

◆ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ◆

LOM-DO7e SERIES
Digital Micro-ohmmeter

User and Service Manual



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LOM-DO7e im/November, 2004



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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.

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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-DO7e is an accurate bench/portable Digital Ohmmeter for the measurement of resistance in the range $1 \mu\Omega$ to 600Ω . 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 or auto-range selection of the range required makes the LOM-DO7e 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 (or I) terminals, and the voltage drop across the unknown resistance R_x is measured at the P (or U) 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-DO7e 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

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 (400 Hz optional)

Power consumption:

<20 VA

Dimensions:

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

Weight:

6.0 kg (2.73 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.

Range	Resolution	Typical Current	Uncertainty At 20°C ± 5°C, 1 Year	Temperature Co-efficient/°C*
600 Ω	100 mΩ	1 mA	±(0.25% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
60 Ω	10 mΩ	10 mA	±(0.25% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
6 Ω	1 mΩ	100 mA	±(0.25% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
600 mΩ	100 μΩ	1 Amp	±(0.25% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
60 mΩ	10 μΩ	1 Amp	±(0.25% Rdg + 0.05% FS)	40 ppm Rdg + 30 ppm FS
6 mΩ	1 μΩ	10 Amp	±(0.25% Rdg + 0.05% 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 (60 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

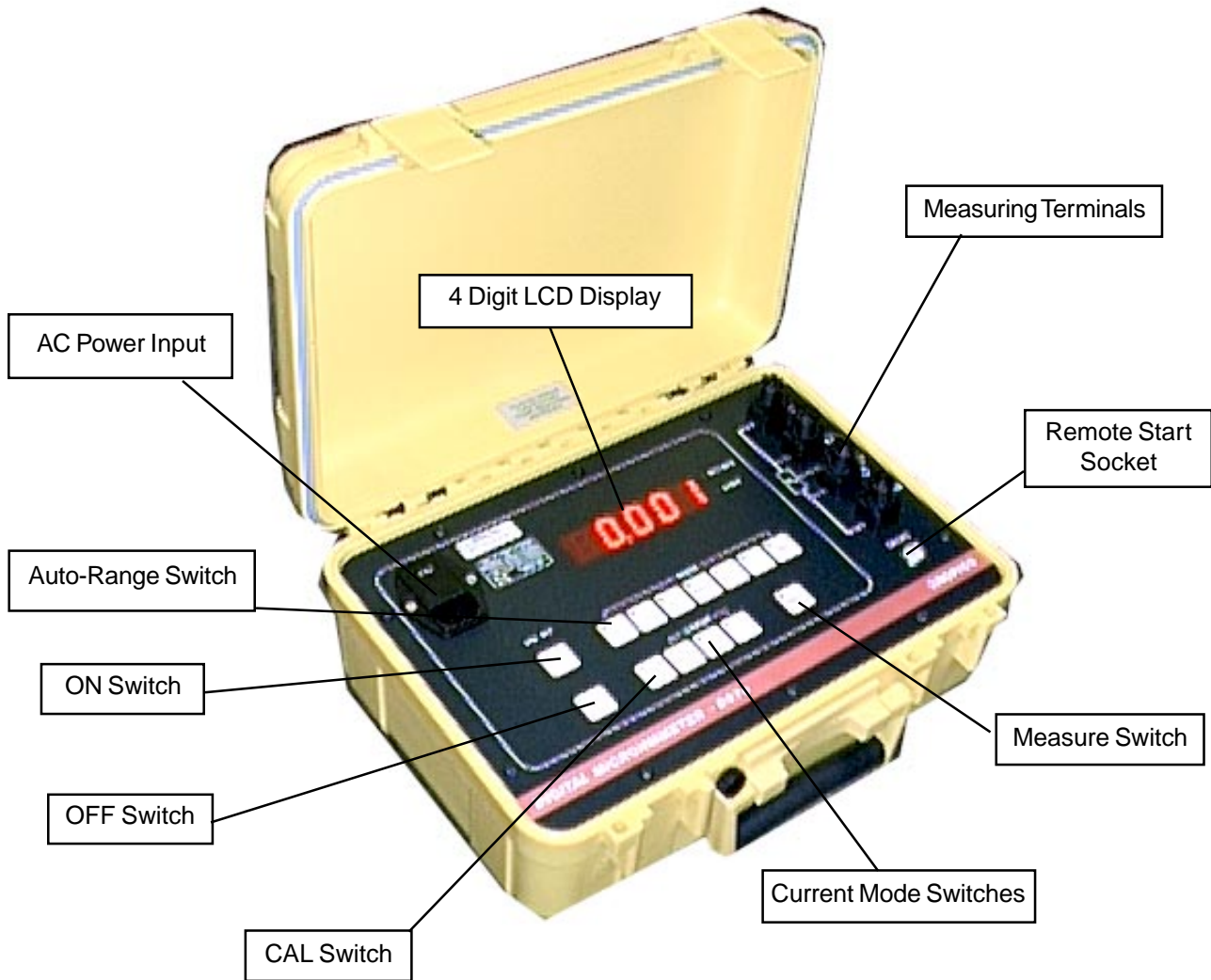


Figure 3.1 Description of Controls

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 indicate "---". 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 "----".

