EurotestXC

MI 3152

EurotestXC 2,5 kV

MI 3152H

Instruction manual

Version 1.5.9, Code no. 20 752 411

METREL®

Distributor:

Manufacturer:

METREL d.d.
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1354 Horjul
Slovenia
web site: http://www.metrel.si
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CE	Mark on your equipment certifies that it meets requirements of all subjected EU regulations

i. About the Instruction manual

- This Instruction manual contains detailed information on the EurotestXC, its key features, functionalities and use.
- It is intended for technically qualified personnel responsible for the product and its use.
- Please note that LCD screenshots in this document may differ from the actual instrument screens in details due to firmware variations and modifications.

Table of Contents

1 General description

1.1 Warnings and notes

Read before use

1.1.1 Safety warnings

In order to reach high level of operator safety while carrying out various measurements using the EurotestXC instrument, as well as to keep the test equipment undamaged, it is necessary to consider the following general warnings:

- **Read this Instruction manual carefully, otherwise the use of the instrument may be dangerous for the operator, the instrument or for the equipment under test!**
- **Consider warning markings on the instrument (see next chapter for more information).**
- **If the test equipment is used in a manner not specified in this Instruction manual, the protection provided by the equipment could be impaired!**
- **Do not use the instrument or any of the accessories if any damage is noticed!**
- **Regularly check the instrument and accessories for correct functioning to avoid hazard that could occur from misleading results.**
- **Consider all generally known precautions in order to avoid risk of electric shock while dealing with hazardous voltages!**
- **Always check for the presence of dangerous voltage on PE test terminal of installation by touching the TEST key on the instrument or by any other method before starting single test and Auto Sequence® measurements. Make sure that the TEST key is grounded thorough human body resistance without any insulated material between (gloves, shoes, insulated floors, pens,...). PE test could otherwise be impaired and results of a single test or Auto Sequence® can mislead. Even detected dangerous voltage on PE test terminal cannot prevent running of a single test or Auto Sequence®. All such behaviour is regarded as misuse. Operator of the instrument must stop the activity immediately and eliminate the fault/connection problem before proceeding with any activity!**
- **Use only standard or optional test accessories supplied by your distributor!**
- **In case a fuse has blown follow the instructions in this manual in order to replace it! Use only fuses that are specified!**
- **Service, calibration or adjustment of instruments and accessories is only allowed to be carried out by a competent authorized person!**
- **Do not use the instrument in AC supply systems with voltages higher than 550 Va.c.**
- **Consider that protection category of some accessories is lower than of the instrument. Test tips and Tip commander have removable caps. If they are removed the protection falls to CAT II. Check markings on accessories!**
    - **cap off, 18 mm tip: CAT II up to 1000 V**
    - **cap on, 4 mm tip: CAT II 1000 V / CAT III 600 V / CAT IV 300 V**

- **The instrument comes supplied with rechargeable Ni-MH battery cells. The cells should only be replaced with the same type as defined on the battery compartment label or as described in this manual. Do not use standard alkaline battery cells while the power supply adapter is connected, otherwise they may explode!**
- **Hazardous voltages exist inside the instrument. Disconnect all test leads, remove the power supply cable and switch off the instrument before removing battery compartment cover.**
- **Do not connect any voltage source on C1/C2 inputs. It is intended only for connection of current clamps. Maximal input voltage is 3 V!**

1.1.2 Markings on the instrument

- **Read the Instruction manual with special care to safety operation«. The symbol requires an action!**
- **Do not use the instrument in AC supply systems with voltages higher than 550 Va.c.!**
- **Mark on your equipment certifies that it meets requirements of all subjected EU regulations.**
- **This equipment should be recycled as electronic waste.**

1.1.3 Warnings related to safety of batteries

- When connected to an installation, the instruments battery compartment can contain hazardous voltage inside! When replacing battery cells or before opening the battery/fuse compartment cover, disconnect any measuring accessory connected to the instrument and turn off the instrument,
- Ensure that the battery cells are inserted correctly otherwise the instrument will not operate and the batteries could be discharged.
- Do not recharge alkaline battery cells!
- Use only power supply adapter delivered from the manufacturer or distributor of the test equipment!

1.1.4 Warnings related to safety of measurement functions

Insulation resistance

- Insulation resistance measurement should only be performed on de-energized objects!
- Do not touch the test object during the measurement or before it is fully discharged! Risk of electric shock!

Continuity functions

- Continuity measurements should only be performed on de-energized objects!

1.1.5 Notes related to measurement functions

Insulation resistance

- The measuring range is decreased if using Plug commander.
- If a voltage of higher than 30 V (AC or DC) is detected between test terminals, the measurement will not be performed.

Diagnostic test

- If any insulation resistance values (R_{ISO}*(15 s) or* R_{ISO}*(60 s)) are over-ranged the* **DAR** factor is not calculated. The result field is blank: DAR:_____!
- If any insulation resistance values (R_{ISO}*(60 s) or* R_{ISO}*(10 min)) are over-ranged the* **PI** factor is not calculated. The result field is blank: PI :_____!

R low, Continuity

- If a voltage of higher than 10 V (AC or DC) is detected between test terminals, the measurement will not be performed.
- Parallel loops may influence on test results.

Earth, Earth 2 clamp, Ro

- If voltage between test terminals is higher than 10 V (Earth, Earth 2 clamps) or 30 V (Ro) the measurement will not be performed.
- Contactless earthing resistance measurement (using two current clamps) enables simple testing of individual earthing rods in large earthing system. It is especially suitable for use in urban areas because there is usually no possibility to place the test probes.
- For two clamps earth resistance measurement clamps A 1018 and A 1019 should be used. Clamps A 1391 are not supported. The distance between clamps should be at least 30 cm.
- For specific earth resistance measurements ρ Adaptor A 1199 should be used.

RCD t, RCD I, RCD Uc, RCD Auto

- Parameters set in one function are also kept for other RCD functions!
- Selective (time-delayed) RCDs have delayed response characteristics. As the contact voltage pre-test or other RCD tests influence the time delayed RCD it takes a certain period to recover into normal state. Therefore a time delay of 30 s is inserted before performing trip-out test by default.
- Portable RCDs (PRCD, PRCD-K and PRCD-S) are tested as general (non-delayed) RCDs. Trip-out times, trip-out currents and contact voltage limits are equal to limits of general (non-delayed) RCDs.
- The a.c. part of MI and EV RCDs is tested as general (non-delayed) RCDs.
- The d.c part of MI and EV RCDs is tested with a d.c. test current. The Pass limit is between 0.5 and 1.0 IdN_{DC}.
- The Zs rcd function takes longer to complete but offers much better accuracy of fault loop resistance (in comparison to the R_L sub-result in Contact voltage function).
- Auto test is finished without x5 tests in case of testing the RCD types A, F, B and B+ with rated residual currents of I_{dN} = 300 mA, 500 mA, and 1000 mA or testing the RCD type AC with rated residual current of I_{dN} = 1000 mA . In this case Auto test result passes if all other results pass, and indications for x5 are omitted.
- Auto test is finished without x1 tests in case of testing the RCD types B and B+ with rated residual currents of I_{dN} = 1000 mA. In this case Auto test result passes if all other results pass, and indications for x1 are omitted (MI 3152 only).
- Tests for sensitivity Idn(+) and Idn(-) are omitted for selective type RCD.

- Trip out time measurement for B and B+ type RCDs in AUTO function is made with sine-wave test current, while trip-out current measurement is made with d.c. test current (MI 3152 only).

Z loop, Zs rcd

- The specified accuracy of tested parameters is valid only if the mains voltage is stable during the measurement.
- The measurement accuracy and immunity against noise are higher if **I test** parameter in Zsrcd is set to 'Standard'.
- Fault loop impedance (Z loop) measurements will trip an RCD.
- The Zs rcd measurement does not normally trip an RCD. However if a leakage current from L to PE already flows or if a very sensitive RCD is installed (for example EV type) the RCD could trip. In this case setting parameter **I test** to 'Low' can help.

Z line, Voltage drop

In case of measurement of $Z_{Line-Line}$ with the instrument test leads PE and N connected together the instrument will display a warning of dangerous PE voltage. The measurement will be performed anyway.

- Specified accuracy of tested parameters is valid only if mains voltage is stable during the measurement.
- If the reference impedance is not set the value of Z_{REF} is considered as 0.00 Ω.
- The highest value of Zref, measured at different settings of the **Test** or **Phase** parameters is used for Voltage drop (ΔU) measurement in Voltage drop single test, Zauto single test, auto tests and Auto Sequences®.
- Measuring Zref without test voltage present (disconnected test leads) will reset Zref value to initial value.

Power, Harmonics, Currents

- Consider polarity of current clamp (arrow on test clamp should be oriented toward connected load), otherwise result will be negative!

Illumination

- A 1172 and A 1173 illumination probes are supported by the instrument.
- Artificial light sources reach full power of operation after a period of time (see technical data for light sources) and should be therefore switched on for this period of time before the measurements are taken.
- For accurate measurement make sure that the milk glass bulb is lit without any shadows cast by hand, body or other unwanted objects.
- Refer to the Illuminance handbook -for more information.

Rpe

- The specified accuracy of tested parameters is valid only if the mains voltage is stable during the measurement.
- Measurement will trip an RCD if the parameter RCD is set to 'No'.
- The measurement does not normally trip an RCD if the parameter RCD is set to 'Yes'. However, the RCD can trip if a leakage current from L to PE already flows.

IMD

- It is recommended to disconnect all appliances from the tested supply to receive regular test results. Any connected appliance will influence the insulation resistance threshold test.

Z line mΩ, Z loop mΩ

- A 1143 Euro Z 290 A adapter is required for this measurements.

AutoTT, Auto TN(RCD), Auto TN, Auto IT, Z auto

- Voltage drop (ΔU) measurement in each Auto test (except Z auto) is enabled only if Z_{REF} is set.
- See notes related to Z line, Z loop, Zs rcd, Voltage drop, Rpe, IMD and ISFL single tests.

Auto Sequences®

- Metrel Auto Sequences® are designed as guidance to tests in order to significantly reduce testing time, improve work scope and increase traceability of the tests performed. METREL assumes no responsibility for any Auto Sequence® by any means. It is the user's responsibility, to check adequacy for the purpose of use of the selected Auto Sequence®. This includes type and number of tests, sequence flow, test parameters and limits.
- See notes related to single tests of selected Auto Sequence®.
- Compensate test leads resistance before entering Auto Sequences®.
- Zref value for Voltage drop test (ΔU) implemented in any Auto Sequence® should be set in single test function.

1.2 Testing potential on PE terminal

In certain instances faults on the installation's PE wire or any other accessible metal bonding parts can become exposed to live voltage. This is a very dangerous situation since the parts connected to the earthing system are considered to be free of potential. In order to properly check the installation against this fault the  key should be used as an indicator prior to performing live tests.

Examples for application of PE test terminal

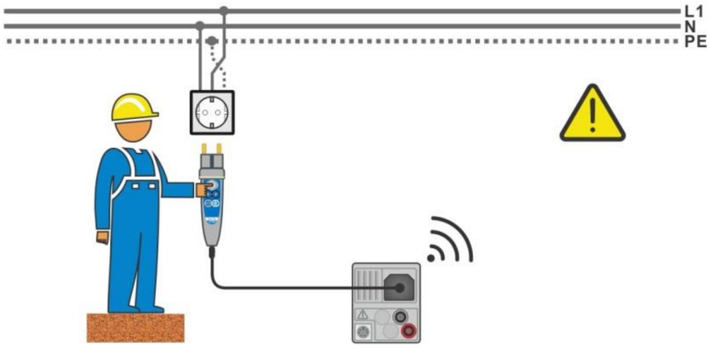


Figure 1.1: Reversed L and PE conductors (plug commander)

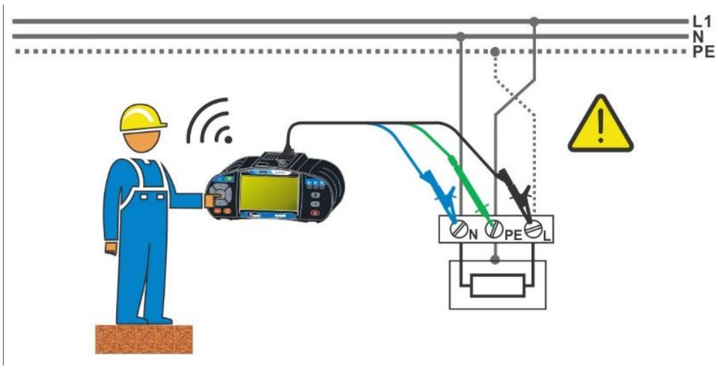


Figure 1.2: Reversed L and PE conductors (application of 3-wire test lead)

Warning!

Reversed phase and protection conductors! The most dangerous situation!
If dangerous voltage is detected on the tested PE terminal, stop all measurements immediately and ensure the cause of the fault is eliminated before proceeding with any activity!

Test procedure

- Connect test cable to the instrument.
- Connect test leads to the object under test, see ***Figure 1.1*** and ***Figure 1.2***.
- Touch  test probe for at least 2 seconds.
  If PE terminal is connected to phase voltage the warning message is displayed, display is yellow coloured, instrument buzzer is activated and further measurements are disabled in RCD tests, Rpe, Z loop, Zs rcd, Z auto, AUTO TT, AUTO TN, AUTO TN (rcd) and Auto Sequences®.

Notes

- PE test terminal is active in the RCD tests, Rpe, Z loop, Zs rcd, Z auto, Z line, ΔU, Voltage, AUTO TT, AUTO TN, AUTO TN (rcd) measurements and Auto Sequences® only!
- In case of detection of phase voltage on PE terminal in IT earthing system, the tests can be enabled/disabled according to setting of parameter 'Ignore PE warning (IT)'.
- For correct testing of PE terminal, the  key has to be touched for at least 2 seconds.
- Make sure that the TEST key is grounded thorough human body resistance without any insulated material between (gloves, shoes, insulated floors, pens, ...). PE test could otherwise be impaired and results of a single test or Auto Sequence® can mislead. Even detected dangerous voltage on PE test terminal cannot prevent running of a single test or Auto Sequence®. All such behaviour is regarded as misuse. Operator of the instrument must stop the activity immediately and eliminate the fault/connection problem before proceeding with any activity!

1.3 Battery and charging

The instrument uses six AA size alkaline or rechargeable Ni-MH battery cells. Nominal operating time is declared for cells with nominal capacity of 2100 mAh. Battery condition is always displayed in the upper right display part. In case the battery is too weak the instrument will be turned off automatically.

The battery is charged whenever the power supply adapter is connected to the instrument. Internal circuit controls charging and assures maximum battery lifetime.

Refer to chapters ***3.2 Connector panel*** and ***4.4.2 Battery indication*** for power socket polarity and battery indication.

Notes

- The charger in the instrument is a pack cell charger. This means that the battery cells are connected in series during the charging. The battery cells have to be equivalent (same charge condition, same type and age).
- If the instrument is not to be used for a long period of time, remove all batteries from the battery compartment.
- Alkaline or rechargeable Ni-MH batteries (size AA) can be used. METREL recommends only using rechargeable batteries with a capacity of 2100 mAh or above.
- Unpredictable chemical processes can occur during the charging of battery cells that have been left unused for a longer period (more than 6 months). In this case METREL recommends repeating the charge/discharge cycle at least 2-4 times.
- If no improvement is achieved after several charge / discharge cycles, then each battery cell should be checked (by comparing battery voltages, testing them in a cell charger, etc.). It is very likely that only some of the battery cells are deteriorated. One different battery cell can cause an improper behaviour of the entire battery pack!
- The effects described above should not be confused with the normal decrease of battery capacity over time. Battery also loses some capacity when it is repeatedly charged / discharged. This information is provided in the technical specification from battery manufacturer.

1.4 Standards applied

The EurotestXC instruments are manufactured and tested in accordance with the following regulations:

Electromagnetic compatibility (EMC)	
EN 61326-1	Electrical equipment for measurement, control and laboratory use – EMC requirements Class B (Hand-held equipment used in controlled EM environments)
Safety (LVD)	
EN 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements
EN 61010-2-030	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits
EN 61010-031	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test
EN 61010-2-032	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement
Functionality	
EN 61557	Electrical safety in low voltage distribution systems up to 1000 V_{AC} and 1500 V_{AC} – Equipment for testing, measuring or monitoring of protective measures Part 1: General requirements Part 2: Insulation resistance Part 3: Loop resistance Part 4: Resistance of earth connection and equipotential bonding Part 5: Resistance to earth Part 6: Residual current devices (RCDs) in TT and TN systems Part 7: Phase sequence Part 10: Combined measuring equipment Part 12: Performance measuring and monitoring devices (PMD)
DIN 5032	Photometry Part 7: Classification of illuminance meters and luminance meters
Reference standards for electrical installations and components	
EN 61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses
EN 61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses
IEC 60364-4-41	Electrical installations of buildings Part 4-41 Protection for safety – protection against electric shock
BS 7671	IEE Wiring Regulations (17th edition)
AS/NZS 3017	Electrical installations – Verification guidelines

2 Instrument set and accessories

2.1 Standard set MI 3152 EurotestXC

- Instrument MI 3152 EurotestXC
- Soft carrying bag
- Earth set 3-wire, 20 m
- Plug commander
- Test lead, 3 x 1.5 m
- Test probe, 3 pcs
- Crocodile clip, 3 pcs
- Set of carrying straps
- RS232-PS/2 cable
- USB cable
- Set of Ni-MH battery cells
- Power supply adapter
- CD with instruction manual, “Guide for testing and verification of low voltage installations” handbook and PC software Metrel ES Manager.
- Short instruction manual
- Calibration Certificate

2.2 Standard set MI 3152H EurotestXC 2,5 kV

- Instrument MI 3152H EurotestXC 2,5 kV
- Soft carrying bag
- Earth set 3-wire, 20 m
- Plug commander
- Test lead, 3 x 1.5 m
- 2.5 kV test lead, 2 x 1.5 m
- Test probe, 3 pcs
- Crocodile clip, 3 pcs
- Set of carrying straps
- RS232-PS/2 cable
- USB cable
- Set of Ni-MH battery cells
- Power supply adapter
- CD with instruction manual, “Guide for testing and verification of low voltage installations” handbook and PC software Metrel ES Manager.
- Short instruction manual
- Calibration Certificate

2.2.1 Optional accessories

See the attached sheet for a list of optional accessories that are available on request from your distributor.

3 Instrument description

3.1 Front panel

Figure 3.1: Front panel

1	**4,3“ COLOR TFT DISPLAY WITH TOUCH SCREEN**
2	**SAVE key** Stores actual measurement result(s)
3	**CURSOR keys** Navigate in menus
4	**RUN key** Start / stop selected measurement. Enter selected menu or option. View available values for selected parameter / limit.
5	**OPTIONS key** Show detailed view of options.
6	**ESC key** Back to previous menu.
7	**ON / OFF key** Switch instrument on / off. The instrument automatically switches off after 10 minutes of idle state (no key pressed or any touchscreen activity) Press and hold the key for 5 s to switch off the instrument.
8	**GENERAL SETTINGS key** Enter General settings menu.
9	**BACKLIGHT key** Toggle screen brightness between high and low intensity.
10	**MEMORY ORGANIZER key** Shortcut key to enter Memory organizer menu.
11	**SINGLE TESTS key** Shortcut key to enter Single Tests menu.
12	**AUTO SEQUENCE® key** Shortcut key to enter Auto Sequences® menu.

3.2 Connector panel

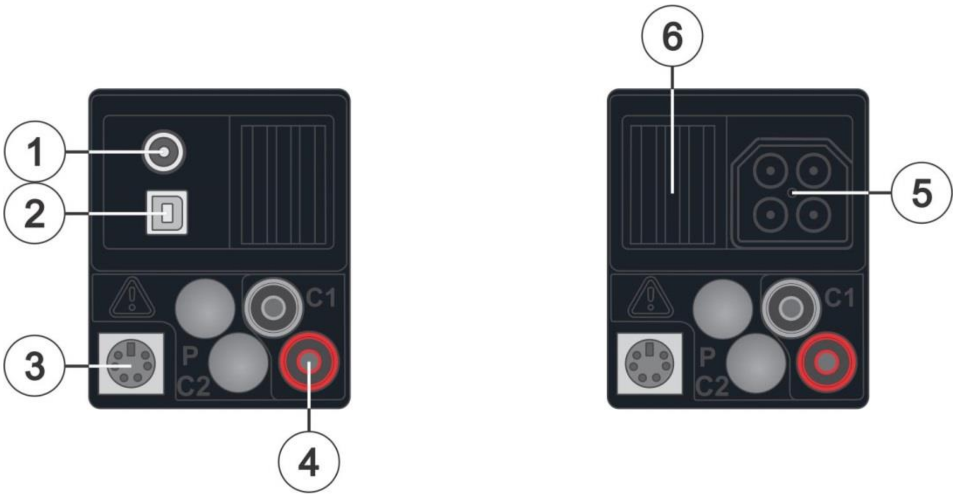


Figure 3.2: Connector panel

1	**Charger socket** 
2	**USB communication port** Communication with PC USB (2.0) port
3	**PS/2 communication port** Communication with PC RS232 serial port Connection to optional measuring adapters Connection to barcode / RFID reader
4	**C1 inputs** Current clamp measuring input
5	**Test connector**
6	**Protection cover**

Warnings!

- Maximum allowed voltage between any test terminal and ground is 550 V!
- Maximum allowed voltage between test terminals on test connector is 550 V!
- Maximum allowed voltage on test terminal C1 is 3 V!
- Maximum short-term voltage of external power supply adapter is 14 V!

3.3 Back side

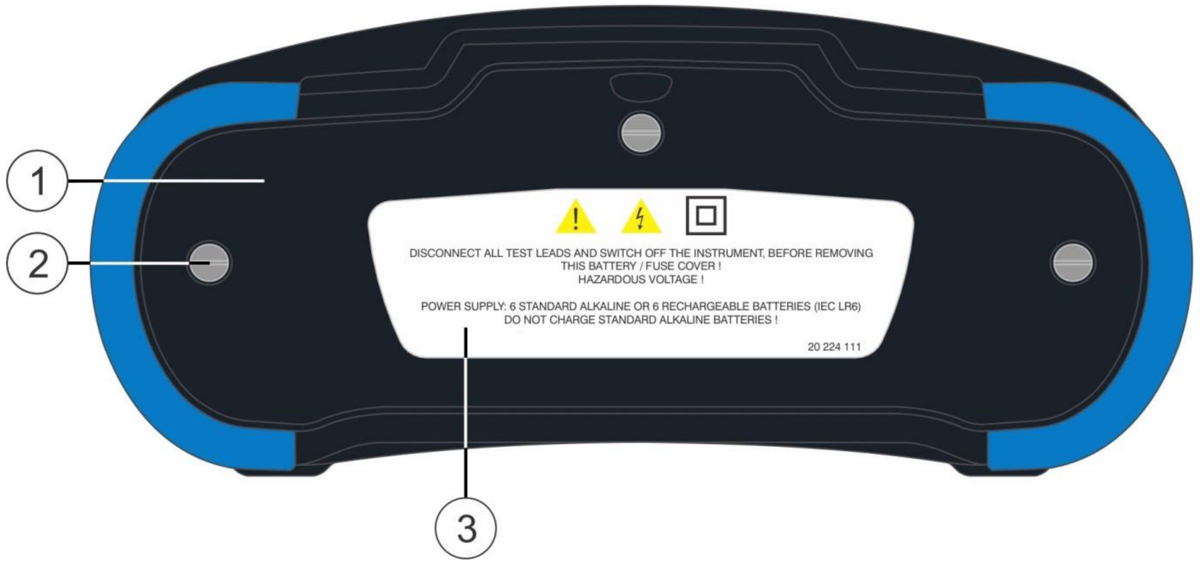


Figure 3.3: Back view

1	**Battery / fuse compartment cover**
2	**Fixing screws for battery / fuse compartment cover**
3	**Back panel information label**

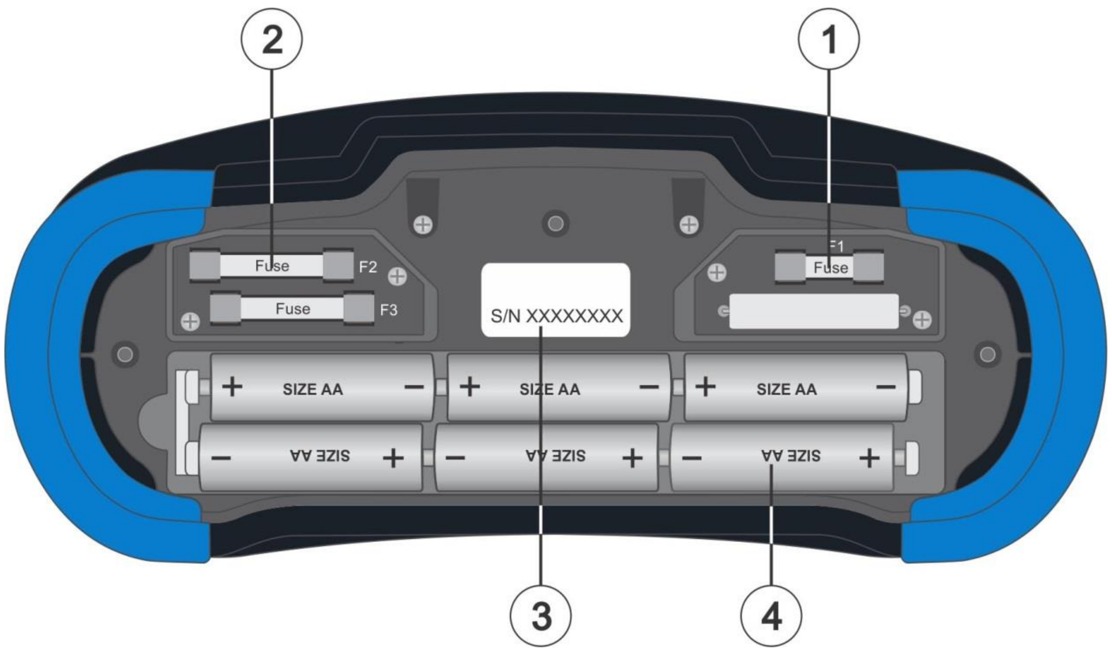


Figure 3.4: Battery and fuse compartment

1	**Fuse F1** M 315 mA / 250 V
2	**Fuses F2 and F3** F 4 A / 500 V (breaking capacity 50 kA)
3	**Serial number label**
4	**Battery cells** Size AA, alkaline / rechargeable NiMH

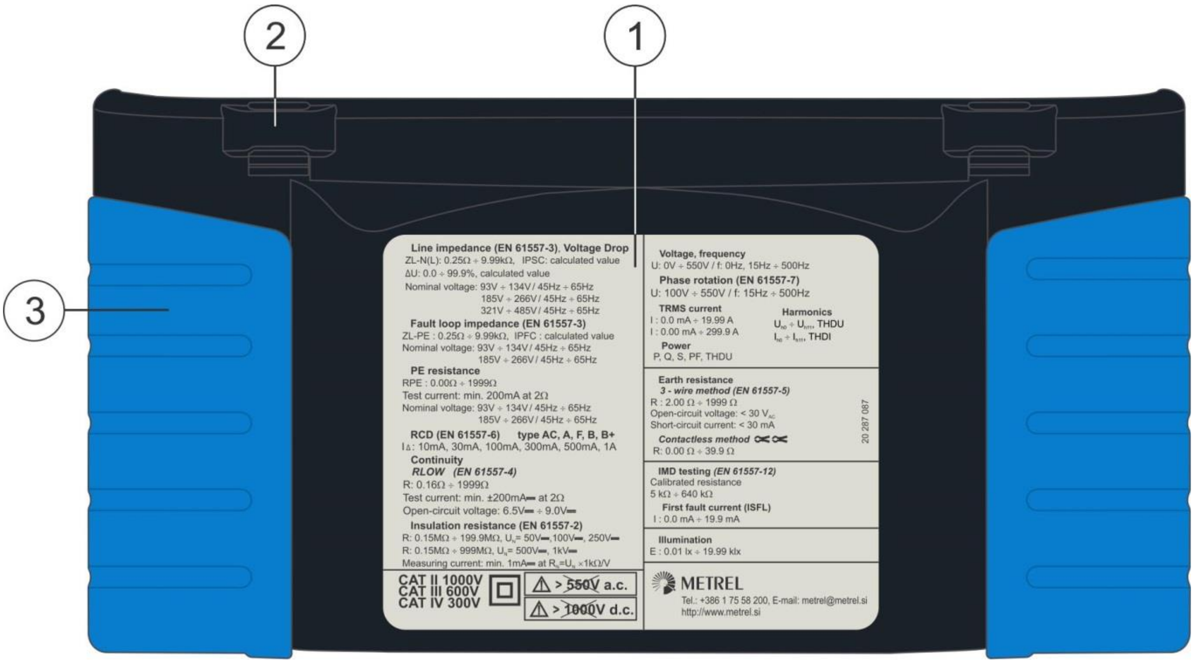


Figure 3.5: Bottom view

1	**Bottom information label**
2	**Neck belt openings**
3	**Handling side covers**

3.4 Carrying the instrument

With the neck-carrying belt supplied in standard set, various possibilities of carrying the instrument are available. Operator can choose appropriate one on basis of his operation, see the following examples:

The instrument hangs around operator's neck only – quick placing and displacing.

The instrument can be used even when placed in soft carrying bag – test cable connected to the instrument through the front aperture.

3.4.1 Secure attachment of the strap

You can choose between two methods:

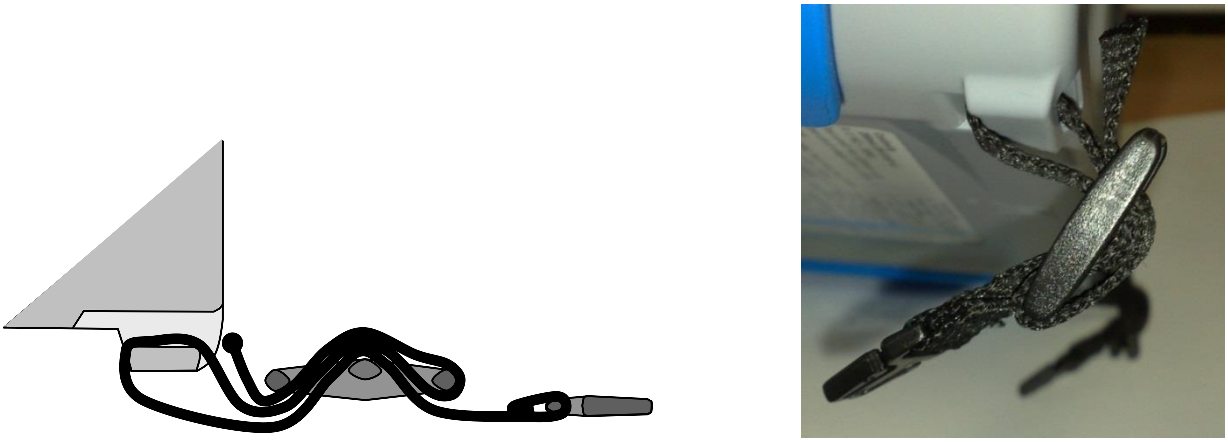


Figure 3.6: First method

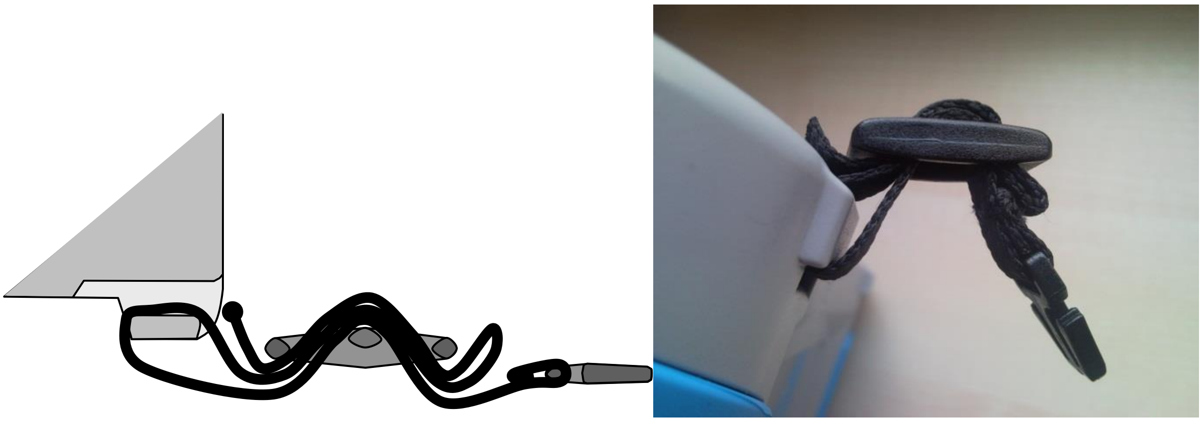


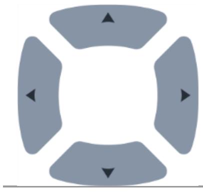
Figure 3.7: Alternative method

Please perform a periodical check of the attachment.

4 Instrument operation

The EurotestXC instrument can be manipulated via a keypad or touch screen.

4.1 General meaning of keys

	Cursor keys are used to: ‣ select appropriate option.
	Run key is used to: ‣ confirm selected option; ‣ start and stop measurements; ‣ test PE potential.
	Escape key is used to: ‣ return to previous menu without changes; ‣ abort measurements.
	Option key is used to: ‣ expand column in control panel.
	Save key is used to: ‣ store test results.
	Single Tests key is used as: ‣ shortcut key to enter Single Tests menu.
	Auto Sequence® key is used as: ‣ shortcut key to enter Auto Sequences® menu.
	Memory Organizer key is used as: ‣ shortcut key to enter Memory Organizer menu.
	Backlight key is used to: ‣ toggle screen brightness between High and Low intensity.
	General Settings key is used to: ‣ enter General Settings menu.
	On / Off key is used to: ‣ switch On / Off the instrument; ‣ switch Off the instrument if pressed and held for 5 s.

4.2 General meaning of touch gestures

	Tap (briefly touch surface with fingertip) is used to: ‣ select appropriate option; ‣ confirm selected option; ‣ start and stop measurements.
	Swipe (press, move, lift) up / down is used to: ‣ scroll content in same level; ‣ navigate between views in same level.
 **long**	Long press (touch surface with fingertip for at least 1 s) is used to: ‣ select additional keys (virtual keyboard); ‣ enter cross selector from single test screens.
	Tap Escape icon is used to: ‣ return to previous menu without changes; ‣ abort measurements.

4.3 Virtual keyboard

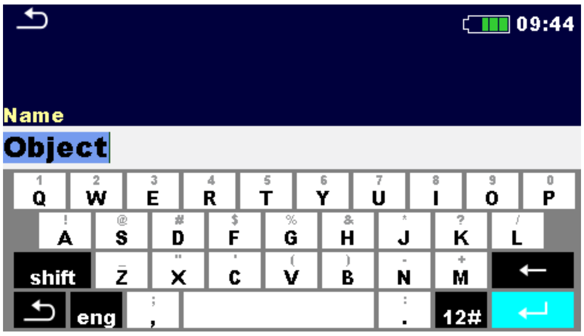


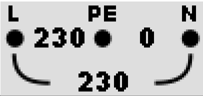
Figure 4.1: Virtual keyboard

shift	Toggle case between lowercase and uppercase. Active only when alphabetic characters keyboard layout selected.
←	Backspace Clears last character or all characters if selected. (If held for 2 s, all characters are selected).
↵	Enter confirms new text.
12#	Activates numeric / symbols layout.
ABC	Activates alphabetic characters.
eng	English keyboard layout.
GR	Greek keyboard layout.
RU	Russian keyboard layout.
⮌	Returns to the previous menu without changes.

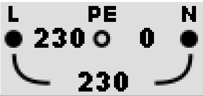
4.4 Display and sound

4.4.1 Terminal voltage monitor

The terminal voltage monitor displays on-line the voltages on the test terminals and information about active test terminals in the a.c. installation measuring mode.

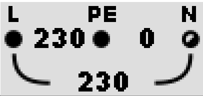


Online voltages are displayed together with test terminal indication. All three test terminals are used for selected measurement.



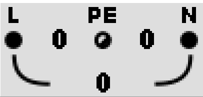
Online voltages are displayed together with test terminal indication.

L and N test terminals are used for selected measurement.



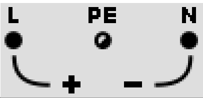
L and PE are active test terminals.

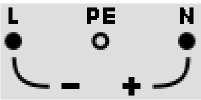
N terminal should also be connected for correct input voltage condition.



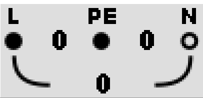
L and N are active test terminals.

PE terminal should also be connected for correct input voltage condition.

