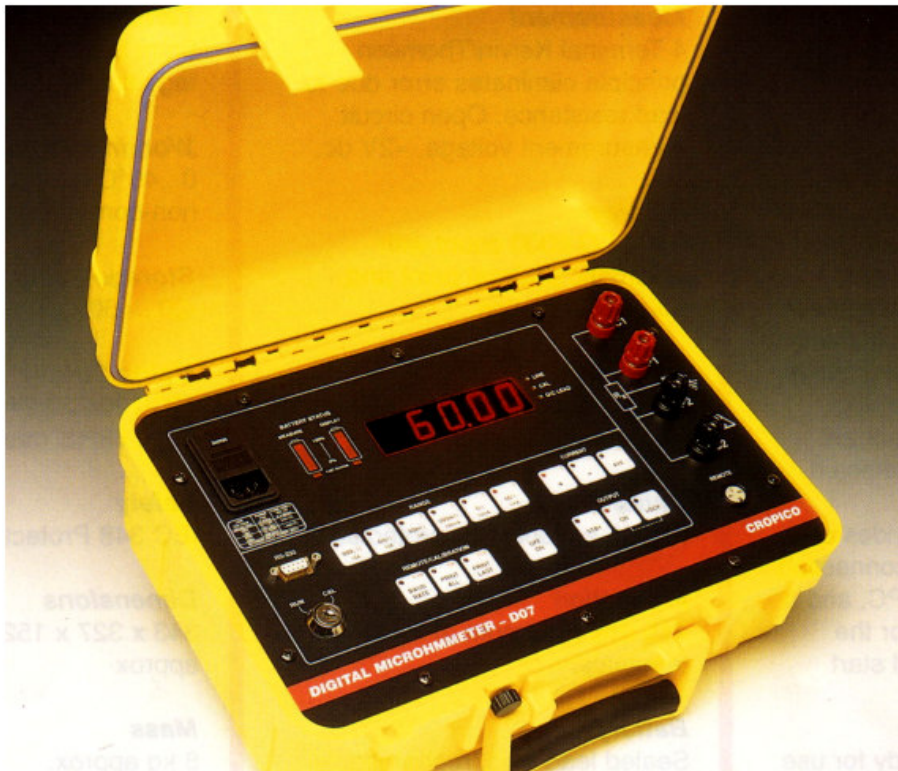


◆ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ◆

LOM-DO7 SERIES
Digital Micro-ohmmeter

User and Service Manual



IET LABS, INC.
534 Main Street, Westbury, NY 11590

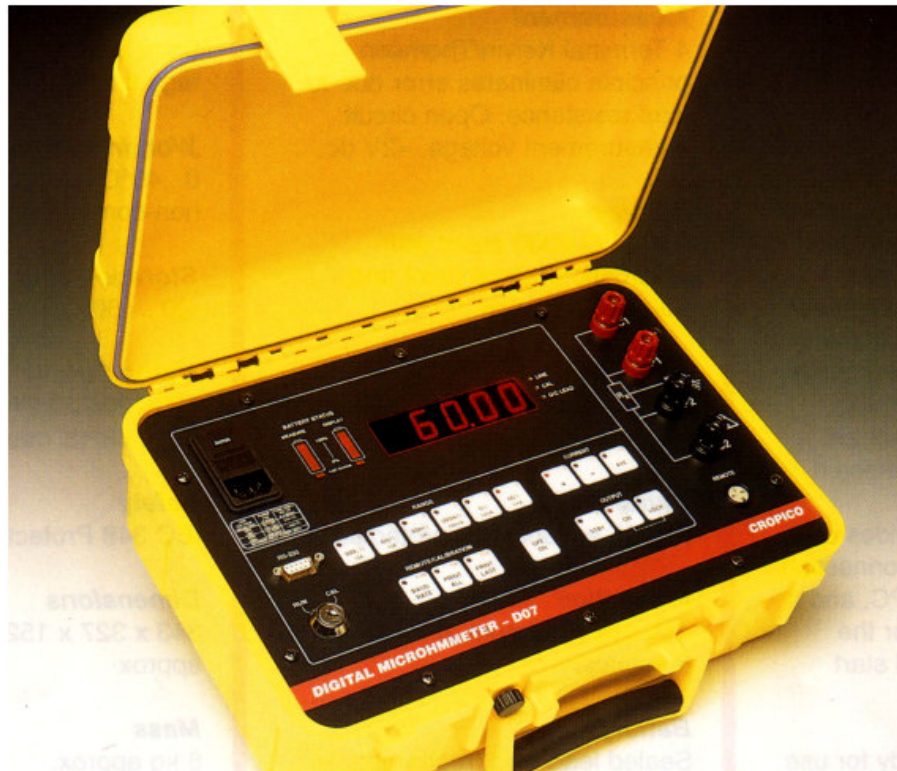
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LOM-DO7 im/December, 2005



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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

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WARNING



OBSERVE ALL SAFETY RULES
'WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

ELECTRICAL SHOCK HAZARD. DO NOT OPEN CASE.
REFER SERVICING TO QUALIFIED PERSONNEL.

