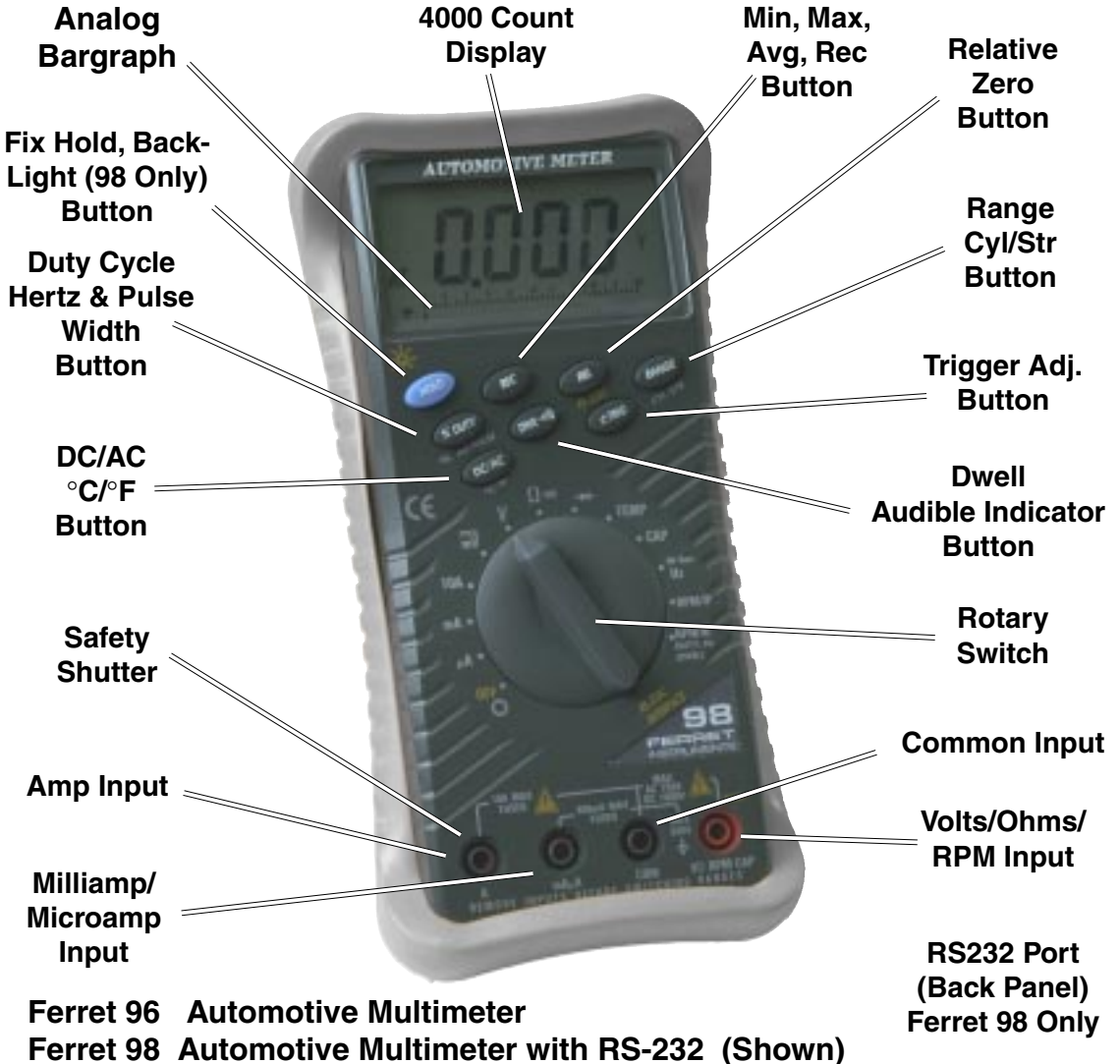




Digital Automotive Multimeters

96 98



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Digital Display:	Counts - 4000 (Frequency Range: 20000) Update - 1 time/sec in RPM, FREQ, DUTY Cycle, Dwell and Pulse Width. 4 times/sec in all other functions and ranges.
Analog Bar Graph:	2 x 41 Segments Updates 20 times/sec.
Fuse Protection:	1 A 600 V High Energy / Fast Fuse for mA and μ A. 15A 600 V High Energy / Fast Fuse for Amps.
Storage Temperature:	-20°C to 45°C (-4°F to 140°F)
Operating Temperature:	0°C to 45°C (32°F to 113°F)
Relative Humidity:	0% to 80%
Battery Life:	200 hrs typical (alkaline) without Backlight. 150 hrs typical (alkaline) with backlight.
Size (H X W X L)	4.0cm x 8.5cm x 19.0 cm, Meter Only. 5.4cm x 10.3 cm x 20.8 cm with Holster.
Weight:	380g Meter Only. 655g with Holster.
Vibration & Shock:	Designed to MIL-T-28800 for a Class II Instrument.
Safety Standards:	Designed to both IEC 1010-1 and the EMC Directive, UL 1244, CSA C22.2 No. 231 and ISA-DS82 CE-mark Certified.

For Your Information

To maintain accuracy of the Meter, replace the discharged battery immediately when the Low Battery symbol appears on the display of the Meter. Keep the Meter away from spark plug or coil wires to avoid measuring error from external interference. Remove the test leads from the test points before changing functions to avoid damaging the Meter when testing voltage. Do not exceed the input limits shown in the table on the next page.

This Manual tells you how to use this Meter. You may also need technical information for the vehicle you plan to test. The most important information resources are the vehicle's service repair manuals.

This Operators' Manual should be used as a guide to get you started in troubleshooting. Your real learning can best be accomplished through experience. As you become more proficient in using the Automotive DMM to troubleshoot, you will very quickly learn how certain electrical symptoms can relate to various driveability problems.

Ranges & Accuracy

Accuracy is given as \pm ([1% of reading] + [number of least significant digits]) at 18°C to 28°C with relative humidity up to 80%, for a period of one year after calibration.

