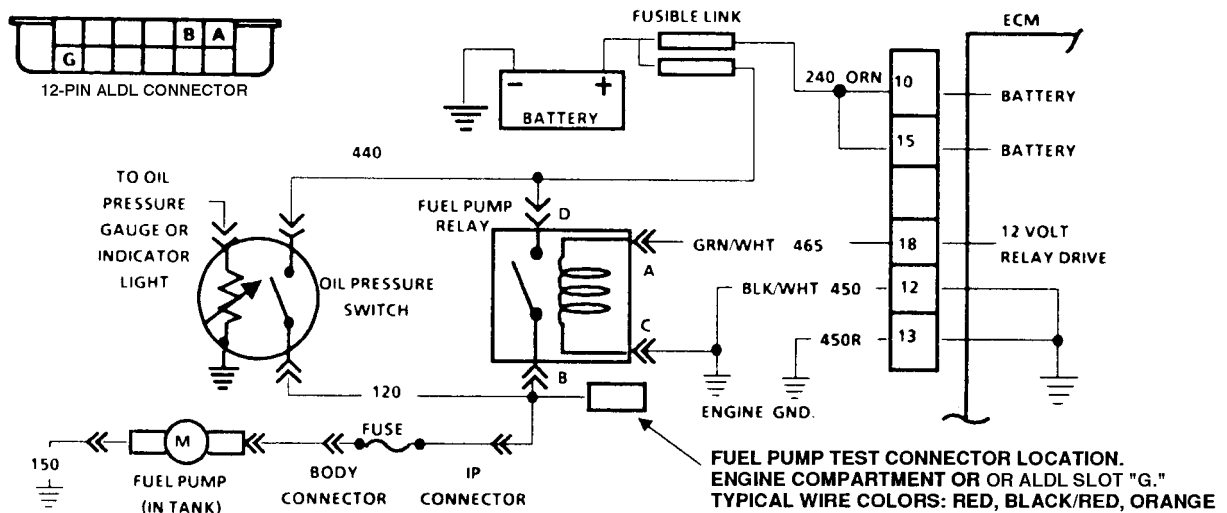


Figure G083-5 Typical fuel pump circuit

Fuel System Diagnosis Using Fuel Pump Current

Knowing whether a running fuel pump is drawing too much or too little current helps you identify a faulty fuel system component.

To measure pump current, use an ammeter, digital multimeter with an inductive probe, or a starting-charging analyzer with an inductive probe and Amp Amplifier (Snap-on® THX 187).

IMPORTANT:

High current through faulty fuel pump circuits may damage a digital multimeter. Do not use a tool whose current-rating is less than the expected current.

If using an ammeter or the Amp Amplifier, remove the fuel pump fuse and connect the leads across the fuse terminals on most vehicles. Some vehicles have an underhood fuel pump test connector (Figure G083-5). On these, measure fuel pump current by connecting the ammeter or Amp Amplifier in series between the test connector and the positive battery terminal. Attach the inductive probe over the Amp Amplifier. If only using an inductive probe, attach its end around the positive feed wire to the fuel pump.

With the test leads or probe connected, start and run the engine if possible. If troubleshooting an intermittent problem, allow the engine to run long enough to give the fault an opportunity to present itself. Then record the key-on engine-running fuel pump current. Turn the ignition switch off, then back on without restarting the engine. After the fuel pump stops running, usually about 2 seconds, record the current again. Nominal current is usually 0 to 0.7 amps.

If the problem affecting the vehicle prevents the engine from starting, turn the key on. Record the key-on engine-off current before the fuel pump stops running. Turn the ignition switch off, then back to on without restarting the engine. After the fuel pump stops running, usually about 2 seconds, record the nominal current.

Subtract the nominal current from the key-on engine-off or key-on engine-running current to obtain the fuel pump current draw. Refer to Table G083-1 on page G173 for specifications.