HIGH VOLTAGE MAY BE PRESENT WITH HIGH VOLTAGE OPTIONS.

WHENEVER HAZARDOUS VOLTAGES (> 45 V) ARE USED, TAKE ALL MEASURES TO
AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS:

- USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE
CONDUCTORS.

REMOVE POWER WHEN HANDLING UNIT.

POST WARNING SIGNS AND KEEP PERSONNEL SAFELY AWAY.



CAUTION



DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS
INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON
THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

Chapter 1

INTRODUCTION

1.1 General Description

The LOM-DO7 is an accurate bench/portable Digital Ohmmeter for the measurement of resistance in the range $0.1 \mu\Omega$ to 60Ω . It utilizes the four-terminal (Kelvin) resistance-measurement method to eliminate the effects of lead resistance. The measured values are displayed on a 4-digit, 6000-count LED display; there is also an overflow indicator.

Simple push-button selection of the range required makes the LOM-DO7 easy to use. Error and status warnings are illuminated when appropriate. The unit will withstand accidental application of line voltage to the measuring terminals.

1.2 Theory of Operation

The measurement is true 4-terminal, using the Kelvin principle. A stable current is produced across the resistance to be measured via the **C** terminals, and the voltage drop across the unknown resistance **R_x** is measured at the **P** terminals. This potential drop is then compared against the voltage drop across internal standards. The ratio of these is then converted to the resistance value of **R_x** and displayed in ohms on the digital display. Use of specially selected components assures high accuracy and long-term stability .

1.3 Case Design

The case is ruggedly constructed from a “safety yellow” ABS/polycarbonate composite . A strong internal sub-frame ensures that the LOM-DO7 will withstand the harshest environments. The

front panel is a reverse-printed polycarbonate overlay with clear and unambiguous text.

1.4 Available Accessories

Supplied:

1	Set of test leads
1	Power cord
1	Operation Manual

Optional Lead Sets:

HSO1	Kelvin Clip Set with 3-meter leads
HSO1-RS	Similar to HSO1, but includes remote-start button
HSO2	Kelvin Clip Set with 3-meter and 15-meter leads
HSO2-RS	Similar to HSO2, but includes remote start button
LSO3	Large Kelvin clips with 3-meter leads— accept cables and bars up to 38 mm in diameter
LSO4	Similar to LSO3 but with 3-meter and 15-meter leads

Other Optional Accessories:

FSO1	Foot Switch for remote actuation
CO1	1 Meter Cable-Test Fixture – Wood Base
CO2	1 Meter Cable-Test Fixture – Metal Base
CBO2	Accessory Pouch—attaches to cover
MTS2	Calibration Standard
PRO2	Portable Thermal Printer
RS101	RS232 Cable

Chapter 2 SPECIFICATIONS

2.1 General:

Digital Display:

4 digit, 0.8" high LED, 6000 count with automatic decimal point and error-warning lamps

Operating temperature range:

0 to +40°C, with maximum relative humidity of 80%

Storage temperature:

-20°C to +50°C

AC power:

103-127 V or 207-253 V, 47-63 Hz
Power consumption: <40 VA

Dimensions:

343 x 327 x 152 mm
(13.5" x 12.9" x 6.0")

Weight:

8.3 kg (18.3 lb)

2.2 Measurement:

Resistance:

True four-terminal measurement with fixed dc measuring currents

Measuring time:

Approximately 0.5 seconds

Polarity:

Selectable positive or negative current flow, plus an average mode which automatically displays the average value of the positive- and negative-polarity measurements.

Ranges and Accuracies

Range	Resolution	Typical Current	Uncertainty At 20°C ± 5°C, 1 Year	Temperature Co-efficient/°C*
60 Ω	10 mΩ	1 mA	±(0.15% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
6 Ω	1 mΩ	10 mA	±(0.15% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
600 mΩ	100 μΩ	100 mA	±(0.15% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
60 mΩ	10 μΩ	1 Amp	±(0.15% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
6 mΩ	1 μΩ	10 Amp	±(0.2% Rdg + 0.1% FS)	40 ppm Rdg + 30 ppm FS
600 μΩ	0.1 μΩ	10 Amp	±(0.2% Rdg + 0.2% FS)	40 ppm Rdg +250 ppm FS

* NOTE: Add temperature coefficient specification value to uncertainty specification value when operating outside the 15°C to 25°C temperature range.

NOTE: Measurements on the lowest range (600 μW) may have an additional zero offset of up to 20 counts if the measuring current is applied repeatedly for long periods. This offset can be eliminated by using the average-measuring mode.