Function	Range	Resolution	Accuracy	Input Impedance
DC Volts	4 V	1mV	\pm (0.3% + 2 digits)	11M Ω
	40 V	10mV	\pm (0.3% + 2 digits)	10M Ω
	400 V	0.1 V	\pm (0.75% + 3 digits)	10M Ω
	1000 V	1 V	\pm (0.3% + 2 digits)	10M Ω
DC MilliVolts	400 mV	0.1mV	\pm (0.3% + 2 digits)	>100m Ω
AC Volts	4 V	1 mV	\pm (0.75% + 3 digits) @ 50-60 Hz	11M Ω
	40 V	10 mV	\pm (0.75%+ 3 digits) @ 50-60 Hz	10M Ω
	400 V	0.1 V	\pm (0.75%+ 3 digits) @ 50-60 Hz	10M Ω
	750 V	1 V	\pm (0.75%+ 5 digits) @ 50-60 Hz	10M Ω
DC Amps	400 μ A	0.1 μ A	\pm (0.5 + 1 digit)	100 μ V/ μ A
	4000 μ A	1 μ A	\pm (0.5 + 1 digit)	100 μ V/ μ A
	40 mA	0.01 mA	\pm (0.5 + 1 digit)	1.2 mV/mA
	400 mA	0.1 mA	\pm (0.5 + 1 digit)	1.2 mV/mA
	4 A	0.001 A	\pm (1.0% + 5 digits)	75mV/A
	10 A	0.01 A	\pm (1.0% + 5 digits)	75mV/A
AC Amps	400 μ A	0.1 μ A	\pm (0.5 + 1 digit)	100 μ V/ μ A
	4000 μ A	1 μ A	\pm (0.5 + 1 digit)	100 μ V/ μ A
	40 mA	0.01 mA	\pm (0.5 + 1 digit)	1.2 mV/mA
	400 mA	0.1 mA	\pm (0.5 + 1 digit)	1.2 mV/mA
	4 A	0.001 A	\pm (1.0% + 5 digits)	75mV/A
	10 A	0.01 A	\pm (1.0% + 5 digits)	75mV/A
Function	Range	Resolution	Accuracy	Open Cir.Voltage
Ohms	400 Ω	0.1 Ω	\pm (0.5% + 10 digits)	< 1.2 V
	4K Ω	1 Ω	\pm (0.5% + 10 digits)	< 1.2 V
	40K Ω	10 Ω	\pm (0.5% + 10 digits)	< 1.2 V
	400K Ω	0.1K Ω	\pm (0.5% + 10 digits)	< 1.2 V
	4M Ω	1K Ω	\pm (0.5% + 10 digits)	< 1.2 V
Continuity	n/a	n/a	Threshold: Approx <100 Ω	< 1.2 V
Diode Check	n/a	n/a	Max Test Current 2.5 mA	< 3V
Temperature	-40°C to 10°C	0.1°C	\pm (3.0°C + 1 digit)	
	-10°C to 20°C	0.1°C	\pm 3.0°C	
	20°C to 400°C	0.1C	\pm (1.0% + 2°C)	
	400°C -1,370°C	1°C	\pm 3.0% of reading	
Frequency (98 Only)	199.99	0.01Hz	\pm (0.05% +2 digits)	
	1999.8	0.1Hz	\pm (0.05% +2 digits)	
	19.999KHz	0.001KHz	\pm (0.05% +2 digits)	
	199.99KHz	0.01KHz	\pm (0.05% +2 digits)	
	200KHz	0.1KHz	n/a	
Frequency Automotive	199.99	0.01Hz	\pm (0.05% +2 digits)	
	1999.8	0.1Hz	\pm (0.05% +2 digits)	
RPM IP	30 - 9,000	1 RPM	\pm 2 RPM	
RPM IG	60 - 12,000	1 RPM	\pm 2 RPM	
Pulse Width	1999.9	.01 mS	\pm (0.05% +2 digits)	
	5.00	0.01 mS	\pm (0.05% +2 digits)	
% Duty Cycle	99.9%	0.1 %	n/a	
Dwell	356.4°	0.1 °	n/a	
Capacitance (98 Only)	1 μ F	0.001 μ	\pm (1.7% + 5 digits)	
	10 μ F	0.01 μ F	\pm (1.7% + 5 digits)	
	100 μ F	0.1 μ F	\pm (1.7% + 5 digits)	
	1000 μ F	1 μ F	\pm (1.7% + 5 digits)	

Features

Safety Shutter

The Safety Shutter protects you from inadvertent connection to the current terminals. If the meter is set to measure volts, the safety shutter will block the current jacks to prevent the improper insertion of test leads.

Adjustable Trigger Levels

Allows the measurement of different types of systems. The adjustable trigger works when the meter is in Duty Cycle, Pulse Width, Frequency, RPM IP or Dwell.

CE Certified

The meter is designed and tested according to IEC Publication 1010-1 (EN 61010-1:1993) (Overvoltage Category II), the EMC Directive (EN 50081-1:1992 and EN50082-1:1992), UL 1244, UL 201, CSA C22.2 No. 231 and ISA-DS82.

Protective Holster

Grey Holster protects the meter from damage due to accidental drops. The built in stand holds the unit at a convenient working angle.

Storage Case

Molded storage case holds Meter, Inductive Pickup, Test Leads, Manual, and optional accessories.

Frequency and Pulse Measurements

Accurate frequency and pulse measurements with 20000 count on the high resolution 4000 count display.

High Speed Bar Graph

Provides an analog representation of readings and updates 20 times per second. The 2 x 41 segment bar graph illuminates from left to right as the input increases. The bargraph is easier to read when the data causes the digital display to rapidly change. It is also useful for trend setting or directional data.

Direct Reading of Dwell

No need to use a Duty Cycle to Dwell conversion chart. Directly read Dwell when testing electronic fuel injection, feedback carburetors, and ignition systems.

Temperature Measurements

Uses a Type K thermocouple to measure temperature quickly and accurately. Any standard Type K thermocouple can be used with the Meter.

RS-232 Communications (Model 98 Only)

The RS-232 connection and software supports long term data gathering. All measurements on the Model 98 are supported.

Backlight

Makes the display easy to read in dark or poorly lighted areas.

Function Buttons

Automatically captures a stable reading, beeps to acknowledge, and holds it on the LCD. In Recording, Compare, Relative or Percentage Mode, the Hold button simply freezes the reading. If you press and hold the HOLD button for 2 seconds, the backlight will turn on. Backlight turns off automatically after 60 seconds to extend battery life. (Model 98 Only)



Press the REC button to enter the Recording mode. The "R" symbol on the LCD turns on. This function allows you to record Maximum, Minimum and Average values for a series of measurements on the same function and range. The Meter will beep every time a new max. or min. value is recorded. Press the REC button to scroll through the stored MAX, MIN and AVG values. When an overload is captured, a beeper tone emits and the Meter displays O.F.L. This overload is not recorded. The Meter will record for 24 hours in this mode.



Press the REL button to displays the difference between the currently measured value and a previously stored value. Low resistance measurements are made more accurate because it zeroes out test lead resistance.



Press the RANGE button to select the Manual Range mode and turn off the "AT" symbol. The Meter remains in the range it was in when manual ranging was selected. Each time you press the RANGE button the range increases and a new value is displayed. If you are in the highest range, the Meter wraps around to the lowest range. To exit the Manual Range mode and return to autoranging, press and hold down the RANGE button for 2 seconds. The "AT" symbol on the LCD1 turns back on. Selects the Number of Cylinders when the Meter is in the RPM IG or Dwell mode. Selects 2-Cycle or 4-Cycle in the RPM IP mode.



When the Meter is in the RPM IG you can select RPM, Duty Cycle, Pulse Width and Frequency by pressing this button.



When the Meter is in the RPM IG mode, press this button to select the Dwell measurement mode.



The trigger level has seven steps and is different for each function. Press the \pm TRIG button to move one step at a time for selecting a suitable trigger level. Press and hold the button for 2 seconds to toggle between a negative and positive trigger slope. The analog bar graph will give you an indication of what trigger level you have selected.



