

MIT510/2

5kV Digital Insulation Tester

USER MANUAL

 SAFETY WARNINGS**Safety Warning must be observed during use.**

- The circuit under test **must** be switched off, de-energised, isolated and checked to be safe **before** insulation test connections are made. **Make sure** the circuit is not re-energised whilst the instrument is connected.
- Circuit connections **must** not be touched during an insulation test.
- After completing a test, capacitive circuits **must** be completely discharged before disconnecting the test leads. Capacitive charges can be lethal.
- Tested items should be firmly shorted out with a shorting link, after discharge, until required for use. This is to guard against any stored dielectric absorption charge subsequently being released thereby raising the voltage to potentially dangerous levels.
- The voltage indicator and automatic discharge features should be regarded as additional safety features and not a substitute for normal safe working practice.
- It is rare, but in certain circumstances, breakdown of the circuit under test may cause the instrument to terminate the test in an uncontrolled manner, possibly causing a loss of display while the circuit remains energised. In this event, the unit **must** be turned off and the circuit discharged manually.
- Test leads, including crocodile clips, must be in good order, clean and with no broken or cracked insulation.
- The instrument should not be used if any part of it is damaged.
- Insulation testing in wet weather conditions might be hazardous. It is recommended that this instrument is not used in these circumstances. If this is unavoidable, the user must take all necessary precautions.
- This instrument is not intrinsically safe and must not be used in hazardous atmospheres.

NOTE**THE INSTRUMENT MUST ONLY BE USED BY SUITABLY TRAINED AND COMPETENT PERSONS.**

Users of this equipment and/or their employers are reminded that National Health and Safety Legislation requires them to carry out valid risk assessments of all electrical work so as to identify potential sources of electrical danger and risk of electrical injury such as inadvertent short circuits. Where the assessments show that the risk is significant then the use of fused test leads may be appropriate.

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Symbols used on the instrument are:



Caution: risk of electric shock



Caution: refer to accompanying notes



Equipment protected throughout by Double Insulation (Class II)



Equipment complies with current EU directives.



This equipment should be recycled as electronic waste.

Terms used in this manual

The word **must** is used to indicate that the instructions following should be followed under all circumstances. Failure to follow these instructions could result in damage to the instrument and / or a hazard to the operator.

The word **should** is used to indicate that the instructions indicate best practice.

Cleaning

Disconnect the instrument and wipe it with a clean cloth slightly dampened with soapy water or Isopropyl alcohol (IPA).

INTRODUCTION

The MIT510/2 is a compact microprocessor controlled high voltage d.c. insulation tester, powered by internal rechargeable battery or mains supply. A comprehensive LCD display shows resistance, current, capacitance, voltage and timer measurements digitally, with resistance being shown in analogue as well.

Features include:

- Resistance or current measurement- front panel selectable
- Resistance measurement range - 10 kΩ to 15 TΩ
- Front panel selectable test voltages - 250 V, 500 V, 1000 V, 2500 V, 5000 V
- Incremental timer (minutes & seconds) – measures during test
- Load capacitance measurement – displayed at end of a test
- LCD backlight – front panel selectable
- Battery level/charging indicator
- Mains (line) input presence LED
- High voltage warning flashing LED shows when greater than 50 V present on test leads
- High voltage warning LCD “flash” shows when greater than 50 V present on test leads
- 8 hours continuous testing on full charge.

POWER LEAD AND CHARGING

If the power lead supplied is not suitable for your type of mains outlet, do not use an adaptor. Always use a power lead fitted with the correct plug.

NB: A plug severed from the power lead is a hazard if plugged into a live socket. Severed plugs must be destroyed immediately.

The instrument is fitted with a two-pin IEC60320 power inlet. Most power leads are made with three-core cable so the ground connection will not be used.