An auto-range capability is also provided: pressing the AUTO key puts the LOM-DO7e into the auto-range mode.

3.3.3 Error & Status Lamps

The following LEDs will light to indicate the instrument status:

LINE:

ac power is connected to the instrument.

LOBAT:

Battery capacity is nearly depleted.

CHG:

The internal battery is charging

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 STANDBY mode.

3.4 Making Measurements

3.4.1 Ohmmeter Connections

The LOM-DO7e 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 +I (or +C) and +U (or +P) terminals, and the red leads to terminals –I (or -C) and –U (or -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-DO7e 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: **600 Ω** range and **STANDBY** mode. The unit is now ready to make measurements. The display will blank after approximately. 25 seconds of inactivity.

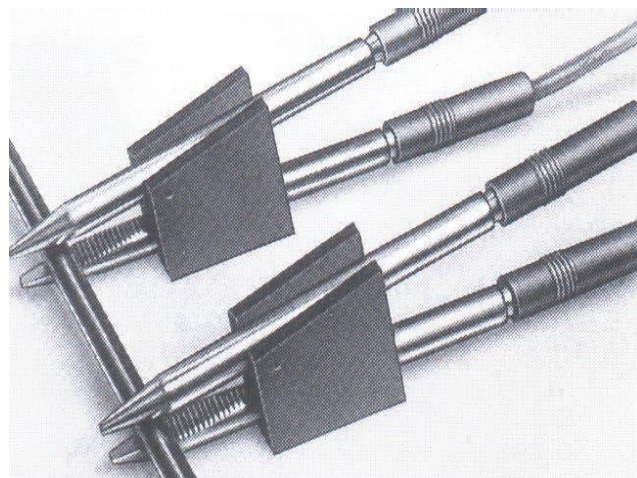


Fig. 3.2 Combined current and potential probes (Kelvin clips)

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 (R_x) 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. 9.1 and 9.2). Select the range required or **AUTO**, and the current measurement mode, i.e., “+”, “-”, or **AVE**. LEDs will light to indicate which functions are active. To initialize the measurement, press the **MEAS** 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 **MEAS** switch. To make another measurement the **MEAS** switch should be pressed again. To take continuous readings, press and hold the **MEAS** switch until a long beep is heard; this will activate a continuous-reading mode.

Note: Continuous measurements are not possible on the lowest (6 m Ω) range.

