

TENMA®

72-9280

Operating Manual



**Handheld Automotive
Multi-Purpose Meter**

P/N:110401102827

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Overview

This Operating Manual covers information on safety and cautions. Please read the relevant information carefully and observe all the Warnings and Notes strictly.



Warning

To avoid electric shock or personal injury, read the “Safety Information” and “Rules for Safe Operation” carefully before using the Meter.

Automotive Digital Multimeter Model 72-9280 (hereafter referred to as “the Meter”) is a 4000 counts, 3-3/4 digits manual ranging meter. The meter uses large scale of integrated circuit with integrated A/D converter as its core. Spotting a unique design with an extra large LCD display. Connect Test Leads display, full overload protection and unique outlook design. For this reason, it emerges as an electric meter with more outstanding performance for safer operation than other meters. In addition to the Dwell, Tach and Data Hold feature, the Meter can be used to test the AC/DC voltage, AC/DC current, resistance, frequency, diode, continuity, and Capacitance.

Unpacking Inspection

Open the package case and take out the Meter. Check the following items carefully to see any missing or damaged part:

Item	Description	Qty
1	Operating Manual	1 piece

2	Test Lead	1 pair
3	Alligator Clip	1 pair
4	RS232C interface cable	1 piece
5	CD-ROM	1 piece
6	9V Battery	1 piece

In the event you find any missing or damage, please contact your dealer immediately.

Safety Information

This Meter complies with standards IEC61010: in pollution degree 2, overvoltage category (CATIII 1000V, CATIV 600V) and double insulation.

CAT III: Distribution level, fixed installation, with smaller transient overvoltages than CAT IV

CAT IV: Primary supply level, overhead lines, cable systems etc.

Use the Meter only as specified in this operating manual, otherwise the protection provided by the Meter may be impaired.


Rules For Safe Operation



Warning

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

- **Before using the meter, inspect the body casing; 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 or missing parts. Examine the insulation around the connectors.**
- **Inspect the test leads for damaged insulation or any exposed metal. Check the test leads for continuity before using. Replace damaged test leads with identical style and electrical specifications before using the meter.**
- **When using the test leads, keep your fingers behind the finger guards.**
- **Do not apply more than the rated voltage, as marked on the meter, between the terminals or between any terminal and grounding.**
- **To avoid injury or damage, never attempt to input an effective voltage over 60V in DC or 30V in AC.**
- **Use the proper terminals, function, and range for your measurements.**
- **The rotary switch should be positioned in the correct setting and not be switched any time during the measurement.**
- **Disconnect circuit power and discharge all high-voltage capacitors before testing, resistance, diodes or continuity.**
- **Before measuring current, check that the fuse is ok. Before connecting the meter in serial to the tested in-circuit, disconnect in-circuit power.**
- **If the value of current to be measured is unknown, use the maximum measurement position, and reduce the range step by step until a satisfactory reading is obtained**

- 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.
- The internal circuit of the meter shall not be altered or tampered with, as it will likely damage the meter and possibly cause electrical shock.
- A soft cloth (slightly damp with a mild detergent and water) should be used to clean the surface of the meter as needed. No abrasive, solvent, or dripping-wet cloth should be used on the meter, as they can cause corrosion or damage that can lead to electrical shock or other accident.
- Turn off the meter when it is not in use and take out the battery when not using for a long time.
- Routinely check the battery as it may leak after being installed for a long period of time; replace the battery and clean the compartment and contacts as soon as leaking appears. A leaking battery will damage the meter.
- Do not use or store the meter in an inclement environment of high temperature, humidity, explosive, inflammable and strong magnetic field. The performance of the meter will deteriorate after dampened.

Automotive Servicing Safety Guide



Warning

Pay attention to the cautions in the automotive servicing manual when you are working

around the components and wiring of the air bags, or any actions that will deploy an air bag, which can result in personal injury and damage. Note that the air bag will also be active for a few minutes after the ignition is off (or even when the automotive battery is cut off), which is driven by a safety power reserve.

To prevent personal injury or any damage to an automobile or any of its meters, please read the following safety guidelines and testing procedures in earnest:

- Wear protective eyeglasses which meet safety requirements.
- Operate on automobiles in a well-ventilated area to prevent exhaust inhalation.
- Keep all of your tools and testing instruments away from all hot components and moving devices of the operating engine.
- Ensure that the automobile is placed in park (automatic transmission) or put into neutral gear (manual transmission) and be sure that it is equipped with functional brakes and the parking or emergency brake is engaged.
- Do not place any tool or material on the automotive battery which will cause a short circuit of the electrodes and in turn lead to any personal injury or damage to a tool or battery.

- **Do not smoke, light a match, burn a candle, or otherwise have any type of open flame near the automobile.**
- **Take extra caution when working near ignition coils, ignition leads, and spark plug sockets because these components are provided with high voltages when the automobile is operating.**
- **Pay close attention to the automotive manufacturer's cautions, servicing notes and procedures.**

All of the information, explanations and detailed descriptions in the operation manual have originated from the industrial information recently published. It is impossible to prove the accuracy and completeness of the information, of which we shall not be responsible for the assumption.

- A. The general automotive information in this guide is meant to helpfully diagnose fault situations in automobiles. Because of the wide variety of makes and models of cars, this information may not pertain to every vehicle. To confirm information or questions on your specific vehicle and situation, please adhere to the following:**
1. Contact the local distributors, retailers, dealerships, and mechanics of automotive components and information
 2. Reference material produced by manufactures or publishers that pertain your specific vehicle and situation.
 3. All self diagnosis should be carefully considered and completed at your own risk; if

there is any doubt in the situation, contact a professional and certified mechanic immediately before any attempt to fix, alter, or further test the vehicle.









B. Before the diagnosis of any trouble, visually inspect all of the components of the vehicle, including the exterior, interior, under the carriage, and under the hood. You will likely find the causes for many of your problems by this visual analysis, which will save you a lot of time.



1. Has the automobile recently been serviced? Has the same problem sometimes occurred where the trouble lies?
2. Do not try to find any short cut. Take your time and adhere to repair directions in your vehicle's manual.
3. Check any trouble with the air purifier or pipeline system.
4. Check any damage to any sensor or the driving gear.
5. Check the ignition lead: any breakage of any terminal, crack on any spark plug or breakage at the insulation of the ignition lead.
6. Check all the vacuum hoses: any right line, shrinkage, bend, crack, fracture or damage.
7. Check the leads: any connection of sharp edges, connection of hot surfaces (such as exhaust manifold), shrinkage, burn or scratch at the insulation or right line connection. Double check the connections of hoses and leads; although they may appear to be

connected, sometimes these parts strictly require a complete connection.

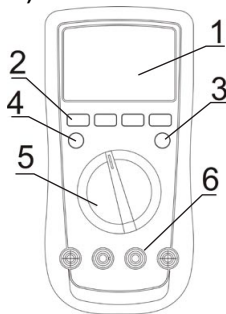
8. Check circuit connections: any pin corrosion, bend or damage, inappropriate connection position or damaged electrode lead.

International Electrical Symbols

	AC (Alternating Current)
	DC (Direct Current)
	Ground
	AC or DC
	Diode
	Double Insulated
	Deficiency of Built-In Battery
	Fuse

	Warning. Refer to the Operating Manual.
	Conforms to Standards of European Union.

The Meter Structure (see figure 1)



(Figure 1)



1. LCD display
2. Functional buttons

- 3. SELECT button
- 4. Power button
- 5. Rotary Switch
- 6. Input Terminals

Rotary Switch

Below table indicated for information about the rotary switch positions.

Rotary Switch Position	Function
V	AC or DC Voltage Measurement
mV	Millivoltage Measurement
Ω	Resistance Measurement
$\text{--}\text{ }\text{--}$	Capacitance measurement
$\text{--}\text{>}\text{--}$	Continuity Test
$\text{--}\text{>}\text{--}$	Diode Test
Hz	Frequency Measurement
μA	Current measurement, unit: μA

mA	Current measurement, unit: mA
A	Current measurement, unit: A
RPM x 10 	Automotive engine tach testing (Displayed Reading x 10), Unit: rpm
DWELL 	Automotive ignition dwell testing, Unit: degree

Functional Buttons (see figure 2)

Below table indicated for information about the functional button operations.