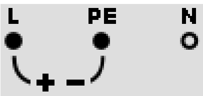


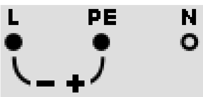


Polarity of test voltage applied to the output terminals, L and N.

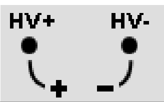


L and PE are active test terminals.





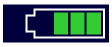
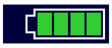
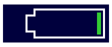
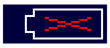
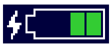
Polarity of test voltage applied to the output terminals, L and PE.



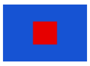
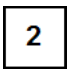
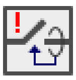
2.5 kV Insulation measurement terminal screen. (MI 3152H only)

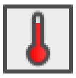
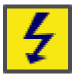
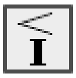
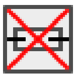
4.4.2 Battery indication

The battery indication indicates the charge condition of battery and connection of external charger.

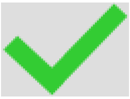
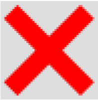
	Battery capacity indication. Battery is in good condition.
	Battery is full.
	Low battery. Battery is too weak to guarantee correct result. Replace or recharge the battery cells.
	Empty battery or no battery.
	Charging in progress (if power supply adapter is connected).

4.4.3 Measurement actions and messages

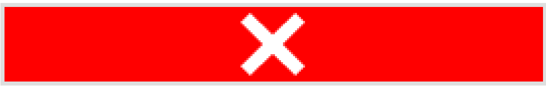
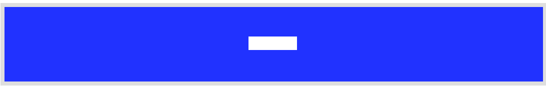
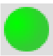
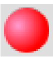
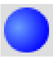
	Conditions on the input terminals allow starting the measurement. Consider other displayed warnings and messages.
	Conditions on the input terminals do not allow starting the measurement. Consider displayed warnings and messages.
	Proceeds to next step of the measurement.
	Stop the measurement.
	Result(s) can be stored.
	Starts test leads compensation in Rlow / continuity measurement. Starts Zref line impedance measurement at origin of electrical installation in Voltage Drop measurement. Zref value is set to 0.00 Ω if pressing this touch key while instrument is not connected to a voltage source.
	Use A 1199 Specific earth resistance adapter for this test.
	Use A 1143 Euro Z 290 A adapter for this test.
	Use A 1172 or A 1173 Illumination sensor for this test.
	Count down timer (in seconds) within measurement.
	Measurement is running, consider displayed warnings.
	RCD tripped-out during the measurement (in RCD functions).

	Instrument is overheated. The measurement is prohibited until the temperature decreases under the allowed limit.
	High electrical noise was detected during measurement. Results may be impaired. Indication of noise voltage above 5 V between H and E terminals during earth resistance measurement.
	L and N are changed. In most instrument profiles L and N test terminals are reversed automatically according to detected voltages on input terminal. In instrument profiles for countries where the position of phase and neutral connector is defined the selected feature is not working.
	**Warning!** High voltage is applied to the test terminals. The instrument automatically discharge tested object after finished insulation measurement. When an insulation resistance measurement has been performed on a capacitive object, automatic discharge may not be done immediately! The warning symbol and the actual voltage are displayed during discharge until voltage drops below 30 V.
	**Warning!** Dangerous voltage on the PE terminal! Stop the activity immediately and eliminate the fault / connection problem before proceeding with any activity! Continuous sound warning and yellow coloured screen is also present.
	Test leads resistance in R low / Continuity measurement is not compensated.
	Test leads resistance in R low / Continuity measurement is compensated.
	High resistance to earth of current test probes. Results may be impaired.
	High resistance to earth of potential test probes. Results may be impaired.
	High resistance to earth of potential and current test probes. Results may be impaired.
	Too small current for declared accuracy. Results may be impaired. Check in Current Clamp Settings if sensitivity of current clamp can be increased. In Earth 2 Clamp measurement results are very accurate for resistances below 10 Ω. At higher values (several 10 Ω) the test current drops to few mA. The measuring accuracy for small currents and immunity against noise currents must be considered!
	Measured signal is out of range (clipped). Results are impaired.
	Single fault condition in IT system. (MI 3152 only)
	Fuse F1 is broken.

4.4.4 Result indication

	Measurement result is inside pre-set limits (PASS).
	Measurement result is out of pre-set limits (FAIL).
	Measurement is aborted. Consider displayed warnings and messages. RCD t and RCD I measurements will only be performed if the contact voltage in the pre-test at nominal differential current is lower than the set contact voltage limit!

4.4.5 Auto Sequence® result indication

	All Auto Sequence® results are inside pre-set limits (PASS).
	One or more Auto Sequence® results are out of pre-set limits (FAIL).
	Overall Auto Sequence® result without PASS / FAIL indication.
	Measurement result is inside pre-set limits (PASS).
	Measurement result is out of pre-set limits (FAIL).
	Measurement result without PASS / FAIL indication.
	Measurement not performed.

4.5 Instruments main menu

From the **Main menu** different main operation menus can be selected.

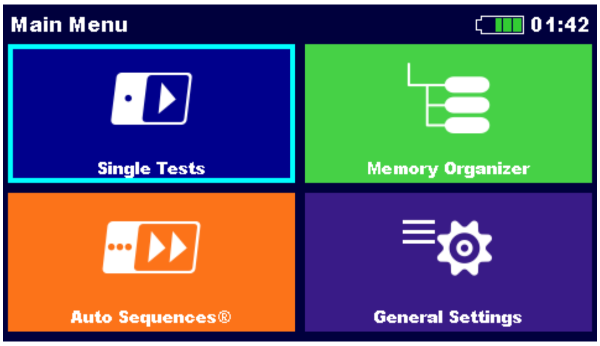
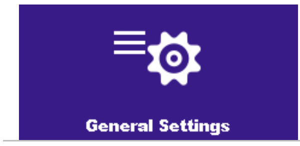


Figure 4.2: Main menu

Options

	**Single Tests** Menu with single tests, see chapter ***6 Single tests***.
	**Auto Sequences®** Menu with customized test sequences, see chapter ***8 Auto Sequences®***.
	**Memory Organizer** Menu for working with and documentation of test data, see chapter ***5 Memory Organizer***.
	**General Settings** Menu for setup of the instrument, see chapter ***4.6 General Settings***.

4.6 General Settings

In the **General settings menu** general parameters and settings of the instrument can be viewed or set.

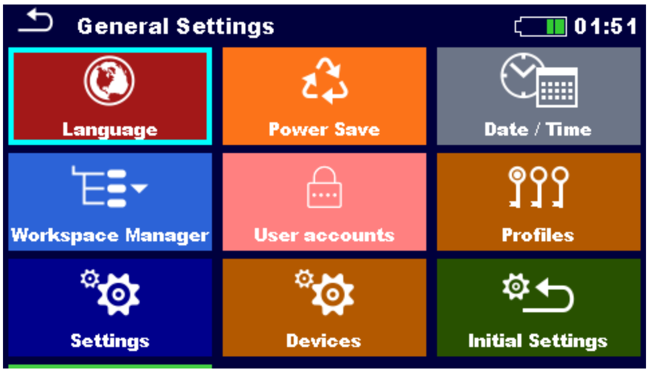
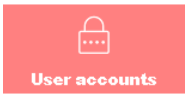


Figure 4.3: General settings menu

Options

	**Language** Instrument language selection.
	**Power Save** Brightness of LCD, enabling/disabling Bluetooth communication.
	**Date /Time** Instruments Date and time.
	**Workspace Manager** Manipulation with project files. Refer to chapter ***4.8 Workspace Manager menu*** for more information.
	**User accounts** User accounts settings. Refer to chapter ***4.6.4 User accounts*** for more information.
	**Profiles** Selection of available instrument profiles. Refer to chapter ***4.7 Instrument profiles*** for more information.
	**Settings** Settings of different system / measuring parameters. Refer to chapter ***4.6.5 Settings*** for more information.
	**Devices** Setting of external devices. Refer to chapter ***4.6.6 Devices*** for more information.

	**Initial Settings** Factory settings.
	**About** Instrument info.

4.6.1 Language

In this menu the language of the instrument can be set.

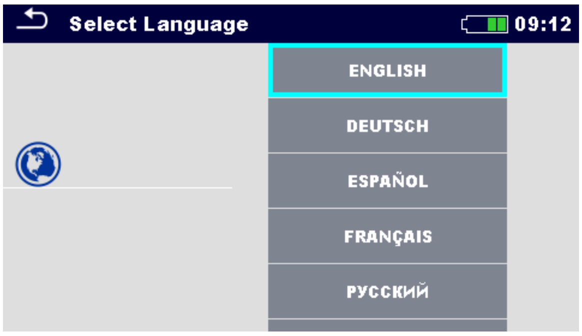


Figure 4.4: Language menu

4.6.2 Power Save

In this menu different options for decreasing power consumption can be set.

Figure 4.5: Power save menu

Brightness	Setting level of LCD brightness level. Power saving at low level: ca 15%
LCD off time	Setting LCD off after set time interval. LCD is switched on after pressing any key or touching the LCD. Power saving at LCD off (at low level brightness): ca 20%
Bluetooth	Always On: Bluetooth module is ready to communicate. Save mode: Bluetooth module is set to sleep mode and is not functioning. Power saving in Save mode: approx. 7 %

4.6.3 Date and time

In this menu date and time of the instrument can be set.

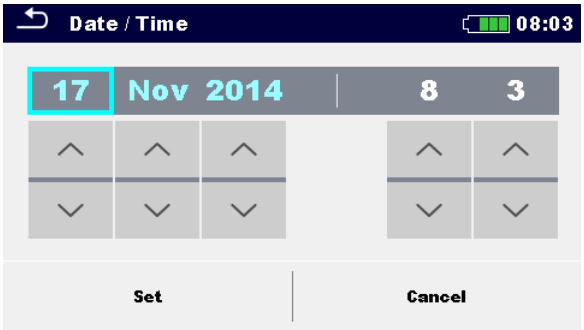


Figure 4.6: Setting date and time

Note

- If the batteries are removed the set date and time will be lost.

4.6.4 User accounts

The demand to sign in can prevent from unauthorized persons to work with the instrument.
In this menu user accounts can be managed:

- Setting if signing in to work with the instrument is required or not.
- Adding and deleting new users, setting their user names and passwords.

The user accounts can be managed by the administrator.
Factory set administrator password: ADMIN.
It is recommended to change factory set administrator password after first use. If the custom password is forgotten the second administrator password can be used. This password always unlocks the Account manager and is delivered with the instrument.

If a user account is set and the user is signed in the user's name will be stored in memory for each measurement.
Individual users can change their passwords.

4.6.4.1 Signing in

If signing in is demanded the user must enter the password in order to work with the instrument.

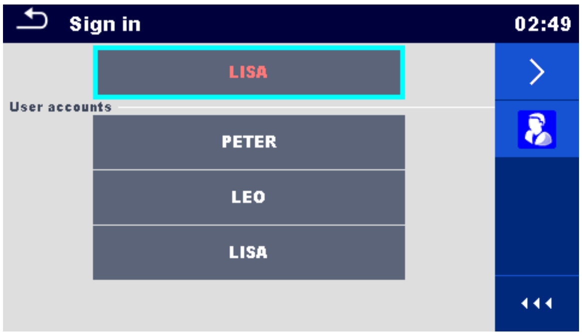
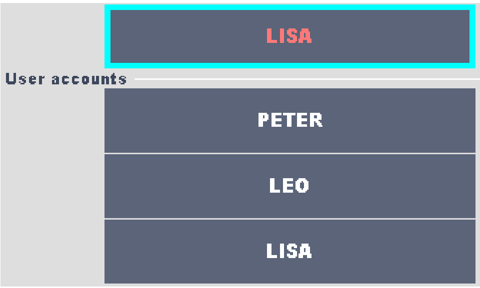


Figure 4.7: Sign in menu

Options

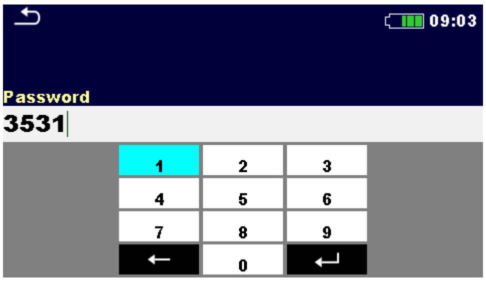
User signing in



The user should be selected first.

The last used user is displayed in the first row.

Sign in with selected user name.

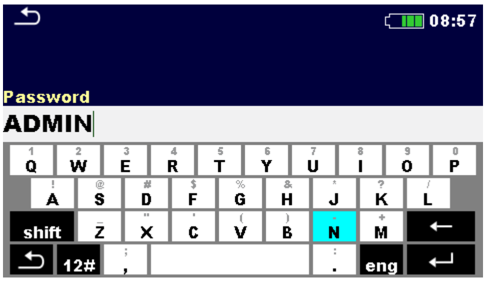


Enter the password and confirm.

The user password consists of an up to 4 digit number.

Administrator signing in

The Account manager menu is accessed by selecting Account manager in Sign in menu or User profile menu.



The account manager password must be entered and confirmed first.

Administrator password consists of letters and/or numbers. Letters are case sensitive.

The default password is ADMIN.

4.6.4.2 Changing user password, signing out

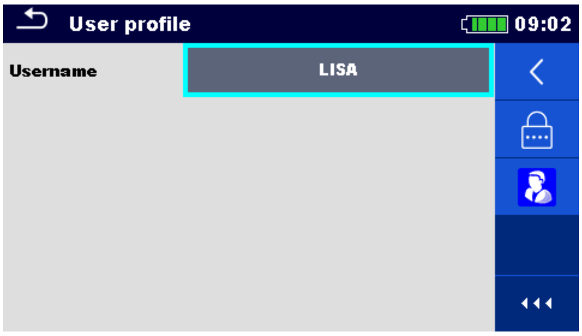
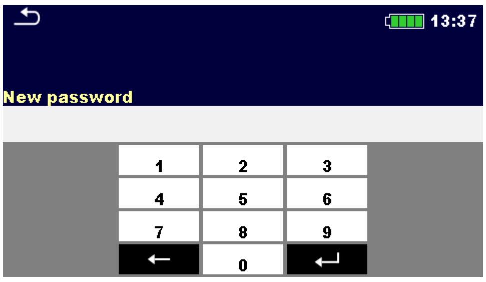


Figure 4.8: User profile menu

Options

	Signs out the set user.
	Enters procedure for changing the user's password.
	The user can change its password. The actual password must be entered first followed by the new password.
	Enters the Account manager menu.

4.6.4.3 Managing accounts

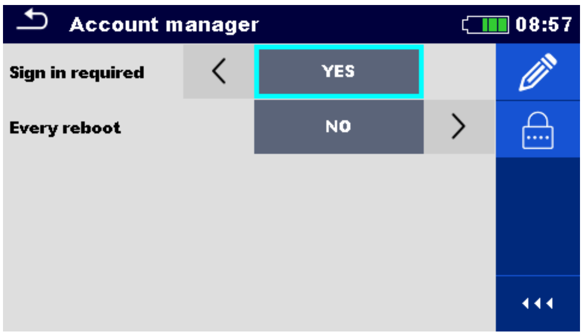
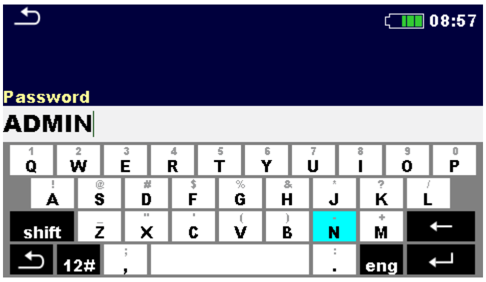


Figure 4.9: Account manager menu

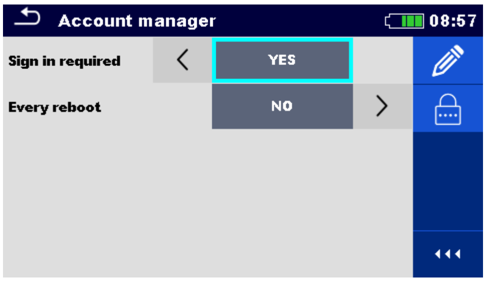
Options

	The Account manager menu is accessed by selecting Account manager in Sign in menu or User profile menu.



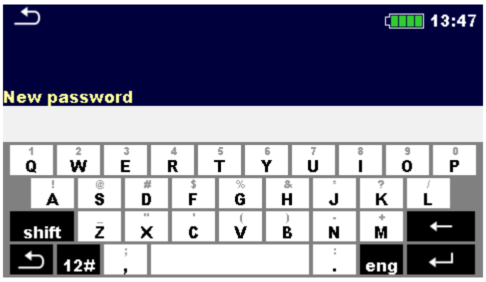
The account manager password must be entered and confirmed first.

The default password is ADMIN.



Field for setting if signing in is required to work with the instrument.

Field for setting if signing is required once or at each power on of the instrument.



Enters procedure for changing the account manager (administrator) password.

To change the password the actual and then the new password should be entered and confirmed.

Enters menu for editing user accounts.

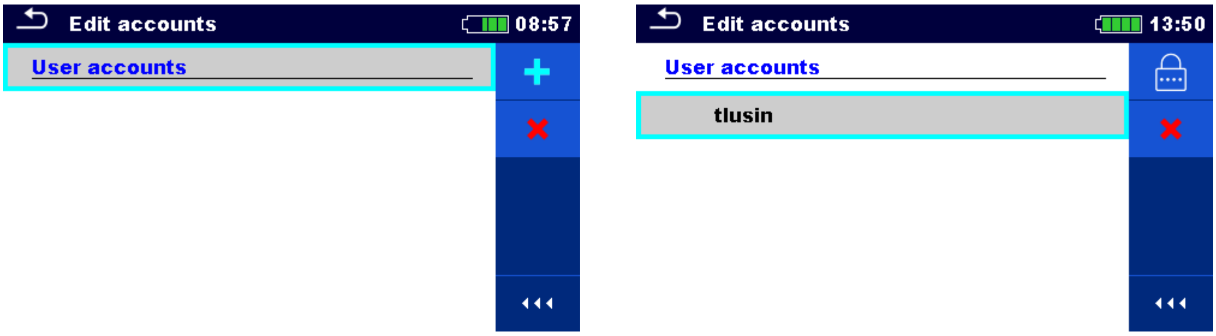
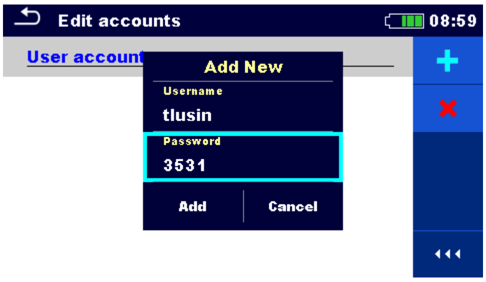


Figure 4.10: Edit accounts menu

Options

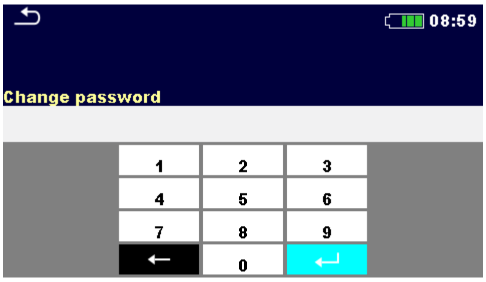
Opens the window for adding a new user.



In the Add New window the name and password of the new user are to be set.

'Add' confirms the new user data.

Changes password of the selected user account.



Deletes all user accounts.

Deletes the selected user.

4.6.5 Settings

In this menu different general parameters can be set.

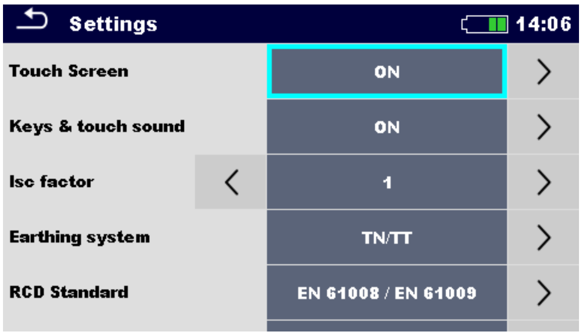


Figure 4.11: Settings menu

	Available selection	**Description**
Touch screen	[ON, OFF]	Enables / disables operation with touch screen.
Keys & touch sound	[ON, OFF]	Enables / disables sound when touch screen or key is pressed.
RCD Standard	[EN 61008 / EN 61009, IEC 60364-4-41 TN/IT, IEC 60364-4-41 TT, BS 7671, AS/NZS 3017]	Used standard for RCD tests. Refer to the end of this chapter for more information. Maximum RCD disconnection times differ in various standards. The trip-out times defined in individual standards are listed below.
Isc factor	[0.20 ... 3.00] Default value: 1.00	Short circuit current Isc in the supply system is important for selection or verification of

		protective circuit breakers (fuses, over-current breaking devices, RCDs). The value should be set according to local regulative.
Length Unit	[m, ft]	Length unit for specific earth resistance measurement.
Ch1 clamp type	[A 1018, A 1019, A1391]	Model of current clamp adaptor.
Range	A 1018:[20 A] A1019: [20 A] A 1391: [40 A, 300 A]	Measuring range of selected current clamp adaptor. Measuring range of the instrument must be considered. Measurement range of current clamp adaptor can be higher than of the instrument.
Merge fuses	[yes, no]	[Yes]: fuse type and parameters set in one function are also kept for other functions! [No]: Fuse parameters will be considered only in function where they have been set.
External Device	[None, Commander]	The None option is intended to disable the commander's remote keys. In case of high EM interfering noise the operation of the commander can be irregular.
Earthing system	[TN/TT, IT (MI 3152 only)]	Terminal voltage monitor is suited according to the selected system. In some measuring functions the results and parameters are suited to the selected system.
Ignore PE warning (IT)	[yes, no]	[yes]: In IT earthing system the instrument will allow to start the selected measurement regardless of PE warning detection. [no], In IT earthing system the instrument will block the selected measurement if PE warning is detected.
IscMax, IscMin calculation	[yes, no]	[yes]: IscMax, IscMin calculation is enabled in Z line measurement. [no]: IscMax, IscMin calculation is disabled in Z line measurement.
Limit Uc	[12 V, 25 V, 50 V]	Contact voltage limit.

4.6.5.1 RCD standard

Maximum RCD disconnection times differ in various standards. The trip-out times defined in individual standards are listed below.

	$\frac{1}{2}\times I_{\Delta N}$ 1)	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$
General RCDs (non-delayed)	t_Δ > 300 ms	t_Δ < 300 ms	t_Δ < 150 ms	t_Δ < 40 ms
Selective RCDs (time-delayed)	t_Δ > 500 ms	130 ms < t_Δ < 500 ms	60 ms < t_Δ < 200 ms	50 ms < t_Δ < 150 ms

Table 4.1: Trip-out times according to EN 61008 / EN 61009

Test according to standard IEC/HD 60364-4-41 has two selectable options:

- **IEC 60364-4-41 TN/IT** and
- **IEC 60364-4-41 TT**

The options differ to maximum disconnection times as defined in IEC/HD 60364-4-41 Table 41.1.

	U_0 [3]	$\frac{1}{2}\times I_{\Delta N}$ [1]	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$
TN / IT	$\leq$ 120 V	t_Δ > 800 ms	$t_\Delta \leq$ 800 ms	t_Δ < 150 ms	t_Δ < 40 ms
	$\leq$ 230 V	t_Δ > 400 ms	$t_\Delta \leq$ 400 ms		
TT	$\leq$ 120 V	t_Δ > 300 ms	$t_\Delta \leq$ 300 ms		
	$\leq$ 230 V	t_Δ > 200 ms	$t_\Delta \leq$ 200 ms		

Table 4.2: Trip-out times according to IEC/HD 60364-4-41

	$\frac{1}{2}\times I_{\Delta N}$ [1]	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$
General RCDs (non-delayed)	t_Δ> 1999 ms	t_Δ< 300 ms	t_Δ< 150 ms	t_Δ< 40 ms
Selective RCDs (time-delayed)	t_Δ> 1999 ms	130 ms < t_Δ< 500 ms	60 ms < t_Δ< 200 ms	50 ms < t_Δ< 150 ms

Table 4.3: Trip-out times according to BS 7671

RCD type	$I_{\Delta N}$ (mA)	$\frac{1}{2}\times I_{\Delta N}$ [1] t_Δ	$I_{\Delta N}$ t_Δ	$2\times I_{\Delta N}$ t_Δ	$5\times I_{\Delta N}$ t_Δ	Note
I	$\leq$ 10	> 999 ms	40 ms	40 ms	40 ms	Maximum break time
II	> 10 $\leq$ 30		300 ms	150 ms	40 ms	
III	> 30		300 ms	150 ms	40 ms	
IV S	> 30	> 999 ms	500 ms	200 ms	150 ms	
			130 ms	60 ms	50 ms	Minimum non-actuating time

Table 4.4: Trip-out times according to AS/NZS 3017[2]

Standard	$\frac{1}{2}\times I_{\Delta N}$	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$
EN 61008 / EN 61009	300 ms	300 ms	150 ms	40 ms
IEC 60364-4-41	1000 ms	1000 ms	150 ms	40 ms
BS 7671	2000 ms	300 ms	150 ms	40 ms
AS/NZS 3017 (I, II, III)	1000 ms	1000 ms	150 ms	40 ms

Table 4.5: Maximum test times related to selected test current for general (non-delayed) RCD

Standard	$\frac{1}{2}\times I_{\Delta N}$	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$
EN 61008 / EN 61009	500 ms	500 ms	200 ms	150 ms
IEC 60364-4-41	1000 ms	1000 ms	150 ms	40 ms
BS 7671	2000 ms	500 ms	200 ms	150 ms
AS/NZS 3017 (IV)	1000 ms	1000 ms	200 ms	150 ms

Table 4.6: Maximum test times related to selected test current for selective (time-delayed) RCD

1) Minimum test period for current of $\frac{1}{2}\times I_{\Delta N}$, RCD shall not trip-out.
2) Test current and measurement accuracy correspond to AS/NZS 3017 requirements.
3) U_0 is nominal U_{LPE} voltage.

Note

- Trip-out limit times for PRCD, PRCD-K and PRCD-S are equal to General (non-delayed) RCDs.

4.6.6 Devices

In this menu operation with external devices is configured.

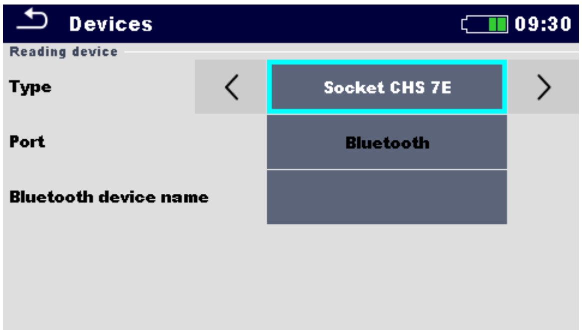


Figure 4.12: Device settings menu

Reading devices

Type	Sets appropriate reading device (QR or barcode scanner).
Port	Sets communication port of selected reading device.
Bluetooth device name	Goes to menu for pairing with selected Bluetooth device.

4.6.7 Initial Settings

In this menu the instrument settings, measurement parameters and limits can be set to initial (factory) values.

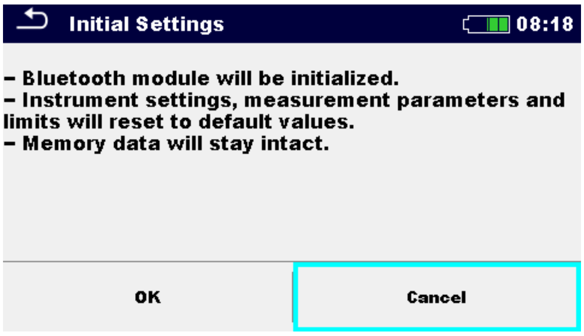


Figure 4.13: Initial settings menu

Warning!
Following customized settings will be lost when setting the instruments to initial settings:

- measurement limits and parameters,
- global parameters, system settings, and Devices in General settings menu,
- opened Workspace will be deselected,
- user will be signed out.

- If the batteries are removed the custom made settings will be lost.

Note
Following customized settings will stay:
- profile settings,
- Data in memory (Data in memory organizer, Workspaces and Auto Sequences®) and
- user accounts.

4.6.8 About

In this menu instrument data (name, serial number, FW / HW versions, fuse version and date of calibration) can be viewed.

Figure 4.14: Instrument info screen

4.7 Instrument profiles

In this menu the instrument profile can be selected from the available ones.

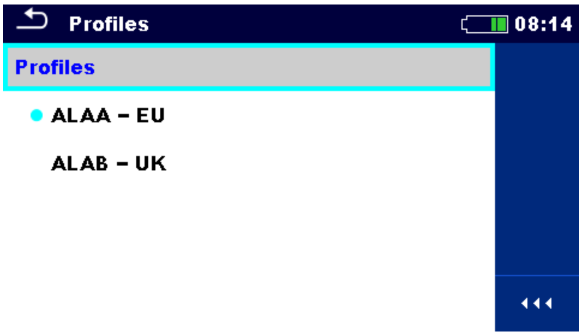


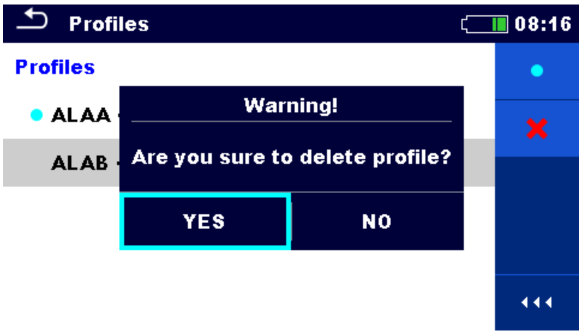
Figure 4.15: Instrument profiles menu

The instrument uses different specific system and measuring settings in regard to the scope of work or country it is used. These specific settings are stored in instrument profiles.

By default each instrument has at least one profile activated. Proper licence keys must be obtained to add more profiles to the instruments.

If different profiles are available they can be selected in this menu.

Options

	Loads the selected profile. The instrument will restart automatically with new profile loaded.
	Deletes the selected profile.
	Before deleting the selected profile user is asked for confirmation.
	Opens more options in control panel / expands column.

4.8 Workspace Manager menu

The Workspace Manager is intended to manage with different Workspaces and Exports that are stored into internal data memory.

4.8.1 Workspaces and Exports

The works with MI 3152(H) EurotestXC can be organized and structured with help of Workspaces and Exports. Exports and Workspaces contain all relevant data (measurements, parameters, limits, structure objects) of an individual work.
Workspaces are stored on internal data memory on directory WORKSPACES, while Exports are stored on directory EXPORTS. Exports are suitable for making backups of important works. To work on the instrument an Export should be imported first from the list of Exports and converted to a Workspace. To be stored as Export data a Workspace should be exported first from the list of Workspaces and converted to an Export.

4.8.2 Workspace Manager main menu

In Workspace manager Workspaces and Exports are displayed in two separated lists.

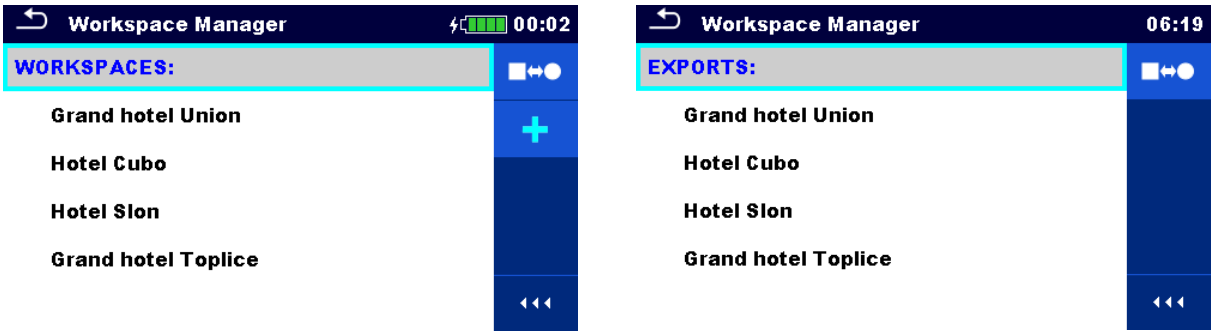


Figure 4.16: Workspace manager menu

Options

WORKSPACES:	List of Workspaces.
	Displays a list of Exports.
	Adds a new Workspace. Refer to chapter ***4.8.5 Adding a new Workspace*** for more information.
EXPORTS:	List of Exports.
	Displays a list of Workspaces.
	Opens more options in control panel / expands column.

4.8.3 Operations with Workspaces

Only one Workspace can be opened in the instrument at the same time. The Workspace selected in the Workspace Manager will be opened in the Memory Organizer.

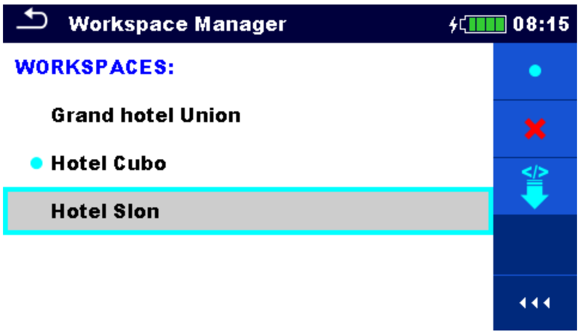


Figure 4.17: Workspaces menu

Options

	Marks the opened Workspace in Memory Organizer. Opens the selected Workspace in Memory Organizer. Refer to chapter ***4.8.6 Opening a Workspace*** for more information.
	Deletes the selected Workspace. Refer to chapter ***4.8.7 Deleting a Workspace / Export*** for more information.
	Adds a new Workspace. Refer to chapter ***4.8.5 Adding a new Workspace*** for more information.
	Exports a Workspace to an Export. Refer to ***4.8.9 Exporting a Workspace*** for more information.
	Opens more options in control panel / expands column.

4.8.4 Operations with Exports

Figure 4.18: Workspace manager Exports menu

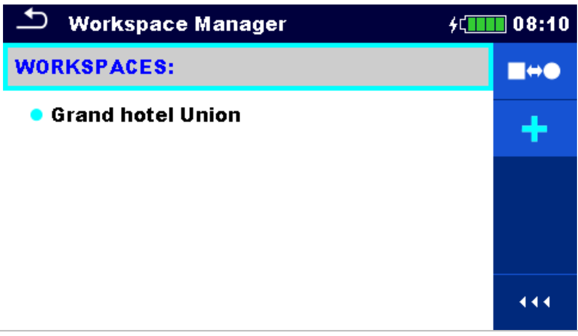
Options

	Deletes the selected Export. Refer to chapter ***4.8.7 Deleting a Workspace / Export*** for more information.
	Imports a new Workspace from Export. Refer to ***4.8.8 Importing a Workspace*** for more information.
	Opens more options in control panel / expands column.

4.8.5 Adding a new Workspace

Procedure

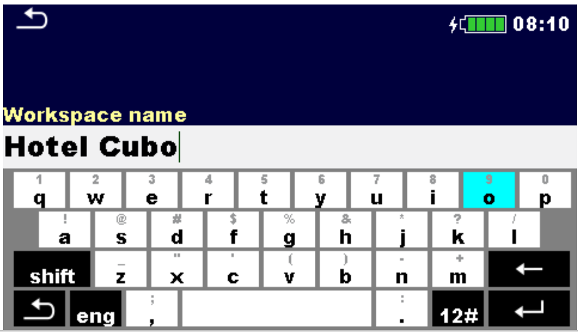
①



New Workspaces can be added from the Workspace Manager screen.

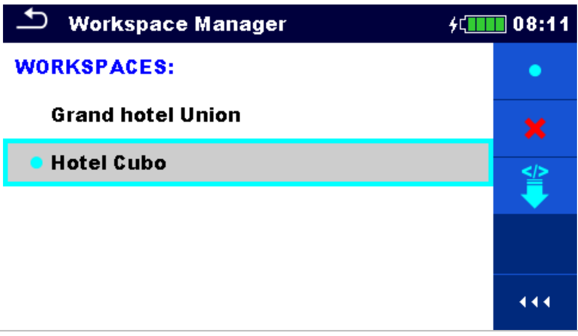
②

Enters option for adding a new Workspace.



Keypad for entering name of a new Workspace is displayed after selecting New.

③

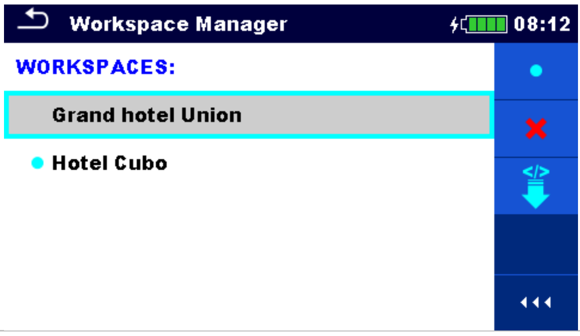


After confirmation a new Workspace is added in the list in Main Workspace Manager menu.

