DIGITAL AUTOMOTIVE MULTIMETER

Stock Number W2972/W2969

OWNER'S MANUAL

Performance Tool®

WARNING!

READ, UNDERSTAND AND FOLLOW ALL INSTRUCTIONS AND WARNINGS BEFORE OPERATING THIS TOOL. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE AND WILL VOID WARRANTY.

It is the owner and/or operators' responsibility to study all WARNINGS, operating, and maintenance instructions contained on the product label and instruction manual prior to operation of this product. The owner/operator shall retain product instructions for future reference.

The owner and/or operator are responsible for maintenance, maintaining all decals or warning labels and while in use, maintaining the unit in good working order. If the owner and/or operator are not fluent in English, the product warnings and instructions shall be read and discussed with the operators' native language by the purchaser/owner or his designee. Make sure that the operator comprehends its contents. Safety information shall be emphasized and understood prior to usage. The product shall be inspected per the operating instructions.

Users of this product must fully understand these instructions. Each person operating this product must also be of sound mind and body and must not be under the influence of any substance that might impair their vision, dexterity or judgment.

Protect yourself and others by observing all safety information.

Failure to comply with instructions could result in personal injury and/or property damage!
If you encounter any problems or difficulties, please contact our customer service department at: 1-800-426-1262 between 6:30 a.m. and 4:30 p.m. Pacific time.

PT® Performance Tool

FOR YOUR SAFETY,
please read these instructions carefully and retain them for future use.

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SAFETY INFORMATION

⚠WARNING!

To avoid possible electric shock or personal injury, and to avoid possible damage to the Meter or to the equipment under test, adhere to the following rules:

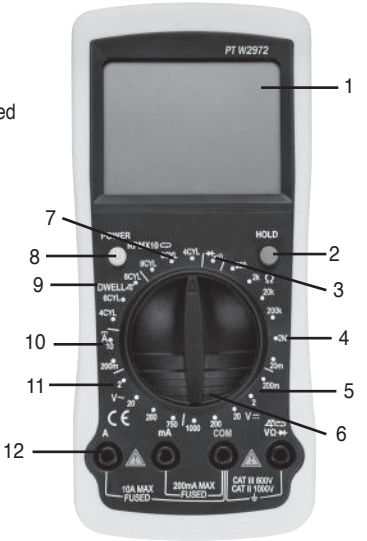
1. Before using the Meter inspect the case. Do not use the Meter if it is damaged or the case (or part of the case) is removed. Look for cracks or missing plastic. Pay attention to the insulation around the connectors.
2. Inspect the test leads for damaged insulation or exposed metal. Check the test leads for continuity.
3. Do not apply more than the rated voltage, as marked on the Meter, between the terminals or between any terminal and grounding.
4. The rotary switch should be placed in the right position and no any changeover of range shall be made during measurement is conducted to prevent damage of the Meter.
5. When the Meter working at an effective voltage over 60V in DC or 30V rms in AC, special care should be taken for there is danger of electric shock.
6. Use the proper terminals, function, and range for your measurements.
7. Do not use or store the Meter in an environment of high temperature, humidity, explosive, inflammable and strong magnetic field. The performance of the Meter may deteriorate after dampened.
8. When using the test leads, keep your fingers behind the finger guards.
9. Replace the battery as soon as the battery indicator appears. With a low battery, the Meter might produce false readings that can lead to electric shock and personal injury.
10. Remove the connection between the testing leads and the circuit being tested, and turn the Meter power off before opening the Meter case.
11. When servicing the Meter, use only the same model number or identical electrical specifications replacement parts.
12. The internal circuit of the Meter shall not be altered at will to avoid damage of the Meter and any accident.
13. Soft cloth and mild detergent should be used to clean the surface of the Meter when servicing. No abrasive and solvent should be used to prevent the surface of the Meter from corrosion, damage and accident.
14. The Meter is suitable for indoor use.
15. Turn the Meter power off when it is not in use and take out the battery when not using for a long time. Constantly check the battery as it may leak when it has been using for some time, replace the battery as soon as leaking appears. A leaking battery will damage the Meter.

ELECTRICAL SYMBOLS

⎓	DC (Direct Current)	⎓~	DC or AC
~	AC (Alternating Current)		Low battery
⚠	Warning. Refer to the manual	⏚	Earth ground
⚠	Dangerous voltage may be present		Fuse
→|	Diode	)))	Continuity test
AUTO	Auto range	⧈	Double insulated

SPECIFICATIONS

Display	: LCD, 1999 Counts updates 2/sec
LCD size	: 46 x 24mm
Polarity Indication	: "-" Displayed automatically
Over-range Indication	: "1" Displayed far left
Low Battery Indication	: " ▭ " Displayed
Range select	: Auto or Manual
Operation Temperature	: 0°C to 40°C, less than 80%RH
Storage Temperature	: -10°C to 50°C, less than 85%RH
Battery Type	: 1.5V x 2, AAA size
Dimension (H×W×D)	: 150×70×22mm
Weight	: Approx. 150g



METER IDENTIFICATION

1. **LCD Display** Large LCD for easy reading
2. **Hold Button** Retains date on the display
3. **Diode/Continuity** Check diodes/circuits audible
4. **Ohms** Measure resistance
5. **DC Volts** Measure DC voltage from 0 to 1000V
6. **Range Selector** Set meter functions
7. **RPM Tachometer** Measure Engine RPM
8. **Power Button** Push for power on and off
9. **Dwell** Measure dwell angle on ignitions/solenoids
10. **DC Amps** Measure direct current from 0 to 10 amps
11. **AC Volts** Measure AC voltage from 0 to 750V
12. **Test Lead Jacks** Test lead locations

BASIC TESTS

Setting Range Position
Select the largest value the multimeter can measure within the test settings.
Example: If you're testing 100V DC turn the Range Selector knob to 200V DC, then the highest voltage the meter can measure is 200V in that range.

Voltage Function AC – DC
Determine the current you're testing AC or DC.
Select the largest value within the range you're testing.

1. **Insert the BLACK** or ground probe to the COM on the meter.
2. **Insert the RED** or positive probe to the on the meter.
3. **Touch RED** probe to the circuit coming from the power supply.
4. **Touch BLACK** probe to ground or the negative (-) circuit.
5. Read the meter display for your results.