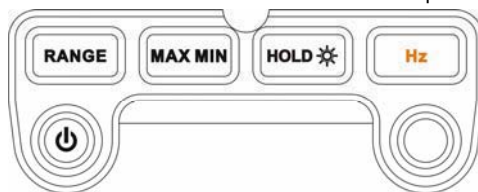




Figure 2

Button	Operation Performed
POWER 	Turn the power on and off.

HOLD/ 	<ul style="list-style-type: none">● Press HOLD once to enter hold mode.● Press HOLD again to exit hold mode and the present value is shown.● Press and hold for 2 seconds to turn the display backlight on or off.
MAX/MIN	Start recording of maximum and minimum values. Press to step the display through high (MAX) and low (MIN) readings at any time.
Hz	<ul style="list-style-type: none">● Press once to enter Frequency measurement mode.● Press and hold for 2 seconds to enter RS232C or USB mode.
RANGE	<ul style="list-style-type: none">● Press RANGE to enter the manual ranging mode;● Press and hold RANGE for 2 seconds to return to auto ranging mode;● Under RPM or Dwell testing mode, press RANGE to select 4CYL, 6CYL, or 8CYL.
SELECT	Press SELECT to select the alternate functions.

Display Symbols (see figure 3)

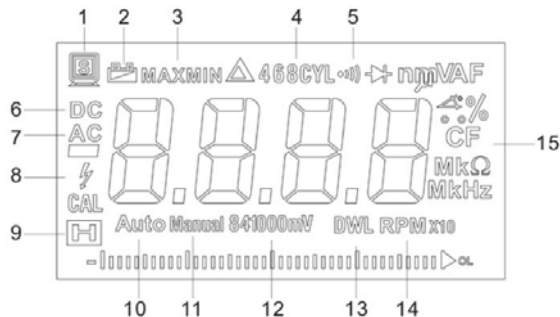


Figure 3

1	Data output is in progress.
2	Low Battery Warning: To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator appears.

3	Maximum or Minimum reading displayed
4	4CYL, 6CYL, or 8CYL displayed
5	Test of continuity
6	Indicates for DC voltage or current
7	Indicates for AC voltage or current
8	Indicates for dangers
9	Data hold is active
10	The meter is in Auto range mode
11	The meter is in Manual range mode
12	Indicates for 841000mV range
13	Test of DWL

14	Test of RPM
15	Indicates for units

Measurement Operation


AC/DC Voltage Testing



Warning

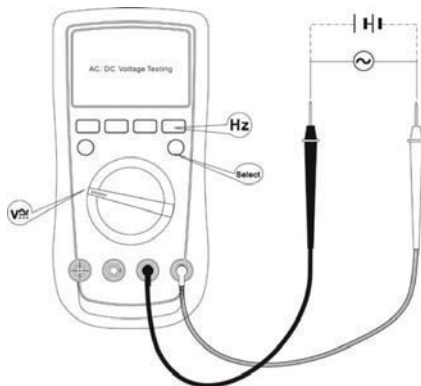
To avoid injury or damage to the meter from electric shock, please do not attempt to measure voltages higher than 1000V, although readings may be obtained. Please take extra care when measuring high voltages to avoid electric shock.

To measure DC voltage, connect the Meter as follows:

1. Insert the red test lead into the **V** terminal and the black test lead into the **COM** terminal.
2. Set the rotary switch to an appropriate measurement position in **V**  press blue button to switch between AC and DC measurement mode.
3. AC voltage measurement displays True RMS value. Press **Hz** button to obtain the frequency value (refer to accuracy specifications for maximum ranges).
4. Connect the test leads with the object being measured. The measured value shows on the display.

Note

- If the value of voltage to be measured is unknown, use the maximum measurement position (1000V) and reduce the range step by step until a satisfactory reading is obtained.
- Please take extra care when measuring high voltages to avoid electric shock.
- In each range, the Meter has an input impedance of approximately 10M Ω . this loading effect can cause measurement errors in high impedance circuits. If the circuit impedance is less than or equal to 10k Ω , the error is negligible (0.1% or less).
- When voltage measurement has been completed, disconnect the testing leads and the circuit under test.



(Figure 4)

DC Millivoltage Testing



Warning

To avoid injury to you or damages to the Meter from electric shock, please do not attempt to measure voltages higher than the range although readings may be obtained.

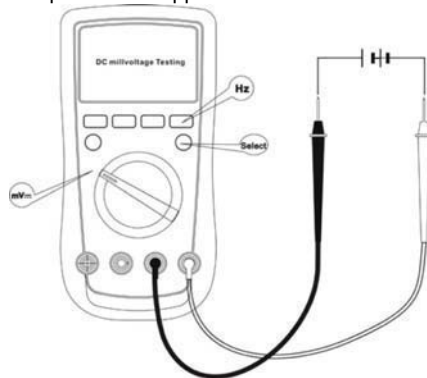
When AC voltage measurement has been completed, disconnect the connection between the testing leads and the circuit under test.

To measure **DC** millivoltage, connect the Meter as follows:

1. Insert the red test lead into the **V** terminal and the black test lead into the **COM** terminal.
2. Set the rotary switch to an appropriate measurement position in **mV**.
3. Connect the test leads with the object being measured.

The measured value shows on the display. Press **Hz** button to obtain the frequency value. (refer to accuracy specifications for maximum ranges).

4. The Meter has an input impedance of approx. 4000M Ω .



(Figure 5)

AC/DC Current Testing



Warning

Before connecting the Meter in serial to the tested in-circuit, disconnect in-circuit power.

If the fuse burns out during measurement, the Meter may be damaged or the operator himself may be hurt.

Use proper terminals, function, and range for the measurement. When the testing leads are connected to the current terminals, do not parallel them across any circuit otherwise it will burn the fuse or damage to the Meter.

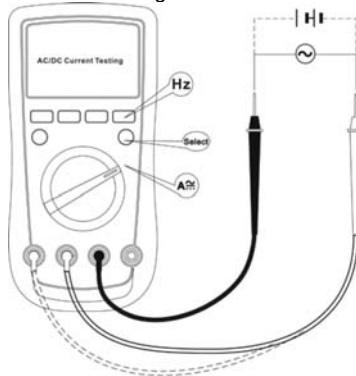
To measure AC/DC current, connect the Meter as follows:

1. Insert the red test lead into the “**μA**” “**mA**” or “**A**” terminal and the black test lead into the **COM** terminal.
2. Set the rotary switch to an appropriate measurement position in “**μA**” “**mA**” or “**A**” . Press blue button to switch between AC and DC measurement mode.
3. C current measurement displays true rms value. Press **Hz** button to obtain the frequency value (refer to accuracy specifications for maximum ranges).
4. Connect the test leads with the object being measured. The measured value shows on the display.

Note

- If the value of the current to be measured is unknown, use the maximum measurement position 10A terminal, and reduce the range step by step until a satisfactory reading is obtained.
- When current measurement has been completed, disconnect the connection between the testing leads and the circuit under test.
- When measuring 5A~10A: maximum continuous measurement should be ≤10 seconds

and interval time between 2 measurement greater than 15 minutes.



(Figure 6)

Resistance Testing



Warning

To avoid damages to the Meter or to the devices under test, disconnect circuit power and discharge all the high-voltage capacitors before measuring resistance.

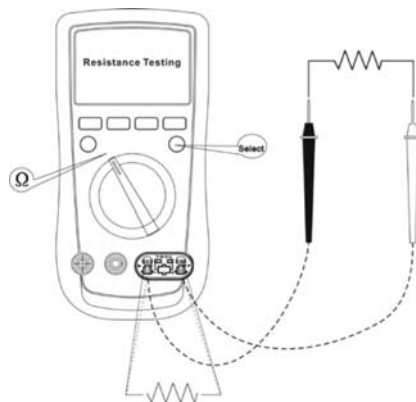
To avoid injury to yourself, never attempt to input an effective voltage over 60V in DC or 30V in AC.

To measure resistance, connect the Meter as follows:

1. Insert the red test lead into the Ω terminal and the black test lead into the **COM** terminal.
 2. Set the rotary switch to an appropriate measurement position in Ω range then press blue button to select resistance measurement mode.
 3. Connect the test leads with the object being measured.
- The measured value shows on the display.

