



Earth - Insulation Tester MI 2088 User Manual

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Mark on your equipment certifies that this equipment meets the requirements of the EU
(European Union) concerning safety and interference causing equipment regulations

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1. Introduction

Congratulations on your purchase of the **Earth - Insulation Tester** and its accessories, produced by METREL d.d. We are glad, to be able to offer high professional test equipment, for carrying out absolute measurement of Earth Resistances and Insulation Resistances on installations in buildings. The equipment was designed and produced on basis of rich experiences, acquired through more-years long period of dealing with Earth Resistance and Electric installation test equipment.

1.1. General description

The Earth - Insulation Tester is high professional, multifunctional, portable test instrument. It is intended for carrying out Earth Resistance, Insulation Resistance and Continuity of Protection Conductors measurements, according to **European standard EN 61557**. It can also do various other tests and measurements.

The instrument is equipped with all accessories, necessary for comfortable carrying out the tests. It is kept in a soft carrying bag, separated from enclosed accessories.

Electronic part of the Earth - Insulation Tester is produced in SMD technology, which demands practically no service interventions. Custom designed LCD display with backlight offers easy to read main results as well as a wide range of subresults, parameters and messages. Operatio is simple and clear, operator does not need to attend any special training (except to read this Instruction Manual) to operate the instrument.

In order, the operator to be familiar enough with measurements, covered by the Earth – Insulation Tester (purpose of each measurement, measurement principle, limit values etc.), it is advisable to read the enclosed handbook **Measurements on electric installations in theory and practice**.

Professional PC SW enables simple transfer of test results and other parameters to PC, as well as simple and quick forming of final protocols.

1.2. Warnings

In order to reach high operator's safety while carrying out various measurements and tests using the Earth - Insulation Tester, as well as to keep the test equipment undamaged, it is necessary to consider the following general warnings:

If the test equipment is used in manner not specified in this Instruction Manual, the protection provided by the equipment may be impaired!

Do not use the instrument and accessories, if any damage is noticed!

In case of blown fuse, follow the instructions in this Instruction Manual, to replace it!

Service intervention or calibration procedure is allowed to be carried out only by a competent, authorized person!

Consider all generally known precautions, in order to avoid risk of electric shock, while dealing with hazardous voltages!

Use only standard or optional test cables, supplied by your dealer!

1.3. List of parameters measurable by the Earth - Insulation Tester

Parameter	Function switch position	Description
Earth Resistance RE (classic four-lead method)	REARTH	- Four test terminals - Two test rods
Partial Earth Resistance RE (classic four-lead method plus test clamp)	REARTH (clamp)	- Four test terminals - Two test rods - One test clamp
Earth Resistance RE (two test clamps)	REARTH (2 clamps)	- Two test clamps
Earth Resistivity ρ	ρ REARTH	- Four test terminals - Four test rods
Continuity R of protection conductors	R \pm 200mA	- Test current > 200 mA d.c. - Single measurement - Auto polarity reverse
Continuity Rx	CONTINUITY	- Test current < 7 mA - Continuous measurement
Insulation Resistance Ri	RINS/VOLTAGE	- Test voltage: 50 ÷ 1000 V
Voltage	RINS/VOLTAGE	- AC or DC voltage 0 ÷ 600 V
Varistor Over-voltage Device - Breakdown Voltage Ub	varistor Test	- Rising test voltage 0 ÷ 1000 V - Treshold current 1 mA
Low-range Current I	CURRENT	- Test clamp
Load Current I	CURRENT	- Test clamp

1.4. Standards applied

Earth - Insulation Tester is designed according to European safety standard

- EN 61010 – 1

EMC (noise and immunity) according to European standards

- EN 50081 – 1
- EN 50082 – 1

Measurements according to European standard EN 61557:

- Insulation Resistance Part 2
- Resistance of Earth connection and Equipotential bonding Part 4
- Earth Resistance Part 5

2. Instrument description

2.1. Front panel

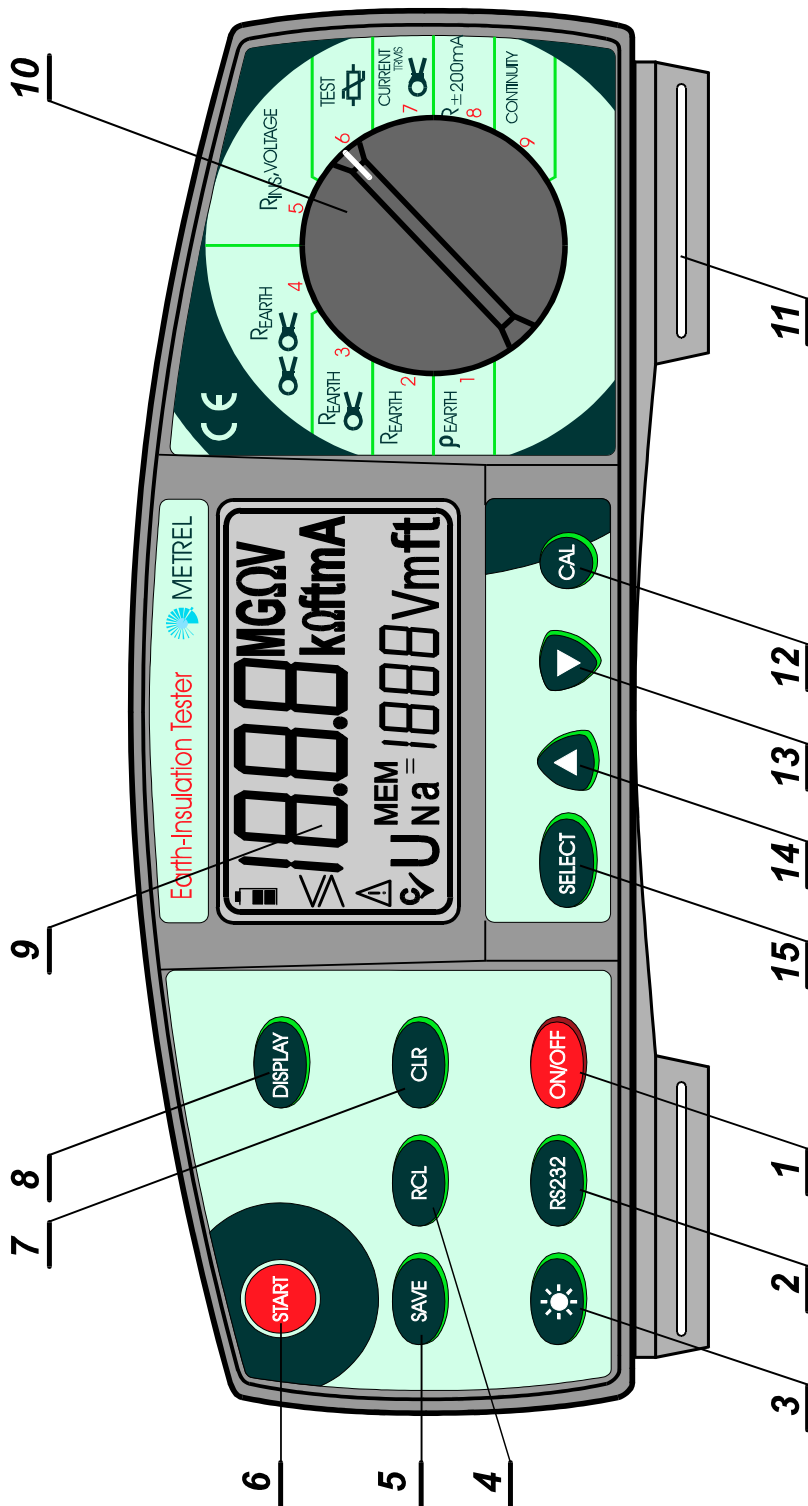


Fig. 1. Front panel

Legend:

- 1 **ON/OFF key**, to switch ON or OFF the instrument. Auto OFF will occur automatically, 10 minutes after last strike to any key or function switch rotation.
- 2 **RS 232 key**, to communicate with PC.
- 3 **LAMP key**, to turn ON or OFF display backlight. The backlight, once switched ON, will switch OFF automatically 20 seconds after last strike to any key or function switch rotation.
- 4 **RCL key**, to recall stored results.
- 5 **SAVE key**, to store test results.
- 6 **START key**, to start any measurement except Voltage (automatic start).
- 7 **CLR key**, to erase stored results.
- 8 **DISPLAY key**, to:
 - Check current and potential probe resistances (r_C and r_P) in **r EARTH**, **R EARTH** and **R EARTH** (one clamp) functions.
 - Switch between Voltage and Insulation Resistance measurement, when function switch in **RINS/VOLTAGE** position.
 - Check U_{ac} voltage in **Varistor test** function.
 - Check lower partial result in **R $\pm 200mA$** function.
- 9 **LCD** with backlight.
- 10 **Function switch**, to select appropriate parameter to be tested.
- 11 **Belt slot**, to fix carrying belt.
- 12 **CAL key**, to compensate resistance of test leads in **R $\pm 200mA$** function.
- 13 **- key**, to decrease settable parameter value.
- 14 **+ key**, to increase settable parameter value.
- 15 **SELECT key**, to select/set function parameters as follows:
 - Earth resistivity function: Distance »a« between test rods.
 - Earth Resistance functions: High limit value of test result.
 - Insulation Resistance function: Nominal test voltage and Low limit value of test result.
 - Varistor Breakdown voltage function: Low and High limit value of test result.
 - Continuity of Protection Conductors function (R $\pm 200mA$): High limit value of test result.
 - General settings: Immunity against mains noise signal (nominal mains frequency 50 Hz / 60 Hz is to be inserted) and Earth resistivity unit (Ω_m or Ω_{ft}).