Press the DC/AC button to toggle between DC and AC when measuring volts or current. If you select the TEMP function, pressing this button will toggle between $^{\circ}$ C and $^{\circ}$ F.

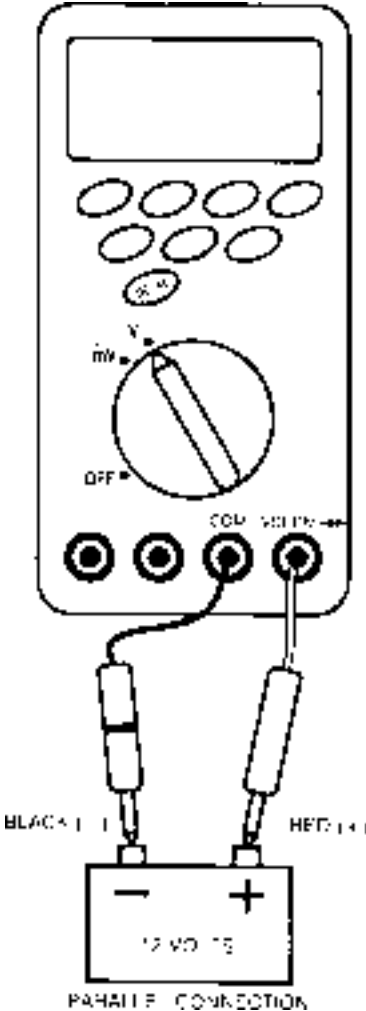


Voltage

WARNING!

TO AVOID THE RISK OF ELECTRICAL SHOCK AND INSTRUMENT DAMAGE, INPUT VOLTAGES MUST NOT EXCEED 1000V DC OR 750V AC RMS. DO NOT ATTEMPT TO TAKE ANY UNKNOWN VOLTAGE MEASUREMENT THAT MAY BE IN EXCESS OF 1000V DC OR 750V AC RMS.

NOTE: When taking voltage measurements, this Meter must be connected in PARALLEL with the circuit, or circuit element under test.



To Measure Voltage:

Select the Voltage (V or mV) range with the rotary switch.

Press the DC/AC button to select AC or DC.

Insert the Black lead in the COM jack.

Insert the Red lead in VΩRPM jack.

Touch the Black probe to the negative (-) circuit or to ground.

Touch the Red probe to the circuit coming from the power source.

Accuracy

A measurement range determines the highest value the Meter can measure. Most Meter functions have more than one range. Being in the right measurement range is very important when measuring. Selection of a lower range will move the decimal point one place and increase the accuracy of the reading. An O.F.L (overload) display means the range is too low; select the next higher range.

Analog Bar Graph

The bar graph is easier to read when the data causes the digital display to rapidly change. It is also useful for trend setting or directional data.

Safety Shutter

When measuring voltage, be sure the Red test lead is in the input jack marked "V". If the test lead is in an A or mA, A jack, you may be injured or the Meter damaged. The Safety Shutter of the Meter frees you from inadvertent connection to the current terminals.

Usable Function Buttons



Resistance

Resistance is measured in Ohms(Ω) and the values can greatly vary from a few Milliohms ($m\Omega$) for contact resistance to billions of ohms for insulators. The Meter can measure down to about 0.1 Ohms and measure as high as 40M Ω .

WARNING!

TURN OFF POWER AND DISCHARGE ALL CAPACITORS ON CIRCUIT TO BE TESTED BEFORE ATTEMPTING IN CIRCUIT RESISTANCE MEASUREMENTS. ACCURATE MEASUREMENT IS NOT POSSIBLE IF EXTERNAL OR RESIDUAL VOLTAGE IS PRESENT.

NOTE: The resistance in the test leads can affect accuracy in the 400 Ω range. Short the leads together and press the REL button to automatically subtract the test lead resistance from the resistance measurements.

To Measure Resistance:

Select the Resistance (Ω) setting with the rotary switch.

If a more accurate measurement is desired, select the proper Resistance range using the RANGE button.

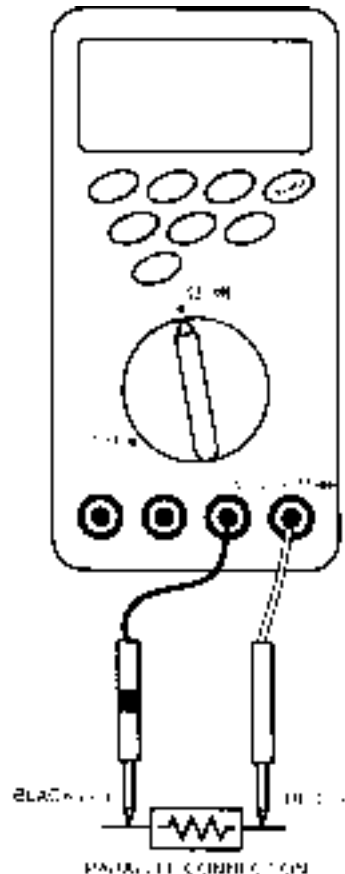
Insert the Black lead in the COM jack.

Insert the Red lead in the V Ω RPM jack.

Touch the test lead probes across the resistance or circuit to be tested.

Accuracy

Rapidly changing display readings (noise) can sometimes be eliminated if you change to a higher range. You can also smooth out noise somewhat by using the averaging (AVG) feature of the Recording function.



Usable Function Buttons

HOLD

REC

REL

RANGE

Continuity

A DMM with a continuity beeper allows you to quickly and easily distinguish between an open and a closed circuit. The Meter beeps when it detects a closed circuit or short, so you do not have to look at the Meter during the test. This can be a valuable troubleshooting aid when determining good or blown fuses and fusible links, open or shorted conductors and wires, the operation of switches, etc.

NOTE: Turn the power off to the circuit to be tested. A beeper tone does not necessarily mean zero resistance.

To Test Circuit Continuity:

- Select the Ω setting with the rotary switch and press the DWL button to select the continuity range.

A symbol will appear on the display and the Meter defaults to the 4K Ω range.

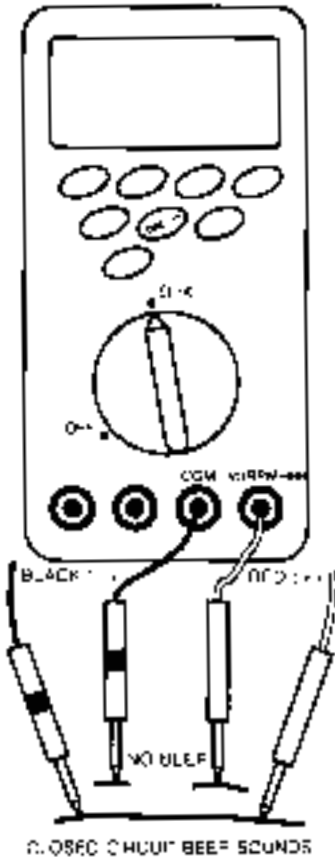
Insert the Black lead in the COM jack.

Insert the Red lead in the V Ω PM jack.

Connect one test probe to each end of the circuit to be tested.

