



GigaOhm 5kV MI 3202 User Manual

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1 General introduction

1.1 Features

The **GigaOhm 5kV** Tester is a portable battery / mains powered test instrument intended for simple testing of Insulation Resistance by using high test voltages of up to 5 kV. It operates on a SIMPLE and CLEAR basis.

The instrument is designed and produced with the extensive knowledge and experience acquired through many years of dealing with similar test equipment.

Available functions offered by the **GigaOhm 5kV** Tester:

- High Insulation Resistance measurement up to 1 T Ω ;
- Programmable test voltage: 250 V, 500 V, 1 kV, 2.5 kV, 5 kV;
- Automatic discharge of tested object after measurement completion;
- Voltage and frequency measurement up to 600 V AC/DC.

A segment LCD offers easy-to-read results and all associated parameters. Operation is simple and clear; the operator does not need any special training (except reading and understanding this Users Manual) to operate the instrument.

1.2 Applied Standards

Instrument operation	IEC / EN 61557-2
Electromagnetic compatibility (EMC)	EN 61326 Class B
Safety	EN 61010-1 EN 61010-031 EN 61010-2-034

2 Instrument Description

2.1 Instrument Casing

The instrument is housed in a plastic box that maintains the protection class defined in the general specifications.

2.2 LC Display

The segment LCD has a backlight and offers easy-to-read results and all shows all associated parameters. See **Fig.1** below.

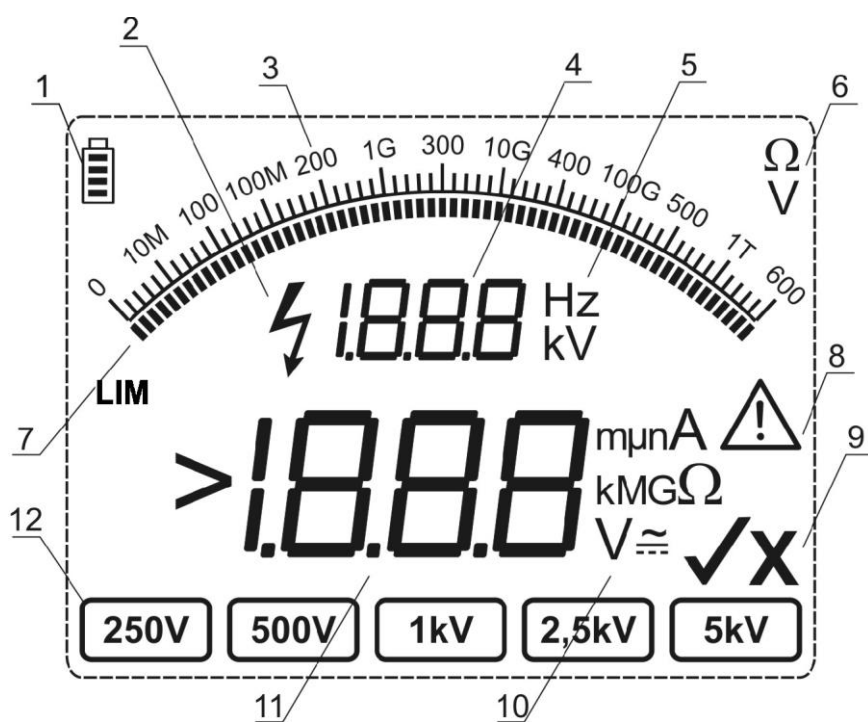


Fig. 1. LC Display

Legend:

- 1..... **Battery indicator.** It indicates condition of the battery. In battery charging mode it flashes.
- 2..... **Hazardous Voltage Warning icon.** It indicates that the voltage higher than 70 V may be present at the test terminals!
- 3..... **Analogue display.**
- 4..... **Auxiliary digital display.**
- 5..... **Auxiliary units.** Units for parameters displayed on auxiliary display.
- 6..... **Analogue units.** Units for parameters displayed on analogue display.
- 7..... **Bar graph.**
- 8..... **Warning icon.** Read the User Manual with special care!
- 9..... **Pass or Fail icon.**
- 10..... **Main units.**
- 11..... **Main digital display.**
- 12..... **Test voltage.** Menu for selecting the test voltage.

2.3 Operator's Panel

The operator's panel is shown in **Fig. 2** below.

