

Megger[®]

DLRO[®]-10 & DLRO[®]-10X **Digital Low Resistance Ohmmeter**

USER GUIDE

GUIDE DE L'UTILISATEUR

BEDIENUNGSANLEITUNG

GUIDA PER L'UTENTE

GUIA DEL USUARIO

SAFETY WARNINGS

- **These safety warnings must be read and understood before the instrument is used.**
- **Whenever possible, circuits should be de-energised before testing.**

If it is impossible to de-energise the circuit, (e.g. high voltage batteries cannot be switched off while their connections are tested) the user must be aware of the dangers. The instrument terminals will become live when connected to the circuit. It is therefore recommended that a suitably insulated and rated lead set be used to provide insulation at the terminals.

- **Testing inductive circuits can be hazardous:**

After testing an inductive load there will be an amount of energy stored in the inductance. This energy is released in the form of a discharge current. Disconnecting an inductive load while current is still flowing will cause a high voltage arc, which is a danger to both the user and the item under test.




Although the DLRO 10 and DLRO 10X are not designed as transformer ohmmeters the DLRO 10 is fitted with a **DISCHARGE** lamp, marked **T**, which indicates that current is flowing in the C1-C2 loop. This lamp will flash at end of a test on an inductive load while a discharge current is still flowing and will stop flashing when the current has decayed to less than 1mA. DLRO 10X uses a message on the display to achieve this.

For testing large inductive resistances the current carrying leads should be connected securely to the item under test before starting the test.

It is not recommended that duplex handspikes be used to carry out tests on inductive loads. If inadvertently using the DH4 handspikes on an inductive load, the L1 lamp on the handspikes will flash amber while discharge current flows, thereby duplicating the function of the **T** lamp on the instrument. It is important to maintain contact until the L1 light stops flashing amber and turns green indicating the end of the test.

- **This product is not intrinsically safe. Do not use in an explosive atmosphere.**
- **Please note. The neck strap is specifically designed to break if subjected to a strain of approximately 50 kg.**

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GENERAL DESCRIPTION

The DUCTER DLRO 10 and DUCTER DLRO 10X make up a family of low resistance ohmmeters that measure resistances in the range from 0.1 $\mu\Omega$ to 2 k Ω . Both instruments provide a maximum test current of 10 Amps d.c. which is automatically selected according to the value of resistance being tested. The DLRO 10X allows you to override this automatic selection and select your own test current.

The measured value of resistance is output to the instrument display with indication of the units, $\mu\Omega$, m Ω or Ω . The DLRO 10 uses a large LED display and indicators to display the value and units respectively, while the DLRO 10X contains all the information on a clear backlit LCD display.

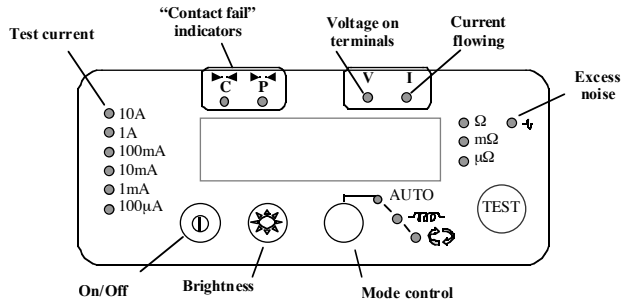
The use of a four terminal measurement technique removes the test lead resistance from the measured value and auto current reversal eliminates the effect of standing voltages across the test sample. Additionally, before and during a test, test lead contact is monitored to further reduce the chance of erroneous readings.

A resistance measurement takes approximately 2.5 seconds and comprises a measurement with forward current, reverse current and a display of the average. On the DLRO 10X all three values are displayed, and optionally, the measurement may be limited to forward current only.

The instrument is powered by a rechargeable Nickel Metal Hydride (NiMH) battery, which permits one thousand 10 Amp tests to be completed on a single charge. The battery module contains intelligent circuitry, which prevents damage to the battery from overcharging, and a battery state indicator. A removable lid that is hinged at the back and held closed by magnetic catches covers the top panel. This lid may be removed if required by opening fully and snapping out of its hinges.

Both instruments are protected against accidental connection to external voltages up to 600 V d.c. applied between any pair of the four terminals for up to 10 seconds. Please note that applying 600 V to the potential terminals will cause some internal heating. Expect errors of up to 30 digits immediately after the application of such voltage. Full accuracy will be restored within two to three minutes. Both instruments are supplied complete with a pair of DH4 Duplex Handspikes with 1.2 m leads. Other lengths and terminations are available if required.

GENERAL OPERATION - DLRO 10



Press the On/Off switch to turn DLRO 10 on. All lamps will light, V and I lamps will flash, the software version will be displayed and the Ω lamp will light. If the test leads have not been connected to the test sample the 'C' and 'P' lamps will also light. Press the On/Off button again to turn the instrument off. If the instrument is not used for 5 minutes it will be turned off automatically.