Note

- When there is no input, for example in an open circuit, the Meter displays “OL”.
- If the resistance reading $\geq 0.5\Omega$ when you short-circuit the leads, please check for loose test leads or other reasons.
- For high resistance ($>1M\Omega$), it is normal to take several seconds to obtain a stable reading. For better accuracy, choose a shorter test lead.
- When resistance measurement has been completed, disconnect the connection between the testing leads and the circuit under test.



(Figure 7)

Continuity Testing





Warning

To avoid possible damage to the Meter and to the device under test, disconnect circuit power and discharge all high-voltage capacitors before testing diodes and continuity.

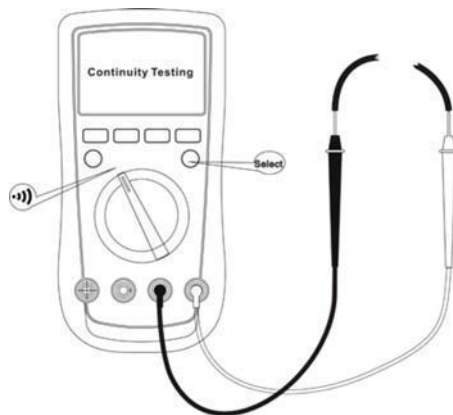
To avoid injury to yourself, never attempt to input an effective voltage over 60V in DC or 30V in AC.

To test for continuity, connect the Meter as below:

1. Insert the red test lead into the  terminal and the black test lead into the **COM** terminal.
2. Set the rotary switch to , then press blue button to select continuity mode.
3. Connect the test leads across with the object being measured.
 - The buzzer does not sound when the resistance value is $>30\Omega$. The circuit is disconnected.
 - The buzzer sounds continuously when the resistance value is $\leq 30\Omega$. The circuit is in good condition.
4. The nearest value of the tested circuit is shown on the display in units Ω .

Note

- Open-circuit voltage is approx. 3V.
- When continuity testing has been completed, disconnect the connection between the testing leads and the circuit under test.



(Figure 8)

Diode Testing





Warning

To avoid possible damage to the Meter and to the device under test, disconnect circuit power and discharge all high-voltage capacitors before testing diodes and continuity.

To avoid injury to yourself, never attempt to input an effective voltage over 60V in DC or 30V in AC.

To test a diode out of a circuit, connect the Meter as follows:

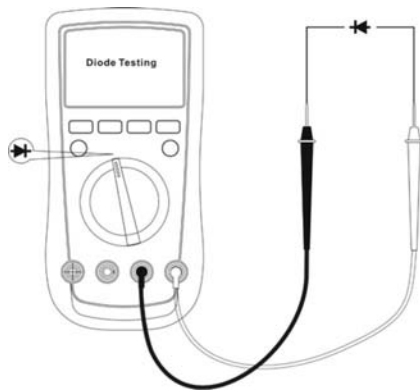
1. Insert the red test lead into the  terminal and the black test lead into the **COM** terminal.
2. Set the rotary switch to .
3. For forward voltage drop readings on any semiconductor component, place the red test lead on the component's anode and place the black test lead on the component's cathode. The polarity of red test lead is "+" while black test lead is "-".
4. The measured value shows on the display.

Note

- In a circuit, a good diode should still produce a forward voltage drop reading of 0.5V to 0.8V; However, the reverse voltage drop reading can vary depending on the resistance of other pathways between the probe tips.

Connect the test leads to the proper terminals as said above to avoid error display.

- The LCD will display “OL” indicating open-circuit or wrong polarity connection.
- When diode testing has been completed, disconnect the connection between the testing leads and the circuit under test.



(Figure 9)



Capacitance Testing



Warning

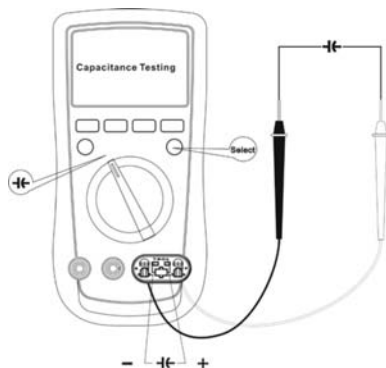
To avoid damage to the Meter or to the equipment under test, disconnect circuit power and discharge all high-voltage capacitors before measuring capacitance.

To measure capacitance, connect the Meter as follows:

1. Insert the red test lead into the  terminal and the black test lead into the **COM** terminal.
2. Set the rotary switch to  and press **BLUE** button to select capacitance measurement mode.
3. The measured value shows on the display.

Note

- The LCD displays **OL** indicating the tested capacitor is shorted or it exceeds the maximum range.
- When capacitance measurement has been completed, disconnect all connections between capacitor and the Meter.



(Figure10)

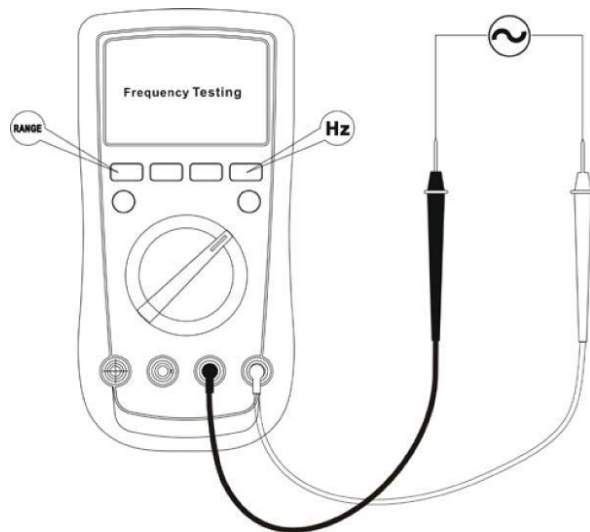
Frequency Testing

To measure frequency, connect the Meter as follows:

1. Insert the red test lead into the **Hz** terminal and the black test lead into the **COM** terminal.
2. Under AC/DC voltage, DC millivoltage or AC/DC current measurement, press **Hz** button to select frequency measurement mode, the measured value shows on the display. Press **RANGE** to select next range and the maximum range is 1MHz.

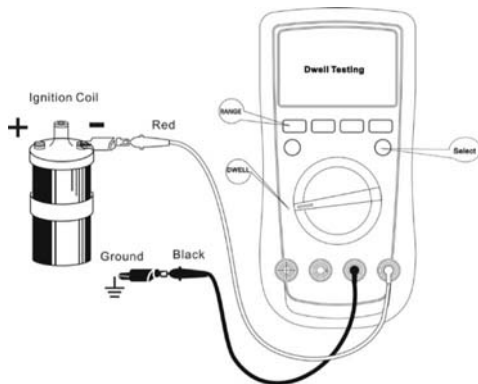
Note

- Refer to accuracy specifications for maximum ranges
- When frequency measurement has been completed, disconnect the connection between the testing leads and the circuit under test, and remove the testing leads from the input terminals of the Meter.



(Figure 11)

Dwell Testing



(Figure 13)

In the past, it was very important to test the dwell of the cut-off switch of an ignition system. The dwell testing measures the duration which the cut-off switch remains off when the cam is turning. Today's automobiles are ignited electronically, and it is no longer necessary to adjust the ignition dwell. However, the dwell testing can also be used to test a mixed-controlled solenoid.

1. Set the rotary switch to **DWELL**. Press **RANGE** button to select the number of cylinders and press **BLUE** button to select DWELL measurement mode.
2. Insert the red test lead into the **DWELL** terminal and the black test lead into the **COM** terminal. Connect the ends to be tested as illustrated.

If the cut-off switch of an ignition system is tested, connect the red test lead probe to the primary negative end of the ignition coil. (Refer to the automotive servicing manual for the specific position.)

If the dwell of an arbitrary ON/OFF equipment is tested, connect the red probe to the end of the equipment, fixed with an ON/OFF switch.

3. Connect the black test lead probe to a ground terminal of the automobile.
4. Read the ignition dwell of the tested automobile directly from the display

K. Engine Tach (Rotation Speed) Testing "RPMx10" (see figure 14)

The RPM means the rotating frequency of the main shaft of the engine per minute.

