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INSTRUCTION MANUAL

LM SERIES

DIGITAL MULTIMETERS

NON-LINEAR SYSTEMS, INC.

DEL MAR, CALIFORNIA

Printed in the United States of America

warranty

Non-Linear Systems, Inc. warrants each new instrument against defects in material or workmanship for a period of one year from date of delivery of the equipment to the original customer and agrees to replace or repair any such defects, without charge, when the complete instrument is returned to Non-Linear Systems, Inc., 533 Stevens Avenue, Solana Beach, California 92075, transportation charges prepaid. This warranty is in lieu of all other warranties implied or expressed and no responsibility is assumed for consequential damage nor for damage due to accident, abuse, lack of reasonable care, loss of parts, or subjecting the instrument to any but the specified voltages.

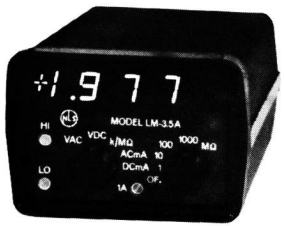
READ THIS NOTICE

This manual provides instructions for operation and maintenance of four different LM Series Digital Multimeters. Two of these (LM-4A and LM-40A) are four-digit instruments, one (LM-3.5A) has three and one-half digits and the other (LM-3A) is a three-digit instrument.

To avoid constant repetition of differences between the instruments, the text of this manual is primarily written for the LM-4A and LM-40A (i.e., number of digits displayed, full scale readings, etc.). If your instrument is an LM-3A or LM-3.5A, always remember the following basic differences between the LM Series meters.

1. Full Scale Ranges
   a. LM-4A and LM-40A: .9999/9.999/99.99/999.9
   b. LM-3A: .999/9.99/99.9/999
   c. LM-3.5A: 1.999/19.99/199.9/999 - in kΩ mode top full scale is 1999 and MegΩ is 19.99
2. Overload Indication: Displays if the signal input exceeds the full scale value of the instrument's range setting. If this occurs, switch to the next higher range.
   a. LM-3A, LM-4A & LM-40A; a "1" followed by all zeros with the "1" flashing.
   b. LM-3.5A: a "10" followed by any two numerals with the "10" flashing.
3. The LM-3.5A does not have "Auto Zero," it has a zero adjustment, the other meters do not.
4. The LM-3.5A has an active input filter, providing a high normal-mode rejection, typically 60 db @ 60 Hz - the other meters do not.

Model LM-3A



Model LM-3.5A

Model LM-4A

Model LM-40A

Figure 5-3. Panel-Mount Flange

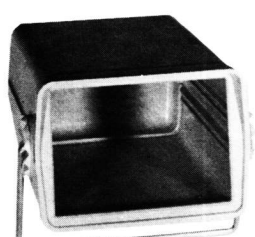


Figure 5-4. Tilt Stand

5-5. PANEL-MOUNT FLANGE.

5-6. The meter can be obtained with a flange permanently attached to the case for panel-mounting. The horizontal dimension between centers of mounting holes is 2-15/16 inches (74.6 mm) and the vertical dimension is 1-15/16 inches (49.2 mm); hole diameter is 1/8 inch (3175 microns). This option is not a retrofit and therefore must be ordered with the meter. It may also be ordered separately as an extra case, providing a case for field use and one for panel-mounting. To order with meter, specify LM-xA/PH (x = Model No.). To order separately, specify Panel-Mount Flange, Part No. 39-454-2

5-7. TILT STAND.

5-8. The meter can be obtained with a tilt stand which permits viewing the display easily when used on a bench. The bale and detents are added to a standard case. The bale is made of stainless steel and can be placed in any one of several positions for desk top use. This option is not a retrofit and therefore must be ordered with the meter. It may also be ordered separately as an extra case, providing a case for field use and one for desk top use. To order with meter, specify LM-xA/LH (x= Model No.). To order separately, specify Tilt Stand, Part No. 39-452-2.

Figure 5-2. High Voltage Probe

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OPTIONAL ACCESSORIES

5-1. LEATHER CASE.

5-2. The leather case (figure 5-1) is designed to hold not only the meter but also several accessories such as the test leads, current shunts, and/or extra batteries. It can be mounted on the user's belt with convenient snaps, or it can be placed around the neck using the neck strap included. It cannot be accidentally pulled off the belt or the neck strap, as one-way snaps are used. The Part No. is 39-439.

5-3. HIGH VOLTAGE PROBE.

