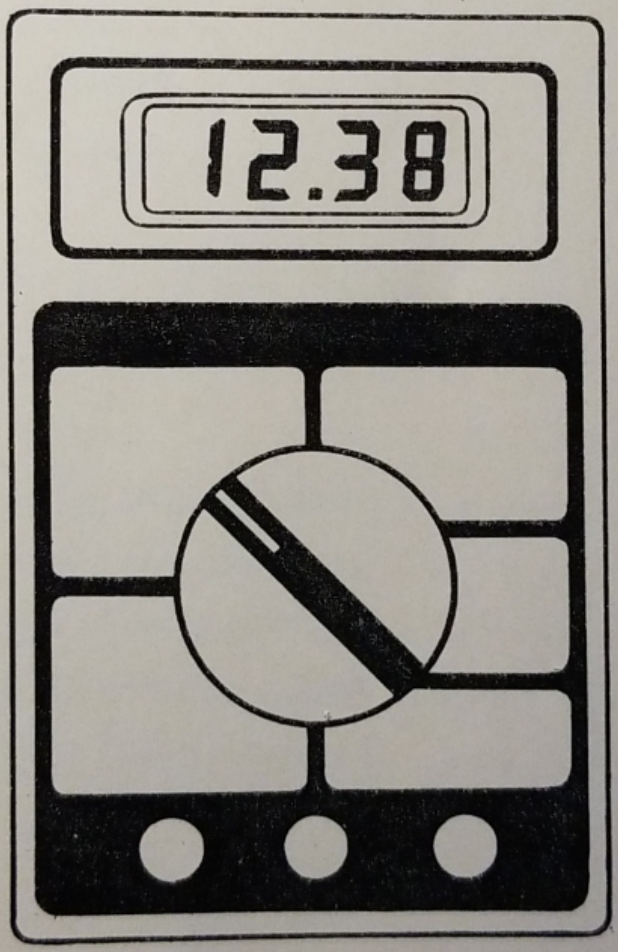
# DIGITAL MULTIMETER

# M-1400

# OPERATION MANUAL

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# I. INTRODUCTION

M—1400 Digital Multimeter is an accurate, compact, hand-held instrument designed for both field and laboratory use. It features one rotary switch to select both function and range at the same time. It requires only two input terminals to measure both AC and DC voltage, current and resistance. A third input terminal is provided for high current measurements. The operation of the instrument is as easy as a traditional analog multimeter.

The 3½ digit, 0.5″ digit height liquid crystal display features, large, easy-to-read numerals with automatic decimal point placement and polarity indication. A 9-volt alkaline battery typically provides 800 hours of operation. Battery condition is continuously monitored and a warning ("LO BAT" or "⇨") is displayed during the last 20% of battery life.

Measurement functions include AC and DC voltages, AC and DC current, resistance and diode check. All functions are protected by a fuse, diodes and transistors against overload. The "Full-Scale" resistance test voltage will not turn on the silicon junction that allow the in-circuit resistance measurement. The instrument is designed using the ICL7136 dual slope integrating A to D converter which features fast recovery from over-range.

This compact, light weight multimeter is carefully designed and will provide long, reliable, performance for your laboratory, workbench, or portable application.

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** **IMPORTANT**: PLEASE READ THIS MANUAL CAREFULLY TO MAKE YOURSELF THOROUGHLY FAMILIAR WITH THE CAPABILITIES AND LIMITATIONS OF THIS INSTRUMENT BEFORE BEGINNING OPERATION.

## II. SPECIFICATIONS

### A. General Specifications

| | |
|---|---|
| Power | 006P DC9V battery |
| Display | 0.5″ digital height, 3½ digit with "–" and "LO BAT" or "⇨" and decimal annunciators. |
| Measurements | DCV, ACV, ACA, DCA, Resistance and Diode Check. |
| Sampling Time | 0.4 second |
| Polarity | "–" will appear automatically in front of readout if input is negative. |
| Overrange Input | Indication on display shows "[1 ]" or "[-1 ]" when input is over the range. |

| | |
|---|---|
| Input Impedance | 10M ohm at all ranges of AC and DC voltage measurement. |
| Low Battery Warning | Display will show "LOBAT" or "⇨" in the last 20% of battery life. |
| Operating Temperature | $0^0$ - $40^0$C |
| Storage Temperature | - $20^0$C - $80^0$C |
| Battery Life | 800 Hours |
| Dimensions | 91 x 170 x 40 mm (W x L x H) |
| Weight | 330 grams with battery |
| Standard Accessories | Test Probes (red & black) 1 pair<br>Spare Fuse (2A) 1 piece<br>Operation Manual 1 piece |