1. Set the rotary switch to **RPM X10**. Press **RANGE** button to select the number of cylinders and

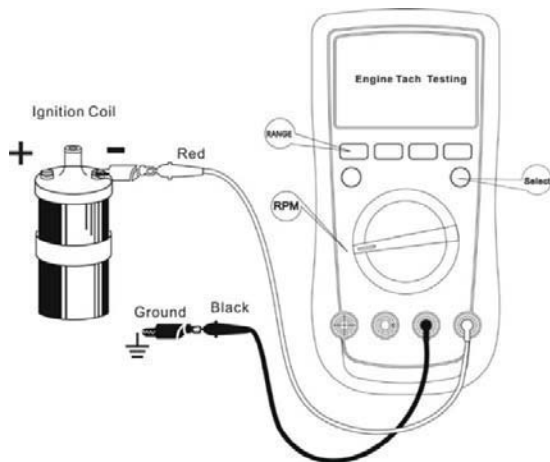
press **BLUE** button to select **RPM X10** measurement mode.

2. Insert the red test lead into the **RPM** terminal and the black one into the **COM** terminal. Select an appropriate number of cylinders. Connect the ends to be tested as illustrated.

- If a DIS ignition system without any distributor board is used in the automobile, connect the red test lead probe to the TACH (tachometer) signal line (which is connected to the computer DIS module of the automotive engine). Refer to the automotive servicing manual for the specific position.
- If an ignition system with a distributor board is used in the automobile, connect the red test lead probe to the primary negative end of the ignition coil. Refer to the automotive servicing manual for the specific position.

3. Connect the black test lead probe to the good ground terminal of the automobile.

4. Upon the start of the engine or during its operation, test the rotation speed of the engine and read the displayed value from the display. The actual rotation speed of the automobile to be tested should be equal to the displayed value multiplied by 10. For example, the actual rotation speed of the engine of the automobile should be 2000 RPM (200 x 10) if the displayed value is 200 and the meter is set at the 6CYL (6 cylinders) notch.



(Figure 14)

Hold

The Hold mode is applicable to all measurement functions:

- Press **HOLD** to enter Hold mode and save the present reading

- Press **HOLD** again to exit Hold mode
- In Hold mode, **H** is displayed while holding the reading

Range

- Press **RANGE** to enter the manual ranging mode (the Meter will beep)
- Press **RANGE** to step through the ranges available for the selected function (the Meter will beep again)
- Press and hold **RANGE** for over 2 seconds to return to auto ranging.

Max/Min

- Press **MAX MIN** to start recording of maximum and minimum values. Steps the display through high (MAX) and low (MIN) readings. The Meter enters manual ranging mode after pressing **MAX MIN** button.
- Press and hold **MAX MIN** for over 2 seconds to exit Max/Min mode and return to the present measurement range.

Data Outputting

- Press and hold **H_z** button for over 2 seconds to enter Data output mode.
- The sleep mode feature will be disabled after entering RS232C or USB mode.
- Press and hold **H_z** button again for over 2 seconds to exit Data output mode.

Display backlight

Press and hold **HOLD** button for over 2 seconds to turn on or turn off the display backlight.

The BLUE button

This button is used for selecting the required measurement function when there is more than one function at one position of the rotary switch.

Automatic power off

The meter power off automatically if you have not changed the rotary switch or pressed a button for 15 minutes.

Part 2**Diagnosis of Automotive Troubles**

The Meter is a tool for the very effective diagnosis of the troubles with the electronic systems of the automobile. This part gives a special introduction as to how the Meter is used to diagnose any trouble with a fuse, switch, solenoid, relay, starting and charging systems, ignition system, fuel system and engine sensor.

Fuse Testing

Check the fuse to see if it is blown out.

1. Set the rotary switch to Ω .
2. Insert the red test lead into the Ω terminal and the black one into the **COM** terminal.
3. Short circuit the red and black test lead probes, when the reading of the meter should be displayed between 0.2Ω and 0.5Ω . If it is more than 0.5Ω , check the test leads to see whether they are well connected to the meter.
4. Connect the red and black test lead probes in parallel to the two ends of the fuse, when the reading of the meter should be displayed less than 10Ω , indicating that the fuse is good. When the display is overload "**OL**", it is shown that the fuse has been blown out.



Warning:

- It must be replaced with a fuse of the same type and size.

Switch Testing

1. The same as in Items 1 to 3 of Fuse Testing.
2. Connect the black test lead probe to one end of the switch and the red one to another end. When the switch is connected, the reading of the meter should be displayed less than 10Ω . When the switch is cut off, overload "**OL**" should be displayed as the reading of the meter.

Solenoid or Relay Testing

1. The same as in Items 1 to 3 of Fuse Testing.
2. Connect the red and black test lead probes in parallel to the two ends of a solenoid or relay. The impedance of most of solenoids or relay coils is less than 200 Ω . (See the details in the automotive manual.)

**Warning:**

- Both ends of a general solenoid or relay are connected with diodes.
- Check to see if there is any damaged coil. Even if the coil is found satisfactory, the solenoid or relay may still be damaged. The relay may be welded or worn due to the frequent sparking of the contacts. The solenoid may be stuck when the coil is in an on-position. Therefore some potential problems cannot be found in testing.

Starting/Charging System Testing

The on-off function of the engine starting system consists of a battery, engine starting button, solenoid and relay starting buttons, lead connections and lines. During the operation of the engine, the charging system keeps the battery charged. This system consists of an AC generator, voltage calibrator, lead connections and circuits. The multimeter is an effective tool for the checking of these systems.

Load-Free Battery Testing

Before testing the starting/charging system, test the battery to see if it is fully charged.

- (1) Set the rotary switch to **DCV**.
- (2) Insert the red test lead into the **V** terminal and the black one into the **COM** terminal.
- (3) Turn off the ignition switch.
- (4) Turn on the driving lights for 10 sec. to release charge from the battery.
- (5) Connect the black test lead probe to the negative pole of the battery and the red one to the positive pole of the battery.

2. The testing results are shown in contrast as follows and if the battery is less than 100%, please use it after charging it.

12.60 V	100%
12.45 V	75%
12.30 V	50%
12.15 v	25%

Battery Power Consumption (Engine off)

The test is carried out to find the amperage of the power consumption of the battery when both the ignition key and the engine are off. The test is helpful for the determination of the additional

consumption of the battery, which may finally lead to the exhaustion of the battery.

1. Turn off and close the ignition key and all its accessories.

Make sure that the bus, engine louver and cabin lights have been turned off and closed.

2. Set the rotary switch to **A 10A**.

Insert the red test lead into the **A** terminal and the black one into the **COM** terminal.

3. Cut off the link between the positive pole of the battery and the cable and connect the test lead probes to the circuit. (Connect the red test lead probe to the positive pole of the battery and the black one to the negative pole of the battery.)



Warning:

- **Do not start the engine of the automobile during testing, or the meter will be damaged.**

4. Read the reading of the tested current directly from the display with the normal current being about 100mA. For the special supply of currents (when the engine is off), please refer to the automotive servicing manual. If there emerges any additional current, do necessary servicing.



Warning:

- **A frequency-modulated radio or lock needs a current supply of 100 mA.**

Trigger Voltage Battery Load Testing

Upon the start of the engine, test the battery to see if it can offer an adequate voltage.

1. Set the rotary switch to **DCV**.
2. Insert the red test lead into the **V** terminal and the black one into the **COM** terminal.
3. Interrupt the ignition system to disable the start of the automobile.

(Cut off the main ignition coil, shunt coil, cam and starting sensor so as to interrupt the ignition system. Operate according to the automotive manual.)

4. Connect the black test lead probe to the negative pole of the battery and the red one to the positive pole of the battery.
5. Start the engine continuously for 15 seconds and the testing results are shown in contrast as follows. If it is within the range, the starting system is normal; on the contrary, it is shown that there may be something wrong with the battery cable, starting system cable, starting solenoid or starting motor.

Voltage

9.6 V or more

9.5 V

Temperature

21.1°C (70°F)

15.6°C (60°F)

9.4 V	10.0°C (50°F)
9.3 V	4.4°C (40°F)
9.1V	-1.1°C (30°F)
8.9 V	-6.7°C (20°F)
8.7 V	-12.2°C (10°F)
8.5 V	-17.8°C (0°F)

Voltage Drop Testing

Test the voltage drops caused by the switch, cable, solenoid or connector. Any abnormal voltage drop generally results from an additional resistance. The resistance will restrict the currents upon the start of the engine, leading to the reduction of the load voltage of the battery and the slow-down of the start of the engine.