Adjust the brightness control to a comfortable level. Select the Test mode by pressing the Mode button repeatedly. The indicator lamps will cycle through the various Test modes in turn (see the section on Test modes). Press the Test button to start a test.

Test Current Indicators

The test current is selected automatically by DLRO 10 and is indicated by the lamps on the left of the panel. The measured value is displayed in the main window and the units ($\mu\Omega$, $m\Omega$ or Ω) are shown by the lamps to the right of the window.

Noise Lamp

Noise in excess of 100 mV 50/60 Hz will light the 'Noise' lamp and measurement accuracy cannot be relied upon.

'C' & 'P' Indicators

The 'C' lamp illuminates to indicate contact failure in the 'C1-C2' loop. The 'P' lamp illuminates when there is a break in the P1-P2 loop.

'V' & 'I' Warning Indicators

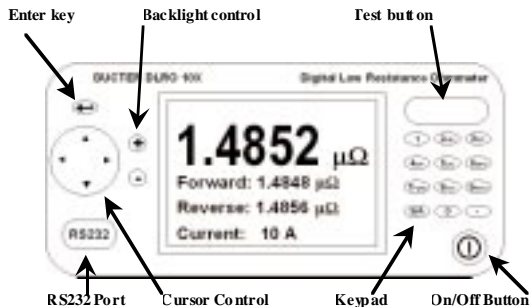
If external voltage is applied to the terminals the 'V' lamp will flash. This is a warning that the item under test is live and might be dangerous. A test cannot be performed in this condition.

The 'V' lamp will light if more than 50 V. is applied between either voltage terminal and a current terminal. If the voltage appears between just the voltage terminals or just the current terminals the lamp will light at 100 V peak or 5 V peak respectively.

Please note - The 'V' lamp will only indicate if a voltage appears between terminals. The lamp will not operate if all terminals are at the same high voltage. The lamp will not operate if the instrument is turned off.

The 'I' lamp will light if a current greater than 1 mA is still flowing after a test is completed. This suggests that an inductive load has been tested and is still discharging. Do not disconnect the current loop until the 'I' lamp has gone out.

GENERAL OPERATION - DLRO 10X



DLRO 10X Top Panel

All the controls needed to set up and operate DLRO 10X are located on the top panel of the instrument.

To the left of the large LCD display are the controls for moving around the display, controlling the menuing system and adjusting the display contrast and backlight.

To the right of the display is the large Test button, Power On/Off button and an alphanumeric keypad for entering notes relating to a test which will be stored with the test results for later reference.

To turn your DLRO 10X on, press the On/Off button for approximately 1 second. Press again to turn the instrument off. If the instrument is not used for 5 minutes it will be turned off automatically.

DLRO 10X Main Menu Screen

When first switched on DLRO 10X displays a copyright screen, followed by the Main Menu screen.

This screen provides you with information such as percentage of battery

charge remaining, index number of the next test, number of tests already stored and the current date and time.

This screen also provides access to the menuing system, through which you set up your instrument and choose the desired test parameters. Navigation of this menuing system is by means of the cursor control and Enter key.

TEST	OPTIONS	RANGE
NORM		10A
	70%	
	NEXT TEST 1	
	0 STORED	
	27/07/00	12.02

Warning Messages

The Main Menu screen will from time to time also contain certain warning messages

Noise

Noise in excess of 100 mV 50/60 Hz will activate the message 'Noise' at the bottom of the display. Above this level accuracy cannot be relied upon.

'C' & 'P' Indicators

A good measurement requires both the current carrying circuit and the voltage detection circuit to be completed by the item under test. DLRO 10X checks for this continuity. If there is poor continuity in either circuit a message will appear at the bottom of the display. This will read "P OPEN CIRCUIT" if the voltage contacts are high resistance, "C OPEN

GENERAL OPERATION - DLRO 10X

CIRCUIT" if the current circuit is not made or "CP OPEN CIRCUIT" if both circuits are inadequate. Check the contacts, since a measurement cannot be made if any of these messages is visible on the display.

External Voltage Warning

If external voltage is applied to the terminals a message "EXT VOLTS" will flash on the display. This is a warning that the item under test is live and might be dangerous. A test cannot be performed in this condition.

The "EXT VOLTS" message will flash if more than 50 V. is applied between either voltage terminal and a current terminal. If the voltage appears between just the voltage terminals or just the current terminals the message will appear at 100 V peak or 5 V peak respectively.

Please note - The message will only appear if a voltage appears BETWEEN terminals. The message will not appear if all terminals are at the same high voltage. The message will not operate if the instrument is turned off.

Discharge Current Warning

A message CURRENT FLOW will appear if a current greater than 1 mA is still flowing after a test is completed. This suggests that an inductive load has been tested and is still discharging. Do not disconnect the current loop while the discharge warning is showing.