If the fuel pump current is much lower than specification, suspect:

- An empty fuel tank
- An open pump circuit
- A damaged pulsator (dampener)
- A leaking internal connection between the pump and fuel line
- A broken pressure regulator spring
- A faulty fuel pump

If the fuel pump current is much greater than specification, suspect a:

- A plugged fuel filter
- A restricted fuel hose
- A faulty fuel pump

Fuel Pump Priming Operation

When the ignition is turned on, the ECM for GM fuel injection systems energizes the fuel pump for about 2 seconds to prime the system. If the ECM does not get a tach (cranking) signal within the 2 seconds, it de-energizes the pump relay (Figure G083-5). When cycling the ignition switch to pressurize the system for testing, leave the ignition off for 15 seconds before turning it on again; or the ECM does not reenergize the pump relay.

All PFI systems and some TBI systems hold residual pressure when the engine is off. Pressure can leak down, however, during a long engine-off period. Other TBI systems bleed off pressure when the engine is off and do not hold residual pressure. The pump priming function is used to avoid lengthy cranking times for any system. Check the pump priming operation by listening for the pump to run when the ignition is turned on. On some vehicles, a stethoscope may be needed to listen carefully at the fuel filler.

Checking Pressure Regulators

All electronic fuel injection systems have a vacuum-operated, or vacuum-sensitive, fuel pressure regulator. Typical fuel pressure regulator locations are shown in Figure G083-2 on page G177, Figure G083-3 on page G178, Figure G083-4 on page G179, Figure G083-6 on page G181, Figure G083-7 on page G182, and Figure G083-8 on page G182.

A PFI regulator has a vacuum hose attached to the top of the diaphragm housing, a TBI regulator does not. A TBI regulator senses vacuum, or air pressure, in the throttle body where the injector is located. Typically, TBI regulators have fewer problems than PFI regulators.



NOTE:

Any fuel in the fuel pressure regulator vacuum line is a sign of a defective PFI regulator.