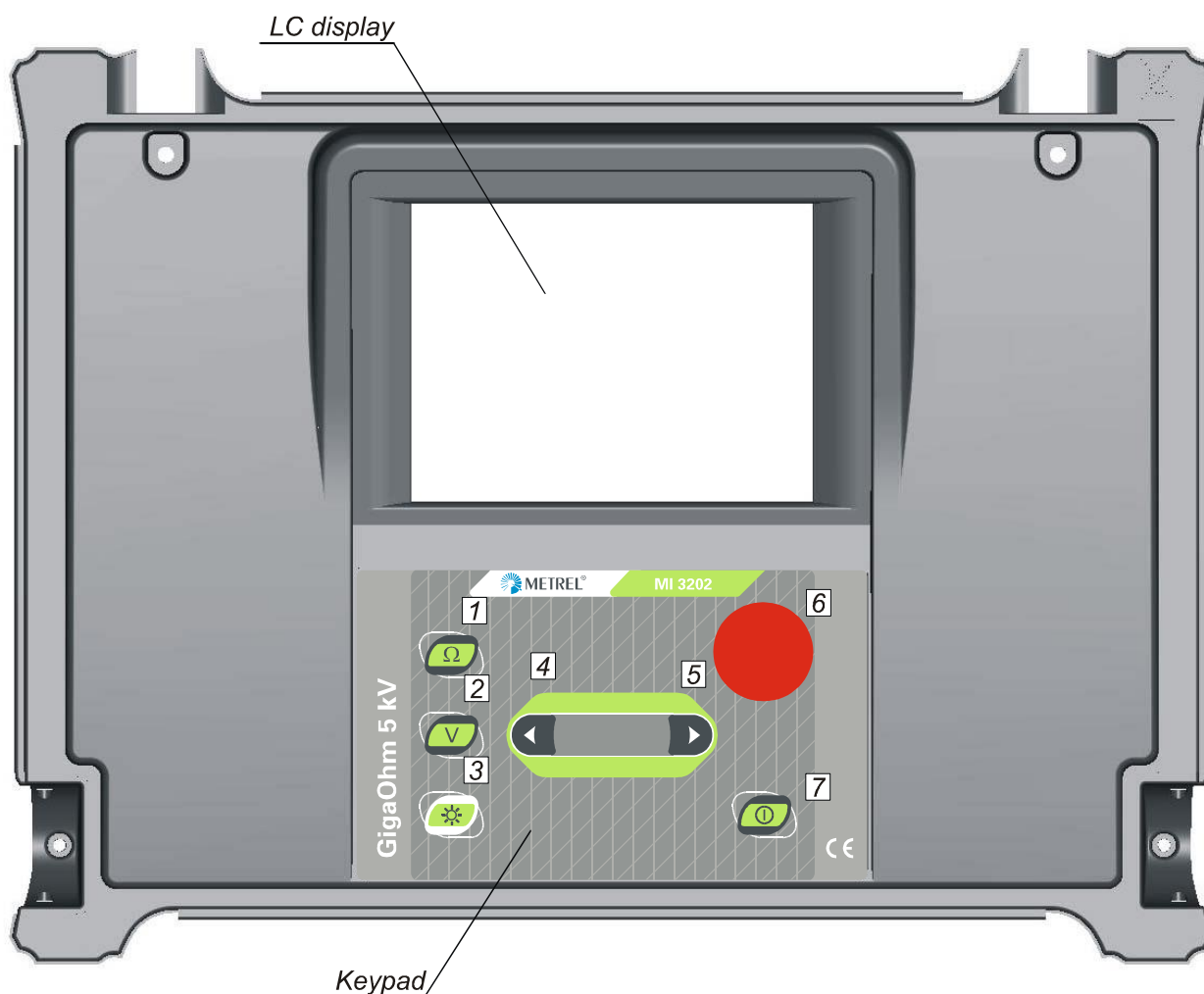


Fig. 2. Front panel

Legend:

- 1..... Ω key to switch to Insulation measurement mode and to set limit value.
- 2..... **V** key to switch to Voltage measurement mode.
- 3..... **Light** key to turn the display backlight ON or OFF.
- 4..... **◀ cursor** key to decrease the test voltage parameter and to select limit value.
- 5..... **▶ cursor** key to increase the test voltage parameter and to select limit value.
- 6..... **START/STOP** key to start or stop insulation measurement.
- 7..... **ON/OFF** key to switch the instrument ON or OFF.

2.4 Connectors

The **GigaOhm 5 kV** Tester contains the following connections:

- Connection of test leads to four banana safety sockets (**Fig. 3**),
- Mains supply cable connection to the mains socket (**Fig. 4**).

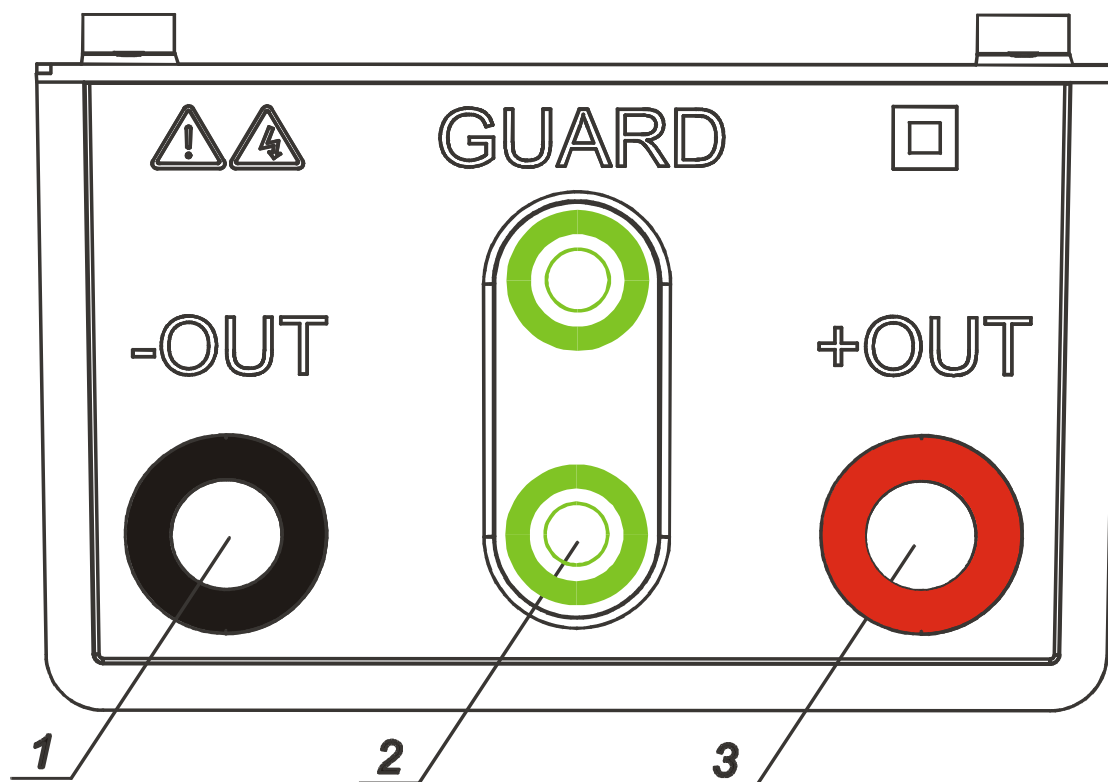


Fig. 3. Test leads connector

- 1..... Negative Insulation Resistance **test terminal**. (-OUT)
- 2..... **GUARD** test terminals intended to lead away potential leakage current while measuring the Insulation. Both green sockets are connected together inside the instrument.
- 3..... Positive Insulation Resistance **test terminal** (+OUT)



Use original test accessories only!

