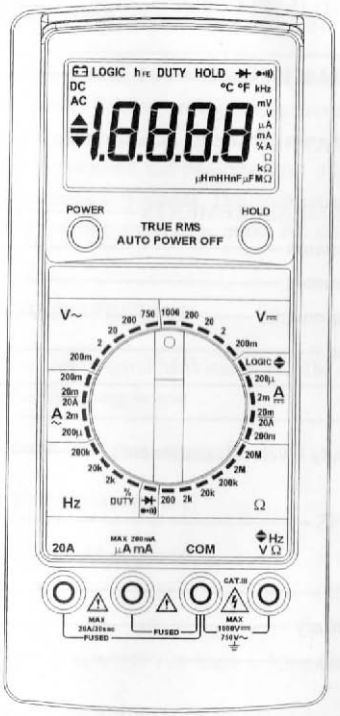
OPERATING INSTRUCTIONS

DIGITAL MULTIMETER



CE

CONTENTS

INTRODUCTION

This manual contains information and warnings which must be followed to ensure safe operation and retain the meter in safe condition.

WARNING
READ "SAFETY INFORMATION" BEFORE USING THE METER.

This multimeter is a handheld, 20000-count instrument that is designed for use in the laboratory, field servicing, and at home. This meter features compact design with rounded corners for easy handling and has a rugged case in shock resistant and fire-retardant. Electronic overload protection for all functions and ranges. The Protective Holster (optional accessory) combined with rugged case make it a durable and reliable instrument.

UNPACKING AND INSPECTION

Upon removing your new Digital Multimeter (DMM) from its packing, you should have the following items:

1. Digital Multimeter
2. Test Lead Set (one black, one red)
3. 9-Volt Battery (installed in meter)
4. Instruction Manual
5. One Spare Fuse (500mA/500V, 6.3mm × 32mm, fast acting)

If any of the above items are missing or are received in a damaged condition, please contact the distributor from whom you purchased the unit.

SAFETY INFORMATION

The following safety precautions must be observed to ensure maximum personal safety during the operation, service and repair of this meter:

1. Read these operating instructions thoroughly and completely before operating your meter. Pay particular attention to WARNINGS which will inform you of potentially dangerous procedures. The instructions in these warnings must be followed.
2. Always inspect your meter, test leads and accessories for any sign of damage or abnormality before every use. If any abnormal conditions exist (e.g.-broken test leads, cracked cases, display not reading, etc.), do not attempt to take any measurements.
3. Do not expose the instrument to direct sun light, extreme temperature or moisture.
4. Never ground yourself when taking electrical measurements. Do not touch exposed metal pipes, outlets, fixtures, etc., which might be at ground potential. Keep your body isolated from ground by using dry clothing, rubber shoes, rubber mats, or any approved insulating material.
5. To avoid electric shock use CAUTION when working with voltages above 40Vdc or 20Vac. Such voltages pose a shock hazard.
6. Never exceed the maximum allowable input value of any function when taking a measurement. Refer to the specifications for maximum inputs.
7. Never touch exposed wiring, connections or any live circuit when attempting to take measurements.
8. Do not attempt to operate this instrument in an explosive atmosphere (i.e. in the presence of flammable gases or fumes, vapor or dust).
9. When testing for the presence of voltage, make sure the voltage function is operating properly by reading a known voltage in that function before assuming that a zero reading indicates a no-voltage condition. Always test your meter before and after taking measurements on a known live circuit.
10. Calibration and repair of any instrument should only be performed by qualified and trained service technicians.
11. Do not attempt calibration or service unless trained and another person capable of rendering first aid and resuscitation is present.
12. Remember: Think Safety, Act Safely.

SAFETY INFORMATION

The instrument complies with class II, overvoltage CAT.III 1000V of the IEC 1010-1 (EN61010-1); UL3111-1; and CAN-CSA C22.2 No. 1010.010-30 standards. Pollution degree 2 in accordance with IEC-664 indoor use. If the equipment is used in a manner not specified, the protection provided by the equipment may be impaired.

⚠ ▣ When servicing, use only specified replacement parts or equivalent.

⚠ WARNING: To avoid electric shock disconnect measuring terminals before removing battery cover.

⚠ AVIS: Pour eviterle le choc electrique, debrancherles bornes de mmeaure avant d'enlever le capotage arriere.