Chapter 3 OPERATION

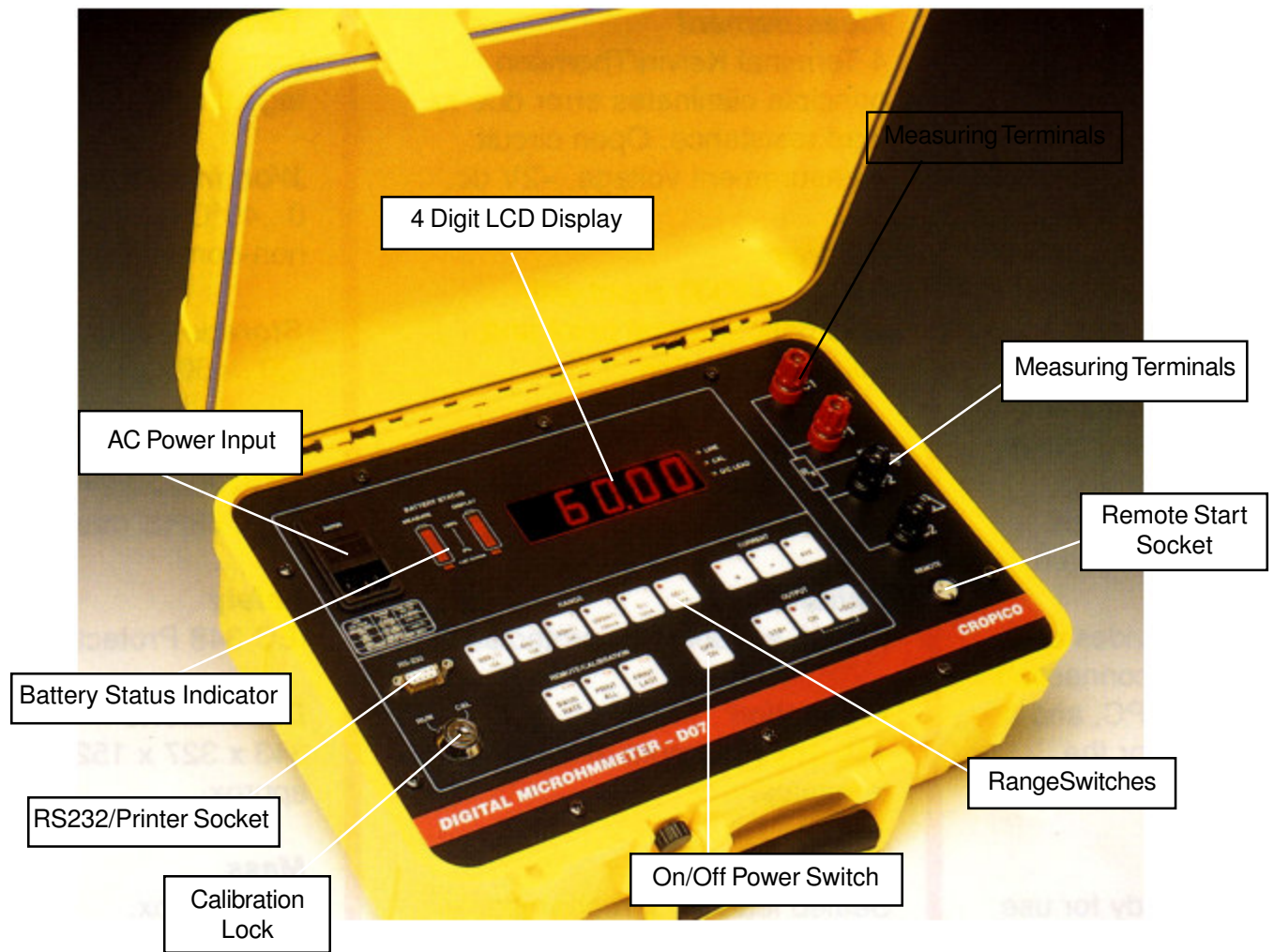


Figure 3.1 Description of Controls

3.1 Initial Inspection

After unpacking, inspect unit for shipping damage and report any problem immediately to the carrier, retaining packaging materials for inspection.

3.2. Safety

This unit is designated Safety Class I as defined in the IEC Publication 1010-1, Amendment 1.

This unit has been designed and tested in accordance with IEC Publication 348, entitled "Safety Requirements for Electronic Measuring Apparatus", and has been supplied in a safe condition. The present instruction manual contains some information and warnings, which should be followed by the user to ensure safe operation and to keep the unit in safe condition.

Before switching on the unit, make sure that it is set to the correct line voltage, and that the correct fuse for that voltage has been installed (See the table in Chapter 6).

The unit must be plugged in to a grounded outlet only, and any extension cord used must be the 3-wire grounding type.

3.3 Features

3.3.1 Measurement Polarity

The measuring-current polarity can be selected from the front panel. The display will indicate either "+" or "-" to show the direction of current flow. This is particularly useful when evaluating circuits with thermal emf, or circuits where diode effects can influence the measurement. For

measurements where thermal emf can cause a large zero-error, there is an automatic-average (**AVE**) button. When it is pressed, the measuring current will automatically be reversed and the average value displayed, thus eliminating the need for external computations. This averaging feature also adjusts the measurement time automatically, giving the fastest possible measurement even for inductive circuits.