Max. allowed external voltage between test terminals and ground is 600V!

Max. allowed external voltage between test terminals is 600V!

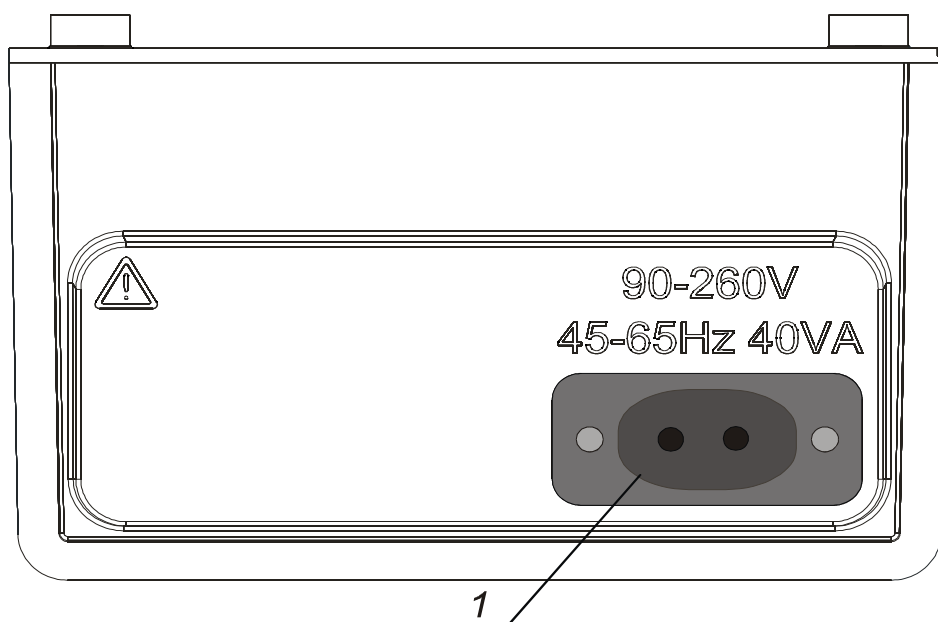


Fig. 4. Mains connector

1..... Mains connector to connect the instrument to the mains supply.



Use original mains supply cable only!

2.5 Accessories

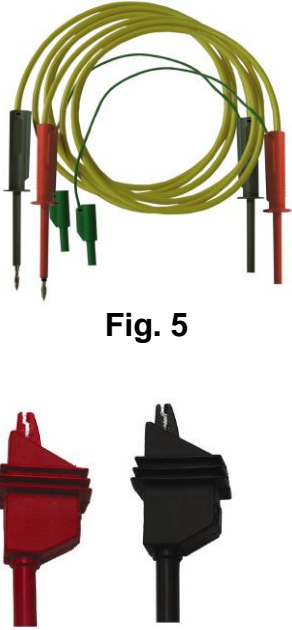
The accessories consist of standard and optional accessories. Optional accessories can be delivered upon request. See attached list for standard configuration and options or contact your distributor or see the METREL home page: <http://www.metrel.si>.

2.6 Test leads

The standard length of test leads is 2m, optional lengths are 8m and 15m. For more details see attached list for standard configuration and options or contact your distributor or see the METREL home page: <http://www.metrel.si>.

All test leads are made of high voltage shielded cable, because shielded cable provides higher accuracy and immunity to disturbance of measurements that can occur in industrial environments

2.6.1 High voltage shielded test tips with High voltage alligators clips.

 <p style="text-align: center;">Fig. 5</p> <p style="text-align: center;">Fig. 6</p>	<p>Application notes: These test leads are designed for diagnostic testing of insulation and also for hand held testing of insulation.</p> <p>Insulation ratings:</p> <ul style="list-style-type: none"> - High voltage banana connector (red, black): 5kV d.c (double insulation). See Fig.5. - High voltage tip (red, black): 5kV d.c (double insulation). - Alligator (red, black): 5kV d.c (double insulation). See Fig.6. - Guard banana connector (green): 600V CAT IV (double insulation). - Cable (yellow): 12kV (shielded). See Fig.5.
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2.6.2 Guard test lead with alligator

Insulation ratings:

- Guard test lead with banana connectors (green): 600V CAT IV (double insulation);
- Alligator (green): 600V CAT IV (double insulation).

3 Warnings and notes

In order to maintain the highest level of operator safety while carrying out various tests and measurements Metrel recommends keeping your **GigaOhm 5 kV** test equipment in good condition and undamaged. When using this test equipment, consider the following general warnings:

- ◆ The  symbol on the test equipment means »Read the Instruction manual with special care for safe operation«. The symbol requires an action!
- ◆ The  symbol on the test equipment means “Hazardous voltage may be present at the test terminals!”.
- ◆ If the test equipment is used in a manner not specified in this Instruction manual, the protection provided by the equipment could be impaired!
- ◆ Read this Instruction manual carefully, otherwise the use of the test equipment may be dangerous for the operator, the test equipment itself or for the tested object!
- ◆ Do not use the test equipment or any of the accessories if any damage is noticed!
- ◆ Consider all generally known precautions in order to avoid risk of electric shock while dealing with hazardous voltages! Act according to requirements of EN 50191 or similar standard dealing with safety at test premises.
- ◆ Do not connect the test equipment to a mains voltage different from the one defined on the label adjacent to the mains connector, otherwise it may be damaged.
- ◆ Service intervention or adjustment is only allowed to be carried out by competent authorized personnel!
- ◆ Hazardous voltages exist inside the test equipment. Disconnect all test leads, remove the power supply cable and switch off the test equipment before opening the battery compartment.
- ◆ All normal safety precautions must be taken in order to avoid risk of electric shock while working on electrical installations!
- ◆ When working on high capacitive loads (more than 4 nF), use personal protective equipment (gloves,..). Do not use communication ports during the measurement.
- ◆ Do not use the equipment in a wet environment, around explosive gas, vapour or dust.
- ◆ Only adequately trained and competent persons may operate the equipment.