2.2 Connector panel

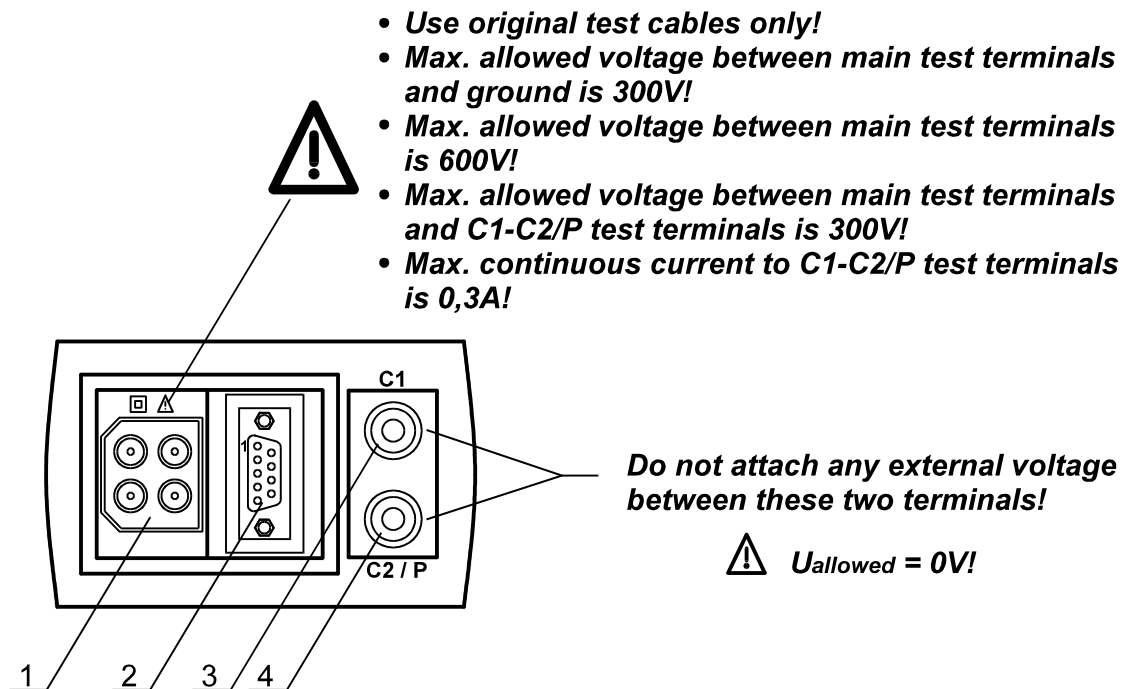


Fig. 2. Connector panel

Legend:

- 1 Main test connector
- 2 RS 232 connector (to connect Earth - Insulation Tester to PC)
- 3 Clamp (C1) test terminal
- 4 Clamp (C2/P) test terminal

2.3. Bottom side

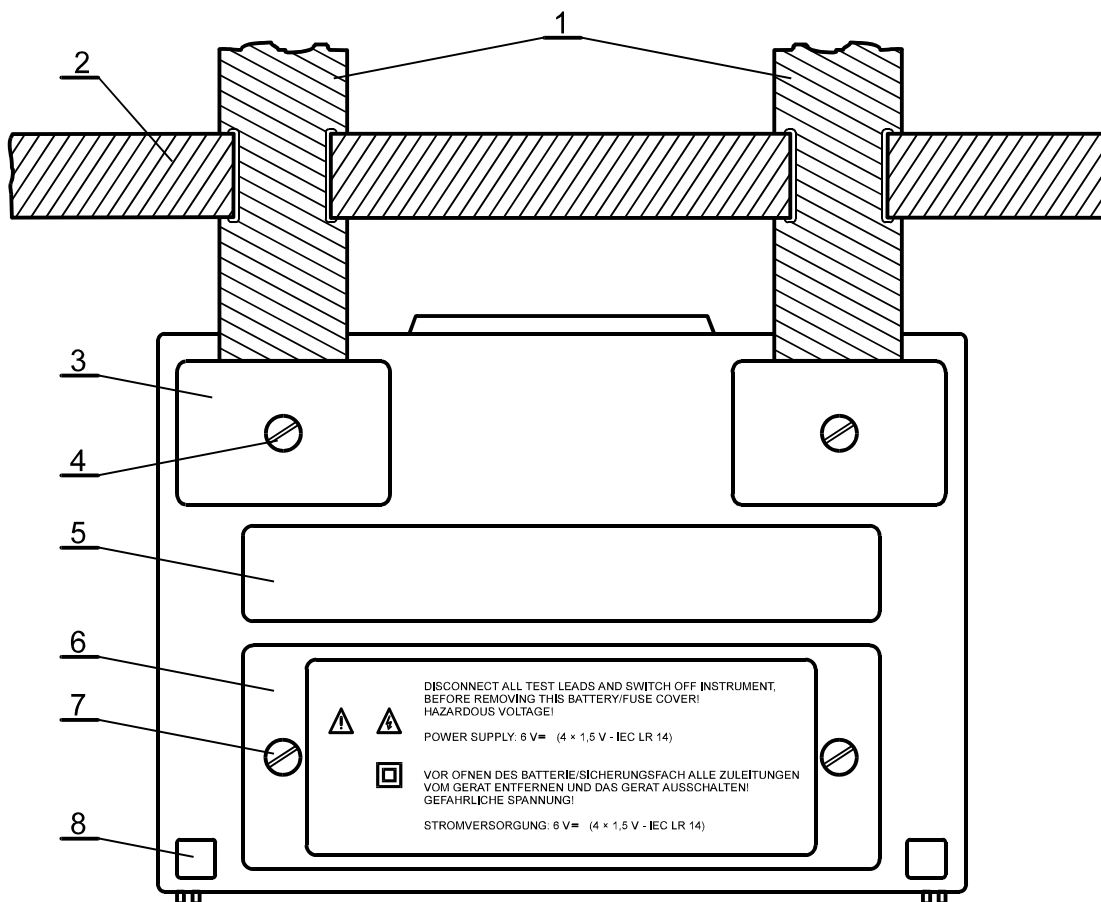


Fig. 3. Bottom side

Legend:

- 1 Nylon strip (it serves the operator to carry the instrument hung on his neck).
- 2 Auxiliary nylon strip (it serves the operator to fix the instrument along his body).
- 3 Plastic cover (it fixes nylon strip to the instrument). There is a screw under the cover (left and right), which is to be unscrewed, when opening the instrument for service or calibration purpose.
- 4 Screw (unscrew it, to remove carrying strip or to open the instrument).
- 5 Label with measurement ranges.
- 6 Battery/fuse compartment cover.
- 7 Screw (unscrew it to replace batteries or blown fuse).
- 8 Rubber foot.

2.4. Standard accessories

See attached sheet, to compare received set of accessories with listed one.

2.5. Optional accessories

See attached sheet, to check the list of available optional accessories, which may be supplied upon request.

2.6. Ways of carrying the instrument

As the Earth - Insulation Tester is equipped with two carrying belts (neck and back), various possibilities of carrying the instrument are available. Operator can choose appropriate one on basis of his operation, see the following examples:



The instrument is hung around operator's neck only - quick placing and displacing.



The instrument is hung around operator's neck and fixed to his body with back belt - stable position.



The instrument can be used even placed in soft carrying bag - test cable connected to the instrument through the side aperture.

The instrument is fixed to operator's body with back belt only - it can be simply moved from side to front position for measurement purpose and back again.



3. Measurement instructions

3.1. Insulation Resistance

There are different objects, where Insulation Resistance is to be measured, in order to assure safety of electric installation and appliances. Let's list a few examples:

- Insulation Resistance between installation conductors L1, L2, L3, N, PE (all combinations).
- Insulation Resistance of non-conductive rooms (walls and floors).
- Insulation Resistance of ground cables.
- Resistance of semiconductive (antistatic) floors.

For additional general information concerning Insulation Resistance measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

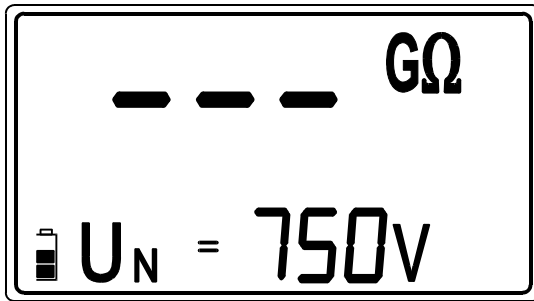
Warnings!

- Make sure tested object to be deenergized (mains voltage disconnected) before starting the measurement!
- When measuring Insulation Resistance between conductors, all loads must be disconnected and all switches closed!
- Do not touch tested object while testing it, risk of electric shock!
- Do not connect test terminals to external voltage higher than 600 V a.c. or d.c., in order not to damage the test instrument!
- In case of capacitive test object (capacitive compensation of reactive power, long tested cable etc.), automatic discharge of the object may not be done immediately after finishing the measurement. Falling voltage will be displayed in that case – do not disconnect test leads until the voltage drops below 50V!

How to carry out the measurement ?

Step 1

- Connect test cable (Split test leads or Tip Commander) to Earth - Insulation Tester.
- Set function switch to **RINS, VOLTAGE** position, the following menu will be displayed:



UN Last set nominal test voltage. Actual test voltage U is displayed during the measurement.

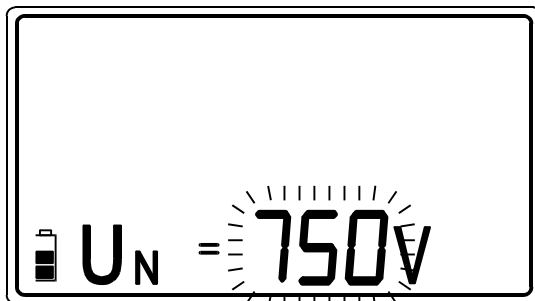
Fig. 4. Insulation Resistance initial menu

Step 2

- Set Nominal Test Voltage.

How to set the Test Voltage?

- Press the **SELECT** key and release it, to enter “Test voltage adjustment mode”, the following menu will be displayed:



Last set Nominal test voltage is blinking.

Available nominal test voltages (V)	Step (V)
50 ÷ 1000	10

Fig. 5. Test voltage adjustment menu and the table of available nominal test voltages

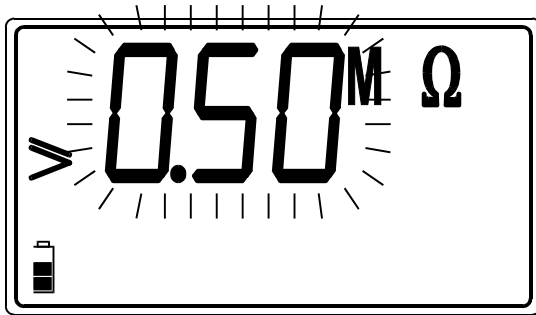
- Use the - and + keys, to set required nominal test voltage. Individual strike will increase/decrease the voltage for one step, while continuous pressure will increase/decrease it continuously (the value will stop for a while, when reaching standard value like 100, 250 or 500 V, enabling the operator to depress used key).

Step 3

- Set **Low Limit Insulation Resistance Value**. Later will test results be compared with the set limit value and, if lower, they will be equipped with “!” mark.

How to set the Low Limit Value ?

- Press the **SELECT** key after setting nominal test voltage, to enter “Low Limit Value adjustment menu”, see the figure below:



Available low limit values (MΩ)	Step (MΩ)
0,00 ÷ 0,10	0,01
0,10 ÷ 1	0,05
1 ÷ 10	1
10 ÷ 1000	10

Last set Low limit value is blinking.

Fig. 6. Low Limit Value adjustment menu and the table of available limit values

- Use the **-** and **+** keys, to set required Low Limit Value. Individual strike will increase/decrease the value for one step, while continuous pressure will increase/decrease it continuously. If test results are not to be compared with Low Limit Value at all, then press the **CLR** key, **no** will be displayed instead of set value.
- Press the **SELECT** key again after setting limit value, to return to “Insulation Resistance initial menu”.