The Menuing System

Use the Left and Right arrows of the cursor control to highlight the menu required. Press the Down cursor control to see the options available on that menu. Select the required option using the cursor control and press Enter to set that option. Depending on the menu item selected the display will either present further options or will return to the main menu screen.

Test Menu

This sub-menu selects the test mode. Only one mode can be active at a time and the active mode is displayed below the heading TEST. (See Test Modes later in this manual for details of each mode.)

Options Menu

The Options menu has five options that are not related to each other, as shown below.

Retrieve

allows the recall of stored results to the display or a PC.

Display

recalls each test, in sequence, to the instrument display

	TEST NUMBER 2
	DD MM YY HH MM
	09/10/00 12:24
	TEST NORMAL
AVERAGE	12.6 $\mu\Omega$
FORWARD	14.0 $\mu\Omega$
REVERSE	11.2 $\mu\Omega$
CURRENT	10 A
RESULTS	MEMO *

starting with the latest stored result.

Use the cursor control Up and Down controls to step later or earlier respectively through the stored results. Alternatively, if you know the index number of the test you wish to display, type the number on the keypad and press Enter.

GENERAL OPERATION - DLRO 10X

An asterisk (*) next to the word "MEMO" means that there are notes attached to this result. Press the right cursor control to view the notes.

Download

causes the entire contents of the data store to be output to the RS232 port to the left of the display. A copy of AVO Download Manager, which facilitates downloading and formats the data, is supplied.

Downloading data does not cause the stored data to be erased from memory. To clear data from memory see "Delete Data" below.

Please note - DLRO 10X also makes data available via the RS232 Port in real time and is suitable for printing on a self-powered serial printer. The output has the following form:

TEST NUMBER
TEST TYPE
DD MM YY HH MM
01/01/00 00:33
FORWARD RESISTANCE
REVERSE RESISTANCE
AVERAGE RESISTANCE
SELECTED CURRENT
UPPER LIMIT
LOWER LIMIT

PASS/FAIL

The last three lines will only appear if passbands have been set

Passbands

This option allows you to set upper and lower limits between which the test result average must fall if it is to be signalled as a Pass (a long tone from the buzzer). Readings outside these limits will be signalled as a Fail (a short tone from the buzzer).

Values are entered via the keypad complete with decimal points, where applicable, and including μ or m (See section on the Alphanumeric Keypad). It is not necessary to enter the Ω symbol. The upper limit must be less than or equal to 2000.0 Ω and the lower limit must be less than the upper limit.

After completing the upper limit press Enter. DLRO 10X will check that valid numbers have been entered and will move to the lower limit. Complete this limit and press Enter. DLRO 10X will check that valid numbers have been entered and will display the option to ENABLE or DISABLE the passbands.

Highlight your choice and press Enter. You will return to the Main Menu screen.

Note: Passbands will remain enabled or disabled until you enter this screen and change the selection. If all that is required is to change Passbands from ENABLED to DISABLE or vice versa, enter the PASSBAND screen and press Enter until the ENABLED / DISABLED choice is shown at which time you may change the selection.

Set Clock

This option sets the real time clock date and time settings as well as setting the date format. When you enter this screen the current date, time and date format will be displayed.

GENERAL OPERATION - DLRO 10X

Use the cursor control Up and Down arrows to adjust the highlighted data. Step to the next item by using the Right cursor control arrow.

The row below DD MM YY HH MM contains respectively the date, the month, the two-digit year, the hour of the day in 24-hour notation and the minute. These must be entered in this sequence regardless of the date format you wish to use.

TEST	OPTIONS	RANGE
NORM		AUTO
DD MM YY HH MM		
09/10/00 15.08		
DD MM YY		
09/10/00 12.02		

The lower DD/MM/YY shows the current date format. Pressing the cursor control Up arrow will cycle through the available options DD/MM/YY, MM/DD/YY or YY/MM/DD.

The bottom line shows the current setting of date and time. This is updated when you press Enter to exit the Set Clock function. However, tests already stored prior to changing the date format will retain the old format.

Delete Data

Select Delete Data if you wish to clear DLRO 10X's memory of stored data. In case you have selected this Option by accident you will be asked to confirm that you wish to delete the data; the default is NO. Change this to YES and press Enter if you wish to delete all data.

Please note - ALL stored data will be deleted.

Storage

The Storage option sets the default for data storage. It may be set to always store data or never to store data. Highlight the desired option at the bottom of the screen and press Enter.

With the exception of tests carried out in Continuous mode, at the end of each test you have the option to change the default by selecting STORE or NO STORE at the bottom of the results screen.

At the end of a test, if memory is full this STORE / NO STORE message will change to MEMORY FULL and no more tests will be stored.

Data is stored indefinitely if a charged battery pack is fitted. If the main battery becomes exhausted or is removed, data is maintained for a period of 4 days by an internal backup battery. When a charged battery pack is refitted, the backup battery will recharge to full capacity within 1 week.

