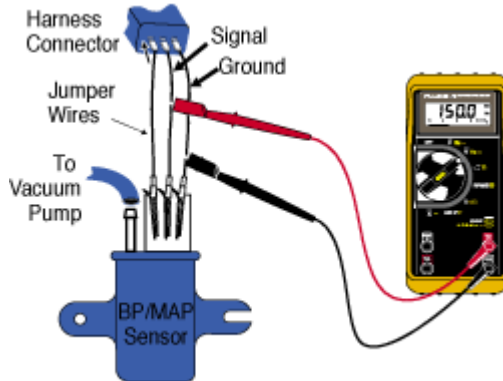


## Ford BP/MAP Sensor

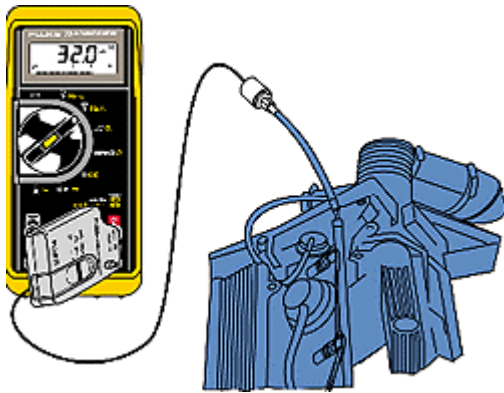
The barometric pressure/manifold absolute pressure (BP/MAP) sensor is critical in determining fuel mixture and spark advance under varying loads. Much like a Throttle Position Sensor, it must provide a smooth, gradual change in output, or driveability problems can occur. In some instances, a BP/MAP sensor can deviate without setting trouble codes. To verify its operation, you need to check its output over its full operating range.



**Fig 8 - Using DC-Coupled Hz to Check BP/MAP Sensors** To test the performance of a BP/MAP sensor, graph its frequency output at various levels of vacuum. Start with the sensor at 0" Hg (0 cm /hg) and read its frequency. Then note the frequency at each increase of 1" Hg (cm Hg). When you plot these frequencies, they should be in a straight line. The frequency will decrease with an increase in vacuum.

## Fuel Pressure

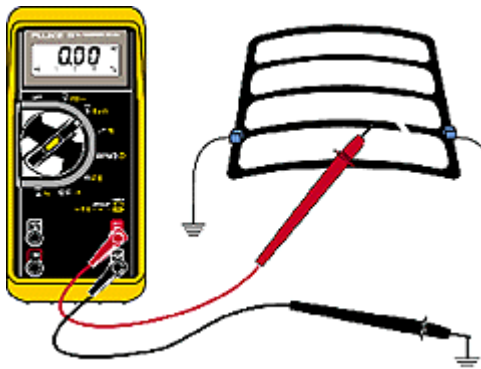
**F**uel pressure is important for both performance and fuel efficiency. Maintaining proper fuel pressure under all operating conditions is the job of the fuel system. The PV350 provides critical fuel pressure readings on a multitude of fuel systems: carbureted, central point, throttle body injection or multipoint injection. Use it with the Fluke 78 to check the operation of fuel pressure regulators, fuel pumps and fuel pump check valves. Fuel pressures fall into two categories: high and low. Central point, or throttle body systems typically use low pressure (10-15 psi, 70-105 kPa). Most multipoint systems use a higher pressure (35-60 psi, 240-415 kPa). Low pressure during hard acceleration can indicate that a fuel filter is starting to clog.



**Fig 10 - Testing Fuel System Pressure** To test fuel pressure, use the schrader hose adapter with the PV500 to tap into the fuel rail. (If the vehicle doesn't have a schrader valve port, ask your local tool supplier for the appropriate adapter). Once you've taken your reading and before disconnecting the fitting, wrap a rag around it to catch any fuel spray. The safest way to do this is to disable the fuel pump and run the engine until it dies. Crank the engine a few seconds longer until all fuel pressure is relieved.

## Rear Window Grid Defogger

**F**luke DMMs allow you to check for opens in the rear window defroster grid. The rear window glass has a series of horizontal grid lines made of a conductive ceramic silver compound that are baked onto the inside surface of the glass. Terminals are soldered to two vertical conductors called bus bars on each side of the glass; one serving as the feed connection (battery voltage) and the other as the chassis ground. Current flows through a relay to the rear grid when both the ignition switch and the rear window grid switch are turned on, usually drawing about 20 amps. (A portion of the grid can be damaged by scratching the inside of the window usually by placing items on the package shelf.) When the circuit of any horizontal grid is interrupted, no current will flow and that particular grid will not heat up. By determining where the open is, you can repair it with a grid repair kit.