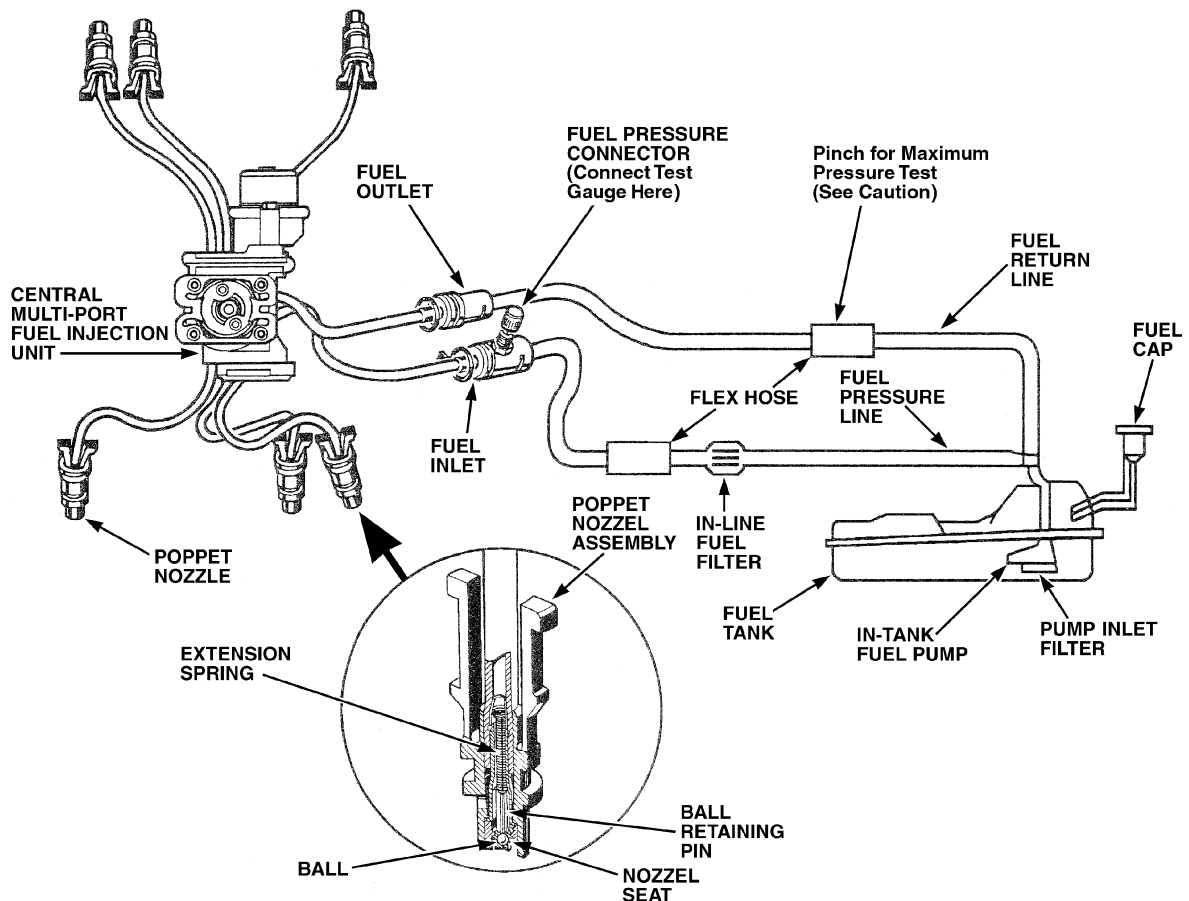


Figure G083-6 Typical CMFI system

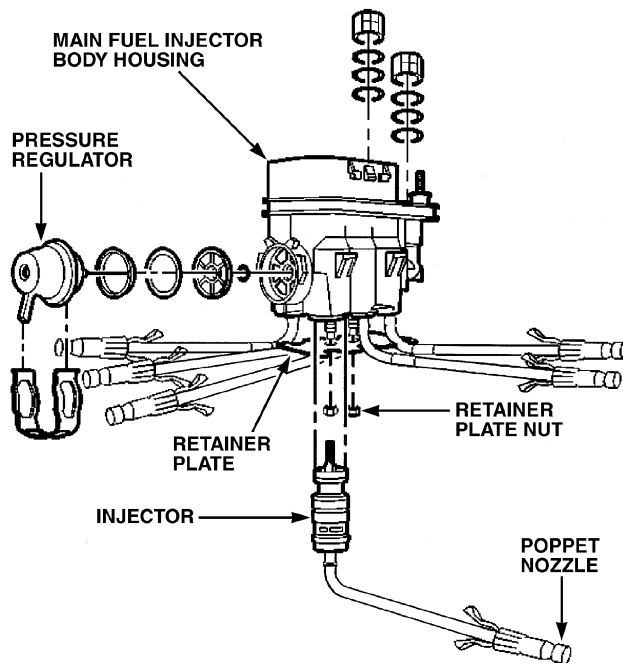


Figure G083-7 Typical CSFI system

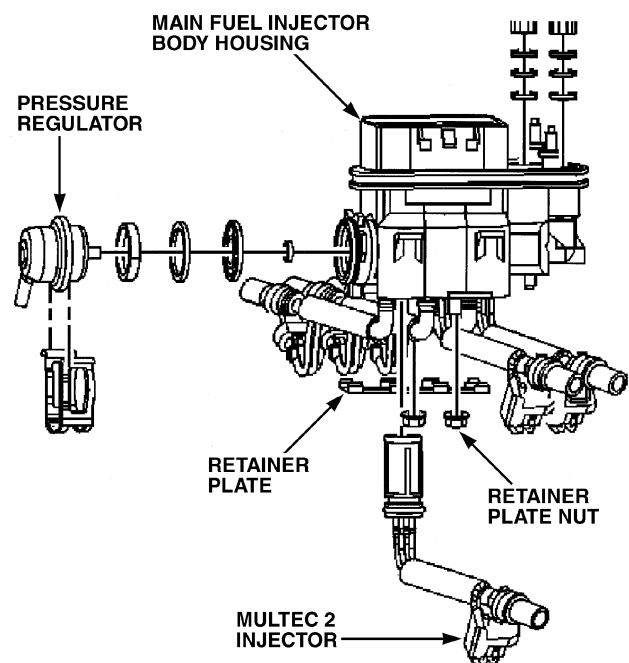


Figure G083-8 2002 and later 4.3L VIN X MFI system

Oil Pressure Switch

Most GM fuel injection systems have an oil pressure switch in parallel with the fuel pump relay (Figure G083-5 on page G179). The oil pressure switch provides an alternate power source for the pump if the relay opens when the engine is running. If this switch sticks closed, however, the pump runs continuously, even with the ignition off, and quickly discharges the battery.