4.8.6 Opening a Workspace

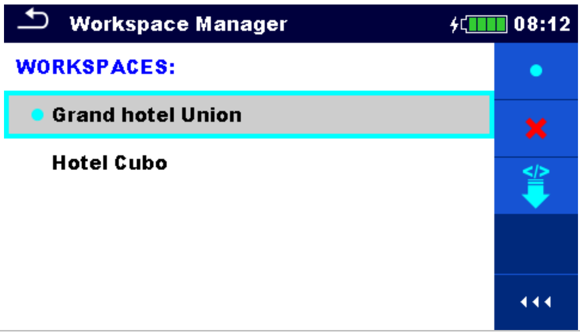
Procedure

①



Workspace can be selected from a list in Workspace manager screen.

②



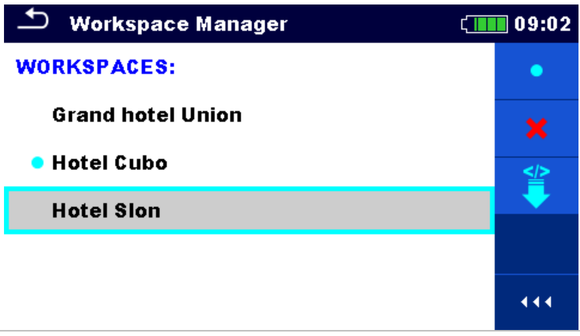
Opens a Workspace in Workspace manager.

The opened Workspace is marked with a blue dot. The previously opened Workspace will close automatically.

4.8.7 Deleting a Workspace / Export

Procedure

①

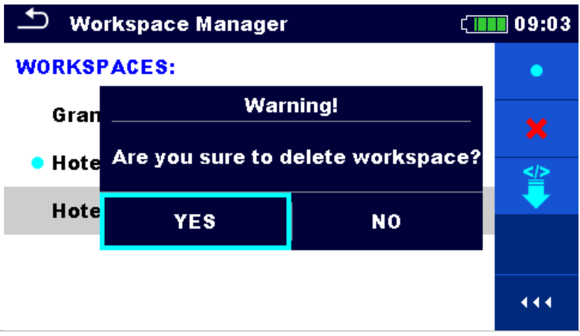


Workspace / Export to be deleted should be selected from the list of Workspaces / Exports.

Opened workspace can't be deleted.

②

Enters option for deleting a Workspace / Export.



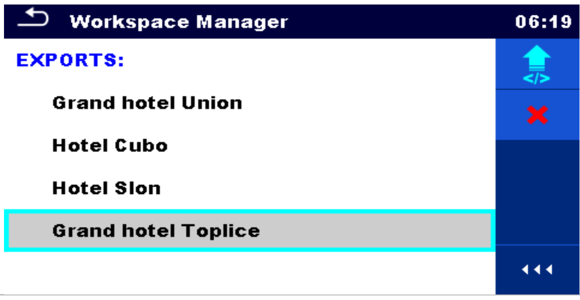
Before deleting the selected Workspace / Export the user is asked for confirmation.

③

Workspace / Export is removed from the Workspace / Export list.

4.8.8 Importing a Workspace

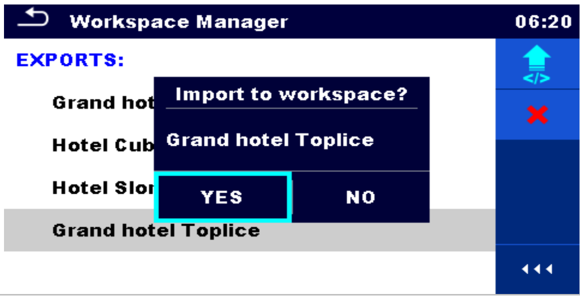
①



Select an Export file to be imported from Workspace manager Export list.

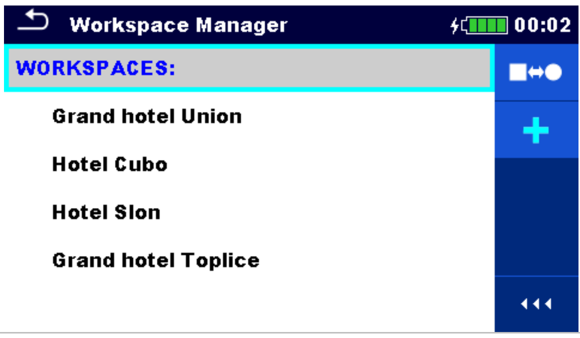
②

Enters option Import.



Before the import of the selected Export file the user is asked for confirmation.

③

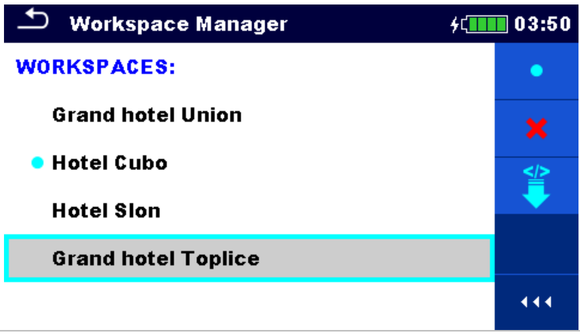


The imported Export file is added to the list of Workspaces.

Note:
If a Workspace with the same name already exists the name of the imported Workspace will be changed (name_001, name_002, name_003, …).

4.8.9 Exporting a Workspace

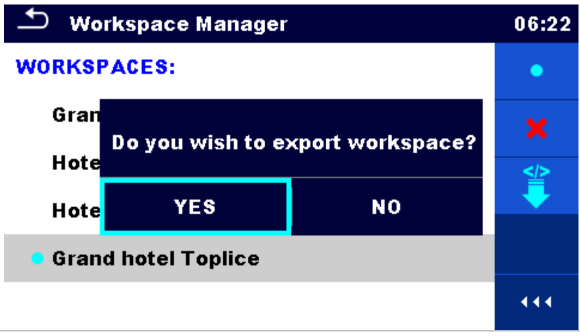
①



Select a Workspace from Workspace manager list to be exported to an Export file.

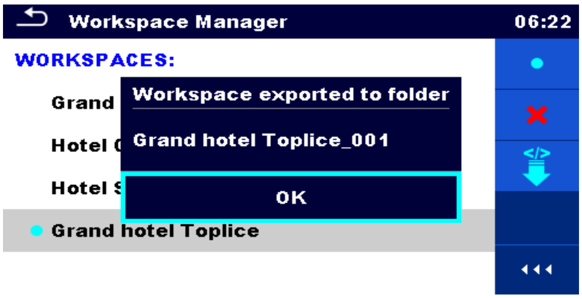
②

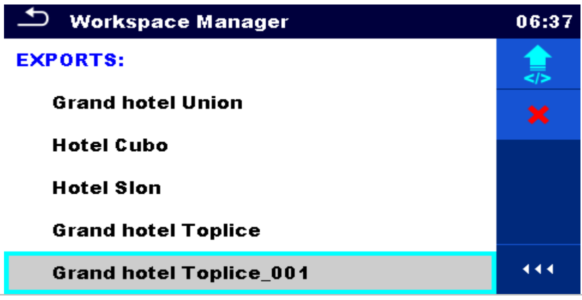
Enters option Export.



Before exporting the selected Workspace the user is asked for confirmation.

③





Workspace is exported to Export file and is added to the list of Exports.

Note:
If an Export file with the same name already exists the name of the Export file will be changed (name_001, name_002, name_003, …).

5 Memory Organizer

Memory Organizer is a tool for storing and working with test data.

5.1 Memory Organizer menu

The data is organized in a tree structure with Structure objects and Measurements. EurotestXC instrument has a multi-level structure. The hierarchy of Structure objects in the tree is shown on ***Figure 5.1***.

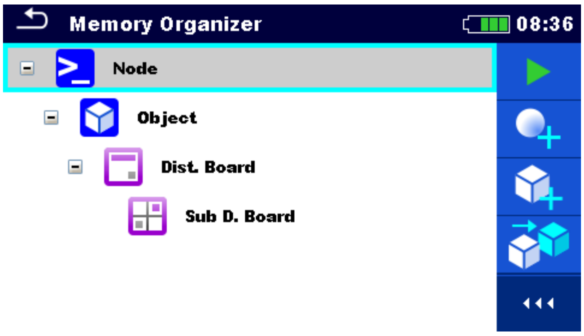


Figure 5.1: Default tree structure and its hierarchy

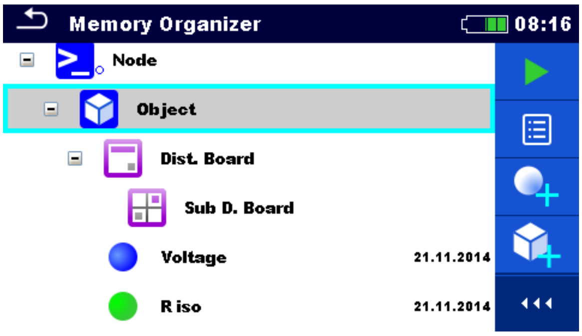


Figure 5.2: Example of a tree menu

5.1.1 Measurement statuses

Each measurement has:

- a status (Pass or Fail or no status),
- a name,
- results,
- limits and parameters.

A measurement can be a Single test or an Auto Sequence®. For more information refer to chapters **7 _Tests and measurements_** and **8 _Auto Sequences®_**.

Statuses of Single tests

	passed finished single test with test results
	failed finished single test with test results

	finished single test with test results and no status
	empty single test without test results

Overall statuses of Auto Sequences®

or	at least one single test in the Auto Sequence® passed and no single test failed
or	at least one single test in the Auto Sequence® failed
or	at least one single test in the Auto Sequence® was carried out and there were no other passed or failed single tests.
or	empty Auto Sequence® with empty single tests

5.1.2 Structure Objects

Each Structure object has:

- an icon
- a name and
- parameters.

Optionally they can have:

- an indication of the status of the measurements under the Structure object and
- a comment or a file attached.

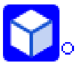
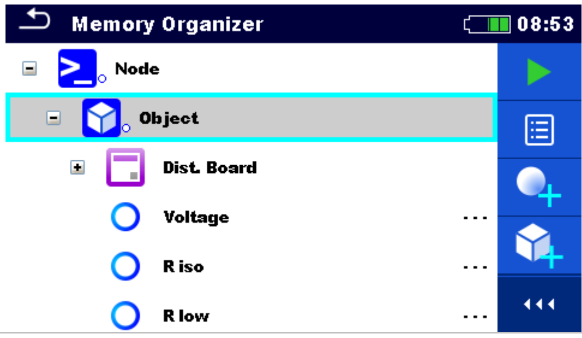
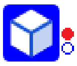
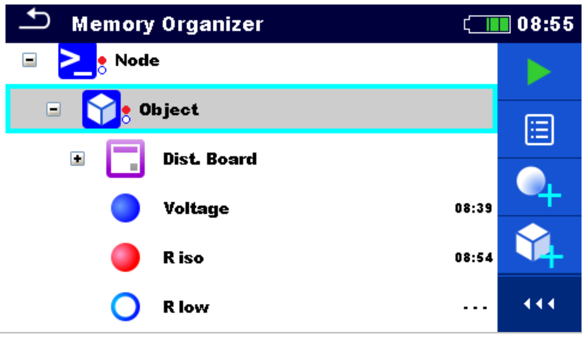
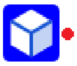
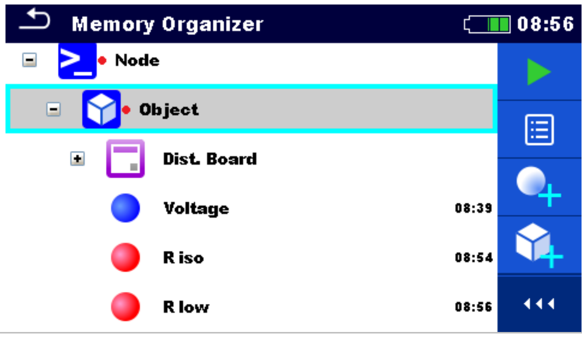
Figure 5.3: Structure object in tree menu

Structure objects supported are described in ***Appendix D – Structure objects***.

5.1.2.1 Measurement status indication under the Structure object

Overall status of measurements under each structure element /sub-element can be seen without spreading tree menu. This feature is useful for quick evaluation of test status and as guidance for measurements.

Options

 **Object**	There are no measurement results under selected structure object. Measurements should be made.	
 **Object**	One or more measurement result(s) under selected structure object has failed. Not all measurements under selected structure object have been made yet.	
 **Object**	All measurements under selected structure object are completed but one or more measurement result(s) has failed.	

Note

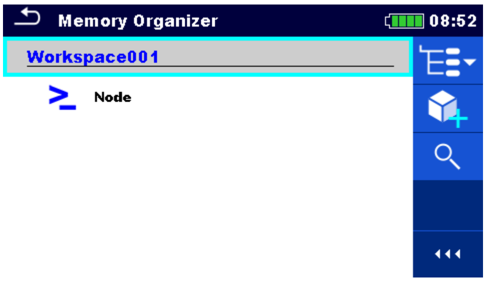
- There is no status indication if all measurement results under each structure element /sub-element have passed or if there is an empty structure element / sub-element (without measurements).

5.1.3 Selecting an active Workspace in Memory Organizer

Memory Organizer and Workspace Manager are interconnected so an active Workspace can be selected also in the Memory Organizer menu.

Procedure

①

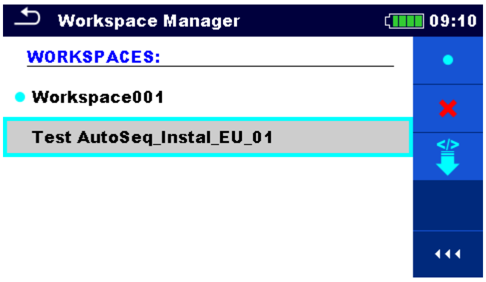


Press the active Workspace in Memory Organizer Menu.

②

Select List of Workspaces in Control panel.

③

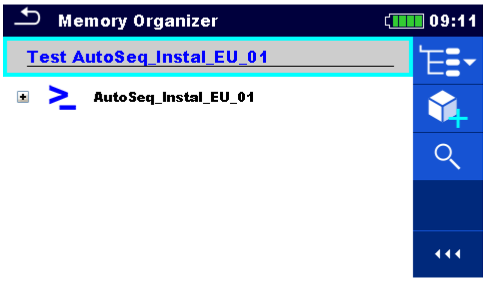


Choose desired Workspace from a list of Workspaces.

④

Use Select button to confirm selection.

⑤



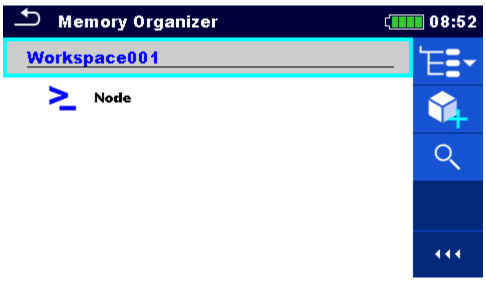
New Workspace is selected and displayed on the screen.

5.1.4 Adding Nodes in Memory Organizer

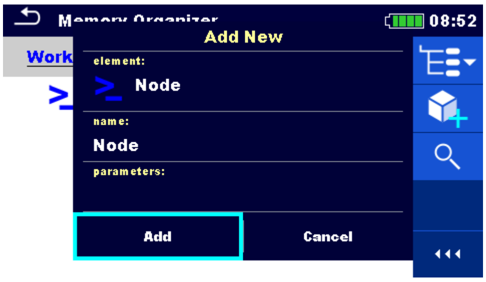
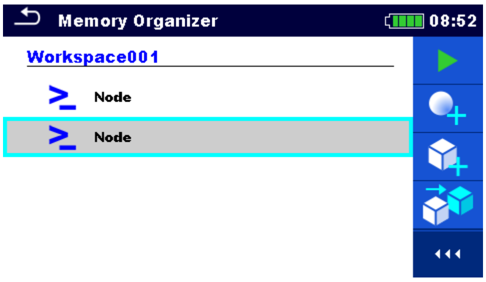
Structural Elements (Nodes) are used to ease organization of data in the Memory Organizer. One Node is a must; others are optional and can be created or deleted freely.

Procedure

①



Press the active Workspace in Memory Organizer Menu.

②		Select Add New Structure Element in Control panel.
③		Change name of the Node if necessary and press Add to confirm.
④		New Structure Element (Node) will be added.

5.1.5 Operations in Tree menu

In the Memory organizer different actions can be taken with help of the control panel at the right side of the display. Possible actions depend on the selected element in the organizer.

5.1.5.1 Operations on measurements (finished or empty measurements)

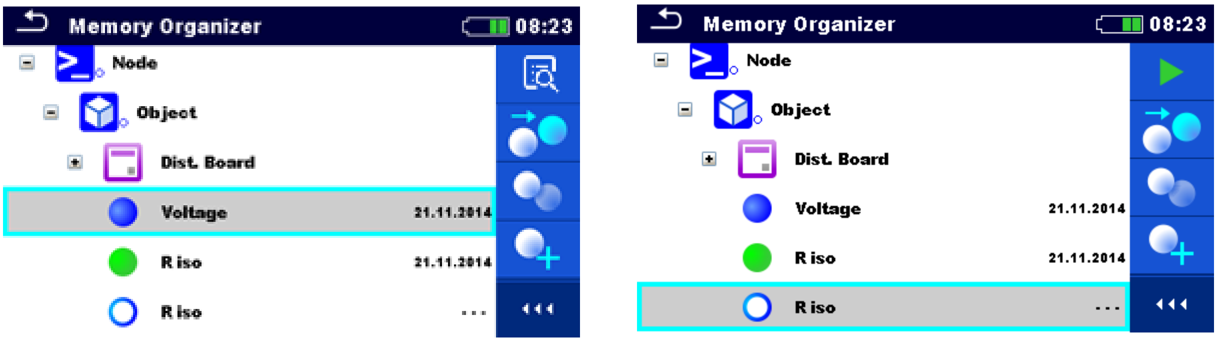


Figure 5.4: A measurement is selected in the Tree menu

Options

	Views results of measurement. The instrument goes to the measurement memory screen. Refer to chapters ***6.1.7 Recall single test results screen*** and ***8.2.4 Auto Sequence® memory screen***.
	Starts a new measurement. Refer to chapters ***6.1.3 Single test start screen*** and ***8.2.1 Auto Sequences® view menu*** for more information.

Saves a measurement.

Saving of measurement on a position after the selected (empty or finished) measurement.

Clones the measurement.

The selected measurement can be copied as an empty measurement under the same Structure object. Refer to chapter ***5.1.5.7 Clone a measurement*** for more information.

Copies & Paste a measurement.

The selected measurement can be copied and pasted as an empty measurement to any location in structure tree. Multiple "Paste" is allowed. Refer to chapter ***5.1.5.10 Copy & Paste a measurement*** for more information.

Adds a new measurement.

The instrument goes to the Menu for adding measurements. Refer to chapter ***5.1.5.5 Add a new measurement*** for more information.

Views and edit comments.

The instrument displays comment attached to the selected measurement or opens keypad for entering a new comment.

Deletes a measurement.

Selected Measurement can be deleted. User is asked for confirmation before the deleting. Refer to chapter ***5.1.5.12 Delete a measurement*** for more information.

5.1.5.2 Operations on Structure objects

The structure object must be selected first.

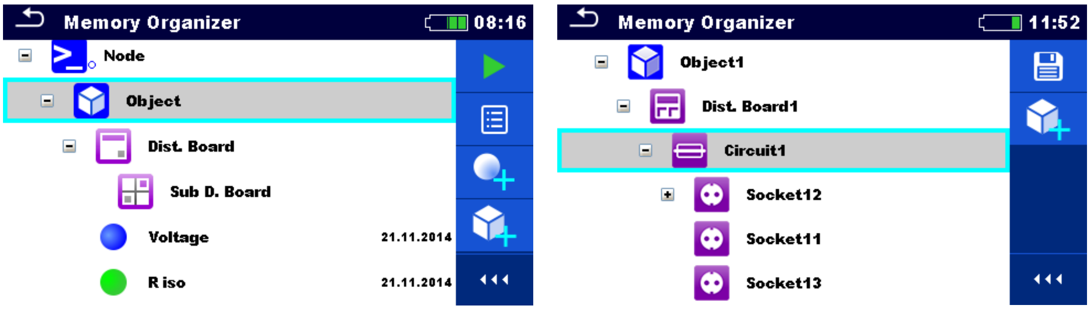


Figure 5.5: A structure object is selected in the Tree menu

Options

Starts a new measurement.

Type of measurement (Single test or Auto Sequence®) should be selected first. After proper type is selected, the instrument goes to Single Test or Auto Sequence® selection screen. Refer to chapters ***6.1 Selection modes*** and ***8.1 Selection of Auto Sequences®.***

Saves a measurement.

Saving of measurement under the selected Structure object.

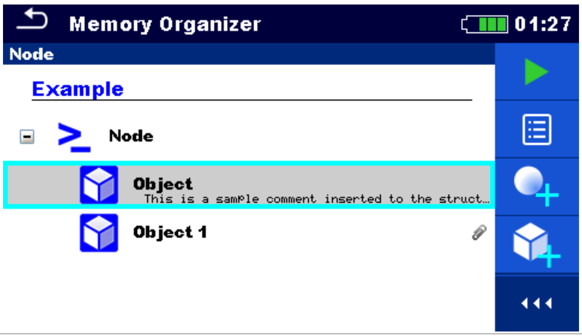
	View / edit parameters and attachments. Parameters and attachments of the Structure object can be viewed or edited. Refer to chapter ***5.1.5.3 View / Edit parameters and attachments of a Structure object*** for more information.
	Adds a new measurement. The instrument goes to the Menu for adding measurement into structure. Refer to chapter ***5.1.5.5 Add a new measurement*** for more information.
	Adds a new Structure object. A new Structure object can be added. Refer to chapter ***5.1.5.4 Add a new Structure Object*** for more information.
	Attachments. Name and link of attachment is displayed.
	Clones a Structure object. Selected Structure object can be copied to same level in structure tree (clone). Refer to chapter ***5.1.5.6 Clone a Structure object*** for more information.
 	Copies & Paste a Structure object. Selected Structure object can be copied and pasted to any allowed location in structure tree. Multiple “Paste” is allowed. Refer to chapter ***5.1.5.8 Copy & Paste a Structure object*** for more information.
	Views and edit comments. The instrument displays comment attached to the selected Structure object or opens keypad for entering a new comment.
	Deletes a Structure object. Selected Structure object and sub-elements can be deleted. User is asked for confirmation before the deleting. Refer to chapter ***5.1.5.11 Delete a Structure object*** for more information.
	Renames a Structure object. Selected Structure object can be renamed via keypad. Refer to chapter ***5.1.5.13 Rename a Structure object*** for more information.

5.1.5.3 View / Edit parameters and attachments of a Structure object

The parameters and their content are displayed in this menu. To edit the selected parameter, tap on it or press the  key to enter menu for editing parameters.

Procedure

①

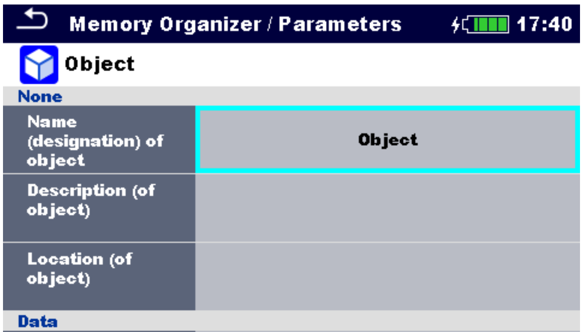


Select structure object to be edited.

②

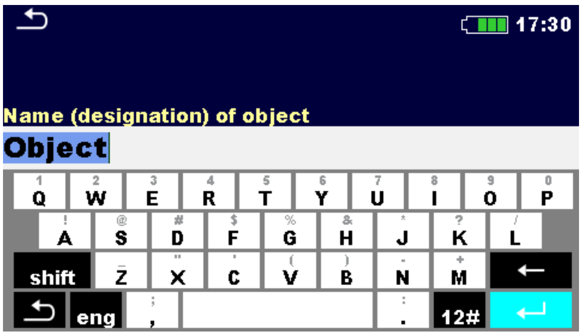
Select Parameters in Control panel.

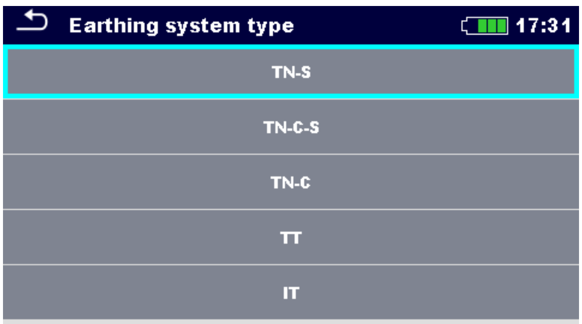
③



Example of Parameters menu.

④

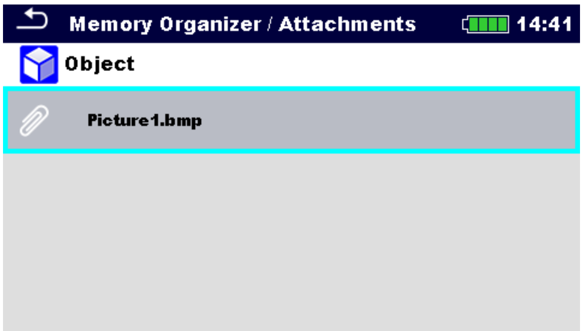
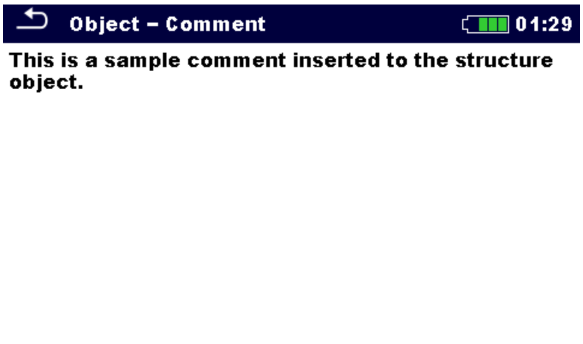
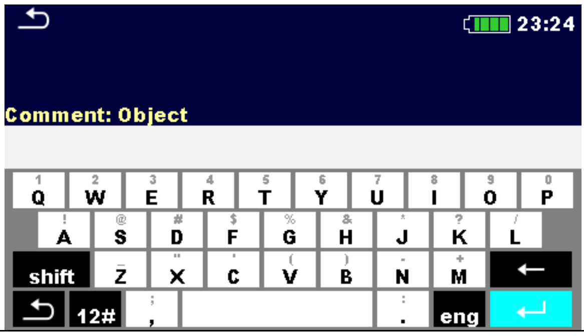




In menu for editing parameters the parameter’s value can be selected from a dropdown list or entered via keypad. Refer to chapter ***4 Instrument operation*** for more information about keypad operation.

②a

Select Attachments in Control panel.

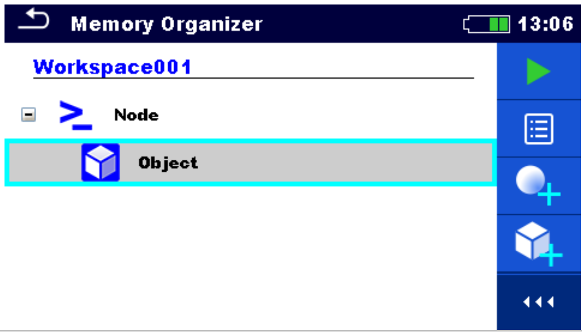
③a		Attachments The name of attachment can be seen. Operation with attachments is not supported in the instrument.
②b		Select Comments in Control panel.
③b	 	View or edit comments Complete comment (if exists) attached to the structure object can be seen on this screen. Press  key or tap on screen to open keypad for entering a new comment.

5.1.5.4 Add a new Structure Object

This menu is intended to add new structure objects in the tree menu. A new structure object can be selected and then added in the tree menu.

Procedure

①



Default initial structure.

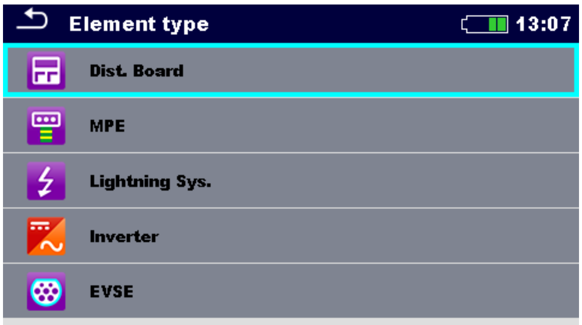
②

Select Add Structure in Control panel.

③

Add a new structure object menu.

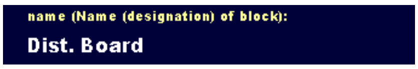
③a

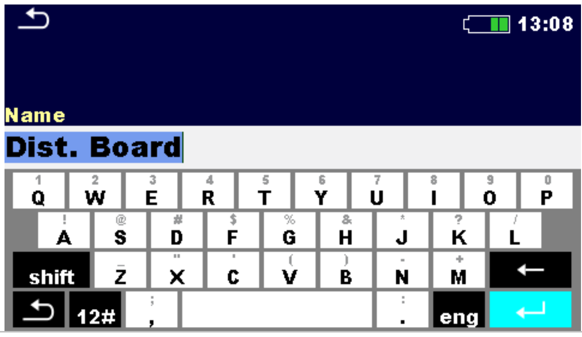


The type of structure object to be added can be selected first from dropdown menu.

Only structure objects that can be used in the same level or next sub-level are offered.

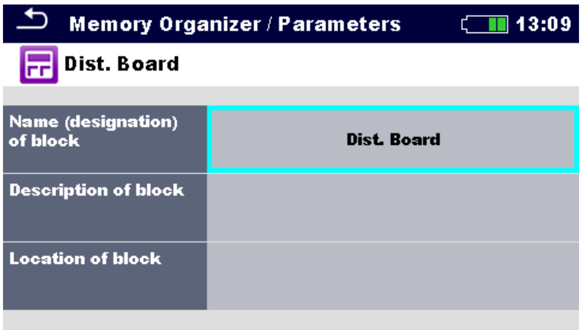
③b

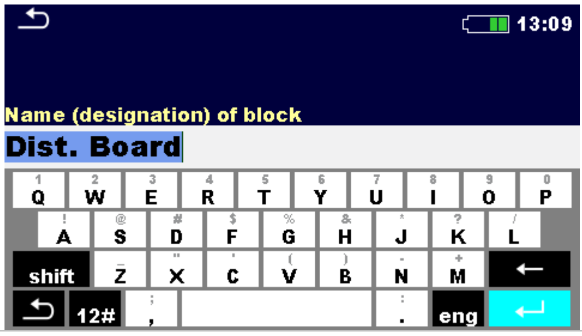




The name of structure object can be edited.

③c





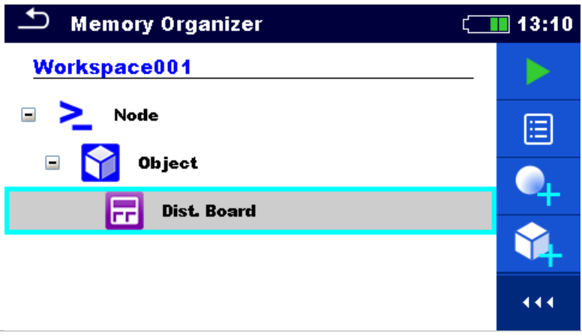
Parameters of the Structure object can be edited.

④

Adds the selected structure object in the tree menu.

Returns to the tree menu without changes.

⑤



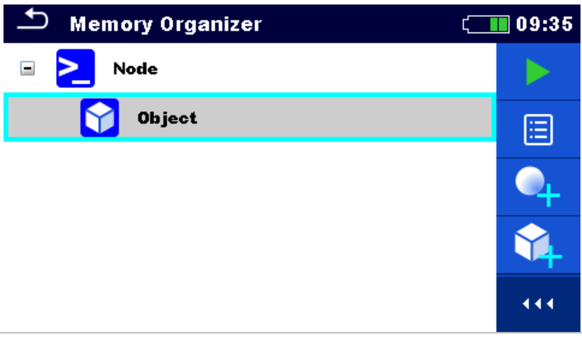
New object added.

5.1.5.5 Add a new measurement

In this menu new empty measurements can be set and then added in the structure tree. The type of measurement, measurement function and its parameters are first selected and then added under the selected Structure object.

Procedure

①

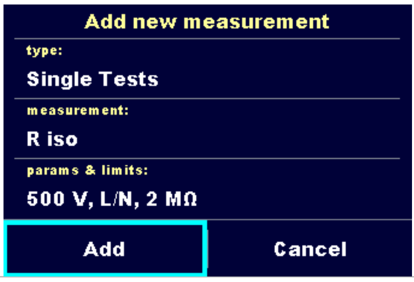


Select level in structure where measurement will be added.

②

Select Add measurement in Control panel.

③



Add new measurement menu.

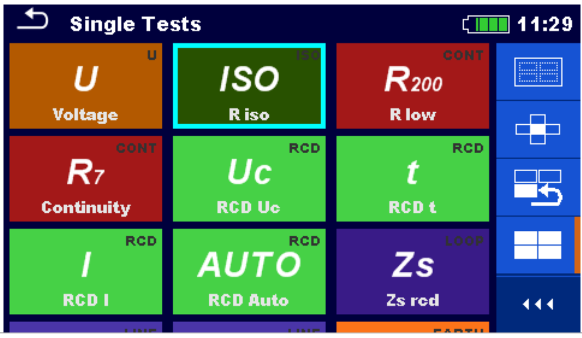
③a

Type of test can be selected from this field.

Options: (Single Tests, Auto Sequences®)

Tap on field or press the  key to modify.

③b



Last added measurement is offered by default.

To select another measurement tap on field or press the  to open menu for selecting measurements.

③c

Select parameter and modify it as described earlier.

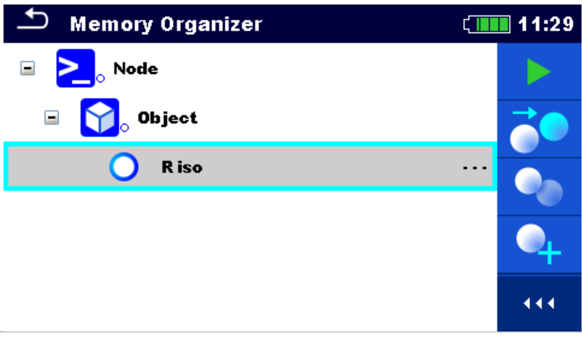
Refer to chapter ***6.1.2 Setting parameters and limits of single tests*** for more information.

④

Adds the measurement under the selected Structure object in the tree menu.

Returns to the structure tree menu without changes.

⑤

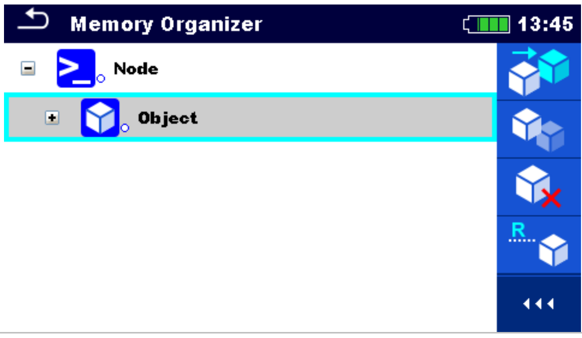
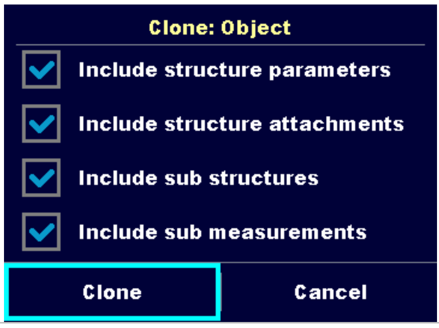
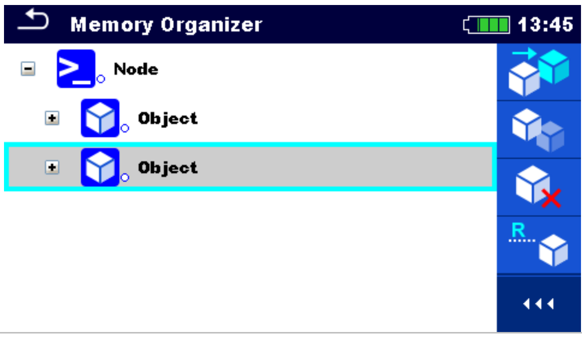


New empty measurement is added under the selected Structure object.