**Fig 18 - Testing Rear Window Grid with a DMM**

Run the engine at idle and set the rear window grid switch to "ON". Connect the black lead from your DMM to one of the vertical "bus bars" and the red lead to the other bus bar. With the meter set to measure DC volts, the display should indicate 10 to 14 volts; a lower reading indicates a loose ground wire. With the black lead of the DMM grounded, touch each grid wire at its midpoint with the red lead. A reading of approximately 6 volts identifies a grid with no opens. A reading of 0 volts indicates the current path is broken between the midpoint and the battery side of the grid. A reading of 12 volts indicates that the circuit is open between the midpoint of the grid line and ground.

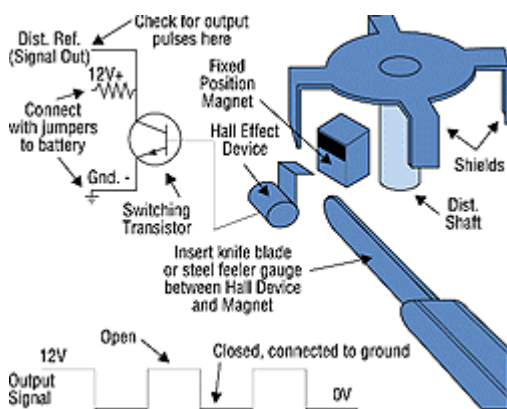
## Bad Grounds

**H**igh resistance among grounds can be among the most frustrating of electrical problems. They can produce bizarre symptoms that don't seem to have anything to do with the cause, once you finally find it. The symptoms include lights that glow dimly, lights that come on when others should, gauges that change when the headlights are turned on, or lights that don't come on at all.

**W**ith the new computer systems, high resistance in ground wires and sensor leads can produce all sorts of unpredictable symptoms. Apply silicone dielectric lubricant, available at radio supply stores, to connections before you assemble them. This will reduce corrosion. Pay particular attention to ground terminals in the vicinity of the battery, where acid speeds corrosion. Often a wire that is corroded through except for a few strands will produce the same symptom as a corroded ground connection. Just looking at the insulated connector does not insure that the connection inside is good. Physically disconnect connectors and use a wire brush or sand paper to "shine" the metal connections.

## Hall-Effect Position Sensors

**H**all-Effect position sensors have replaced ignition points in many distributors and are used to directly detect crank and/or cam position on distributorless ignition systems (DIS), telling the computer when to fire the coils. Hall-Effect sensors produce a voltage proportional to the strength of a magnetic field passing through them, which can come from a permanent magnet or an electric current. Since magnetic field strength is proportional to an electric current, Hall-Effect sensors can measure current. They convert the magnetic field into millivolts that can be read by a DMM.



**Fig 14 - Checking Hall-Effect Sensors** Check for reference voltage from battery at connector. Hall sensors require power where magnetic sensors do not. To test sensor: connect +12V from battery to power terminal, set DMM to measure volts and connect it between signal output and ground. Insert feeler blade between sensor and magnet while watching for the bar graph to move. Signal should vary from 12V to 0V.

## Ignition Coils

Fluke analog/digital multimeters will measure from tenths of an ohm (.01\_ on the Fluke 88) up to 32 million ohms, making ignition tests easy to interpret. Analog meters usually can't measure less than 1 ohm.

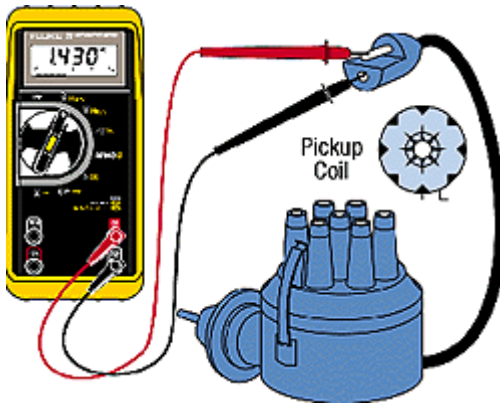


**Fig 12 - Measuring Internal Coil Resistance** *If you suspect a malfunctioning ignition coil, check the resistance of primary and secondary windings. Do this when the coil is hot, and again when it is cold. Also measure from the case to each connector.*

*The primary windings should have a very low resistance, typically from a few tenths of an ohm to a few ohms. The secondary windings have a higher resistance, typically in the 10,000 to 13,000 ohm range. To get the actual figures for a specific coil, check the manufacturer's specs. But as a rule of thumb, primary windings range from a few tenths of an ohm to a few ohms, and secondary winding may be 10 ohms or more.*

## Magnetic Position Sensors

The magnetic type of position sensor is simply a magnet with a coil of wire wrapped around it. The clearance between the pickup and reluctor is critical. Be sure to check it. Specs are usually between 0.030" and 0.070" (0.8 mm to 1.8 mm).