If the circuit is closed, the Meter will beep at < 100 Ω .

If circuit is open, there is no beep.



Diode Check

A diode is an electronic switch that allows current to flow in one direction only. It turns on when the voltage is over a certain level, generally greater than 0.3 Volts for a silicon diode. The Meter has a special mode called "Diode Check". In this mode, the readings across the diode will typically be greater than 0.7 Volts in one direction, and indicate an open circuit in the other direction. This indicates a good diode.

NOTE: Turn the power OFF to the circuit to be tested.

To Check a Diode:

Select the  setting with the rotary switch.

Insert the Black lead in the COM jack.

Insert the Red lead in the the VΩRPM jack.

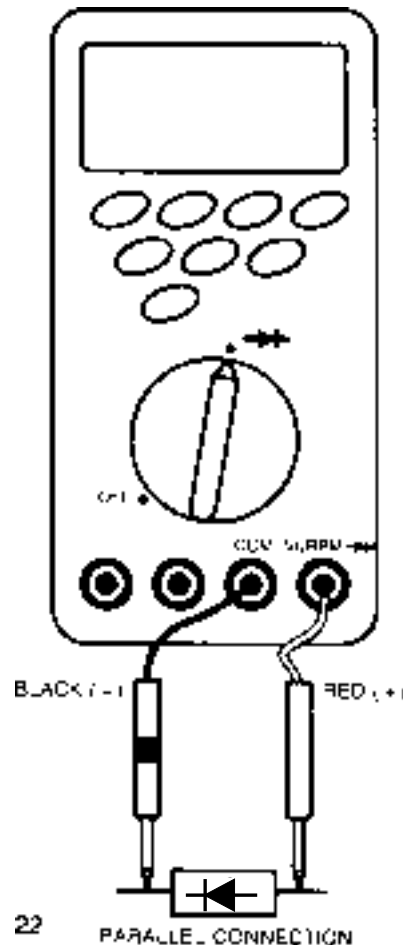
Touch the Black test probe to the negative (-) side of the diode.

Touch the Red test probe to the positive (+) side of the diode.

If the diode is good, the reading should indicate 0.3V to 0.8V on the LCD.

Reverse the probes. If the LCD reads O.F.L. (the overload sign), the diode is good.

NOTE: A defective diode will read O.F.L. (overload) between 1.0 to 3.0V in both directions or have the same reading no matter how the test leads are connected.



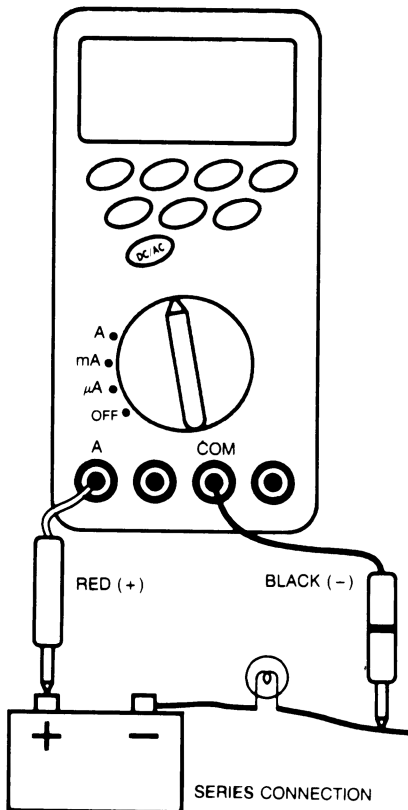
Current

CAUTION

THE CURRENT FUNCTIONS ARE PROTECTED BY A FUSE OF 600 VOLT RATING. TO AVOID DAMAGE TO THE INSTRUMENT, CURRENT SOURCES HAVING OPEN CIRCUIT VOLTAGES GREATER THAN 600 VOLTS DC OR AC MUST NOT BE MEASURED.

NOTE: When making current measurements, this Meter must be connected In SERIES with the circuit (or circuit element) under test. **NEVER CONNECT THE TEST LEADS ACROSS A VOLTAGE SOURCE** while the rotary switch is set to Amps. This can cause damage to the circuit under test or this Meter.

For current measurements of more than 10A use an Inductive Current Probe.



To Measure Current:

Turn off all power to the circuit or disconnect the circuit from the power source.

Disconnect, cut or unsolder the circuit, creating a place where the Meter probes can be inserted.

Select the AMP (A, mA or μ A) range with the rotary switch.

Press the DC/AC button to select DC or AC.

Insert the Black lead in the COM jack.

Insert the Red lead in the A or mA/ μ A Jack.

Connect the Red probe to the side of the circuit closest to the power source.

Connect the Black probe to the side of the circuit to ground.

Turn the circuit power back on and test.

Usable Function Buttons

DC / AC

HOLD

REC

REL

RANGE

Temperature

CAUTION

DO NOT ALLOW TEMPERATURE PROBES TO CONTACT ANY LIVE VOLTAGE THAT MAY EXCEED 30V AC RMS OR 42V AC PEAK OR 60V DC. UNPLUG TEMPERATURE PROBE BEFORE TAKING MEASUREMENTS OTHER THAN TEMPERATURE. TO AVOID HEAT DAMAGE TO THE METER, KEEP IT AWAY FROM SOURCES OF VERY HIGH TEMPERATURE. THE LIFE OF A TEMPERATURE PROBE IS ALSO REDUCED WHEN EXPOSED TO VERY HIGH TEMPERATURES (OPERATING RANGE IS -40°F TO $2,498^{\circ}\text{F}$).

NOTE: The Meter automatically defaults to the Centigrade-scale. To measure In Fahrenheit, toggle the DC/AC button when the rotary switch is set to TEMP position.

To Measure Temperature:

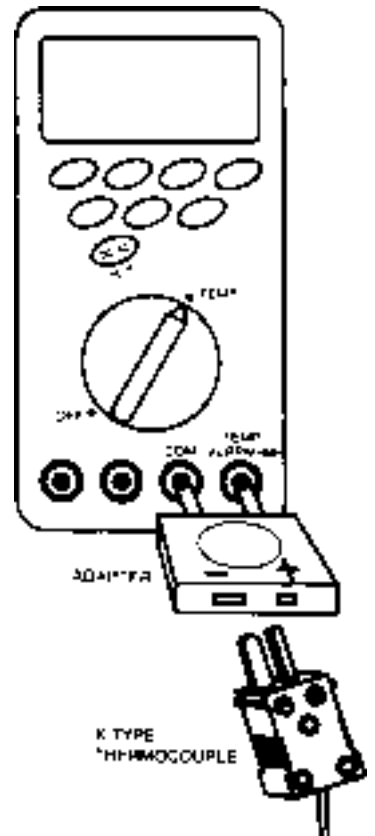
Select the TEMP setting with the rotary switch.

Press the DC/AC button to toggle between $^{\circ}\text{C}$ and $^{\circ}\text{F}$.

Insert the thermocouple adaptor and thermocouple into the $\text{V}\Omega\text{RPM}$ and COM jack.

Touch the end of the K-type thermocouple to the area or surface of the object to be measured.