5-4. The high voltage probe (figure 5-2) permits measurements of voltages up to 45,000 volts. It has a 1000 to 1 ratio of attenuation which results in the instrument reading kilovolts directly with the decimal point in the correct place. It is usable on any scale, and application of 45,000 volts to any range will not damage the meter or probe. Accuracy is ±3% when used with the LM Series meters. Part No. is 39-525-2.

Figure 5-1. Leather Case

Table 4-4. Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE	CORRECTION
Switch on and no digits on display (battery operation).	Batteries not charged. Batteries faulty. Check voltage of each.	Charge for 16 hours, or run on AC charger unit. Replace batteries.
Switch on, and dim or no digits on display, charger unit connected.	Batteries not charged, and charger unit not functioning.	Measure battery voltage at charger input pin. If less than 3.2 volts, batteries are low. Measure charger voltage (7 volts nominal).
Switch on, display on, erratic numbers and no response to input.	Pins between PC boards not in sockets.	Check pins by removing meter assembly from case

SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION.

1-2. The LM Series Digital Multimeter is the finest instrument of its kind available. With reasonable care and usage, it should provide years of practical and useful voltage and resistance measuring service. Its compact size, rugged construction, low cost and wide measurement capability make it truly a "Volksmeter."

NOTE

The batteries are not charged when the meter is shipped. Plug charger unit cord into meter then plug charger unit into a 115 vac power source. Allow 14-16 hours for batteries to reach full charge when meter is not operating.

1-3. Compared to other instruments, aside from its accuracy and versatility, one of the meter's outstanding features is the auto-zeroing which occurs just before a conversion. Auto-zero means that it is no longer necessary to constantly zero-out the meter whenever function or range is changed; it is done automatically for you. In addition, when measuring ohms, the "zero" is correct regardless of the meter's physical position or range. Furthermore, full scale adjustment is not required at any time. Merely connect the test leads to the resistor or non-powered circuit and read the value in the digital display.

1-4. THEORY OF OPERATION.

1-5. In reading the following discussion, refer to figure 1-1.

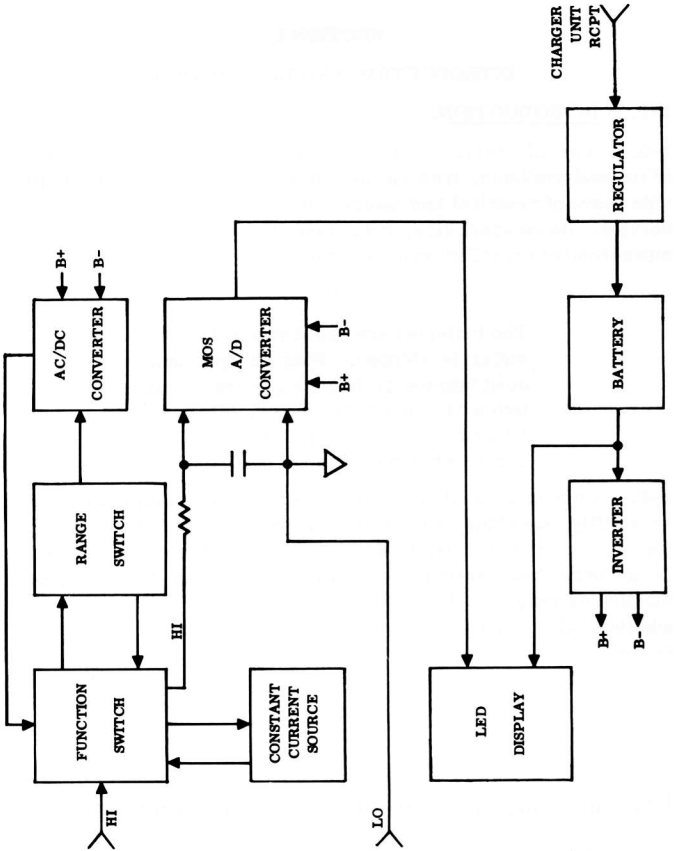


Figure 1-1. Simplified Block Diagram - LM Series Multimeters

Table 4-3. LM-4A and LM-40A Calibration

STEP	FUNCTION SWITCH	RANGE SWITCH	INPUT	READOUT	ADJUST
1	VDC	1	+.0010 VDC	+.0010	R18
2	VDC	1	+.9000 VDC	+.9000	R1
3	k/MΩ	100	90.00 kΩ	90.00	R26