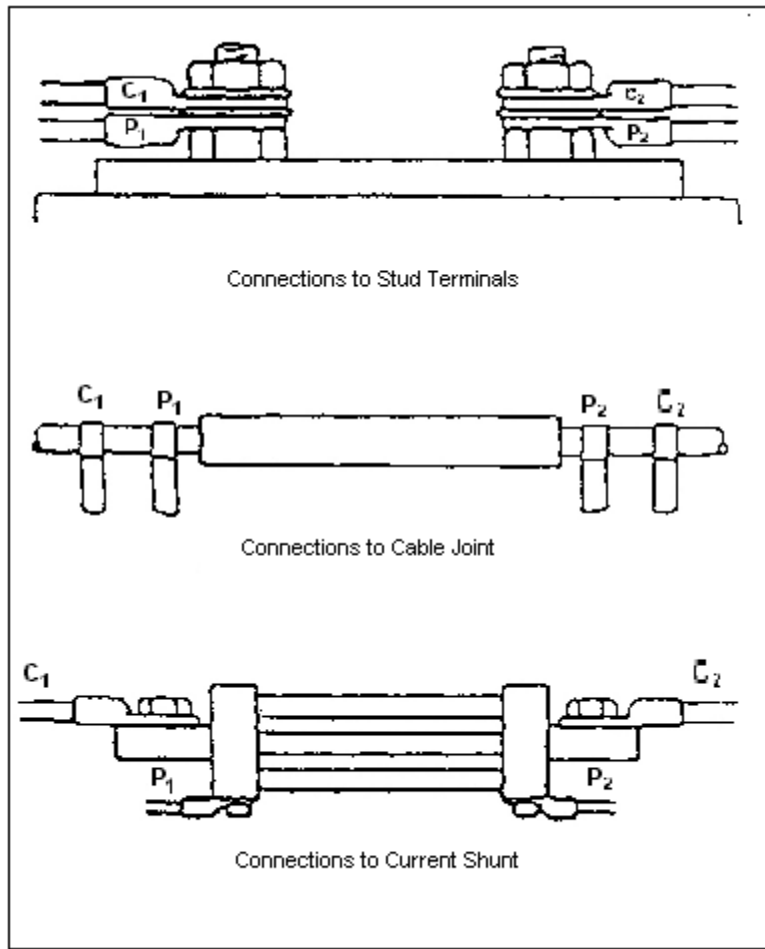


Fig. 3.3 Connections for resistance measurements with various DUT configurations

Measurements will continue until the **MEAS** key is pressed again. To preserve battery life, the unit will automatically turn off after 5 minutes of inactivity.

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

3.4.4 Current Mode

The current mode can be set to “+I”, “-I” or **AVE**. The **AVE** mode should be selected for all measurements 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-DO7e 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 **STANDBY** mode, this LED will always be lit.

3.4.7 Low Battery

The **LOBAT** LED will light when the battery has ~10% charge remaining. When this occurs, the LOM-DO7e should be connected to the ac line to recharge the batteries. Full measurement accuracy is maintained even when the **LOBAT** LED is lit.

3.4.7 Connections

To make the most accurate possible measurements, ensure that all test leads are in good condition, and have less than 0.2 Ω 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

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 **RE-**

MOTE socket, it will mimic the function of the **MEAS** key when activated. See Figure 3.4.

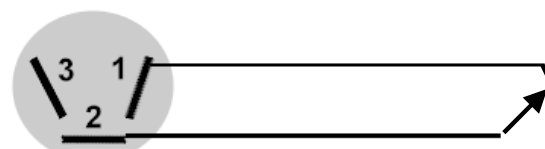


Figure 3.4 Remote Start Socket, viewed from panel

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.

Chapter 4 CALIBRATION

4.1 Calibration Process

This procedure describes the standard calibration method for the LOM-DO7e Micro-ohmmeter using the IET MTS2 Calibration Standard or discrete resistance standards of the required values.

CAUTION

The LOM-DO7e 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 password-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 environment (20°C ±5°C) for a minimum of 4 hours. Ensure that the batteries are fully charged.

4.3.2 Connect each of the four LOM-DO7e terminals to the equivalent terminals on the calibration standard. It is essential that low thermal emf leads are used for the P1 (or +U) and P2 (or -U) leads. See Figure 4.1 for the preferred setup.

4.3.3 An internal battery powers the LOM-DO7e 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 400.0 Ω.

4.3.5 Turn the LOM-DO7e **ON** while holding down the **CAL** key.

4.3.6 Let the setup stabilize for a few minutes .

4.4 Calibration Using MTS2 Standard

4.4.1 Entering a password, and Calibration

1. Hold down CAL key, whilst powering up - the LOM-DO7E displays 'CODE'.
2. Enter the 4-digit password (default is 9252) and press **OK**.
3. If the code was incorrect, a long beep will sound. Start again from step 2.

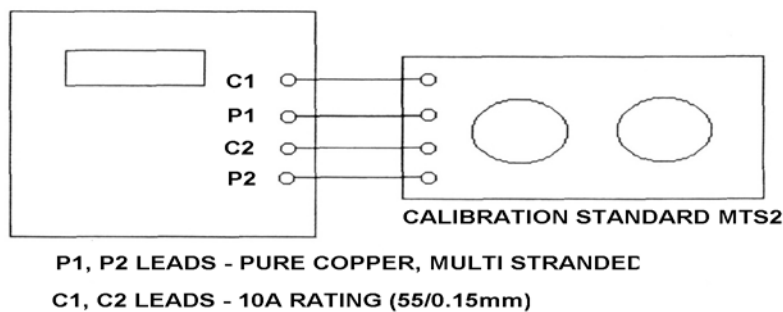


Figure 4.1 Preferred calibration setup.

4. If correct, the LOM-DO7e displays zero (e.g. '0.0'), and is now in Calibration mode. At this point, a desired range can be chosen for calibration by pressing the appropriate **RANGE** key. Otherwise, each range will be selected in turn automatically, starting with 600 Ω .

5. At this point, a specific range can be chosen for calibration by pressing the relevant range key. Otherwise, each range will be selected in turn automatically, starting with 600 Ω .

6. With the display showing zero, select the correct resistor value and the **ZERO** setting on the calibration box, and press **OK**. If there is an error, a long beep will be emitted, and the user should check the settings, and repeat Step 6.