## B. Measurement Range and Accuracy

1. DC Voltage

| Range | Accuracy | Resolution | Input Impedance | Overload Protection |
|---|---|---|---|---|
| 200mV | ±0.5% of reading + 1 digit | 100μV | 10MΩ | DC700V AC500Vrms |
| 2 V | | 1mV | | DC 1000 V<br>AC 750 Vrms |
| 20 V | | 10mV | | |
| 200 V | | 100mV | | |
| 1000 V | | 1 V | | |

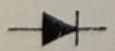
2. AC Voltage

| Range | Accuracy | Resolution | Input Impedance | Overload Protection |
|---|---|---|---|---|
| 200mV | ±1% of reading +2 digits (40Hz–600Hz) | 100μV | 10MΩ | DC350V AC250Vrms |
| 2 V | | 1mV | | DC 1000 V AC 750 Vrms |
| 20 V | | 10mV | | |
| 200 V | | 100mV | | |
| 750 V | ±1.5% of rdg +2 digits (40Hz–600Hz) | 1 V | | |

3. Resistance

| Range | Accuracy | Resolution | Full Scale Voltage | Open-Circuit Voltage | Max Test Current | Overload Protection |
|---|---|---|---|---|---|---|
| 200 Ω | ±0.5% of reading +1 digit | 0.1 Ω | <0.40V | <3.2V | 2.10mA | 250V DC/rms |
| 2KΩ | | 1 Ω | | | 0.13mA | |
| 20KΩ | | 10 Ω | | | 12.8μA | |
| 200KΩ | | 100 Ω | | | 1.30μA | |
| 2MΩ | | 1KΩ | | <1.3V | 0.13μA | |
| 20MΩ | ±1% of reading +1 digit | 10KΩ | | | 0.03μA | |

Diode Check

| Range | Function | Description | Open Voltage | Max Test Current | Protection |
|---|---|---|---|---|---|
|  | Diode Check | Display read approx forward voltage of diode | 3.2V max | 0.2mA | 250V DC/rms |

4. DC Current

| Range | Accuracy | Resolution | Volt Drop at Full Scale | Overload Protection |
|---|---|---|---|---|
| 200μA | ±0.5% of reading + 1 digit | 0.1μA | 250 mV | 2A Fuse |
| 2mA | | 1μA | | |
| 20mA | | 10μA | | |
| 200mA | ±0.8% of rdg + 1 dgt | 0.1mA | | |
| 2 A | | 1mA | | |
| 10 A | | 10mA | 350 mV | —— |

5. AC Current

| Range | Accuracy | Resolution | Volt Drop at Full Scale | Overload Protection |
|---|---|---|---|---|
| 2mA | ±1.5% of rdg + 1 dgt (40Hz–600Hz) | 1μA | 250mVrms | 2A Fuse |
| 200mA | | 0.1mA | | |
| 10 A | | 10mA | 350mVrms | —— |