The symbols used on this instrument are:

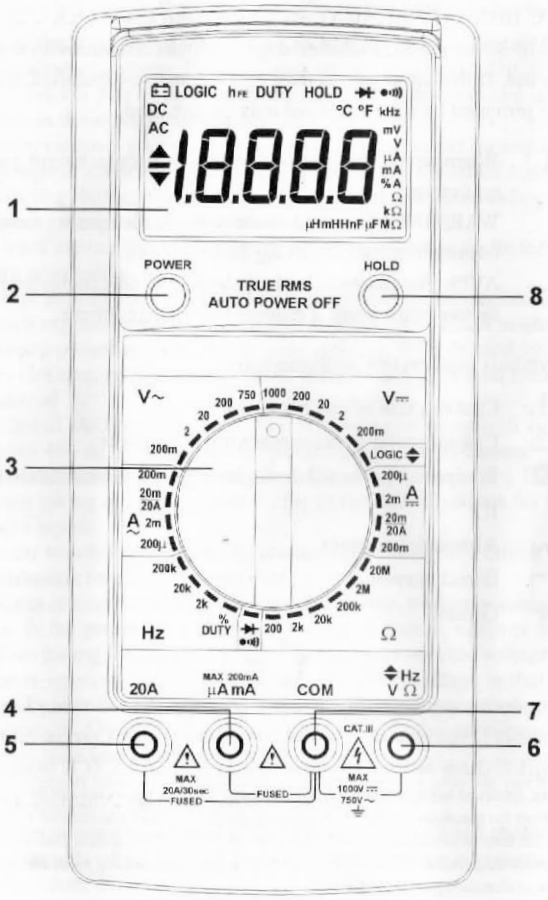
- ⚠ Caution, risk of electric shock
- ⚠ Caution, refer to accompanying documents
- ▣ Equipment protected throughout by Double insulation (Class II)
- ~ Alternating current
- ⎓ Direct current
- ⏚ Ground

CE

This product complies with the requirements of the following European Community Directives: 89/336/EEC (Electromagnetic Compatibility) and 73/23/EEC (Low Voltage) as amended by 93/68/EEC (CE Marking).

However, electrical noise or intense electromagnetic fields in the vicinity of the equipment may disturb the measurement circuit. Measuring instruments will also respond to unwanted signals that may be present within the measurement circuit. Users should exercise care and take appropriate precautions to avoid misleading results when making measurements in the presence of electromagnetic interference.

INSTRUMENT LAYOUT



1. **Display.** 4-1/2 digit display (19999 maximum) with automatic decimal point, polarity indication. high-low logic indicators, and low battery indicator. Indicates measured value, unit of measurement, and whether dc or ac is selected (for current and voltage readings). Overrange is indicated by displaying OL.

2. **Power Button**
   This switch is used to turn meter on or off.

3. **Function / Range Selector Rotary Switch**
   This rotary switch selects the function and range desired.

4. **µA mA Microamp/Milliamp Input Terminal**
   This is the positive input terminal for current measurement (ac or dc) up to 200 mA. Connection is made to it using the red test lead.

5. **20A 20 Amperes Input Terminal**
   This is the positive input terminal for current measurement (ac or dc) up to 20A. connection is made to it using the red test lead.

6. **V Ω Hz ⬍ ⊣◀ Volt, Ohms, Frequency, Logic, Diode Input Terminal**
   This is the positive input terminal for all functions except current measurements. Connection is made to it using the red test lead.

7. **COM Common Terminal**
   This is the negative (ground) input terminal for all measurement modes. Connection is made to it using the black test lead.

8. **Data Hold Button**
   Press (HOLD) button to toggle in and out of the Data Hold mode. In the Data Hold mode, the " HOLD " annunciator is displayed and the last reading is held on the display. Press the (HOLD) button again to exit and resume readings.

9. Other Functions

• Auto Power Off

Automatic power-off extends the life of the battery by turning the meter off. After approximately 45 minutes of inactivity. The meter turns back on if a POWER switch is pressed.

- **Input Warning Beeper**

The Input Warning Beeper is a feature to protect the meter and you from unintentional misuse. If the DMM is set to measure a voltage while the test leads are plugged into a current jack, very high current could result when the test lead tips are placed to the voltage test point. This feature warns you that the test lead needs to be changed from a current jack to the voltage jack.

All current ranges are fused with fast acting ceramic fuses as an added protection.

- **True RMS Measurements**

This multimeter permits direct measurement of the true RMS value of a signal. This is the best way to measure parameters used for measurements relating to power.