Note: If you don't know positive (+) and which side is negative (-), then arbitrarily connect the **RED** test lead to one side and the **BLACK** to the other. The multimeter automatically senses polarity and will display a minus (-) sign when negative polarity is measured.

⚠**WARNING:** When measuring voltage be sure the red test lead is in the terminal marked V. If the test lead is in and Amp (A) or Milliamp (mA) terminal you may be injured or the meter damaged.

DC Current Function
This meter measures DC current from 0 to 10A. If the current exceeds 10A, the internal fuse will blow and will need to be replaced. The capability of isolating current drains and short circuits are some applications for DC Current.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into "10A" test lead jack or "mA" test lead jack.
3. Disconnect the circuit from power where you want to measure current. Possible ways to do this are by

BASIC TESTS CONT.

removing wires from a threaded power terminal. Separate the wiring harness at the plug, or worst case scenario, cut the wires.
4. Disconnect wiring harness.
5. Attach your alligator clips to the probes, black on black, red on red.
6. Connect RED alligator clip to one side of the disconnected circuit.
7. Connect BLACK alligator clip to remaining side of disconnected circuit.
8. Turn multimeters range selector to 10A DC position, or 200mA position.
9. Read the meter display for your results. If the results displayed are negative (-), then reverse **RED** and **BLACK** test leads. See display for corrected results.

Resistance Test
This meter measures resistance from 0.1Ω to 20MΩ. Infinite resistance is shown with the "1" figure on the left side of display. This meter can measure resistance on anything called out in your vehicles service manual. Testing light bulbs, ignition coils/wires, engine sensors, and wires circuits, are just some of the tests the Ohms function can do.

1. Turn circuit power off to get a resistance measurement and avoid possible damage to the meter or electrical circuit getting tested, turn off all electrical power to the circuit.
2. **Insert BLACK** test lead into COM test lead jack.
3. **Insert RED** test lead into test lead jack.
4. **Turn multimeters range selector** to 200Ω range.
5. **Touch RED and BLACK** multimeter leads together and view reading on display. Display should read typically 0.2Ω to 1.5Ω. If display reading was greater than 1.5Ω, check both ends of test leads for bad connections. If bad connections are found, replace test leads.
6. **Connect RED and BLACK** test leads across component where you want to measure resistance. When measuring resistance, polarity is not important. The test leads just have to be connected across the component.
7. **Turn multimeters range selector** to desired OHM range. If the approximate resistance is unknown, start at the largest OHM range and decrease to the appropriate range as required. View reading on display. Note range setting for correct units.

NOTE: 2KΩ = 2,000Ω; 2MΩ = 2,000,000Ω
For precise resistance measurements, subtract the test lead resistance found from the display reading. Do this for resistance measurements less than 10Ω.

Continuity Test
A quick way to check if you have an open or closed circuit. The meter beeps when the circuit is closed or shorted, so you don't need the meters display in view. A common automotive use is checking for blown fuses, proper switch operation, and broken or shorted wires.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn meters range selector** to function.
4. **Touch RED and BLACK** test leads together to test continuity. You should hear a tone to verify.
5. **Connect RED and BLACK** test leads across the circuit where you want to check for continuity. If you hear tone the circuit is closed or shorted. If there is no tone the circuit is open.

Diode Test
Automotive alternators generates AC voltage, the diode inside converts it to DC voltage allowing current to flow in only one direction. When positive voltage > 0.5V, is applied to the anode side of the diode, the diode will turn on and allow current to flow. If this same voltage is applied to the cathode side, the diode would remain off and no current would flow. When testing the diode both sides need to be checked, anode-to-cathode, and cathode-to anode.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn the meters range selector** to function.
4. **Touch RED and BLACK** test leads together to test continuity. The display should show 0.00 and an audible tone should be heard.
5. Disconnect one end of the diode from the circuit. The diode must be totally isolated from circuit in order to verify its function.
6. Add the alligator clips and **connect RED** clip to one side of the diode.
7. **Connect BLACK** clip to the other end of the diode. View results on the display, you should see one of three things. A typical voltage drop of 0.7V, no voltage drop at all, or the meter will display "1" on the far left (overranging). Record the results.
8. Now switch the **RED** and **BLACK** clips and view the results. If the display showed no voltage drop in either directions, then the diode is shorted and needs to be replaced. If the "1" appears in both directions, then the diode is an open circuit and needs to be replaced. If the display reads > 0.5V in one direction and the "1" appears in the other direction then the diode is good and functioning properly.

MECHANICAL TESTS

Engine RPM

When checking engine RPM the meter results must be multiply by 10 to get the final figure. For example, if your meter display reads 65 and is set to 6 cylinder RPM, the actual engine RPM is 10 times 65 or 650 RPM.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Connect RED** test lead to the TACH signal wire from the DIS Ignition Module if the vehicle is equipped with a Distributor less Ignition System. The TACH signal wire going from the DIS module to the vehicle engine computer. Refer to vehicle service manual for the wiring diagram. Vehicles with distributors, connect RED test lead to negative side of primary ignition coil.
4. **Connect BLACK** test lead to a good vehicle ground.
5. **Turn the meters range selector** to the correct cylinder setting, 8CYL, 6CYL, or 4CYL.

Engine RPM is measurement while engine is running.

5. Take the display results and multiply by 10 to get actual engine RPM.

Measuring Dwell

Dwell angle can be measured and set on breaker point ignition systems. Dwell is the length of time, in degrees, the breaker points remained closed. The correct dwell angle is extremely important for proper engine performance. Another application for dwell is in testing the mixture control solenoid on GM feedback carburetors. For dwell angle of your breaker point ignition system connect as follows.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Connect RED** test probe to the negative terminal side of the primary ignition coil. Refer to your vehicles service manual.

For measuring dwell angle on GM mixture control solenoids the meter connections stay the same.

1. **Connect RED** probe lead to ground side or computer driven side of solenoid. Refer to vehicle service manual for solenoid location.
2. **Connect BLACK** test lead to a good vehicle ground.
3. **Turn the meters range selector** to DWELL and the correct cylinder setting, 8CYL, 6CYL, or 4CYL.

View reading on display.

BATTERY/STARTING/CHARGING

No Load Battery Test

Before testing the starting/charging system, first test the battery to make sure it is fully charged.