The **+VE** and **-VE** lamps will light to indicate that the current polarity is changing. For very unstable values where the average mode is unable to establish a stable reading, the averaging will be aborted after approximately 25 seconds and the display will show "- - - -". A new **AVE** cycle will be started automatically.

3.3.2 Range Selection:

Any of the six measuring ranges can be selected manually by simply pressing the desired **RANGE** button. The selected range is indicated by an lit LED. Over-range is indicated by the display reading "- - - -".

3.3.3 Error & Status Lamps

The following LEDs will light to indicate the instrument status:

LINE:

ac power is connected to the instrument.

O/C:

One of the measuring leads is open

LEAD:

Open-circuited (too high a resistance), or not connected to the test sample correctly, or the internal protection fuse is open. This lamp will always be lit in the **STBY** (Standby) mode.

3.4 Making Measurements

3.4.1 Ohmmeter Connections

The LOM-DO7 employs a four-wire method of measurement, i.e. four connections to the resistor under test are required. The unit is supplied with four leads: two voltage leads to be placed across the exact measurement points, and two current leads to be placed “outside” the measurement points. The Kelvin clips, shown in Figure 3.2, place voltage and current connections at the same point.

- a) Connect the black leads to the **+C** and **+P** terminals, and the red leads to terminals **-C** and **-P**.
- b) Clip the test leads onto the resistor under test. Cleanliness is important; if the DUT is not clean, clean it with fine emery cloth or steel wool to remove oxides.
- c) It is not always possible to use the combined current and potential (Kelvin) clips, in which case test leads with spade lugs—or a special test fixture - may have to be made for a particular application.
- d) Fig. 3.3 illustrates connections to various types of test resistors
- e) When measuring 4-terminal resistance standards, the Kelvin clips may not be usable because of terminal geometry. Make four separate connections to the current and potential terminals

3.4.2 Start-up

When the LOM-DO7 is first switched on, an internal self-test is automatically performed. The display indicates **-8888** followed by **PASS**, then performs an automatic zero sequence and finally sets to the following default start-up conditions:

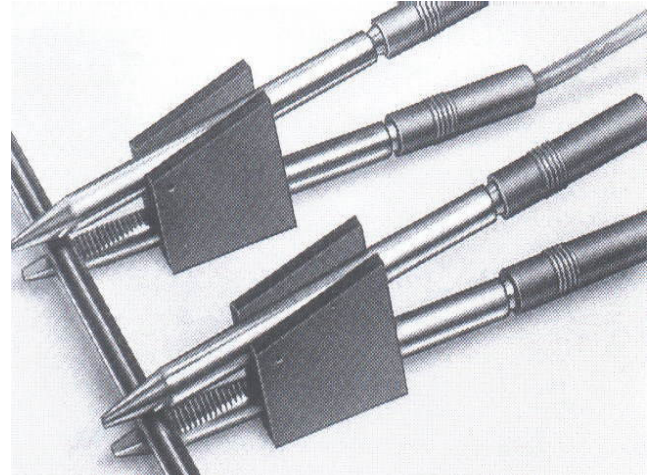


Fig. 3.2 Combined current and potential probes (Kelvin clips)

60Ω range and **STBY** (Standby) mode. The unit is now ready to make measurements. The display will blank after approximately 25 seconds of inactivity.

If the internal checks indicate an error, the display will read **HELP**. Contact our Service Department or your IET Representative for assistance.

3.4.3 Measurement

Connect the resistance to be measured to the measuring terminals in accordance with the diagram on the instrument panel and using the most appropriate connection technique for the unknown (See Figs. 3.1 and 3.2). Select the range required and the current measurement mode, i.e.. “+”, “-“, or **AVE**. LEDs will light to indicate which functions are active. To initialize the measurement, press the **ON** switch. A single measurement will be taken and the value held on the display for approximately 25 seconds. After 25 seconds, the display will go blank and only the **RANGE** LED will remain lit. The last measured value can be recalled by pressing the **ON** switch. To make another measurement the **ON** switch should be pressed again. To take continuous readings, press and hold the **LOCK** and **ON** switches until a beep is heard; this will activate a continuous-reading mode.