Power lead cable colour coding:

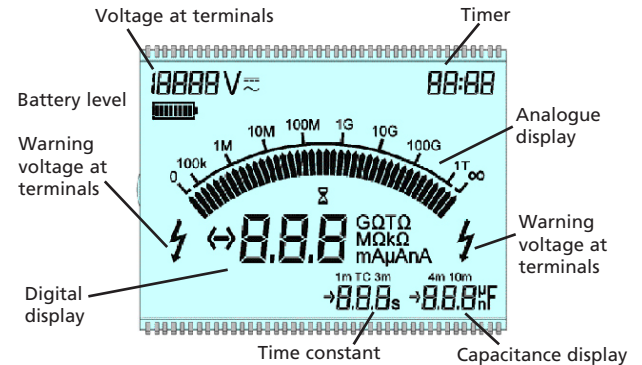
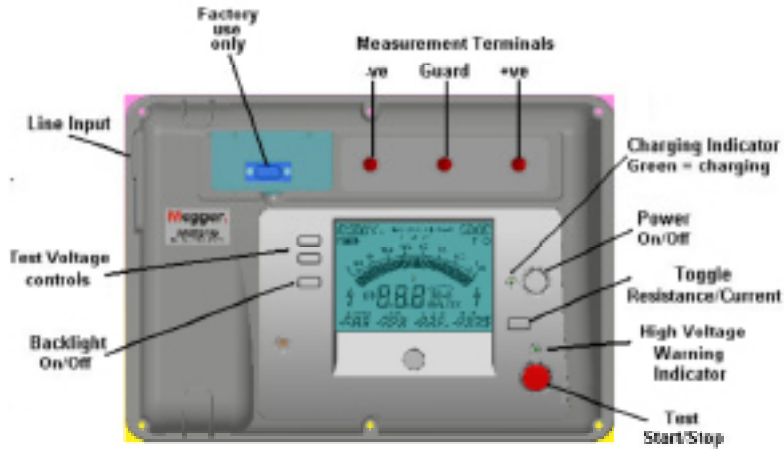
	International	USA
Earth/Ground	Yellow/Green	Green
Neutral	Blue	White
Live (Line)	Brown	Black

If using a fused plug ensure it is fitted with a 3 Amp fuse.

The instrument can be powered from 95 - 240 V rms, ±10% 50/60 Hz. With power connected the battery will charge as long as a test is not in progress. The **Power On/Off** button has a green LED which illuminates when mains power is present.

For best battery lifetime, charge the battery after each use. A completely exhausted battery will take 14 hours to recharge.

INSTRUMENT CONTROLS AND INDICATORS



1. Check connections to load - see **SAFETY WARNINGS**
2. To turn on, press Power On/Off button and release after display responds. The instrument first will perform a self-check during which Ini is displayed. After Ini disappears the instrument is ready for use.
3. Check voltage at terminals display to be sure the load is safe to energise.
4. Set test voltage required with V▲ and V▼ buttons.
5. To start a test, press **TEST** button and release after red LED shows. If external voltage at terminals <50 V, testing starts.
6. **TEST** button red LED and display warning symbols will flash during a test to show high voltage present at terminals.
7. Timer will count up from zero during test.
8. To stop the test press **TEST** button.
9. Timer will stop.
10. Analogue display shows insulation resistance.
11. Digital display shows resistance or current selected by pressing Ω/I button.
12. Load capacitance will be calculated and displayed after the end of the test.
13. Time-constant will be displayed after the end of the test.

Power On/Off button

The instrument will only turn on if this button is pressed, held and then released when the display responds. The instrument will not turn on if the button is released before the display responds, or if the button is held down for too long. This is a safety feature to prevent the instrument being inadvertently turned on.

The instrument is turned off either by pressing the button again, or if the instrument is running on the battery, by timing out after 10 minutes of inactivity.

Upon switching the instrument on the display will first show 'Ini' while it undergoes a self-checking routine. When Ini disappears, the instrument is ready for use.

Test voltage ▲ and ▼ buttons

Using these buttons one of five test voltages can be selected: 250 V, 500 V, 1 kV, 2.5 kV, and 5 kV. The selected voltage is shown on the display.

If there is an external voltage greater than 50 V on the test leads, the high voltage warning indicators are flashed, and the display shows this voltage instead. The instrument will not perform a test if this voltage is greater than 50 V.

During a test the display shows the actual voltage on the test leads. If the test voltage is changed during a test, the new test voltage will be displayed briefly.

When the test has stopped, the display continues to show the voltage present on the test leads. Pressing either test voltage ▲ or ▼ button will then display the test voltage immediately before the end of the test.