5.1.5.6 Clone a Structure object

In this menu selected structure object can be copied (cloned) to same level in the structure tree. Cloned structure object has the same name as the original.

Procedure

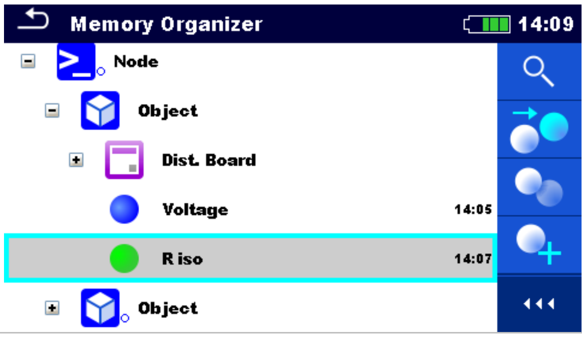
①		Select the structure object to be cloned.
②		Select Clone in Control panel.
③		The Clone Structure object menu is displayed. Sub-elements of the selected structure object can be marked or un-marked for cloning. Refer to chapter ***5.1.5.9 Cloning and Pasting sub-elements of selected structure object*** for more information.
④		Selected structure object is copied (cloned) to same level in the structure tree.
		Cloning is cancelled. No changes in the Structure tree.
⑤		The new structure object is displayed.

5.1.5.7 Clone a measurement

By using this function a selected empty or finished measurement can be copied (cloned) as an empty measurement to the same level in the structure tree.

Procedure

①

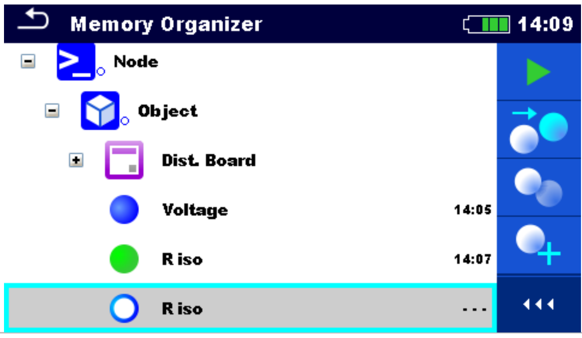


Select the measurement to be cloned.

②

Select Clone in Control panel.

③



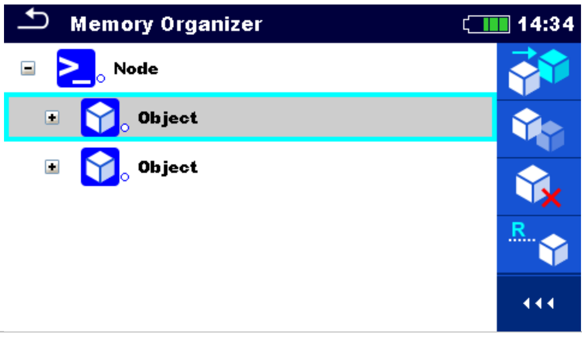
A new empty measurement is displayed.

5.1.5.8 Copy & Paste a Structure object

In this menu selected Structure object can be copied and pasted to any allowed location in the structure tree.

Procedure

①

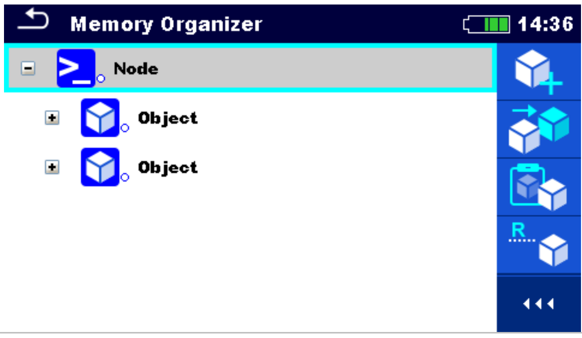


Select the structure object to be copied.

②

Select Copy in control panel.

③

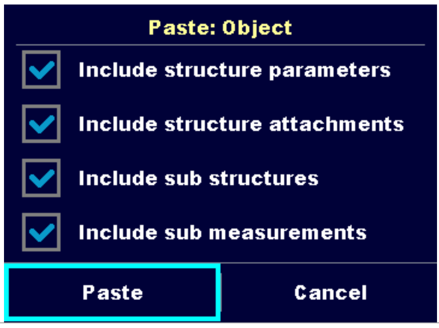


Select location where structure element should be copied.

④

Select Paste in Control panel.

⑤



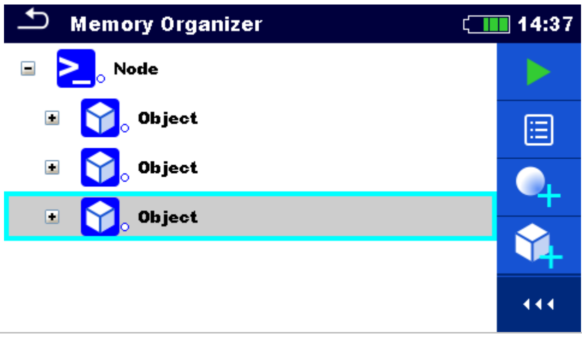
The Paste structure object menu is displayed.

Before copying it can be set which sub-elements of the selected structure object will be copied too. Refer to chapter ***5.1.5.9 Cloning and Pasting sub-elements of selected structure object*** for more information.

⑥

The selected structure object and elements are copied (pasted) to selected position in the tree structure.

Returns to the tree menu without changes.

⑦ 

The new structure object is displayed.

Note

The Paste command can be executed one or more times.

5.1.5.9 Cloning and Pasting sub-elements of selected structure object

When structure object is selected to be cloned, or copied & pasted, additional selection of its sub-elements is needed. The following options are available:

Options

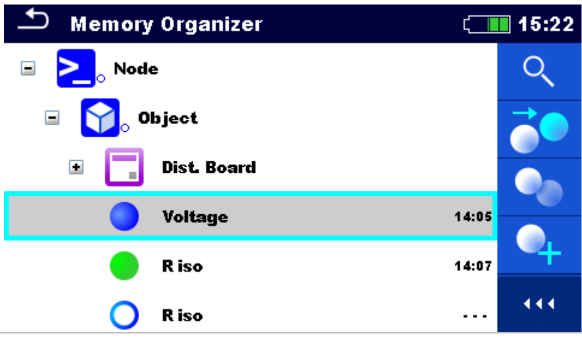
Include structure parameters	Parameters of selected structure object will be cloned / pasted too.
Include structure attachments	Attachments of selected structure object will be cloned / pasted too.
Include sub structures	Structure objects in sub-levels of selected structure object will be cloned / pasted too.
Include sub measurements	Measurements in selected structure object and sub-levels will be cloned / pasted too.

5.1.5.10 Copy & Paste a measurement

In this menu selected measurement can be copied to any allowed location in the structure tree.

Procedure

①

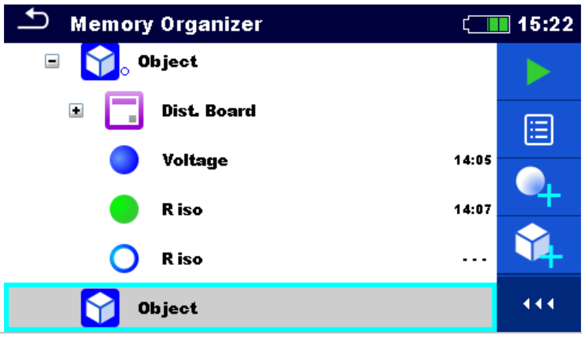


Select the measurement to be copied.

②

Select Copy in Control panel.

③

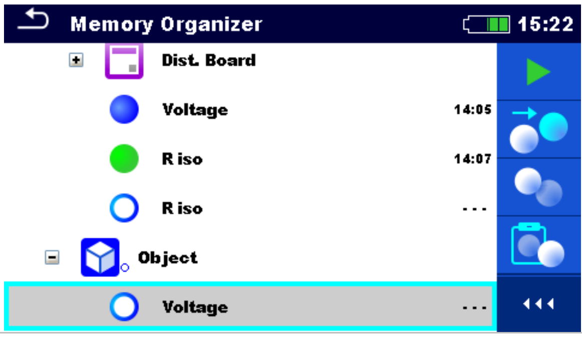


Select the location where measurement should be pasted.

④

Select Paste in Control panel.

⑤



A new (empty) measurement is displayed in selected Structure object.

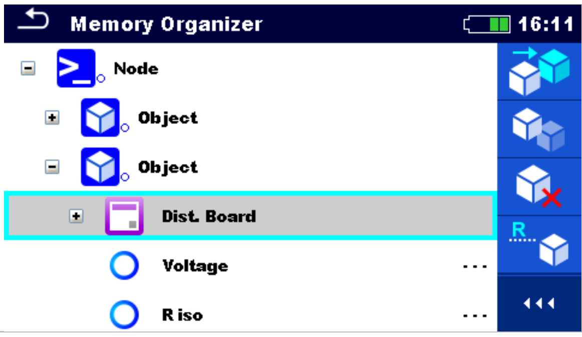
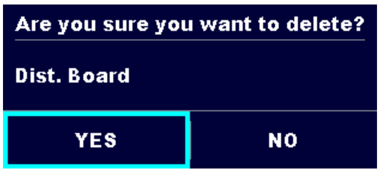
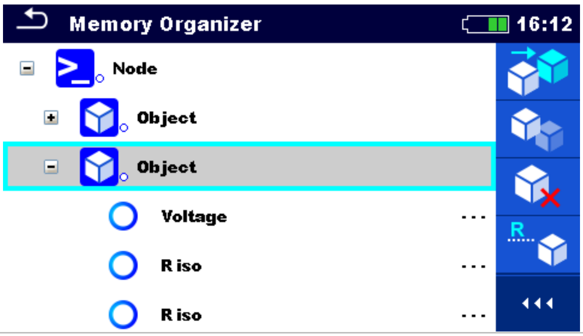
Note

The Paste command can be executed one or more times.

5.1.5.11 Delete a Structure object

In this menu selected Structure object can be deleted.

Procedure

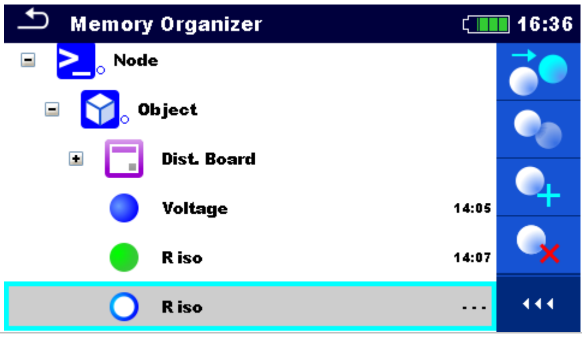
①		Select the structure object to be deleted.
②		Select Delete in Control panel.
③		A confirmation window will appear.
		Selected structure object and its sub-elements are removed.
		Returns to the tree menu without changes.
④		Structure without deleted object.

5.1.5.12 Delete a measurement

In this menu selected measurement can be deleted.

Procedure

①

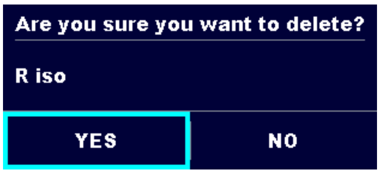


Select a measurement to be deleted.

②

Select Delete in Control panel.

③

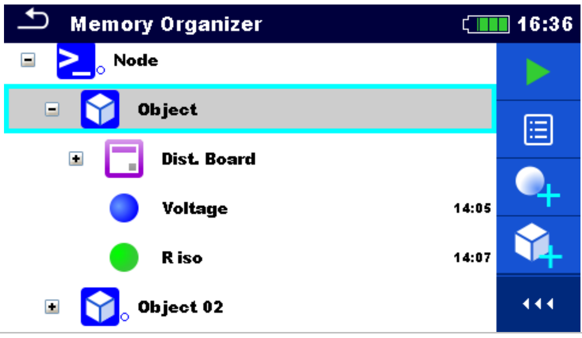


A confirmation window will appear.

Selected measurement is deleted.

Returns to the tree menu without changes.

④

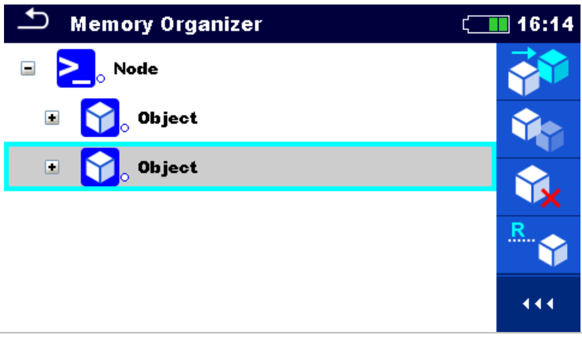
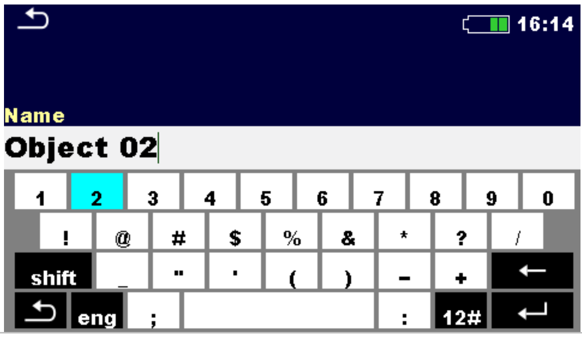
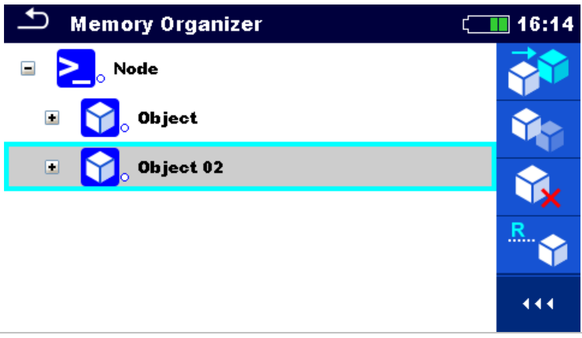


Structure without deleted measurement.

5.1.5.13 Rename a Structure object

In this menu selected Structure object can be renamed.

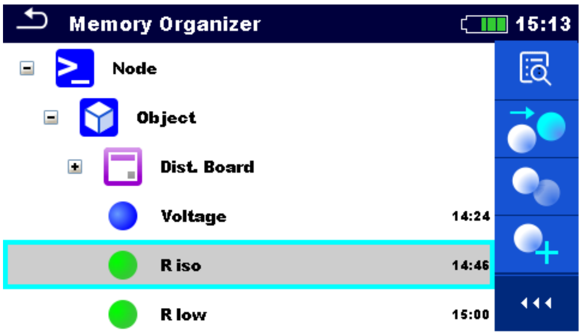
Procedure

①		Select the structure object to be renamed.
②		Select Rename in Control panel.
③		Virtual keypad will appear on screen. Enter new text and confirm. Refer to chapter ***4.3 Virtual keyboard*** for keypad operation.
④		Structure object with the modified name.

5.1.5.14 Recall and Retest selected measurement

Procedure

①

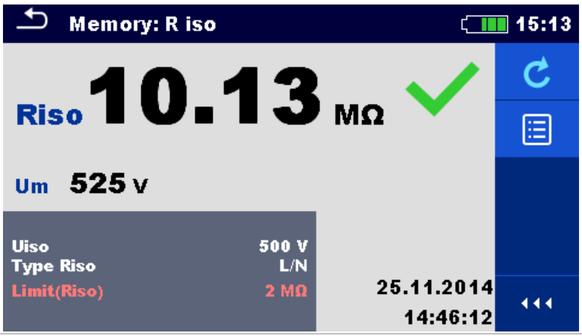


Select the measurement to be recalled.

②

Select Recall results in Control panel.

③

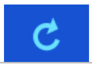


Measurement is recalled.

③ a

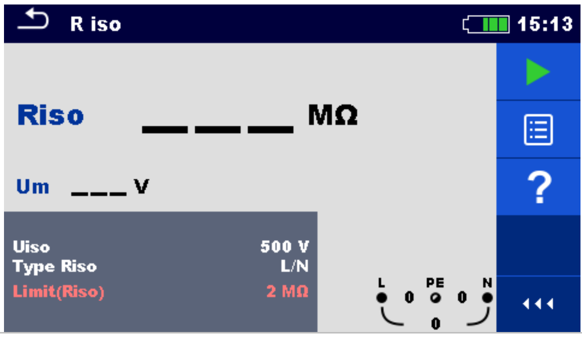
Parameters and limits can be viewed but cannot be edited.

④



Select Retest in Control panel.

⑤

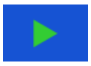


Measurement retest starting screen is displayed.

⑤a

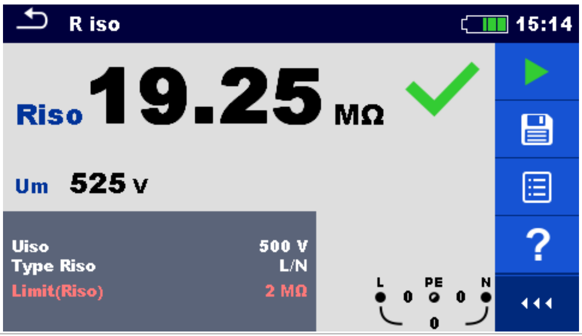
Parameters and limits can be viewed and edited.

⑥



Select Run in Control panel to retest the measurement.

⑦

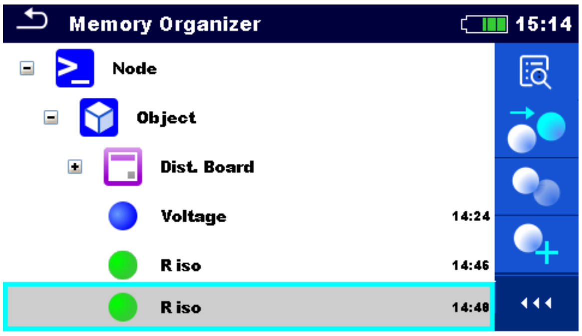


Results / sub-results after re-run of recalled measurement.

⑧

Select Save results in Control panel.

⑨



Retested measurement is saved under same structure object as original one.

Refreshed memory structure with the new performed measurement.

5.1.6 Searching in Memory Organizer

In Memory organizer it is possible to search for different structure objects and parameters. Search function is available from the active workspace directory line as presented on **Figure 5.6**.

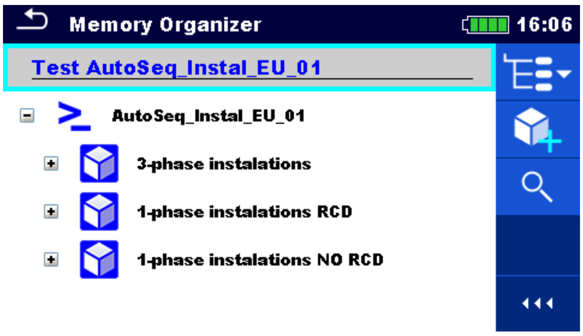
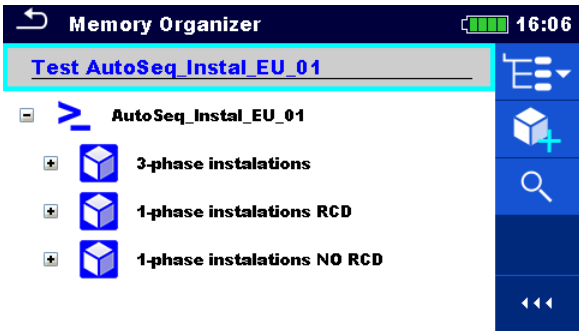


Figure 5.6: Active workspace directory

Procedure

①

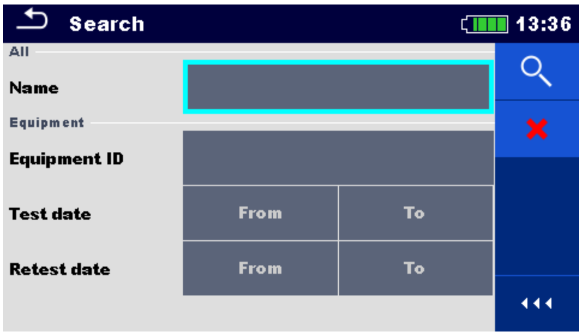


Search function is available from the active workspace directory line.

②

Select Search in control panel to open Search setup menu.

③

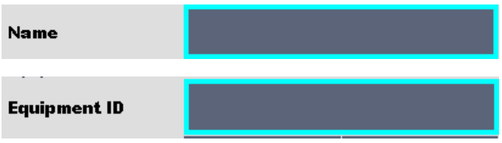


The parameter that can be searched for is displayed in the search setup menu.

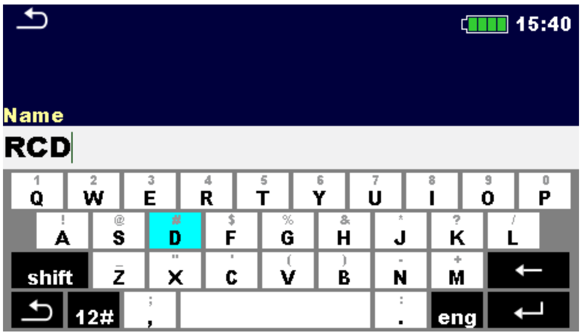
Name is referred to all structure objects.

Equipment ID, Test date and Retest date are referred to Machine structure objects.

③a

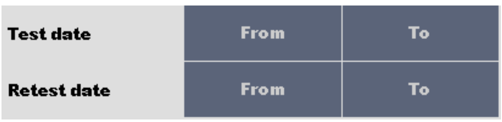


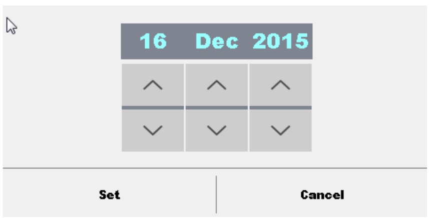
The search can be narrowed by entering a text in the Name and/or Equipment ID field.



Strings can be entered using the on-screen keyboard.

③b





The search can be narrowed on base of test dates / retest dates (from / to).

③c

Clears filters.

④ Searches through the Memory Organizer for objects according to the set filter. The results are shown in the Search results screen presented on **Figure 5.7**.

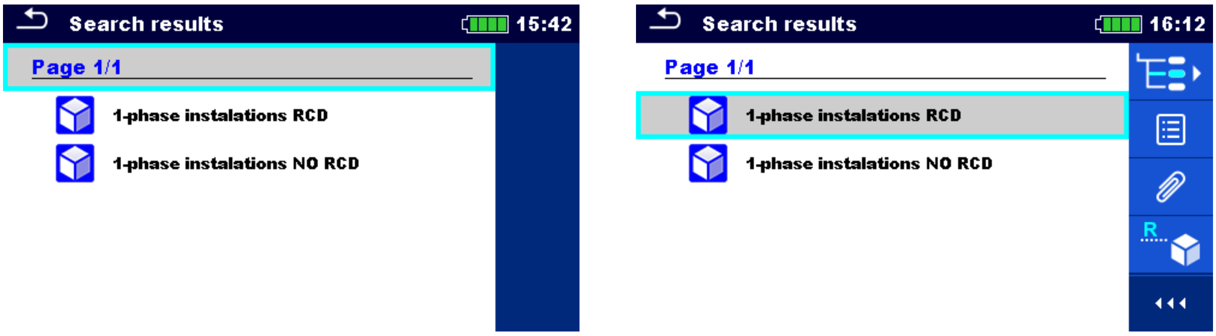


Figure 5.7: Search results screen (left), structure object selected (right)

Options

Next page (if available).

Previous page (if available).

Goes to location in Memory Organizer.

View / edit parameters and attachments.

Parameters and attachments of the Structure object can be viewed or edited. Refer to chapter ***5.1.5.3 View / Edit parameters and attachments of a Structure object*** for more information.

Attachments.

Name and link of attachment is displayed.

Views comment.

The instrument displays comment attached to the selected Structure object.

Renames the selected Structure object.

Refer to chapter ***5.1.5.13 Rename a Structure object*** for more information

Note

- Search result page consist of up to 50 results.

6 Single tests

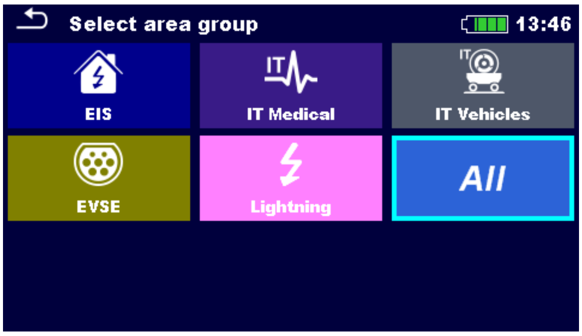
Single tests can be selected in the main **Single tests** menu or in **Memory organizer** main menu and sub-menus.

6.1 Selection modes

In **Single tests main menu** four modes for selecting single tests are available.

Options

Area Group

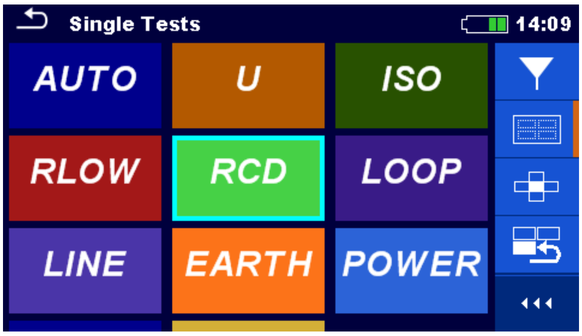


With help of area groups it is possible to limit the offered single tests. The instrument has several area groups:

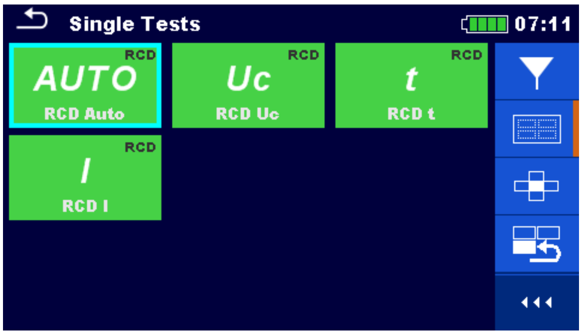
- The EIS group,
- the EVSE group,
- the Lightning group,
- the IT_Medical group,
- the IT Vehicles group,

In the All group all measurements are offered.

Groups

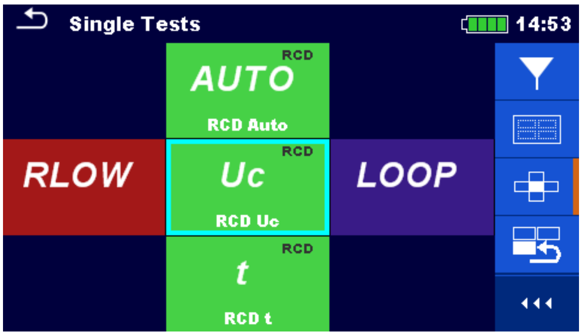


The single tests are divided into groups of similar tests.



For the selected group a submenu with all single tests that belongs to the selected group is displayed.

Cross selector

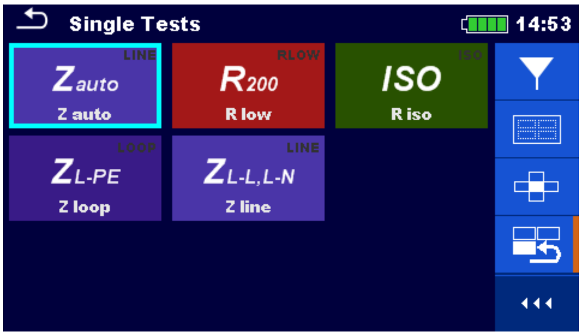


This selection mode is the fastest for working with the keypad.

Groups of single tests are organized in a row.

For the selected group all single tests are displayed and easy accessible with up /down keys.

Last used



Last 9 made different single tests are displayed.

6.1.1 Single test (measurement) screens

In the Single test (measurement) screens measuring results, sub-results, limits and parameters of the measurement are displayed. In addition on-line statuses, warnings and other info are displayed.

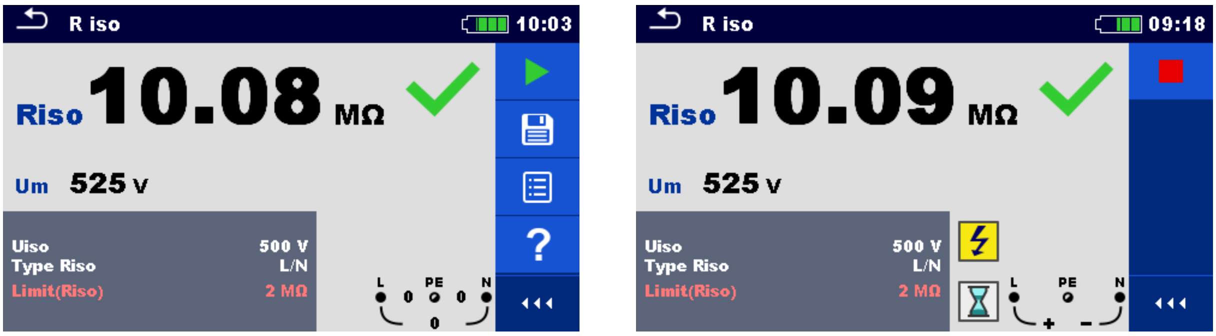
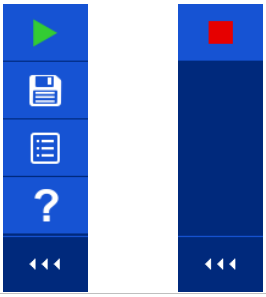


Figure 6.1: Single test screen organization, example of insulation resistance measurement

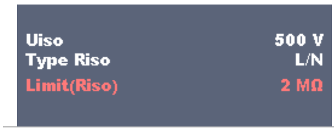
Single test screen organization

Header line:

- ESC touch key
- function name
- battery status
- real time clock



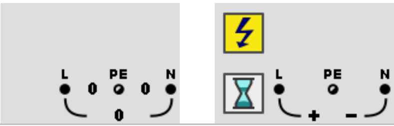
Control panel (available options)



Parameters (white) and limits (red)

Result field:

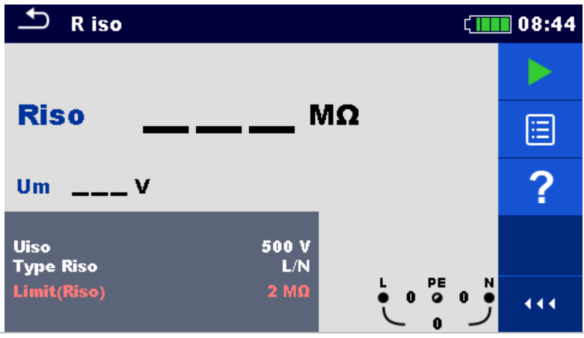
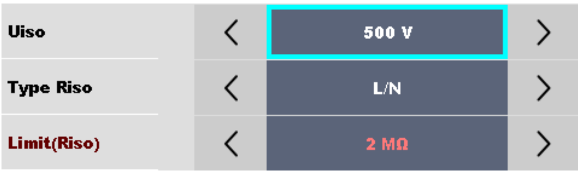
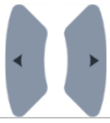
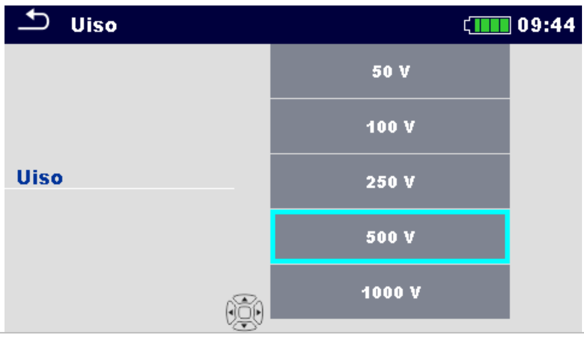
- main result(s)
- sub-result(s)
- PASS / FAIL indication



Voltage monitor with info and warning symbols

6.1.2 Setting parameters and limits of single tests

Procedure

①		Select the test or measurement. The test can be entered from: ‣ Single tests menu or ‣ Memory organizer menu once the empty measurement was created in selected object structure.
②		Select Parameters in Control panel.
③		Select parameter to be edited or limit to be set.
	 on  	Set parameter or limit value.
③a	 on  	Enters Set value menu.
③b		Set value menu.
③c	 on  	Accepts a new parameter or limit value and exits.

④	Accepts the new parameters and limit values and exits.

6.1.3 Single test start screen

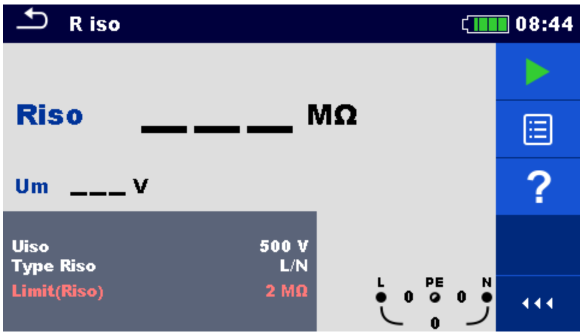


Figure 6.2: Single test start screen, example of insulation resistance measurement

Options (before test, screen was opened in Memory organizer or Single test main menu)

	Starts the measurement.
long **long**	Starts the continuous measurement (if applicable on selected single test).
	Opens help screens.
on 	Opens menu for changing parameters and limits. Refer to chapter ***6.1.2 Setting parameters and limits of single tests*** for more information.
long on 	Enters cross selector to select test or measurement.
	Expands column in control panel.

6.1.4 Single test screen during test

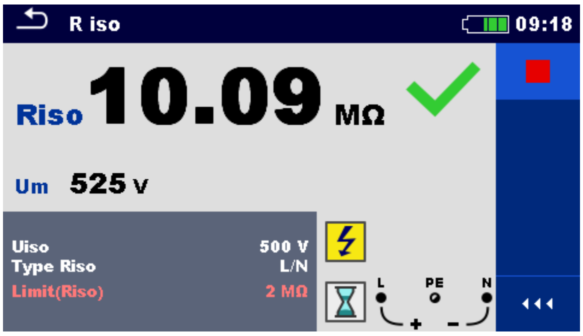
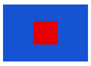


Figure 6.3: Single test is running, example of insulation resistance continuous measurement

Operations when test is running

 	Stops the single test measurement.
	Proceeds to next step of the measurement (if measurement consists of more steps).
 	Previous value.
 	Next value.
 	Stops or aborts the measurement and returns one menu back.

6.1.5 Single test result screen

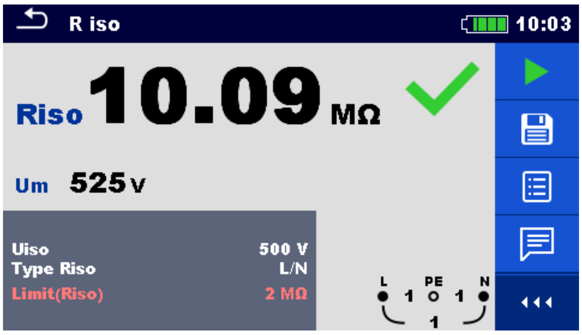
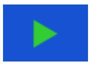
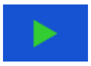


Figure 6.4: Single test results screen, example of insulation resistance measurement results

Options (after measurement is finished)

 	Starts a new measurement.
 **long**  **long**	Starts a new continuous measurement (if applicable on selected single test).
 	Saves the result. A new measurement was selected and started from a Structure object in the structure tree: • the measurement will be saved under the selected Structure object. A new measurement was started from the Single test main menu: • saving under the last selected Structure object will be offered by default. The user can select another Structure object or create a new Structure object. • By pressing the  key in Memory organizer menu the measurement is saved under selected location. An empty measurement was selected in structure tree and started: • the result(s) will be added to the measurement. The measurement will change its status from ‘empty’ to ‘finished’.

	An already carried out measurement was selected in structure tree, viewed and then restarted: ▸ a new measurement will be saved under the selected Structure object.
	Opens help screens.
  on 	Opens screen for changing parameters and limits. Refer to chapter ***6.1.2 Setting parameters and limits of single*** **tests** for more information.
 **long** on 	Enters cross selector to select test or measurement.
	Adds comment to the measurement. The instrument opens keypad for entering a comment.
 	Expands column in control panel.

6.1.6 Editing graphs (Harmonics)

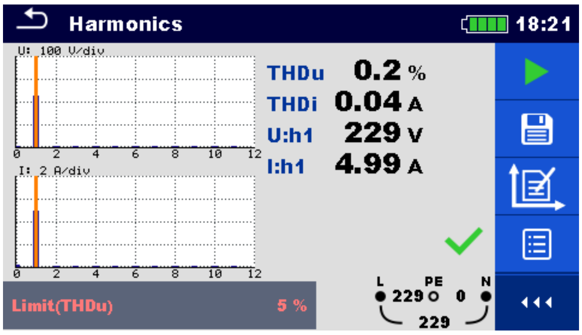


Figure 6.5: Example of Harmonics measurement results

Options for editing graphs (start screen or after measurement is finished)

	Plot edit Opens control panel for editing graphs.
 	Increase scale factor for y-axis.
 	Decrease scale factor for y-axis.
	Toggle between U and I graph to set scale factor
 	Exits from editing graphs.