Range Menu

DLRO 10X uses a test current between 100 μ A and 10 A to measure the resistance of the item under test. If set to AUTO, DLRO 10X will select the current according to the resistance it detects. (see Specifications, Ranges)

However, in some cases it may be desirable set a maximum test current. If this is so, move the cursor to the desired current and press Enter.

Six test currents are available; 10 A, 1 A, 100 mA, 10 mA, 1 mA and 100 μ A. Selecting the 10 A maximum will have the same effect as selecting AUTO.

The Main Menu screen will show the active current range beneath the RANGE heading.

GENERAL OPERATION DLRO 10X

ENTERING NOTES IN THE MEMO SCREEN

At the end of each test, (with the exception of a test in Continuous mode), you can select the STORE or NO STORE option to store the test results or not. Select the desired option using the cursor control. This overrides the default setting under Options, Storage for one test only.

If you wish to add comments to the test results, instead of pressing Enter, briefly press one of the twelve keys on the keypad. You will enter a memo screen that allows you to enter up to 200 characters of alphanumeric information concerning the test. When you have entered all information press Enter and the measurement and memo will be stored regardless of whether STORE or NO STORE was selected.

If you do not wish to add notes and are happy to accept the default STORE / NO STORE setting you may press the Test button and a new test will be started.

TEST RESULT STORAGE

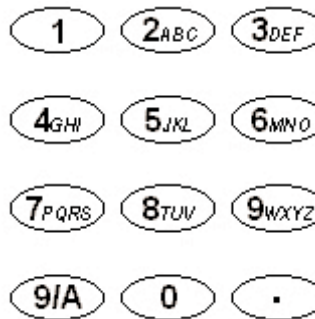
Each test is numbered, starting at test 1. This test number is incremented automatically, as each result is stored. The test result memory can store a maximum of 700 tests, each being identified by its test number, date and time.

It is advisable to retrieve all data to a PC and then to delete all data before the test number reaches this maximum. Deleting the data will reset the test number to 1. This will save loss of data.

KEYPAD OPERATION

The 12 key keypad is similar to those used on mobile telephones in that each key is capable of producing one of several characters depending on the number of times the key is pressed.

The keypad is used to enter data into the Memo field.



Pressing the blue key marked 9/A changes the function of the keyboard between alpha and numeric modes.

In alpha mode a full height flashing vertical bar (|) indicates the cursor. The keys 2 to 9 will produce the letter shown on the keys depending on the number of presses. For example if the 2 key is pressed once an 'A' will appear, twice and a 'B' will appear etc.

The 0 key produces a space.

The 1 key is a destructive backspace.

In numeric mode a half height flashing bar (|) indicates the cursor. The keys marked 1 - 9 and 0 produce that number when pressed. Press the respective key briefly to enter the desired number. Pausing will cause the cursor to move on to the next character. If a key is held down it will auto-repeat.

The key at the bottom right hand corner of the keypad marked with a dot is a special key that produces 20 special symbols. Each press will sequentially produce the character shown on next page:

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.	Decimal point or full stop
Ω	Ohms symbol
m	lower case m (abbreviation for milli)
μ	Symbol for micro
#	Symbol known as hash or pound and commonly used as shorthand for "number"
%	Percent sign
(Left round bracket
)	Right round bracket
-	Hyphen, dash or minus sign
/	Slash
:	Colon
@	"at" symbol;
√	Tick mark
!	Exclamation mark
?	Question mark
\$	"Dollar" symbol
=	"Equals" sign
<	"Less than" symbol
>	"Greater than" symbol
*	Asterisk

TEST MODES

TEST MODES

DLRO 10 has 4 test modes which are selected by repeated presses of the Mode button. At the end of each test, DLRO 10 will display the average of the values obtained with forward and reverse current.

DLRO 10X has 5 modes. On DLRO 10X these modes are selected from the TEST menu using the cursor control and Enter key. At the end of a test, DLRO 10X will show three resistance values; that obtained with forward current, that obtained with reverse current and the average value.

Normal mode

Normal mode makes a single measurement of the resistance of the sample using forward and reverse current

Please note that in this mode both the current and voltage leads must be connected across the test sample before the Test button is pressed. To make another measurement, ensure the test leads are connected and press the test button.

Automatic mode

If Automatic mode is selected, your instrument will remain in a state of readiness waiting for both the current AND voltage measuring leads to be connected to the test piece. When this is done, a forward and reverse current test will be started automatically.

To make another measurement simply break contact with the test sample and remake contact.

For example, if measuring joints in a long bus bar, you may leave the current circuit connected at opposite ends of the bus bar. Simply making contact with voltage probes across the joint(s) you wish to measure will then activate the measurement.

Continuous mode

Continuous mode requires the connections to be made before pressing the Test button. Your instrument will then repeat its forward and reverse measurements and display the results approximately every 3 seconds until contact is broken or the Test button is pressed.

Inductive mode

DLRO 10 and DLRO 10X are able to make d.c. resistive measurements on loads that exhibit an inductive component using the test mode indicated by the inductor symbol on the DLRO 10, or by using the inductive mode on the DLRO 10X.