Step 4

- **Connect test cable** to tested object, according to the figure below:

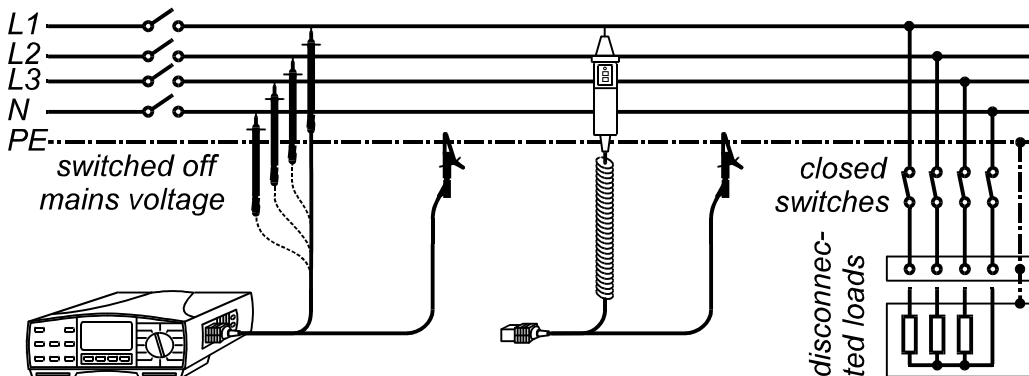


Fig. 7. Connection of Split test leads (left side) and Tip Commander (right side)

Step 5

- Press the **START** key and keep it pressed, until result is stabilized, then release the key. Last result will stay displayed.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results.

Notes!

- In case of present external voltage higher than 30 V a.c./d.c. between test terminals, the Insulation Resistance measurement will not be carried out after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too.
- Tested object is discharged automatically after finishing the measurement, actual voltage is displayed during discharging, until the voltage drops below 30 V!
- If test result is out of measurement range (open test leads or good isolation), **>29,9 GW** message will be displayed ($U_N \geq 250$ V) or **>200 MW** ($U_N < 250$ V)!
- Positive pole of test voltage is attached to red test lead (Split test leads) or to commander test tip (Tip Commander)!
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.2. Voltage

Voltage measurement is common function, often often, for example, when locating installation faults or, as a safety measure, before starting any installation adaptation activity.

Warning!

- Do not connect test terminals to external voltage higher than 600 V a.c. or d.c., in order not to damage the test instrument!

How to carry out the measurement?

Step 1

- Connect test cable (Split test leads or Tip Commander) to Earth - Insulation Tester.
- Set function switch to **RINS, VOLTAGE** position, Insulation Resistance initial menu will be displayed (see the figure 4.).

Step 2

- Press the **DISPLAY** key and release it, measurement starts to run, result will be currently displayed as follows:

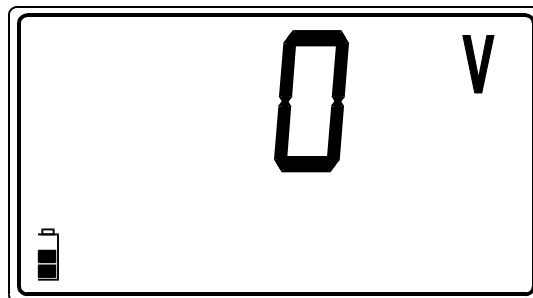


Fig. 8. Voltage measurement

Step 4

- **Connect test cable** to tested terminals and follow displayed result.

Step 5

- Press the **DISPLAY** key again and release it after finishing the Voltage measurement, Insulation Resistance initial menu (see the figure 4.) will be displayed again.

Instead of pressing **DISPLAY** key, it is also possible to start Insulation Resistance measurement directly, pressing the **START** key.

- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results.

Notes!

- AC (effective value) or DC voltage, up to 600V can be measured. Polarity, in case of DC voltage, will not be displayed!
- If measured voltage is higher than 600V, **>600V** message will be displayed!
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.3. Continuity of Protection Conductors

Continuity of protection conductors is to be measured, before mains voltage is connected to tested installation (new or adapted installations). Max. allowed resistance value depends on the power of connected loads, used installation system (TN, TT) etc.

For additional general information concerning Continuity measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

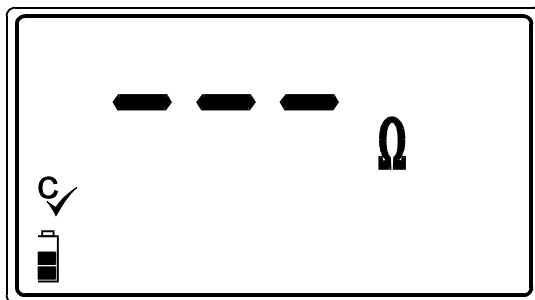
Warning!

- Make sure tested object to be deenergized (mains voltage disconnected) before starting the measurement!

How to carry out the measurement ?

Step 1

- Connect test cable (Split test leads or Tip Commander) to Earth - Insulation Tester.
- Set function switch to **R ±200mA** position, the following menu will be displayed:



Cü Resistance of test leads has been compensated.

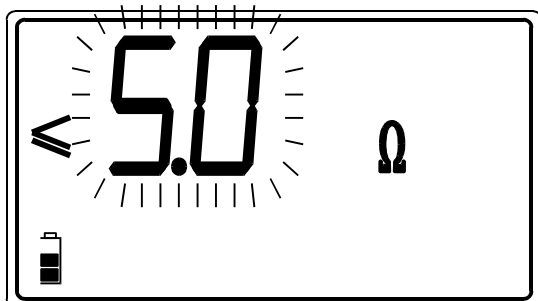
Fig. 9. Continuity initial menu

Step 2

- Set **High Limit Resistance Value**. Later will test results be compared with the set limit value and, if higher, they will be equipped with “!” mark.

How to set the High Limit Value ?

- Press the **SELECT** key, to enter “High Limit adjustment menu”, see the figure below.



Last set High Limit Value is blinking.

Available high limit values (Ω)	Step (Ω)
0,0 ÷ 20,0	0,1

Fig. 10. High Limit adjustment menu and the table of available high limit values

- Use the - and + keys, to set required High Limit Value. Individual strike will increase/decrease the value for one step, while continuous pressure will increase/decrease it continuously. If test results are not to be compared with High Limit Value at all, then press the **CLR** key, **no** will be displayed instead of set value.
- Press the **SELECT** key again after setting limit value, to return to “Continuity initial menu”.

Step 3

- **Compensate test leads** (if they have not been compensated yet or, if already compensated test leads have been exchanged).

How to carry out the compensation ?

- Short test leads, see the figure below.

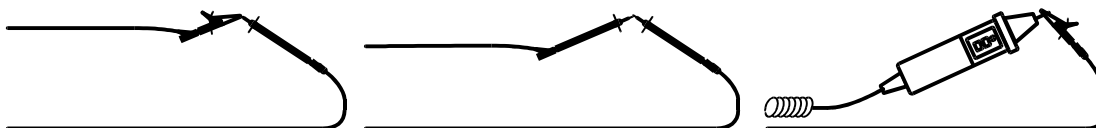


Fig. 11. Shorted test leads

- Press the **START** key and release it, in order to carry out regular measurement. Result (close to 0 Ω) will be displayed.
- Press the **CAL** key and release it, displayed result will alter to 0,00 Ω and **Cū** mark will appear, indicating the compensation was successfully accomplished. Test instrument is thus ready to be used.
- In order to annul potential compensation, follow in this step described procedure at open test leads. **Cū** mark will disappear after finishing the procedure, indicating, the compensation has not been effected.

Compensation, effected in this function, will be considered in **CONTINUITY** function too.

Step 4

- **Connect test leads** to tested object according to the figures below.

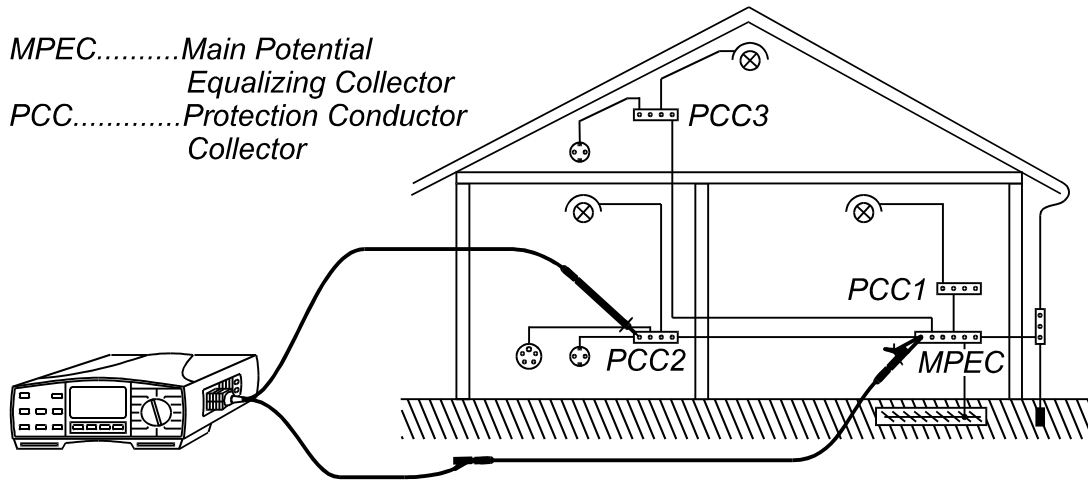


Fig. 12. Connection of Split test leads and extra test lead

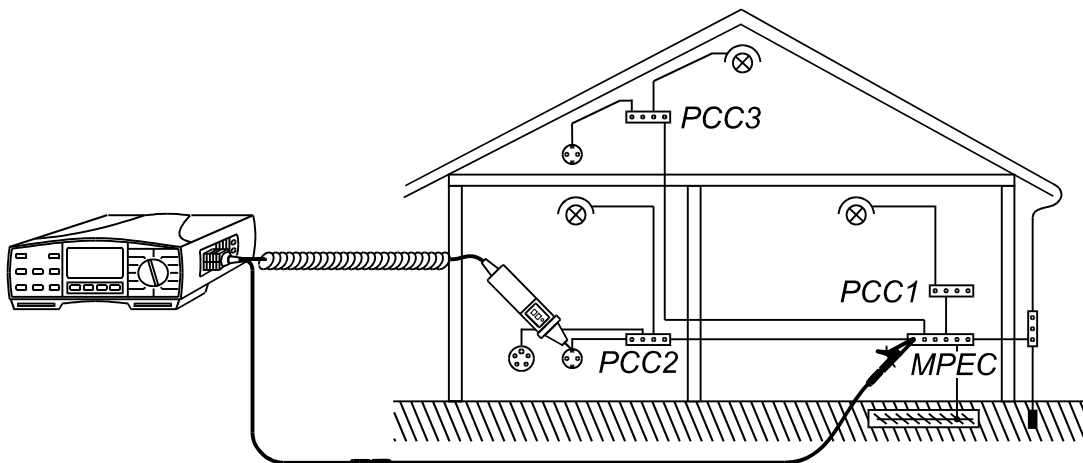


Fig. 13. Connection of Tip Commander and extra test lead

Step 5

- Press the **START** key and release it. Measurement will be carried out and result displayed afterwards. Each measurement is accomplished in two steps (polarity is reversed between the two steps automatically). Higher partial result will be displayed. The result will be equipped with beep sound signal, if lower than set High limit value.
- Check lower partial result, pressing the **DISPLAY** key.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In case of present external voltage higher than 9 V a.c./d.c. between test terminals, the Continuity measurement will not be carried out after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too.
- If resistance value higher than 5 Ω (measured with not-compensated instrument) is displayed, compensation will not be carried out after pressing **CAL** key, even more, already effected compensation will be annuled (**Cü** mark will disappear)!
- If test result is out of measurement range (open test leads), **>1999 W** message will be displayed!
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.4. Continuity

The function is intended to be used especially when arranging terminal to terminal connections, maintaining and repairing electric equipment, carrying out auxiliary measurements etc. The function operates continuously and serves as ordinary Ω -meter with low test current.