The relationship between the total true RMS (AC+DC) and the component AC and DC signals is given by the following expression:

$$\text{True RMS} = \sqrt{(\text{AC RMS Component})^2 + (\text{DC Component})^2}$$

RMS is equivalent to that DC value which dissipates the same amount of power in a resistor as the original signal and can be visualized by the relationships

$$\text{Power} = \frac{\text{VRMS}^2}{\text{R}} = \frac{\text{VDC}^2}{\text{R}}$$

" Average-responding " meters provide accurate RMS readings for sinusoidal signals, but can introduce significant errors when measuring nonsinusoidal waveforms.

The following table shows the errors that result when the average-responding measurement is used instead of the True RMS value.

Power Calculations (watts) from Voltage Measurements (Vpk=100V, Load=1kΩ resistor)			
	AC RMS average responding	AC True RMS	Error
Sine wave	5.0	5.0	0%
Square wave	12.3	10.0	+23%
Triangle wave	3.1	3.1	-6%

This multimeter is AC coupled and will accurately measure the AC RMS component of an input signal. The DC voltage function will measure the DC component. To obtain the total true RMS value, measure the RMS AC component on the AC function and the DC component on the DC function. Then, calculate the True RMS value, using the measured AC and DC components and the True RMS expression given above.

AC converters of all types are limited by their frequency response and input dynamic range. Measurements of complex waveforms will not be affected by converter bandwidth limitations, provide that all significant AC components contained within the waveforms are within the bandwidth of the converter.

Crest factor is a measure of the input dynamic range of an AC converter. It expresses the ability of the converter to accept a signal that has large peak values compared to its RMS value without saturating the converter circuitry and degading the specified accuracy. Crest factor is defined as the ratio of the peak voltage to the total AC RMS voltage.

$$\text{Crest Factor} = \frac{\text{V (PEAK)}}{\text{V (AC RMS)}}$$

CAUTION

A common abuse of multimetrs in to attempt to measure a voltage while the test leads are still plugged into the current input terminals. This basically puts a short circuit across the voltage source since current ranges have a low impedance. If the voltage source is typically 240VAC or a 3-phase industrial voltage (415V), very high fault currents can result. This is why all current input terminal are fused. If the fuses blow they must only be replaced by the equivalent ones otherwise the safety of the instrument may be impaired.

7. Never apply a voltage between the COM terminal and current terminals.

8. When switching between current ranges to obtain greater accuracy and better resolution, completely de-energize the circuit to be measured before changing the range.

RESISTANCE MEASUREMENTS

CAUTION

Turn off power on the test circuit and discharge all capacitors before attempting in-circuit resistance measurements. If an external voltage is present across a component, it will be impossible to take an accurate measurement of the resistance of that component.

1. Insert the BLACK and RED test leads into the COM and VΩ input terminals respectively.

2. Select the desired ohms (Ω) range.

3. Connect the BLACK and RED test probe tips to the circuit or device under test, making sure it is de-energizes first.

4. Test lead resistance can interfere when measuring low resistance readings and should be subtracted from resistance measurements for accuracy. Select lowest resistance range and make the test leads short together. The display value is the test lead resistance to be subtracted.

CONTINUITY TESTING

1. Select the (•)) position by turning the rotary selector switch.

2. Follow steps 1 and 3 as for resistance measurements. An audible tone will sound for resistance less than approximately 100Ω. After all measurements are completed, disconnect the test leads from the circuit and from the multimeter input terminals.

DIODE TESTING

CAUTION

Measurements must only be made with the circuit power OFF.

1. Set the rotary selector switch to the (→|←) position.

2. Follow steps 1 and 3 as for resistance measurements.

3. The RED lead should be connected to the anode and the BLACK lead to the cathode. The typical forward voltage drop should be about 0.7V for silicon diode or 0.4V for germanium diode.

4. If the diode is reverse biased or there is an open circuit the reading display shows "1".

LOGIC TESTING

1. Insert the BLACK and RED test leads into the "COM" and "VΩ" input terminals respectively.

2. Select the logic function by rotating the selector dial to the (◆) logic position.

3. Connect the BLACK probe tip to the Common Bus of the logic circuity to be measured.

4. Connect the RED probe tip to the point to be tested.

5. With a logic high pulse (1), the ▲ indicator will display in the LCD and a beeping sound will emit. With a logic low pulse (0), the ▼ indicator will appear in the LCD.

FREQUENCY AND DUTY CYCLE MEASUREMENTS

1. Set the rotary selector switch to the "Hz" range desired for a measurement.
2. Insert the BLACK and RED test leads into the "COM" and "VΩ" input terminals respectively.

> **CAUTION**
> The frequency ranges have overload protection to 500Vac/Vdc. DO NOT EXCEED THIS LIMIT. To do so could damage your multimeter.