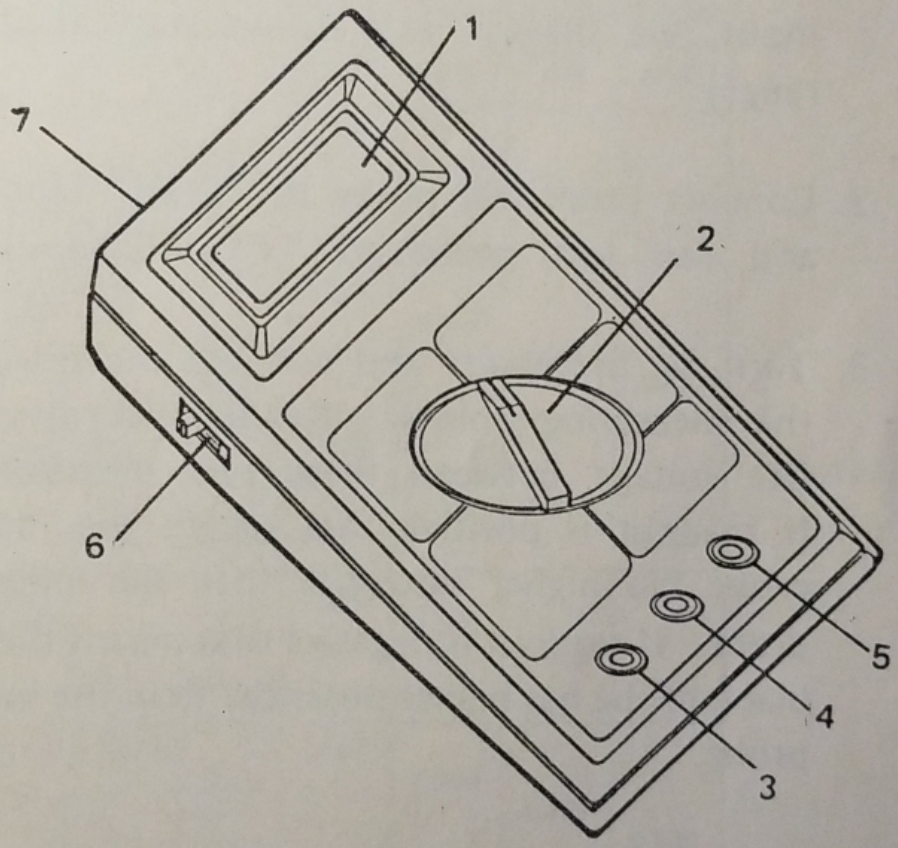
**NOTE: ALL THE ACCURACY MENTIONED ABOVE IS GUARANTEED AT TEMPERATURE OF 15°C TO 28°C, RELATIVE HUMIDITY UP TO 80% AND 1-YEAR CALIBRATION CYCLE.

# III. OPERATING INSTRUCTIONS

This section of the manual will provide you with information on measurement techniques that will help you to fully utilize the measurement capabilities of this instrument.

## A. Physical Features

All of the external features of M–1400 are shown and described in Figure 1..




1. Display
2. Rotary switch
3. Input terminal "10A"
4. Input terminal "COM"
5. Input terminal "V Ω A"
6. Power switch
7. Battery cover

Figure 1

B. Input Power

Power supplied by 006P 9V battery: Open the battery cover, pull the battery snap from battery compartment. Connect it to the battery and return both to battery compartment, then slide on the battery cover.

C. DC Voltage Measurement

1. Set the rotary switch to the desired range at DCV section. (If you have no idea about the value of input, we suggest you always start at the highest range).

2. Connect black test probe to "COM" input terminal and red test probe to "V Ω A" input terminal.

3. Turn on the power and connect the test probes to the measuring points. Readout at display is the DC voltage between these two measuring points. If readout is positive that means the input at red probe has higher potential than the input at black probe. If readout is negative that means the input at black probe has higher potential than the input at red probe.

## D. AC Voltage Measurement

The M–1400 measures the average value of an AC signal and displays it as equivalent rms value for a sine wave. The measurement errors are introduced when the input wave form is distorted (non-sinusoidal). The amount of error depends upon the amount of distortion. Figure 2 shows the relationship between sine, square and triangular waveforms, and reguired conversion factors.

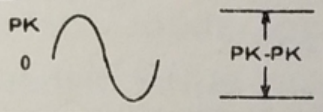
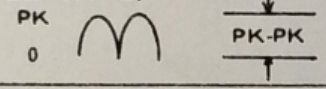
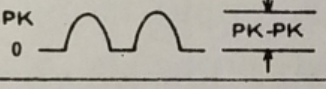
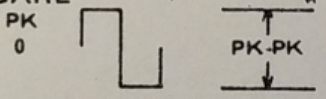
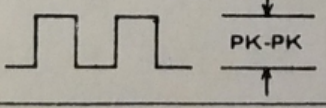
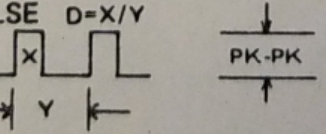
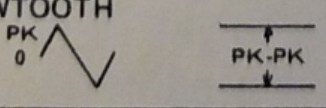
| INPUT WAVEFORM | DISPLAY MULTIPLIER FOR MEASUREMENT CONVERSION | | | |
|---|---|---|---|---|
| | PK-PK | O-PK | RMS | AVG |
| SINE   | 2.828 | 1.414 | 1.000 | 0.900 |
| RECTIFIED SINE (FULL WAVE)   | 1.414 | 1.414 | 1.000 | 0.900 |
| RECTIFIED SINE (HALF WAVE)   | 2.828 | 2.828 | 1.414 | 0.900 |
| SQUARE   | 1.800 | 0.900 | 0.900 | 0.900 |
| RECTIFIED SQUARE   | 1.800 | 1.800 | 1.272 | 0.900 |
| RECTANGULAR PULSE D=X/Y   | 0.9/D | 0.9/D | 0.9/D/2 | 0.9D |
| TRIANGLE SAWTOOTH   | 3.600 | 1.800 | 1.038 | 0.900 |