6.1.7 Recall single test results screen

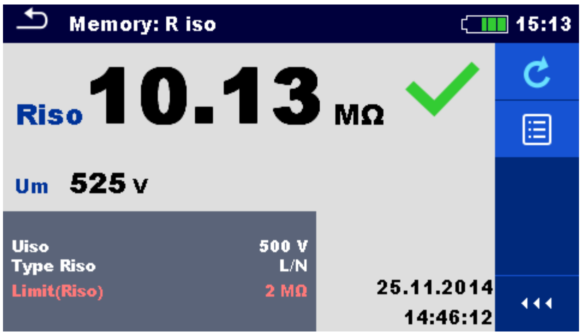


Figure 6.6: Recalled results of selected measurement, example of insulation resistance recalled results

Options

	Retest Enters starting screen for a new measurement. Refer to chapter ***6.1.3 Single test start screen*** for more information.
  on 	Opens menu for viewing parameters and limits. Refer to chapter **6.1.2 Setting parameters and limits of single tests** for more information.
 	Expands column in control panel.

6.1.8 Single test (inspection) screens

Visual and Functional inspections can be treated as a special class of tests. Items to be visually or functionally checked are displayed. In addition on-line statuses and other information are displayed. Type of inspection depends on type and profile of the instruments.

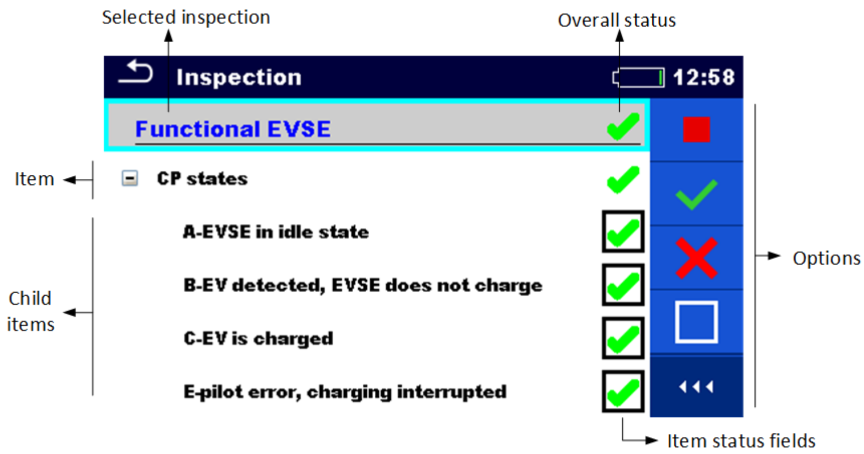


Figure 6.7: Inspection screen organisation

6.1.8.1 Single test (inspection) start screen

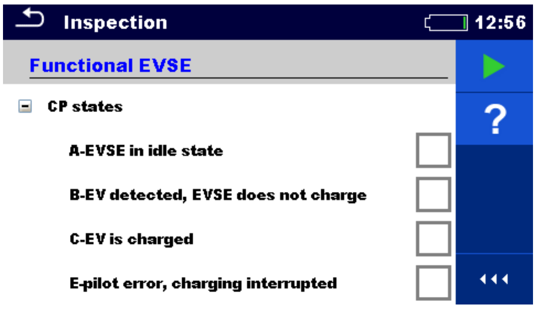


Figure 6.8: Inspection start screen

Options (inspection screen was opened in Memory organizer or from Single test main menu)

	Starts the inspection
	Opens help screens. Refer to chapter ***6.1.9 Help screens*** for more information.

6.1.8.2 Single test (Inspection) screen during test

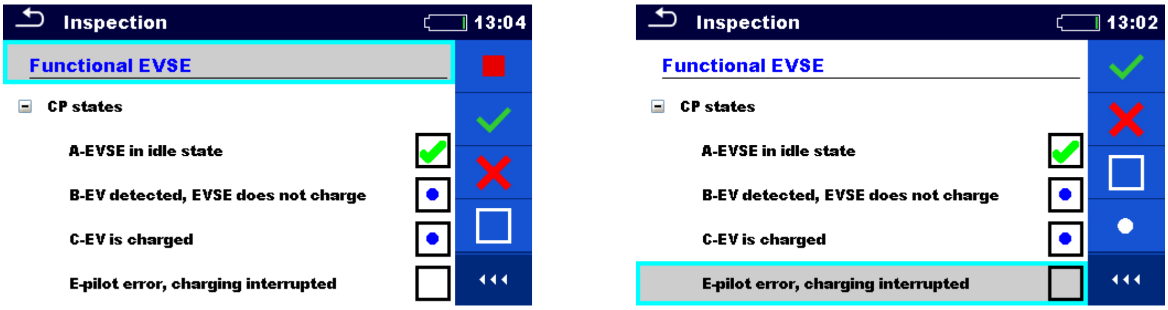
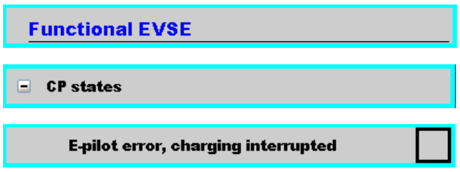
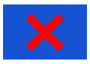
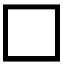


Figure 6.9: Inspection screen (during inspection)

Options (during test)

	Selects item.
	Stops the inspection.
	Applies a pass to the selected item or group of items.
	Applies a fail to the selected item or group of items.
	Clears status in selected item or group of items
	Applies checked status to selected item or group of items.
 on 	A status can be applied Multiple taps toggles between statuses.
	Toggle between statuses.
	Goes to the result screen.

Rules for automatic applying of statuses:

- The parent item(s) can automatically get a status on base of statuses in child items.
  - the fail status has highest priority. A fail status for any item will result in a fail status in all parent items and an overall fail result.
  - if there is no fail status in child items the parent item will get a status only if all child items have a status.
  - Pass status has priority over checked status.

- The child item(s) will automatically get a status on base of status in the parent item.
  - All child items will get the same status as applied to the parent item.

Note

- Inspections and even inspection items inside one inspection can have different status types. For example some basic inspections don’t have the ‘checked’ status.
- Only inspections with overall statuses can be saved.

6.1.8.3 Single test (Inspection) result screen

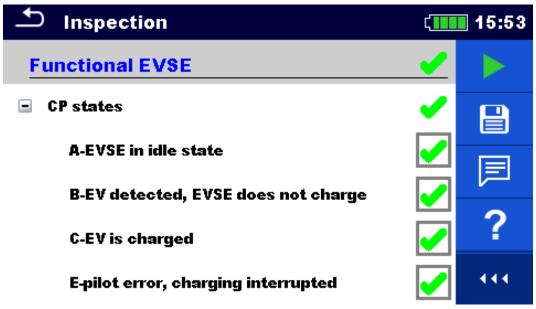


Figure 6.10: Inspection result screen

Options (after inspection is finished)

	Starts a new inspection.
	Saves the result. A new inspection was selected and started from a Structure object in the structure tree: • The inspection will be saved under the selected Structure object. A new inspection was started from the Single test main menu: • Saving under the last selected Structure object will be offered by default. The user can select another Structure object or create a new Structure object. By pressing the  key in Memory organizer menu the inspection is saved under selected location. An empty inspection was selected in structure tree and started: • The result(s) will be added to the inspection. The inspection will change its status from ‘empty’ to ‘finished’. An already carried out inspection was selected in structure tree, viewed and then restarted: • A new measurement will be saved under the selected Structure object.
	Adds comment to the measurement. The instrument opens keypad for entering a comment.
	Opens help screens. Refer to chapter ***6.1.9 Help screens*** for more information.

6.1.8.4 Single test (inspection) memory screen

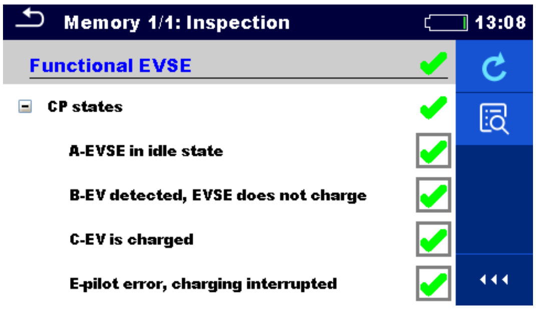


Figure 6.11: Inspection memory screen

Options

	**Retest** Enters screen with “empty” measurement.
	Enters view mode.

6.1.9 Help screens

Help screens contain diagrams for proper connection of the instrument.

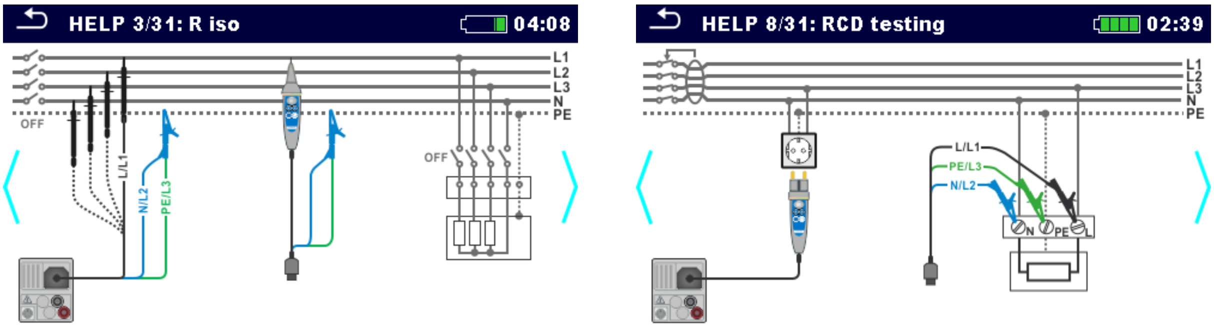
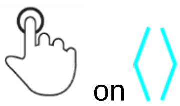
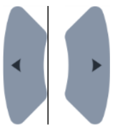


Figure 6.12: Examples of help screens

Options

	Opens help screen.
 	Goes to previous / next help screen.
 	Back to test / measurement menu.

7 Tests and measurements

See chapter ***6.1 Selection modes*** for instructions on keys and touch screen functionality.

7.1 Voltage, frequency and phase sequence

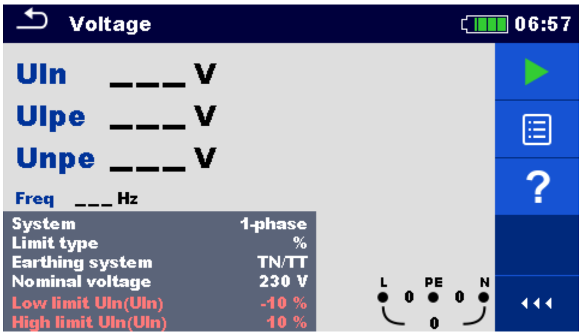


Figure 7.1: Voltage measurement menu

Measurement parameters

System [1)]	Voltage system [-, 1-phase,3-phase]
Limit type	Type of limit [Voltage, %]
Earthing system	Earthing system [TN/TT, IT]
Nominal voltage [2)]	[110V, 115V, 190V, 200V, 220V, 230V, 240V, 380V, 400V, 415V]

1) There are no limits to set if System parameter is set to '–'.
2) Active only if limit type is set to %

Refer to chapter ***4.6.5 Settings*** for more information.

Measurement limits for TN/TT earthing system:

Low limit Uln[3)]	**Min. voltage** [0 V … 499 V]
High limit Uln[3)]	**Max. voltage** [0 V … 499 V]
Low limit Uln[4)]	**Min. voltage** [-20% … 20%]
High limit Uln[4)]	**Max. voltage** [-20% … 20%]
Low limit Ulpe[3,4)]	**Min. voltage** [0 V … 499 V]
High limit Ulpe[3,4)]	**Max. voltage** [0 V … 499 V]
Low limit Unpe[3,4)]	**Min. voltage** [0 V … 499 V]
High limit Unpe[3,4)]	**Max. voltage** [0 V … 499 V]
Low limit U12[5)]	**Min. voltage** [0 V … 499 V]
High limit U12[5)]	**Max. voltage** [0 V … 499 V]
Low limit U13[5)]	**Min. voltage** [0 V … 499 V]
High limit U13[5)]	**Max. voltage** [0 V … 499 V]
Low limit U23[5)]	**Min. voltage** [0 V … 499 V]
High limit U23[5)]	**Max. voltage** [0 V … 499 V]
Low limit Ull[6)]	**Min. voltage** [-20% … 20%]
High limit Ull[6)]	**Max. voltage** [-20% … 20%]

3) In case of 1-phase voltage system and limit type set to voltage.
4) In case of 1-phase voltage system and limit type set to %.
5) In case of 3-phase voltage system and limit type set to voltage.
6) In case of 3-phase voltage system and limit type set to %.

Measurement limits for IT earthing system:

Low limit U12[7,9]	**Min. voltage** [0 V … 499 V]
High limit U12[7,9]	**Max. voltage** [0 V … 499 V]
Low limit U12[8]	**Min. voltage** [-20% … 20%]
High limit U12[8]	**Max. voltage** [-20% … 20%]
Low limit U1pe[7,8]	**Min. voltage** [0 V … 499 V]
High limit U1pe[7,8]	**Max. voltage** [0 V … 499 V]
Low limit U2pe[7,8]	**Min. voltage** [0 V … 499 V]
High limit U2pe[7,8]	**Max. voltage** [0 V … 499 V]
Low limit U13[9]	**Min. voltage** [0 V … 499 V]
High limit U13[9]	**Max. voltage** [0 V … 499 V]
Low limit U23[9]	**Min. voltage** [0 V … 499 V]
High limit U23[9]	**Max. voltage** [0 V … 499 V]
Low limit Ull[10]	**Min. voltage** [-20% … 20%]
High limit Ull[10]	**Max. voltage** [-20% … 20%]

7) In case of 1-phase voltage system and limit type set to voltage.
8) In case of 1-phase voltage system and limit type set to %.
9) In case of 3-phase voltage system and limit type set to voltage.
10) In case of 3-phase voltage system and limit type set to %.

Connection diagrams

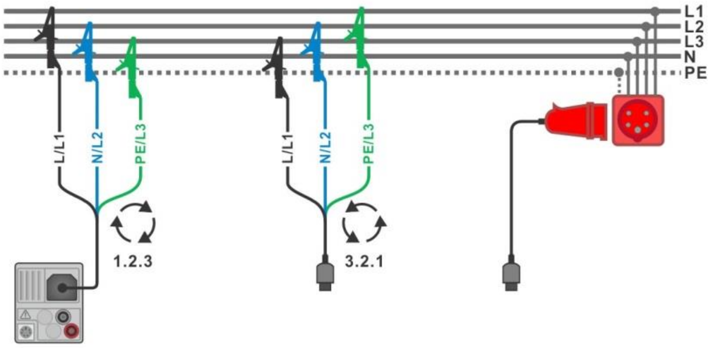


Figure 7.2: Connection of 3-wire test lead and optional adapter in three-phase system

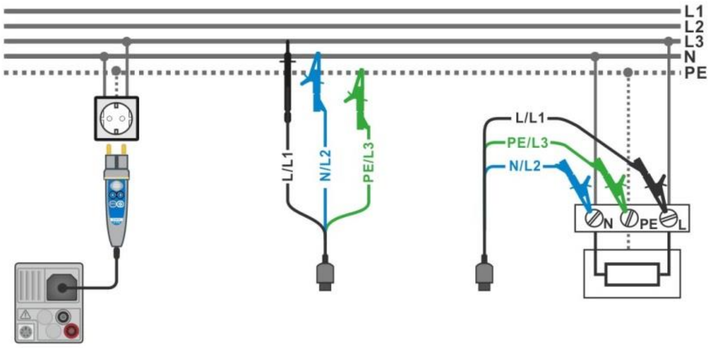


Figure 7.3: Connection of Plug commander and 3-wire test lead in single-phase system

Measurement procedure

- Enter the **Voltage** function.
- Connect test cable to the instrument.
- Connect test leads to object under test (see ***Figure 7.2*** and ***Figure 7.3***).
- Start the continuous measurement.

- Stop the measurement.
- Save results (optional).

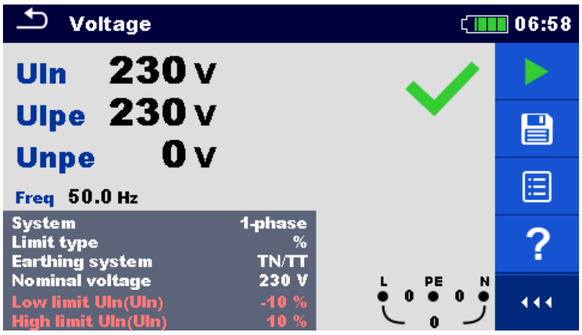


Figure 7.4: Example of Voltage measurement in single-phase system

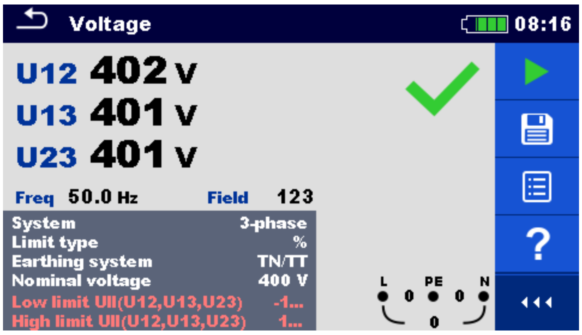


Figure 7.5: Examples of Voltage measurement in three-phase system

Measurement results / sub-results

Single-phase TN/TT system

Uln	voltage between phase and neutral conductors
Ulpe	voltage between phase and protective conductors
Unpe	voltage between neutral and protective conductors
Freq	frequency

Single-phase IT earthing system

U12	voltage between phases L1 and L2
U1pe	voltage between phase L1 and PE
U2pe	voltage between phase L2 and PE
Freq	frequency

Three-phase TN/TT and IT system

U12	voltage between phases L1 and L2
U13	voltage between phases L1 and L3
U23	voltage between phases L2 and L3
Freq	frequency
Field	**1.2.3** - correct connection – CW rotation sequence **3.2.1** - invalid connection – CCW rotation sequence

7.2 R iso – Insulation resistance

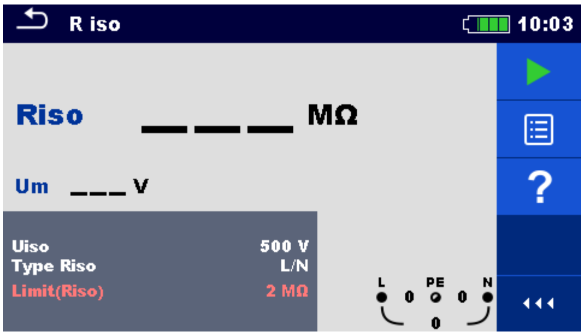


Figure 7.6: Insulation resistance measurement menu

Measurement parameters / limits

Uiso	**Nominal test voltage** [50 V, 100 V, 250 V, 500 V, 1000 V, 2500 V[1)]]
Type Riso[2)]	**Type of test** [-, L/PE, L/N, N/PE, L/L, L1/L2, L1/L3, L2/L3, L1/N, L2/N, L3/N, L1/PE, L2/PE, L3/PE]
Limit(Riso)	**Min. insulation resistance** [Off, 0.01 MΩ ... 100 MΩ]

1) Nominal test voltage 2500 V is available on MI 3152H only.
2) With Plug test cable or Plug commander Insulation is always measured between L/L1 and N/L2 test lead regardless of the setting. The parameter is meant for documentation.

Connection diagrams

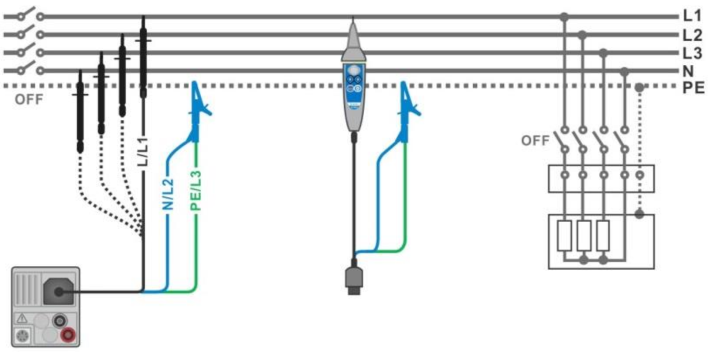


Figure 7.7: Connection of 3-wire test lead and Tip commander ($U_N \leq 1$ kV)

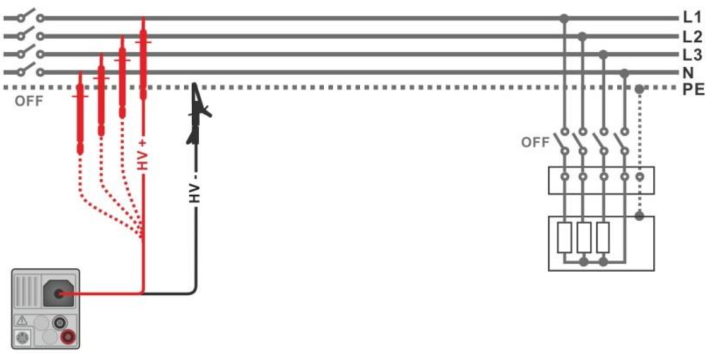


Figure 7.8: Connection of 2.5 kV test lead (U_N =2.5 kV)

Measurement procedure

- Enter the **R iso** function.
- Set test parameters / limits.
- Disconnect tested installation from mains supply and discharge installation as required.
- Connect test cable to the instrument.
- Connect test leads to object under test (see ***Figure 7.7*** and ***Figure 7.8***). Different test cable must be used for testing with nominal test voltage $U_N \leq$ 1000 V and U_N= 2500 V. Also different test terminals are used. The standard 3-wire test lead, Schuko test cable or Plug / Tip commanders can be used for the insulation test with nominal test voltages ≤ 1000 V. For the 2500 V insulation test the two wire 2.5 kV test lead should be used.
- Start the measurement. A longer press on TEST key or a longer press on “Start test” option on touch screen starts a continuous measurement.
- Stop the measurement. Wait until object under test is fully discharged.
- Save results (optional).

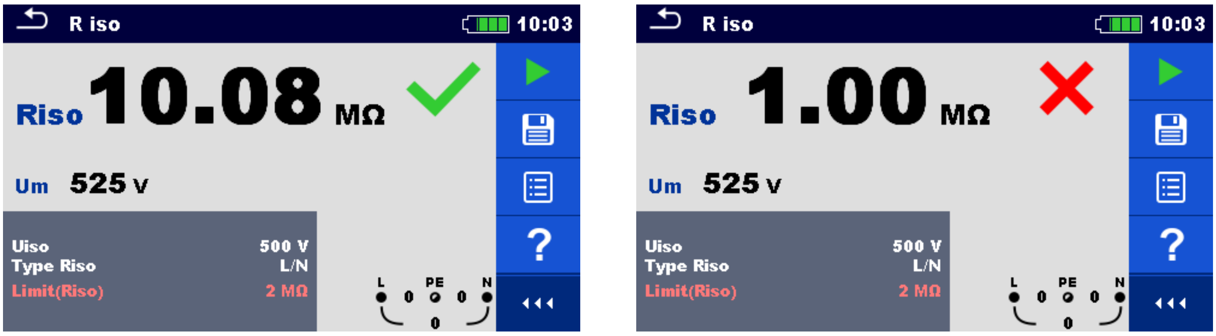


Figure 7.9: Examples of Insulation resistance measurement result

Measurement results / sub-results

Riso	Insulation resistance
Um	Actual test voltage

7.3 The DAR and PI diagnostic (MI 3152H only)

DAR (**D**ielectric **A**bsorption **R**ation) is ratio of insulation resistance values measured after 15 seconds and after 1 minute. The DC test voltage is present during the whole period of the measurement.

$$DAR = \frac{R_{ISO}(1\ \text{min})}{R_{ISO}(15\ \text{s})}$$

PI (**P**olarization **I**ndex) is the ratio of insulation resistance values measured after 1 minute and after 10 minutes. The DC test voltage is present during the whole period of the measurement

$$PI = \frac{R_{ISO}(10\ \text{min})}{R_{ISO}(1\ \text{min})}$$

For additional information regarding PI and DAR diagnostic, please refer to Metrel's handbook **Modern insulation testing**.

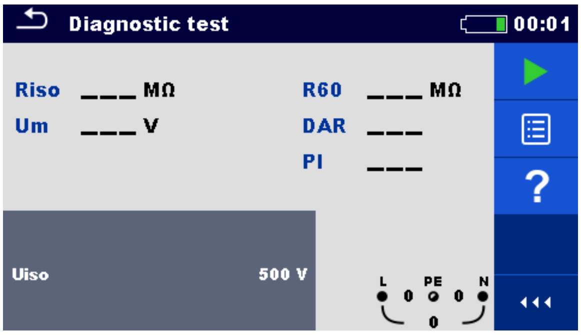


Figure 7.10: Diagnostic test menu

Measurement parameters / limits

Uiso	**Nominal test voltage** [500 V, 1000 V, 2500 V]

Connection diagrams

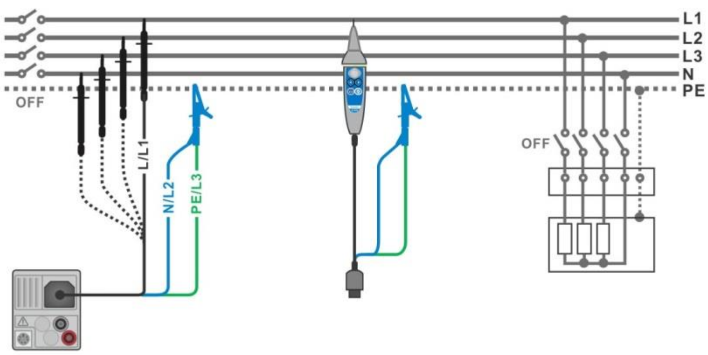


Figure 7.11: Connection of 3-wire test lead and Tip commander ($U_N \leq 1$ kV)

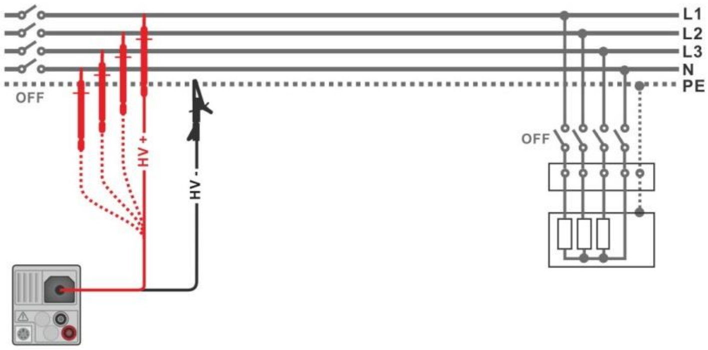
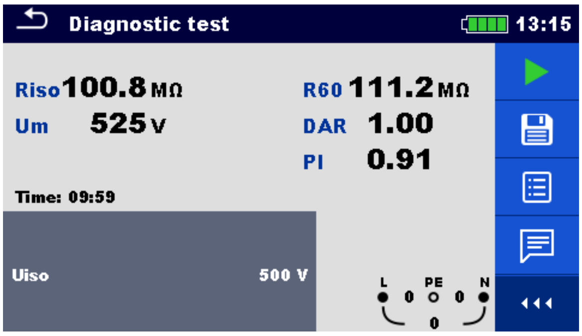


Figure 7.12: Connection of 2.5 kV test lead (U_N = 2.5 kV)

Measurement procedure

- Enter the **Diagnostic test** function.
- Set test parameters / limits.
- Disconnect tested installation from mains supply and discharge installation as required.
- Connect test cable to the instrument.
- Connect test leads to object under test (see ***Figure 7.11*** and ***Figure 7.12***). Different test cable must be used for testing with nominal test voltage U_N ≤ 1000 V and U_N= 2500 V. Also different test terminals are used. The standard 3-wire test lead, Schuko test cable or Plug / Tip commanders can be used for the insulation test with nominal test voltages ≤ 1000 V. For the 2500 V insulation test the two wire 2.5 kV test lead should be used.
- Start the measurement. Internal timer begins to increment. When internal timer reaches 1 min R60 and DAR factor are displayed and short beep is generated. Measurement can be interrupted at any time.
- When internal timer reaches 10 min also PI factor is displayed and measurement is completed. Wait until object under test is fully discharged.
- After the measurement is finished wait until tested item is fully discharged.
- Save results (optional).



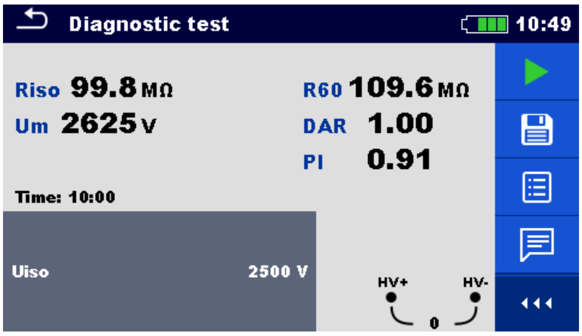


Figure 7.13: Examples of Diagnostic test result

Measurement results / sub-results

Riso	Insulation resistance
Um	Actual test voltage
R60	Resistance after 60 seconds
DAR	Dielectric absorption ratio
PI	Polarization index

7.4 Varistor test

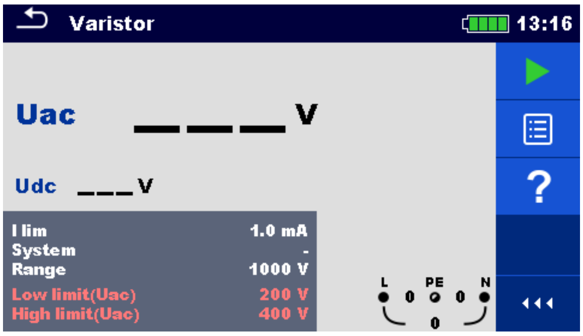


Figure 7.14: Varistor test main menu

Measurement parameters / limits

I lim	**Current limit** [1.0 mA]
System	**System** [-, TT, TN, TN-C, TN-S]
Range	**Test voltage range** [1000 V, 2500 V*]
Low limit (Uac)	**Low breakdown limit value** @ **1000 V** range [Off, 50 V … 620 V] @ **2500 V** range [Off, 50 V … 1550 V]*
High limit (Uac)	**High breakdown limit value** @ **1000 V** range [Off, 50 V … 620 V] @ **2500 V** range [Off, 50 V … 1550 V]*

* For MI 3152H only

Test circuit for Varistor test

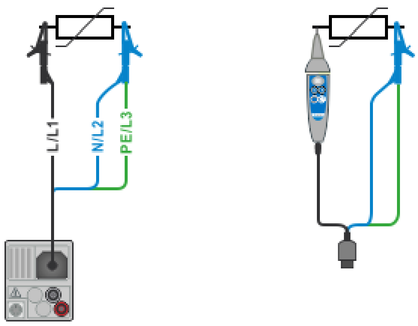


Figure 7.15: Connection of 3-wire test lead ($U_N \leq$ 1 kV)

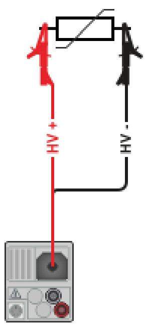


Figure 7.16: Connection of 2.5 kV test lead (Range: 2500 V)

Measurement procedure

- Enter the **Varistor test** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to object under test (see ***Figure 7.15*** and ***Figure 7.16***).
  Different test cable must be used for testing with MI 3152 where end voltage is 1000 V and MI 3152H where end voltage is 2500 V. Also different test terminals are used.
  The standard 3-wire test lead, Plug test cable or Plug / Tip commander can be used for the Varistor test with end voltage 1000 V. For the 2500 V Varistor test the two wire 2.5 kV test lead should be used.
- Start the measurement.
  A voltage ramp starts from 50 V and rises with a slope of 100 V/s (Range parameter set to 1000 V) or 350 V/s (Range parameter set to 2500 V). The measurement ends when the defined end voltage is reached or if the test current exceeds the value of 1 mA.
- After the measurement is finished wait until tested item is fully discharged.
- Save results (optional).

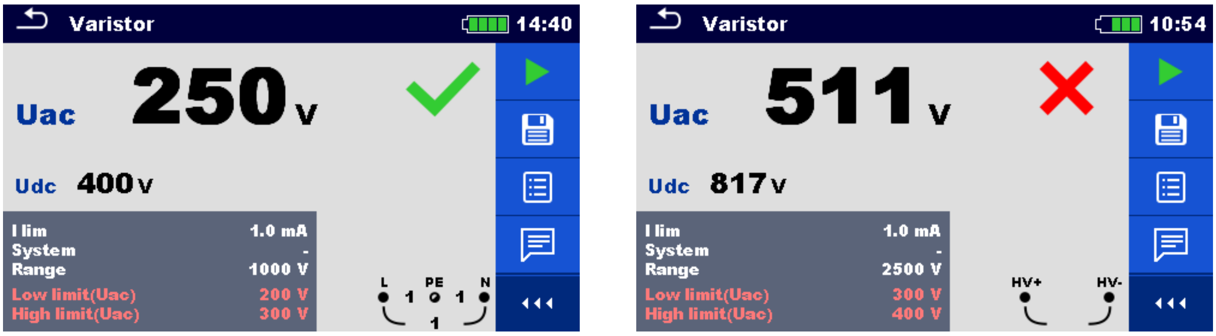


Figure 7.17: Examples of varistor test result

Measurement results / sub-results

Uac	Calculated a.c. breakdown voltage
Udc	Breakdown voltage

Meaning of the Uac voltage

Protection devices intended for a.c. network are usually dimensioned approx. 15 % above peak value of the nominal mains voltage. The relation between Udc and Uac is following:

$$Uac \approx \frac{Udc}{1.15 \times \sqrt{2}}$$

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

7.5 R low – Resistance of earth connection and equipotential bonding

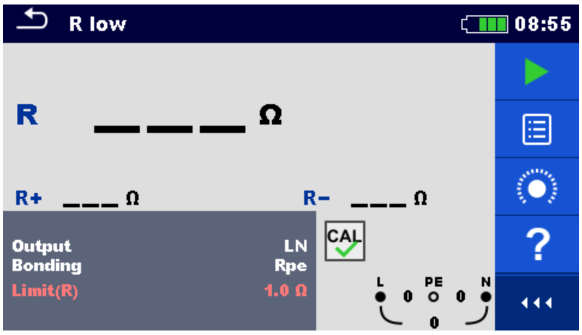


Figure 7.18: R low measurement menu

Measurement parameters / limits

Output[1)]	[LN, LPE]
Bonding	[Rpe, Local]
Limit(R)	**Max. resistance** [Off, 0.05 Ω ... 20.0 Ω]

1) R low measurement depends on Output parameter setting, see table below.

Output	Test terminals
LN	L and N
LPE	L and PE

Connection diagram

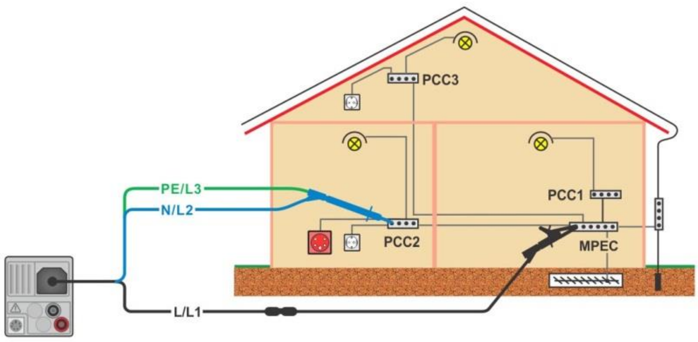
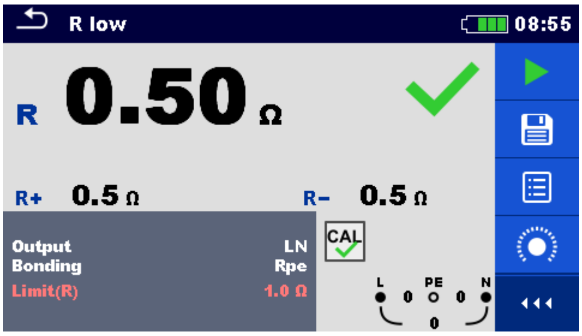


Figure 7.19: Connection of 3-wire test lead plus optional Extension lead

Measurement procedure

- Enter the **R low** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Compensate the test leads resistance if necessary, see section ***7.6.1 Compensation of test leads resistance***.
- Disconnect tested installation from mains supply and discharge insulation as required.
- Connect test leads, see ***Figure 7.19***.
- Start the measurement.
- Save results (optional).