Test start / stop button

A test will only start if this button is pressed, held and then released as soon as the red high voltage warning indicator LED lights. The LCD and red LED high voltage warning indicators flash when the test starts.

A test will not start if the button is released before the red LED shows, or pressed continuously for longer than 5 seconds. This is a safety feature to prevent a test being started inadvertently.

The presence of a voltage greater than 50 V on the test leads is indicated with flashing high voltage warning indicators. Testing is disabled if the external voltage exceeds 50 V.

Testing will stop if the test start / stop button is pressed again.

When a test has finished, the instrument will discharge the load, which may take some time. The operator must always check the load has been discharged before touching the test leads.

Ω/I button

Pressing this button toggles the digital display between the insulation resistance and current.

button

Pressing this button toggles the display backlight on and off.

High voltage warning LED

This is a red LED next to the TEST button on the front panel. The LED flashes when the voltage on the test inputs exceeds 50 V.

Line input present LED

This is a green LED next to the power On/Off button on the front panel. It is illuminated whenever the mains power is connected.

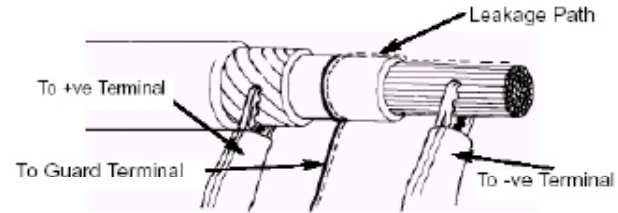
Test terminals

There are three test terminals marked +, - and G. These terminals are designed to accept only the test leads supplied. Shutters across the terminals prevent accidental ingress of dirt and other objects. Test lead plugs interlock with the shutters and are released by rotating the test lead plug a quarter turn.

The Guard terminal is explained below and is only used in cases where surface leakage currents need to be eliminated. Most measurements use just the + and - terminals. The instrument's internal voltage generator drives the + terminal with respect to the - terminal, current being measured in the - terminal.

Guard terminal

For basic insulation tests and where there is little possibility of surface leakage affecting the measurement, it is unnecessary to use the guard terminal i.e. if the insulator is clean and there are unlikely to be any adverse current paths. However in cable testing for example, there may be surface leakage paths across the insulation between the bare cable and the external sheathing due to the presence of moisture or dirt. Where it is required to remove the effect of this leakage, particularly at high testing voltages, a bare wire may be bound tightly around the insulation and connected via the third test lead to the guard terminal 'G'.



The guard terminal is at the same potential as the negative terminal. Since the leakage resistance is effectively in parallel with the resistance to be measured, the use of the guard causes the current flowing through surface leakage to be diverted from the measuring circuit. The instrument therefore reads the leakage of the insulator, ignoring leakage across its surface. The display will show 'FUS' if the internal guard terminal fuse is found to have blown. The instrument must be switched off to clear the message before further testing is permitted. The fuse should be replaced by an authorised repairer. The instrument may be used in the mean time if the guard terminal not used. Refer to notes regarding measurements above 100 G Ω on page 9.

Factory programming socket

This is a 9 pin socket under the hinged cover and is not for customer use.

Battery bar graph

This is a battery symbol on the LCD display comprising 4 pairs of segments. The battery is monitored continuously when the instrument is turned on. The charge remaining in the battery is shown in the table below.

Fully charged battery



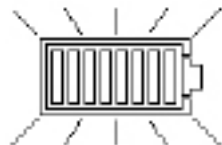
50% charged battery



Tests cannot be started, and the battery may fail at any time.



Symbol flashes when there is not enough charge for a test. The instrument then turns itself off



When mains power is present the indicator shows the battery is being charged by animating the segments of the bar graph.

Voltage at terminals

The test voltage will default to that selected in the previous test. If the instrument has been switched off since the previous test, the test voltage defaults to 250 V.

If there is an external voltage greater than 50 V present, this will be displayed regardless of changes made to the test voltage. In this case the instrument will not perform a test. The high voltage warning indicators flash, and the beeper sounds, to warn of the hazard until the external voltage becomes less than 50 V.

When testing, the voltage displayed is the voltage present at the test terminals of the instrument. If the test voltage is changed, by pressing either of the test voltage ▲ and ▼ buttons during a test, the new test voltage is displayed momentarily.