7. If the zero measurement is successful, a short beep will be emitted, and the full-scale value is displayed (e.g. 600.0).

8. Select **FULL SCALE** on the calibration box.

9. Then enter the exact value of the standard resistor, using all four digits (e.g. 300.0) - the decimal point will be added automatically - and press **OK**.

10. If the entered value is outside the allowed limits, a long beep will be emitted immediately, and the user should go back to Step 9.

11. If the entered value is OK but there is an error in the measurement, a long beep will be emitted at the end of the measurement. The user should check the settings, and go back to Step 8.

12. If the full-scale measurement is successful, a short beep will be emitted, and the user is returned to Step 4 with the next range down already selected.

Note:

Calibration mode can be exited by pressing the **CAL** key at any time, except when a number is being entered.

Partially-entered codes or values can be cleared at any time by pressing **CLE**, and then **ENTER**.

Ideally, the LOM-DO7e 600 W range should be calibrated against a 600 W standard, but the software will allow any value between 90 Ω and 600 Ω . Similar ratios apply to the other ranges.

4.4.2 Changing a password

1. Turn on unit and enter existing password as described above.

2. Press and hold the **CLE** key for 2 seconds the LOM-DO7e displays 'CODE'.

3. Enter the new 4-digit password and press **OK** - the LOM-DO7e displays 'CODE' again.

4. Reenter the new 4-digit password and press **OK**.

5. If the new password was not entered correctly both times, a long beep will be emitted, and the process must be repeated from #3.

6. If correct, the LOM-DO7e displays zero (e.g. '0.0'), and is now in Calibration mode. If calibration is not required at this time, exit the calibration mode by pressing **CAL**.

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-DO7e measuring current must also be taken into account when selecting the standards. The LOM-DO7e 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 (or U1) and P2 (or U2) terminals are conventionally connected. Bear in mind that thermal emf's may be present. The LOM-DO7e is particularly sensitive to these on the 6 mW 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 full scale measurements, perform steps 4 through 10 of the above procedure (which uses the MTS2 standard) to complete the calibration.

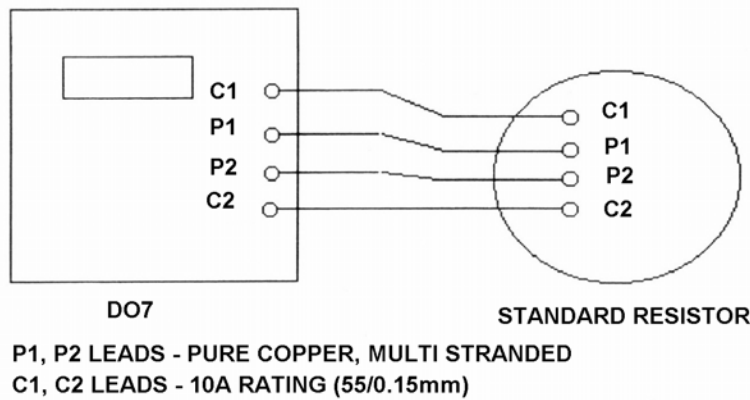


Figure 4.2 Full Scale calibration setup

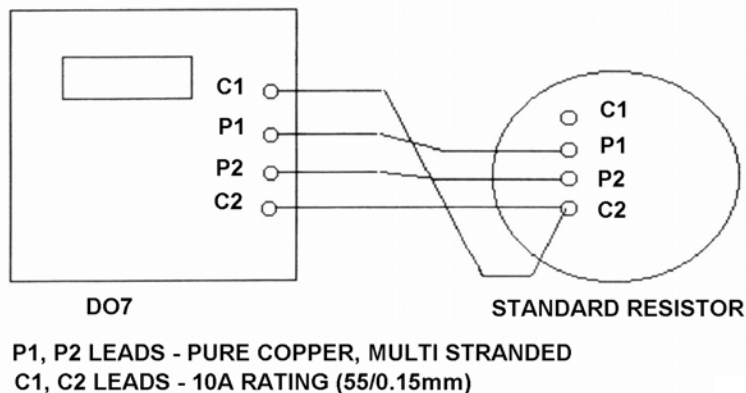


Figure 4.3 Zero calibration setup

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
102 V	104-132 V	250 mA(T)(sb)
230 V	209-264 V	125 mA(T)(sb)
Maximum input power: 18 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-DO7e 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-DO7e incorporates a sophisticated battery management system. Low battery condition is indicated by a panel-mounted LED.

The battery charger is built-in and the instrument may be connected to a 120 or 230 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 illuminate 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, and the “**LOW BATTERY**” indicator will illuminate. The battery will recharge in approximately six hours; leave the LOM-DO7e 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).