For additional general information concerning Continuity measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

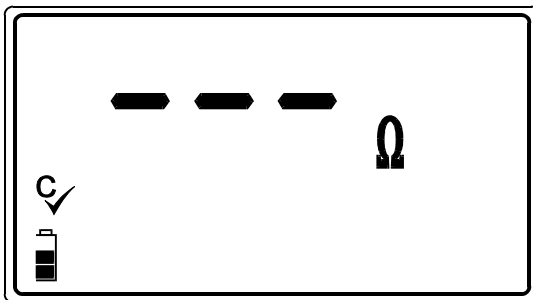
Warning!

- If test tips are connected to mains voltage during the measurement is running, fuse M 0,315 A / 250 V (mounted in vertical plastic cylinder under battery cover) will blow (see the chapter 5.2. Fuses).

How to carry out the measurement ?

Step 1

- Connect test cable (Split test leads or Tip Commander) to Earth - Insulation Tester.
- Set function switch to **CONTINUITY** position, the following menu will be displayed:



Cü Resistance of test leads has been compensated in $R_{\pm 200mA}$ function.

Fig. 14. Continuity initial menu

Step 2

- Press the **START** key and release it. Measurement starts to run (continuous measurement), results are currently displayed.

Step 3

- ◆ **Connect test leads** to tested object according to the figures below and follow displayed result or sound information (result is accompanied with sound signal, if displayed value is lower than 20Ω).

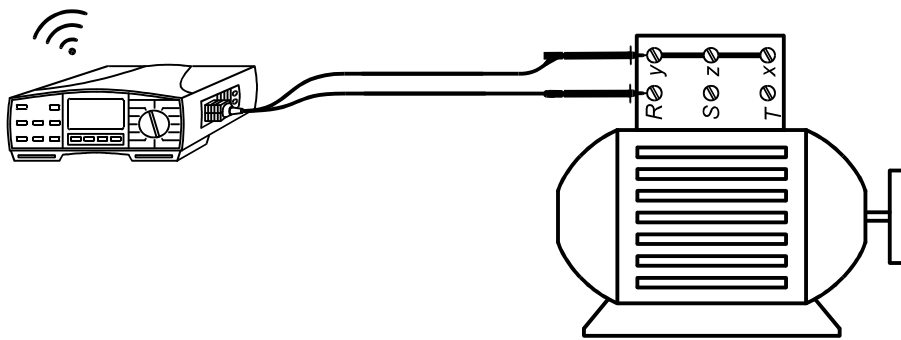


Fig. 15. Connection of Split test leads

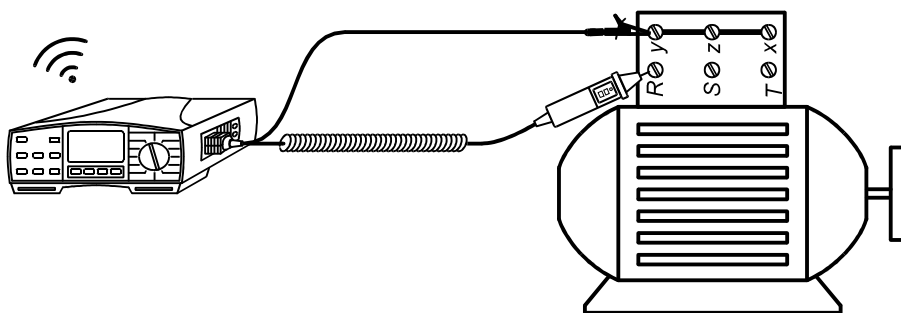


Fig. 16. Connection of Tip Commander

- Press the **START** key again after finishing the measurement, last result will stay displayed.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In case of present external voltage higher than 9 V a.c./d.c. between test terminals, the Continuity measurement will not start after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too.
- If test result is out of measurement range (open test leads), **>1999 W** message will be displayed!
- Positive pole of test voltage is attached to red test lead (Split test leads) or to commander test tip (Tip Commander)!
- Compensation of test leads, effected in **R ±200mA** function, will be considered in this function too.
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.5. Earth Resistance (internal generator)

The Earth - Insulation Tester is able to carry out Earth Resistance measurement using three different methods. The appropriate one is to be selected by the operator on basis of concrete earthing system to be tested. Main advantages of Internal-generator system against external (mains)- test voltage one are:

- Test instrument operates autonomously (regardless of present or not present mains voltage).
- Partial Earth Resistances can be measured, using test clamp (without mechanical disconnection of tested electrode).
- Probeless measurement can be done, using two test clamps.

For additional general information concerning Earth Resistance measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

How to carry out Earth Resistance measurement, using standard four-lead test method ?

Step 1

- Set function switch to **REARTH** position, the following menu will be displayed:

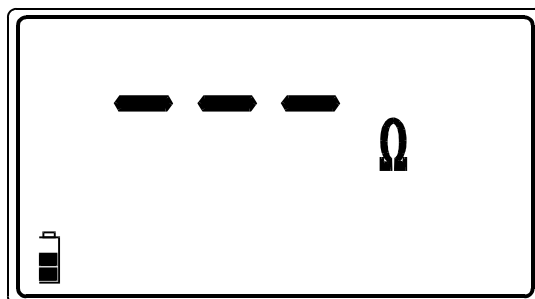


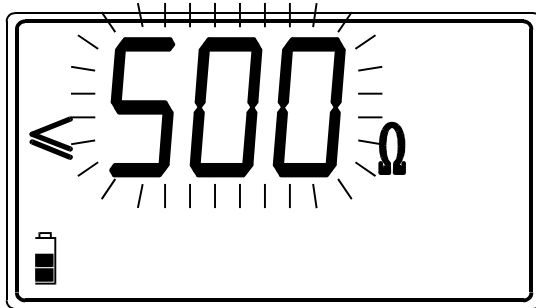
Fig. 17. Earth Resistance initial menu

Step 2

- Set **High Limit Earth Resistance Value**. Later will test results be compared with the set limit value and, if higher, they will be equipped with “!” mark.

How to set the High Limit Value ?

- Press the **SELECT** key, to enter “High Limit Value adjustment mode”, the following menu will be displayed:



Last set High limit value is blinking

Available High limit values (Ω)	Step (Ω)
1 – 100	1
166, 250, 500, 833, 1666, 2500, 5000	/

Fig. 18. Limit adjustment menu and the table of available limit values

See explanation for above listed available limit values in enclosed handbook **Measurements on electric installations in practice and theory**, under paragraph 5.7.4. Earth Resistance (external test voltage).

- Use the - and + keys, to set required High Limit Value. Individual strike will increase/decrease the value for one step, while continuous pressure will increase/decrease it continuously. If test results are not to be compared with High Limit Value at all, then press the **CLR** key, **no** will be displayed instead of set value.
- Press the **SELECT** key again after setting limit value, to return to “Earth Resistance initial menu”.

Step 3

- Connect test leads** to the instrument and to tested object according to the figures below.

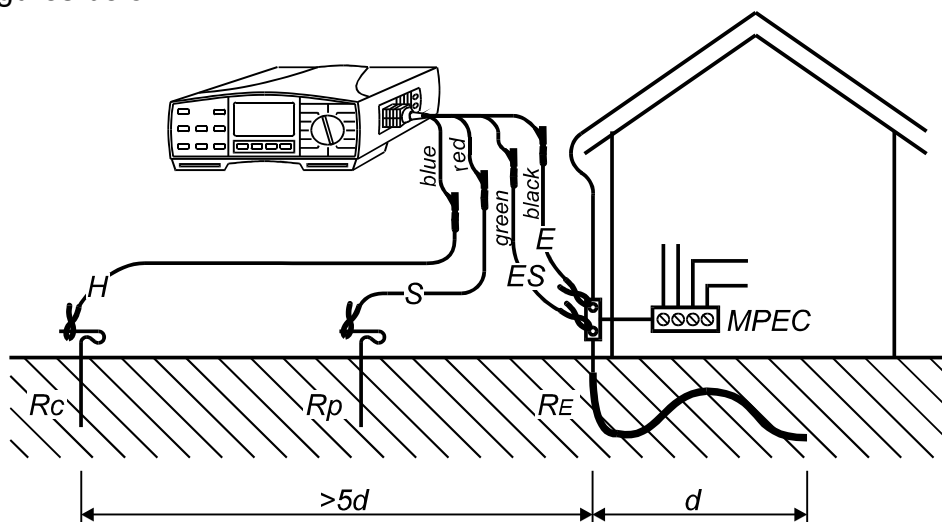


Fig. 19. Connection of standard 20 m long test leads

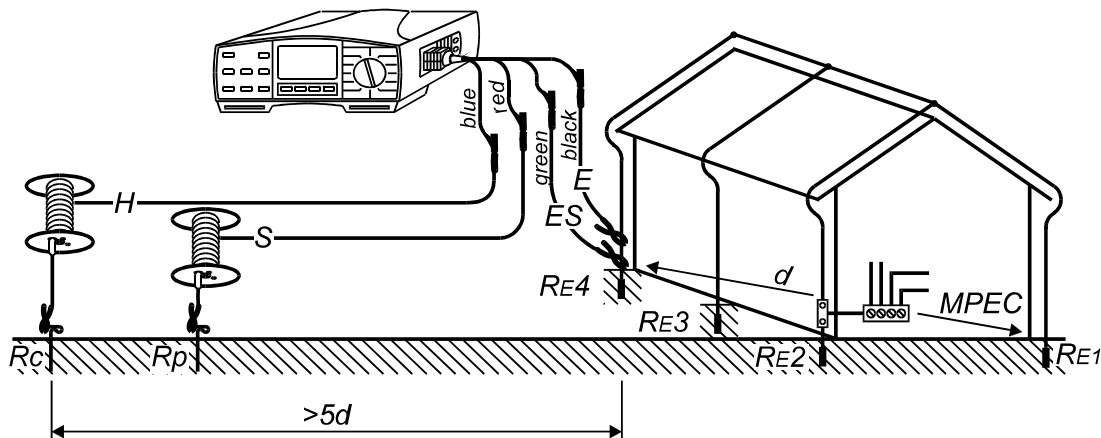


Fig. 20. Connection of optional 50 m long test leads

Step 4

- Press the **START** key and keep it pressed, until result is stabilized, then release the key. Last result will stay displayed.
- Check resistances of current and potential test rod, pressing the **DISPLAY** key. **rP** and then value of potential probe will be displayed, automatically followed by **rC** and then value of current probe. After a while, main result will automatically be displayed again.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In case of present external voltage higher than 19 V a.c./d.c. between H and E or ES and S test terminals, the Earth Resistance measurement will not be carried out after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too!
- If resistance of current or potential rod is too high ($>(4 \text{ k } \Omega + 100 \text{ RE})$ or $>50 \text{ k}\Omega$, whichever is lower), test result will be equipped with “!” mark and **rC** or **rP** message. If resistance of both (current and potential) probes is too high, **rCP** message will be displayed.
- If test result is out of measurement range (open test leads), **>19,99 kW** message will be displayed!
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

How to carry out Earth Resistance measurement (partial resistance), using standard four-lead test method in combination with test clamp ?