3. Apply the test leads to the points across which the frequency is to be measured, and read the result directly from the display.
4. To make duty cycle test during frequency measurements, place the range selector switch into the "DUTY %" position. The display will indicate 0% to 90.0% of the frequency duty cycle.

SPECIFICATIONS

- **Display:** 4½ digits, 17mm large LCD maximum reading 19999 with function and unit sign annunciators.
- **Polarity:** Automatic, (-) negative polarity indication.
- **Overrange indication:** "1" most significant digit blinks.
- **Low battery indication:** The " ⊟ " is displayed when the battery voltage drops below the operating level.
- **Auto power off:** Meter automatically shuts down after approx. 45 minutes of inactivity.
- **Altitude:** 6561.7 feet (2000M).
- **Measurement rate:** 2.5 times per second, nominal.
- **Operating environment:** 0°C to 50°C at < 70% **R.H.**
- **Storage temperature:** -20°C to 60°C, 0 to 80% **R.H.** with battery removed from meter.
- **Temperature coefficient:** 0.1 × (specified accuracy) / °C (0°C to 18°C or 28°C to 50°Cz).
- **Power:** Single 9V battery, NEDA 1604, JIS 006P, IEC 6F22.
- **Battery life:** 500 hours typical with alkaline.
- **Size (H×W×D):** 7.8×3.6×1.7 inches (198×90×44mm)
- **Weight:** Approx. 14.1 oz (400 g) including battery.

*Accuracy is given as ±([% of reading] + [number of least significant digits]) at 18°C to 28°C, with relative humidity up to 70%.

DC Volts

Range	Resolution	Accuracy	Input Impedance
200mV	10μV	±(0.05% rdg + 3 d)	10MΩ
2V	100μV	±(0.05% rdg + 3 d)	10MΩ
20V	1mV	±(0.05% rdg + 3 d)	10MΩ
200V	10mV	±(0.05% rdg + 3 d)	10MΩ
1000V	100mV	±(0.05% rdg + 3 d)	10MΩ

Overload Protection: 500VDC / 350VRMS on 200mV range
1000VDC / 750VRMS on all other ranges

AC Volts (True RMS)

Range	Resolution	Accuracy(50Hz to 500Hz)	500Hz to 2kHz
200mV	10µV	±(1.0% rdg + 10 d)	±(2.0% rdg + 20 d)
2V	100µV	±(1.0% rdg + 10 d)	±(2.0% rdg + 20 d)
20V	1mV	±(1.0% rdg + 10 d)	±(2.0% rdg + 20 d)
200V	10mV	±(1.0% rdg + 10 d)	±(2.0% rdg + 20 d)
750V	100mV	±(2.0% rdg + 20 d)	Unspecified

Input Impedance: 10MΩ
Crest Factor: ≤3
Overload Protection: 500VDC / 350VRMS on 200mV range
1000VDC / 750VRMS on all other ranges

DC Current

Range	Resolution	Accuracy	Voltage Burden
200µV	10nA	±(0.5% rdg + 5 d)	300mV
2mA	100nA	±(0.5% rdg + 5 d)	300mV
20mA	1µA	±(0.5% rdg + 5 d)	300mV
200mA	10µA	±(0.5% rdg + 5 d)	600mV
20A**	1mA	±(2.0% rdg + 10 d)	800mV

Overload Protection: 500mA/500V fuse on mA inputs (fast blow ceramic fuse). 20A/600V fuse on 20A inputs (fast blow ceramic fuse).
** 20A for 30 seconds maximum.

AC Current (True RMS)

Range	Resolution	Accuracy(50Hz to 1kHz)	Voltage Burden
200µV	10nA	±(1.2% rdg + 10 d)	300mV
2mA	100nA	±(1.2% rdg + 10 d)	300mV
20mA	1µA	±(1.2% rdg + 10 d)	300mV
200mA	10µA	±(1.2% rdg + 10 d)	600mV
20A**	1mA	±(2.5% rdg + 10 d)	800mV

Crest Factor: ≤3
Overload Protection: 500mA/500V fuse on mA inputs (fast blow ceramic fuse). 20A/600V fuse on 20A inputs (fast blow ceramic fuse).
** 20A for 30 seconds maximum.