Fuel Pump Relay (Long Cranking Time)

The ECM energizes the fuel pump relay for the 2-second priming function when the ignition is turned on (Figure G083-9). If the relay is defective, the engine may crank for several seconds until the oil pressure switch closes and energizes the pump. On early vehicles, a bad relay causes long cranking times; but the ECM does not have a fuel pump relay trouble code to set. On some later vehicles, the ECM sets fuel pump relay trouble codes.

Remember that long cranking times may also be caused by loss of residual pressure, particularly in PFI systems, due to a regulator or the integral fuel pump check valve problem.

Cold-Start Valve

Some PFI systems have a cold-start valve that provides extra fuel when cranking a cold engine, when coolant temperature is below 95°F (35°C). The valve operates only when the engine is cranking, and it operates independently from the ECM. Current is supplied through a thermotime switch, directly from the starter solenoid (Figure G083-9).

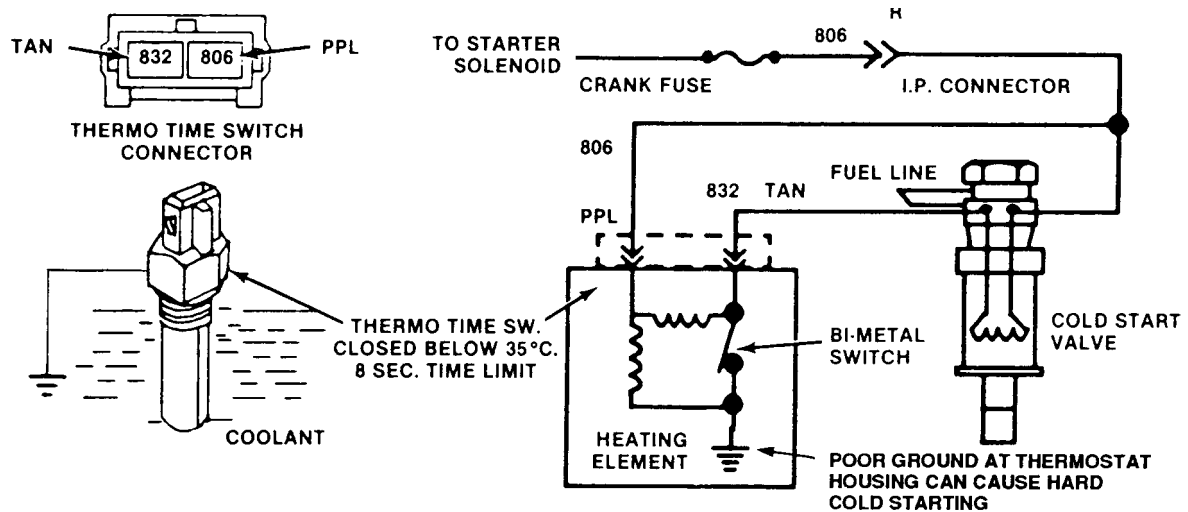


Figure G083-9 Typical fuel cold-start valve circuit

The thermotime switch is a simple bimetal element that provides a ground for the cold-start valve. The switch opens when temperature rises above 95°F (35°C). The switch has a heating element that prevents it from staying closed more than 8 seconds at -5° F (-20°C). As coolant temperature rises, cold-start valve operating time decreases.

A poor thermotime switch ground, installed in the thermostat housing, keeps the switch from closing. This results in very long cranking times and hard starting for a cold engine.