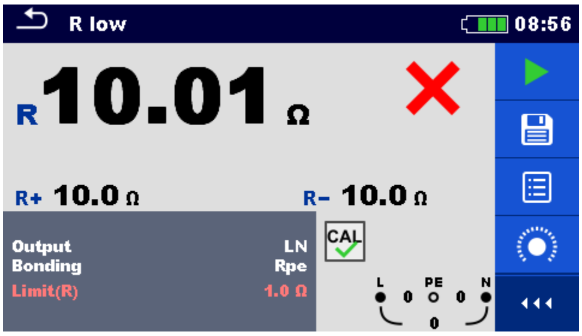


Figure 7.20: Examples of R low measurement result

Measurement results / sub-results

R	Resistance
R+	Result at positive test polarity
R-	Result at negative test polarity

7.6 Continuity – Continuous resistance measurement with low current

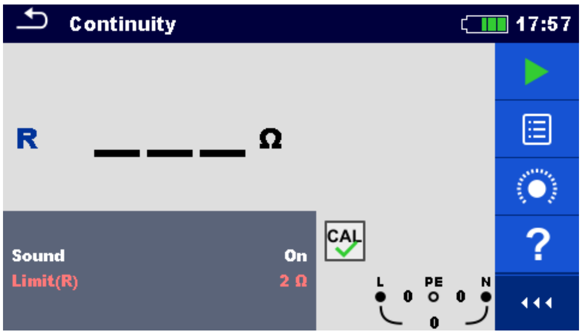


Figure 7.21: Continuity resistance measurement menu

Measurement parameters / limits

Sound	[On*, Off]
Limit(R)	**Max. resistance** [Off, 0.1 Ω ... 20.0 Ω]

*Instrument sounds if resistance is lower than the set limit value.

Connection diagrams

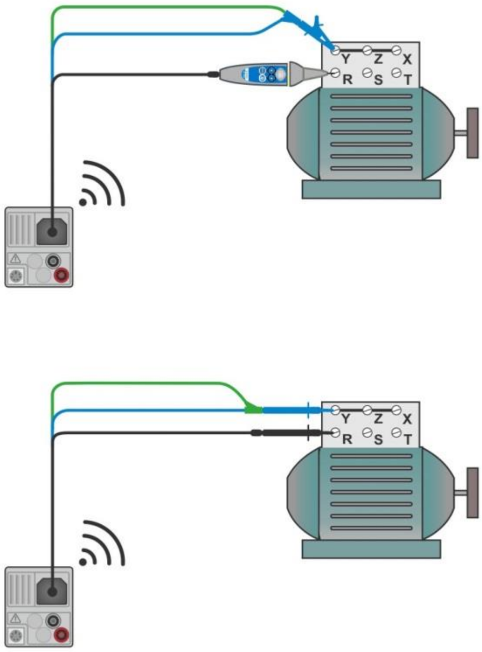


Figure 7.22: Tip commander and 3-wire test lead applications

Measurement procedure

- Enter the **Continuity** function.
- Set test parameters / limits.
- Connect test cable to the instrument.

- Compensate the test leads resistance if necessary, see section ***7.6.1 Compensation of test leads resistance***.
- Disconnect device under test from mains supply and discharge it as required.
- Connect test leads to device under test, see ***Figure 7.22.***
- Start the measurement.
- Stop the measurement.
- Save results (optional).

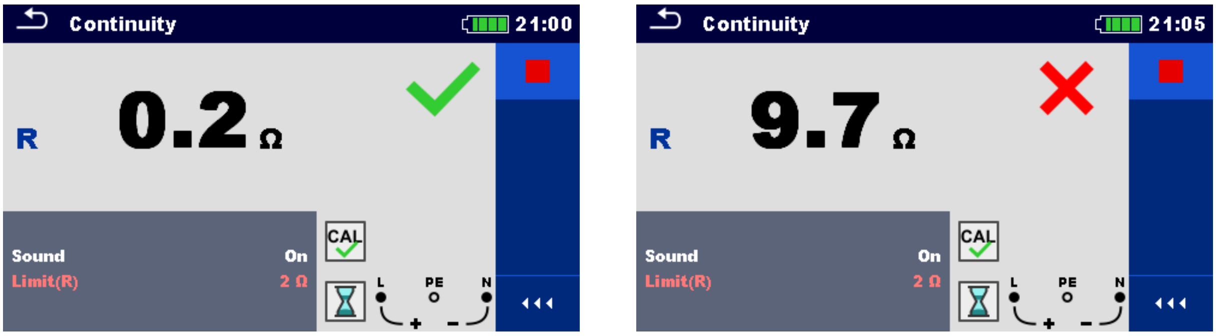


Figure 7.23: Examples of Continuity resistance measurement result

Measurement results / sub-results

R	Resistance

7.6.1 Compensation of test leads resistance

This chapter describes how to compensate the test leads resistance in **R low** and **Continuity** functions. Compensation is required to eliminate the influence of test leads resistance and the internal resistances of the instrument on the measured resistance. The lead compensation is therefore a very important feature to obtain correct result.

symbol is displayed if the compensation was carried out successfully.

Connections for compensating the resistance of test leads

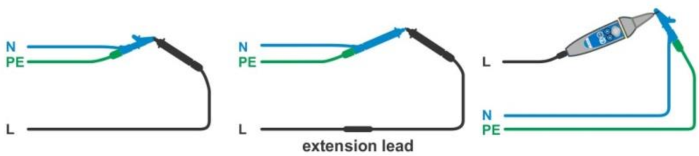


Figure 7.24: Shorted test leads

Compensation of test leads resistance procedure

- Enter **R low** or **Continuity** function.
- Connect test cable to the instrument and short the test leads together, see ***Figure 7.24***.
- Touch the  key to compensate leads resistance.

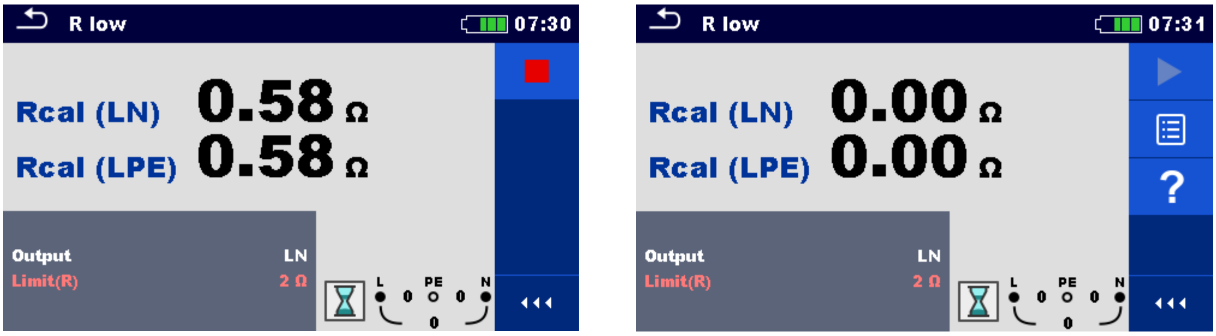


Figure 7.25: Result with old and new calibration values

7.7 Testing RCDs

Various test and measurements are required for verification of RCD(s) in RCD protected installations. Measurements are based on the EN 61557-6 standard.
The following measurements and tests (sub-functions) can be performed:

- Contact voltage,
- Trip-out time,
- Trip-out current and
- RCD Auto test.

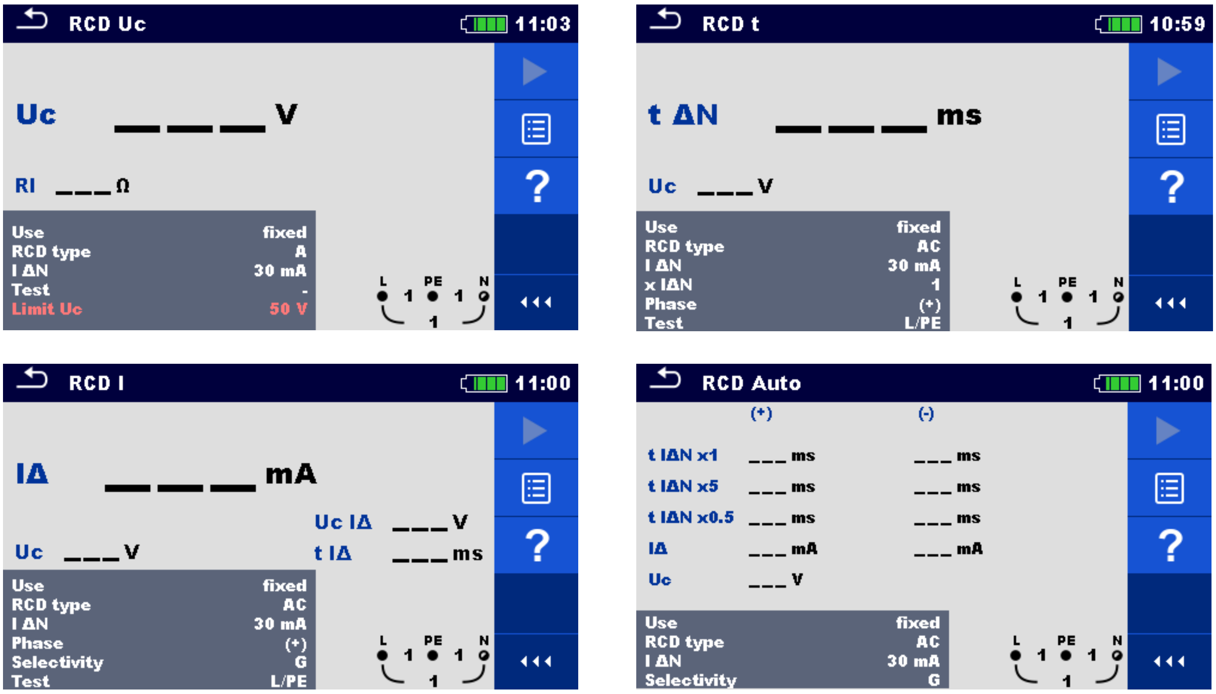


Figure 7.26: RCD menus

Test parameters / limits

I ΔN	**Rated RCD residual current sensitivity** [10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]
I ΔN/ I ΔNdc	**Rated RCD residual current sensitivity for special RCDs types** [30 mA / 6 mA d.c.] [1)]
Type	**RCD type** [AC, A, F, B*, B+*, EV RCD[1)], MI RCD[1)]]
Use	**RCD / PRCD selection** [fixed, PRCD, PRCD-S, PRCD-K, other]
Selectivity	**Characteristic** [G, S]
x IΔN	**Multiplication factor for test current** [0.5, 1, 2, 5]
Phase	**Starting polarity** [(+), (-), (+,-)]
Limit Uc	**Conventional touch voltage limit** [12 V, 25 V, 50 V]
Test	**Test current shape** [a.c., d.c.][1), 3)]
Test	**Test** [-, L/PE, L1/PE, L2/PE, L3/PE] [2)]
RCD standard	Refer to chapter ***4.6.5.1 RCD standard*** for more information.
Earthing system	Refer to chapter ***4.6.5 Settings*** for more information.

* Model MI 3152 only.

1) Parameter is available only when parameter Use is set to other (for Electrical Vehicle (EV) RCDs and Mobile installations (MI) RCDs).

2) With Plug test cable or Plug commander RCD tests are measured in the same way regardless of the setting. The parameter is meant for documentation.

3) Parameter is available only when RCD I test is selected and parameter Use is set to other.

Connection diagram

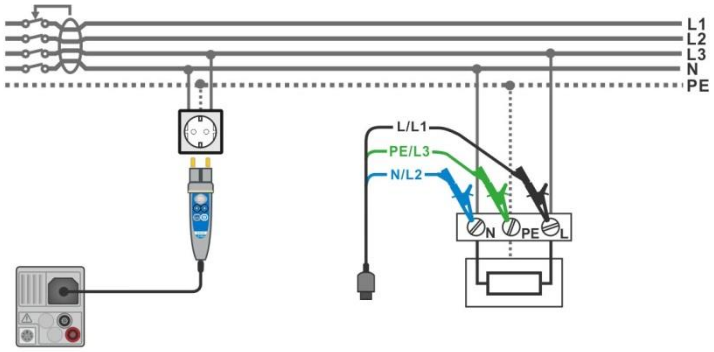


Figure 7.27: Connecting the Plug commander and the 3-wire test lead

7.7.1 RCD Uc – Contact voltage

Test procedure

- Enter the **RCD Uc** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.27***.
- Start the measurement.
- Save results (optional).

The contact voltage result relates to the rated nominal residual current of the RCD and is multiplied by an appropriate factor (depending on RCD type and type of test current). The 1.05 factor is applied to avoid negative tolerance of result. See ***Table 7.1*** for detailed contact voltage calculation factors.

RCD type		**Contact voltage Uc proportional to**	**Rated $I_{\Delta N}$**	**Notes**
AC, EV, MI (a.c. part)	G	$1.05 \times I_{\Delta N}$	any	All models
AC	S	$2 \times 1.05 \times I_{\Delta N}$		
A, F	G	$1.4 \times 1.05 \times I_{\Delta N}$	≥ 30 mA	
A, F	S	$2 \times 1.4 \times 1.05 \times I_{\Delta N}$		
A, F	G	$2 \times 1.05 \times I_{\Delta N}$	< 30 mA	
A, F	S	$2 \times 2 \times 1.05 \times I_{\Delta N}$		
B, B+	G	$2 \times 1.05 \times I_{\Delta N}$	any	Model MI 3152 only
B, B+	S	$2 \times 2 \times 1.05 \times I_{\Delta N}$		

Table 7.1: Relationship between Uc and $I_{\Delta N}$

Fault Loop resistance is indicative and calculated from Uc result (without additional proportional factors) according to: $R_L = \frac{U_C}{I_{\Delta N}}$.

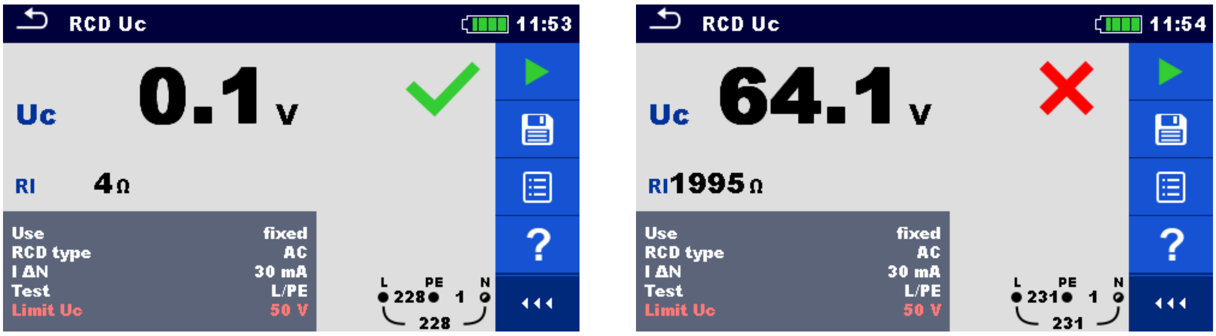


Figure 7.28: Examples of Contact voltage measurement result

Test result / sub-results

Uc	Contact voltage
Rl	Calculated fault loop resistance

7.7.2 RCD t – Trip-out time

Test procedure

- Enter the **RCD t** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.27***.
- Start the measurement.
- Save results (optional).

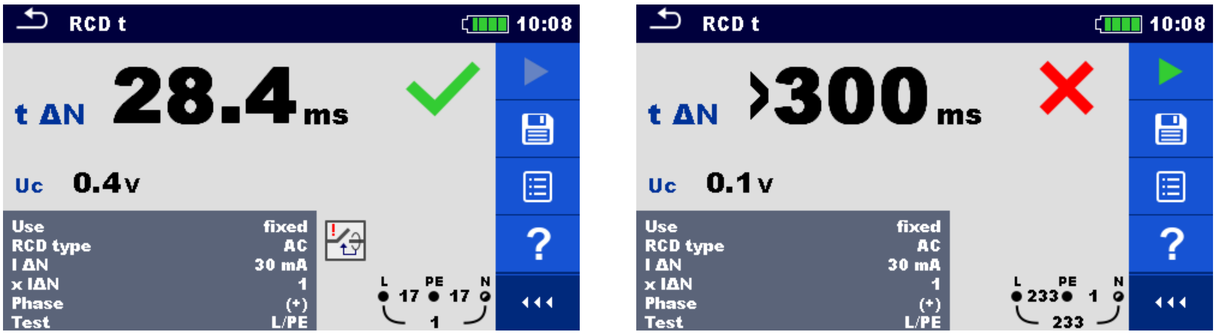


Figure 7.29: Examples of Trip-out time measurement result

Test results / sub-results

t ΔN	Trip-out time
Uc	Contact voltage for rated $I_{\Delta N}$

7.7.3 RCD I – Trip-out current

The instrument increases the test current in small steps through appropriate range as follows:

RCD type	**Slope range**		**Waveform**	**Notes**
	Start value	**End value**		
AC, EV, MI (a.c. part)	$0.2 \times I_{\Delta N}$	$1.1 \times I_{\Delta N}$	Sine	All models
A, F ($I_{\Delta N} \geq$ 30 mA)	$0.2 \times I_{\Delta N}$	$1.5 \times I_{\Delta N}$	Pulsed	All models
A, F ($I_{\Delta N}$ = 10 mA)	$0.2 \times I_{\Delta N}$	$2.2 \times I_{\Delta N}$	Pulsed	All models
EV, MI (d.c. part)	$0.2 \times I_{\Delta N}$	$2.2 \times I_{\Delta N}$	DC	All models
B, B+	$0.2 \times I_{\Delta N}$	$2.2 \times I_{\Delta N}$	DC	Model MI 3152 only

Table 7.2: Relationship between RCD type, slope range and test current

Maximum test current is I_{Δ} (trip-out current) or end value in case the RCD didn't trip-out.

Test procedure

- Enter the **RCD I** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.27***.
- Start the measurement.
- Save results (optional).

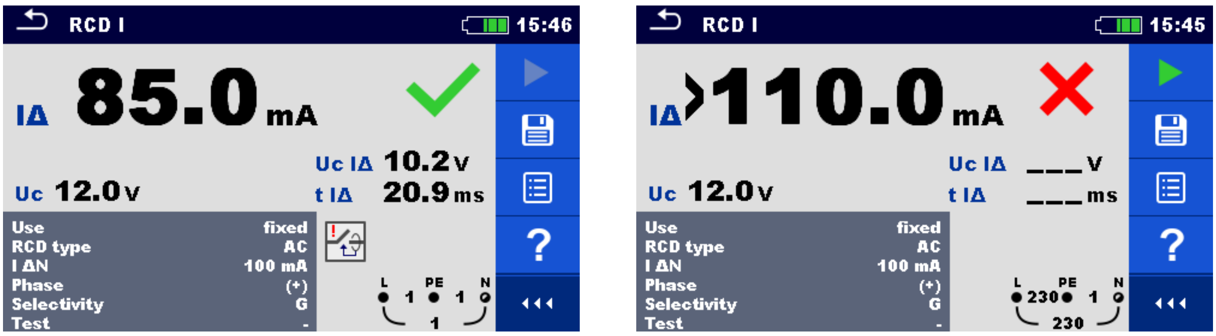


Figure 7.30: Examples of Trip-out current measurement result

Test results / sub-results

IΔ	Trip-out current
Uc	Contact voltage
Uc IΔ	Contact voltage at trip-out current IΔ or no value if the RCD didn't trip
t IΔ	Trip-out time at trip-out current IΔ

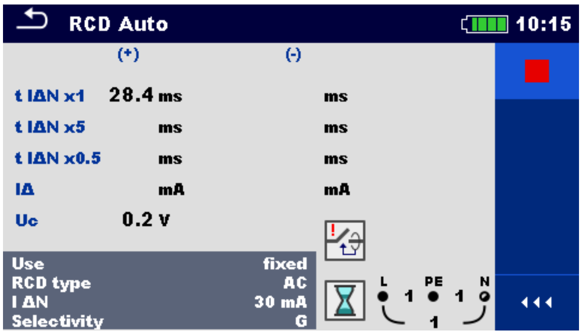
7.8 RCD Auto – RCD Auto test

RCD Auto test function performs a complete RCD test (trip-out time at different residual currents, trip-out current and contact voltage) in one set of automatic tests, guided by the instrument.

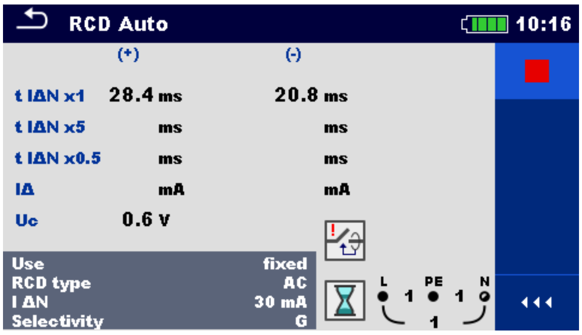
RCD Auto test procedure

RCD Auto test steps	Notes
▸ Enter the **RCD Auto** function. ▸ Set test parameters / limits. ▸ Connect test cable to the instrument. ▸ Connect test leads or Plug commander to the object under test, see ***Figure 7.27*** ▸ Start the measurement.	 Start of test
Test with $I_{\Delta N}$, (+) positive polarity (step 1).	RCD should trip-out
▸ **Re-activate RCD**. Test with $I_{\Delta N}$, (-) negative polarity (step 2).	 RCD should trip-out
▸ **Re-activate RCD**. Test with $5\times I_{\Delta N}$, (+) positive polarity (step 3).	 RCD should trip-out
▸ **Re-activate RCD**. Test with $5\times I_{\Delta N}$, (-) negative polarity (step 4).	 RCD should trip-out
▸ **Re-activate RCD**. Test with $½\times I_{\Delta N}$, (+) positive polarity (step 5). Test with $½\times I_{\Delta N}$, (-) negative polarity (step 6).	 RCD should not trip-out RCD should not trip-out
Trip-out current test, (+) positive polarity (step 7).	RCD should trip-out
▸ **Re-activate RCD**. Trip-out current test, (-) negative polarity (step 8).	 RCD should trip-out
▸ **Re-activate RCD**[1).] Trip-out current test for d.c. part, (+) polarity (step 9).	 RCD should trip-out
▸ **Re-activate RCD**[1).] Trip-out current test for d.c. part, (-) polarity (step 10).	 RCD should trip-out
▸ **Re-activate RCD**. Save results (optional).	 End of test

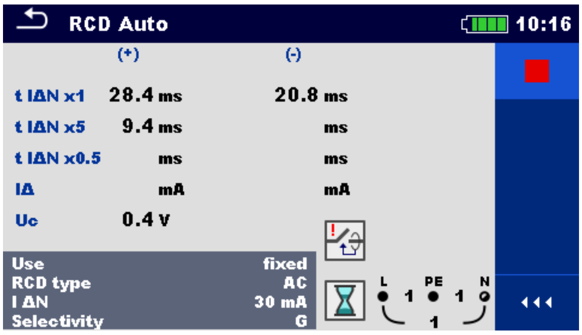
1) Steps 9 and 10 are performed if parameter Use is set to 'other' and Type to EV RCD or MI RCD.



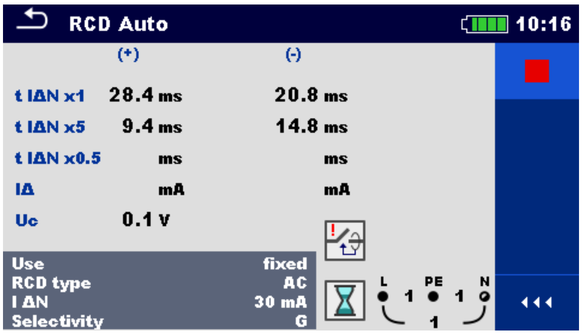
Step 1



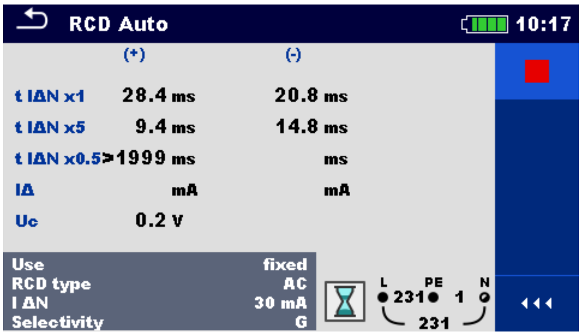
Step 2



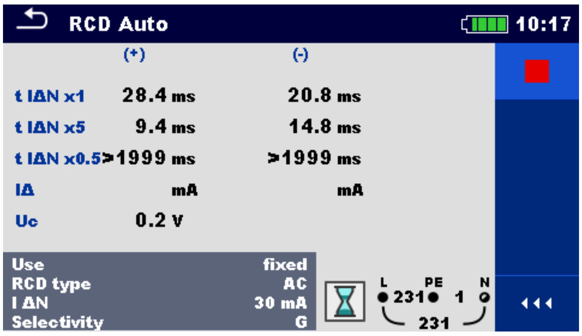
Step 3



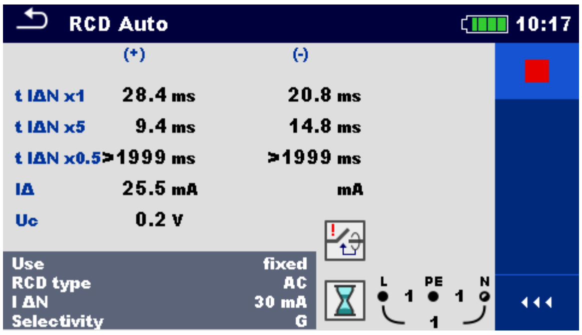
Step 4



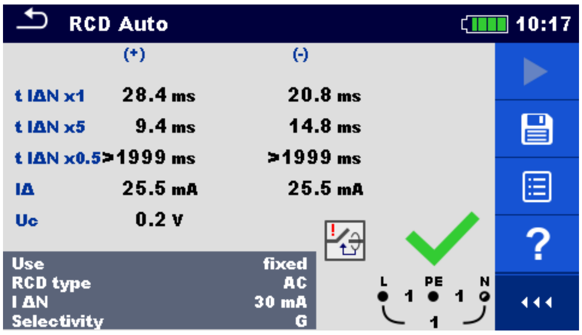
Step 5



Step 6



Step 7



Step 8

Figure 7.31: Example of individual steps in RCD Auto test

Test results / sub-results

t I∆N x1, (+)	Step 1 trip-out time ($I_{\Delta}=I_{\Delta N}$, (+) positive polarity)
t I∆N x1, (-)	Step 2 trip-out time ($I_{\Delta}=I_{\Delta N}$, (-) negative polarity)
t I∆N x5, (+)	Step 3 trip-out time ($I_{\Delta}=5\times I_{\Delta N}$, (+) positive polarity)
t I∆N x5, (-)	Step 4 trip-out time ($I_{\Delta}=5\times I_{\Delta N}$, (-) negative polarity)
t I∆N x0.5, (+)	Step 5 trip-out time ($I_{\Delta}=½\times I_{\Delta N}$, (+) positive polarity)
t I∆N x0.5, (-)	Step 6 trip-out time ($I_{\Delta}=½\times I_{\Delta N}$, (-) negative polarity)
I∆ (+)	Step 7 trip-out current ((+) positive polarity)
I∆ (-)	Step 8 trip-out current ((-) negative polarity)
I∆ d.c. (+) [1)]	Step 9 trip-out current ((+) positive polarity)
I∆ d.c, (-) [1)]	Step 10 trip-out current ((-) negative polarity)
Uc	Contact voltage for rated $I_{\Delta N}$

[1)] Result is displayed when parameter Use is set to ‘other’ and Type to EV RCD or MI RCD.

7.9 Z loop – Fault loop impedance and prospective fault current

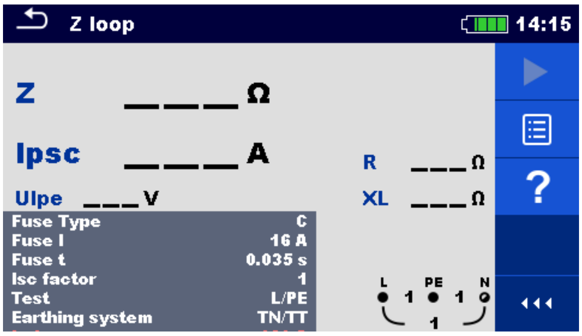


Figure 7.32: Z loop menu

Measurement parameters / limits

Fuse Type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
Isc factor	**Isc factor** [0.20 ... 3.00]
Test	**Selection of test** [-, L/PE, L1/PE, L2/PE, L3/PE] [1)]
Earthing system	Refer to chapter ***4.6.5 Settings*** for more information.
Ia(Ipsc)	**Minimum fault current for selected fuse or custom value**

[1)] With Plug test cable or Plug commander Z loop is measured in the same way regardless of the setting. The parameter is meant for documentation.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

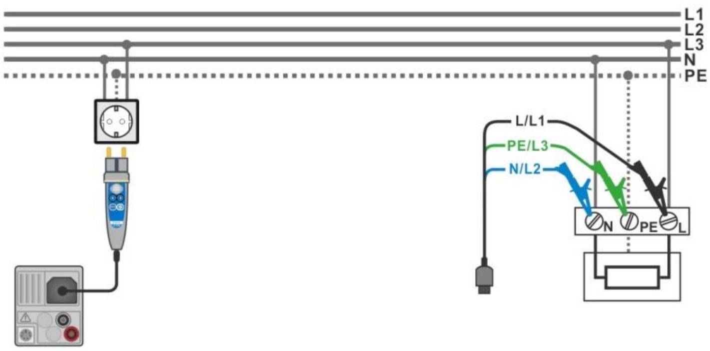


Figure 7.33: Connection of Plug commander and 3-wire test lead

Measurement procedure

- Enter the **Z loop** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.33***.
- Start the measurement.
- Save results (optional).

Figure 7.34: *Examples of Loop impedance measurement result*

Measurement results / sub-results

Z	Loop impedance
Ipsc	Prospective fault current
Ulpe	Voltage L-PE
R	Resistance of loop impedance
XL	Reactance of loop impedance

Prospective fault current I_{PSC} is calculated from measured impedance as follows:

$$I_{PSC} = \frac{U_N \times k_{SC}}{Z}$$

where:

U_n......... Nominal U_{L-PE} voltage (see table below),

k_{SC} .... Correction factor (Isc factor) for I_{PSC}. Refer to chapter ***4.6.5 Settings*** for more information.

U_n	Input voltage range (L-PE)
110 V	(93 V ≤ U_{L-PE} ≤ 134 V)
230 V	(185 V ≤ U_{L-PE} ≤ 266 V)

Table 7.3: Relationship between Input voltage – U_{L-PE} and nominal voltage – U_n used for calculation

7.10 Zs rcd – Fault loop impedance and prospective fault current in system with RCD

Zs rcd measurement prevents trip-out of the RCD in systems with the RCD.

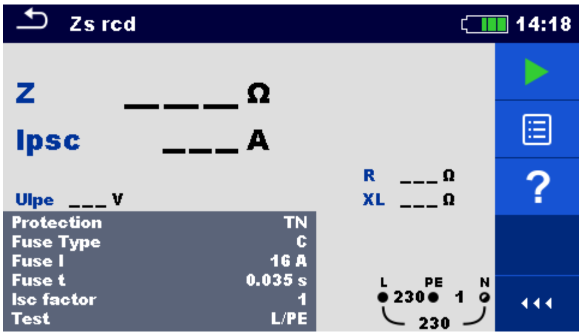


Figure 7.35: Zs rcd menu

Measurement parameters / limits

Measurement parameters / limits	
Protection	**Protection type** [TN, TTrcd]
Fuse Type [1]	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I [1]	**Rated current of selected fuse**
Fuse t [1]	**Maximum breaking time of selected fuse**
Isc factor	**Isc factor** [0.20 ... 3.00]
Ia(Ipsc) [1]	**Minimum fault current for selected fuse or custom value**
I ΔN[2]	**Rated RCD residual current sensitivity** [10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]
RCD type[2]	**RCD type** [AC, A, F, B[4], B+[4],F]
Selectivity[2]	**Characteristic** [G, S]
Test	**Selection of test** [-, L-PE, L1-PE, L2. PE, L3-PE] [3]
I test	**Test current** [Standard, Low]
Limit Uc[2]	**Contact voltage limit** [12 V, 25 V, 50 V] [2]

1) Parameter or limit is considered if Protection is set to TN
2) Parameter or limit is considered if Protection is set to TTrcd
3) With Plug test cable or Plug commander Zs rcd is measured in the same way regardless of the setting. The parameter is meant for documentation.
4) Model MI 3152 only

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

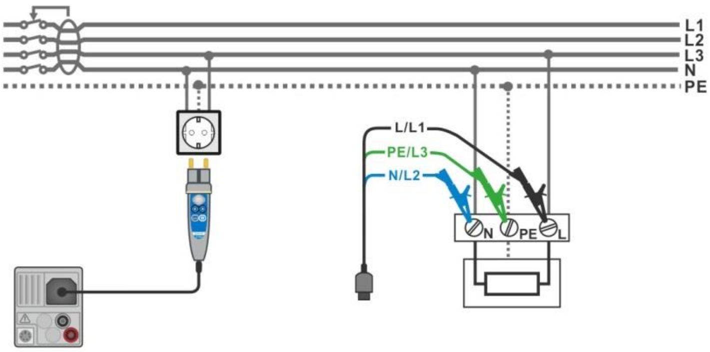


Figure 7.36: Connection of Plug commander and 3-wire test lead

Measurement procedure

- Enter the **Zs rcd** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.36***.
- Start the measurement.
- Save results (optional).

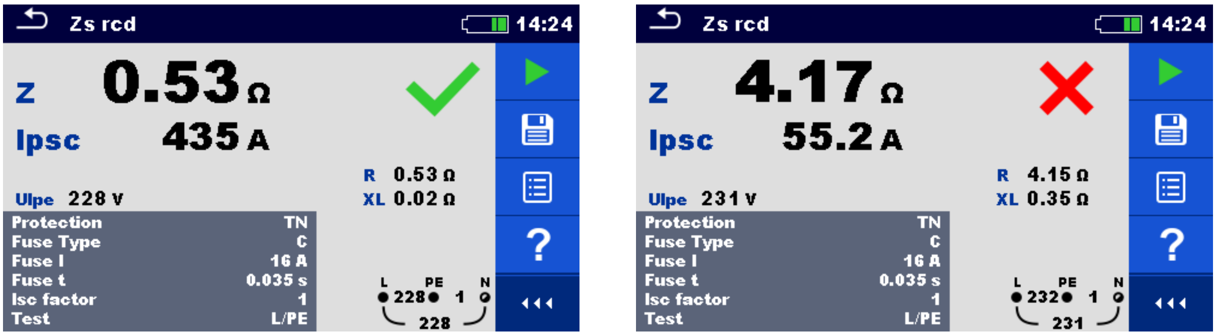


Figure 7.37: Examples of Zs rcd measurement result

Measurement results / sub-results

Z	Loop impedance
Ipsc	Prospective fault current
Ulpe	Voltage L-PE
R	Resistance of loop impedance
XL	Reactance of loop impedance
Uc [1)]	Contact voltage

[1)] Result is presented only if Protection is set to TTrcd

Prospective fault current I_{PSC} is calculated from measured impedance as follows:

$$I_{PSC} = \frac{U_N \times k_{SC}}{Z}$$

where:

U_n......... Nominal U_{L-PE} voltage (see table below),

k_{SC} .... Correction factor (Isc factor) for I_{PSC} Refer to chapter ***4.6.5 Settings*** for more information.