**Warnings related to measurement functions:
Working with the instrument**

- ◆ Use only standard or optional test accessories supplied by your distributor!
- ◆ 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 cannot be re-energised whilst the instrument is connected.
- ◆ Circuit connections and circuit under test 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.
- ◆ The clips cannot in any circumstance be relied on to protect the user from live systems above 600 V.
- ◆ Test tips should only be used for TRMS voltage measurement (CAT IV 600 V).
- ◆ Do not use high voltage test lead with tip for TRMS voltage measurement in CAT III or CAT IV environment. Risk of bridging two high-energy conductors with tip resulting in arc flash and short circuit.
- ◆ Always connect accessories to the test equipment and to the test object before starting high voltage measurement. Do not touch test leads or crocodile clips during measurement.
Only hand-held part of high voltage test lead with tip is allowed to be touched (held) during measurement.
- ◆ Do not touch any conductive parts of equipment under test during the test, risk of electric shock!
- ◆ Make sure that the tested object is disconnected (mains voltage disconnected) and de-energized before connecting the test leads and starting the measurement (except Voltage measurement)!
- ◆ In case of a capacitive test object, automatic discharge of the object may not be done immediately after finishing the measurement.
- ◆ Do not connect test terminals to an external voltage higher than 600 V DC or AC (CAT IV environment) to prevent any damage to the test equipment!
- ◆ In rare cases (internal fault) the test equipment can behave in an uncontrolled manner (LCD blinking, freezing, not responding to keys, etc.). In this case consider the test equipment and the test object as hazardous live, and perform all safety measures to turn off (reset) the test equipment and to discharge the test object manually!

Handling with capacitive loads

- ◆ Note that 40 nF charged to 1 kV or 8 nF charged to 5 kV are hazardous live!
- ◆ Never touch the measured object during the testing until it is totally discharged automatically and manually!
- ◆ Because of dielectric absorption, capacitive test objects (capacitors, cables, transformers, etc.) must be shorted out after the measuring process is completed.

Note:

For **manual discharge** Metrel recommends the use of A 1513 Discharge link. The internal discharge resistors of A 1513 ensure a damped discharge up to 10 μ F at 10 kV.



Warnings related to Batteries:

- ◆ Disconnect all test leads, main supply cable and switch the power off before opening the Battery cover!
- ◆ Use only NiMh rechargeable batteries (C size)!

4 Performing measurements

⚠ Inspection of instrument behavior is mandatory before use. In case of frequently use should be on daily basis, in other case before measurements. The inspection should cover the operation of the hazard indicator, buzzer, and metrological features. Metrel recommend use of calibration box A 1740.

Note:

- A 1740 Calibration Box 5kV is optional accessory intended for time-to-time verification of insulation resistance measurement of the Metrel instruments. This unit contains four high ohm resistors enclosed in plastic package.

4.1 Switching on the instrument

Auto-calibration

The instrument is switched ON by pressing the **ON/OFF** key. After turning on (**Fig. 7**), the instrument first executes the auto-calibration (**Fig. 8**).

Note:

If batteries are defective or missing and the instrument is powered from mains supply, the instrument could not be turn ON.

Measuring test leads have to be disconnected during auto-calibration. If not the auto-calibration procedure could be false.

After finishing the auto-calibration, the **pass icon** will appear; the instrument goes to the **Insulation Mode (Fig.9)** and is prepared for normal operation.

Auto-calibration prevents a reduction in accuracy when measuring very low currents. It compensates the effects caused by ageing, temperature and humidity changes etc.

A new auto-calibration is recommended when the temperature changes by more than 5°C.

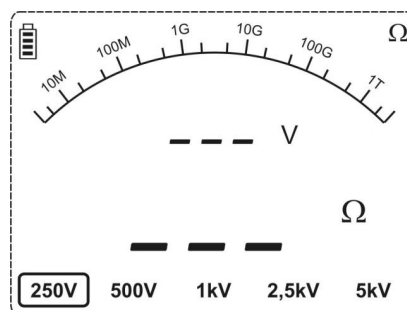
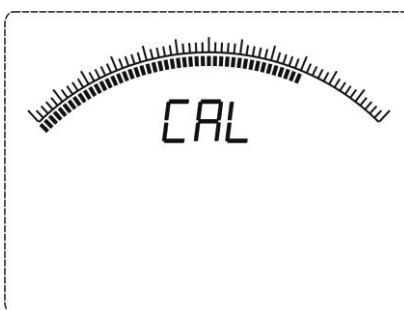
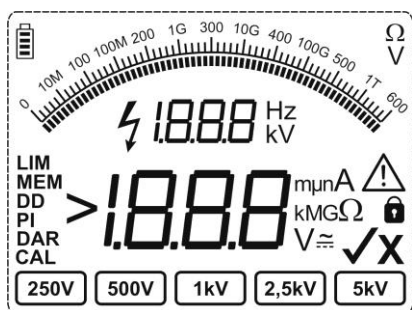


Fig. 7. First introduction

Fig. 8. Auto-calibration state

Fig. 9. Insulation Mode

Note:

If the instrument detects an incorrect state during the auto-calibration, the **fail icon X** will be displayed:

Possible reasons for out of range conditions are excessive humidity, excessively high temperature, etc. In this case it is possible to perform measurements by press START/STOP button again but results could be out of technical specification.

Mains powered instrument operation

If you connect the instrument to the mains supply when the instrument is turned OFF, internal charger will begin to charge the batteries but instrument will be remain turned OFF. In upper left angle of LCD, flashing battery indicator will appear to indicate that the batteries are charging.

Note: If batteries are defective or missing, the charger will not work.

If you connect the instrument to the mains supply when instrument is turn ON, the instrument will automatically switch from the battery supply to the main supply. If the instrument is not in insulation *measuring mode**, internal charger will begin to charge the batteries. In upper left angle of LCD, battery indicator will start to flash, indicating that the batteries are charging.