1. Turn Ignition OFF.
2. Turn ON headlights for approx. 10 seconds to dissipate surface charge.
3. **Insert BLACK** test lead into COM test lead jack.
4. **Insert RED** test lead into test lead jack.
5. Disconnect positive (+) red battery cable. Be sure positive cable clamp is securely away from the battery.
6. **Add the alligator clips and connect RED** clip to the positive (+) terminal of battery.
7. **Connect BLACK** clip to the negative (-) terminal of battery.
8. **Turn multimeter range selector** to 20V DC range. View voltage results on the display.

Voltage Displayed	Percentage of Charge
12.75V or greater	100%
12.45V	75%
12.35V	50% Charge before any further tests.
12.15V or less	25% Charge before any further tests.

Cranking Battery Load Test

This test puts a load on the battery to determine if there's enough voltage delivered to the starter under cranking conditions.

1. Disable ignition system so vehicle won't start. Refer to vehicle service manual for disabling procedure.
2. **Insert BLACK** test lead into COM test lead jack.
3. **Insert RED** test lead into test lead jack.
4. **Add the alligator clips and connect RED** clip to positive (+) terminal/post of the battery.
5. **Connect BLACK** clip to negative (-) terminal/post of the battery.
6. **Turn meter range selector** to 20V DC.
7. Crank engine for 15 seconds continuously while observing display. An assistant may be needed so you're able to watch the display. Battery voltage should be at least 9.6 volts at the end of the 15 second load test with battery temperature at 70 degrees.

Battery Voltage After load Test	Temperature of Battery
9.6V	70 Deg. F and above
9.5V	60 Deg.
9.4V	50 Deg.
9.3V	40 Deg.
9.1V	30 Deg.
8.9V	20 Deg.
8.7V	10 Deg.
8.5V	0 Deg.

Battery Current Draw
Test to determine the amount of current being drawn from the battery with the ignition key off. This test helps to identify possible sources of a short or excessive battery current draw. Excessive draw could lead to shortened battery life, or a dead battery.

1. Ignition OFF including all accessories. Be sure trunk, hood, and dome lights are all OFF.
2. **Insert BLACK** test lead into COM test lead jack.
3. **Insert RED** test lead into the "A" (or mA) test lead jack.
4. Disconnect positive (+) red battery cable.
5. **Add the alligator clips and connect RED** clip to positive (+) battery terminal/post of the battery.
6. **Connect BLACK** test lead to positive (+) red battery cable (that as disconnected).
DO NOT start vehicle during this test, doing so will damage the meter, and void warranty.
7. **Turn meters range selector** to 10A DC (or 200 mA) position.
8. View results on display, typical current draw is 0.1 ampere (100mA). Refer to vehicle service manual for your vehicles specific Engine off Battery Current Draw. Vehicle clocks, ECU's and presets are calculated in the normal 100mA draw.

Finding Excessive Current Draw
Display reading in the steps above are well outside manufacturer's specifications.

1.While watching the meter display remove fuses from the fuse box one at a time until source of excessive current draw is located. When the suspect fuse is pulled there should be a drop in the amps displayed on the meter. For non-fused circuits such as headlights, relays, and solenoids it may involve unplugging the unit from the wiring harness. When the source of excessive current drain is found service as needed.

Charging System Voltage
Check the charging system for output voltage. Charging system provides power to maintain the battery and feed power to the rest of the vehicles electrical systems (lights, fan, radio etc).
1. **Insert BLACK** test lead into COM
2. **Insert RED** test lead into test lead jack.
3. **Add the alligator clips** and connect RED clip to positive (+) terminal/post of battery.
4. **Connect BLACK** clip to negative (-) terminal of battery.
5. **Turn meters range selector** to 20V DC range.
6. Be sure the meter and connecting wire are clear from all moving parts. Start engine and let it idle.
7. With accessories in the off position, no radio, or lights etc. View and record the results from the display.
8. Open throttle, keep engine speed between 1500 and 2500 RPM. Have an assistance help hold speed so you can view and record the results from the display.
9. Fully load the electrical system by turning on the lights, windshield wipers, and the blower fan on high.
10. Turn off all accessories, return engine to idle and shut off. Refer to vehicle service manual for recommended voltage outputs. If voltage readings were as expected, then charging system is normal.

Typical charging system output voltages:
At normal idle, display should read 13.2 to 15.2 volts.

With idle speed increased, voltage reading should not change by more than 0.5 volt.

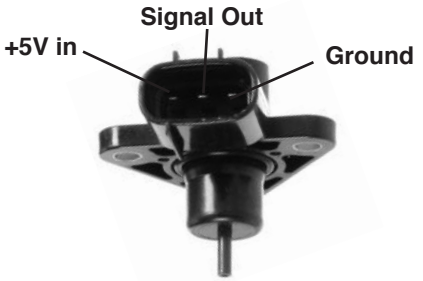
With idle speed increased under load, voltage should not drop under 13 volts.

If any of the above results were less than the vehicles specifications check the following.
Check for corroded battery terminals, a loose belt, bad voltage regulator, alternator, or poor terminal connections.

ENGINE SENSORS TESTS

Throttle Position/EGR Valve Sensors
Throttle Position/EGR Position Sensors are potentiometers or a variable resistor. The ECU uses the information provided by the sensors to determine the position and direction of movement. The following are applications for a position sensor; Throttle, EGR valve, and Vane air flow.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. Disconnect wiring harness from sensor. Refer to vehicle service manual for your vehicles pin identifications. You'll be looking for the power, ground, and signal pin locations. Typically you'll find the signal pin in the center of the three pins. If you have four pins your sensor incorporates an idle



switch, still typically both signal and idle pins are in the center.
4. **Add the alligator clips and connect the RED** clip to the sensors POWER pin.
5. **Connect the BLACK** clip to the sensors GROUND pin.
6. **Turn meters range selector** to 20KΩ range.
7. View and record the reading displayed.
The results should show a small amount of resistance. If the meter shows over range the circuit is open and the sensor is defective.
8. Move the RED alligator clip to the sensors SIGNAL pin.
9. Find the linkage on the Throttle Position Sensor, manually move the throttle linkage cycling from closed to fully open.
10. Watch the meter display, the reading will either increase or decrease resistance.
Some throttle position sensors include a WOT, Wide Open Throttle switch. These switches are tested like the other switches in the Fuse/Switch section.
11. Find the vane on the Vane Air Flow Sensor, typically on or near the multiport electronic fuel injector.
12. Slowly open the butterfly valve from closed to open by pushing on it. This is the normal function of the valve and will not harm the sensor.
13. Watch the meter display, the reading will either increase or decrease resistance.
Some vane air flow sensors have an idle switch and an intake air temperature sensor in addition to a potentiometer. If so equipped these switches are tested like the other switches in the Fuse/Switch section.Refer to vehicle service manual for recommended resistance outputs.