When measuring inductive loads it is essential that the current carrying leads are securely clamped to the item being tested and that they are not removed before any stored charge has been discharged at the end of the test. Failure to comply with these instructions might result in an arc being produced, which might be dangerous for the instrument and the operator.

Having selected inductive mode, connect all four leads to the item being tested and press the Test button.

DLRO will check that all four leads are in adequate contact with the test piece and will then apply a test current and try to find the correct range. The display will show 1 - - followed by 1 - - - -. During this time you may see the current range increasing or decreasing. On the DLRO 10 the "I" lamp will flash and the message "Current Flowing" will appear on the DLRO 10X display.

After a short time resistance readings will appear on the display, reducing gradually over a period of time until eventually a stable reading will be obtained.

The time required for a stable reading may vary from a few seconds up

Test Modes

to several minutes depending on the inductance and resistance of the test sample. There is no time limit for the inductive mode test, which will continue until the operator presses the Test button.

When the test is terminated, the “I” lamp will remain illuminated on the DLRO 10 or the message “Discharging” will appear on the DLRO 10X display until any stored energy has discharged. When these messages are extinguished it should be safe to disconnect the “C” leads.

However, the discharge indicator is an active electronic device and should not be relied upon. You should observe your organisation’s operating procedures.

At the end of the test both instruments will display the measured resistance, the DLRO 10 will flash the relevant current lamp while the DLRO 10X will display the test current used on the display.

Please note:- In inductive mode the 10A test current will not be used.

Undirectional mode

On the DLRO 10X only, this mode makes the measurement as in automatic mode but using forward current only.

This mode speeds up measurements on samples that are known to be free of any standing voltages or thermal emfs. However the accuracy of the reading may be degraded by any thermal emfs but should not be worse than $0.2\% \pm 30$ digits.

Since current is only applied in the forward direction, in this mode only a single resistance value will be displayed.

A test may be repeated by breaking contact and reapplying the test probes or by pressing the Test button.

TEST TECHNIQUES & APPLICATIONS

TESTING USING DH4 DUPLEX HANDSPIKES

Each handspike is marked with the letter P. This indicates the potential terminals. These should be the 'inside' contacts when making a measurement (as shown in the next section 'Testing Using Duplex Handspikes or Individual Leads').

One of the DH4 handspikes is fitted with two lamps marked L1 and L2 and an extra lead. This lead should be plugged into the 4 mm socket next to the main terminals on the right hand side of the instrument. These lamps provide information to the operator, which would otherwise only be available on the instrument display. The meaning of these lamps is described below.

For example, using the DH4 Duplex Handspikes with the DLRO 10 in AUTO test mode:

1. Press the TEST button on the instrument.
2. Lamp L1 will illuminate a continuous red to indicate contact failure. See the instrument panel for details if required.
3. When all four contacts connect, L1 will extinguish.
4. No lamps will show during the test unless contact fails.
5. Lamp L2 will light a continuous green when current flow has decayed to less than 1 mA to signal end of test.
6. Removing the probes will extinguish the green L2 (end of test) and Light the red L1 (no contact).

Since your DLRO always ensures good contact before applying the full test current, there will be no 'splash' to erode the contact tips. However, should the tips become worn or blunted, they can be simply replaced by pulling out the worn tips and inserting new ones.

DLRO 10 and DLRO 10X (no passbands)

Lamp L1	Lamp L2	Meaning
Red	Off	Inadequate contact at C and/or P contacts
Flashes Red	Off	Voltage present between contacts
Off	Green	Current less than 1 mA and test complete.
DLRO 10X ONLY if passbands set		
Off	Green	Measurement Pass
Off	Red	Measurement Fail

TESTING USING DUPLEX HANDSPIKES OR INDIVIDUAL LEADS.

Connect the four leads as shown.



If using Duplex Handspikes ensure that the probe marked P is inside the C probes.

TEST TECHNIQUES & APPLICATIONS

TEST SEQUENCE

Pressing the TEST button starts the test sequence.

Contact resistance is checked by passing 100 μ A through the C1-C2 loop and checking that the voltage is less than 4 V. Then passing 80 mA through the P1-P2 loop and checking that the voltage is less than 250 mV. If either value is exceeded the respective lamp or warning message will be displayed.

When all faults have been rectified the test current is increased until the voltage on P1-P2 is within the 2 mV to 20 mV range. This current is then applied in a forward and then reverse direction to obtain two measurements.

Both measurements are displayed by DLRO 10X along with the average, while the DLRO 10 displays the average only.

If the combined resistance of the current leads and test sample is greater than 100 m Ω , testing at 10 A will not be possible.

A 1.9 m Ω resistor will then be tested at the next lowest current (1 A) and the result will be shown as 1.900 m Ω instead of 1.9000 m Ω .