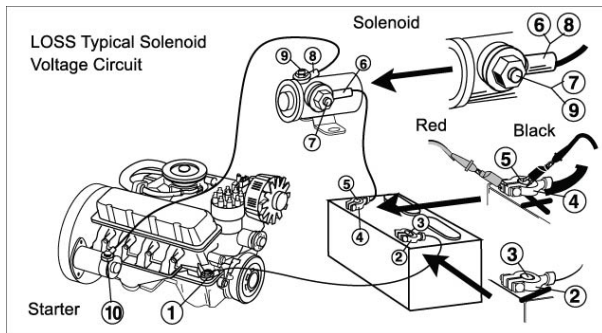
1. Cut off the ignition system so as to disable the start of the automobile.
(Cut off the main ignition coil, shunt coil, cam and starting sensor so as to cut off the ignition system. Operate by reference to the automotive manual.)
2. Set the rotary switch to **DCmV** or **DCV**. Insert the red test lead into the **A** terminal and the black

test lead into the **COM** terminal.

3. Refer to the LOSS typical trigger voltage circuit. (See figure 15)

Test the voltage between any of the following pairs of points respectively:

1&2, 2&3, 4&5, 5&6, 6&7, 7&8, 8&9, 8&10



(Figure 15)

Component

Switch

Voltage

300 mV

Lead	200 mV
Grounding	100 mV
Battery Lead Connector	50 mV
Wiring	0.0 V

Compare the readings of the tested voltages against the example table. If the voltage is on the high side, check the components and connectors to see if there is anything wrong. If anything wrong is found, complete necessary servicing.

Charging System Voltage Testing

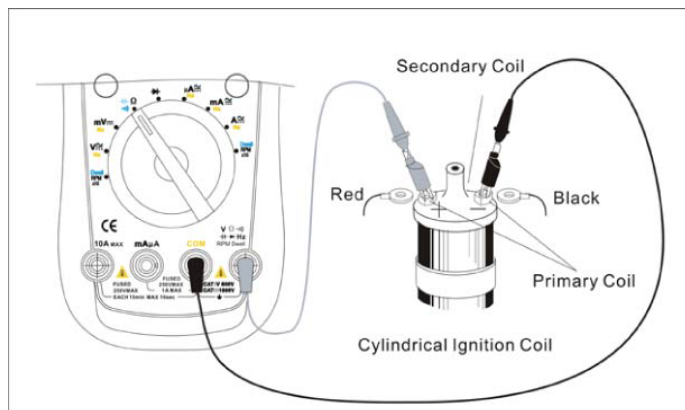
This testing is used to see if the charging system operates normally so as to provide the electronic systems with adequate power (lamps, electric fans, radio sets, etc.).

1. Set the rotary switch to the **DCV**. Insert the red test lead into the **A** terminal and the black one into the **COM** terminal.
2. Connect the black test lead probe to the negative pole of the battery and the red one to the positive pole of the battery.
3. Run the engine idle and close or turn off all the accessories with the normal voltage readings being 13.2 V to 15.2 V.
4. Open the throttle and control the rotation speed of the engine between 1800 RPM and 2800 RPM. The voltage readings should be consistent with those in (3) (with the difference being no more than 0.5 V).

5. Turn on the lamps, windshield wipers, fans and so on to increase the loads of the electronic systems with the voltage readings being no less than 13.0 V.
6. If the readings in Steps 3, 4, and 5 are normal, the charging system is also normal. If the readings in Steps 3, 4, and 5 are beyond the limits or inconsistent with those in the operation manual, check the current ranges of the conveying belt, regulator, AC generator, connector and open-circuit AC generator. If any further diagnosis is required, refer to the appropriate automotive manuals.

Ignition Coil Testing

- (1) Before the operation, cool the engine and cut off the ignition coil.
- (2) Set the rotary switch to the Ω . Insert the red test lead into the Ω terminal and the black one into the **COM** terminal. Test the primary coil of the ignition coil.
- (3) Short circuit the red and black test lead probes. Their short circuit resistance should be less than 0.5 Ω . If it is more, check the test lead to see if it is loose or damaged. If it is damaged, replace it with a new one.
- (4) Connect the red test lead probe to the primary “+” pole of the ignition coil and the black one to the primary “-” pole of the coil. (see figure 16.) See the detailed positions in various kinds of automotive manuals.



(Figure 16)



Warning:

- The reading of the testing becomes the actual tested resistance only after the reduction of the short-circuit values of the test leads.
- The primary resistance is generally between $0.3\ \Omega$ and $2.0\ \Omega$.

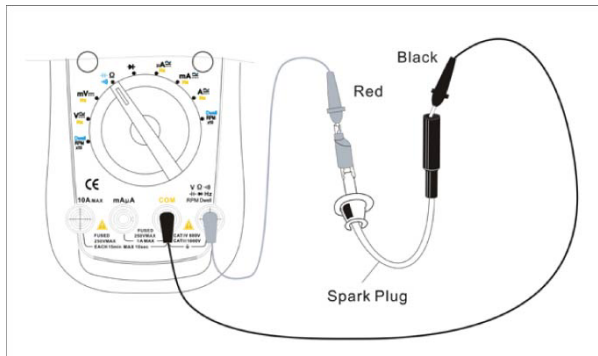
- (5) Make sure the unit is set to auto ranging and test the primary coil of the ignition coil.
- (6) Connect the red test lead probe to the secondary outlet and the black one to the primary “-” pole. Refer to the appropriate automotive manuals for details.
- (7) The primary resistance is generally in a range of 6 k Ω to 30 k Ω . Refer to various kinds of automotive manuals for the details.
- (8) For a heater ignition coil, repeat the said testing steps.



Warning:

For a heater ignition coil, the resistance may be a little higher because the resistance of a coil will vary with the temperatures. The higher the temperature, the resistance will be higher; on the contrary, it will become lower.

Ignition System High-Voltage Damper Testing



(Figure 17)

- (1) Move the connectors of the ignition system from the engine. Refer to the ignition system movement procedure in various kinds of automotive manuals for the details.



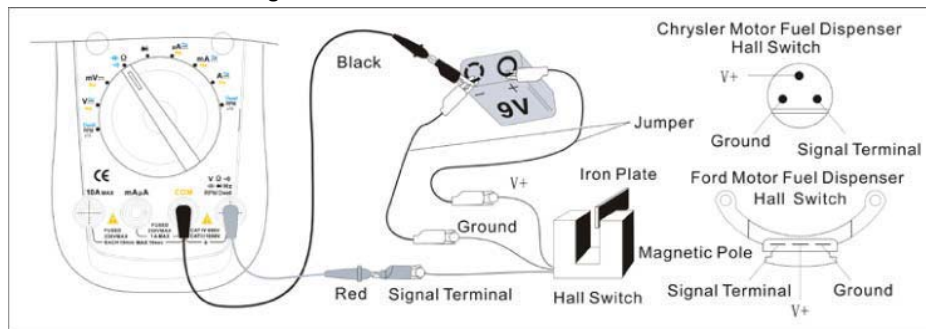
Warning:

Some of Chrysler's products use a spark plug high voltage damper with "positive lock" end electrodes, which can only be moved out of the distributor board. If it is moved out of anywhere else, damage will occur. Refer to the appropriate automotive manuals for the

details.

- (2) Set the rotary switch to the Ω . Insert the red test lead into the Ω terminal and the black one into the **COM** terminal.
- (3) Connect the red and black test lead probes in parallel to the two ends of the high-voltage damper and observe the reading. The normal resistance is generally in a range of 3 k Ω to 50 k Ω . In bending the lead, the reading should remain unchanged.