NOTE: To avoid error, it is very important to use a thermocouple adaptor whose materials match the thermocouple you are using.



Usable Function Buttons

DC/AC

HOLD

REC

REL

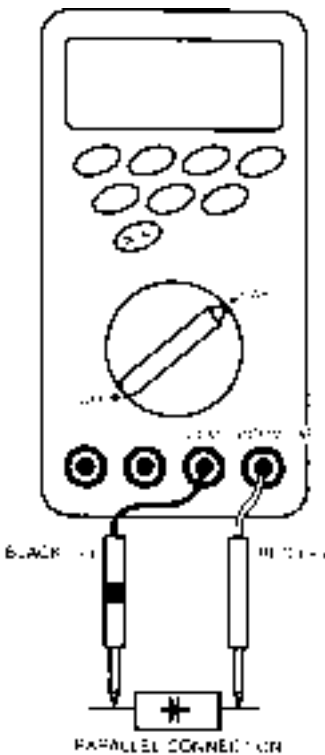
RANGE

Capacitance (98 Only)

CAUTION

TURN THE POWER OFF TO THE CIRCUIT TO BE TESTED. DISCHARGE THE CAPACITOR BY SHORTING THE CAPACITOR LEADS TOGETHER. USE THE DC VOLTS FUNCTION TO CONFIRM THAT THE CAPACITOR IS DISCHARGED.

NOTES: Holding the probes with your hands may charge the capacitor in circuit and generate a false reading. Residual voltage charges on the capacitor, poor insulation resistance or poor dielectric absorption may cause measurement errors. If more discharge is necessary, the Meter displays "d.I.S.C." while the capacitor is discharging. In $1/\mu\text{F}$ range, the readings are probably unstable due to environmentally induced electrical noise and floating capacity of the test leads. Therefore, directly connect the capacitor to the input terminals.



To Measure Capacitance:

Select the Capacitance (CAP) setting with the rotary switch.

The Meter will automatically select a suitable range from $1\mu\text{F}$ to $1000\mu\text{F}$.

Insert the Black lead in the COM jack.

Insert the Red lead in the VΩRPM CAP jack.

Touch the test probes to the capacitor and read the display. When measuring polarized capacitors, connect the positive to the VΩRPM CAP jack and the negative to the COM jack.

Please note that large value capacitors may take up to 5 seconds or more to measure and display the results.

Automotive Frequency

Frequency (Hz) is the number of times a voltage pattern repeats positive compared to negative, On Compared to Off, during 1 second of time. There are many sensors and signals on a vehicle that have a frequency that can be measured. Wheel Speed sensors, Vehicle Speed sensors, Fuel Injector control signals, Cam and Crank outputs and engine reference signals are good examples.

This example measures the frequency output of a digital Mass Air Flow sensor. Depending on the type of MAF sensor, the output can be from several hundred to ten thousand Hz.

NOTE: Although similar in appearance, MAF sensors made by different manufacturer's function differently, have different frequency range's square waves and are not interchangeable. Voltage level of square waves should be consistent. Frequency should change smoothly with engine load and speed.

To Measure Frequency (Hz):

Select the RPM IG range with the rotary switch.

Press the % DUTY button until Hz appears on the right side of the display.

Insert the Black lead in the COM jack.

Insert the Red lead in the V Ω RPM jack.

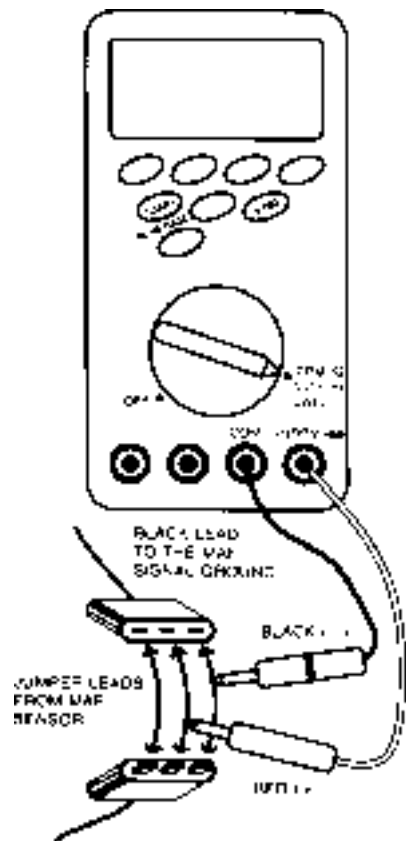
Connect Jumper wires between the MAF sensor and the harness connector.

Connect the Black test probe to the ground jumper wire.

Connect the Red test probe to the signal output jumper wire.

Start the engine. At idle, note the frequency displayed on the Meter. Move the throttle and note the change in frequency displayed.

If reading is unstable, adjust the trigger level by pressing the +TRIG button repeatedly.



Usable Function Buttons

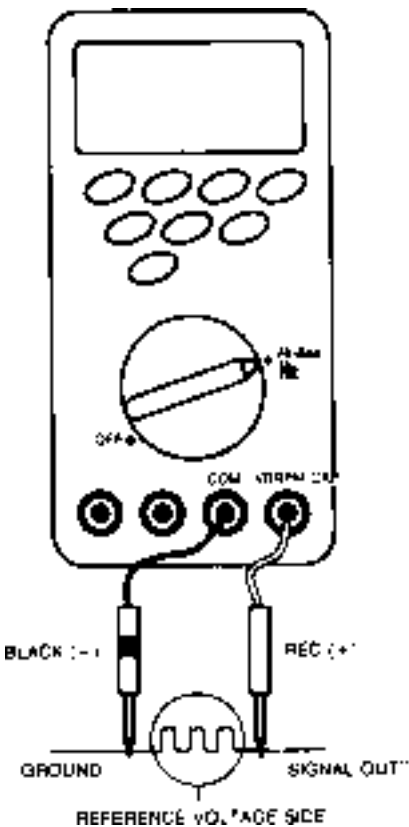


High Sensitivity Frequency (98 Only)

The 98 has two frequency measurement modes; High Sensitivity for general frequency counter mode and the Hz of RPM IG mode for the automotive measurement.

In the HI-Sen Frequency counter mode, the Meter autoranges to one of four ranges: 199.99Hz, 1999.9Hz, 19.999KHz and 199.99KHz.

If the input signal is below the trigger level, frequency measurement will not be taken. If your readings are unstable, the input signal may be near the trigger level for that range. You can usually correct this by selecting a lower range by using the RANGE button. If your readings seem to be a multiple of what you expected, your input signal may have distortion or ringing like the signals from electronic motor controls. In this case, use the Hz of RPM IG mode to get the correct reading.



To Measure Frequency (Hz):

Select the Hi-Sen Hz setting with the rotary switch.

Insert the Black lead in the COM jack.

Insert the Red lead in VΩRPM CAP jack.

Connect the Black test probe to GROUND side.

Connect the Red test probe to the "SIGNAL OUT" wire of the object to be tested.

NOTE: The display will show 00.00Hz for frequencies below 0.5Hz.