TEST LEAD RESISTANCE

For testing at 10 A, the combined resistance of the current leads must not exceed 100 m Ω . This will ensure that the voltage drop in the leads is less than 1 volt and will enable 10 A testing under worst case conditions. If you wish to limit test current to no more than 1 A, on DLRO 10 use current leads with a resistance of about 1 Ω , or on DLRO 10X select 1A as the maximum test current on the RANGE submenu.

OVERHEATING

When performing rapidly repeated tests at 10 A, using current leads with a combined resistance of 100 m Ω , 10 W of heat will be dissipated in the

leads and 30 W within your instrument. If the ambient temperature is high this will cause internal overheating and the message "hot" will appear on the instrument display and testing will be halted.

After a few minutes to cool down, testing will be allowed to continue.

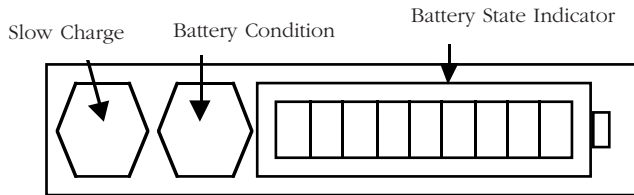
If this is a persistent problem, use current leads with a higher resistance (e.g. 200 m Ω to 300 m Ω). This will reduce the generation of internal heat.

BATTERY MODULE AND CARE

THE BATTERY MODULE

The battery module contains nickel-metal-hydride cells and has a built-in battery-management system that controls charging and monitors discharge. This provides a high capacity, low-weight battery system, which can be recharged at any time. It is not possible for the user to over-charge or over discharge the battery. For your own convenience it is best to charge it regularly to keep it topped up, but leaving it in a discharged state will do no harm.

On the front of the battery module are two buttons and a 10-segment LED display.



To find the amount of charge in your battery module, whether connected to your DLRO or separate, press the Battery Condition Button. The Battery State indicator will light between 1 and 10 segments signifying between 10% and 100% charge respectively. After a few seconds this display will automatically go out.

BATTERY CHARGING

Please note - The battery should only be charged within the temperature range 0°C to 45°C. Fast charging will not be allowed if the temperature is below 10°C. Fast charging causes the temperature of the battery to rise. If the temperature exceeds 45°C the charging rate will be reduced automatically.

To charge the battery, your battery module must be removed from the instrument. Remove the module by pressing on the raised circular area of the retaining clips and pull the top of the clip away from the instrument body. The module now unplugs from the base of the instrument.

Plug in the charger or connect to a 12 volt vehicle-type battery using the 'cigar lighter' lead provided. The LED "Battery State" indicator will light and show movement when the battery is charging. The battery may be recharged before it has been fully discharged. It will normally be recharged to 90% of capacity within 2 1/2 hours. Full charge may take up to 4 hours before indicating that the battery is full depending on the initial state of the battery. When charging is complete the battery management circuitry will switch off so that over-charging is prevented.

Your battery module can be safely used in a partially charged state and will not suffer if stored in a discharged state. However, you may wish to have a spare battery that can be interchanged with the one in use to provide continuous use of your DLRO.

As the battery ages, it may start to lose its capacity. In this case the battery module has a slow charge facility which is activated by pressing the Slow Charge button while switching on the charger supply until the indicator bars start to move. This method of charging can take up to 48 hours and so is best reserved for a weekend or a period when the instrument is not required to be used.

A fully charged battery, even if not used, will self discharge over a period of several weeks (faster at higher temperatures). Always check the "Battery State" indicator before starting work. A fully charged battery will light all segments. A fully discharged battery will light no segments.

BATTERY MODULE AND CARE

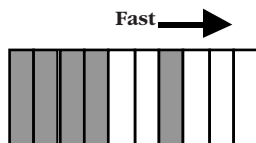
Please note that all batteries suffer a reduced life if exposed to constant high temperatures. A constant temperature of 30°C will probably cause the battery to fail in less than 5 years. 40°C will shorten its life to 2 years.

THE BATTERY STATE INDICATOR

The Battery State Indicator provides information on the amount of charge in the battery, but is also used to signal other conditions as follows:

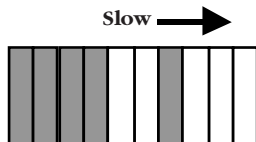
Standard Charging.

The battery module is charging at its standard rate.



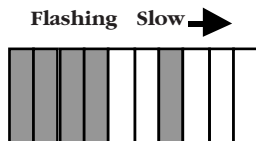
Slow Charging.

The battery module is charging at its slow rate.



Standard charging but at a slow rate.

The battery has been set to charge at its standard rate but, because the battery has become hot, it has switched charge rates to a lower rate while the battery cools down. Wait for the temperature to drop and/or move to a cooler location.



Not charging. There is a temperature problem.

The battery is too hot or too cold and charging has therefore been interrupted until the battery returns to a temperature between 0°C and 45°C (32°F and 113°F)

Flashing



Input Voltage Too Low.