**Fig 15 - Checking For Pulses from Magnetic Distributor Pickup** Disconnect the distributor from the ignition module. Connect the DMM across the pickup and set it to AC volts. When the engine is cranked, pulses should appear on the bar graph. If no pulses appear, it is likely the reluctor wheel or the magnetic pickup is faulty. Use this technique for other magnetic position sensors too. On GM cars, remove the distributor cap for access.

## Example of Ohm's Law

If you measure 0.5V across a ground connection in a starter circuit, and the starter draws 100 amps, calculate the resistance as follows:

$$\text{Ohm's Law } E = I \times R$$

$$0.5V = 100A \times R$$

Solve for R

$$R = \frac{0.5V}{100A}$$

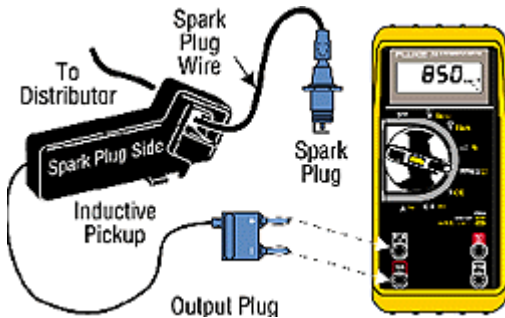
$$R = 0.005 \text{ Ohm}$$

Therefore R = .005 Ohm

**.005** ohm is too much, so clean the connection. .5 Volts tells you the same thing—the connection is dirty or corroded.

# RPM

The RPM80 Inductive Pickup accessory allows the Fluke 78 to measure engine RPM via the secondary ignition impulses in the spark plug wires. It features a selection for DIS or conventional systems.



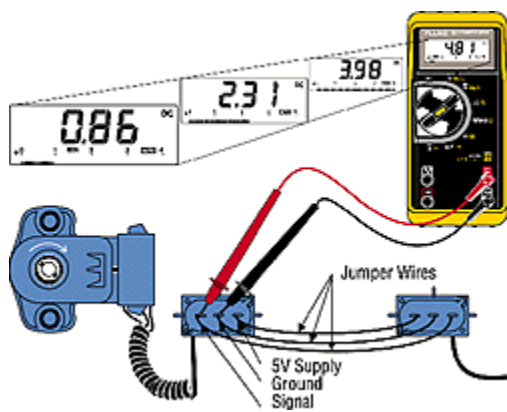
**Fig 16 - Measuring RPM with the RPM80 Inductive Pickup** The RPM80 Inductive Pickup converts the magnetic field created by the current in the spark plug wire to a pulse that triggers an RPM measurement. To measure RPM using the pickup, attach the probe to any accessible sparkplug wire and select the normal (1) or DIS (2) setting to read the correct RPM for the engine you are working on.

## Spark Plug Wires

**P**lug wires should be checked if your scope indicates that there may be a problem or if they're more than a couple of years old. Not all wires indicate the date they were manufactured. Due to the heat of the spark plug insulator, a spark plug boot may bond to the spark plug. Pulling a spark plug boot straight off the spark plug can damage the delicate conductor inside the insulated wire. Rotate the boot to free it before pulling it off. If you suspect bad wires, test the resistance of the wire while gently twisting and bending it. Resistance values should be about 10,000 ohms per foot ( 30,000 ohms per meter), depending on the type of wire being tested; some may be considerably less. You should compare readings to other spark plug wires on the engine to insure the accuracy of the test.

## Throttle Position Sensor (TPS)

**T**hrottle position sensors (TPSs) are a common source of faults in today's on-board computers. A TPS is simply a variable resistor connected to the throttle shaft. Some people think of it as a replacement for an accelerator pump on throttle body or port fuel injected engines. But it is much more. It tells the on-board computer how far the throttle is open, whether it is opening or closing—and how fast. As its resistance changes, so does the voltage signal returning to the computer. The TPS can be tested by watching either the voltage or resistance change, using the analog pointer on any Fluke DMM.



**Fig 11 - Testing a Throttle Position Sensor** Use the Min/Max recording feature of the Fluke 78 to check your base TPS setting at idle; to get the maximum reading, depress the accelerator. By comparing these readings to those you get when you open the throttle by hand, you can verify whether the throttle cable and/or linkage is properly adjusted to allow full throttle opening. If it isn't, this may be the source of a problem with poor acceleration.