U_n	**Input voltage range (L-PE)**
110 V	(93 V ≤ U_{L-PE} ≤ 134 V)
230 V	(185 V ≤ U_{L-PE} ≤ 266 V)

Table 7.4: Relationship between Input voltage – U_{L-PE} and nominal voltage – U_n used for calculation

7.11 Z loop mΩ – High precision fault loop impedance and prospective fault current

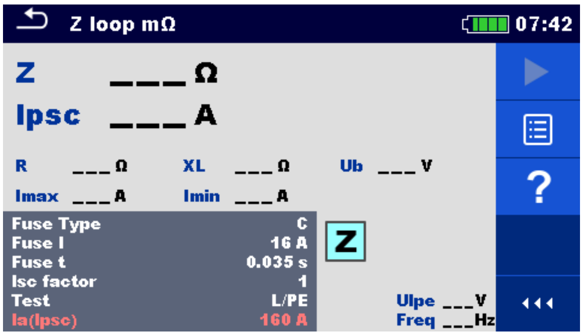


Figure 7.38: Z loop mΩ menu

Measurement parameters / limits

Fuse Type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
Test	**Test** [-, L/PE, L1/PE, L2/PE, L3/PE] [1)]
Ia(Ipsc)	**Minimum fault current for selected fuse or custom value**

1) The measurement doesn't depend on the setting. The parameter is meant for documentation.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

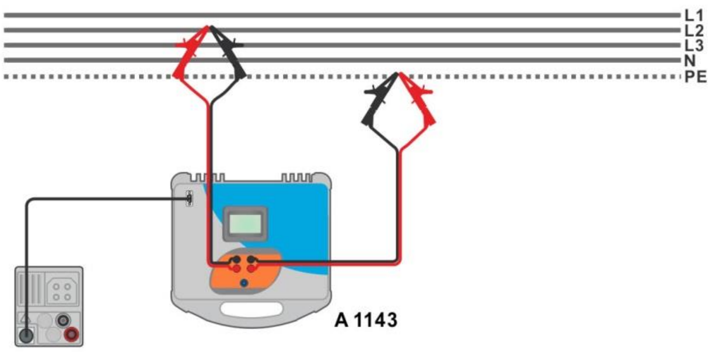


Figure 7.39: High precision Loop impedance measurement – Connection of A 1143

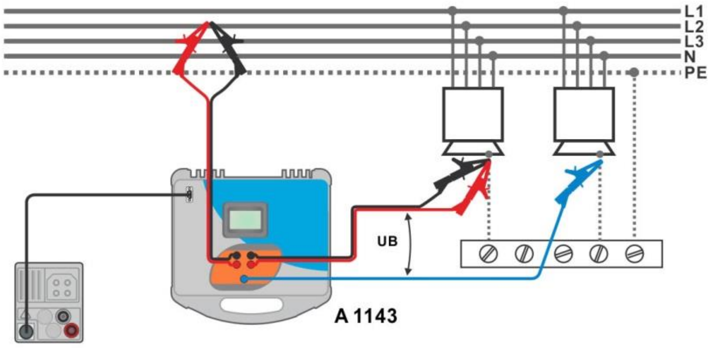


Figure 7.40: Contact voltage measurement – Connection of A 1143

Measurement procedure

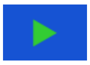
- Enter the **Z loop mΩ** function.
- Set test parameters / limits.
- Connect test leads to A 1143 – Euro Z 290 A adapter and switch it on.
- Connect A 1143 – Euro Z 290 A adapter to the instrument using RS232-PS/2 cable.
- Connect test leads to the object under test, see ***Figure 7.39*** and ***Figure 7.40***.
- Start the measurement using  or  button.
- Save results (optional).

Figure 7.41: Examples of high precision Loop impedance measurement result

Measurement results / sub-results

Z	Loop impedance
Ipsc	Standard prospective fault current
Imax	Maximal prospective fault current
Imin	Minimal prospective fault current
Ub	Contact voltage at maximal prospective fault current (contact voltage measured against Probe S if used)
R	Resistance of loop impedance
XL	Reactance of loop impedance
Ulpe	Voltage L-PE
Freq	Frequency

Standard prospective fault current I_{PSC} is calculated as follows:

$$I_{PSC} = \frac{230\,V}{Z} \qquad \text{where} \qquad U_{L-PE} = 230\,V\ \pm 10\,\%$$

The prospective fault currents I_{Min} and I_{Max} are calculated as follows:

$$I_{Min} = \frac{C_{min} U_{N(L-PE)}}{Z_{(L-PE)hot}} \qquad \text{where} \qquad Z_{(L-PE)hot} = \sqrt{(1.5 R_{L-PE})^2 + X_{L-PE}^2}$$

$$C_{min} = \begin{cases} 0.95;\ U_{N(L-PE)} = 230\,V\ \pm 10\,\% \\ 1.00;\ otherwise \end{cases}$$

and

$$I_{Max} = \frac{C_{max} U_{N(L-PE)}}{Z_{L-PE}} \qquad \text{where} \qquad Z_{L-PE} = \sqrt{R_{L-PE}^2 + X_{L-PE}^2}$$

$$C_{max} = \begin{cases} 1.05;\ U_{N(L-PE)} = 230\,V\ \pm 10\,\% \\ 1.10;\ otherwise \end{cases}$$

Refer to ***A 1143 – Euro Z 290 A adapter Instruction manual*** for detailed information.

7.12 Z line – Line impedance and prospective short-circuit current

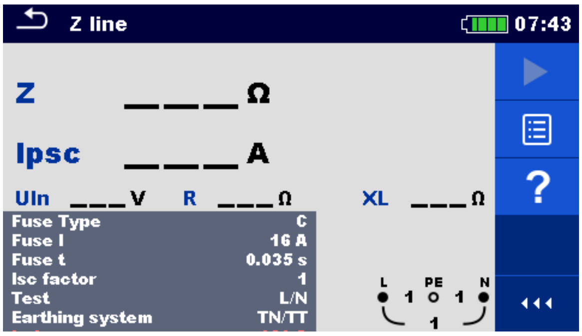


Figure 7.42: Z line measurement menu

Measurement parameters / limits

Fuse Type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
Isc factor	**Isc factor** [0.20 ... 3.00]
Test	**Test** [-, L/N, L/L, L1/N, L2/N, L3/N, L1/L2, L1/L3, L2/L3] [1)]
Earthing system	Refer to chapter ***4.6.5 Settings*** for more information.
Ia(Ipsc)	**Minimum short-circuit current for selected fuse or custom value**

[1)] With Plug test cable or Plug commander Z line is measured in the same way regardless of the setting. The parameter is meant for documentation.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

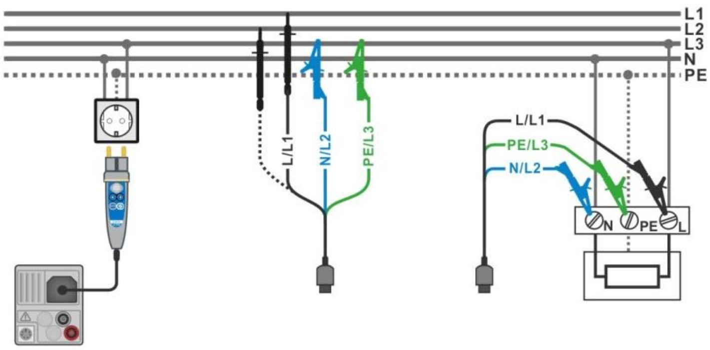


Figure 7.43: Phase-neutral or phase-phase line impedance measurement – connection of Plug commander and 3-wire test lead

Measurement procedure

- Enter the **Z line** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.43***.
- Start the measurement.
- Save results (optional).

Figure 7.44: Examples of Line impedance measurement result

Measurement results / sub-results

Z	Line impedance
Ipsc	Prospective short-circuit current
Uln	Voltage measured between L/L1 – N/L2 test terminals
R	Resistance of line impedance
XL	Reactance of line impedance
Imax3p	Maximal three-phases prospective short-circuit current
Imin3p	Minimal three-phases prospective short-circuit current
Imax2p	Maximal two-phases prospective short-circuit current
Imin2p	Minimal two-phases prospective short-circuit current
Imax	Maximal single-phase prospective short-circuit current
Imin	Minimal single-phase prospective short-circuit current

Prospective short circuit current I_{PSC} is calculated as follows:

$$I_{PSC} = \frac{U_N \times k_{SC}}{Z}$$

where:

U_n......... Nominal U_{L-N} or U_{L-L} voltage (see table below),

k_{SC} .... Correction factor (Isc factor) for I_{PSC}. Refer to chapter ***4.6.5 Settings*** for more information.

U_n	**Input voltage range (L-N or L-L)**
110 V	(93 V ≤ U_{L-N} ≤ 134 V)
230 V	(185 V ≤ U_{L-N} ≤ 266 V)
400 V	(321 V ≤ U_{L-L} ≤ 485 V)

Table 7.5: Relationship between Input voltage – $U_{L-N(L)}$ and nominal voltage – U_n used for calculation

The prospective short-circuit currents I_{Min}, I_{Min2p}, I_{Min3p} and I_{Max}, I_{Max2p}, I_{Max3p} are calculated as follows:

$I_{Min} = \frac{C_{min} U_{N(L-N)}}{Z_{(L-N)hot}}$	where	$Z_{(L-N)hot} = \sqrt{(1.5 \times R_{(L-N)})^2 + X_{(L-N)}^2}$ $C_{min} = \begin{cases} 0.95; \ U_{N(L-N)} = 230\,V \ \pm 10\,\% \\ 1.00; \ otherwise \end{cases}$

$I_{Max} = \frac{C_{max} U_{N(L-N)}}{Z_{(L-N)}}$	where	$Z_{(L-N)} = \sqrt{R_{(L-N)}^2 + X_{(L-N)}^2}$ $C_{max} = \begin{cases} 1.05; U_{N(L-N)} = 230\,V \ \pm 10\,\% \\ 1.10; \ otherwise \end{cases}$

$I_{Min2p} = \frac{C_{min} U_{N(L-L)}}{Z_{(L-L)hot}}$	where	$Z_{(L-L)hot} = \sqrt{(1.5 \times R_{(L-L)})^2 + X_{(L-L)}^2}$ $C_{min} = \begin{cases} 0.95; \ U_{N(L-L)} = 400\,V \ \pm 10\,\% \\ 1.00; \ otherwise \end{cases}$

$I_{Max2p} = \frac{C_{max} U_{N(L-L)}}{Z_{(L-L)}}$	where	$Z_{(L-L)} = \sqrt{R_{(L-L)}^2 + X_{(L-L)}^2}$ $C_{max} = \begin{cases} 1.05; U_{N(L-L)} = 400\,V \ \pm 10\,\% \\ 1.10; \ otherwise \end{cases}$

$I_{Min3p} = \frac{C_{min} \times U_{N(L-L)}}{\sqrt{3}} \frac{2}{Z_{(L-L)hot}}$	where	$Z_{(L-L)hot} = \sqrt{(1.5 \times R_{(L-L)})^2 + X_{(L-L)}^2}$ $C_{min} = \begin{cases} 0.95; \ U_{N(L-L)} = 400\,V \ \pm 10\,\% \\ 1.00; \ otherwise \end{cases}$

$I_{Max3p} = \frac{C_{max} \times U_{N(L-L)}}{\sqrt{3}} \frac{2}{Z_{(L-L)}}$	where	$Z_{(L-L)} = \sqrt{R_{(L-L)}^2 + X_{(L-L)}^2}$ $C_{max} = \begin{cases} 1.05; U_{N(L-L)} = 400\,V \ \pm 10\,\% \\ 1.10; \ otherwise \end{cases}$

7.13 Z line mΩ – High precision line impedance and prospective short-circuit current

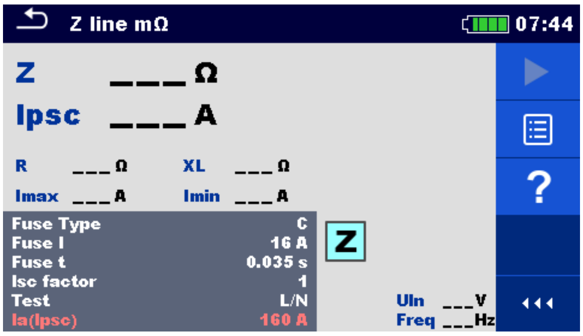


Figure 7.45: Z line mΩ menu

Measurement parameters / limits

Fuse Type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
Test [1)]	**Test** [-, L/N, L/L, L1/N, L2/N, L3/N, L1/L2, L1/L3, L2/L3]
Ia(Ipsc)	**Minimum short circuit current for selected fuse or custom value**

[1)] The measuring results (for phase – neutral or phase – phase line) are set according to the setting. The parameter is meant for documentation.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

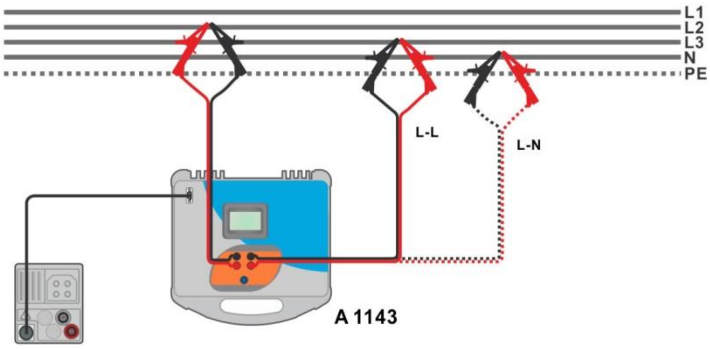


Figure 7.46: Phase-neutral or phase-phase high precision Line impedance measurement – Connection of A 1143

Measurement procedure

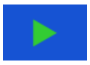
- Enter the **Z line mΩ** function.
- Set test parameters / limits.
- Connect test leads to A 1143 – Euro Z 290 A adapter and switch it on.
- Connect A 1143 – Euro Z 290 A adapter to the instrument using RS232-PS/2 cable.
- Connect test leads to the object under test, see ***Figure 7.46***.
- Start the measurement using  or  button.
- Save results (optional).

Figure 7.47: Examples of high precision Line impedance measurement result

Measurement results / sub-results

Z	Line impedance
Ipsc	Standard prospective short-circuit current
Imax	Maximal prospective short-circuit current
Imin	Minimal prospective short-circuit current
Imax2p	Maximal two-phases prospective short-circuit current
Imin2p	Minimal two-phases prospective short-circuit current
Imax3p	Maximal three-phases prospective short-circuit current
Imin3p	Minimal three-phases prospective short-circuit current
R	Resistance of line impedance
XL	Reactance of line impedance
Uln	Voltage L-N or L-L
Freq	Frequency

Standard prospective short-circuit current I_{PSC} is calculated as follows:

$$I_{PSC} = \frac{230\,V}{Z} \qquad \text{where} \qquad U_{L-N} = 230\,V\ \pm 10\,\%$$

$$I_{PSC} = \frac{400\,V}{Z} \qquad \text{where} \qquad U_{L-L} = 400\,V\ \pm 10\,\%$$

The prospective short-circuit currents I_{Min}, I_{Min2p}, I_{Min3p} and I_{Max}, I_{Max2p}, I_{Max3p} are calculated as follows:

$I_{Min} = \frac{C_{min} U_{N(L-N)}}{Z_{(L-N)hot}}$	where	$Z_{(L-N)hot} = \sqrt{(1.5 \times R_{(L-N)})^2 + X_{(L-N)}^2}$ $C_{min} = \begin{cases} 0.95;\ U_{N(L-N)} = 230\,V \pm 10\,\% \\ 1.00;\ otherwise \end{cases}$

$I_{Max} = \frac{C_{max} U_{N(L-N)}}{Z_{(L-N)}}$	where	$Z_{(L-N)} = \sqrt{R_{(L-N)}^2 + X_{(L-N)}^2}$ $C_{max} = \begin{cases} 1.05;\ U_{N(L-N)} = 230\,V \pm 10\,\% \\ 1.10;\ otherwise \end{cases}$

$I_{Min2p} = \frac{C_{min} U_{N(L-L)}}{Z_{(L-L)hot}}$	where	$Z_{(L-L)hot} = \sqrt{(1.5 \times R_{(L-L)})^2 + X_{(L-L)}^2}$ $C_{min} = \begin{cases} 0.95;\ U_{N(L-L)} = 400\,V \pm 10\,\% \\ 1.00;\ otherwise \end{cases}$

$I_{Max2p} = \frac{C_{max} U_{N(L-L)}}{Z_{(L-L)}}$	where	$Z_{(L-L)} = \sqrt{R_{(L-L)}^2 + X_{(L-L)}^2}$ $C_{max} = \begin{cases} 1.05;\ U_{N(L-L)} = 400\,V \pm 10\,\% \\ 1.10;\ otherwise \end{cases}$

$I_{Min3p} = \frac{C_{min} \times U_{N(L-L)}}{\sqrt{3}} \frac{2}{Z_{(L-L)hot}}$	where	$Z_{(L-L)hot} = \sqrt{(1.5 \times R_{(L-L)})^2 + X_{(L-L)}^2}$ $C_{min} = \begin{cases} 0.95;\ U_{N(L-L)} = 400\,V \pm 10\,\% \\ 1.00;\ otherwise \end{cases}$

$I_{Max3p} = \frac{C_{max} \times U_{N(L-L)}}{\sqrt{3}} \frac{2}{Z_{(L-L)}}$	where	$Z_{(L-L)} = \sqrt{R_{(L-L)}^2 + X_{(L-L)}^2}$ $C_{max} = \begin{cases} 1.05;\ U_{N(L-L)} = 400\,V \pm 10\,\% \\ 1.10;\ otherwise \end{cases}$

Refer to ***A 1143 – Euro Z 290 A adapter Instruction manual*** for detailed information.

7.14 Voltage Drop

The voltage drop is calculated based on the difference of line impedance at connection points (sockets) and the line impedance at the reference point (usually the impedance at the switchboard).

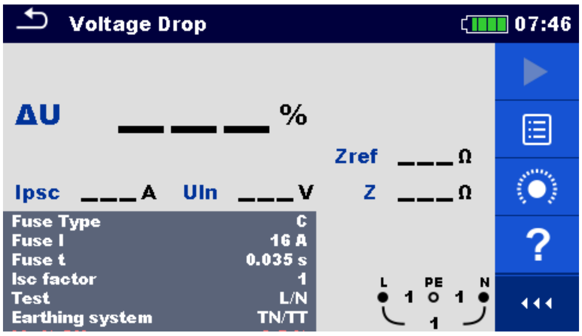


Figure 7.48: Voltage drop menu

Measurement parameters / limits

Fuse Type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
I (ΔU) [1)]	**Rated current for ΔU measurement (custom value)**
Isc factor	**Isc factor** [0.20 ... 3.00]
Test [2)]	**Test** [Off, L-N, L/L, L1-N, L2-N, L3-N, L1-L2, L1-L3, L2-L3]
Earthing system	Refer to chapter ***4.6.5 Settings*** for more information.
Limit(ΔU)	**Maximum voltage drop** [3.0 % … 9.0 %]

1) Applicable if Fuse type is set to Off or Custom

2) With Plug test cable or Plug commander Voltage drop is measured in the same way regardless of the setting. The parameter is meant for documentation.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

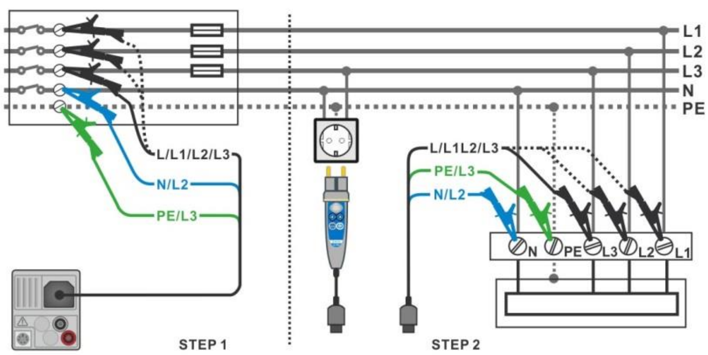


Figure 7.49: Voltage drop measurement – connection of Plug commander and 3-wire test lead

Measurement procedure

STEP 1: Measuring the impedance Zref at origin

- Enter the **Voltage Drop** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to the origin of electrical installation, see ***Figure 7.49***.
- Touch or select the  icon to initiate Zref measurement.
- Press the  button to measure Zref.

STEP 2: Measuring the Voltage drop

- Enter the **Voltage Drop** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the tested points, see ***Figure 7.49***.
- Start the measurement.
- Save results (optional).

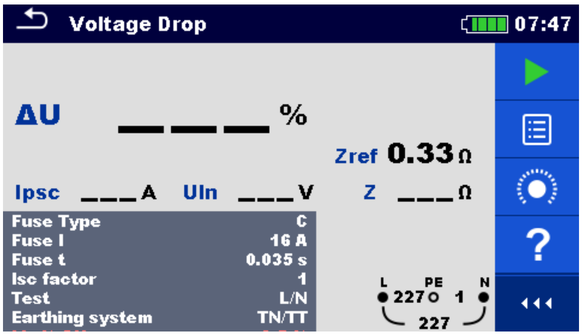


Figure 7.50: Example of Zref measurement result (STEP 1)

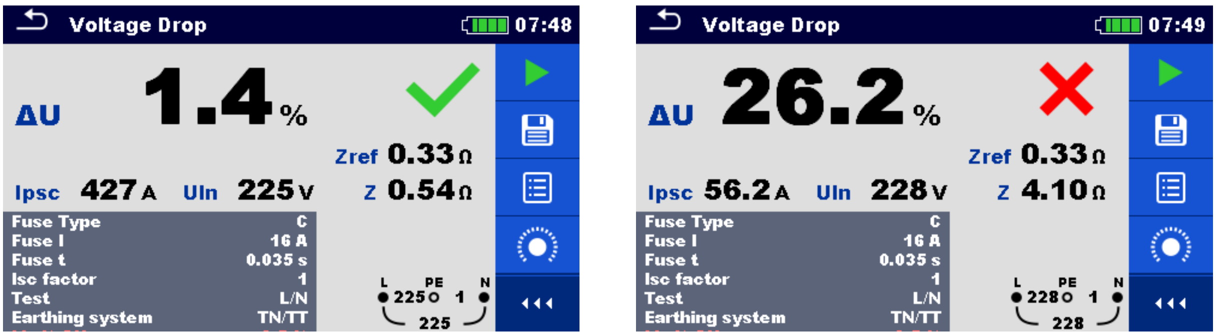


Figure 7.51: Examples of Voltage drop measurement result (STEP 2)

Measurement results / sub-results

ΔU	Voltage drop
Ipsc	Prospective short-circuit current
Un	Voltage L-N
Zref	Reference line impedance
Z	Line impedance

Voltage drop is calculated as follows:

$$\Delta U[\%] = \frac{(Z - Z_{REF}) \cdot I_N}{U_N} \cdot 100$$

where:

ΔU	Calculated Voltage drop
Zref	Impedance at reference point (at origin)
Z	Impedance at test point
U_n	Nominal voltage
I_n	Rated current of selected fuse (Fuse I) or custom value I (ΔU)

U_n	Input voltage range (L-N or L-L)
110 V	(93 V ≤ U_{L-N} ≤ 134 V)
230 V	(185 V ≤ U_{L-N} ≤ 266 V)
400 V	(321 V ≤ U_{L-L} ≤ 485 V)

Table 7.6: Relationship between Input voltage – $U_{L-N(L)}$ and nominal voltage – U_n used for calculation

7.15 Earth – Earth resistance (3-wire test)

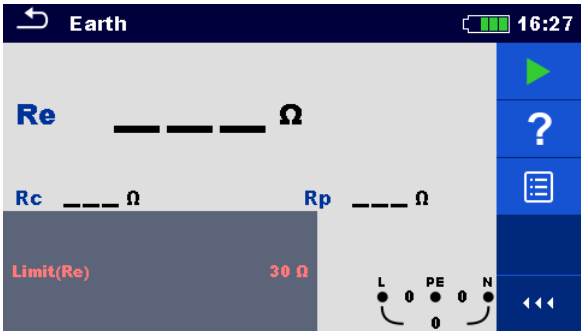


Figure 7.52: Earth menu

Measurement parameters / limits

Limit(Re)	**Maximum resistance** [Off, 1 Ω ... 5 kΩ]

Connection diagrams

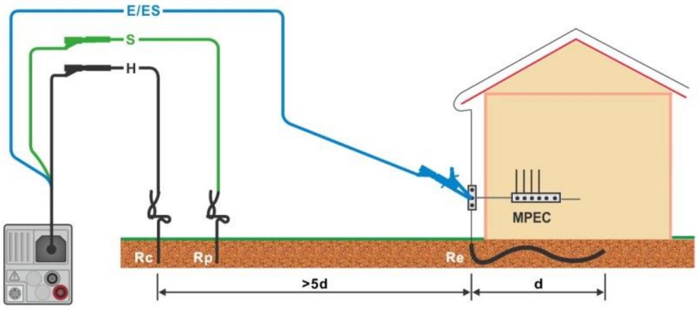


Figure 7.53: Resistance to earth, measurement of main installation earthing

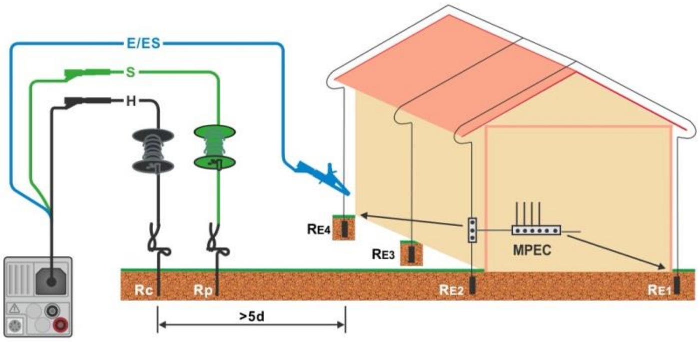


Figure 7.54: Resistance to earth, measurement of a lighting protection system

Measurement procedure

- Enter the **Earth** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to the object under test, see ***Figure 7.53*** and ***Figure 7.54***.
- Start the measurement.
- Save results (optional).

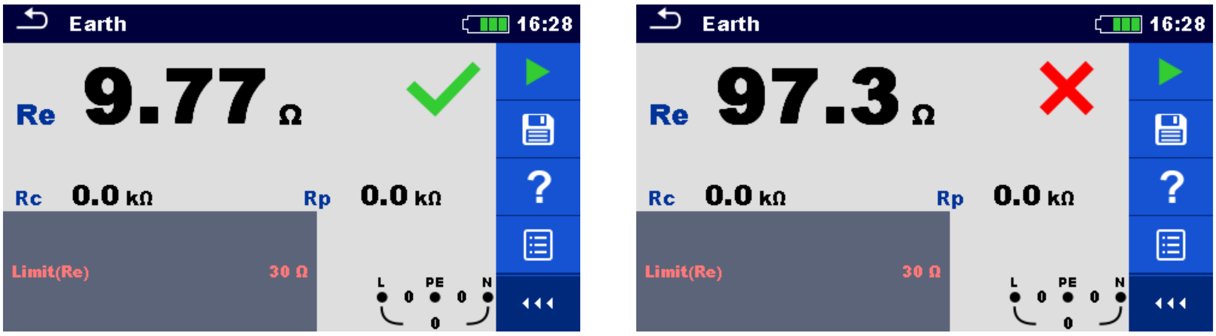


Figure 7.55: Examples of Earth resistance measurement result

Measurement results / sub-results

Re	Earth resistance
Rc	Resistance of H (current) probe
Rp	Resistance of S (potential) probe

7.16 Earth 2 clamp – Contactless earthing resistance measurement (with two current clamps)

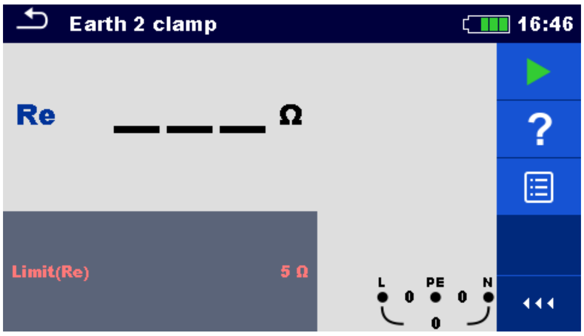


Figure 7.56: Earth 2 clamps menu

Measurement parameters / limits

Limit(Re)	**Maximum resistance** [Off, 1 Ω ... 30 Ω]

Connection diagram

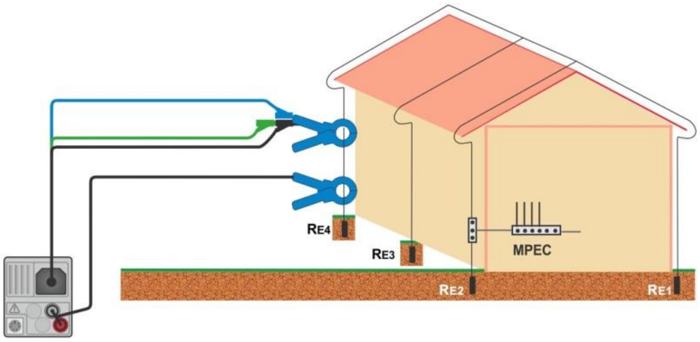


Figure 7.57: Contactless earthing resistance measurement

Measurement procedure

- Enter the **Earth 2 clamp** function.
- Set test parameters / limits.
- Connect test cable and clamps to the instrument.
- Clamp on object under test, see ***Figure 7.57***.
- Start the measurement.
- Stop the measurement.
- Save results (optional).

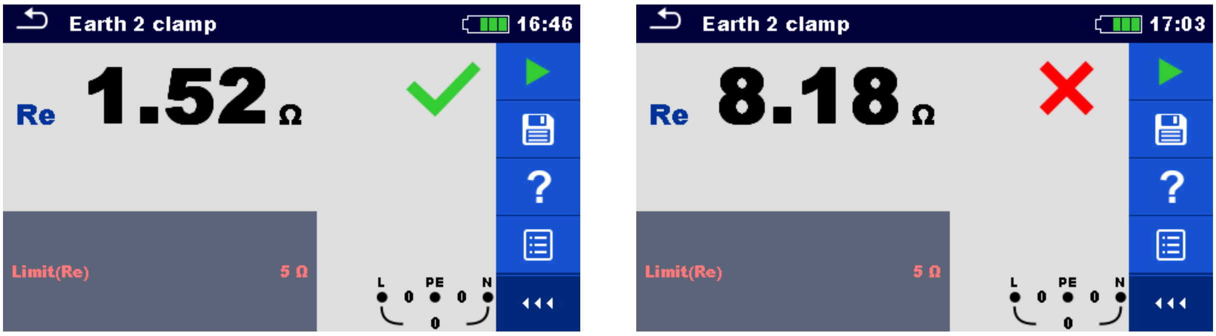


Figure 7.58: Examples of Contactless earthing resistance measurement result

Measurement results / sub-results

Re	Earth resistance

7.17 Ro – Specific earth resistance

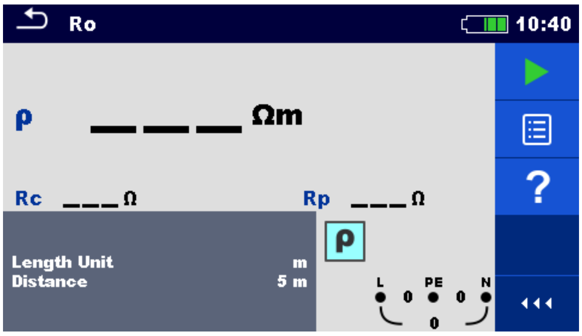


Figure 7.59: Earth Ro menu

Measurement parameters / limits

Length Unit	**Length Unit** [m, ft]
Distance	**Distance between probes** [0.1 m ... 29.9 m] or [1 ft ... 100 ft]

Connection diagram

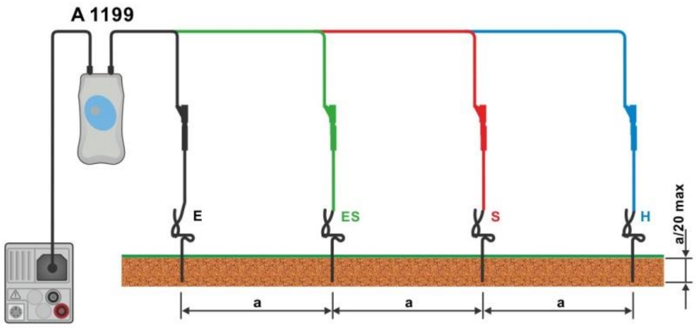


Figure 7.60: Specific earth resistance measurement

Measurement procedure

- Enter the **Ro** function.
- Set test parameters / limits.
- Connect A 1199 adapter to the instrument.
- Connect test leads to earth probes, see ***Figure 7.60***.
- Start the measurement.
- Save results (optional).