Injector Pulse Test

The easiest way to check for a fuel injector operating pulse is to use a test light, or “noid” light (Figure G083-10). Snap-on® injector harness test kit YA8837 contains most noid light styles to test most popular injection systems. Remove the harness connector from the injector and install the appropriate noid light across the harness terminals. Then crank the engine; the light should blink. If not, check for system voltage at both connector terminals with the ignition on.

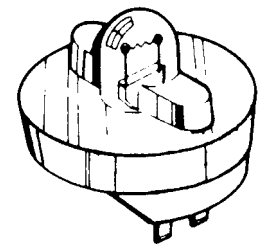


Figure G083-10 Typical noid light

Voltage should be present at one of the terminals. If you find no voltage, the circuit is open. The cause may be a blown fuse or a wiring problem. If there is voltage available at one terminal of the injector connector but the noid light does not flash, the ECM may not be pulsing the injector. Use a test light to check for a reference pulse on the purple-and-white wire, either at the ECM or the ignition module. The test light should flash when the engine is cranking.

Reference Pulse Scratch Test

This test checks for wiring harness problems and for the ability of the ECM to drive the fuel injectors. Connect a noid light to the injector harness terminals and turn the ignition on. Then connect a test light to battery positive (+) voltage and momentarily touch the test light to the purple-and-white reference wire at the ECM or the ignition module (Figure G083-11, Figure G083-12, Figure G083-13, and Figure G083-14). The noid light should flash. If not, a problem may exist in the wiring or the ECM.