The charger supply is not supplying sufficient voltage to the battery module to charge the batteries.

Rapid



Battery nearly exhausted

The battery capacity is very low. Recharge it.

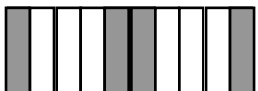
Flashing



Error: Reset

An error has occurred within the battery module. The circuitry is resetting. Wait a few moments and the fault should clear.

Flashing



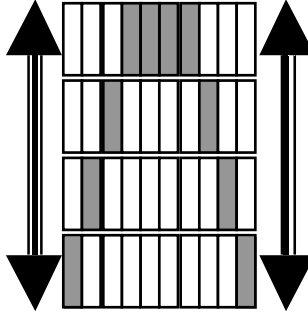
BATTERY MODULE AND CARE

Overvoltage problem

The charging supply voltage is too high. Disconnect the charger and rectify the fault.

WARNING

Connecting to greater than 15 volts can cause permanent damage to the battery module.



SPECIFICATIONS

Ranges

Full Scale	Resolution	Accuracy	Full Scale Volts		Test Current	
			Resistance	Induction	Resistance	Induction
1,9999 mΩ	0,1 μΩ	±0,2%±0,2 μΩ	20 mV		10 A	
19,999 mΩ	1 μΩ	±0,2%±2 μΩ	20 mV	20 mV	1 A	1 A
199,99 mΩ	10 μΩ	±0,2%±20 μΩ	20 mV	200 mV	100 mA	1 A
1,9999 Ω	100 μΩ	±0,2%±0,2 mΩ	20 mV	200 mV	10 mA	100 mA
19,999 Ω	1 mΩ	±0,2%±2 mΩ	20 mV	200 mV	1 mA	10 mA
199,99 Ω	10 mΩ	±0,2%±20 mΩ	20 mV	200 mV	100 μA	1 mA
1999,9 Ω	100 mΩ	±0,2%±0.2 Ω	200 mV	200 mV	100 μA	100 μA

		DLRO 10	DLRO 10X
Display	Measurement	4 1/2 digit seven segment LED	Large backlit LCD
	Range and Safety	LED Indication	
Measurement	Mode	Manual, Auto, Continuous, Inductive	Manual, Auto, Continuous, Inductive, Unidirectional.
	Control	Fully Automatic	Fully Automatic with manual override of maximum current
	Speed	<3s for forward & reverse current and to display average	
	Test Method	Single cycle reversing d.c. ratiometric measurements and average result calculated.	
	Test Current Accuracy	10%	
	Output Current Stability	<10 ppm per second @ 10 mA <100 ppm per second at higher currents	

SPECIFICATIONS

		DLRO 10	DLRO 10X
Maximum Lead Resistance		100 mΩ total for 10A operation irrespective of battery condition.	
Voltmeter Input Impedance		> 200 kΩ	
Hum Rejection		Less than 1% ± 20 digits additional error with 100 mV peak 50/60 Hz. on the potential leads. Warning will show if hum or noise exceeds this level.	
Data	Transfer		Real Time or from storage via RS232
	Storage		700 tests
	Memo Field		Up to 200 characters per test via integral alphanumeric keypad.
Battery	Capacity	7 Ah NiMH rechargeable.	
	Life	Typically 1000 x 10 A tests before recharge	
	Recharge	Via External 90V - 260 V 50/60 Hz charger or from 12 to 15 V d.c. supply	
Charging Time		2.5 hours to 90% capacity, 4 hrs for full charge	
Temperature	Operation	+5°C to +45°C (41°F to 113°F) at full specification. -10°C to +50°C (14°F to 122°F) at reduced accuracy	
	Storage	-30°C to +70°C (-22°F to 158°F)	
	Calibration	20°C (68°F)	
	Coefficient	<0.01% per °C from 5°C to 40°C (<0.006% per °F from 41°F to 104°F)	
	Standard charging	0°C to +45°C (32°F to 113°F)	
	Fast charging	+10°C to +45°C (50°F to 113°F)	
Humidity	Max	90% RH @ 40°C (104°F) non-condensing	
Altitude	Max	2000m (6562 ft.) to full safety specifications	
Safety		In accordance with EN61010-1 600 V Category III	
EMC		In accordance with IEC61326 including amendment No.1	
Dimensions		220 x 100 x 237 mm (8.6 x 4 x 9.5 in)	
Weight		2.6 kg (5 3/4 lb.) including battery module	

TROUBLE SHOOTING

Error Message	Fault	Action required.
bAtt	The main battery module is low.	Recharge the main battery or replace with a charged one
-----	An error has occurred during the measurement. e.g. contact has been lost at one of the probes.	Rectify the error and repeat the measurement.
ERR 114	Checksum Failure in EEPROM. Calibration constants have been lost. The DLRO will continue to work but the accuracy will now be typically $\pm 2\%$. At switch on the display will show the software version with dashes each side e.g. - 1.0 -	Return for recalibration.
ERR 115	Checksum Failure in battery backed RAM. This can occur if the main battery module and the backup battery become completely exhausted.	Recharge the main battery or replace it with a charged one. Switch the instrument on. Calibration constants will be retrieved from EEPROM.