Inductive RPM

RPM refers to revolutions per minute. Using the inductive pickup, which comes with the Meter, RPM can be measured by clamping it around any spark plug wire of a two stroke or a four stroke automotive engine.

Using the inductive pickup allows you to make RPM measurements on any 2 or 4 stroke automotive engine with any number of cylinders without physically touching any wires.

WARNING

THE IGNITION SYSTEM CAN GENERATE A POTENTIAL SHOCK HAZARD. ENSURE THAT THE ENGINE IS OFF BEFORE CONNECTING OR REMOVING THE INDUCTIVE PICKUP.

To Measure RPM:

Select the RPM IP range with the rotary switch.

Press the RANGE button to select either 2 or 4 stroke engine.

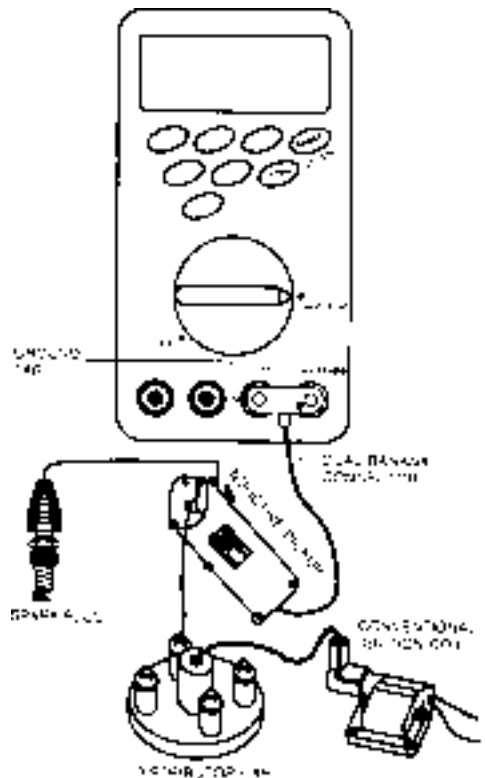
Insert the Black lead from the Inductive Pickup in the COM jack.

Insert the Red lead from the Inductive Pickup in the V Ω RPM jack.

Connect the inductive pickup to a spark plug wire and start the engine. If no reading is received, unhook the pickup and turn it over, and connect again.

If the reading is too high or unstable, adjust the trigger level.

NOTES: Position the pickup as far away from the distributor and the exhaust manifold as possible. Position the pickup within six inches of the spark plug or move it to another plug wire if no reading or an erratic reading is received.



Usable Function Buttons

DC / AC

HOLD

REC

REL

RANGE

± TRIG

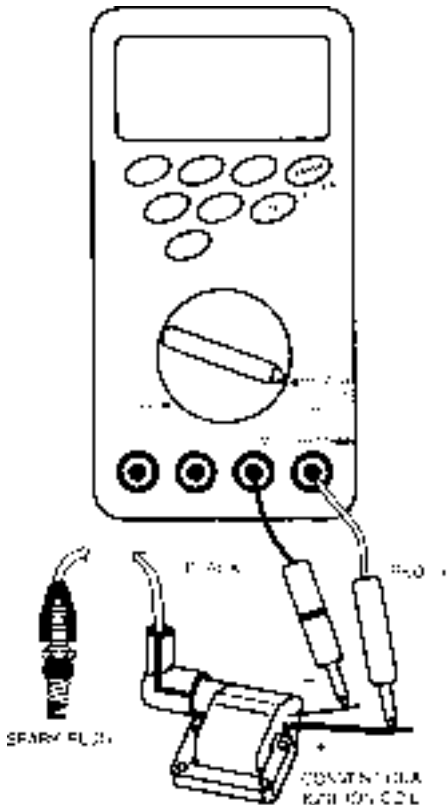
Primary RPM

This exercise shows how to measure RPM using the test leads from the primary side of the regular conventional distributor type ignition coils. In order to measure RPM, you need to determine whether you have a two stroke or a four stroke engine and the number of cylinders.

When the RPM IG setting is first selected, the Meter defaults to four strokes and four cylinders so that RPM IG, 4 STR, 4 CYL, and TRIG - appear on the display. If you want to select a different number of cylinders, press the CYL (RANGE) button repeatedly to cycle through the number of cylinders up to 12. In the RPM IG, the number of strokes can not be changed. If you want to change the number of strokes, you must go to the RPM IP to change strokes by pressing the STR (RANGE) button and then return to the RPM IG mode.

WARNING!

THE IGNITION SYSTEM CAN GENERATE A POTENTIAL SHOCK HAZARD. ENSURE THAT THE ENGINE IS OFF BEFORE CONNECTING OR REMOVING THE TEST LEADS.



To Measure RPM:

Select the RPM IG range with the rotary switch.

Press the RANGE button to select the required number of cylinders.

Insert the Black lead in the COM jack.

Inset the Red lead in the VΩRPM jack.

Connect the Black test probe to any good ground near the coil.

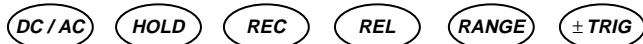
Connect the Red test probe to the primary side of the ignition coil.

Start the engine and note the reading on the display while moving the throttle.

If the reading is too high or unstable, adjust trigger level.

NOTE: Before measuring RPM, consult the car's service manual to obtain the information on the number of strokes and cylinders for the car's engine to be tested.

Usable Function Buttons



Duty Cycle

Duty Cycle is the percentage (%) of time that a voltage is positive compared to negative: On compared to Off. There are many signals on a vehicle where you might be required to measure duty cycle. Signals from the Mixture Control Solenoid of a feedback carburetor, signals from Cam or Crank sensors and the control signals for fuel injectors are good examples.

This exercise shows how to measure duty cycle on the signal for the mixture control solenoid of a feedback carburetor using the Meter.

To Measure Duty Cycle (%):

Select the RPM IG range with the rotary switch.

Press the %DUTY button until % appears on the right side of the display.

Insert the Black lead in the COM jack.

Inset the Red lead in the V Ω RPM jack.

Connect the Black test probe to a good ground at the carburetor or the negative (-) vehicle battery post.

Connect the Red test probe to the solenoid signal.

Press the + TRIG button for 2 seconds to toggle between the negative (-) and positive (+) slope.

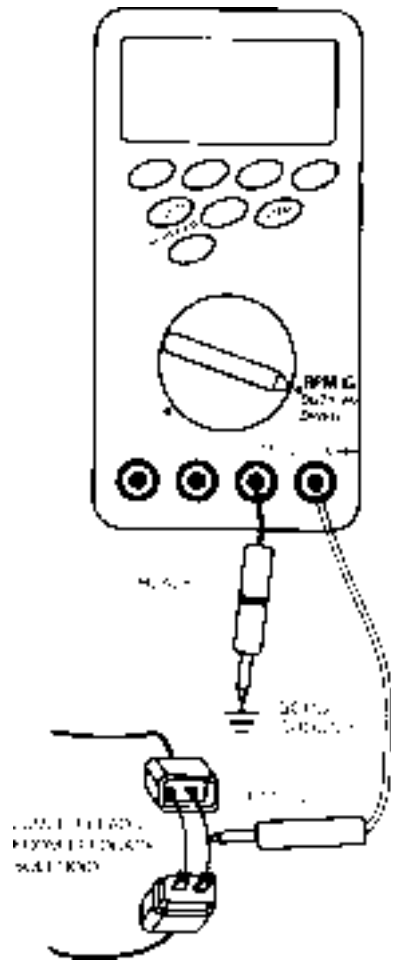
Start the engine. A duty cycle of approximately 50% should be read.