Resistance

Range	Resolution	Accuracy	Open Circuit Volts
200Ω	10mΩ	±(0.25% rdg + 10 d)	3.3Vdc
2kΩ	0.1Ω	±(0.15% rdg + 3 d)	3.3Vdc
20kΩ	1Ω	±(0.15% rdg + 3 d)	3.3Vdc
200kΩ	10Ω	±(0.15% rdg + 3 d)	3.3Vdc
2MΩ	100Ω	±(0.25% rdg + 10 d)	3.3Vdc
20MΩ	1kΩ	±(1.0% rdg + 10 d)	3.3Vdc

Overload Protection: 500VDC or RMS AC

Continuity Test

Range	Audible Threshold	Response Time	Open Circuit Volts
2V	Less than 100Ω	Approx. 500ms	3.3Vdc typical

Overload Protection: 500VDC or RMS AC

Diode Test

Range	Resolution	Accuracy	Test Current	Open Circuit Volts
2V	0.1mV	±(0.5% rdg + 1d)	1.0mA	3.3Vdc typical

Overload Protection: 500VDC or RMS AC

Logic Test

Thresholds		Pulse Rise	Pulse Rep	Pulse Width
Logic 1 (Hi)	Logic 0 (Lo)	(max.)	(max.)	(min.)
2.8V±0.8V	0.8V±0.5V	10µSec	1Mpps	25ns

Test Voltage: 5VDC
Duty Cycle: >20% and <80%
Frequency Response: 20MHz
Indication: 40msec beep at logic 1 (Hi)
Overload Protection: 500VDC or RMS AC

Frequency

Range	Resolution	Accuracy	Min Input Range
2kHz	0.1Hz	±(0.5% rdg + 3 d)	> 10Hz
20kHz	1Hz	±(0.5% rdg + 3 d)	> 60 dgts
200kHz	10Hz	±(0.5% rdg + 3 d)	> 60 dgts

Sensitivity: 50mV RMS min. (Sine Wave)

400mV RMS min. at >30% and <70% duty cycle

Effect reading: More than 10Hz at pulse width >2μSec

Overload protection: 500VDC or RMS AC

Duty Cycle

Range	Resolution	Pulse Width	Accuracy (5V Logic)
0 to 90.0%	0.1%	> 10μSec	±(2.0% rdg + 10 d)

Frequency range: 40Hz to 20kHz

Overload protection: 500VDC or RMS AC

MAINTENANCE

Repairs or servicing not covered in this manual should only be performed by qualified personnel.

REPLACING THE BATTERY

WARNING

TO AVOID ELECTRICAL SHOCK, DISCONNECT THE TEST LEADS AND ANY INPUT SIGNALS BEFORE REPLACING THE BATTERY. REPLACE ONLY WITH SAME TYPE OF BATTERY.

This meter is powered by a NEDA type 1604 or equivalent 9-volt battery. When the multimeter displays the " " the battery must be replaced to maintain proper operation. Use the following procedure to replacing the battery:

1. Disconnect test leads from any live source, turn the rotary switch to OFF, and remove the test leads from the input terminals.
2. The case bottom is secured to the case top by three screws and two internal snaps (at the LCD end). Using a Phillips-head screwdriver, remove the three screws from the case bottom and turn the case over.
3. Lift the input terminal end of the case bottom until it gently unsnaps from the case top at the end nearest the LCD.
4. Remove battery and replace with a new equivalent 9-volt battery.
5. Replace the case bottom, ensuring that the two snaps on the case top (at the end near the LCD) are engaged. Reinstall the three screws.

REPLACING THE FUSE

WARNING

TO AVOID ELECTRICAL SHOCK, DISCONNECT THE TEST LEADS AND ANY INPUT SIGNALS BEFORE REPLACING THE FUSES. REPLACE ONLY WITH SAME TYPE OF FUSES. THE 20A INPUT TERMINAL IS PROTECTED BY A F20A, 600V HIGH ENERGY, FAST ACTING. THE mA INPUT TERMINAL IS PROTECTED BY A F500mA, 500V FAST ACTING FUSE.

Use the following procedure to examine or replace the meter's fuses:

1. Disconnect test leads from any live source, turn the rotary switch to OFF, and remove the test leads from the input terminals.
2. The case bottom is secured to the case top by three screws and two internal snaps (at the LCD end). Using a Phillips-head screwdriver, remove the three screws from the case bottom and turn the case over.
3. Lift the input terminal end of the case bottom until it gently unsnaps from the case top at the end nearest the LCD.
4. Remove blown fuse, replace with fuse of the same size and rating. Make sure the new fuse is centered in the fuse holder.
5. Replace the case bottom, ensuring that the two snaps on the case top (at the end near the LCD) are engaged. Reinstall the three screws.

NOTE