EGR Valve Position Sensor
1. Find the vacuum port on the EGR Valve Position Sensor.
2. Remove the vacuum hose from EGR valve.
3. Connect a hand vacuum pump (W87030) to the EGR valve.
4. **Add the alligator clips and connect the RED** clip to the sensors signal pin (typically the center).
5. **Connect the BLACK** clip to a good body GROUND.
6. Slowly apply vacuum to the EGR valve. Typically, 6 - 10 inches of Hg. should fully open the valve.
7. Watch the meter display, the reading will either increase or decrease resistance. Refer to vehicle service manual for recommended resistance outputs.
• A good sensor should show an increase or decrease in the resistance as the sensor is opened and closed.
• A bad sensor will have no change in resistance.

MAF vs MAP
Manifold Absolute Pressure (MAP) is a sensor to measure vacuum, the computer calculates the engine air flow based on the vacuum, throttle position, and intake air temperature.

Mass Air Flow (MAF) is a sensor that measures the actual air flow going into the engine

MAP/BARO Sensors
These sensors send signals to the ECU indicating atmospheric pressure and/or engine vacuum. There are two different types of MAP sensors. The first, depending on the vehicle manufacturer may be a frequency generator used by Ford. The other type MAP may send a DC voltage signal to the ECU. This is the most common used by Honda, Toyota, Honda, GM etc. Refer to your vehicle service manual for the type MAP sensor your vehicle uses.

1. Insert BLACK test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. For this test you'll need to back probe or add jumper leads from the A and C pin in the harness. If adding jump leads disconnect the MAP from the wiring harness and the vacuum line from the sensor. Special back probe lead attachments are available from most electronic stores (not included).
4. Connect a hand held vacuum pump to vacuum port on MAP sensor, our model W87030.
5. Identify the A, B, and C pin/wire location on the MAP harness connection. **Connect a jumper wire** between Pin A on wiring harness and sensor.
6. **Connect another jumper wire** between Pin C on wiring harness and sensor.
7. **Add the alligator clips and connect RED** clip to lead to sensor Pin B.
8. **Connect the BLACK** clip to a good vehicle body ground. Jumper leads/back probes should be isolated so they can't touch each other.
9. Turn the Ignition to the ON position but do not start the engine.
10. **Turn the meters range selector** to 20V DC range for DC signals, and 4CYL for Frequency signals.
11. With vacuum at 0 in. Hg. your DC volts should be approximately 3V or 5V. With a Frequency MAP, when testing a Ford, your display reading should be between 4532 to 5021 RPM's, (Display RPM x 10) For other frequency type MAP sensors refer to your vehicle service manual for MAP sensor specifications.
12. With the Vacuum pump attached to the MAP slowly apply vacuum. Do not exceed 20 in. Hg or you'll damage the MAP sensor. Voltage and RPM readings should decrease as vacuum increases. Refer to your vehicle service manual for voltage and frequency drops to increasing engine vacuum.

Use the following equation to convert your recorded RPM to Frequency Hz = RPM ÷ 30.

Typical Vacuum to Frequency Results (Ford)

Hg (Vacuum)	Hz (Hertz)
0	159
3	150
6	141
9	133
12	125
15	117
18	109

• A good sensor should show an increase or decrease in the output voltage as the sensor is opened and closed. A bad sensor will have no change in resistance
• A good sensors output voltage or frequency (RPM) fall within manufacturers specifications at 0 Hg. or decrease with increasing vacuum.
• A bad sensors output voltage or frequency (RPM) won't fall within manufacturers specifications at 0 Hg. or show change with increased vacuum.

Oxygen Sensor O2

The Oxygen Sensor is used to measure the exhaust gas concentration in the exhaust system. The ECU uses the information to calculate and, if required, adjust the air fuel ratio so that catalytic converters can function efficiently. The sensor sends information to the ECU based on the amount of oxygen in the exhaust system and adjusts the air/fuel ratio as needed. The two most common types of O2 Sensors used are Zirconia and Titania. In addition, when testing these two types you'll need to know if they are heated or unheated. If the sensor has 3 or more wires, then your vehicle uses a heated O2 sensor.
• A low voltage, high resistance, indicates a lean exhaust, or too much oxygen.
• A high voltage, low resistance, indicates a rich exhaust, or not enough oxygen.
Refer to illustration for appearance differences of the two sensor types.

Unheated Type
1-2 Wires

Heated Type
3-4 Wires

Any time dealing with the exhaust system let the vehicle cool down before proceeding. Although these sensors can be checked in the vehicle, the following test is done with the sensor removed.

NOTE: Never apply external voltage to the zirconia sensors for testing, this may damage it.

1. Remove the Oxygen Sensor from the vehicle, use the special slotted socket to avoid damaging the wires.
2. **Insert BLACK** test lead into COM test lead jack.
3. **Insert RED** test lead into test lead jack.

O2 Heater Circuit

The following is for testing the heater circuit of the O2 Sensor. Refer to your vehicles service manual for the location of the heater pins in the wiring connector.

1. **Add the alligator clips and connect the RED** clip to either of the two pins.
2. **Connect the BLACK** clip to remaining heater pin.
3. Turn the meters range selector to the 200Ω range.
4. View and record the display readings. Compare them to the manufacturer's specification in your vehicles service manual. When completed remove the test leads from the sensor.

O2 Sensor Circuit

The following is for testing the Oxygen Sensor Circuit. Refer to your vehicles service manual for the location of the ground pin and the signal pin in the wiring connector. Also, know the type of O2 Sensor your vehicle uses, Zirconia type or Titania type. A propane torch is needed to conduct this test.

1. **Connect the BLACK** alligator clip to the sensors ground pin.
There are two different ways the sensor could be grounded. The outside housing of the sensor, or the ground will be in the wire harness connection. 1 and 3 wire sensors use the housing, while 2 and 4 wire sensors have the ground in the harness connection.
2. **Connect RED** alligator clip to sensors SIGNAL pin.
3. **Turn the meters range selector** to 2V for Zirconia or 200Ω for Titania.
4. Lock the pliers on the hex socket drive of the sensor.
5. Secure and light the propane torch and set it to a mild flame. Heat the sensors tip as hot as possible with the mild flame. Do not heat the tip to the point of glowing.
The oxygen sensor must be hot, about 600 degrees or higher, before it will start to generate a voltage signal. Hold the sensor as close as possible to the torch flame to quench the sensor tip. This will deplete the sensor of oxygen signaling a Fuel Rich Condition.