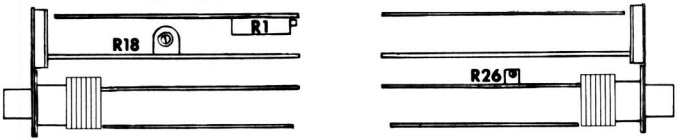


Figure 4-3. LM-4A and LM-40A Calibration Potentiometers

Table 4-1. LM-3A Calibration

STEP	FUNCTION SWITCH	RANGE SWITCH	INPUT	READOUT	ADJUST
1	VDC	1	+.900 VDC	+.900	R1
2	k/MΩ	100	90.0 kΩ	90.0	R26

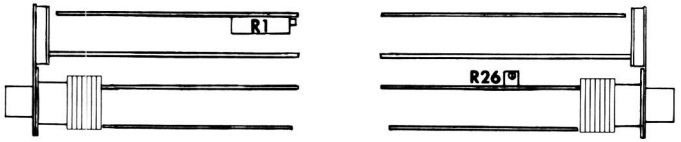


Figure 4-1. LM-3A Calibration Potentiometers

Table 4-2. LM-3.5A Calibration

STEP	FUNCTION SWITCH	RANGE SWITCH	INPUT	READOUT	ADJUST
1	VDC	1	*	.000	R4
2	VDC	1	+.900 VDC	+.900	R9
*Connect input leads together.					

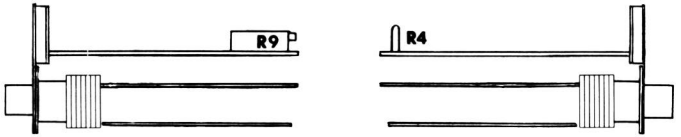


Figure 4-2. LM-3.5A Calibration Potentiometers

1-6. GENERAL. The initial input signal is applied to the function switch, and then in turn to the range switch for proper scaling. If VAC function is selected, the AC/DC converter is put into the circuit.

1-7. The scaled output (1V full scale) representing AC, DC or ohms from the function switch is then channeled into the analog-to-digital circuitry.

1-8. A constant current source provides the test current for ohms measurement. Application of a known constant current into a resistor of unknown value generates a voltage across the resistor which is directly proportional to the resistance value, thereby enabling exact determination of resistance value.

1-9. In sequence, under clock control, the circuitry is first zeroed. The input signal is then sampled for a period of approximately 100 milliseconds. Sampling is repeated at the approximate rate of two per second. During this period the input is integrated by the amplifier and fed to the MOS A/D LSI integrated circuits. This component provides the outputs required to drive the LED display.

1-10. Very high input impedance minimizes the effect of the meter on the signal being measured. The bias current of the input amplifier is a maximum of only 50 picoamps, due to use of a monolithic MOS input operational amplifier. This is complemented by very low leakage input clamp diodes and MOS-FET switches.

1-11. Analog-to-digital conversion is performed by simultaneous integration of analog signals and counting of clock pulses in the LM-3A, LM-4A and LM-40A. Input integration time is fixed at approximately 60 milliseconds for the LM-3A and 100 milliseconds for the LM-4A and LM-40A. Total conversion, including automatic compensation for zero drift, takes about 330 milliseconds for the LM-3A and 500 milliseconds for the LM-4A and LM-40A. All logic signals are handled by C-MOS integrated circuits or by a MOS-LSI circuit. The LM-3.5A

employs a single ramp A/D converter with a three-pole active filter in front of it to provide excellent normal-mode rejection. Its conversion rate is set at three per second.

1-12. DISPLAY. Light-emitting diode (LED) seven-segment indicators are used to display the digital data. Electrical energy is converted to light within the LED, eliminating the need for light bulbs. In addition to the display of digital numerals, another LED is used to display plus and minus signs together with the numeral "1" to indicate an overload. Decimal points are provided between digits to properly scale the number displayed.

1-13. POWER SUPPLY. The power supply consists of 3 AA-size nickel-cadmium batteries which power the display and provide power to the inverter which generates the voltages and current required by MOS A/D, clock, input amplifier, AC/DC converter and the constant current source. Battery recharge rate is regulated to ensure no battery-overcharge, whether the meter is operating or not.

1-14. SPECIFICATIONS.

Accuracy & Resolution:	Refer to table 1-1 or 1-2.
Range Selection:	Manual
Polarity Selection:	Automatic
Decimal:	Set by range switch.
Display:	0.3" High, LED, red.
Zero Stability:	Automatic zero*
Overload Indication:	"1," followed by all zeros,* with the numeral "1" flashing, is displayed for all inputs exceeding full scale.