After testing, the voltage displayed is the voltage present on the terminals. To see what the voltage was immediately prior to the end of the test, press either test voltage ▲ or ▼ buttons.

Timer indicator

The timer shows minutes and seconds. At the start of a test the timer will start from zero and at the end of a test it will stop. The duration of the last test remains on the display until another test is started.

Digital Display

The digital display shows the resistance or current being measured during a test. The Ω/I button toggles between the two. After a test the display shows the last measurement made until the timer or voltage test settings are changed or the test start/stop button is pressed.

Analogue display

This simulates an analogue meter movement to give the user a better “feel” for how a measurement is progressing. The analogue display shows resistance only.

Capacitance display

At the end of a test the capacitance of the circuit under test is calculated and displayed. After a test the display shows the last measurement made until the **V▲**, **V▼**, or **TEST** buttons are pressed.

Time constant:

At the end of a test the time constant of the circuit under test is calculated and displayed. After a test the display shows the last measurement made until the **V▲**, **V▼**, or **TEST** buttons are pressed.

Noise detection

Excessive noise during test

In environments such as HV switch yards or substations electrical noise levels can be high enough to effect insulation test measurements. This noise takes the form of induced currents in the measurement circuit.

The noise current is either picked up by test leads or induced directly in the item under test. The MIT510/2, MIT520/2 and MIT1020/2 are all capable of accurate measurements with up to 2mA of induced noise current. The S1-554/2 and S1-1054/4 are design for very high noise environments and can provide accurate measurements with up to 4mA of noise current present.

A level of noise exceeding the instruments specified capability will be indicated by an alternating sine wave on the display. The test continues while displaying the noise. If the noise drops back down the normal display is resumed.

The effects of noise can be reduced significantly with the use of high quality Megger screened test leads.

The picture displayed on the right shows the expected screen result of an IR test on with a 5000V test voltage after 2 minutes 9 seconds. The black and grey waveforms are displayed alternately while the noise is present. When the noise is removed the waveform is replaced by the correct reading.



Test aborted due to extremely high noise

Should an extremely high level of noise be present, particularly at the start of a test, the instrument will indicate nSE (Noise). The instrument will require switching off and on again to reset.



In certain rare circumstances breakdown of the circuit under test may interfere with the sensitive current measuring circuit. In this event the unit stops and also displays nSE. The instrument will again require switching off and on again to reset.

Measurements above 100 GΩ

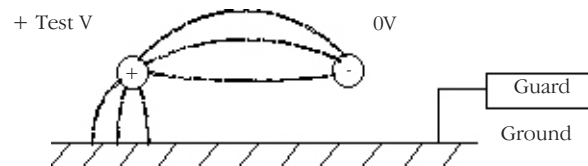
Measurements up to 100 GΩ can be made without any special precautions, assuming that the test leads are reasonably clean and dry. The guard lead can be used to remove the effects of surface leakage if necessary. When measuring resistances above 100 GΩ, the test leads should not be allowed to touch each other, or any other object since this will introduce leakage paths. Sharp points at the test lead connections should also be avoided since this will encourage corona discharge.

The output is isolated, and so will float relative to ground such that the positive terminal is at plus half of the test voltage, and the negative terminal is at minus half of the test voltage with respect to ground. Leakages therefore occur between the positive terminal and ground, between the negative terminal and ground, and directly between the positive and negative terminals. These leakages have a significant effect and can occur through the air itself.



If the guard lead is connected to ground, then since the negative terminal is at the same voltage as the guard terminal, the leakage into the negative terminal will be considerably reduced. This will improve accuracy because the current flowing into the negative terminal is measured by the instrument and used to calculate resistance. This technique is only permissible if the item under test is isolated from ground. “Isolated” in this context means insulated by a resistance of at least $5\text{ M}\Omega$ for the positive terminal, or at least $10\text{ k}\Omega$ for the negative terminal.

Conversely, if the positive terminal is grounded, then the negative terminal will be at a voltage equal to the test voltage relative to ground, which will result in an increase in leakage current, and worsening of measurement accuracy.