For detailed general instruction concerning this type of measurements, refer to enclosed handbook **Measurements on electric installations in practice and theory**. High acquaintance is required, to measure Earth resistance this way correctly!

Step 1

- Set function switch to **REARTH (clamp)** position, menu according to the figure 17. will be displayed.

Step 2

- Set **High Limit Earth Resistance Value**, follow Step 2 on page 22. Value 1 up to 100 Ω in steps of 1 Ω can be set.

Step 3

- Connect test leads and Low-range test clamp** to the instrument and to tested object, according to the figure below.

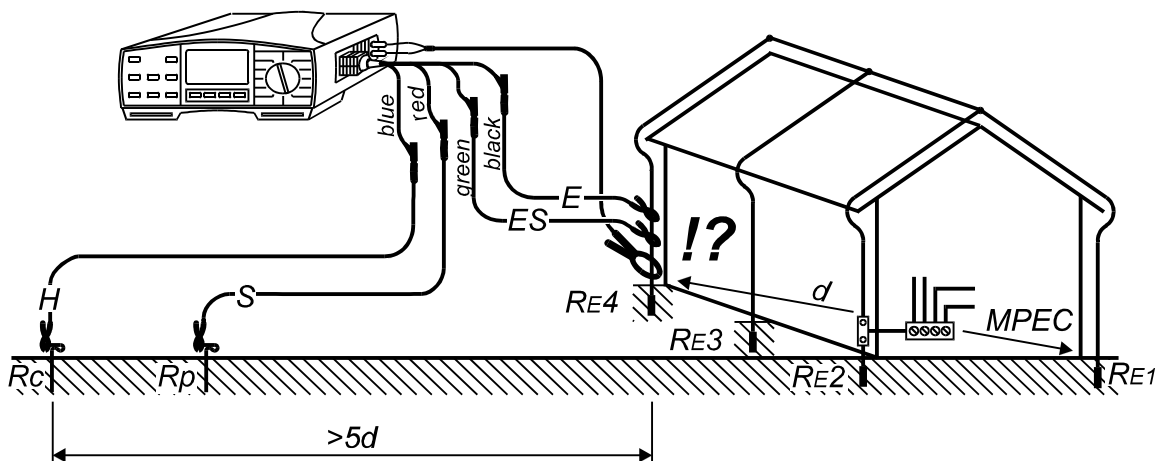


Fig. 21. Connection of standard 20 m long test leads and clamp

!?.... Make sure to connect test clamp under the E test terminal, otherwise parallel resistance of all other electrodes (RE1 up to RE3) will be measured!

Step 4

- Press the **START** key and keep it pressed, until result is stabilized, then release the key. Last result will stay displayed.

- Check resistances of current and potential probe pressing the **DISPLAY** key. **rP** and then value of potential probe will be displayed, automatically followed by **rC** and then value of current probe. After a while, main result will automatically be displayed again.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In case of present external voltage higher than 19 V a.c./d.c. between H and E or ES and S test terminals, the Earth Resistance measurement will not be carried out after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too!
- If resistance of current or potential probe is too high ($>(4 \text{ k}\Omega + 100 \text{ RE})$ or $>50 \text{ k}\Omega$, whichever is lower), test result will be equipped with “!” mark and **rC** or **rP** message. If resistance of both (current and potential) probes is too high, **rCP** message will be displayed.
- If test result is out of measurement range (open test leads), **>1,99 kW** message will be displayed!
- If the current, measured with clamp, is lower than 0,5 mA, **LC** (low current) message will be displayed, indicating test result may not be correct (the result is still correct, if **Rtot./Rpart. < 100**).

Where:

Rtot. Total Earth Resistance, measured when function switch is in **REARTH** position.

Rpart. Partial Earth Resistance, measured with clamp, when function switch is in **REARTH (clamp)** position.

- In case of present noise current higher than approx. 2,4 A in clamp loop, **nC** (noise current) message will be displayed, indicating test result may not be correct! The value of noise current may be also measured in **CURRENT** function.
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

How to carry out Earth Resistance measurement, using two test clamps ?

For detailed general instruction concerning this type of measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**. High acquaintance is required, to measure Earth resistance this way correctly!

Step 1

- Set function switch to **REARTH (2 clamps)** position, menu according to the figure 17. will be displayed.

Step 2

- Set High limit Earth Resistance value, follow Step 2 on page 22. Value 1 up to 100 Ω in steps of 1 Ω can be set.

Step 3

- **Connect test clamps** to the instrument and to tested object according to the figure below.

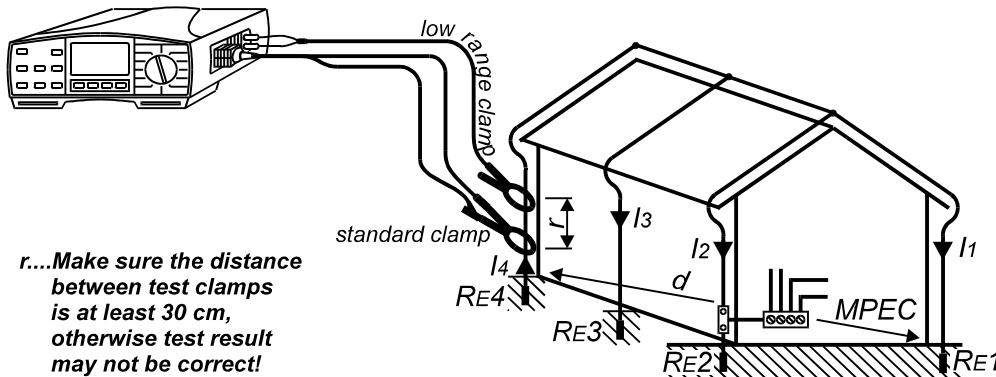


Fig. 22. Connection of two test clamps

Step 4

- Press the **START** key and release it. The measurement starts to run (continuous measurement), results are currently displayed.
- Press the **START** key again after finishing the measurement, last result will stay displayed.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In case of present external voltage higher than 19 V a.c./d.c. between H and E or ES and S test terminals, the Earth Resistance measurement will not be carried out after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too!
- In case of the ratio Noise current / Measurement current > 100, **nC** (noise current) message will be displayed, indicating test result may not be correct! The value of noise current may be also measured in **CURRENT** function.
- If test result is out of measurement range (open test leads), **>99,9** W message will be displayed!
- If the current, measured with clamp, is lower than 0,5 mA, **LC** (low current) message will be displayed, indicating test result may not be correct!
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.6. Specific Earth Resistance

It is advisable to measure Earth Resistivity, when defining parameters of earthing system (required length and surface of earth electrodes, most appropriate depth of installing earthing system etc.) in order to reach more accurate calculations.

For additional general information concerning Earth Resistivity measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

Different units are used for Earth Resistivity parameter namely:

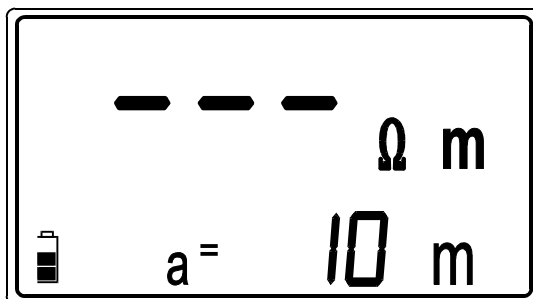
- Ωm (European countries)
- Ωft (The United States)

That is why the Earth – Insulation Tester offers both units, as well as both units for inserted distance “a” (m / ft) between test rods. See the procedure how to select appropriate unit on page 40.

How to carry out the measurement ?

Step 1

- Set function switch to r EARTH position, the following menu will be displayed:



a Set distance between test rods.

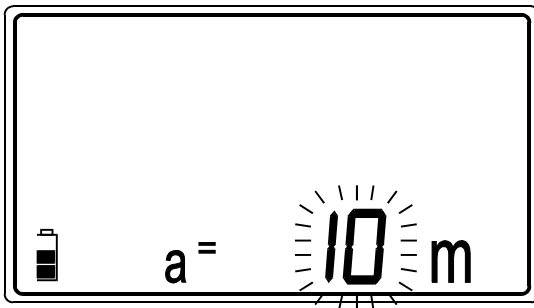
Fig. 23. Earth Resistivity initial menu

Step 2

- Set **distance “a”** between test rods. The distance must be equal to the one, used in practical measurement, otherwise test result will not be correct.

How to set the distance ?

Press the **SELECT** key, to enter “Distance Value adjustment mode”, the following menu will be displayed:



Last set distance »a« is blinking.

Available distances		Step (m / ft)
(m)	(ft)	
1 ÷ 30	1 ÷ 90	1

Fig. 24. Distance value adjustment menu

- Use the - and + keys, to set appropriate Distance “a”. Individual strike will increase/decrease the value for one step, while continuous pressure will increase/decrease it continuously.
- Press the **SELECT** key after setting the distance value, to return to “Earth Resistivity initial menu”.

Step 3

- **Connect test leads** to the instrument and to test rods, according to the figure below.

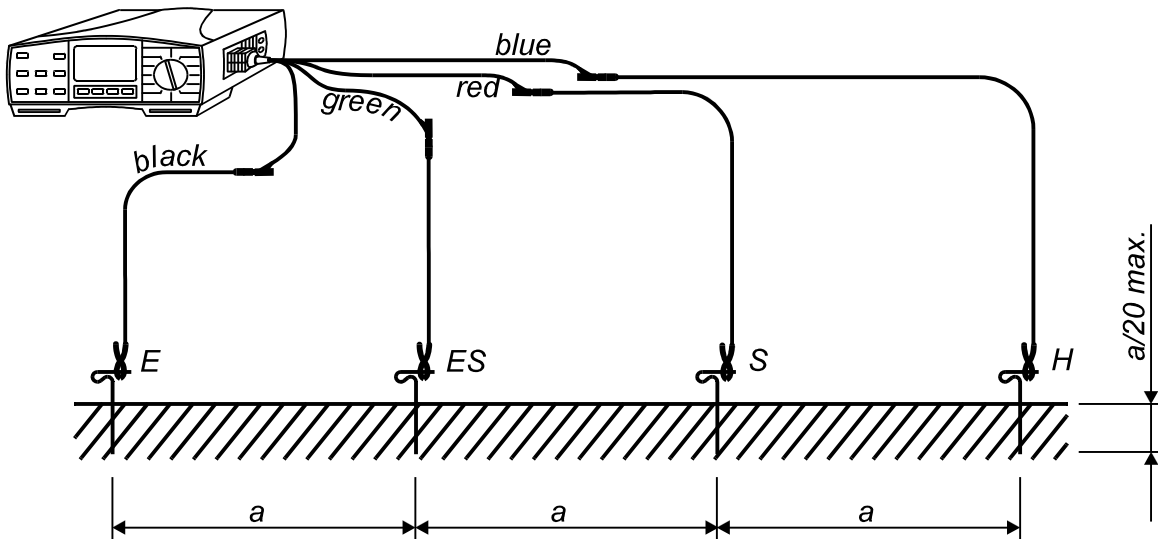


Fig. 25. Connection of standard 20 m long test leads

Step 4

- Press the **START** key and keep it pressed, until result is stabilized, then release the key. Last result will stay displayed.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In case of present external voltage higher than 19 V a.c./d.c. between H and E or ES and S test terminals, the Earth Resistivity measurement will not be carried out after pressing **START** key, but the voltage will be displayed, equipped with “!” mark! Beep warning sound will be effected too!
- If resistance of current or potential probe is too high ($>(4 \text{ k } \Omega + 100 \text{ RE})$ or $>50 \text{ k}\Omega$, whichever is lower), test result will be equipped with “!” mark and
- **rC** or **rP** message. If resistance of both (current and potential) probes is too high, **rCP** message will be displayed.
- If test result is out of measurement range (for example open test leads), then **>999 kWm** ($a < 8\text{m}$) / **>1999 kWm** ($a \geq 8\text{m}$) or **> 999 kWft** ($a < 8\text{ft}$) / **>1999 kWft** ($a \geq 8\text{m}$) message will be displayed!
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.7. Current (True RMS)

For general information concerning the measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

Warning!