Note: It is not recommended to connect or disconnect the instrument to mains supply while the instrument is in measuring mode*.

**measuring mode* When the instrument performing insulation measurements.

Backlight operation (battery powered instrument)

After turning the instrument ON the LCD backlight is automatically turned ON. It can be turned OFF and ON by simply clicking the **LIGHT** key.

Backlight operation (mains powered instrument)

After turning the instrument ON the LCD backlight is automatically turned OFF. It can be turned OFF and ON by simply clicking the **LIGHT** key.

Off function

The instrument can be switched OFF only by pressing the **ON/OFF** key. The auto-off function is not available to allow long-term measurements.

5 Measurements

5.1 Generally about DC High voltage testing

The purpose of insulation tests

Insulating materials are important parts of almost every electrical product. The material's properties depend not only on its compound characteristics but also on temperature, pollution, moisture, ageing, electrical and mechanical stress, etc. Safety and operational reliability require the regular maintenance and testing of the insulation material to ensure it is kept in good operational condition. High voltage tests are used to test insulating materials.

DC vs. AC testing voltage

Testing with a DC voltage is widely accepted as being as useful as testing with AC and / or pulsed voltages. DC voltages can be used for breakdown tests especially where high capacitive leakage currents interfere with measurements using AC or pulsed voltages. DC is mostly used for insulation resistance measurement tests. In this type of test, the voltage is defined by the appropriate product application group. This test voltage is lower than the voltage used in the withstanding voltage test so the tests can be applied more frequently without stressing the test material.

Electrical representation of insulating material

The following figure (Fig.10) represents the equivalent electrical circuit of insulating material

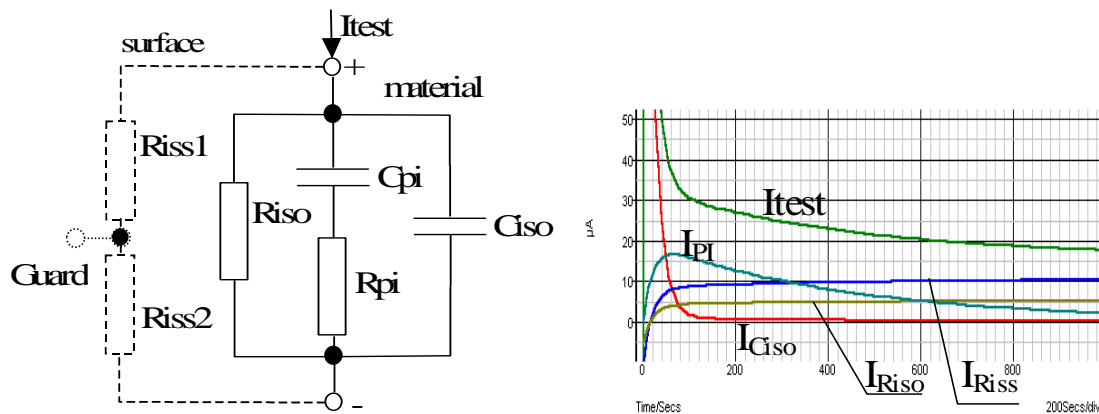


Fig. 10

R_{iss1} and R_{iss2} - the surface resistivity (position of optional guard connection)

R_{iso} - the actual insulation resistance of material

C_{iso} - capacitance of material

C_{pi} , R_{pi} - represents polarization effects.

The right figure shows typical currents for that circuit.

I_{test} = overall test current ($I_{test} = I_{pi} + I_{R_{iso}} + I_{R_{iss}}$)

I_{pi} = polarization absorption current

$I_{R_{iso}}$ = actual insulation current

$I_{R_{iss}}$ = surface leakage current

5.2 Guard terminal

The purpose of the GUARD terminal is to lead away potential leakage currents (e.g. surface currents), which are not a result of the measured insulation material itself but are a result of surface contamination and moisture. This current interferes with the measurement i.e. the Insulation Resistance result is influenced by this current. The GUARD terminal is internally connected to the same potential as the negative test terminal (black one). The GUARDs test clip should be connected to the test object so as to collect most of the unwanted leakage current, see the **Fig. 11** below.

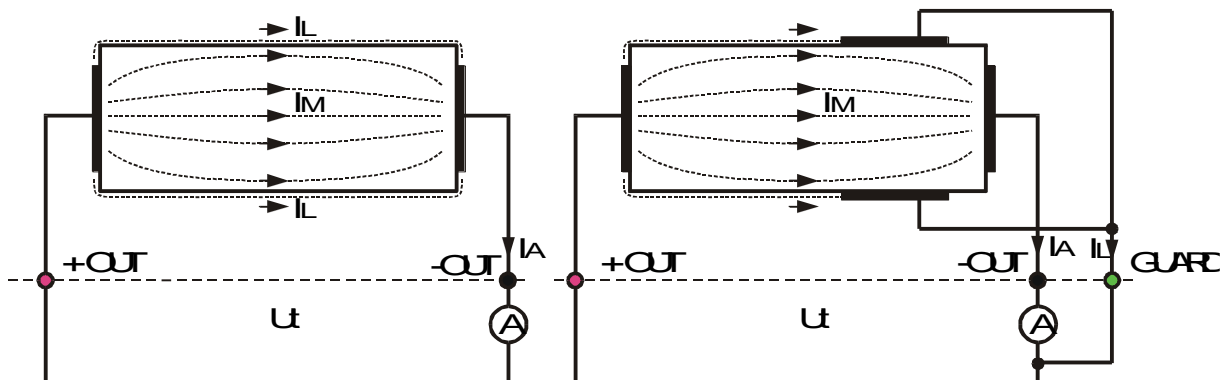


Fig. 11. Connection of GUARD terminal to measured object

where:

U_t Test voltage

I_L Leakage current (resulted by surface dirt and moisture)

I_M Material current (resulted by material conditions)

I_A A-meter current

Result without using GUARD terminal: $R_{INS} = U_t / I_A = U_t / (I_M + I_L)$...incorrect result.