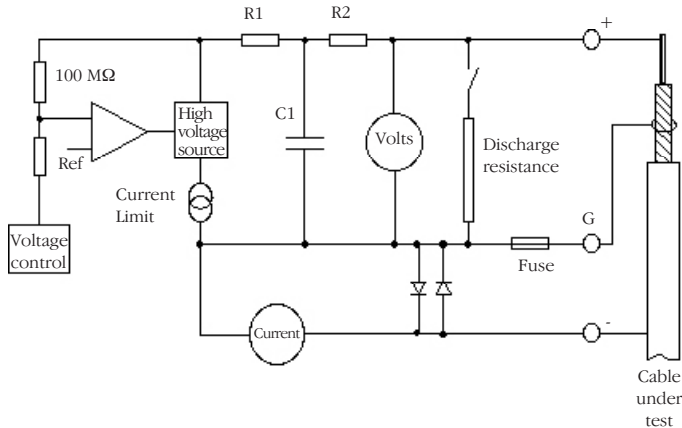


When making measurements above $100\text{ G}\Omega$ therefore, the user should ground the Guard Lead where possible, otherwise parallel leakage paths may occur.

Alternatively, screened leads are available as an optional accessory from Megger. The lead to the negative terminal is fully screened. The screen is plugged into the Guard terminal, diverting any stray leakage currents. This considerably improves measurements made with a floating output, where the leads might touch each other or anything other than the test piece.

SPECIFICATION

Circuit block diagram



For 5 kV instruments $C1 = 47 \text{ nF}$, $R1 = 50 \text{ k}\Omega$, $R2 = 40 \text{ k}\Omega$

For 10 kV instruments $C1 = 15 \text{ nF}$, $R1 = 156 \text{ k}\Omega$, $R2 = 110 \text{ k}\Omega$

Voltage input range

85-265 V rms, 50/60 Hz, 60 VA

Battery life

Typical capacity is 6 hours continuous testing at 5 kV with a 100 M Ω load

Test voltages

250 V, 500 V, 1000 V, 2500 V, 5000 V

Accuracy (23 °C, 5 kV)

	5000 V	2500 V	1000 V	500 V	250 V
$\pm 5\%$ to	1 T Ω	500 G Ω	200 G Ω	100 G Ω	50 G Ω
$\pm 20\%$ to	10 T Ω	5 T Ω	2 T Ω	1 T Ω	500 G Ω

Guard

2% error guarding 500 k Ω leakage with 100 M Ω load

Display range

Digital display (3 digits)	10 k Ω to 15 T Ω
Analogue display	100 k Ω to 1 T Ω

Short circuit/charge current

3 mA @ 5 kV

Capacitor charge time

<3 seconds per μF at 3mA to 5 kV

Capacitor discharge time

<120 ms per μF to discharge from 5000 V to 50 V

Capacitance measurement (500 V minimum test voltage)

10 nF to 50 μF (dependent on test voltage)

Capacitance measurement accuracy (23 °C)

$\pm 5\% \pm 5 \text{ nF}$

Voltage output accuracy (0 °C to 30 °C)

+4%, -0% ± 10 V of nominal test voltage at 1 G Ω load

Current measurement range

0.01 nA to 5 mA

Current measurement accuracy (23 °C)

$\pm 5\%$ ± 0.2 nA at all voltages

Interference rejection

1 mA rms per 250 V test voltage up to a maximum of 2 mA

Timer range

Counts up to 99 minutes from start of test

Test regimes

Auto IR

Lead set

Three flexible silicon insulated leads with compact clamp.

Safety

Meets the requirements of IEC61010-1 CAT IV 600 V

EMC

Meets the requirements of IEC61326-1

Operating uncertainties

Refer to www.megger.com

Operating temperature

-20 °C to 50 °C

Storage temperature

-25 °C to 65 °C

Ingress protection (lid closed)

IP65

Humidity

90% RH non-condensing at 40 °C

Dimensions

305 x 194 x 360 (mm) (12 x 7.6 x 14.2 inches)