- Do not attach any external voltage between C1 and C2(P) test terminals!

How to carry out the measurement ?

Step 1

- Connect current / current (1000:1) test clamp to Earth - Insulation Tester, see the figure 27. Be aware that low-range test clamp, supplied by METREL, can cover the range 0,5 mA up to 200 A, while standard-range test clamp can measure within 10 mA and 200 A.
- Set function switch to **CURRENT (clamp)** position, the following menu will be displayed:

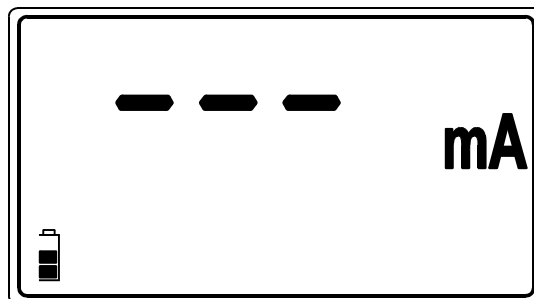


Fig 26. Current function initial menu

Step 2

- Connect test clamp** to tested object, according to the figure below.

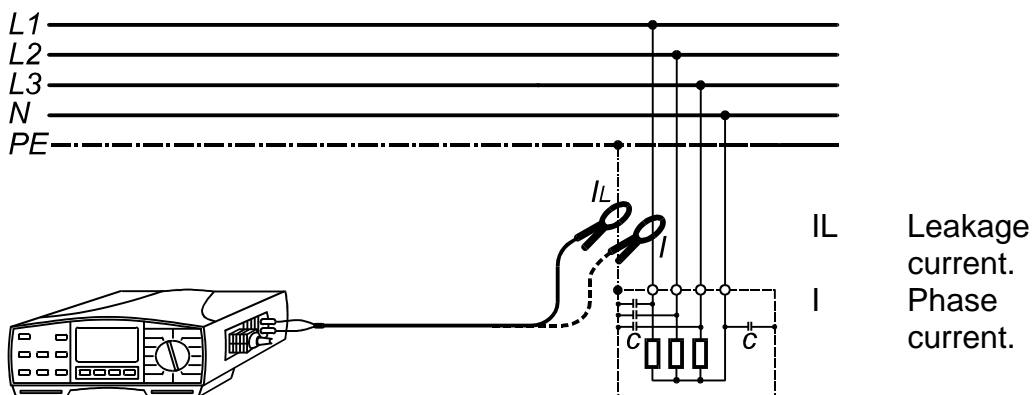


Fig. 27. Connection of test clamp

Step 3

- Press the **START** key and release it. Measurement starts to run (continuous measurement), result is currently displayed.
- Press the **START** key again after finishing the current measurement, last result will stay displayed.
- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Note!

- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.

3.8. Varistor Over-voltage Protection Devices

For general information concerning the measurement, refer to enclosed handbook **Measurements on electric installations in practice and theory**.

How to carry out the Breakdown voltage measurement ?

Step 1

- Connect Split test leads to Earth - Insulation Tester.
- Set function switch to **varistor TEST** position, the following menu will be displayed:

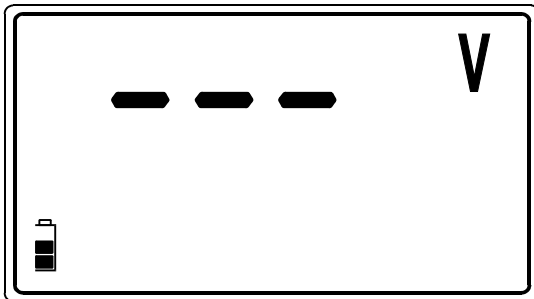


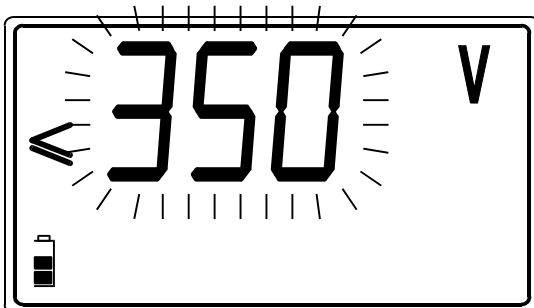
Fig. 28. Varistor Test initial menu

Step 2

- Set **High Limit Breakdown Varistor Voltage**. Later will test results be compared with the set limit value and, if higher, they will be equipped with “!” mark.

How to set the High Limit Value ?

- Press the **SELECT** key, to enter “High Limit Value adjustment mode”, the following menu will appear:



Last set High limit value is blinking.

Available values (V)	Step (V)
0 ÷ 1000	10

Fig. 29. High limit value adjustment menu and the table of available limit values

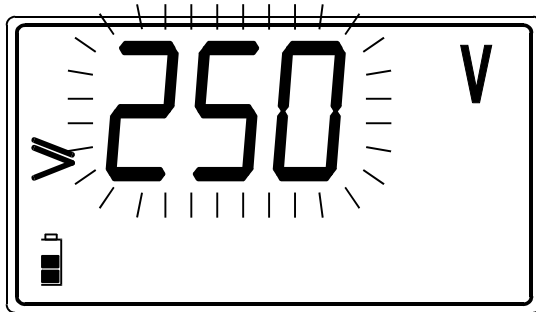
- Use the $-$ and $+$ keys, to set required High Limit Value. Individual strike will increase/decrease the value for one step, while continuous pressure will increase/decrease it continuously. If test results are not to be compared with High Limit Value at all, then press the **CLR** key, **no** will be displayed instead of set value.

Step 3

- Set **Low Limit Breakdown Varistor Voltage**. Later will test results be compared with the set limit value and, if lower, they will be equipped with “!” mark.

How to set the Low Limit Value ?

- Press the **SELECT** after setting the High Limit Value, to enter “Low Limit Value adjustment mode”, the following menu will be displayed:



Last set Low limit value is blinking.

Available values (V)	Step (V)
0 ÷ 1000	10

Fig. 30. Low limit value adjustment menu and the table of available limit values

- Use the $-$ and $+$ keys, to set required Low Limit Value. Individual strike will increase/decrease the value for one step, while continuous pressure will increase/decrease it continuously. If test results are not to be compared with Low Limit Value at all, then press the **CLR** key, **no** will be displayed instead of set value.
- Press the **SELECT** key again after setting the limit values, to return to “Varistor Test initial menu”.

Step 4

- Connect Split test leads** to tested Varistor Over-voltage Protection Device, according to the figure below.

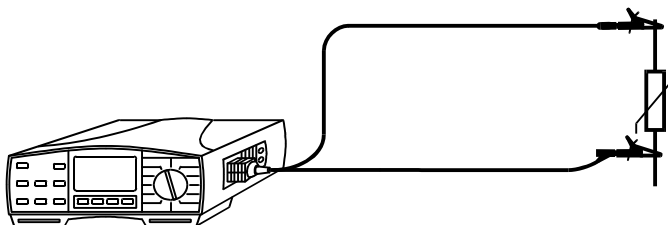


Fig. 31. Connection of Split test leads

Step 5

- Press the **START** key and release it. Test voltage starts to rise (500 V/s) and as soon as varistor's forward current reaches the value of 1 mA (Breakdown Voltage is defined at that current), the voltage will be displayed. Generator will stop to generate test voltage.
- Check the Breakdown voltage scaled to a.c. value called Uac presing the **DISPLAY** key. **Uac = Ubreakdown (main result) / 1,6**

Meaning of the Uac voltage:

Protection devices intended for a.c. network are usually dimensioned approx. 20% of nominal mains voltage above peak value of nominal mains voltage.

Example:

Nominal mains voltage $U_n = 230V$

$U_{peak} = 230V \cdot 1,41 = 324V$

$U_{breakdown} = (U_{peak} + 0,2 \cdot U_n) \cong U_n \cdot 1,6 = 368V$

Uac voltage may be directly compared with the voltage declared on tested protection device.

- Store displayed result for documentation purpose, see instructions how to store it in chapter 4.1. Storing of test results .

Notes!

- In order test result not to be influenced by connected loads, tested Over-voltage Device must be removed from installation, before testing it.
- If the Over-voltage Protection Device to be tested, is not possible to be removed from installation (permanent connection), make sure to disconnect all other elements connected to installation, which may influence on test result.
- **bat** message, displayed during or after finishing the measurement, means, batteries are too weak to guarantee correct result. Replace the batteries.





4. Memory and other operations

4.1. Storing of test results

All test results can be stored, for later documentation purpose except Voltage and CONTINUITY measurements (auxiliary functions).

How to store displayed test result?

Once test result is displayed, the following procedure is to be realized:

-  Last used MEM code is offered (blinking).
-   Select MEM code, where result is to be stored to. MEM = 1 up to 255 can be selected.
-  Store displayed result under selected MEM code.

Result is thus stored, note down used MEM code for later recognition of stored result. Main result, potential subresults and potential function parameters as well as Function identification number (see the figure below) are stored, whenever “Store” procedure is effected.

More test results (regardless of test function) can be stored under the same MEM code. This will be done simply, effecting double click to **SAVE** key.

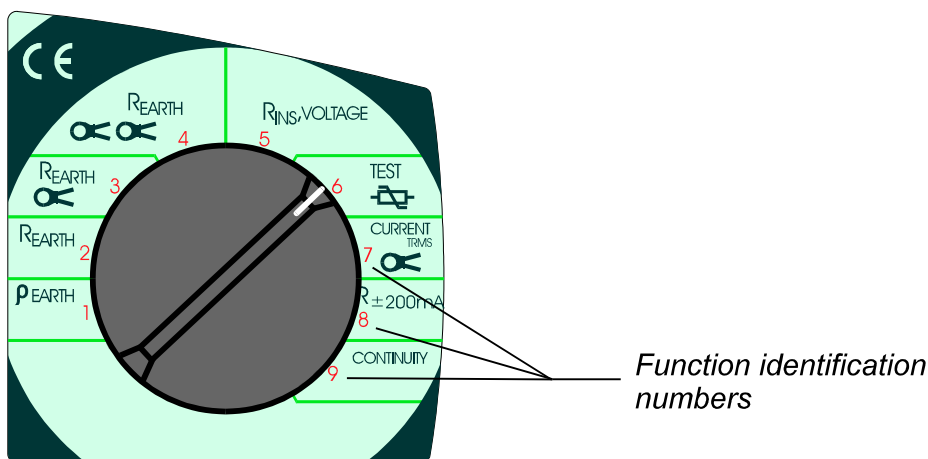


Fig. 32. Function identification numbers

Notes!