Result using GUARD terminal: $R_{INS} = U_t / I_A = U_t / I_M$ correct result.

It is recommended to use the GUARD connection when high insulation resistance (>10G Ω) are measured.

Note:

- The guard terminal is protected by an internal impedance (200 K Ω).
- The instrument has two guard terminals to allow easy connection of shielded measuring leads.

5.3 Insulation Resistance measurement

Select this function by pressing the Ω key displays the following states (initial state and state with results after the completion of the measurement). See **Fig. 12** below.

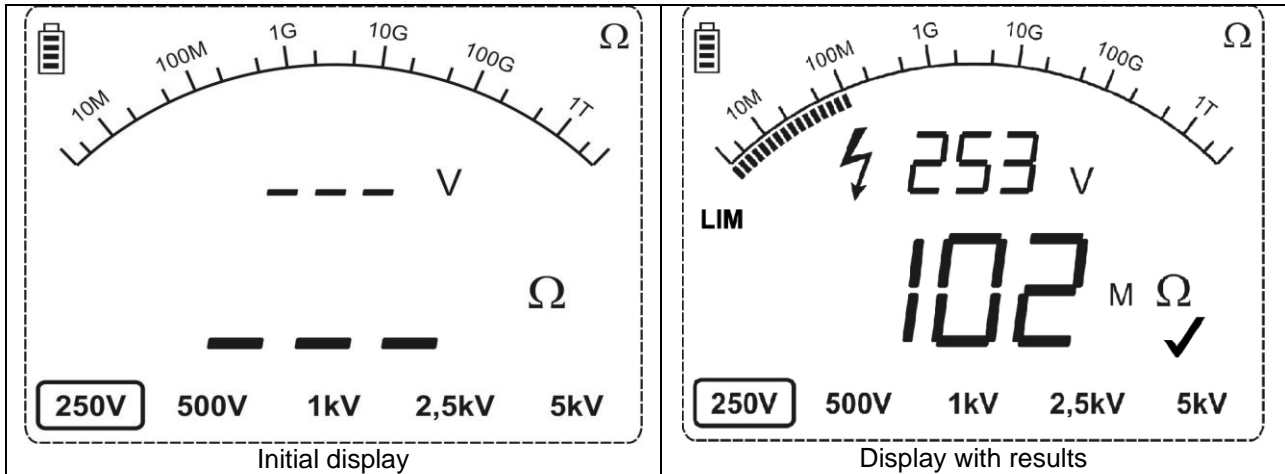


Fig. 12. Insulation Resistance function display states

Legend of displayed symbols in Fig 12:

INSULATION RESISTANCE	Name of selected function
250V	Selected test voltage
253 V	Actual test voltage (measured value)
102 M Ω	Insulation Resistance – result
Bar	Analog presentation of result

Measurement procedure:

- Connect the test leads to the instrument and to the test object.
- Select **INSULATION RESISTANCE** mode by pressing the Ω key.
- Press the **START/STOP** key and release it, (continuous measurement will begin).
- Wait until the test result has stabilized then press the **START/STOP** key again to stop the measurement.
- Wait for the object under test until it is discharged.

Notes:

- A high-voltage warning symbol appears on the display during the measurement to warn the operator of a potentially dangerous test voltage.

Set-up test voltage for Insulation Resistance (**Fig.13**):
Adjust test voltage using the ← and → keys.

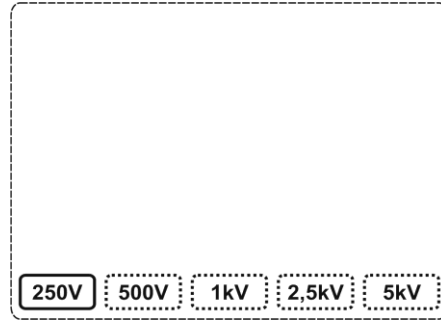


Fig. 13. Set-up test voltage in Insulation Resistance measurement

Legend of displayed symbols:

INSULATION RESISTANCE		Name of selected function
Unominal	250V	Set test voltage

Set-up Insulation resistance limit value for Insulation Resistance (**Fig.13**):

- Press the key Ω,
- Adjust the limit value using the keys ← and →,
- Press the key Ω again or the key START to return to into insulation resistance measurement menu.

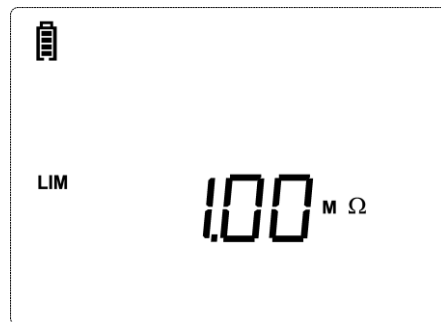


Fig. 13a. Set-up Insulation Resistance limit value

Legend of displayed symbols:

INSULATION RESISTANCE		Name of selected function
Resistance value	1 MΩ	Selected insulation resistance limit

Insulation resistance limit selection range: [10 kΩ .. 200 MΩ]

No limit selected indication: ---

Warning!

- Refer to Warnings chapter for safety precautions!

5.4 Voltage measurement

Select this function by pressing the **V** key. Voltage measurement is active immediately after entering the function. See **Fig. 14** below.



Fig. 14. Voltage function display

Measurement procedure:

- Connect the test leads to the instrument and to the measured source.
- Press the **V** key to select voltage mode, continuous measurement will automatically start to run.

Warning!

- Refer to Warnings chapter for safety precautions!

6 Maintenance

6.1 Inspection

To maintain the operator's safety and to ensure the reliability of the instrument it is advisable to inspect the instrument on a regular basis. Check that the instrument and its accessories are not damaged. If any defect is found please consult your service center, distributor or manufacturer.