Adjust the trigger level by pressing the + TRIG button repeatedly if reading is too high or unstable.

Most cars have the points of the solenoid closed for a duty cycle between 50-70%.

Once the engine warms up and goes into open loop, the duty cycle should fluctuate.

NOTE: Consult the car's service manual to verify the slope assigned to position for each component.



Usable Function Buttons



Pulse Width

Pulse Width is the length of time an actuator is energized. For example, fuel injectors are activated by an electronic pulse from the Engine Control Module (ECM). This pulse generates a magnetic field that pulls the injector nozzle valve open. The pulse ends and the injector nozzle is closed. This Open to Close time is the Pulse Width and is measured in milliseconds (mS).

The most common automotive application for measuring pulse width is on fuel injectors. You can also measure the pulse width of the fuel mixture control solenoid and the idle air control motor.

This exercise shows how to measure Pulse Width on Port Fuel Injectors.

To Measure Pulse Width (mS):

Select the RPM IG range with the rotary switch.

Press the % DUTY button until mS appears on the right side of the display.

Press the + TRIG button for 2 seconds until the negative (-) trigger slope is displayed on the lower left side of the display.

NOTE: The applied time for most fuel Injectors is displayed on the negative (-) slope.

Insert the Black lead in the COM jack.

Inset the Red lead in the VΩRPM jack.

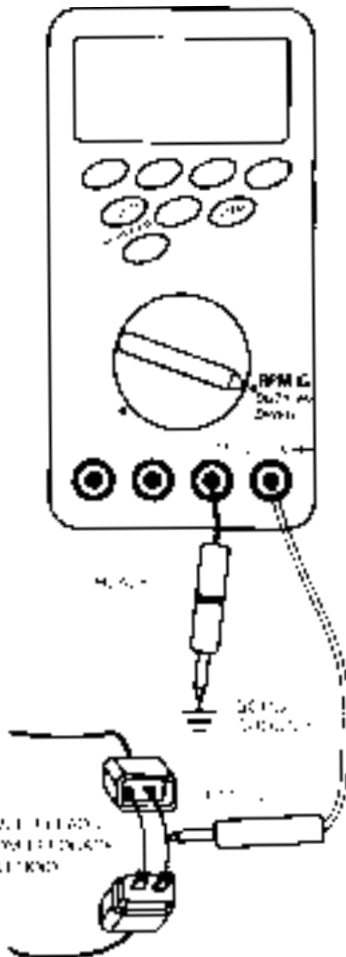
Connect jumper wires between the fuel injector and the harness connector.

Connect the Black test probe to a good ground at the fuel injector or the negative (-) vehicle battery post.

Connect the Red test probe to the fuel injector solenoid driver input on the jumper cable.

Start the engine. A pulse width in milliseconds should be read.

If reading is too high or unstable, adjust the trigger level by pressing the + TRIG button repeatedly.



Usable Function Buttons



Dwell is the number of degrees of distributor rotation where the points remain closed. Dwell can be measured for 1,2,3,4,5,6,8,10,12 cylinder engines using the Meter.

In the Dwell mode, the Meter defaults to 4 cylinders and the negative (-) slope so DWL°, 4 CYL, TRIG, and - appear on the display. Press the CYL (RANGE) button repeatedly to select the required number of cylinders.

To Measure Dwell:

Select the RPM IG range with the rotary switch.

Press the DWL button until DWL°, 4 CYL, TRIG, and - appear on the display.

Insert the Black lead in the COM jack.

Insert the Red lead in the VΩRPM jack.

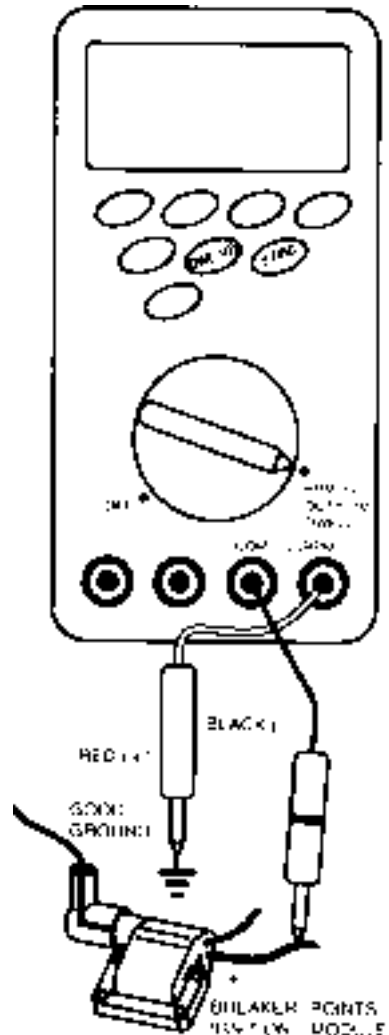
Connect the Red test probe to a good ground or the negative (-) vehicle battery post.

Connect the Black test probe to the wire that connects to the breaker points.

Press the CYL (RANGE) button repeatedly to select the required number of cylinders.

Start the engine and observe the reading.

Adjust trigger level pressing the ±TRIG button repeatedly, if the reading is too high or unstable.



Usable Function Buttons

DC / AC

HOLD

REC

REL

RANGE

± TRIG

RS-232 Communications

RS-232C is a standard for a serial communications interface commonly used between computers, terminals, and modems. This Meter is capable of RS-232C interface with a Windows computer by using its bidirectional RS-232C serial interface cable and the software included with this Meter (Model 98 Only).

Interfacing the Meter with a Personal Computer

Follow these steps to interface the Meter with a Windows or Windows 95 computer.

1. Connect the RS-232C cable to an available serial port on the computer. Plug the DB9 male connector into the RS-232C terminal on the back of the Meter. The RS-232C driver is powered by + 12V supplied from the interfaced computer through "DTR" and "RTS" pins of the DB25 female connector.

The RS-232C connector's pin configuration is as follows:

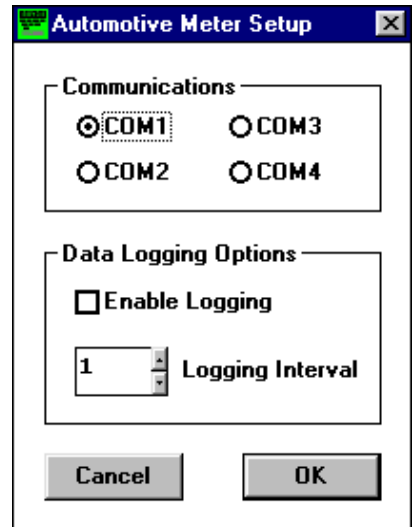
< DMM >	< Computer >
2	3 RXD
3	2 TXD
4	20 DTR
5	7 GND
7	4 RTS

2. Turn on the Meter and Press the RS-232C (REL) button for 2 seconds to activate the RS232C communication. The symbol 'RS-232C' will appear on the LCD.
3. Insert the Floppy disk labeled Auto meter 1 of 1 into your computer.
4. Run the program called Setup found on Disk 1. Follow the on screen prompts.
5. Run the program AUTOMTR.
6. Now you will have access to various functions of the Meter using the menu and your computer . You can log data and control the buttons of the Meter.