Zirconia Sensor: Meter display reading should be >0.6V

Titania Sensor: Meter display should show variable resistance as flame temperature changes.

6. Now move the torch flame away fron the sensor tip. This will allow oxygen to be drawn into the flame and signal a Fuel Lean Condition.

Zirconia Sensor: Meter display reading should be <0.4V

Titania Sensor: Meter display should show an over range with resistance set at the highest range.

7. Let the sensor cool then repeat the above test to verify the results.
8. Turn the propane torch off, let the sensor cool and remove the alligator test clips.
• A good heater circuit's output resistance is within manufacturer's specifications.
• A good sensor circuit signal changes when moving from a rich to a lean exhaust condition.
• A bad heater circuit output resistance is not within manufacturer's specifications.
• A bad sensors signal does not change when moving from a rich to lean exhaust condition.
• A bad sensors signal moves between lean to rich condition to slowly, >3 seconds.

Typically drivers don't react until the MIL (Check Engine) light come on
The following are symptoms of a failing Oxygen Sensor prior to the MIL getting triggered.
• Increased tailpipe emissions
• Increased fuel consumption
• Hesitation on acceleration
• Stalling or a rough idle

MAF Sensors
This sensor send a signal to the ECU indicating the air volume entering the engine. There are three types of MAF sensors, the signal sent may be a DC voltage, high frequency, or a low frequency.
This meter can only test DC voltage and low frequency MAF sensors. High frequency MAF sensors were common on some 1989 and newer GM vehicles. Refer to your vehicle service manual for the type MAF sensor your vehicle uses.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Add the alligator clips and connect the RED** clip to the sensors signal pin (typically the center).
4. **Connect the BLACK** clip to a good body GROUND.
5. Refer to your service manual for the MAF location, identify the power, ground, and signal pin locations. Typically you'll find the signal pin in the center of the three pins.
For this test you'll need to back probe or pierce the signal wire in the MAF wire connection.
Refer to vehicle service manual for best way to connect to MAF signal wire.
6. Turn Ignition KOEO (Key on engine off, do not start engine).
7. **Turn the meters range selector** to 20V DC range for DC signals, and 4CYL for Frequency signals.
Your DC volts should be approximately 1V or less.
With a Frequency MAF your display reading should be between 314 to 347 RPM's, for the GM low frequency type sensor, (display RPM x 10).
Refer to your service manual for your specific vehicles MAF sensor specifications.

Use the following equation to convert your recorded RPM to Frequency Hz = RPM ÷ 30.

8. Turn the Ignition to the ON position and start the vehicle. Be sure all wires, and leads are clear of moving parts. At idle the voltage and RPM reading should increase from your earlier results. As you rev the engine both values should continue to increase.
Refer to vehicle service manual for charts relating MAF sensor voltage or frequency (RPM) to increasing air flow.

Use the following equation to convert your recorded RPM to Frequency Hz = RPM ÷ 30.

• A good sensors output voltage or frequency (RPM) fall within manufacturer's specifications with KOEO, or increase with increased air flow.
• A bad sensors output voltage or frequency (RPM) won't fall within manufacturer's specifications, or show change with increased air flow.

Temperature Sensor
A typical Temperature Sensor or thermistor are thermally sensitive resistors whose prime function is to exhibit a large, predictable and precise change in electrical resistance when subjected to a corresponding change in body temperature. The hotter the sensor gets, the lower the resistance becomes.

Typical Thermistor applications:
• Engine Coolant Temp. (ECT)
• Vane Air Temp, (VAT)
• Air Change Temp. (ACT)
• Throttle Body Temp (TBB)
• Manifold Air Temp. (MAT)

ENGINE SENSORS TESTS CONT.

Perform the following test on an engine that has not been run or has cooled.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. Disconnect the wiring harness from the temperature sensor. Refer to your vehicle service manual for the location of the specific temperature sensor you wish to test.
The Intake Air Temperature Sensor needs to be removed for testing, all other temperature sensors can remain on the vehicle for testing.
4. **Add the alligator clips and connect the RED** clip to either pin on the Intake Air Temperature Sensor.
5. **Connect the BLACK** clip to the remaining pin.
6. **Turn meters range selector** to largest Ω range, decrease to the next lower range until the appropriate range is found. View and record the results.
7. Heat up the sensor, the best method is to use a hair dryer or heat gun. Do not use open flame to conduct this test as some sensors are made of plastic. Hot water can be used if the sensor has a sealed temperature probe. If wires are exposed liquids should be avoided. Heat up sensor, view and record the smallest reading displayed as the sensor is heated.
8. When the test is completed, disconnect the meter and reconnect the sensor to the wiring harness.

For the following test the engine should be warmed up. Let the engine idle until it's close to operating temperature. Feel the upper radiator hose, it should be warm, not necessarily hot, (be cautious).

1. Turn the engine off with the ignition key in the off position.
2. Disconnect the wiring harness from the sensor, leave the sensor mounted in the car.
3. Reconnect the meter test clips and view and record the readings from the display.
A good temperature sensors resistance, with the engine hot, should be a minimum of 350Ω less than the reading when the engine was cold or resistance should fall within manufacturer's specifications.
A bad temperature sensors resistance will be unchanged meaning an open or a short circuit.