6.2 Insertion and charging batteries for the first time

Battery cells are stored in the bottom section of the instrument casing under the battery cover (see **Fig. 15**). When inserting batteries for the first time please note the following:

- ◆ **Disconnect any measurement accessories or mains supply cable connected to the instrument before opening the battery cover to avoid electric shock.**
- ◆ **Remove the battery cover.**
- ◆ **Insert batteries correctly (see Fig. 15), otherwise the test instrument will not operate!**
- ◆ **Replace the battery cover and fixed the cover back in place.**

Connect the instrument to the mains power supply for 14 hours to fully charge batteries. (Typical charging current is 300 mA).

When you charge the batteries for the first time, it normally takes about 3 charge and discharge cycles for the batteries to regain full capacity.

6.3 Replacement and charging batteries

The instrument is designed to be power by rechargeable battery supported by mains supply. The LCD contains an indication of battery condition (upper left section of LCD). When the low-battery indication appears (**Err**) the batteries have to be recharged, connect the instrument to the mains power supply for 14 hours to recharge cells. Typical charging current is 300 mA.

Note:

- Operator does not need to disconnect the instrument from mains supply after the full recharging period. The instrument can be connected permanently.

Fully charged rechargeable batteries can supply the instrument for approx. 4 hours. (Continues testing at 5kV)

If the batteries have been stored for a long time, it normally takes about 3 charge and discharge cycles for the batteries to regain full capacity.

Battery cells are stored in the bottom section of the instrument casing under the battery cover (see **Fig. 15**). In case of defective batteries please note the following:

- ◆ Turn the power off and disconnect any measurement accessories or mains supply cable connected to the instrument before opening the battery cover to avoid electric shock.
- ◆ Remove the battery cover.
- ◆ All six cells have to be replaced and they have to be of the same type.
- ◆ Insert the batteries correctly (see Fig. 15), otherwise the test instrument will not operate and the batteries may be discharged!
- ◆ Replace the battery cover and fixed the cover back in place.
- ◆ The Instrument will only work when rechargeable batteries are inside the instrument.

Nominal power supply voltage is 7.2 V DC. Use six NiMH cells with C size (dimensions: diameter = 26 mm, height = 46 mm). See the next figure **Fig.15** for correct polarity of batteries.

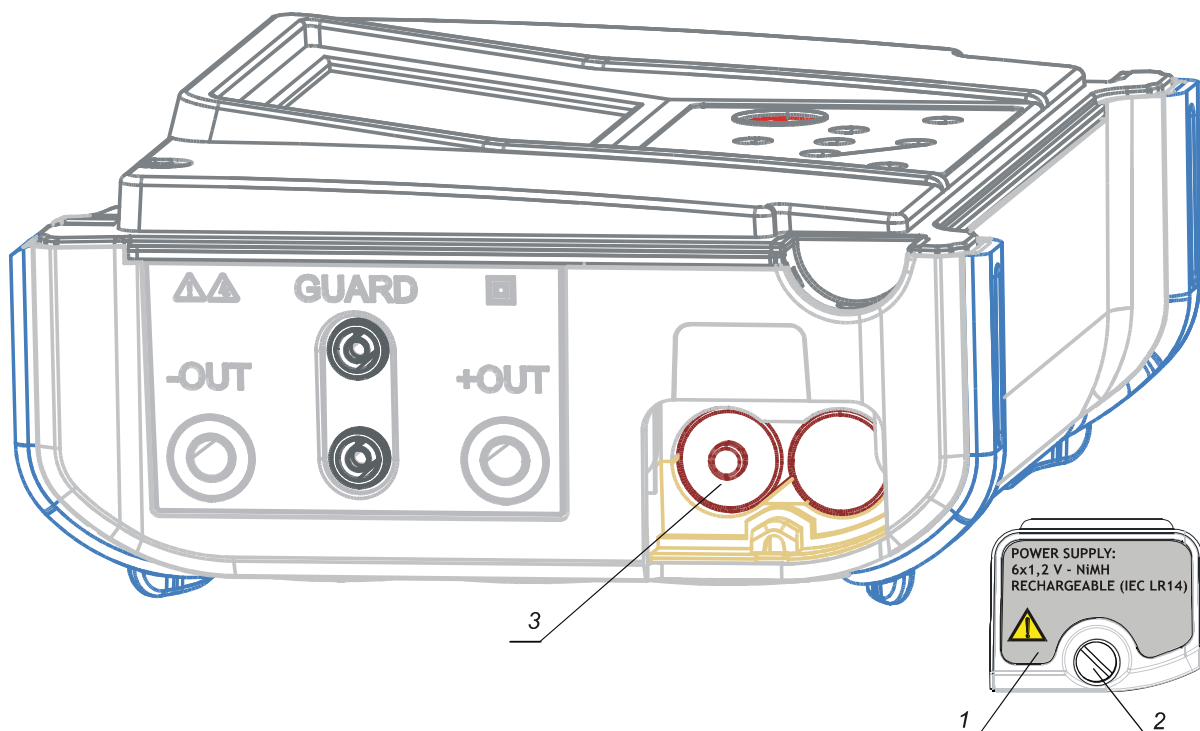


Fig. 15. Correct inserted batteries

- 1..... Battery cover.
- 2..... Screw (unscrew to replace the batteries).
- 3..... Correct inserted batteries.

Ensure batteries are used and disposed of in accordance with Manufacturers guidelines and in accordance with Local and National Authority guidelines



DISCONNECT ALL TEST LEADS AND SWITCH OFF INSTRUMENT BEFORE REMOVING THE BATTERY COVER! HAZARDUS VOLTAGE!

6.4 Cleaning

Use a soft cloth, slightly moistened with soapy water or spirit to clean the surface of the instrument and leave the instrument to dry totally before using it.

Notes!

- Do not use liquids based on petrol or hydrocarbons!
- Do not spill cleaning liquid over the instrument!

6.5 Calibration

It is essential that all measurement instruments be regularly calibrated. For occasional daily use we recommend an annual calibration to be carried out. When the instrument is used continuously every day, we recommend calibrating the instrument every six months.

6.6 Service

For repairing under or out of warranty period contact your distributor for further information.