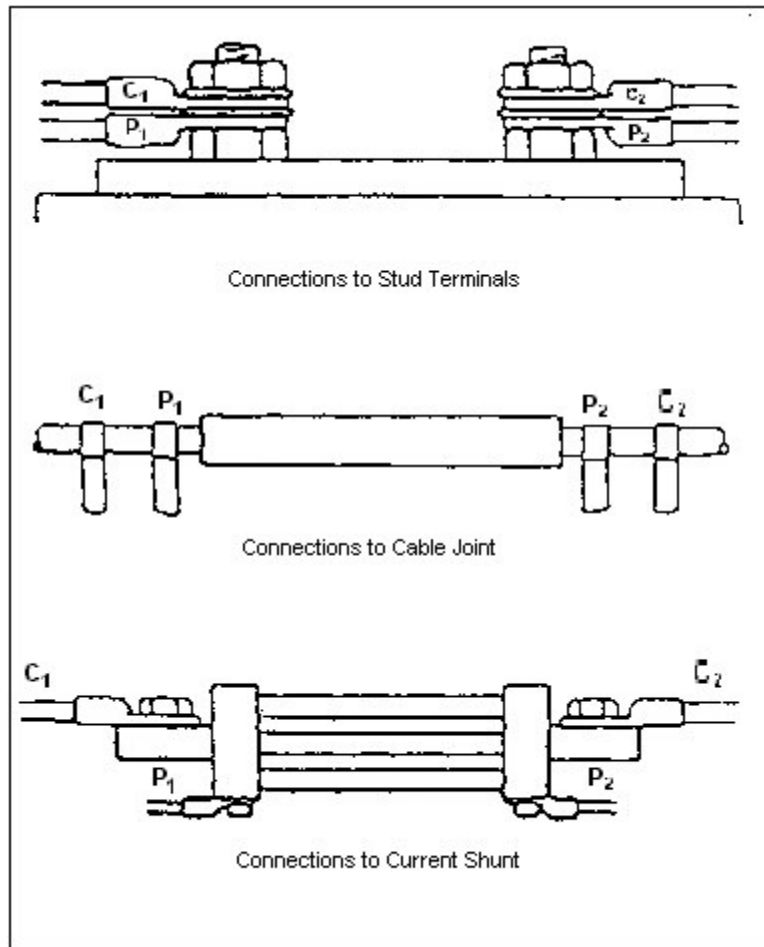


Fig. 3.3 Connections for resistance measurements with various DUT configurations

Measurements will continue, and periodic beeps will be heard, until the **ON** or **STBY** key is pressed. Remember that the current drain on the internal battery can be up to 10 A on the lowest ranges. To preserve battery life, the unit will automatically turn off after 5 minutes of inactivity.

Note: the **ON** key LED remains lit while measurements are being made.

3.4.4 Current Mode

The current mode can be set to “+I”, or **AVE**. The **AVE** mode should be selected for all mea-

surements that are not inductive, as this eliminates errors due to thermal emf in the measurement circuit or test leads. In the **AVE** mode the LOM-DO7 takes readings with the current flowing in both directions and displays the average of the two readings. For measurement of inductive circuits the measuring current should either be set in “+I” or “-I” mode.

3.4.5 Over-Range

If the measured value exceeds the upper limit of the range selected, the display will indicate “- - -”. Select a higher range.

3.4.6 Open-Circuit Lead

If one of the test leads is open-circuited, or exceeds a preset resistance, the **O/C LEAD** LED will light and the display will indicate “- - -”. (The C terminals are checked for compliance voltage). Measurements cannot be made if this warning message is displayed. This warning will also be displayed if the internal protection fuse is open. When in **STBY** mode, this LED will always be lit.

3.4.7 Low Battery and AC Operation

The LED bar graph display indicates the state-of-charge of the battery. Batteries must be fully charged for proper operation on the lowest two ranges due to the high current required. The other ranges may be used during battery charging (ac operation), however an additional error of up to eight digits will be introduced.

3.4.8 Connections

To make the most accurate possible measurements, ensure that all test leads are in good condition, and have less than 0.2Ω resistance. Some spade lugs and crocodile clips - especially nickel-plated brass types - can produce high thermal emfs when heated. This can sometimes cause problems, for example when connecting to hot motor windings. Avoid such problems by using plain copper or brass connections and keeping them clean and oxide-free.

The heavy-duty binding posts used are designed to accept standard banana plugs in the top socket, and bare wires and spade lugs may be clamped when inserted from the side.

3.5 Remote Operation and Printer Output

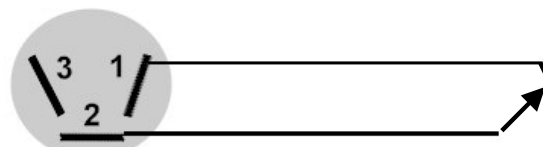


Figure 3.4 Remote Start Socket, viewed from panel

3.5.1 Remote Operation

If a normally-open switch, such as a footswitch, test leads with a “start” button, or some other type of contact closure is connected to pins 1 and 2 of the **REMOTE** socket, it will mimic the function of the **ON** key when activated. See Figure 3.4.

3.5.2. Printer Output

The print format will be as follows:

<u>Sign</u>	<u>Value</u>	<u>Units</u>	<u>(Mode)</u>
	600.0	m Ω	(+VE)
-	600.0	m Ω	(-VE)
	600.0	m Ω	(AVE)

The value printed will be followed by a line feed and carriage return.

If the DO7 displays an over-range condition, it will print as “ - - - - ”.

For cable connection details see page 8.

Print All

All measured values will be sent to the printer (RS232) when the **PRINT ALL** switch is **ON**, as indicated by the LED on the switch. This key toggles ON/OFF.