It is possible to reset your DLRO 10X to the original factory settings. This will clear all stored results, set the clock to a default value and format, and will set all other settings to their default values. This is effected by holding down the '3' button on the alphanumeric keypad while switching on your instrument.

ACCESSORIES

Standard Accessories supplied with instrument.

7 Ah NiMH battery module.	6340-101	5.5m/18ft	242011-18
		6m/20ft	6111-023
		9m/30 ft	242011-30
DH4 Duplex handspikes (2), one with indicator lights. 1.2m / 4 ft	6111-503	Straight Duplex Handspikes (2) Heavy Duty with fixed contacts.	242002-7
		2m/7 ft	242002-18
Battery charger for operation from 115/230 V. 50/60Hz supply.	6280-333	5.5m/18ft	242002-30
		9m/30 ft	242002-30
Cigar lighter adapter for battery charging.	6280-332	Duplex Heavy Duty 5cm (2") C-Clamps. (2)	242004-7
User guide.	6172-681	2m/7 ft	242004-18
Warranty book.	6170-618	5.5m/18ft	242004-30
		9m/30 ft	242004-30

Optional Accessories at extra cost

Carrying case for DLRO10 and all standard accessories.	6380-138	Duplex handspikes with replaceable Needle Points	2m/7 ft	242003-7
Carrying case for optional lead sets.	18313	Duplex 1.27 cm (1/2") Kelvin Clips. (2) gold plated	2m/7 ft	241005-7
Calibration Shunt, 10 Ω , current rating 1 mA.	249000	silver plated	2m/7 ft	242005-7
Calibration Shunt, 1 Ω , current rating 10 mA.	249001	Duplex 3.8 cm (1 1/2") Kelvin Clips. (2)	2m/7 ft	242006-7
Calibration Shunt, 100 m Ω , current rating 1A.	249002	5.5m/18ft	242006-18	
Calibration Shunt, 10 m Ω , current rating 10 A.	249003	9m/30 ft	242006-30	
Certificate of Calibration for Shunts, NIST	CERT-NIST	Single Leads		
Replacement tips for DH4 handspikes. Needle point	25940-012	Single handspikes (2) for potential measurement.	2m/7 ft	242021-7
Waffle end	25940-014	5.5m/18ft	242021-18	
		9m/30 ft	242021-30	

Optional Test Leads at extra cost

Duplex Leads

DH5 straight duplex handspikes (2).		5.5m/18ft	242041-18	
One has indicator lights. 2.5m/8ft	6111-517	9m/30 ft	242041-30	
Duplex handspikes (2) suitable for working on 600 V. systems. 2.5m/8ft	6111-518	Current clips (2) for current connections.	2m/7 ft	242041-7
		5.5m/18ft	242041-18	
Duplex Handspikes (2)with spring loaded helical contacts.		9m/30 ft	242041-30	
		2m/7 ft	242011-7	
		2.5m/8ft	6111-022	

REPAIR AND WARRANTY

The instrument circuit contains static sensitive devices, and care must be taken in handling the printed circuit board. If the protection of an instrument has been impaired it should not be used, and be sent for repair by suitably trained and qualified personnel. The protection is likely to be impaired if, for example, the instrument shows visible damage, fails to perform the intended measurements, has been subjected to prolonged storage under unfavourable conditions, or has been exposed to severe transport stresses.

New Instruments are Guaranteed for 1 Year from the Date of Purchase by the User.

Note: Any unauthorised prior repair or adjustment will automatically invalidate the Warranty.

Instrument Repair and Spare Parts

For service requirements for Megger Instruments contact:-

Megger Limited
Archcliffe Road
Dover
Kent, CT17 9EN.
England.

or

Megger
Valley Forge Corporate Centre
2621 Van Buren Avenue
Norristown, PA 19403
U.S.A.

Tel: +44 (0) 1304 502100

Tel: +1 (610) 676-8579

Fax: +44 (0) 1304 207342

Fax: +1 (610) 676-8625

or an approved repair company.

Approved Repair Companies

A number of independent instrument repair companies have been approved for repair work on most Megger instruments, using genuine Megger spare parts. Consult the Appointed Distributor / Agent regarding spare parts, repair facilities and advice on the best course of action to take.

Returning an Instrument for Repair

If returning an instrument to the manufacturer for repair, it should be sent freight pre-paid to the appropriate address. A copy of the Invoice and of the packing note should be sent simultaneously by airmail to expedite clearance through Customs. A repair estimate showing freight return and other charges will be submitted to the sender, if required, before work on the instrument commences.

NOTE: The batteries are Nickel-metal-hydride and if these are changed the disposal of old cells should be in accordance with local regulations.