Each result can be stored only once.

FUL message will be displayed in case all memory locations are occupied.

4.2. Recalling of stored results

Stored results can be displayed whenever needed for visual check. Main result, potential subresult and potential function parameter can be recalled.

How to recall stored results?



MEM code will be offered (blinking). Function identification number of last result, stored under offered MEM code, will be displayed.



Set MEM code, Function identification number will follow set MEM code currently.



MEM code will stop blinking.



Check main result, subresult and function parameter, hidden behind displayed Function identification number.



Move to other test results, stored under the same MEM code. Function identification number must be displayed (set by **DISPLAY** key), before using the \uparrow and \downarrow keys.



Check main result, subresult and function parameter, hidden behind displayed Function identification number.



MEM code starts blinking again, repeat the whole procedure, to recall results, stored under other MEM codes.

If there is no stored result at all, **no** message will be displayed for a while, after pressing RCL key.

If there is no stored result under set MEM code, **no** message will be displayed for a while whenever the code is changed.

Organisation of memory locations, under a certain MEM code, is presented on the figure below.

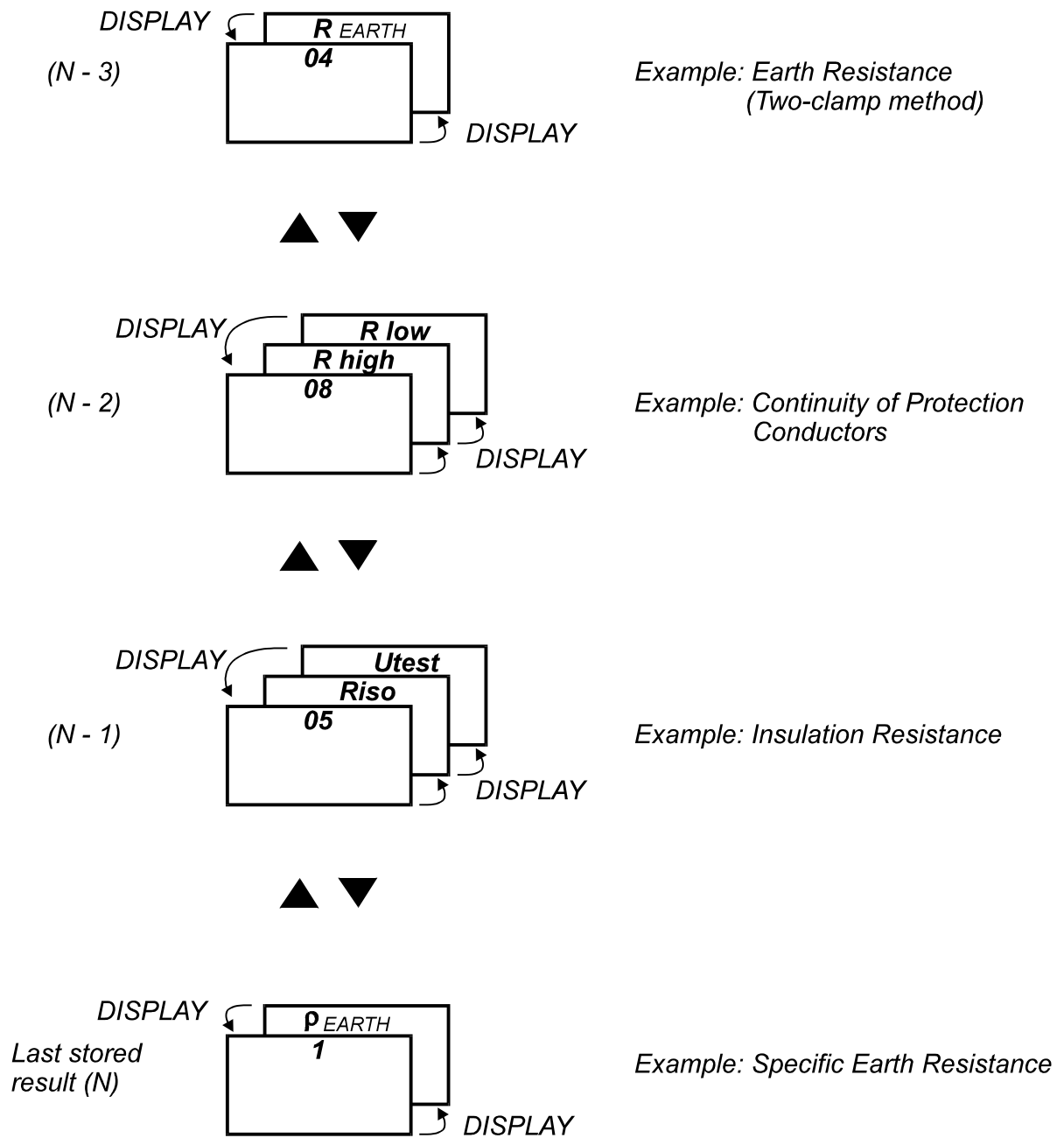


Fig. 33. Organisation of memory locations

4.3. Erasing of stored results

Two modes of erasing stored results are available namely:

All stored results can be erased in one step

A certain stored result only, can be erased

How to erase all stored results?

Press the **CLR** key, **Clr ALL MEM** message starts to blink. Confirm erasing, pressing the **CLR** key again, all stored results will be erased.

How to erase only a certain stored result?

Recall a certain result to be erased, following the procedure described in paragraph **4.2. Recalling of stored results.**

Press the **CLR** key, **Clr MEM** message starts to blink. Confirm erasing, pressing the **CLR** key again. Only result, displayed before **CLR** key was pressed, will be erased.

The procedure may be repeated, in order to erase other stored results too.

4.4. RS 232 communication

Stored results can be transferred to PC, where final test protocol will be formed. PC SW **EarthIso – Link** (enclosed in Standard set) is needed for this operation.

How to transfer stored results?

Connect the Earth – Insulation Tester to PC as shown on the figure below.

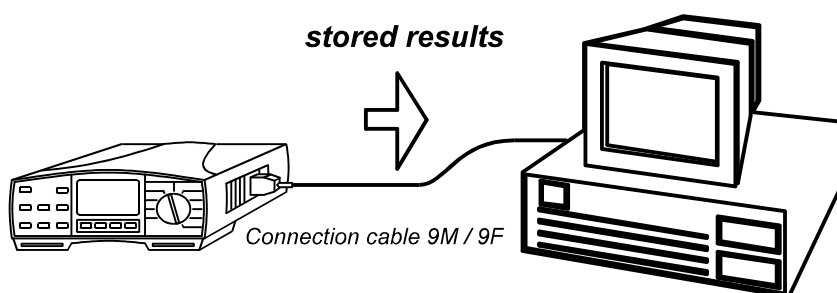


Fig. 34. Connection of the Earth – Insulation Tester to PC

Instal and run PC SW **Earth – Link**.

Set the Earth – Insulation Tester to RS232 mode, pressing the **RS232** key.

Use the **EarthIso – Link** commands on PC, to transfer stored results from Earth – Insulation Tester to PC.

4.5. Reset of the instrument

If any malfunction is noticed when dealing with the Earth – Insulation Tester, it is advisable **RESET** of the instrument to be carried out. In that case all settable parameters will be set to their initial values, see the table below. Stored results will not be erased.

How to reset the instrument?

Switch OFF the instrument.

Press the **CLR** key and keep it pressed, while switching ON the instrument. **RES** message will be displayed for a while, meaning RESET function has been completed.

Parameter	Function	Initial value
Compensation of test leads	R±200mA	Annuled
Distance “a” between test rods	ρEARTH	1m /1ft
High limit of RE value	all REARTH functions	no
Test voltage	R INS	500 V
Low limit of RINS value	R INS	no
High limit of Breakdown voltage	varistor TEST	no
Low limit of Breakdown voltage	varistor TEST	no
High limit R value	R±200mA	no

Table 1. Initial values of settable parameters

Note!

- After performing reset function (**CLR** key), the instrument will automatically enter “Frequency” and “Unit selection” procedure, see the next page.

4.6. General settings

Usually, there are noise voltages/currents present on measured objects, caused by mains voltage somewhere in near or far neighbourhood. Mains voltage frequency is different in different countries (50 Hz in European countries etc., 60 Hz in the United States etc.). In order, test results to be stable and correct, regardless of present noise, it is necessary to insert nominal frequency of mains system. On basis of set frequency will the Earth – Insulation Tester automatically adjust integrating timing, in order to reach high immunity against mains noise.

The frequency once set, will stay set, even after replacing batteries.

How to insert the frequency of mains voltage (50/60 Hz) and the unit of Specific Earth Resistance parameter (Wm/Wft)?

- Switch OFF the instrument.
- Press the **SELECT** key and keep it pressed while switching ON the instrument, until **50** or **60** value (last selected) starts to blink. Select appropriate frequency of mains voltage using the - or $\bar{\quad}$ key.
- Press the **SELECT** key, unit **m** or **ft** (last selected), used in Earth Resistivity measurement, starts to blink. Select appropriate unit using the - or $\bar{\quad}$ key.
- Press the **SELECT** key again, to abandon “Frequency” and “Unit selection menu”, the instrument is ready for regular measurements.

New selection is also offered after each resetting of the instrument, see the procedure in chapter **4.5.Reset of the instrument!**

5. Maintenance

5.1. Batteries



- Disconnect test cable and switch off the instrument, before removing battery compartment cover!



- Hazardous voltage under the battery compartment cover!

Battery condition is currently displayed, see the battery condition mark in the left upper corner of display. Fully dark battery mark presents full-capacity batteries. Follow the battery condition even during carrying out measurements. Results obtained with low battery voltage (the results may be incorrect) will be marked with **bat** mark after finishing the measurement.

Replace all four batteries, when the battery mark is empty in static mode (no measurement is running) or when the battery mark trips to empty frame just temporarily, while a measurement is running!

Nominal power supply voltage is 6 Vd.c.. Use four 1,5 V alkaline batteries, type IEC LR14 (dimensins: diameter = 26 mm, hight = 50 mm).