Print Last

The last measured value only will be sent to the printer. This is defined as the last value measured when switching from **ON** to **STBY**. This key toggles **ON/OFF**.

Baud Rate

This key will display the currently set Baud Rate when pressed. To change the value, press **CLE**, and then use the keyboard to enter the new value, finishing with **OK**. If the newly entered value is valid, it will be stored in non-volatile RAM. If it is invalid, a long beep will sound and the existing rate will be retained. The valid Baud Rates are: 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200. The format is fixed at 8-bit data, 1 start bit, 1 stop bit, and no parity.

3.6 Protection

This instrument is protected against voltages

being applied inadvertently to the terminals. A high-interrupting-capacity fuse is installed internally in the current circuit and a gas discharge tube (GDT) is installed across the current terminals. If voltages above ~90 V are applied to the measuring terminals, the GDT will strike, effectively shorting the C (or I) terminals through the protective fuse, which will open and interrupt the circuit. The voltage terminals are not fused, and will withstand up to 460 Volts without damage to the instrument.

!WARNING!

To replace the protection fuse, the top cover should be removed, but only after ac power and all input connections are removed. The protection fuse is located on the main printed circuit board. This fuse has a 40,000-to-200,000 A interrupting capacity, depending on the exact type used. Always replace this fuse with one of the same current rating (10 A) and at least a 40,000 A interrupting capacity.

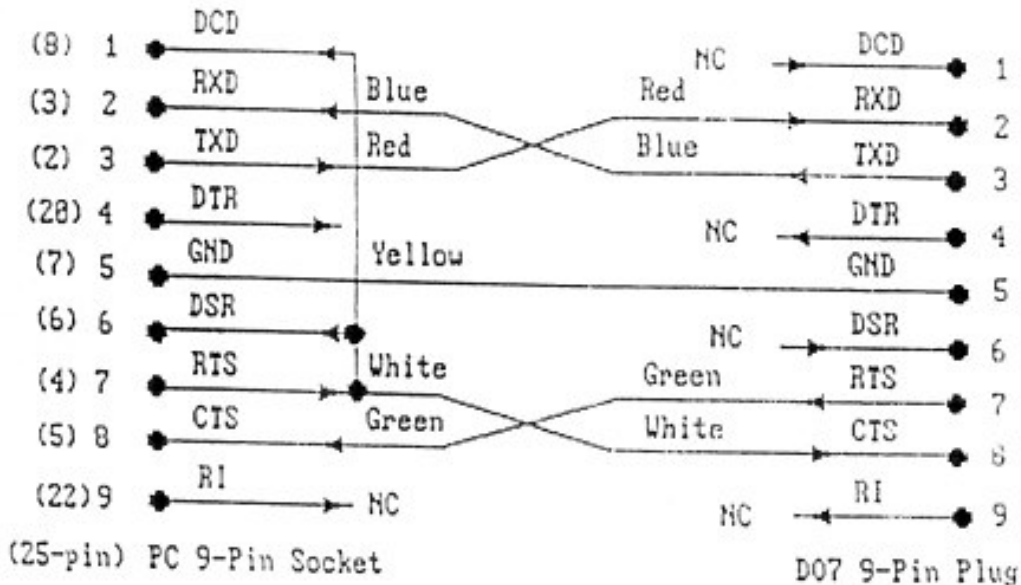


Figure 3.5 Printer Output Connections

Chapter 4

CALIBRATION

4.1 Calibration Process

This procedure describes the standard calibration method for the LOM-DO7 Micro-ohmmeter using the IET MTS2 Calibration Standard or discrete resistance standards of the required values.

!CAUTION!

The LOM-DO7 comes factory-calibrated to its full accuracy, and any recalibration by the user will invalidate this initial calibration. The user should therefore be certain that only authorized and competent personnel are permitted access to the calibration process, which is keylock-protected.

4.2 Equipment Required

- IET Calibration Standard MTS2, or equivalent 4-terminal standard/s.
- Set of 2 low-thermal-emf leads
- Set of 2 general-purpose leads (10 A rating)

4.3 Preparation

4.3.1 Ensure that the unit is completely assembled. Place it in a temperature-controlled en-

vironment ($20^{\circ}\text{C} \pm 5^{\circ}\text{C}$) for a minimum of 4 hours. Ensure that the batteries are fully charged.

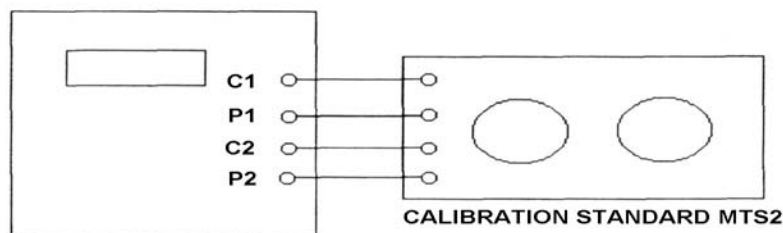
4.3.2 Connect each of the four LOM-DO7 terminals to the equivalent terminals on the calibration standard. It is essential that low thermal emf leads are used for the P1 and P2 leads. See Figure 4.1 for the preferred setup.