Hall Switch/Sensor Testing

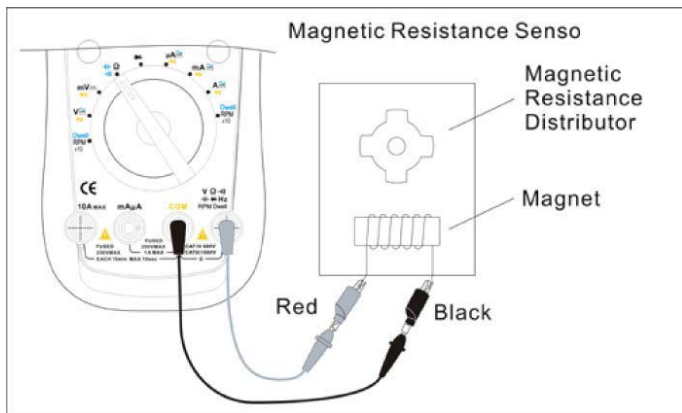


(Figure 18)

When the tach and dwell are tested in the computer of the automobile, a Hall sensor is used. The Hall sensor is normally used in the ignition system to detect the position of the camshaft so that the computer of the automobile can set the optimal time for the ignition and the opening of the fuel injector.

- (1) Move the Hall sensor out of the automobile and see the details of the operation in various kinds of automotive manuals.
- (2) Connect the positive pole of a 9 V battery to the source end of the sensor and the negative pole to the ground end of the sensor by referring the details to the positions of the source and ground ends of the sensor in various kinds of automotive manuals.
- (3) Set the rotary switch of the meter to Ω . Insert the red test lead into the Ω terminal and the black one into the **COM** terminal.
- (4) Connect the red and black test lead probes in parallel to the signal connect terminal and ground end of the sensor and the meter should display a small ohm.
- (5) When a metal plate (blade, steel tape, etc.) is inserted into the concave magnetic pole of the sensor, the display of the meter will be enlarged or overloaded; if the metal plate is moved away, the display will become smaller, which proves that the sensor is satisfactory.

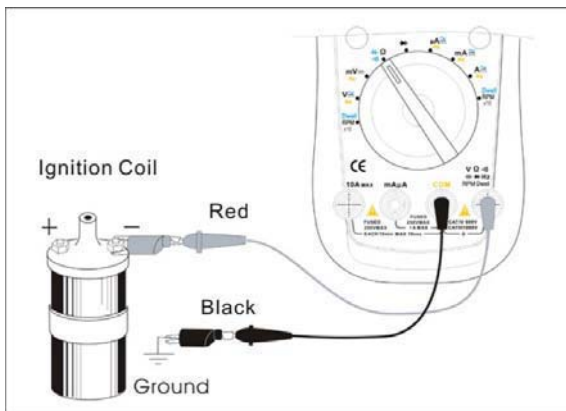
Magnetic Resistance Sensor



(Figure 19)

The functions of a magnetic resistance sensor is similar to those of a Hall sensor and the testing methods of both sensors are also similar. Their normal resistance is generally in a range of $150\ \Omega$ to $1\ \text{k}\Omega$. Refer to the ranges of resistance in various kinds of automotive manuals for the details.

RPM Testing



(Figure 20)

- (1) Set the rotary switch to **RPMx10** and select the number of cylinders in the automobile to be tested.
- (2) Insert the red test lead into the **Ω** terminal and the black one into the **COM** terminal.
- (3) Connect the black test lead probe to the ground (i.e. ground strap connection) of the automobile and the red one to the appropriate testing test terminal of the computer of the automobile if the automobile is in a DIS type (Refer to the servicing handbooks of various kinds of automotive

manuals for the detailed position); or the negative pole of the ignition coil if the automobile is equipped with a distributor board (Refer to the appropriate service manuals for the detailed position).

(4) The normal starting rotation speed of an engine is about 50 RPM to 275 RPM. Refer the detailed position to the servicing handbooks of various kinds of automotive manuals because this value relates to the then temperature, engine size, battery size, etc..



Warning:

- **The displayed value of the meter becomes the actual tach reading only after it is multiplied by 10.**

Fuel System Testing

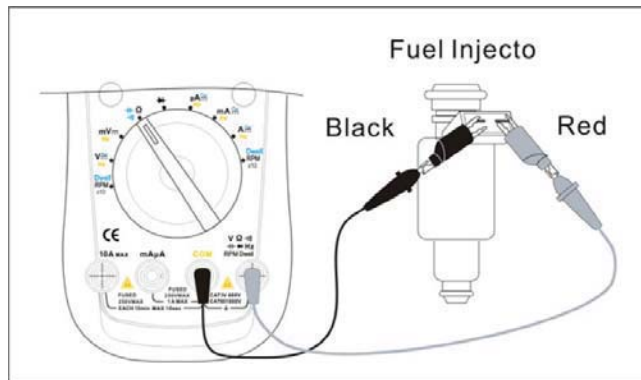
It is necessary to add more accurate engine fuel control to a low injection automobile. Since 1980, the automotive manufacturing industry has used electronically-controlled carburetor and fuel injection so as to achieve lower fuel injection.

(1) **GM (General Motor):** Testing the dwell of the C-3 mixed-control solenoid: Place the solenoid in a cylinder, monitoring the ratio between the air and the fuel, which should generally be 14.7 to 1 between the air and the fuel so as to reduce the injection of surplus fuel. The testing is used to see if the solenoid is installed right in the position and the dwell of the meter can also indirectly be used for the testing.

- [1] Start the engine of the automobile to achieve a rotation speed of 3000 RPM.
So far as a GM automobile is concerned, set the rotary switch to the **DWELL** and select **6CYL**.

- [2] When the automobile is operating in a short fuel state or in a long fuel state, the dwell of the meter should be displayed between 10° and 50°.

Fuel Injector Resistance Testing



(Figure 21)

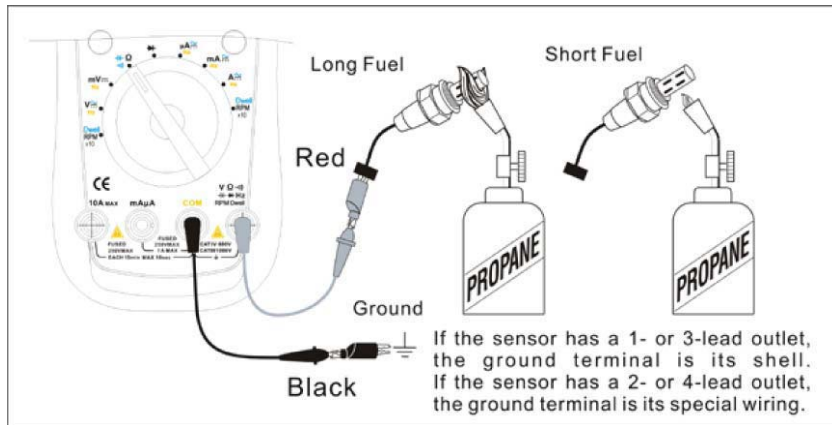
The testing method is similar to that of the resistance of an ignition coil.

- [1] Disconnect the electrical link from the injector. (Refer to the appropriate automotive service

manuals for the detailed position.)

[2] Connect the red and black test lead probes to the two ends of the injector. The general normal resistance is less than or equal to 10 Ω .

Engine Sensor Testing



(Figure 22)

To adapt to the provisions for low injection and fuel saving in the early 1980's, the computer-controlled regulators were installed in the automobile and the sensors provided the computer with required data. The Meter is an effective tool for the detection of the operation of a sensor.

Oxygen Sensor

The oxygen sensor is used to test the oxygen content in the exhaust, giving rise to an appropriate voltage or resistance. A low voltage (high resistance) indicates a high oxygen content in the exhaust, while a high voltage (low resistance) indicates a low oxygen content. The computer regulates the ratio between the air and the fuel according to voltage. There are normally two types of oxygen sensors: the zirconia and titania sensors. (Refer to the different external properties of the two types for the details.)

Testing Procedure:

- (1) Remove the oxygen sensor from the automobile
- (2) Set the rotary switch to Ω . Insert the red test lead into the Ω terminal and the black one into the **COM** terminal.
- (3) Connect the black test lead probe of the meter to the ground terminal (i.e. cold end) of the sensor.



Warning:

If the sensor has a 1- or 3-lead outlet, the ground terminal is its shell.

If the sensor has a 2- or 4-lead outlet, the ground terminal is its special wiring.

- (4) Connect the red test lead probe of the meter to the signal terminal (i.e. hot end) of the sensor.

If the sensor has more than 3 leads, what is used in the automobile is **a heated oxygen sensor**, which has 2 hot ends. Refer the positions of the hot ends in various kinds of automotive manuals.