*Refer to Notice in front of manual.

2. Carefully remove fuse from its sockets and gently insert new fuse, ensuring that fuse terminals are firmly seated within sockets.

3. Reassemble instrument.

4-9. CALIBRATION.

4-10. Your meter has been designed to give service for at least one year between calibrations. If possible, a check should be made after one year to allow for any possible component aging. To calibrate the meter, a known DC voltage source and a known calibrated resistance source are needed.

4-11. If the batteries are low or partially charged allow sufficient time for fully recharging. Connect the charger unit to the meter, and plug charger unit into the AC power source. Calibration of the meter should always be performed with the batteries fully charged or with new non-rechargeable batteries.

4-12. To calibrate the instrument, first remove rear cover and remove meter assembly from case. Perform the steps set forth in tables 4-1, 4-2 or 4-3 as applicable to the Model number of your meter, placing the function and range switches in the positions indicated, applying the input as listed and adjusting the applicable potentiometer to obtain the indicated readout. Check accuracy specifications for your meter to determine tolerance allowed in readout display. For location of adjustment potentiometers, see figures 4-1, 4-2 or 4-3 as applicable.

4-13. TROUBLESHOOTING.

4-14. In the event of meter malfunction, the troubleshooting information listed in table 4-4 may be of assistance. If the cause of the manfunction cannot be determined, the meter should be returned to the factory for service.

1. Follow the steps for disassembly above (paragraph 4-2).

2. After the assembly has been removed from its case, remove the battery cells individually. To do so, press the battery cell against the retaining spring and at the same time pull the positive end away from the battery box.

3. Install the three batteries in the cavity on the bottom side of the meter assembly.

NOTE

Ensure correct installation by observing the polarity indications shown on the battery box.

CAUTION

Never try to recharge any battery other than NiCad cells. Never try to operate from 115 VAC without NiCad batteries in meter. To do so voids the warranty, as severe damage to meter can result.

4-7. FUSE REPLACEMENT.

4-8. To guard against inadvertent application of voltage while in the k/MΩ, ACmA or DCmA mode of operation, a 0.25 ampere protective fuse is provided within the instrument. It is located on the meter's left side, adjacent to the power/range sector of the Rollaball switch assembly. The part number of the fuse is 275250 and it is manufactured by Littlefuse, Inc. An alternate fuse is part number GFA1/4, manufactured by Bussmann Manufacturing. Fuse replacement may be effected as follows:

1. Follow the steps for disassembly above.

Overload protection in kΩ and Current Modes:	An internal fuse protects the meter from voltage applied to the input terminals when the mode switch is set to k/MΩ, ACmA or DCmA.
Operating Temperature Range:	0° to 45°C.
Size:	1.9" H x 2.7" W x 4.0" D.
Weight:	9.2 ounces (with batteries)
Power:	
Battery Operation:	3.6V (nominal) at approximately 200 mA, <1W (<3W when batteries are being charged).
Rechargeable:	Three type AA NICAD cells. Capable of over 2000 readings or over two hours of continuous operation from full charge. Recharge from a discharged state is less than 14 hours. Continuous charging will not damage batteries.
Non-rechargeable:	Three type AA zinc carbon cells. (Alkaline batteries may also be used.) Typically capable of over 2000 readings from a set of batteries or over 2 hours of continuous operation.

Table 1-1. Specifications - LM-3A and LM-3.5A

MODE	RANGE	ACCURACY LM-3A	ACCURACY LM-3.5A†	RESOLUTION	INPUT RESISTANCE	TEST CURRENT
VOLTS DC*	1 10 100 1000	±1% Reading (±2 Digits)	±0.5% Reading (±2 Digits)	1 mV 10 mV 100 mV 1 V	10 MΩ	
VOLTS AC*	1 10 100 1000	±1% Reading (±2 Digits) 50-400 Hz	±0.7% Reading (±2 Digits) 50-400 Hz	1 mV 10 mV 100 mV 1 V	10 MΩ, 20 pF	
KILOHMS**	1 10 100 1000 10000	±1% Reading (±2 Digits)	±0.5% Reading (±2 Digits)	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ		1 mA 100 μA 10 μA 1 μA 100 nA
CURRENT	1 mA 10 mA 100 mA 1 A	±2% Reading (±2 Digits)	±2% Reading (±2 Digits)	1 μA 10 μA 100 μA 1 mA	1 kΩ 100 Ω 10 Ω 1 Ω	

* 1000 vdc or peak ac maximum any range.
**Test Voltage (Ohms): 1 vdc Full Scale - LM-3A; 2 vdc Full Scale - LM-3.5A
† LM-3.5A has 100% over-range - full scale readings are 1.999, 19.99, etc.