Hall Effect Sensor
A Hall Effect sensor is a transducer that varies its output voltage in response to a magnetic field. Hall Effect sensors are used for proximity switching, positioning, speed detection, and current sensing applications. These sensors are used whenever the vehicle ECU needs to know speed and position of a rotating object. Examples of use are ignition systems to determine camshaft and crankshaft position. This enables the ECU to know the optimum time to fire the ignition coil, and turn on the fuel injectors. This test checks for proper switching action in any Hall Effect sensor, Ignition, RPM, Crankshaft, etc..
Refer to your service manual for the best procedure for your specific sensor. Some can stay in the vehicle for testing. The following will be for testing the sensor in the vehicle.
1. **Insert BLACK** test lead into COM test lead jack
2. **Insert RED** test lead into test lead jack.
3. **Add the alligator clip to the BLACK** probe and clip it to the Negative (-) post on the battery.
4. **Turn the meters range selector** to 20V DC.
5. Turn the ignition key on, KOEO.
6. **Touch the RED** test probe to the three pins of the sensor. Find the Signal, Supply, and Ground Pins. Back probing may be necessary to avoid piercing the wiring.
• Ground reading should be the same voltage as the ground.
• Supply wire reading should be the same voltage as the input source.
• Signal wire reading should be 0 or the same voltage as the input source. This will cycle or toggle high and low as the shutter rotates.
7. Slide a flat blade of iron or magnetic steel between sensor and magnet or have a helper crank the engine and watch the meter display. Record the results and compare to manufacturer's specifications.
• A good sensors meter voltage will toggles from as steel blade is inserted and removed.
• A bad sensors meters voltage will have no change as steel blade is inserted and removed.

FUSE/SWITCH/SOLENOID TESTS

Fuses/Switches
This test checks to see if a switch Opens and Closes properly and if a fuse is blown.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn meter range selector** to function.
4. **Add alligator clips and connect BLACK** clip to one side of switch.
5. **Connect RED** clip to other side of switch.
6. Listen for a tone, if you hear a tone he switch is closed. If you don't hear tone the switch is open.
7. Flip the switch on and off, listen for the tone. The tone should react as you flip the switch on and off.

To test fuses touch the RED and BLACK test leads to opposite ends of the fuse, listen for tone.

FUSE/SWITCH/SOLENOID TESTS CONT.

If you hear a tone the fuse is good. If there is no tone the fuse is blown and needs to be replaced.

Solenoids/Relays
This test checks the solenoid or relay for a broken internal coil. Typically a resistance of 200Ω or less is present in a good solinoid/relay. If a high resistance is detected the unit has break in the coil and is bad.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn the meters range selector** to 200Ω function. If the meter over ranges, turn the meters range selector to next higher range.
4. **Add the alligator clips and connect BLACK** clip to one side of coil.
5. **Connect RED** clip to other side of coil.
View results on display. If the solenoid/relay coil resistances is 200Ω or less, the unit should be good. Refer to vehicle service manual for your vehicles resistance range.
• A good Solenoid/Relay Coil displays results within manufacturer's specification.
• A bad Solenoid/Relay Coil displays results not within manufacturer's specifications. If the display reads over range, that indicating an open circuit or defective Solenoid/Relay

IGNITION SYSTEM TESTS

Distributor Cap/Rotor Resistance
This test checks for open circuits or high resistance in the distributor cap and rotor if your vehicle is so equipped.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn meters range selector** to 200Ω range.
4. For the distributor cap test connect the test leads to opposite ends of the distributor cap. One into the top center of the cap (coil wire position). The other on lead touches the inside center of the cap, view the displayed results. General resistance should be 5K – 10K. Refer to vehicle service manual for your vehicles resistance range.
5. For the rotor test connect the test leads to opposite ends of the rotor. One to the top metal contact, and the other to the extended metal finger contact. General resistance should be 0.1Ω or less. Refer to vehicle service manual for your vehicles resistance range.

Variable Reluctance Sensor
A variable reluctance sensor is a transducer that, detects the change in presence or proximity of

IGNITION SYSTEM TESTS CONT.

ferrous objects. Reluctance sensor are used whenever the vehicle's ECU needs to know speed and/or the position of a rotating object. In ignition systems, it's used to determine camshaft and crankshaft position. This tells the vehicle ECU when to fire the ignition coil and turn on the fuel injectors. Speed sensors are another type of reluctance sensor used in transmissions to measure the rotational speed of shafts. These sensors help the ECU to determine when to shift from one gear to the next.

1. Insert BLACK test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Add the alligator clips and connect the RED** clip to either pin on the Variable Reluctance Sensor.
4. **Connect the BLACK** clip to the remaining pin.
5. **Turn the meters range selector** to largest 2KΩ range. View and record the reading on the display.
6. Now watch the meter while flexing the sensor wires from the harness connection to the sensor. Common resistance range is 100 to 1KΩ, refer to your service manual for resistance range.
• A good sensors display reading will fall within manufacturer's specification. There is no erratic changes in the display readings, results are steady while sensor wires are flexed.
• A bad sensors display reading changes when the wiring is flexed, or the reading is not within manufacturers specifications.

Crankshaft Timing Sensor
The Crankshaft timing sensor is typically located in the front of the crankshaft to trigger the ignition system. This sensor consists of a single Hall Effect magnetic switch activated by 3 vanes on the crankshaft damper and pulley assembly. This sensor sends a signal that feeds timing and RPM information to the DIS and EPU.
To test if it your crankshaft position sensor is working properly, you need to test for a voltage output.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
For this test you'll need to back probe or add jumper leads from the two pin in the harness.
3. **Turn the meters range selector** to 2V AC range.
4. Crank the engine, view and record the reading displayed. A normal reading would be at or near .2 volts. Refer to vehicles service manual for recommended voltage outputs.

Some reference manuals states a resistance value, if so you can check the sensor without cranking the engine.

1. Insert BLACK test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. Turn the meters range selector to the 20KΩ range. Refer to vehicles service manual for recommended resistance outputs.

If the test results are within specifications, you should check the sensor's electrical connector and the wiring harness. The trigger wheel located on the crankshaft or damper could have damaged or missing teeth. Any of these components could trigger a CKP sensor to trouble code. Completing the above tests thoroughly will let you know if the crankshaft position sensor is working or not.

Pick-up Coil Resistance

The resistance test checks for open circuits or high resistance. The voltage test compares voltage output to resistance.

1. **Insert the BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn meters range selector** to 200Ω range.
4. **Connect the RED and BLACK** test leads to the pick-up coil leads from the distributor. View the displayed results.

The majority of the pick-up coils will test between 500 - 1500Ω's resistances. Refer to vehicle service manual for your vehicles resistance range.

5. **Set range selector to** AC volts. Crank the engine 10 – 15 seconds, view the voltage results on the display.

Resistance on a good pick-up coil will match the AC output voltage. For example 950Ω would equal 950mV output. Resistance can be good but voltage low if the magnet has lost magnetism or if the reluctor is too far from the stator.