Connect the red and black test lead probes respectively to these two hot ends. Compare the readings with the specifications in the operation manual provided by the manufacturer.

The ZIRCONIA sensor is tested with the **DCV**. Insert the red test lead into the **V** terminal and insert the black test lead into the **COM** terminal.

The TITANIA sensor is tested with the Ω . Insert the red test lead into the Ω terminal and insert the black test lead into the **COM** terminal.

Secure the sensor with a table vice, using a propane or similar burner and add heat to sensor terminal. Increase the temperature to about 660°F and exhaust the oxygen from the sensor, when the readings can be obtained:

The ZIRCONIA sensor has a voltage of 0.6 V or more.

The TITANIA sensor has a resistance of about 1 Ω .

Move the burner away for heating, when the reading can be obtained:

The ZIRCONIA sensor has a voltage of 0.4 V or more.

The TITANIA sensor has a resistance of about 4 k Ω .

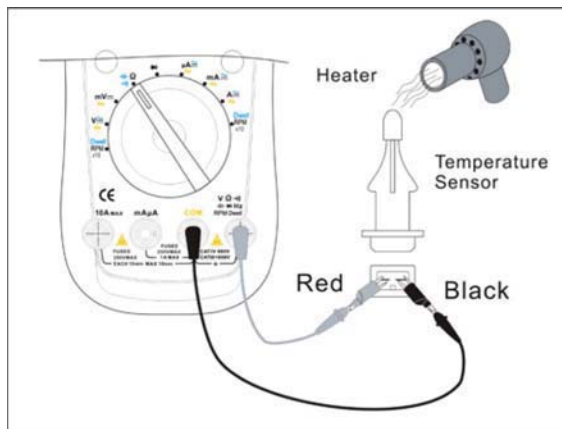


Warning:

● **In testing, the readings will vary with the heating temperature. Be extremely cautious when working with the heating devices and open flame. Allow appropriate time to cool before further testing. Keep all flammable materials away from the testing area.**

Temperature Sensor

The temperature sensor changes the output resistance through the changes in peripheral temperatures. The hotter the sensor is, the lower the resistance becomes. The temperature sensor is generally used in engine braking, air ventilation, flow, fuel temperature and other equipment.



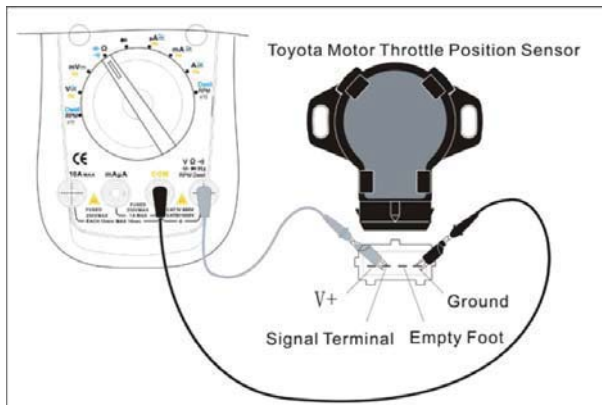
(Figure 23)

Testing Procedure:

- (1) The same as in the resistance testing method.
- (2) When the general temperature of a sensor rises, its resistance will drop. The thermal resistance of the temperature sensor of the automotive engine is generally less than $300\ \Omega$.

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Position Sensor



(Figure 24)

The position sensor is an electrometer or variable resistance. It is used for the computer monitoring of the position and direction of a mechanical device. The typical position sensors include throttle, exhaust recirculating EGR, blade air flow and other sensors.

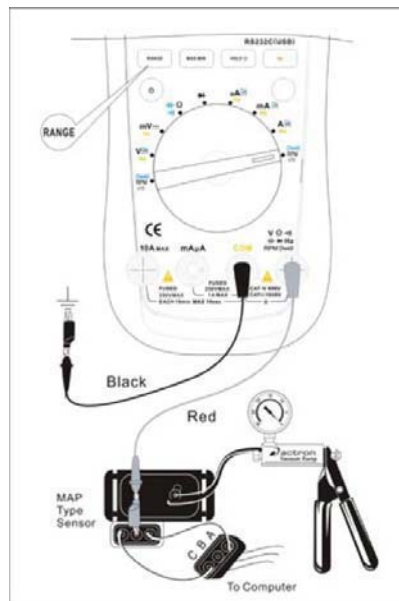
Testing Procedure:

- (1) The same as in the resistance testing method.

(2) Connect the red and black test lead probes respectively to the signal test terminal and ground terminal. Refer to various automotive servicing manuals for its position and the resistance to be tested.

Absolute Pressure (MAP) and Baro Sensor

Absolute Pressure (MAP) and Baro Sensor



(Figure 25)

The MAP sensor is used to change a pressure signal into a DC voltage or frequency one. All GM, Chrysler, Honda and Toyota use DC voltage type MAP sensors, while Ford uses frequency type MAP sensors. Refer to relevant manuals for other automotive manufacturers.

Testing Procedure:

- (1) Connect the DC voltage type MAP sensor in the DC voltage testing method and set the rotary switch to **DCV**.
- (2) Connect the frequency type MAP sensor in the RPMx10 testing method and set the meter to the number of cylinders in the automobile.
- (3) Taking 4 cylinders (4CYL) for example, connect the black test lead probe of the meter to the ground terminal (i.e. ground strap connection) and connect the red one as illustrated in figure 25.
- (4) Turn on the ignition key but do not start the engine.

Displayed Values:

DC Voltage Type Sensor: In a vacuum state, the displayed value is generally between 3 V and 5 V. (The details shall be based on the parameters furnished by the supplier.)

Frequency Type Sensor: In a vacuum state, the displayed value is generally 4770 RPM \pm 5%. (This only applies to the MAP sensor produced by Ford and the other sensors shall be based on the parameters furnished by the supplier.)



Warning:

- **RPM = Frequency * 120 / the number of cylinders.**

Mass Air Flow (MAF) Sensor

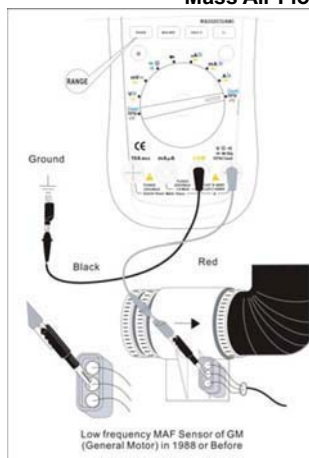


Figure 26

The sensor converts the air flow into a DC voltage, low frequency or high frequency signal. The Meter can only be used to test a DC voltage or low frequency signal.

Testing Procedure:

- (1) Connect the DC voltage type MAF sensor in the DC voltage testing method and set the rotary switch to **DCV**. Connect the frequency type MAF sensor in the RPM testing method and set the meter to the number of cylinders in the automobile. Now take 4 cylinders (4CYL) for example.
- (2) Connect the black test lead probe of the meter to the ground terminal (i.e. ground strap connection) and connect the red one as illustrated in figure 25.
- (3) Turn on the ignition key but do not start the engine.
- (4) Displayed Values:

DC Voltage Type Sensor: The displayed value should be less than or equal to 1V. (The details shall be based on the parameters furnished by the supplier.)




Frequency Type Sensor: In a vacuum state, the displayed value should be 330 RPM \pm 5%. (This only applies to GM low frequency sensors.) The other low frequency sensors shall be based on the parameters furnished by the supplier.)



Warning:

- **RPM =Frequency X 120/ the number of cylinders.**

General Specifications

- Maximum Voltage between any Terminals and grounding: Refer to the different range input protection voltage.
-  Fuse Protection of **μA mA** terminal: 1A, H 240V, fast type, φ6x25mm
-  Fuse Protection of **A** terminal: 10A, H 240V, fast type, φ6x25mm
- Maximum Display: 4000; analogue bar graph 41 segments
- Measurement Speed: Updates 2-3 times/second
- Range: Auto or manual
- Polarity Display: Auto
- Overload Display: **OL**
- Battery Deficiency: Display .
- Temperature:
Operating: 0°C ~40°C (32°F~104°F).
Storage: -10°C ~50°C (14°F ~122°F).
- Relative Humidity : ≤75% @ 0°C to 30°C;
≤ 50% @ 30°C to 40°C.
- Altitude: Operating : 2000m; Storage: 10000m.
- Electromagnetic Compatibility: EN61326-1:2006, EN61326-2:2006
- Battery Type: 9V (NEDA1604 or 6F22 or 006P).
- Dimensions (HxWxL): 180 x 87 x 47mm
- Weight: 370g (including holster and battery)
- Safety/Compliances:

IEC61010: CATIII 1000V, CAT IV 600V overvoltage and double insulation standard.