SECTION IV

MAINTENANCE

4-1. DISASSEMBLY.

4-2. To remove the meter from its case, perform the following steps:

1. Snap off the rear cover of the instrument with the blade of a small screwdriver or pen knife. Two small slots on each side have been provided for this purpose.

2. Remove the meter assembly from its case by gently pushing the two switch-knobs on the front panel toward the rear.

4-3. The internal assembly consists of four printed circuit boards.* These boards are separable, although it is not recommended that they be separated. In the event that they have been separated, great care should be taken to ensure that all pins which interconnect the boards are properly inserted in their sockets.

4-4. To install the meter in the case, be sure that the charger socket aligns with the notch in the case and that the front panel switches are closest to the bottom or label side of the case. There are two sets of tracks in the sides of the case, be sure the middle two PC boards slide on the tracks. Do not force the assembly into the case.

4-5. BATTERY REPLACEMENT.

4-6. The meter uses standard AA type rechargeable NiCad batteries. If the batteries supplied with the meter ever need replacement or if non-rechargeable batteries are desired to be used, replacement may be effected as follows:

*The LM-3.5A has only three printed circuit boards.

Table 1-2. Specifications - LM-4A and LM-40A

MODE	RANGE	ACCURACY LM-4A	ACCURACY LM-40A	RESOLUTION	INPUT RESISTANCE	TEST CURRENT
VOLTS DC*	1 10 100 1000	±0.03% Reading (±2 Digits)	±0.1% Reading (±2 Digits)	100 μV 1 mV 10 mV 100 mV	10 MΩ	
VOLTS AC*	1 10 100 1000	±0.2% Reading (±10 Digits) 50-400 Hz	±0.3% Reading (±10 Digits) 50-400 Hz	100 μV 1 mV 10 mV 100 mV	10 MΩ, 20 pF	
KILOHMS**	1 10 100 1000 10000	±0.1% Reading (±2 Digits)	±0.2% Reading (±2 Digits)	100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ		1 mA 100 μA 10 μA 1 μA 100 nA
CURRENT	1 mA 10 mA 100 mA 1 A	±2% Reading (±2 Digits)	±2% Reading (±2 Digits)	100 nA 1 μA 10 μA 100 μA	1 kΩ 100 Ω 10 Ω 1 Ω	

* 1000 vdc or peak ac maximum any range.
**Test Voltage (Ohms): 1 vdc Full Scale.

1. If the current to be measured is +120 microamps DC, place the function switch in the DCmA position and the power/range switch in the 1 position. Connect the test leads to HI and LO input jacks. With +120 μA applied, the reading will be +.1200.

2. If the current to be measured is 1.5 milliamps AC, place the function switch in the ACmA position and the power/range switch in the 10 position. Connect test leads to HI and LO input jacks. With 1.5 mA applied, the reading will be 1.500.

3. If the current to be measured is -50 milliamps DC, place the function switch in the DCmA position and the power/range switch in the 100 position. Connect test leads to HI and LO input jacks. With -50 mA applied, the reading will be -50.00.

4. If the current to be measured is 160 milliamps AC, place the function switch in the ACmA position and the power/range switch in the 1000 position. Connect red test lead to 1A input jack and black test lead to LO input jack. With 160 mA applied, the reading will be 160.0.

CAUTION

Refer to CAUTION following paragraph 3-20.

3-19. FUSE PROTECTION. If an inadvertent application of voltage is made (to the HI and LO input jacks) while in the ACmA or DCmA modes, the meter will not be damaged as a protective fuse is provided. If the fuse should blow, refer to paragraph 4-7 for fuse replacement instructions.

3-20. If the current to be measured is less than 100 mA, insert test leads into HI and LO input jacks. If the current to be measured exceeds 100 mA insert the red test lead into the 1A input jack (the black lead into the LO input jack).

CAUTION

If a value of 250 mA or more is applied to the HI input jack the input protection fuse will blow. It is therefore necessary to use the 1A input jack for current in the 1000 mA range. Do not attempt to measure current in excess of 1A as there is no fuse protection for this input.