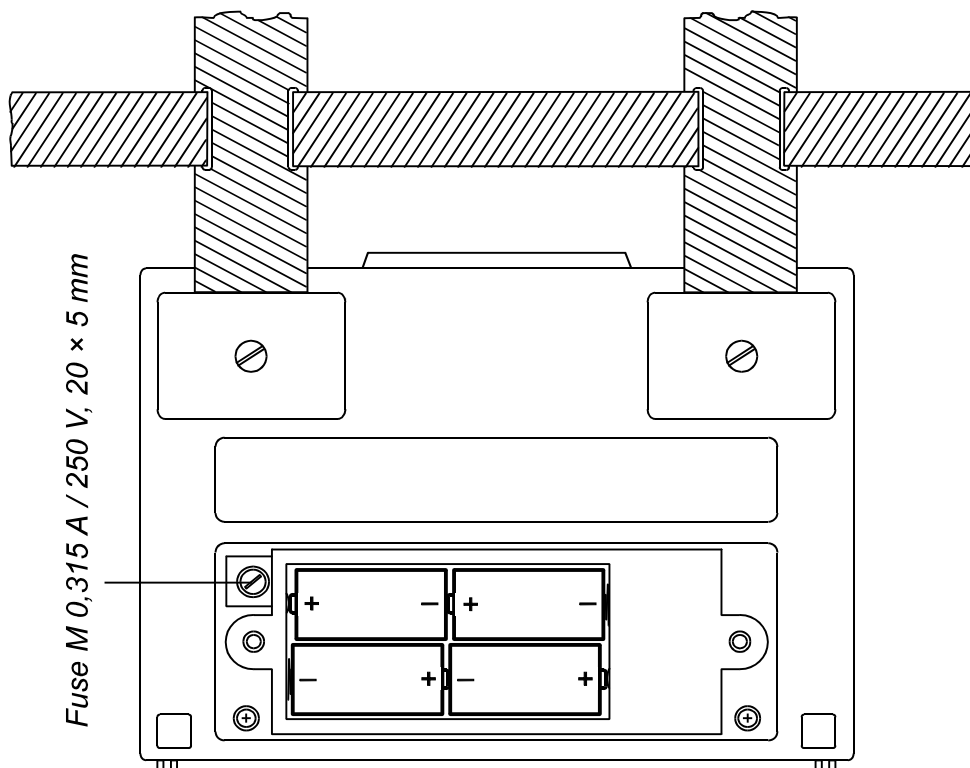


Fig. 35. Correct polarity of inserted batteries

One set of full-capacity batteries can supply the instrument approx. 50 hours at the ratio measurement / pause = 5s / 25s.

Notes!

- Insert batteries correctly, otherwise test instrument will not operate and batteries may be discharged, see the figure 35. for correct battery polarity.
- Transfer stored results to PC, before removing the batteries!
- The results will be lost, when the batteries are removed and all settable parameters will be set to their initial values after replacing the batteries, see the paragraph 4.5. Reset of the instrument!

In order not to loose stored data, follow the next procedure, when replacing the batteries:

- Switch OFF the instrument.
- Replace the batteries within one minute.
- Switch ON the instrument, **Clr mem** message will not be displayed, indicating stored data has not been erased.

5.2. Fuses

There is one fuse under battery compartment cover (see the figure 35.). It is intended to protect internal circuitry of the test instrument, if test tips are connected to mains voltage by mistake, when function switch in **R ±200mA** or **CONTINUITY** position.

Fuse type: **M 0,315A/250V**, 20 × 5 mm

Check the fuse if **"FUS"** message is displayed.

Warning!

- Replace blown fuse with original one only, otherwise the instrument may be damaged and/or operator's safety impaired!

5.3. Cleaning

Use soft patch, slightly moistened with soap water or alcohol, to clean the surface of Earth - Insulation Tester 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!

5.4. Periodic calibration

It is essential, that all measurement instruments are 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 that calibration is carried out every sixth months.

5.5. Service

Repairs under or out of warranty time: Please contact your distributor for further information.

Distributor's address:

Producer's address:

METREL d.d.
Ljubljanska 77
SI-1354 Horjul

Tel.: +386 1 75 58 200
Fax.: +386 1 75 49 226
E-mail: metrel@metrel.si
<http://www.metrel.si>

Unauthorised person is not allowed to open the Earth - Insulation Tester. There are no user replacable components inside the instrument, except the fuse, refer to paragraph **5.2. Fuses.**

6. Technical specification

6.1. Functions

Insulation Resistance

Meas. range Riso (Un ≥ 250V) .. (0,008 ÷ 29,9k)MΩ

Display range Riso (Ω) Un ≥ 250V	Resolution (MΩ)	Accuracy*
0,000M ÷ 1,999M	0,001	±(2% of r. + 2D)
2,00M ÷ 19,99M	0,01	
20,0M ÷ 199,9M	0,1	
200M ÷ 1999M	1	±(1% of r. /
2,00G ÷ 19,99G	10	1GΩ of r. +
20,0G ÷ 29,9G	100	2% of r. +2D)

*Specified accuracy is valid, if **Universal test cable** is used, while it is valid up to 200 MΩ , if **Tip Commander** is used.

Meas. range Riso (Un < 250V) .. (0,012 ÷ 199,9)MΩ

Display range Riso (Ω) Un < 250V	Resolution (MΩ)	Accuracy
0,000M ÷ 1,999M	0,001	±(5% of r. + 3D)
2,00M ÷ 19,99M	0,01	
20,0M ÷ 199,9M	0,1	

Display range Test voltage (V)	Resolution (V)	Accuracy
0 ÷ 1200	1	±(2% of r. + 3D)

Nom. test voltage...50 ÷ 1000Vd.c. in steps of 10 V
 Current capability of test generator
 (at Utest. > Un)>1mA
 Short-circuit test current<3 mA
 Automatic discharge of tested object.....yes

Continuity of protection conductors

Meas. range R(0,08 ÷ 1999)Ω

Display range R (Ω)	Resolution (Ω)	Accuracy
0,00 ÷ 19,99	0,01	±(2% of r. + 2D)
20,0 ÷ 199,9	0,1	±(3% of r.)
200 ÷ 1999	1	

Open-terminal test voltage4 - 7 Vd.c.
 Short-circuit test current> 200 mA
 Compensation of test leads (up to 5 Ω).....yes
 Sound signal.....yes
 Automatic polarity exchangeyes
 Measurement mode.....single measurement

Continuity

Display range R (Ω)	Resolution (Ω)	Accuracy
0,0 ÷ 199,9	0,1	±(3% of r. + 3D)
200 ÷ 1999	1	

Open-terminal test voltage.....4 - 7 Vd.c.
 Short-circuit test current..... < 7 mA
 Sound signal (R > 20Ω) yes
 Measurement mode continuous measurement

Earth Resistance four–lead method

Meas. range RE(0,11 ÷ 19,99k)Ω

Display range (Ω)	Resolution (Ω)	Accuracy
0,00 ÷ 19,99	0,01	±(2% of r. + 3D)
20,0 ÷ 199,9	0,1	
200 ÷ 999	1	
1,000 ÷ 1,999	1	±(5% of r.)
2,00k ÷ 19,99k	10	

Additional spike resistance error
 at Rc max. or Rp max. ±(3% of r. + 10D)
 Rc max..... (4kΩ + 100RE) or
 50kΩ (whichever is lower)
 Rp max..... (4kΩ + 100RE) or
 50kΩ (whichever is lower)

Additional error
 at 10 V voltage noise (50 Hz) ±(5% of r. +10D)
 Open-terminal test voltage.....40 Va.c.
 Test voltage shape..... sine wave
 Test voltage frequency..... 125/150 Hz
 Short-circuit test current..... < 20 mA
 Automatic test of current and
 potential test probe resistance yes
 Automatic test of voltage noise yes

Earth Resistance using one clamp in combination with four – lead method

All technical data listed under four-lead method are valid, except display and meas. ranges, see adapted ones below.

Meas. range RE(0,11 ÷ 1,99k)Ω

Display range	Resolution	Accuracy
---------------	------------	----------

(Ω)	(Ω)	
0,00 ÷ 19,99	0,01	±(2% of r. + 3D)
20,0 ÷ 199,9	0,1	
200 ÷ 999	1	
1,00k ÷ 1,99k	10	

Additional specification:

Additional error at lowest noise current where **nC** indication is already displayed (valid at max. ratio $R_{tot}/R_{part} = 1/2$)±(10% of r. + 10D)
 Noise current indication **nC**>2,4A approx.

Additional error

of resistance ratio $R_{partial}/R_{total} \cdot 1\%$

$R_{partial}$ = resistance measured with clamp

R_{total} = resistance of earthig system

Indication in case of low clamp current< 0,5 mA

Automatic test of noise currentyes

Additional clamp error is to be considered.

Earth Resistance using two clamps

Meas. range R_E (0,08 ÷ 100)Ω

Display range R_E (Ω)	Resolution (Ω)	Accuracy*
0,00 ÷ 19,99	0,01	±(10% of r. +2D)
20,0 ÷ 100,0	0,1	±(20% of r.)

*Distance between test clamps >30 cm

Additional error at lowest noise current where **nC** indication is already displayed...±(10% of r. + 10D)

Noise current indication **nC** starts to be displayed at..... $I_{noise} / I_{signal} > 100$

Additional clamp error is to be considered.

Specific Earth Resistance (resistivity)

All technical data listed under four-lead method are valid, except display range table, see adapted one below.

Display range ρ (Ωm)	Resolution (Ωm)	Accuracy
0,00 ÷ 19,99	0,01	Consider accuracy of R_E measurement $\rho = 2\pi a R_E$
20,0 ÷ 199,9	0,1	
200 ÷ 1999	1	
2,00k ÷ 19,99k	10	
20,0k ÷ 199,9k	0.1k	
200k ÷ 999k (a < 8m)	1k	
200k ÷ 1999k (a ≥ 8m)		

Display range ρ (Ωft)	Resolution (Ωft)	Accuracy
0,00 ÷ 19,99	0,01	
20,0 ÷ 199,9	0,1	
200 ÷ 1999	1	
2,00k ÷ 19,99k	10	
20,0k ÷ 199,9k	0.1k	
200k ÷ 999k (a < 8ft)	1k	
200k ÷ 1999k (a ≥ 8ft)		

Distance between test rods1 up to 30 m or
1 up to 60 ft

Voltage a.c./d.c.

Display range U (V)	Resolution (V)	Accuracy
0 ÷ 600	1	±(2% of r. + 2D)

Nominal frequency range.....45 – 65 Hz, d.c.

Current (True RMS)

Display range I (A)	Resolution (A)	Accuracy
0,0m ÷ 99,9m	0,1m	±(5% of r. + 3D)
100m ÷ 999m	1m	
1,00 ÷ 9,99	0,01	
10,0 ÷ 99,9	0,1	
100 ÷ 200	1	

Input resistance..... 10Ω/1W

Measurement principle..... current clamp 1A/1mA

Nominal frequency 50/60 Hz

Additional clamp error is to be considered.

Varistor over-voltage protection devices – Breakdown voltage

Display range U (V)	Resolution (V)	Accuracy
0 ÷ 1000	1	±(5% of r. + 10V)

Measurement principle..... d.c.voltage ramp

Test voltage slope.....500 V/s

Treshold current.....1 mA

6.2. General characteristics

Power supply .. 6 Vd.c. (4 x 1,5V battery IEC LR14)	Protection classification double insulation
Automatic comparison of test result with set high and low limit valueyes	Over-voltage chateg. .. CATIII/300V or CATII/600 V
Vizual and sound warnings.....yes	Polution degree..... 2
Dimensions (w x h x d)..... 26,5 x 11 x 18,5 cm	Degree of protectionIP 44
Weight (without accessories, with batteries) .. 1,7kg	Working temp. range..... 0 ÷ 40 °C
Display LCD with backlight	Nominal (reference) temp. range..... 10 ÷ 30 °C
Memories over 1000 measurements	Max. humidity 85 % RH (0 ÷ 40°C)
Computer connection RS 232	Nominal (reference) hum. range..... 40 ÷ 60 % RH
	Auto power off..... yes