4.3.3 An internal battery powers the LOM-DO7 and this should be fully charged before calibration. The ac charger can be left connected, if desired.

4.3.4 Set the calibration standard to 40 Ohm, Zero.

4.3.5 Turn the LOM-DO7 **ON** by pressing the **ON/OFF** switch. If the **HELP** message is displayed, perform a special **CAL RESET** operation as follows:

1. Insert the Calibration Key into the panel Switch and turn it to the **CAL** position. The **CAL** LED should light.
2. Press the **CLE** Switch. Its LED should light for ~ one second. The "**HELP**" message should now be replaced by a normal display.
3. Turn the panel switch back to the **RUN** position.



P1, P2 LEADS - PURE COPPER, MULTI STRANDED
 C1, C2 LEADS - 10A RATING (55/0.15mm)

Figure 4.1 Preferred calibration setup.

4.3.6 Let the setup stabilize for a few minutes.

4.4 Calibration Using MTS2 Standard

4.4.1 Calibration

1. Turn the panel switch to the **CAL** position. The **CAL** LED should light.

2. Set the **LOM-DO7** to the 60 Ω range, **+VE**, and press the **LOCK** and **ON** switches at the same time; hold them down until you hear a beep.

3. When the reading stabilizes, press the **KYB** switch. The display should show “0”.

4. Press the **OK** switch. The **OK** LED should light for about 3 seconds.

5. The display should now show “0.00” ± 1 digit. If not, repeat steps 3 and 4.

6. Set the **MTS2** to **+FS**.

7. When the reading has stabilized, press the **KYB** switch.

8. Enter the value “40” using the keypad, and then press **OK**. The **OK** LED should light for ~three seconds.

9. The display should now show “40.00” ± 1 digit. If it does not, repeat steps.

10. Repeat steps 2 through 9 for the remaining ranges, in each case setting the **MTS2** to the appropriate value.

11. Turn the panel switch to **RUN** and remove the key.

4.2.2 Verification

1. Verify that the panel switch is set to **RUN** and the calibration key is removed.

2. Set the **MTS2** to 40 Ohm, Zero.

3. Set the DO7 to the 60 Ω range, **+VE**, and press **LOCK+ON**. Wait for the reading to stabilize. The reading should be “0.00” ± 1 digit. Record this reading and subsequent readings if required.

4. Set the **MTS2** to **+FS** and wait for the reading to stabilize. The reading should be “40.00” ± 1 digit.

5. Set the DO7 to **-VE** and wait for the reading to stabilize. The reading should be “-40.00” ± 1 digit.

6. Set the DO7 to **AVE** and wait for the reading to stabilize. The reading should be “40.00” ± 1 digit.

7. Reset the DO7 to **+VE**. Set the **MTS2** to 4 Ω , **+FS** and wait for the reading to stabilize. The reading should be “4.00” ± 1 digit.

8. Set the **MTS2** to 400 mW, **+FS** and wait for the reading to settle. The reading should be “0.40” ± 1 digit.

9. Set the **MTS2** to 40 m Ω , **+FS** and wait for the reading to settle. The reading should be “0.04” ± 1 digit.

10. Repeat steps 2 through 10 for the remaining ranges, Setting the **MTS2** appropriately.

11. Turn the DO7 power **OFF** and remove the test.

12. Document the results in accordance with company policies and procedures..

4.5 Calibration Using Discrete Resistance Standards

4.5.1

Discrete, 4-terminal resistance standards may be used in place of the IET Calibration Standard. The standards must have an uncertainty better than 0.01% if the full calibration accuracy is to be achieved. Full consideration of the LOM-DO7

measuring current must also be taken into account when selecting the standards. The LOM-DO7 can be calibrated to standards between 1000 and 6000 digits for each range using the **KYB** entry. However, full accuracy will only be achieved if standards of 4000 to 6000 digits are used. The following nominal standards are recommended:
 400 Ω, 40 Ω, 4 Ω, 400 mΩ, 40 mΩ and 4 mΩ.

4.5.2

In all measurements the P1 and P2 terminals are conventionally connected. Bear in mind that thermal emf's may be present. The LOM-DO7 is particularly sensitive to these on the 6 mΩ range.

4.5.3

For **FS** measurements, connect the C1 (or I1) and C2 (or I2) leads in the conventional manner (see Fig 4.2).

4.5.4

For ZERO measurements, connect the C1 (or I1) and C2 (or I2) leads to the C2 terminal of the standard (see Fig. 4.3).

4.5.5

Using the above described connections for **ZERO** and **FS** (Full Scale) measurements, perform steps 4 through 10 of the above procedure (which uses the **MTS2** standard) to complete the calibration.