3-21. OPERATING EXAMPLES.

NOTE

In these examples, the indicated readout display is for the LM-4A and the LM-40A; the right-most digit as indicated will not appear in the LM-3A or in the LM-3.5A meters, i.e., only three numerals will be displayed. The actual reading your instrument displays should be within the accuracy specifications shown in either table 1-1 or table 1-2.

SECTION II

PREPARATION FOR USE

2-1. GENERAL.

2-2. The LM Series meters are portable-designed to operate from self-contained batteries or from 115 VAC power (charger unit with rechargeable batteries only). A 220 VAC charger unit is also available.

2-3. AC OPERATION. (Using charger unit and NiCad batteries.)

2-4. For AC power operation, the meter must always be equipped with three nickel-cadmium (NiCad) batteries. The charger unit operates from the AC line and has been designed to operate the meter and charge the batteries simultaneously even if the batteries are fully discharged. Your digital multimeter was shipped from the factory with a set of three type AA NiCad batteries installed within the case. The batteries are not fully charged. To bring the batteries to a charged state, or to operate from the AC line, plug the charger unit cord into the meter and then plug the charger unit into an AC power source. Allow 14 to 16 hours for the batteries to reach full charge with the meter not operating. Protection against over-charging the batteries has been designed into the instrument.

CAUTION

The instrument will also operate with non-rechargeable batteries; and if this type is used, NEVER try to recharge them, as they may explode and damage the meter; to do so voids the warranty. Charge only NiCad batteries!

2-5. BATTERY OPERATION.

2-6. This type of operation is used when there is no AC power source available or when a high degree of isolation from the power line is desired. The instrument will operate from three type AA batteries of most any type, carbon-zinc, alkaline, or the standard NiCad batteries supplied with the meter. No special battery pack is required. Standard AA size batteries, available most anywhere may be used. The life or duration of continuous operation is longest with the alkaline type, typically maintaining accurate operation for six to nine hours. The alkaline batteries cannot be used when AC operation is desired, as noted above, even if they are called "rechargeable" The charge rate is different for "rechargeable" alkaline batteries then for NiCad batteries. The carbon-zinc batteries will give one to two hours of continuous operation; also, AC operation is not possible.

2-7. NiCad batteries will provide typically two to four hours of operation from a fully-charged state and are recommended for use. When used with the charger unit AC operation is possible, regardless of the state of charge of the batteries. After receiving a full charge, NiCad batteries will lose their charge at a rate dependent upon temperature. At normal room temperature this can be from 0.4% to 2.1% per day. It can go to 5% per day at 104°F. The lower the temperature, the longer the charge is retained. The phenomenon by which the battery loses its energy is known as chemical self-discharge. Even though a charged battery will eventually lose all of its charge through self-discharge, it can be returned to service with a normal charge. Chemical discharge is in no way detrimental to the battery life.

2-7. The meter will operate within specification from full charge voltage of 4.4 volts down to 3.2 volts DC (1.06 volts per cell). At this point the display will become dim, indicating the need to recharge the battery. To measure the battery voltage at any time merely connect the "HI" lead to the pin with which the charger plug

3-13. SEMICONDUCTOR MEASUREMENT.

3-14. The forward voltage drop of semiconductors can be measured using the LM Series meters in the resistance measuring mode. The current flowing through the junction under test is listed in tables 1-1 and 1-2. For example, the 1 kΩ range will have 1 mA flowing through the junction during the measurement. The voltage drop across the junction is indicated by the readout. Remembering that a reading of full scale (9999) is equal to 1V drop across the junction, then a reading of 6000 means a 0.6V drop across the junction. This is true regardless of the range selected. In the reverse direction, the meter will indicate overload, since the reverse breakdown voltage will equal 1V.

3-15. IN-CIRCUIT RESISTANCE MEASUREMENT.

3-16. The measurement of resistance in an unpowered circuit which includes semiconductors presents a problem because the forward junctions of the semiconductors may conduct and interfere with the measurements. The way to avoid this is to make sure the reading is less than 5000 digits (0.5V) if silicon semiconductors are used and less than 3000 digits (0.3V) if germanium semiconductors are present. This can be accomplished by upranging the meter until a reading less than 5000 or 3000 digits is obtained.

3-17. CURRENT MEASUREMENT.