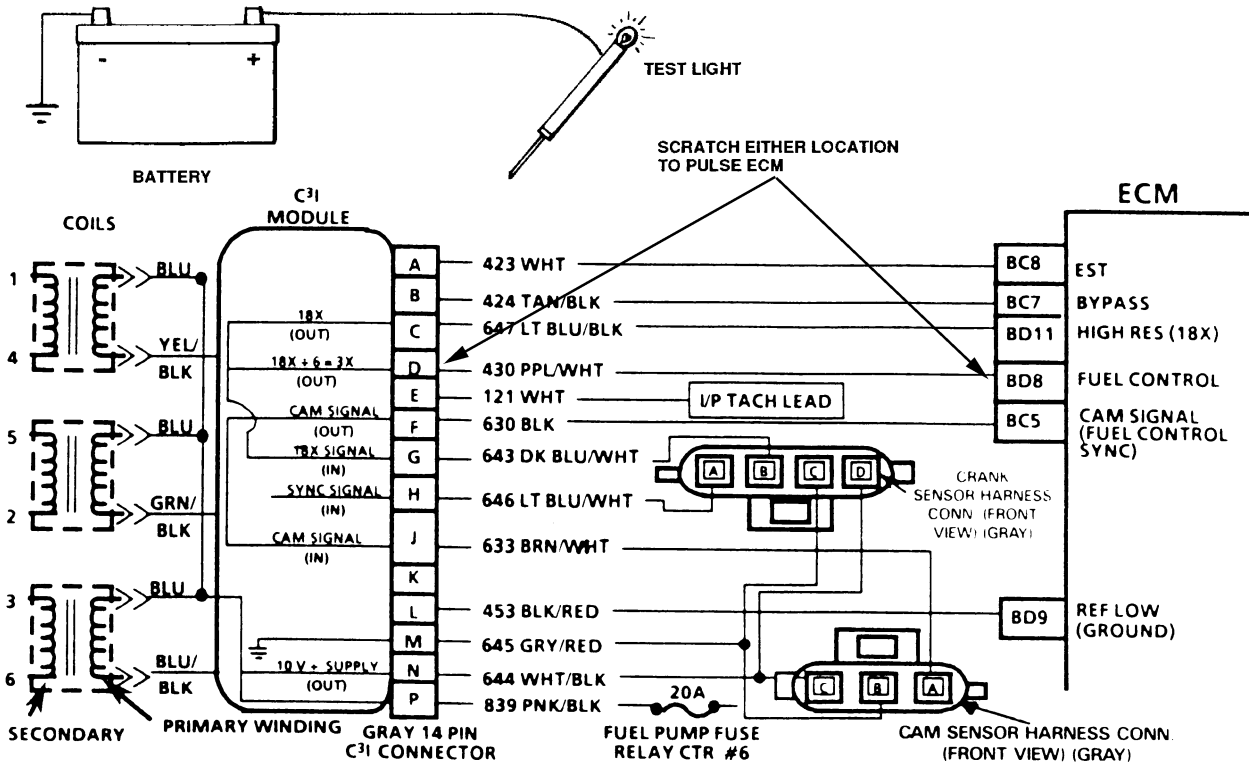


Figure G083-11 Typical 3.8L (3800) "fast-start" ignition and ECM circuits

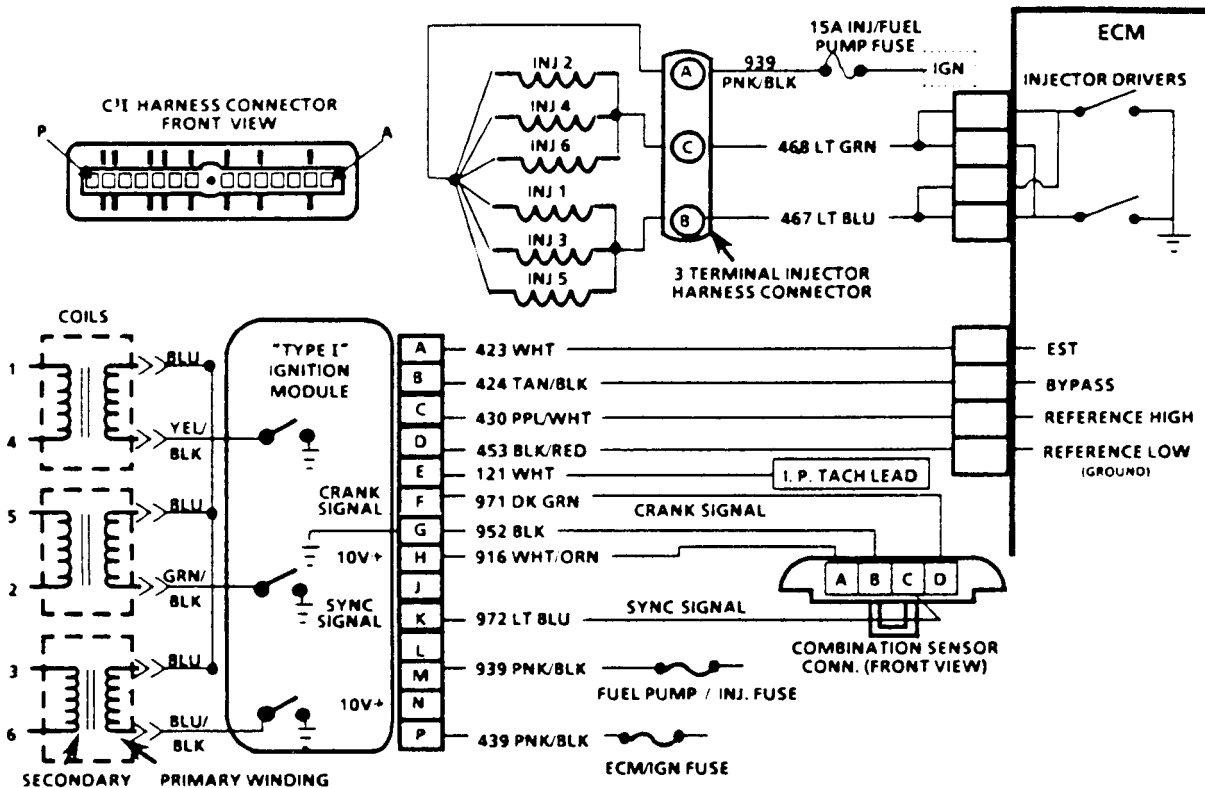


Figure G083-12 Typical non-sequential port fuel injection circuits

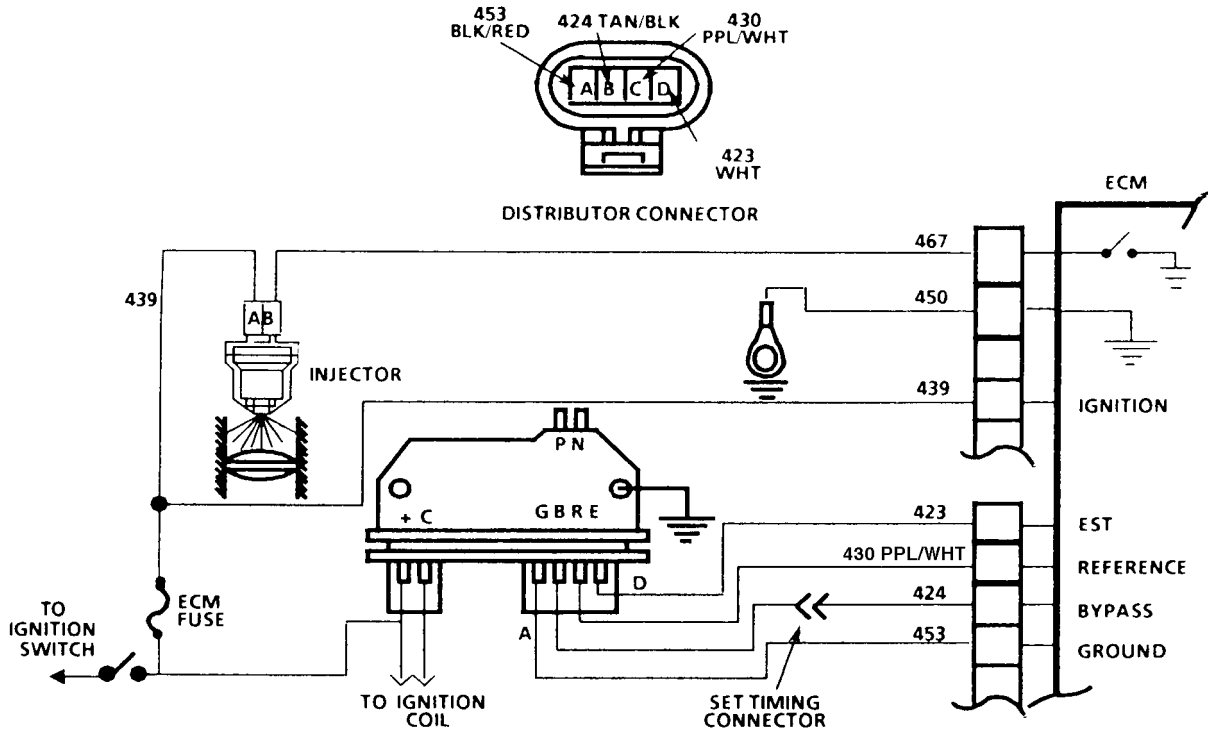


Figure G083-13 Typical throttle body injection circuits

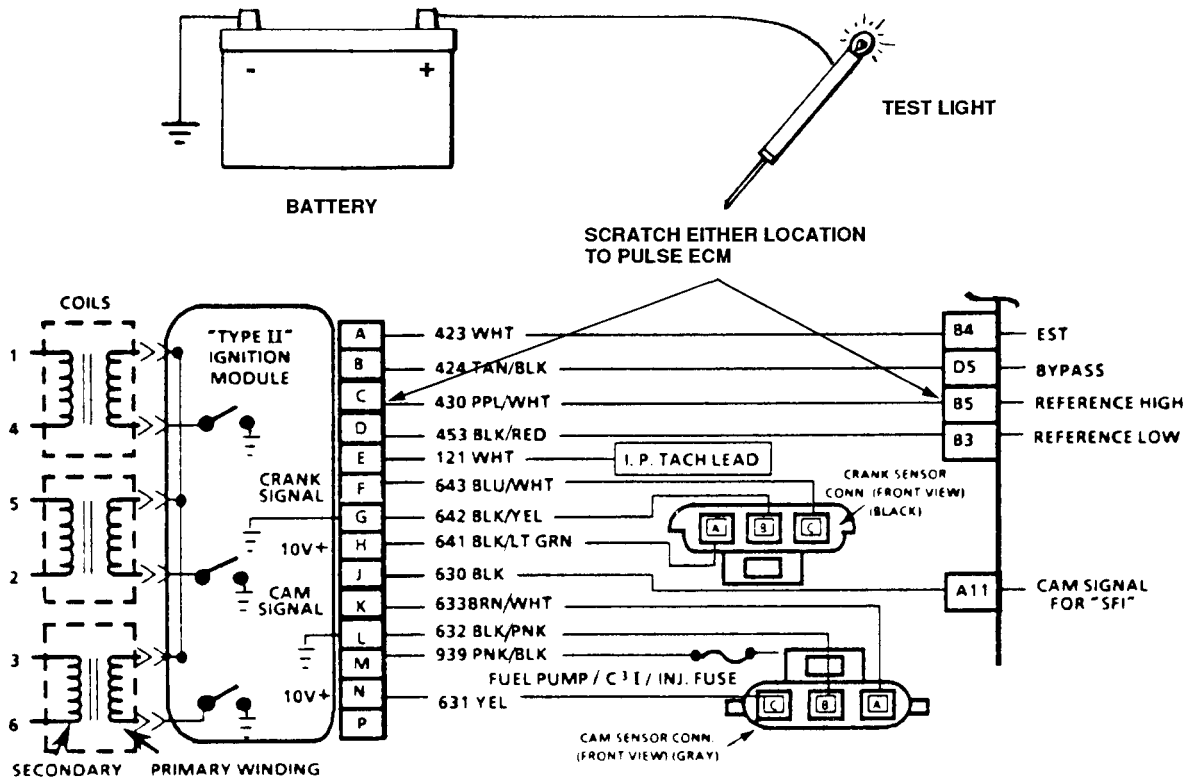


Figure G083-14 Typical sequential port fuel injection circuits

Hard Start and Hesitation From Low-Volatility, High-Octane Gasoline

In May 1992, some oil companies lowered the volatility of gasoline in several areas of the United States to comply with Clean Air Act requirements. Volatility, which is the ability of gasoline to vaporize, is measured in Reid vapor pressure. High Reid vapor pressure equals high volatility that results in easy vaporization. Low Reid vapor pressure equals just the opposite. Several oil companies lowered the Reid vapor pressure from 9.0 to 7.8 for critical smog areas in many parts of the United States.