Weight

6.75 kg (15 lb) approx

ACCESSORIES

	Order Code	Screened HV test leads
Included Accessories		
3 m lead set, medium size insulated clips	1002-531	1 x 3 m, with 5 kV screened un-insulated small clips 6220-835
User guide on CD-ROM	2000-213	1 x 15 m, with 5 kV screened un-insulated small clips 6311-080
Optional Accessories		
HV test lead sets		
3 x 3 m with un-insulated small clips	8101-181	
3 x 8 m with un-insulated small clips	8101-182	
3 x 15 m with un-insulated small clips	8101-183	
3 x 5 m with medium insulated clips	1002-641	
3 x 8 m with medium insulated clips	1002-642	
3 x 10 m with medium insulated clips	1002-643	
3 x 15 m with medium insulated clips	1002-644	
3 x 5 m with large insulated clips	1002-645	
3 x 8 m with large insulated clips	1002-646	
3 x 10 m with large insulated clips	1002-647	
3 x 15 m with large insulated clips	1002-648	
Control circuit test lead set		
2 x 3 m with small insulated clips	6220-822	

REPAIR AND WARRANTY

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

NEW INSTRUMENTS ARE GUARANTEED FOR 1 YEAR FROM THE DATE OF PURCHASE BY THE USER.

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

CALIBRATION, REPAIR AND SPARE PARTS

For service requirements for Megger Instruments **contact:**

Megger Limited	or	Megger
Archcliffe Road		Valley Forge Corporate Centre
Dover		2621 Van Buren Avenue
Kent CT17 9EN		Norristown PA 19403
England.		U.S.A.

Tel: +44 (0) 1304 502 243 Tel: +1 610 676 8579

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Megger operate fully traceable calibration and repair facilities, ensuring your instrument continues to provide the high standard of performance and workmanship you expect. These facilities are complemented by a worldwide network of approved repair and calibration companies to offer excellent in-service care for your Megger products.

Returning your product to Megger - UK and USA service centres

1. When an instrument requires recalibration, or in the event of a repair being necessary, a Returns Authorisation (RA) number must first be obtained from one of the addresses shown above. You will be asked to provide the following information to enable the Service Department to prepare in advance for receipt of your instrument, and to provide the best possible service to you.
 - Model, e.g. MIT510/2.
 - Serial number, to be found on the underside of the case or on the calibration certificate.
 - Reason for return, e.g. calibration required, or repair.
 - Details of the fault if the instrument is to be repaired.

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2. Make a note of the RA number. A returns label can be emailed or faxed to you if you wish.
 3. Pack the instrument carefully to prevent damage in transit.
 4. Ensure the returns label is attached, or that the RA number is clearly marked on the outside of the package and on any correspondence, before sending the instrument, freight paid, to Megger. Copies of the original purchase invoice and packing note should be sent simultaneously by airmail to expedite clearance through customs. In the case of instruments requiring repair outside the warranty period, an immediate quotation can be provided when obtaining the RA number.
 5. You may track the progress of your return on line at www.megger.com

Approved Service Centres

A list of Approved Service Centres may be obtained from the UK address above, or from Megger's website at www.megger.com

Service note

Battery replacement

Should the internal lead acid battery require replacement the unit **must** be sent to a Megger authorised service agent. A replacement battery connection wiring loom must be fitted to ensure future connection integrity. In addition the on screen battery charge level indicator will need to be calibrated to the new battery's characteristics.

End of life disposal

WEEE

The crossed out wheeled bin placed on the Megger products is a reminder not to dispose of the product at the end of its product life with general waste.

Megger is registered in the UK as a Producer of Electrical and Electronic Equipment.

The Registration No is WEE/HE0146QT

Batteries

The crossed out wheeled bin placed on the batteries is a reminder not to dispose of them with general waste at the end of their life.

This product contains a sealed lead acid battery 12V, 4Ah (NP4-12 type)

Battery replacement should only be performed by a Megger authorised repair agent, who will correctly dispose of the spent battery.

For the purpose of end of life disposal only, the battery can be accessed by removing the four recessed screws on rear of instrument and lifting inner instrument out of outer case. Remove screws and remove the inner front cover to access battery.

The battery fitted in this instrument is classified as a Portable Battery and should be disposed of in the UK in accordance with Local Authority requirements.

For disposal of batteries in other parts of the EU contact your local distributor. Megger is registered in the UK as a producer of batteries. The registration number is BPRN00142



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Megger products are distributed in 146 countries worldwide.

This instrument is manufactured in the United Kingdom.
The company reserves the right to change the specification or design without prior notice.

Megger is a registered trademark

Part No. MIT510_2_UG_en_V10 1112
www.megger.com