3-18. For current measurement, place the function switch in either the ACmA or DCmA position (depending upon type of current to be measured). Place the power/range switch to the range setting appropriate for the anticipated value of the current to be measured. The 1 range for current of .0001 to .9999 milliamps, the 10 range for current of 1.000 to 9.999 milliamps, the 100 range for current of 10.00 to 99.99 milliamps and the 1000 range for current of 100.0 milliamps to 1 ampere.

the reading should be 6.800 which is 6.8 kΩ.

3. To measure 10,000 to 100,000 ohms (10 kΩ to 100 kΩ), set the power/range switch to the "100" position. Full scale is 99.99 and measurement of a 47,000 ohm resistor will read 47.00 which is 47 kΩ.

4. Similarly, to measure 100,000 to 1,000,000 ohms, set the power/range switch to the "1000" position. Full scale is 999.9 kΩ, and a 560,000 ohm resistor will read 560.0 on the meter.

5. For megohm measurement, to 10 megohms, the power/range switch should be in the "MΩ" position and the reading will be in megohms with the least significant digit representing 10,000 ohms. Any resistor up to 10 megohms can be read; however, if it is less than 10,000 ohms, a 0.000 will be displayed.

6. When measuring ohms, position the power/range switch so that a digit other than "0" is in the left-most position in the display. If the display reads 0000, turn the power/range switch counterclockwise. If the display reads 10000 with the "1" flashing*, rotate the power/range switch clockwise until a number other than zero appears in the left position.

3-11. CONTINUITY TEST

3-12. Place the power/range switch in the 1 kΩ range and connect the input leads to the terminals of resistance to be measured. If continuity exists, the readout will display 0000, indicating less than one-tenth ohm under test. A display of 0000 in the 10 kΩ range indicates continuity and less than one ohm under test; each higher range displaying 0000 indicates continuity and ohmic value under test multiplied by a factor of 10. The 1 kΩ range is therefore the most useful when measuring continuity.

*Refer to Notice in front of manual.

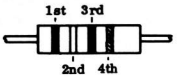
makes contact. A reading from 3.2 to 4.4 volts on the 10-volt range is satisfactory. It is recommended that the meter not be left "on" after the LED display dims. Low voltage under load can decrease the life of a NiCad battery. Useful life of a NiCad battery is typically from three to eight years, even if cycled daily. It is better to keep the battery charged than to let it discharge completely.

meters, i.e., only three numerals will be displayed. The actual reading your instrument displays should be within the accuracy specifications shown in either table 1-1 or table 1-2.

1. To measure a resistor in the range of 1 ohm to 1000 ohms, set the function switch to k/MΩ and the power/range switch to "1." Full scale reading is .9999 kilohms. Note that the decimal point is to the left and the display reads .8200 for an 820 ohm resistor (not considering the resistor inaccuracy). For reference purposes a resistor color code chart is provided in table 3-1.

2. To measure 1,000 to 10,000 ohms (1 kΩ to 10 kΩ), set the power/range switch to the "10" position. Measure a 6800 ohm resistor, and

Table 3-1. Resistor Color Code Chart

DIGIT	COLOR OF BAND	RESISTANCE VALUES
0	BLACK	1ST BAND IS FIRST DIGIT 2ND BAND IS SECOND DIGIT 3RD BAND IS MULTIPLIER (NO. OF ZEROS) 4TH BAND IS TOLERANCE - RED = 2% GOLD = 5% SILVER = 10% NO COLOR = 20% EXAMPLE: 1ST BAND IS RED = 2 2ND BAND IS BLUE = 6 3RD BAND IS YELLOW = 4 4TH BAND IS GOLD = 5% RESISTOR IS 260,000 OHMS = 260 kΩ, ±5% 
1	BROWN	
2	RED	
3	ORANGE	
4	YELLOW	
5	GREEN	
6	BLUE	
7	VIOLET	
8	GREY	
9	WHITE	

reading is in kilohms with the decimal point properly positioned. With the range switch in the 10 MΩ position, the reading is in megohms again with the decimal point positioned correctly to read 10 megohms full scale.

3-8. FUSE PROTECTION. If an inadvertent application of voltage is made while in the k/MΩ mode, the meter will not be damaged as a protective fuse is provided. If the fuse should blow, refer to paragraph 4-7 for fuse replacement instructions.

NOTE

In resistance measurements involving semiconductor devices, polarized capacitors, etc., it should be noted that the polarity in the meter is reversed, i.e., the red input lead is negative in relation to the black input lead.