Ignition Coil

The ignition coil is designed to transform the battery's low voltage to 30,000 volts to bridge the spark plugs and ignite the fuel. Coils consist of a laminated iron core surrounded by two coils of copper wire. The Primary winding has just a few turns of heavy wire. The Secondary winding has thousands of turns of smaller wire. Today's vehicle uses one ignition coil for each cylinder called COP, or coil on plug. This improvement system eliminates the fault-prone spark plug cables and a distributor to route the high voltage pulses. This test measures the resistance across the primary and secondary coils of the ignition coil. This test can be used for distributor less ignition systems (DIS) providing the primary and secondary ignition coil terminals are easily accessible.

For testing the PRIMARY SIDE of the ignition coil the engine must be cool and off. You'll need to identify both the primary ignition coil terminals, (+) positive and the (-) negative terminals. Once identified disconnect them from the coil. It's recommended to mark the wires if they're not color coded, red (+) and black (-). Next remove the center high tension lead that goes to the distributor.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into test lead jack.
3. **Turn the meters range selector** to the 200Ω range. Because of the sensitivity of this test touch the two probes of the test leads together. View the reading on the display and record the resistance value.
4. **Add the alligator clips and connect the RED** clip to primary ignition coil positive (+) terminal.
5. **Connect the BLACK** clip to primary ignition coil negative (-) terminal.

View the reading on the display, subtract the test lead resistance value from above. Record this final figure. If your vehicle has DIS, repeat the above steps for each ignition coil and record the results. Refer to your service manual for your vehicles primary ignition coils resistance values.

• A common range for the primary side of the coil is <2.0Ω.

For testing the SECONDARY SIDE of the ignition coil, meter connections remain the same.

1. **Turn the meters range selector** to the 200KΩ range.
2. **Remove the alligator clip from the RED** test lead, and move the probe to the secondary ignition coil terminal. Typically that's the tower where the high tension lead was plugged into.
3. **Connect the BLACK** clip to primary ignition coil negative (-) terminal.

View and record the reading. If the vehicle has DIS, repeat above steps for each coil, record the results.

• A common range for the secondary side of the coil is 6 to 35KΩ.

Refer to your service manual for your vehicles secondary ignition coils resistance values.

Because heat can affect resistance levels, repeat the above tests with the engine at normal operating temperature. Testing the coil hot helps to diagnosing intermittent ignition system problems. Just be cautious, the engine parts will be hot, gloves are recommended.

• A good Ignition Coil Resistance readings were within manufacturer's specification.

Primary side of the coil is <2.0Ω.

Secondary side of the coil range is 6 to 35KΩ.

• A bad Ignition Coil Resistance readings were not within manufacturer's specification.

Primary side of the coil is >2.0Ω.
Secondary side of the coil range is on <6 or >35KΩ.

Coil Switching ON/OFF
The primary circuit is driven by closing a switch to ground, which allows current to flow from the power supply through the primary. This test checks if the negative terminal of the primary ignition coil is getting switched ON and OFF. The signal comes from the ignition module, and the crankshaft position sensors. The ON/OFF signal from the ignition coil is where the Tach gets its RPM information. If the test vehicle cranks but won't fire, this test and fuel delivery is a good place to start.

1. **Insert BLACK** test lead into COM test lead jack.
2. **Insert RED** test lead into ⏃°◯VΩ→|– test lead jack.
3. **Add the alligator clips and connect the RED** clip to the negative side of the primary ignition coil. Refer to your service manual for the primary ignition coil location.
4. **Connect the BLACK** clip to a good body ground. Vehicle with DIS (Distributorless Ignition System), you'll need to identify the Tachometer sign wire that goes from the DIS module to the ECU. Refer to your vehicle service manual for the location.
5. **Connect the RED** test probe to the TACH signal wire, either back probe or pierce the wire.
6. **Use the alligator clips and connect BLACK** clip to a good body ground.
7. **Turn the meters range selector** to the RPM settings, choice the range that coincides with the vehicles cylinder count. View the reading on the display while engine is cranking. Use a helper to turn the key, or use a remote starter switch, (part number W80586). A common meter RPM reading is >20 but <280. Refer to the service manual for your vehicles cranking RPM range.
• A good Switching Coils RPM reading should have a value consistent with manufacturer's specifications.
• A bad Switching Coil will display 0 RPM's meaning the coil is not switched ON and OFF.
Possible items to check for would be bad or shorted wiring, or bad camshaft/crankshaft sensors.

Ignition Wires
OEM type plug wires are usually have a carbon fiber core that helps minimize RF noise (Radio noise). The drawback to carbon fiber is it's a higher resistance wire. This resistance reduces the amount of electrical charge that can be delivered to the spark plug. A hot spark generated the proper bridge on the plug electrode to burn a full cylinder of fuel. Use the following steps to test the resistance of ignition wires, flex the wire while testing for breaks in the carbon fibers. This test can be used for DIS. Test the Coil-On-Plug Insulators for breaks and those systems that mount their ignition coils away from the spark plugs.

1. Pull and test the ignition wires one at a time. Avoid the confusion pulling all the wires without marking where they go.
If possible use a spark plug boot puller, (part number W80531) to remove the boot and wire. It's best to twist the boot a quarter turn both directions prior to pulling to break the seal.
2. Once removed, look for cracks, burns, or bad ends.

NOTE: Early Chryslers used a plug wire that had positive-locking terminal electrodes. To pull the wires the distributor cap needs to be removed. The release is on the underside of the Dodge Omni, and the Plymouth Horizon distributor caps.
3. **Insert BLACK** test lead into COM test lead jack.
4. **Insert RED** test lead into ⏃°◯VΩ→|– test lead jack.
5. **Add the alligator clip to the RED** test probe only, connect it to the distributor side of the plug wire.
6. **Connect the BLACK** test probe into the spark plug boot at the other end of the wire. Be sure it contacts the metal electrode connector.
7. **Turn meters range selector** to the 200KΩ range.
8. View the meter while holding and bending the wire in several places. Over time with heat and vibration the carbon fibers tend to loosen which degrades the conduction.
Commonly the resistance levels range from 4KΩ to 40KΩ. The resistance value is directly affected by the length of each plug wire, averaging 8KΩ to 10KΩ per foot. Refer to vehicle service manual for your vehicles resistance range.
• A good Ignition Wire will have no change while flexing and will meet manufacturer's specification.
• A bad Ignition Wire reading will be erratic while the wire is flexed, or the readings won't be within manufacturer's specification.