Figure. 2

1. Set the rotary switch to the desired range at ACV section. (If you have no idea of the input value, we suggest you always start at the highest range.)

2. Connect red test probe to "VΩA" input terminal and black test probe to "COM" input terminal.

3. Turn on the power. Connect the probes to the measuring points and read the displayed value.

E. DC Current Measurement

1. Set the rotary switch to the desired range at DCA section. (If you have no idea about the value of input we suggest you always start at the highest range.)

2. Connect black test probe to "COM" input terminal and red test probe to "VΩA" or "10A" input terminal. (For measuring current larger than 2A red probe must be placed at "10A" input terminal. For other measurements the red probe is placed at "VΩA" terminal.)

   NOTE: IF RED TEST PROBE IS PLACED AT "VΩA" INPUT TERMINAL AND INPUT IS HIGHER THAN 2A, THE FUSE WILL BLOW TO PROTECT THE CIRCUIT.

3. Turn on the power. Connect the probes to the measuring points and read the displayed value.

## F. AC Current Measurement

1. Set rotary switch to desired range at ACA section. (If you have no idea about the value of the input, we suggest you start at the highest range.)

2. Connect black test probe to "COM" input terminal and connect red test probe to "VΩA" or "10A" input terminal. (For measuring current larger than 200mA, the red probe must be plugged into the "10A" input terminal. For other measurements the red probe is plugged into the "VΩA" input terminal.)

   NOTE: IF RED TEST PROBE IS PLACED AT "VΩA" INPUT TERMINAL AND INPUT IS HIGHER THAN 200mA, THE DIODE WILL PROTECT THE CIRCUIT UP TO 2A. IF INPUT IS OVER 2A THE FUSE WILL BLOW.

3. Turn the power on. Connect the probes to measuring points and read the displayed value.

## G. Resistance Measurement

1. Set the rotary switch to the desired range at OHM section.

2. Connect test probes to the "COM" and "VΩA" input terminals, respectively.

3. Turn the power on. Connect the probes to the measuring point and read the displayed value.

## H. Diode Check

1. Set the rotary switch to the position of "→|" at OHM section.

2. Connect black test probe to "COM" input terminal and red probe to "V Ω A" input terminal.

3. Turn power on. Connect the probes to the semiconductor junction (diode or transistor) as shown in Figures 3 and 4, and read displayed value.

   In the case of Figure 3, the readout shall be the approx. forward voltage of the semiconductor junction. It readout is .000 that means the junction is short. If readout is 1. that means the junction is open.

   In the case of Figure 4, the readout shall be 1. . If readout is different (.000 or other number) that means the semiconductor junction is defective.