Low-volatility gasoline—particularly in cool weather—may cause long cranking times, hard starting, hesitation, and generally sluggish performance until the engine thoroughly warms up. These problems may be compounded in some cases by using high-octane fuel with lowered volatility. The octane rating of gasoline indicates the ability of the fuel to resist explosion or uncontrolled ignition. High-octane gasoline supports more stable combustion but resists easy ignition. Although higher-octane fuel with good volatility provides better mileage and performance than lower-octane fuel with equal volatility, the opposite may be true when volatility is lowered.

Several manufacturers advised motorists to avoid using 92-octane gasoline to prevent hard starting, hesitation, and poor performance. Drivers are advised to use 87, 88, or 89-octane fuel as specified in owner's manuals to avoid these problems.

Test equipment is available from several sources to measure the Reid vapor pressure of gasoline. This equipment may help you pinpoint low volatility as the cause of driveability problems like those listed above. Changing to a lower-octane fuel may reduce or correct these problems. lists other driveability symptoms and possible causes related to fuel quality.

Symptom	Possible Cause
Excessive spark knock (detonation)	Possible Fuel Quality Cause
	Octane too low
Hard, cold starting	Low volatility, fuel contamination
Stall after starting, tip-in hesitation	Low volatility, fuel contamination, intake valve deposits*, low fuel level
Poor performance when cold	Low volatility, fuel contamination, low fuel level
Surging, hesitation, sluggishness, lack of power, misfire, or cutout	Fuel contamination
Rough, unstable idle	Fuel contamination, intake valve deposits*
* Intake valve deposits may be due to unburned, heavy-end hydrocarbons or a lack of detergent additives. Changing gasoline brands may reduce the problem.	