7 Specifications

7.1 Measurements

Note: All data regarding accuracy are given for nominal (reference) environment condition.

Insulation resistance

Nominal test voltage: 250 V, 500 V, 1 kV, 2.5 kV, 5 kV

Current capability of test generator: >1 mA

Short-circuit test current: 5 mA.

Automatic discharge of tested object: yes

Measuring range Riso: 0.12 MΩ up to 999 GΩ*)

Display range Riso	Resolution	Accuracy
5 ÷ 999 kΩ	1 kΩ	±(5 % of reading + 3 digits)
1.00 ÷ 9.99 MΩ	10 kΩ	
10.0 ÷ 99.9 MΩ	100 kΩ	
100 ÷ 999 MΩ	1 MΩ	
1.00 ÷ 9.99 GΩ	10 MΩ	
10.0 ÷ 99.9 GΩ	100 MΩ	±(10 % of reading + 3 digits)
100 ÷ 999 GΩ	1 GΩ	

*Full-scale value of insulation resistance is defined according the following equation:

$$R_{FS} = 1G\Omega * U_{test}[V] \text{ (if } U_{test} > 1kV \text{ then } R_{FS} = 1T\Omega)$$



For insulation resistance value under 5 kΩ the instrument displays value 0 Ω.

DC test voltage:

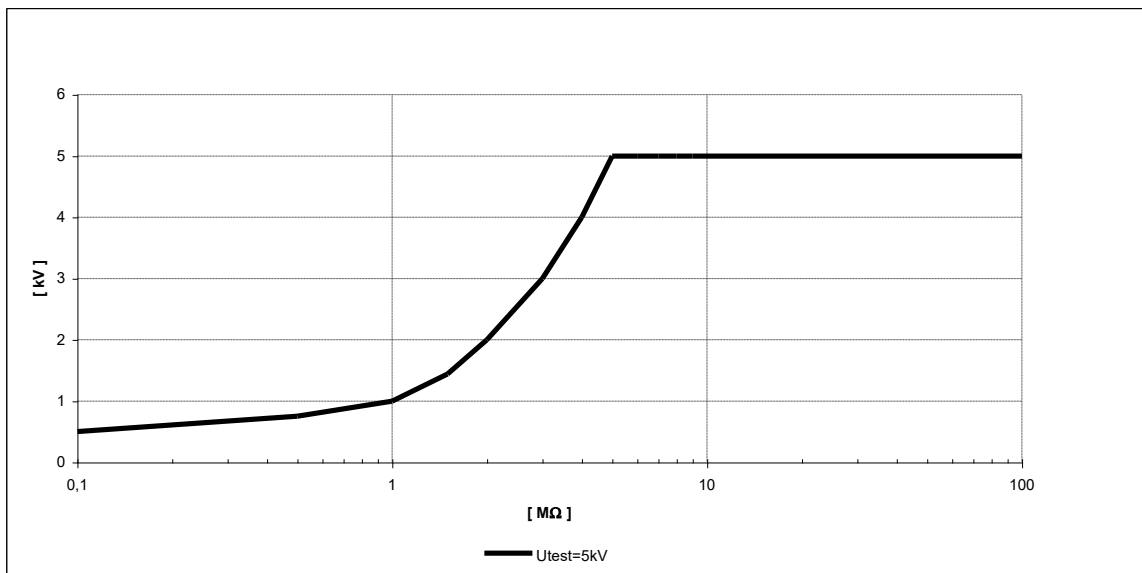
Voltage value: 250V, 500V, 1kV, 2,5kV, 5kV.

Accuracy: -0 / +10 % + 20 V.

Output power: 5 W max.

Display range test voltage (V)	Resolution	Accuracy
0 ÷ 1999V	1 V	±(3 % of reading + 3 V)
2.00k ÷ 5.50k	10 V	

Generator Capability vs Resistance



Voltage

Voltage AC or DC

Display range External Voltage (V)	Resolution	Accuracy
0 ÷ 600	1 V	±(3 % of reading + 4 V)

Frequency of external voltage

Display range (Hz)	Resolution	Accuracy
0 and 45 ÷ 65	0.1 Hz	±0.2 Hz

Note:

- for frequency between 0 and 45 Hz frequency result is shown as ---
- for frequency over 65 Hz frequency result is shown as ---
- for voltages under 10V frequency result is shown as ---

Input resistance: 3 MΩ ± 10 %

7.2 General specifications

Battery power supply	7.2 V DC (6 × 1.2V _{DC} NiMH C size)
Nominal mains power supply	100-240 V _{AC} , 45-65 Hz, 40 VA (300 V CAT II)
Operating mains power supply	90-260 V _{AC} , 45-65 Hz, 40 VA (300 V CAT II)
Protection classification	double insulation <input type="checkbox"/>
Measurement category	600 V CAT IV
Pollution degree.....	2
Degree of protection	IP 40 with case closed
Dimensions (w × h × d).....	31 cm x 13 cm x 25 cm
Weight (without accessories, with batteries) ..	3 kg
Visual and sound warnings.....	yes
Display.....	LCD segments and analogue scale with backlight

ENVIRONMENT CONDITIONS

Working temperature range	-10 ÷ +50 °C
Nominal (reference) temperature range.....	+10 ÷ +30 °C
Storage temperature range.....	-20 ÷ +70 °C
Maximum humidity	90% RH (0 ÷ 40 °C) non-condensing
Nominal (reference) humidity range.....	40 ÷ 60 % RH
Nominal altitude	up to 2000m
Operation.....	Indoor use

AUTO-CALIBRATION

Auto-calibration of measuring system.....	every time after turning power on
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CONNECTING SYSTEM

Two safety banana sockets	+OUT, -OUT (5kV CAT I, Double)
Two GUARD. banana sockets.....	GUARD (600V CAT IV, Double)
Guard resistance	200 kΩ ± 10 %

DISCHARGING

Every time after measurement completion.	
Discharging resistance:	300 kΩ ± 10 %