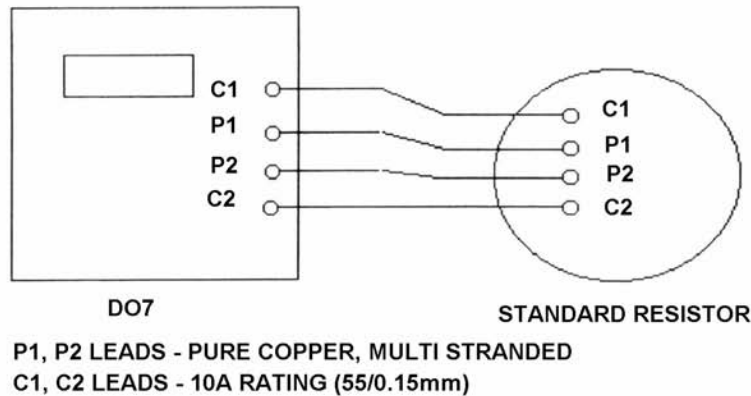


Figure 4.2 Full Scale calibration setup

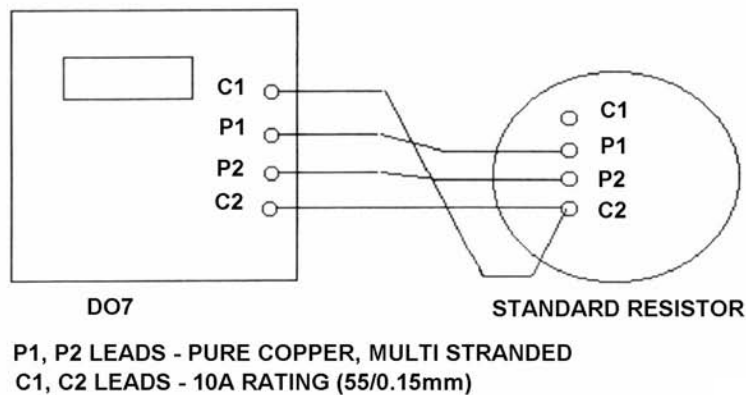


Figure 4.3 Zero calibration setup

Chapter 5 MAINTENANCE

5.1 General

Normally no maintenance is required other than cleaning with a moist cloth. Avoid strong detergents or solvents.

If a failure occurs, or if the unit cannot be calibrated, it should be returned to IET or to an IET representative. Contact IET for an RMA number before returning the unit directly to IET.

There is a line fuse in the ac power input socket on the front panel, and an input-protecting fuse on the circuit board. Examine and replace these fuses if necessary, before a final decision to return the unit for repair.

CAUTION: Disconnect ac power cord and all connecting leads before removing a fuse. Replace only with the correct fuse types as shown below.

Nominal Line Voltage	Voltage Range	Fuse (250 V) IEC 127 5 x 20 mm
120 V	104-132 V	1.25 A(T)(sb)
220 V	191-242 V	630 mA(T)(sb)
Maximum input power: 40 W		

The input circuits are protected by a 10 A fuse located in a holder on the main printed circuit board. Remove the top cover for access. Replace only with the correct fuse type as shown below:

NFC63210, Altech 10C10x38GI
or Cooper Bussman KTK-10

5.2 Battery Charging

The LOM-DO7 has a built-in, rechargeable, sealed-lead-acid battery, which is fully charged when delivered. To ensure good service life from the battery, the LOM-DO7 incorporates a sophisticated battery management system. Battery condition is indicated by a LED bar graph display.

The battery charger is built-in and the instrument may be connected to a 120 or 220 volt ac supply. The appropriate voltage setting must be selected on the ac input socket and the correct fuse inserted. The “**LINE**” LED on the front panel will light to indicate when the unit is connected to ac power.

Charging is automatically controlled, with built-in protection circuits eliminating the possibility of overcharging. The display will go blank when the battery voltage is too low to allow accurate measurements. The battery will recharge in approximately six hours; leave the LOM-DO7 lid open to permit maximum ventilation.

IMPORTANT: Always connect the unit to ac power after use to charge the battery. It should be stored with batteries fully charged; when the instrument is stored or not used for long periods, the batteries should be recharged monthly. If the batteries become deeply discharged due to being left uncharged for long periods, the internal charger will automatically sense the battery state and will trickle-charge with a very low current to restore the batteries before automatically switching to fast charge. This low-current charge may take up to 20 hours to restore the batteries.

Continuous charging will not damage the batteries, and is recommended in order to keep them in the best condition.

!BATTERY CAUTIONS!

The internal battery is the sealed-lead-acid type. When disposal is required, be sure to do so in accordance with local regulations.

Do not attempt to incinerate the battery.

Do not short circuit the battery terminals.

Do not crush, puncture, open, dismantle, etc. the battery.

NOTE: If a battery is stored for long periods, it should be fully recharged every six months.

5.3 Battery Replacement

Only competent and skilled personnel should carry out battery replacement. Be sure to maintain correct polarity of the connecting wires. The red wire always goes to the positive battery terminal (Note: the blue tag on the red wire does NOT indicate polarity).



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