FUEL SYSTEM TESTS

C3 Meter Control Solenoid
Today's emission requirements have forced auto makers to move away from the carbureted fuel delivery systems. Starting in the early 80s' auto makers began using electronically controlled carburetors to lower vehicle emissions. As emission requirements got tougher the introduction of computer commanded fuel injection was introduced. With the reduced emissions, and the benefit of increased performance, fuel injection was the future of fuel delivery. Early GM vehicles used the fuel mixture control solenoid, these solenoids can be tested with a digital multimeter that offers a Dwell

measurement. The MC solenoid's purpose is to maintain an air/fuel ratio of 14.7 to 1.
This test can verify if the solenoid dwell is varying as designed. This test is very detailed and you need to pay close attention to the shop manual instructions. Visit this web address http://s7d9.scene7.com/is/content/GenuinePartsCompany/1787689pdf?PDF or use a shop manual for the complete test procedures for adjusting a Lean/Rich fuel mixtures. Refer to vehicle service manual for the specific meter test connection points.

1. The engine needs to be running and at normal operating temperature.
2. **Turn the meters range selector** to the 6 cyl. Dwell position for all GM vehicles with MC solenoids.
3. The engine idle needs to be at 3000 RPM.
Use the reference web site, or shop manual for the procedure to run the engine both RICH and LEAN. View the meter display, the Dwell values should vary from 10° to 50° as vehicle runs from rich to lean.

Measuring Fuel Injector Resistance
Fuel injectors are basically an ON/OFF switch. Very similar to solenoids, they contain a coil that is controlled by the ECU. If your engine is running rough, there may be an issue with the vehicle's fuel delivery system. Having a faulty injector can cause one or more cylinders to not ignite fully. The ECU directs the injector to deliver precise amounts of fuel into each cylinder, regardless of the engines RPMs. An injector fires millions of times over its life span. Eventually they can wear out or clog up, preventing the engine from firing properly. To determine if the injector is operating properly the resistance of the internal coil is tested. Testing this resistance reading will advise if you have an open circuit, or if the coil is shorted. Its best if you have the specific injector manufactures rated resistance. Some of the more common manufacturers of fuel injectors are Bosch, Siemens, Deka, Continental, Lucas, Japanese Electronics Corp. (JECS), and Denso.

Injector Test
Some engines have plastic panels that need to be removed before you can access the injectors. They are typically secured by bolts and can be removed with a basic socket set including an extension.

1. Testing the Injector, make sure the key is off, no power is needed for this test.
2. Remove the injector wiring harness. Be cautious, the harness has slide lock that you need to move before you can press on the tabs to remove the wiring harness.
3. **Insert BLACK** test lead into COM test lead jack.
4. **Insert RED** test lead into ⍋°◯VΩ⇥⊢ test lead jack.
5. Turn the meters range selector to the 200Ω setting. Because of the sensitivity of this test touch the two probes of the test leads together. View the reading on the display and record the resistance value.
6. **Add the alligator clips and connect the RED** clip to a single prong inside the injector's connector.
7. **Connect the BLACK** clip to the other prong, be sure the two clips don't touch.
8. View the reading on the display, subtract the test lead resistance value from above. Record this final figure.
9. Repeat the above steps for each injector and record the results. They should all have a resistance within half an ohm from each other. Any major difference and that injector should be inspected to make sure its firing correctly. If the resistance of the injector coil is within manufacturer's specifications, the fuel injector could still be defective. It is possible that the fuel injector is clogged or dirty and that is causing your drivability problem.
High impedance injectors are the most common on vehicles today, they will range from 12 to 17 ohms. Low impedance injectors are found on high performance and larger injectors. They have much lower resistance, typically around 2-5 ohms.
• A good Injectors Coil resistance is within manufacturers specifications.
• A bad Injectors Coil resistance is not within manufacturers specifications.

Injector Wiring Harness Test
1. Testing the Injectors wiring, turn the key to the ON position, KOEO.
2. **Insert BLACK** test lead into COM test lead jack.
3. **Insert RED** test lead into ⍋°◯VΩ⇥⊢ test lead jack.
4. **Turn the meters range selector** to the 20VDC setting.
5. **Add the alligator clip to the BLACK** test lead only, clip to a good body ground.
6. **Touch the RED** test leads probe to a single prong inside the injectors wiring harness. (Not the injectors, but the harness that plugs into the injectors connection). One prong will be the ground and your meter will read 0 volts. The other prong is the power source for the injector and should read around 12 volts.
7. View and record the reading on the display.
8. Leave the ground lead in position and repeat the above steps for each injectors wiring harness and record the results. Your results should all be around 12 volts. A lower reading means theres excess resistance in the injectors wiring somewhere.
• A good Injector Harness voltage is within manufacturers specifications.
• A bad Injectors Harness voltage is not within manufacturers specifications.

MAINTENANCE & TROUBLESHOOTING

Overrange Indication
If the 1 or -1 appears on the left side of the display the multimeter is overranged. This is when a range has been selected that is lower than what the meter is currently reading. Increase the range until this disappears. If it doesn't, then the value being measured is too large for the meter to measure.

Zero Adjustment
There is no meter adjustments, this unit will automatically zero on the Volts, Amps and RPM functions.

Automatic Polarity
If the meter displays a minus (-) symbol on the DC volts or DC amp functions then the test leads are reversed.

Alligator Clip Adapters
Some meter tests and measurements are better done by using the alligator clips instead of just the test probes. The clip provided just push onto the test probes.

Low Battery
When the 9v battery needs to be replaced a battery symbol will appears in the lower left corner of the display.

Battery Replacement
Turn meter OFF and remove test leads.
Remove screw from battery cover, remove battery cover, and battery
Install a new 9 Volt battery and re-assemble meter.

Fuse Replacement
Turn meter OFF and remove test leads.
Remove rubber holster and remove screw from battery cover, remove battery cover, and battery.
Remove screws from back of multimeter, remove back cover and remove fuse.
Replace fuse with same size and type as originally installed, re-assemble meter.
Fuse: 10A, 250V

Maintenance
Periodically wipe the case with a damp cloth, do not use abrasives or solvents. Do not subject the meter to extreme heat or cold temperatures. Keep test probes away from extreme such as vehicle exhaust manifolds.

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PERFORMANCE TOOL, P.O. Box 88259 Tukwila, WA 98138

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