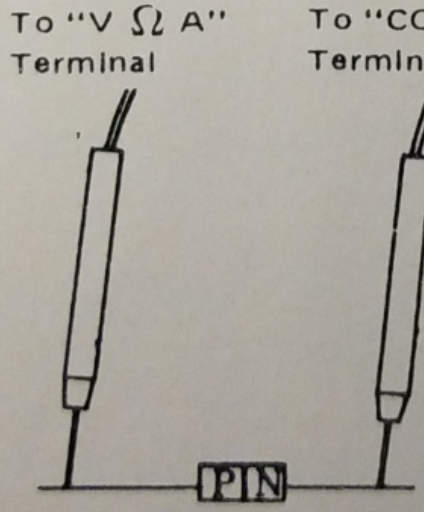



Figure 3

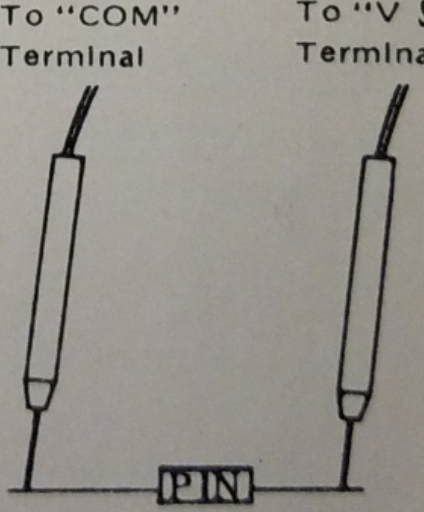



Figure 4

# IV. MAINTENANCE

## A. Replacement of Battery

If reading of display becomes unstable and dim, battery must be replaced.

1. Set power switch of M–1400 to OFF.

2. Open the battery compartment by pressing the "OPEN" mark on the battery cover and push it from the case.

3. Get the battery out of the compartment and take the battery snap off of the battery terminal carefully.

4. Plug the battery snap onto the replacement battery and return both to the battery compartment.

## B. Replacement of Fuse

In the event the fuse is blown, follow the procedure below to replace the fuse (2A fuse).

1. Loosen the screw on the back of the case.

2. The case of M–1400 is designed with inter-lock design. Use your finger and press the top-side of rear case (please refer to Figure 5) and open the case carefully.

3. Carefully remove the defective fuse and put in the replacement.

4. Re-align the case and insert screw tightly.

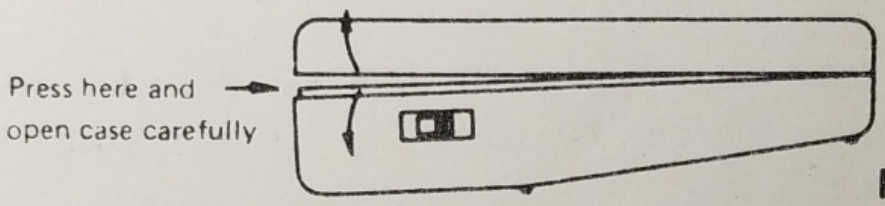



Figure 5

## C. Calibration

Under normal operating conditions the M–1400 should be calibrated once a year to maintain the specification given in Section II of this manual. If instrument repairs have been made or if the unit fails the performance test, immediate calibration is required. Follow the procedure below to calibrate the M–1400. (This procedure assumes an ambient temperature of $23^0 \pm 2^0$C ($70$ to $77^0$F) and relative humidity of less than 80%.)

1. Remove the rear case by the procedure given in Section IV. B of this manual.

2. Remove the PCB from the front case by loosening four screws located at the corners of PCB.

3. Turn on the power of M–1400 and select rotary switch at DCV 200mV.

4. Set the output of DC calibration to +190.0mV and connect it to the input terminals "VΩA" and "COM."

5. Adjust VR1(refer to Figure 6) for a readout of 190.0 or 190.1

6. Disconnect the DC calibrator from the M–1400 input terminal and select 200mV AC range on M–1400.

7. Set the output of the AC calibrator to 190mV at 100Hz and connect it to the M–1400 input terminal "VΩA" and "COM."

8. Adjust VR2(refer to Figure 6) for a readout of 190.0 (flash to ±1 digit is acceptable).

9. Disconnect AC calibrator from M–1400.

10. Carefully screw the PCB on to front case and assemble M–1400 into complete unit.

NOTE: TO AVOID PCB CONTAMINATION, HOLD THE PCB ONLY BY ITS EDGE. CONTAMINATION ON PCB WILL PULL-DOWN THE ACCURACY OF M–1400.

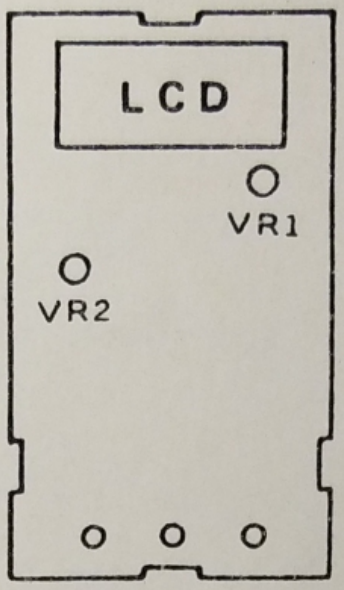



Figure 6