- Certification:

**Accuracy Specifications**

Accuracy: \pm (a% Reading + Digits), guarantee for 1 year.

Operating Temperature: 18°C to 28°C.

Relative Humidity: No more than 75% RH.

1. DC Voltage

Range	Resolution	Accuracy	Overload Protection
4V	1 mV	\pm (0.5%+3)	1000V DC/AC
40V	10 mV		
400V	100 mV		
1000V	1 V		

Note: Input impedance: Around 10M Ω .

2. AC Voltage

Range	Resolution	Accuracy 40Hz ~ 400Hz	Accuracy 400Hz ~ 1kHz
4V	1mV	\pm (1%+3)	\pm (2%+3)
40V	10mV		
400V	100mV		
1000V	1V	\pm (1.2%+5)	\pm (2%+5)

Note:

- Input impedance: Around 10M Ω .

- Overload Protection: 1000V DC or AC
- Displays effective value of sine wave (mean value response)(10%~100% of the range)

3. DC millivoltage

Range	Resolution	Accuracy	Overload Protection
40mV	0.01 mV	$\pm (0.8\%+3)$	500AC
400mV	0.1 mV		

Note: Input impedance: Around 4000M Ω .

4. DC Current

Range	Resolution	Accuracy	Overload Protection
400μA	0.1μA	± (1%+2)	Fuse 1A, H 240V, fast type, φ6x25mm
4000μA	1μA		
40mA	10μA	± (1.2%+3)	
400mA	100μA		
4A	1mA	± (1.5%+3)	Fuse 10A, H 240V, fast type, φ6x25mm
10A	10 mA		

Note:



- **When measuring 5 to 10A:**

For continuous measurement ≤ 10 seconds and interval time between 2 measurement greater than 15 minutes.

5. AC Current

Range	Resolution	Accuracy 40Hz ~ 400Hz	Accuracy 400Hz ~ 1kHz
400μA	0.1μA	± (1.2%+5)	± (1.2%+10)
4000μA	1μA		
40mA	10μA	± (1.5%+5)	± (1.5%+10)
400mA	100μA		
4A	1mA	± (2%+5)	± (2%+10)
10A	10mA		

Note:

-  Fuse Protection of **μA** **mA** terminal: 1A, H 240V, fast type, φ6x25mm
-  Fuse Protection of **A** terminal: 10A, H 240V, fast type, φ6x25mm
- Displays effective value of sine wave (TRMS)(10%~100% of the range)
- **When measuring 5 to 10A:**

For continuous measurement ≤10 seconds and interval time between 2 measurement greater than 15 minutes.

6. Resistance

Range	Resolution	Accuracy	Overload Protection
400Ω	0.1Ω	± (1%+5)	500Vp
4kΩ	1Ω		
40kΩ	10Ω		
400kΩ	100Ω		
4MΩ	1kΩ		
40MΩ	10kΩ	± (1.5%+5)	

7 Capacitance


Range	Resolution	Accuracy	Overload Protection
10nF	10pF	± (3%+5)	500Vp
100nF	100pF		
1000nF	1nF		
10μF	10nF		
100μF	100nF		

8. Frequency

Range	Accuracy
10Hz~1MHz	± (0.1%+4)

- Overload Protection: the same as AC/DC voltage, DC millivoltage, AC/DC Current, and RPM mode.
- Input Amplitude: a
 - 1) AC/DC voltage mode,
When 40Hz ~ 1KHz: $a \geq \text{range} \times 10\%$ (except 1000V range)
 $a \geq 400\text{V}$ (1000V range)
When 10Hz ~40Hz or 1k Hz ~1MHz: for reference only.
 - 2) AC/DC Current mode,
When 40Hz ~ 1KHz: $a \geq \text{range} \times 10\%$ (except 10 A range)
 $a \geq 4\text{A}$ (10 A range)
When 10Hz ~40Hz or 1k Hz ~1MHz: for reference only.
 - 3) DC millivoltage mode,
When $\leq 100\text{KHz}$: $40\text{mV} \leq a \leq 200\text{V rms}$
When 10Hz ~1MHz ~1MHz: $200\text{mV} \leq a \leq 10\text{V rms}$

9. Diode

Range	Resolution	Overload Protection
	1mV	500Vp

Note:

- Open circuit voltage approximate 3V.
- The silicon PN junction normal voltage is about 500 mV to 800 mV.

10. Continuity Testing

Range	Resolution	Overload Protection
•))	1Ω	500Vp

Note:

- Open circuit voltage approximate 3V.
- The buzzer does not sound when the resistance value is $>30\Omega$. The circuit is disconnected.
- The buzzer sounds continuously when the resistance value is $\leq 30\Omega$. The circuit is in good condition.

11. Dwell Testing

Range	Resolution	Accuracy	Overload Protection
4CYL	0.1°	$\pm (3\%+5)$	500 Vp
6CYL			
8CYL			

Note:

- Input Scope:
 $\geq 10V$ in forward impulse;
 Bandwidth $\geq 0.5mS$

12. Tach (Rotation Speed) Testing

Range	Resolution	Accuracy	Overload Protection
4CYL	10 RPM	$\pm (3\%+5)$	500 Vp
6CYL			
8CYL			

Note:

- Input Scope:
 $\geq 10V$ in forward impulse;
Bandwidth $\geq 0.5mS$
- Maximum Tach: 10000 RPM, Tach = Displayed Reading x 10.

Maintenance

This section provides basic maintenance information including battery and fuse replacement instruction.



Warning

Do not attempt to repair or service your meter unless you are qualified to do so and have the relevant calibration, performance test, and service information.

To avoid electrical shock or damage to the meter, do not get water or excessive moisture inside the case.

General Service

- Periodically wipe the case with a damp cloth and mild detergent. Do not use abrasives or solvents.
- To clean the terminals with cotton bar with detergent, as dirt or moisture in the terminals can affect readings.
- Turn the Meter off when it is not in use and take out the battery when not using for a long time.
- Do not store the Meter in a place of humidity, high temperature, explosive, inflammable and strong magnetic field.

Replacing the Fuses



Warning

To avoid electrical shock or arc blast, or personal injury or damage to the Meter, use specified

fuses ONLY in accordance with the following procedure.

To replace the Meter's fused:


1. Turn the Meter off and remove all connections from the terminals.
2. Remove the holster from the Meter.
3. Remove the 3 screws from the case bottom, and separate the case top from the case bottom.
4. Remove the fuse by gently prying one end loose, and remove the fuse from its bracket.
5. Install **ONLY** replacement fuses with the identical type and specification as follows and make sure the fuse is fixed firmly in the bracket.
Fuse 1: 1A, H 240V, fast type, $\phi 6 \times 25$ mm.
Fuse 2: 10A, H 240V, fast type, $\phi 6 \times 25$ mm.
6. Rejoin the case bottom and case top, and reinstall the 3 screws and holster.

Replacement of the fuses is seldom required. Burning of a fuse always results from improper operation.

Replacing the Battery



Warning

To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator “  ” appears.

To replace the Meter's battery:

1. Turn the Meter power off and remove all connections from the terminals.
2. Take the Meter out from the holster.
3. Remove the screw from the battery compartment and open the battery compartment.
4. Take out the battery and replace with a new 9V battery.
5. Rejoin the battery compartment and the case bottom, and reinstall the screw and the holster.

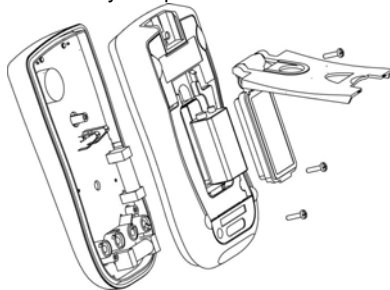


Figure 27

This operating manual is subject to change without notice.



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