3-9. The test current used for resistance measurement is indicated in the specifications for each range (tables 1-1 and 1-2). Overload is indicated whenever the value of the resistance measured exceeds the full scale value for the range selected; e.g., a 5.8 kΩ resistor will read "1" followed by all zeros with the "1" flashing* when the power/range switch is in the "1" position. as in the measurement of voltage, maximum accuracy is obtained when the meter reads a number in the left-most decade (excluding the overload "1").

3-10. OPERATING EXAMPLES

NOTE

In these examples, the indicated readout display is for the LM-4A and the LM-40A; the right-most digit as indicated will not appear in the LM-3A or in the LM-3.5A

*Refer to Notice in front of manual.

SECTION III

OPERATION

3-1. PREPARATION.

3-2. Connect the meter to 115 VAC (WITH NICAD BATTERIES ONLY!) as outlined in paragraph 2-4 or operate from the self-contained batteries. (Be sure thay are charged.)

3-3. DC VOLTAGE MEASUREMENT.

1. Place the function switch in the VDC position. Connect the black test lead to the LO terminal of meter and to the common or ground of voltage source to be measured. Connect the red test lead to the HI terminal and to the voltage to be measured. The meter will automatically indicate the correct polarity of the source relative to "common."

CAUTION

Do not apply more than 1000 VDC or RMS VAC or damage to the instrument may occur.

2. Place the power/range switch in the "1" position and allow five seconds for settling. The decimal point will be to the left of the left-most digit. The maximum voltage that can be measured is ±.9999 or approximately ±1 volt. Accidental connection to voltages up to a maximum of 1000 VDC or RMS VAC will not harm the meter on this or any other range. Any applied voltage greater than 1 volt is indicated by a flashing "1" to the left, followed by all zeros.* Polarity of the voltage will be indicated correctly, however, even in an overload condition. When this condition occurs, change the power/range switch to the next higher range.

*Refer to Notice in front of manual.

3-4. OPERATING EXAMPLES. Four VDC ranges are provided: 1, 10, 100 and 1000 volts full scale.

NOTE

In these examples, the indicated readout display is for the LM-4A and the LM-40A; the right-most digit as indicated will not appear in the LM-3A or in the LM-3.5A meters, i.e., only three numerals will be displayed. The actual reading your instrument displays should be within the accuracy specifications shown in either table 1-1 or table 1-2.

1. Place the function switch in the VDC position and the power/range switch in the "1" position.

2. Connect the test leads to a +2-volt source and the meter will indicate an overload condition. Place the power/range switch in the "10" position. The meter will read +2.000; reverse the leads and the meter will read -2.000.

3. Change the power/range switch to the "100" position and the reading will be +02.00. This is still reading correctly, only now the full scale reading is 99.99 volts.

4. Change the power/range switch to the "1000" position and the reading will be +002.0. The decreased accuracy of reading on this range and the "100" range shows the necessity of using the lowest range possible (10-volt range) for maximum accuracy.

5. A ±1 digit in the right-hand decade is due to the inherent ambiguity of an A/D converter, hence the accuracy is generally based upon reading and full scale. The full scale percent being the inherent ambiguity. Connect the test leads to a +28-volt source, and put the power/range switch in the "1" or "10" position and the meter will indicate an overload condition. Put the power/range switch in the "100" position. The decimal point shifts, and the reading will be +28.00. In the "1000" range position, the reading will be +028.0. It can be seen from this that the most accurate reading will occur when a number other than zero is in the left-most position. This will occur when the range switch is positioned to the range just above overload; e.g., position the range switch to position "10" to read a 6.35-volt source; since in the "1" range, an overload would be indicated and in the "100" range a "0" would be in the left-most decade. Only in the "10" range would a full 6.350 reading be obtained.

3-5. AC VOLTAGE MEASUREMENT.

1. Place the function switch in the VAC position. Connect leads as you do for DC voltage.

CAUTION

Do not apply more than 1000 VDC or RMS VAC or damage to the instrument may occur.

2. Refer to DC voltage measurement (paragraph 3-3). Operation is the same for AC, except that there is no polarity indication. The remarks about overload and best operating range apply to AC measurements also. As in DC voltage measurement, inadvertent application of 1000 RMS VAC to the input on any range--1, 10, 100, or 1000 -- will not damage the meter.

3-6. RESISTANCE MEASUREMENT.

3-7. For resistance measurement, place the function switch in the k/MΩ position. With the function switch in this position, ohms will be indicated in kilohms or megohms, depending upon the position of the range switch. In range switch positions 1, 10, 100 and 1000, the