Setting up the Software

From the Data Menu, access Setup. A screen will appear that will allow you to pick which COM port you want to use. A warning is displayed if the COM port selection is invalid. Your COM port selection is invalid if the port is already in use or is otherwise not available.

The data logging software will record data from once every second to once every 9999 seconds.



RS-232 Communications

Using the Software

Once the program screen is displayed you can control many aspects of the meter. You will need to turn the rotary knob on the meter to select which measurement you would like to take. All buttons, however, can be controlled from the PC.

The status box at the bottom of the screen will indicate what measurement you have selected. If "No Meter" appears in the box, see the Communication Problems section.

The buttons perform the same functions on the meter whether they are activated using the software, or the meter. If you would like a detailed explanation of how to control each button through software, access the Help Menu and select Buttons Help.

Through the Data Menu you can enable logging. This will cause the computer to begin recording information from the meter based on the functions you have selected.

Graphing Data

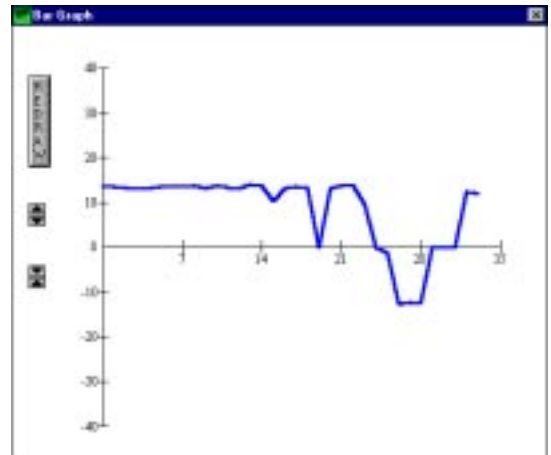
By Selecting Bar under the Graph menu, a graph of the data will be displayed. Buttons on the Left hand side of the display will Redraw the screen, or expand or contract the range of the vertical scale.

Communication Problems

The communication setup is very simple. Problems can be cleared up easily if you use the following check list.

1. Is the Meter turned on, and the RS-232 indicator on the meter's LCD display on?
2. Have you selected an appropriate COM Port?
3. Is your data cable connected and of the proper configuration?

All other difficulties can be handled by calling (800) 627-5655.



Service & Technical Support

REPAIRS OR SERVICING NOT COVERED IN THIS MANUAL SHOULD ONLY BE PERFORMED BY QUALIFIED PERSONNEL. TO AVOID ELECTRICAL SHOCK, DO NOT SERVICE UNLESS YOU ARE QUALIFIED TO DO SO.

Technical Support

Questions or inquiries about service can be answered by contacting Ferret at: Ferret Instruments, Inc., 1310 Higgins Drive, Cheboygan, MI 49721. (616) 627-5664, Fax: (616) 627-2727, Toll Free (800) 627-5655.

Routine Service

Periodically wipe the case with a damp cloth and detergent; do not use abrasives or solvents. Water, dirt, or contamination in the A or mA/A input terminals may harm this Meter. Calibrate this Meter once a year to maintain its performance specifications.

Battery Replacement

The Meter uses a 9V battery (NEDA 1604 or IEC 6F22). To replace the battery, remove the two screws of the battery compartment from the back of the Meter and lift off the cover of the compartment. Replace the battery. Reattach the battery compartment to the back of the Meter, and reinstall the screws.


Replacement Parts

RPM Pickup with Banana Jacks	952
Black Test Lead	W090-00
Red Test Lead	W090-01
Temperature Adapter	W096-01
Temperature Probe	W096-02
Software for 98	X098-PC

Service & Technical Support

Fuse Test

To test the internal fuses of this Meter:

Set the rotary switch to the “” position.

To test F2 (15A, 600V), insert a test lead into the $V\Omega$ RPM input terminal and touch the probe to the A input terminal. The display should read about 0.000V. If the display reads O.F.L. (overload), replace the fuse and test again. If the display reads any other value, have this Meter serviced.

To test F11 (1A, 600V) fuse, move the probe from the A input terminal to the mA μ A input jack. The display should read about 1.2V. If the display reads O.F.L. (overload), replace the fuse and test again. If the display reads any other value, have this Meter serviced.

Fuse Replacement

Follow these steps to replace the internal fuse(s).

1. Unplug the test leads. Remove the rubber boot from the instrument.
2. Remove the screws in the rear of the instrument and separate the front and rear housing.
3. Replace the fuse(s) with the same type and size as the one removed.
4. Snap the front and rear housing back together and reinstall the screws.
5. Reattach the rubber boot.

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SAFETY PRECAUTIONS

—Read All Instructions Before Using The Meter—

Exceeding the limits of this meter is Dangerous. It will expose you to serious or possible fatal injury. Carefully read and understand the cautions and the specifications limits of this meter.

Do not try to measure any voltage that exceeds 1000V DC or 750V AC RMS. Voltages above 60V DC or 25 VAC RMS may constitute a serious shock hazard.

Circuit tested must be protected by a 15A fuse or circuit breaker.

Do not attempt to use this Meter if either the Meter or the test leads have been damaged.

Use a current clamp to measure circuits exceeding 10A.

Avoid electrical shock: do not touch the test leads, tips or the circuit being tested.

Select the proper function and range for the measurement. Do not try voltage or current measurements that may exceed the ratings marked on the input limit for switch or terminal.

Never connect more than one set of test leads to the Meter.

Disconnect the live test lead before disconnecting the common test lead.

Battery gas is highly explosive. If a battery explodes flush the acid away from skin with generous amounts of water. Follow up with a neutralizing solution of baking soda and then more water.

Never use a wrench on the ungrounded battery terminal until the grounded one has been disconnected. Contact between the vehicle body metal and the hot terminal can cause sparks to ignite gas or even weld tools into a battery short circuit.

Keep the space around a battery well ventilated. Do not make sparks or allow flames near batteries.

Before working on a vehicle set the brakes and block the wheels. Beware of automatic parking brake releases.

Keep your work area well ventilated and free of exhaust.

Avoid electrical shocks caused by getting close to live ignition wires or touching the coil TACH terminal. A person's reaction near a live engine can be more damaging than the shock.

Keep spark producing devices at least 0.5m (18") above the floor to reduce the hazard of igniting gasoline vapor.

Do not let test leads wind up in a moving fan or pulley. Route leads away.

Remove finger rings and metal wrist bands. They can short terminals and become very hot from electric current.