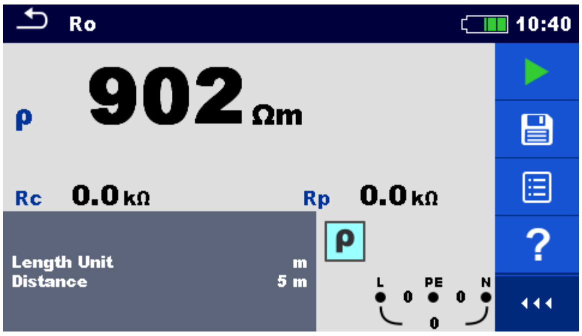


Figure 7.61: Example of Specific earth resistance measurement result

Measurement results / sub-results

ρ	Specific earth resistance
Rc	Resistance of H, E (current) probe
Rp	Resistance of S, ES (potential) probe

7.18 Power

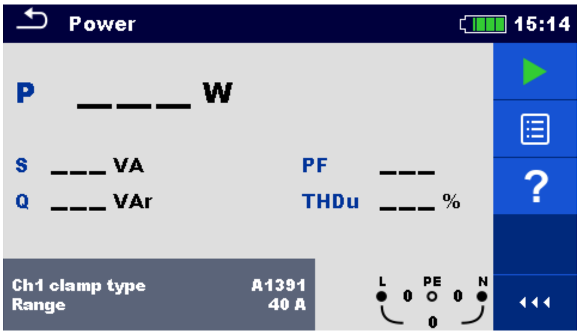


Figure 7.62: Power menu

Measurement parameters / limits

Ch1 clamp type	**Current clamp adapter** [A1018, A1019, A1391]
Range	**Range for selected current clamp adapter** A1018 [20 A] A1019 [20 A] A1391 [40 A, 300 A]

Connection diagram

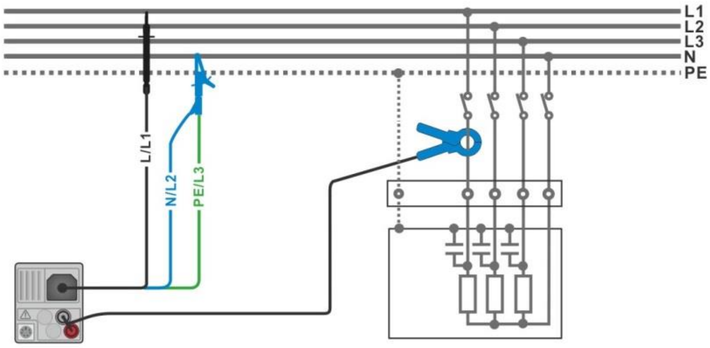


Figure 7.63: Power measurement

Measurement procedure

- Enter the **Power** function.
- Set parameters / limits.
- Connect the voltage test leads and current clamp to the instrument.
- Connect the voltage test leads and current clamp to the item to be tested (see ***Figure 7.63***).
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

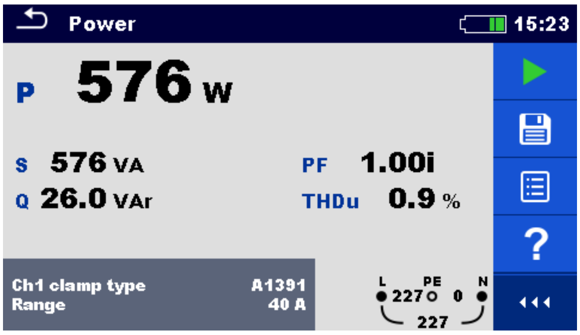


Figure 7.64: Example of Power measurement result

Measurement results / sub-results

P	Active power
S	Apparent power
Q	Reactive power (capacitive or inductive)
PF	Power factor (capacitive or inductive)
THDu	Voltage total harmonic distortion

7.19 Harmonics

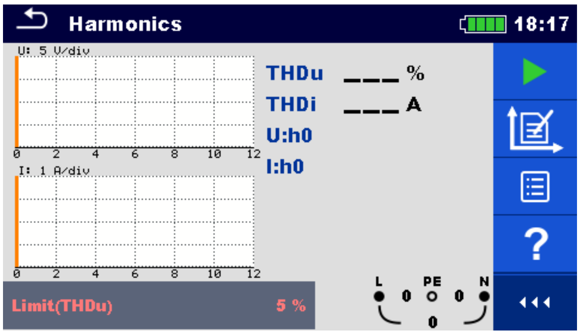


Figure 7.65: Harmonics menu

Measurement parameters / limits

Ch1 clamp type	**Current clamp adapter** [A1018, A1019, A1391]
Range	**Range for selected current clamp adapter** A1018 [20 A] A1019 [20 A] A1391 [40 A, 300 A]
Limit(THDu)	**Max. THD of voltage** [3 % ... 10 %]

Connection diagram

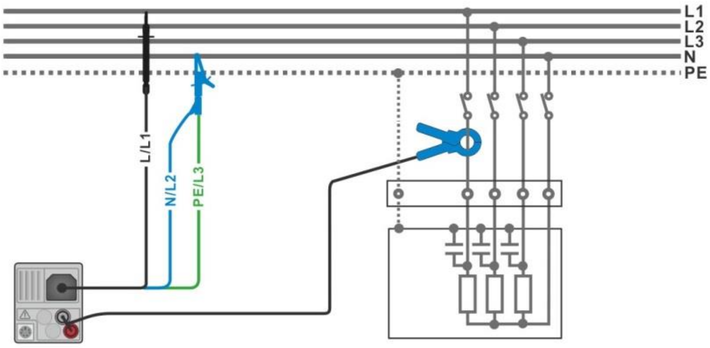


Figure 7.66: Harmonics measurement

Measurement procedure

- Enter the **Harmonics** function.
- Set parameters / limits.
- Connect voltage test leads and current clamp to the instrument.
- Connect the voltage test leads and current clamp to the item to be tested, see ***Figure 7.66***.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

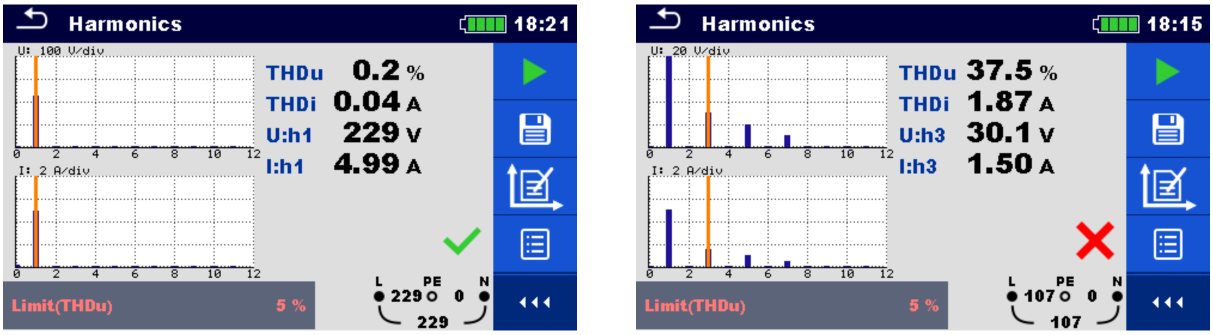


Figure 7.67: Examples of Harmonics measurement results

Measurement results / sub-results

U:h(i)	TRMS voltage of selected harmonic [h0 ... h11]
I:h(i)	TRMS current of selected harmonic [h0 ... h11]
THDu	Voltage total harmonic distortion
THDi	Current total harmonic distortion

7.20 Currents

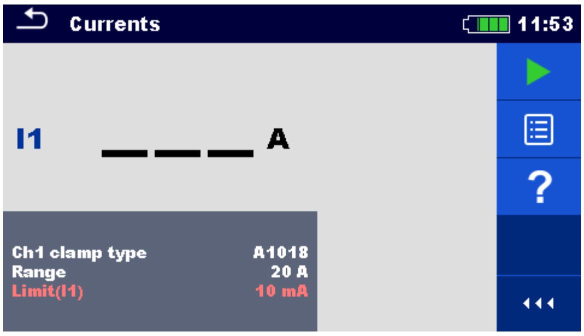


Figure 7.68: Current menu

Measurement parameters / limits

Ch1 clamp type	**Current clamp adapter** [A1018, A1019, A1391]
Range	**Range for selected current clamp adapter** A1018 [20 A] A1019 [20 A] A1391 [40 A, 300 A]
Limit(I1)	**Max. PE leakage** [Off, 0.1 mA ... 100 mA]

Connection diagram

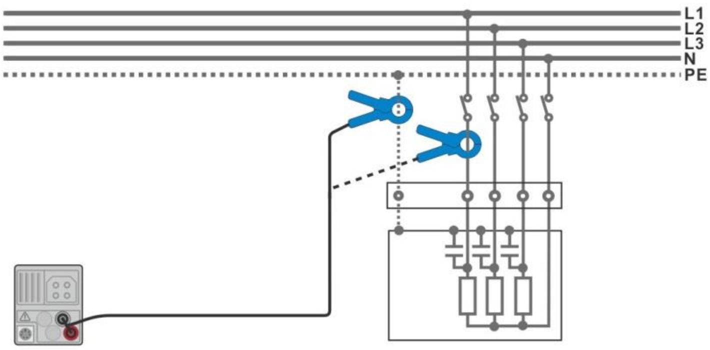


Figure 7.69: PE leakage and load current measurements

Measurement procedure

- Enter the **Currents** function.
- Set parameters / limits.
- Connect the current clamp to the instrument.
- Connect the clamp to the object under test, see ***Figure 7.69***.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

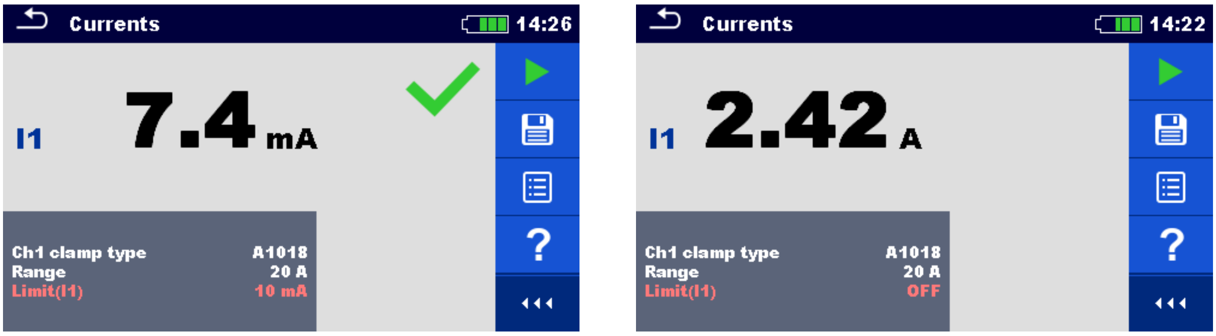


Figure 7.70: Examples of Current measurement result

Measurement results / sub-results

I1	PE leakage or load current

7.21 ISFL – First fault leakage current (MI 3152 only)

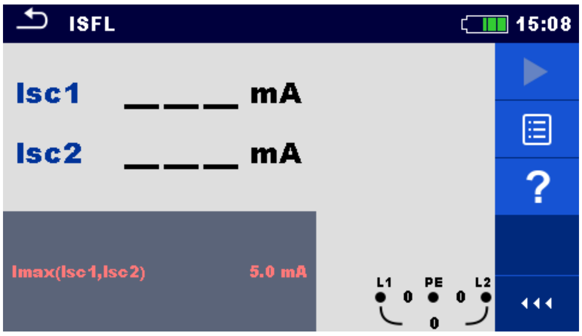


Figure 7.71: ISFL measurement menu

Measurement parameters / limits

Imax(Isc1, Isc2)	**Maximum first fault leakage current** [Off, 3.0 mA ... 19.5 mA]

Connection diagrams

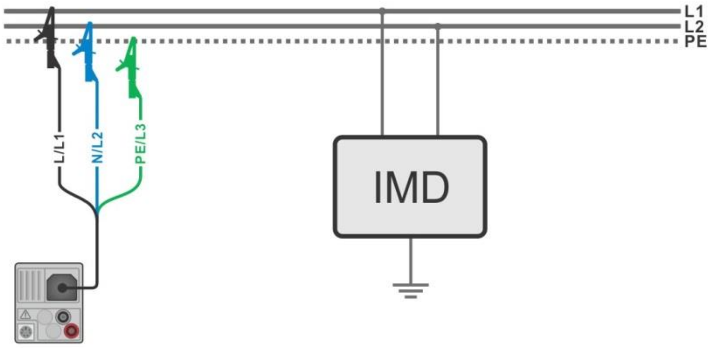


Figure 7.72: Measurement of highest First fault leakage current with 3-wire test lead

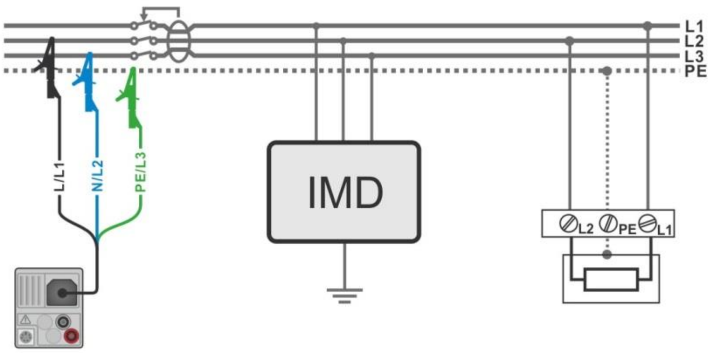
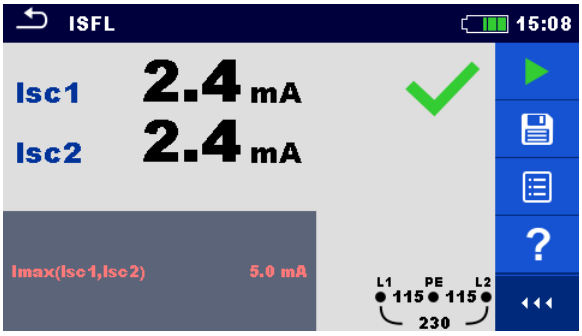


Figure 7.73: Measurement of First fault leakage current for RCD protected circuit with 3-wire test lead

Measurement procedure

- Enter the **ISFL** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to the object under test, see ***Figure 7.72*** and ***Figure 7.73***.
- Start the measurement.
- Save results (optional).



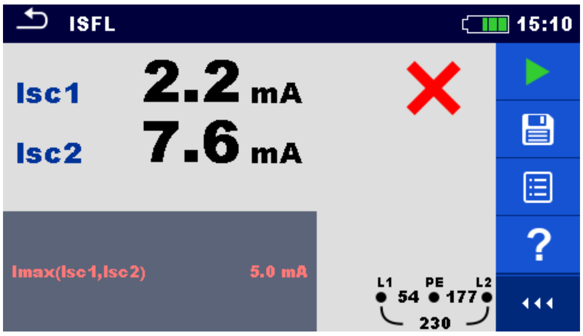


Figure 7.74: Examples of First fault leakage current measurement result

Measurement results / sub-results

Isc1	First fault leakage current at single fault between L1/PE
Isc2	First fault leakage current at single fault between L2/PE

7.22 IMD – Testing of insulation monitoring devices (MI 3152 only)

This function checks the alarm threshold of insulation monitor devices (IMD) by applying a changeable resistance between L1/PE and L2/PE terminals.

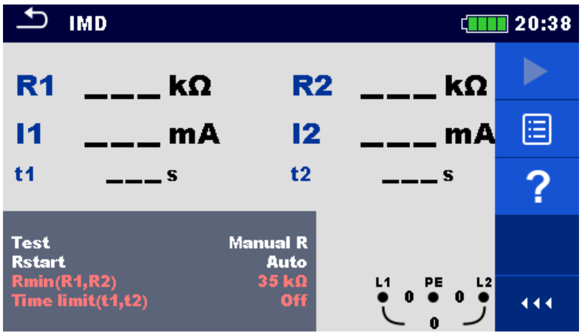


Figure 7.75: IMD test menu

Test parameters / limits

Test	**Test mode** [MANUAL R, MANUAL I, AUTO R, AUTO I]
Rstart	**Starting insulation resistance** [Auto, 5 kΩ ... 640 kΩ]
Istart	**Starting fault current** [Auto, 0.1 mA ... 19.9 mA]
t step	**Timer (AUTO R and AUTO I test modes)** [1 s ... 99 s]
Rmin(R1,R2)	**Min. insulation resistance (R_{LIMIT})** [Off, 5 kΩ ... 640 kΩ],
Imax(I1,I2)	**Max. fault current (I_{LIMIT})** [Off, 0.1 mA ... 19.9 mA]
Time limit (t1, t2)	**Max. activation / disconnection time limit** [Off, 1 s, custom]

Connection diagram

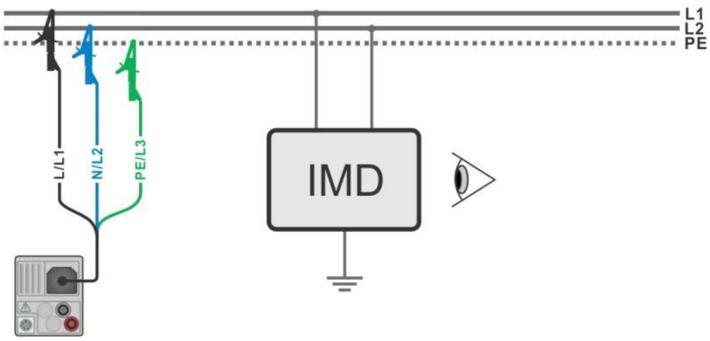


Figure 7.76: Connection with 3-wire test lead

Test procedure (MANUAL R, MANUAL I)

- Enter the **IMD** function.
- Set test parameter to MANUAL R or MANUAL I.
  Set other test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to the object under test, see ***Figure 7.76***.
- Start the measurement.
- Use the or keys to change insulation resistance*) until IMD alarms an insulation failure for L1.
- Press or the key to change line terminal selection to L2.
  (If IMD switches off voltage supply, instrument automatically changes line terminal selection to L2 and proceeds with the test when supply voltage is detected.)
- Use the or keys to change insulation resistance*) until IMD alarms an insulation failure for L2.
- Press the or the key.
  (If IMD switches off voltage supply, instrument automatically proceeds to the PASS / FAIL / NO STATUS indication.)
- Use to select PASS / FAIL / NO STATUS indication.
- Press or the key to confirm selection and complete the measurement.
- Save results (optional).

Test procedure (AUTO R, AUTO I)

- Enter the **IMD** function.
- Set test parameter to AUTO R or AUTO I.
- Set other test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to the object under test, see ***Figure 7.76***.
- Start the measurement.
  Insulation resistance between L1-PE is decreased automatically according to limit value*) every time interval selected with timer. To speed up the test press the or keys until IMD alarms an insulation failure for L1.
- Press or the key to change line terminal selection to L2.
  (If IMD switches off voltage supply, instrument automatically changes line terminal selection to L2 and proceeds with the test when supply voltage is detected.)

- Insulation resistance between L2-PE is decreased automatically according to limit value*) every time interval selected with timer. To speed up the test press the or keys until IMD alarms an insulation failure for L2.
- Press the or the key. If IMD switches off voltage supply, instrument automatically proceeds to the PASS / FAIL / NO STATUS indication.
- Use to select PASS / FAIL / NO STATUS indication.
- Press or the key to confirm selection and complete the measurement.
- Save results (optional).

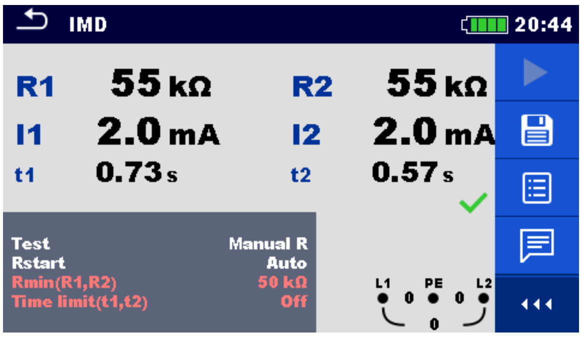
*) Starting and ending insulation resistances are determined by selection of IMD test sub-function and test parameters. See tables below:

Sub-function	Rstart parameter	Starting insulation resistance value	Ending insulation resistance value
MANUAL R	Auto	$R_{START} \cong 1.5 \times R_{LIMIT}$	-
	[5 kΩ ... 640 kΩ]	$R_{START} = Rstart$	-
AUTO R	Auto	$R_{START} \cong 1.5 \times R_{LIMIT}$	$R_{END} \cong 0.5 \times R_{LIMIT}$
	[5 kΩ ... 640 kΩ]	$R_{START} = Rstart$	$R_{END} \cong 0.5 \times R_{START}$

Table 7.7: Starting / ending insulation resistance values for MANUAL R and AUTO R sub-functions

Sub-function	Istart parameter	Starting insulation resistance value	Ending insulation resistance value
MANUAL I	Auto	$R_{START} \cong 1.5 \times \frac{U_{L1-L2}}{I_{LIMIT}}$	-
	[0.1 mA ... 19.9 mA]	$R_{START} \cong \frac{U_{L1-L2}}{I_{start}}$	-
AUTO I	Auto	$R_{START} \cong 1.5 \times \frac{U_{L1-L2}}{I_{LIMIT}}$	$R_{END} \cong 0.5 \times \frac{U_{L1-L2}}{I_{LIMIT}}$
	[0.1 mA ... 19.9 mA]	$R_{START} \cong \frac{U_{L1-L2}}{I_{start}}$	$R_{END} \cong 0.5 \times \frac{U_{L1-L2}}{I_{start}}$

Table 7.8: Starting / ending insulation resistance values for MANUAL I and AUTO I sub-functions



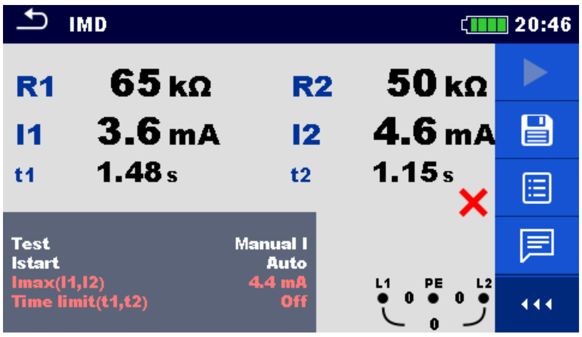


Figure 7.77: Examples of IMD test result

Test results / sub-results

R1	Threshold insulation resistance between L1-PE
I1	Calculated first fault leakage current for R1
t1	Activation / disconnection time of IMD for R1
R2	Threshold insulation resistance between L2-PE
I2	Calculated first fault leakage current for R2
t2	Activation / disconnection time of IMD for R2

Calculated first fault leakage current at threshold insulation resistance is given as $I_{1(2)} = \frac{U_{L1-L2}}{R_{1(2)}}$, where U_{L1-L2} is line-line voltage. The calculated first fault current is the maximum current that would flow when insulation resistance decreases to the same value as the applied test resistance, and a first fault is assumed between opposite line and PE.

If any of the activation / disconnection time result (t1, t2) is out of set limit, overall status of the test is “failed” and cannot be modified manually. Otherwise overall status can be user defined.
If activation of IMD device is visual indication and/or audio alert, without voltage disconnection, Time limit (t1,t2) parameter should be set to “Off” to disable timing limitation.

7.23 Rpe – PE conductor resistance

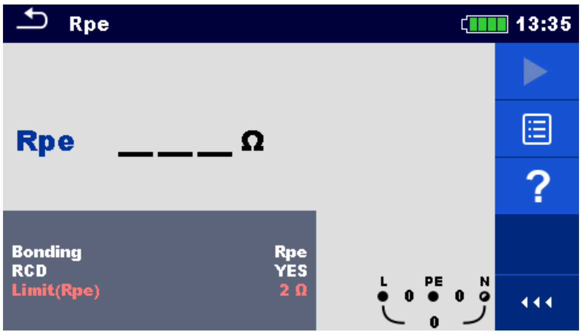


Figure 7.78: PE conductor resistance measurement menu

Measurement parameters / limits

Bonding	[Rpe, Local]
RCD	[Yes, No]
Limit(Rpe)	**Max. resistance** [Off, 0.1 Ω ... 20.0 Ω]

Connection diagram

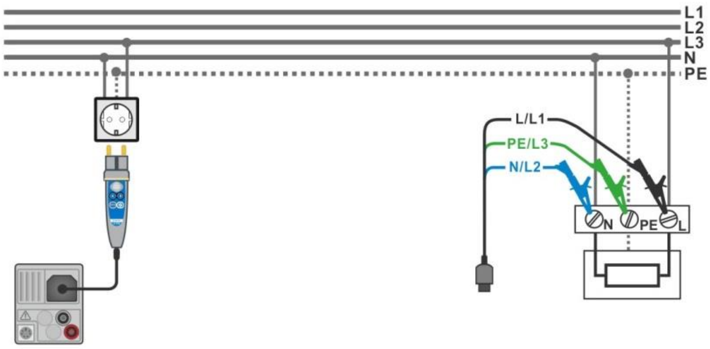
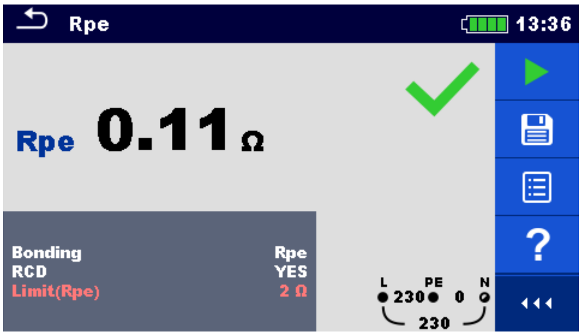


Figure 7.79: Connection of Plug commander and 3-wire test lead

Measurement procedure

- Enter the **Rpe** function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.79***.
- Start the measurement.
- Save results (optional).



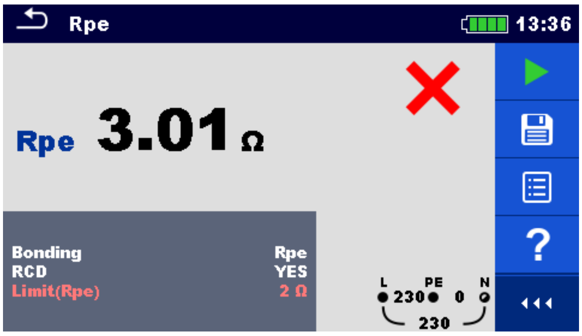


Figure 7.80: Examples of PE conductor resistance measurement result

Measurement results / sub-results

Rpe	PE conductor resistance

7.24 Ilumination

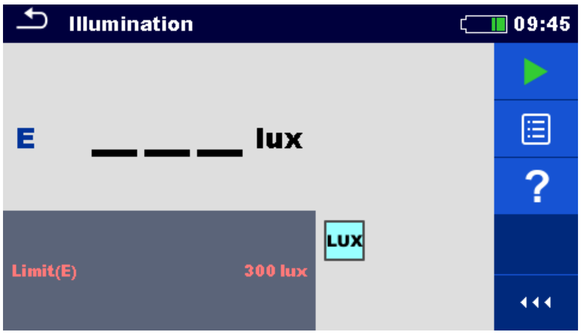


Figure 7.81: Illumination measurement menu

Measurement parameters / limits

Limit(E)	**Minimum illumination** [Off, 0.1 lux ... 20 klux]

Probe positioning

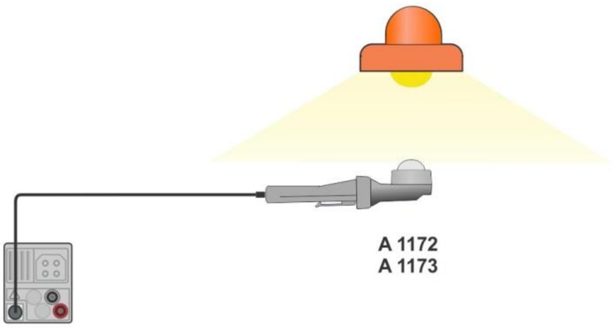


Figure 7.82: LUXmeter probe positioning

Measurement procedure

- Enter the **Illumination** function.
- Set test parameters / limits.
- Connect illumination sensor A 1172 or A 1173 to the instrument.
- Take the position of LUXmeter probe, see ***Figure 7.82***.
  Make sure that LUXmeter probe is turned on.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

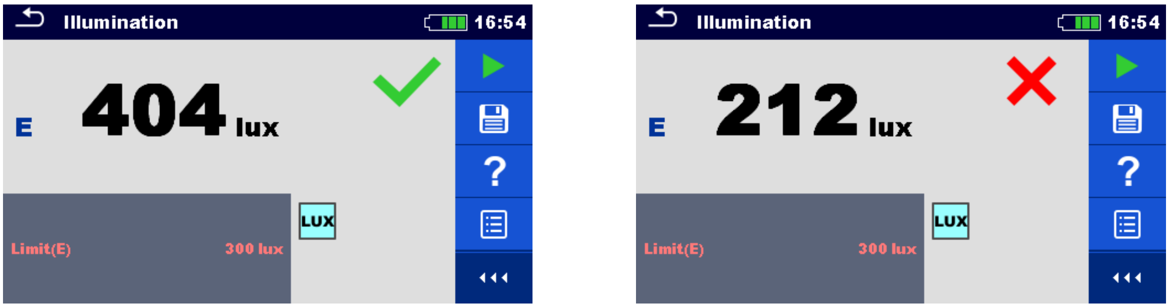


Figure 7.83: Examples of Illumination measurement result

Measurement results / sub-results

E	Illumination

7.25 AUTO TT – Auto test for TT earthing system

Tests / measurements implemented in AUTO TT

Voltage
Z line
Voltage Drop
Zs rcd
RCD Uc

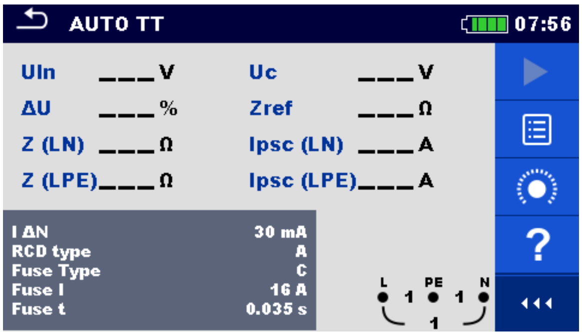


Figure 7.84: AUTO TT menu

Measurement parameters / limits

I ΔN	**Rated RCD residual current sensitivity** [10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]
Type	**RCD type** [AC, A, F, B*, B+*]
Selectivity	**Characteristic** [G, S]
Fuse type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
I (ΔU) [1)]	**Rated current for ΔU measurement (custom value)**
Isc factor	**Isc factor** [0.20 ... 3.00]
I test	**Test current** [Standard, Low]
Limit(ΔU)	**Maximum voltage drop** [3.0 % ... 9.0 %]
Limit Uc	**Conventional touch voltage limit** [12 V, 25 V, 50 V]
Ia(Ipsc (LN))	**Minimum short circuit current for selected fuse or custom value**

[1)] Applicable if Fuse type is set to Off or Custom.

* Model MI 3152 only.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

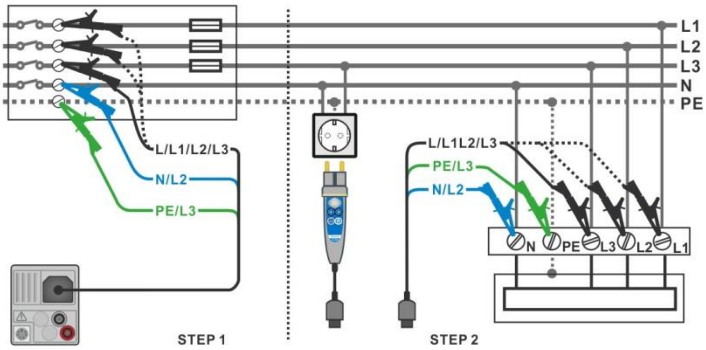


Figure 7.85: AUTO TT measurement

Measurement procedure

- Enter the **AUTO TT** function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter ***7.14 Voltage Drop***.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.85***.
- Start the Auto test.
- Save results (optional).

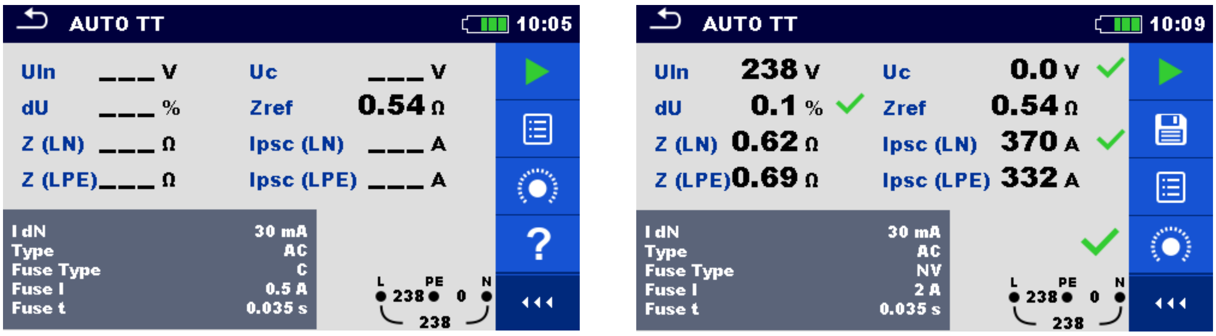


Figure 7.86: Examples of AUTO TT measurement results

Measurement results / sub-results

UIn	Voltage between phase and neutral conductors
ΔU	Voltage drop
Z (LN)	Line impedance
Z (LPE)	Loop impedance
Uc	Contact voltage
Zref	Reference Line impedance
Ipsc (LN)	Prospective short-circuit current
Ipsc (LPE)	Prospective fault current

7.26 AUTO TN (RCD) – Auto test for TN earthing system with RCD

Tests / measurements implemented in AUTO TN (RCD)

Voltage
Z line
Voltage Drop
Zs rcd
Rpe rcd

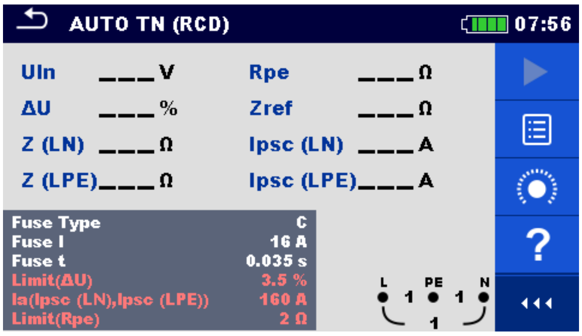


Figure 7.87: AUTO TN (RCD) menu

Measurement parameters / limits

Fuse type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
I (ΔU) [1)]	**Rated current for ΔU measurement (custom value)**
Isc factor	**Isc factor** [0.20 ... 3.00]
I test	**Test current** [Standard, Low]
Limit(ΔU)	**Maximum voltage drop** [3.0 % ... 9.0 %]
Limit (Rpe)	**Max. resistance** [Off, 0.1 Ω ... 20.0 Ω]
Ia(Ipsc (LN), Ipsc (LPE))	**Minimum short circuit current for selected fuse or custom value**

1) Applicable if Fuse type is set to Off or Custom.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

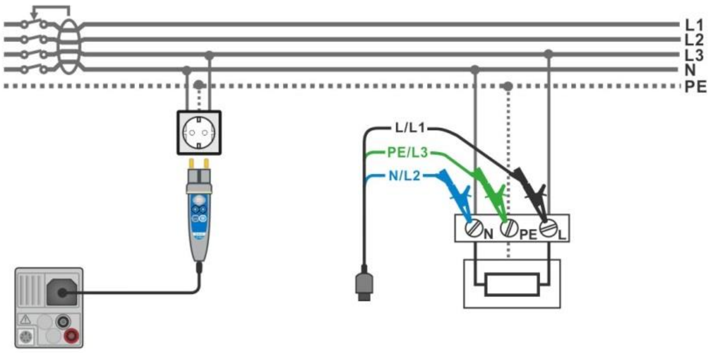


Figure 7.88: AUTO TN (RCD) measurement

Measurement procedure

- Enter the **AUTO TN (RCD)** function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter ***7.14 Voltage Drop***
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.88***.
- Start the Auto test.
- Save results (optional).

Figure 7.89: Examples of AUTO TN (RCD) measurement results

Measurement results / sub-results

Uln	Voltage between phase and neutral conductors
ΔU	Voltage drop
Z (LN)	Line impedance
Z (LPE)	Loop impedance
Rpe	PE conductor resistance
Zref	Reference Line impedance
Ipsc (LN)	Prospective short-circuit current
Ipsc (LPE)	Prospective fault current

7.27 AUTO TN – Auto test for TN earthing system without RCD

Tests / measurements implemented in AUTO TN

Voltage
Z line
Voltage Drop
Z loop
Rpe

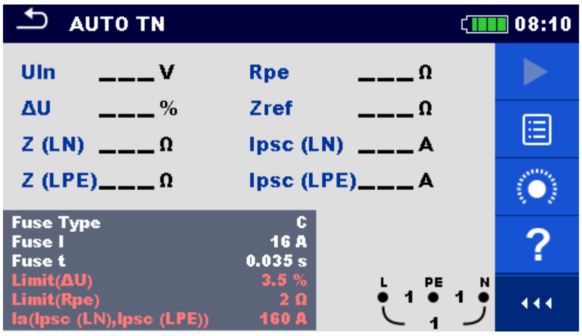


Figure 7.90: AUTO TN menu

Measurement parameters / limits

Fuse type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
I (ΔU) [1)]	**Rated current for ΔU measurement (custom value)**
Isc factor	**Isc factor** [0.20 ... 3.00]
Limit(ΔU)	**Maximum voltage drop** [3.0 % ... 9.0 %]
Limit(Rpe)	**Max. resistance** [Off, 0.1 Ω ... 20.0 Ω]
Ia(Ipsc (LN), Ipsc (LPE))	**Minimum short circuit current for selected fuse or custom value**

[1)] Applicable if Fuse type is set to Off or Custom.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

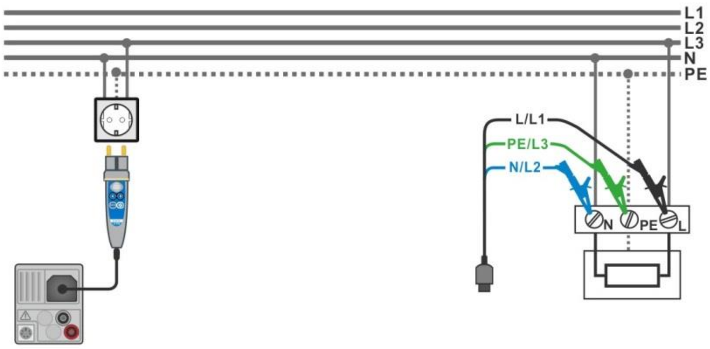


Figure 7.91: AUTO TN measurement

Measurement procedure

- Enter the **AUTO TN** function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter ***7.14 Voltage Drop***.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.91***.
- Start the Auto test.
- Save results (optional).

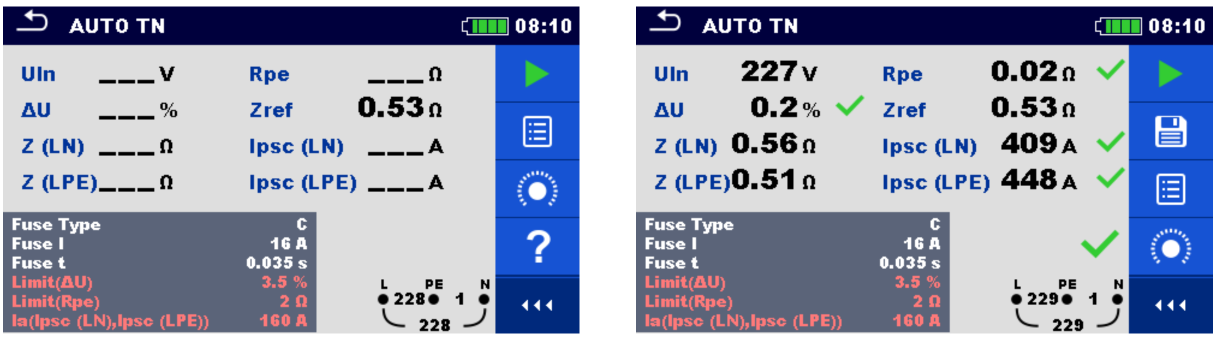


Figure 7.92: Examples of AUTO TN measurement results

Measurement results / sub-results

Uln	Voltage between phase and neutral conductors
ΔU	Voltage drop
Z (LN)	Line impedance
Z (LPE)	Loop impedance
Rpe	PE conductor resistance
Zref	Reference Line impedance
Ipsc (LN)	Prospective short-circuit current
Ipsc (LPE)	Prospective fault current

7.28 AUTO IT – Auto test for IT earthing system (MI 3152 only)

Tests / measurements implemented in AUTO IT

Voltage
Z line
Voltage Drop
ISFL
IMD

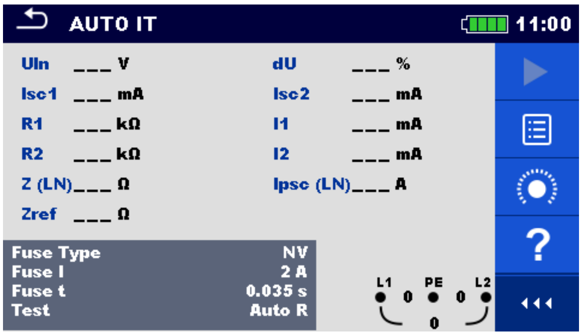


Figure 7.93: AUTO IT menu

Measurement parameters / limits

Fuse type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
I (ΔU) [1)]	**Rated current for ΔU measurement (custom value)**
Test	**Test mode** [MANUAL R, MANUAL I, AUTO R, AUTO I]
t step	**Timer (AUTO R and AUTO I test modes)** [1 s … 99 s]
Isc factor	**Isc factor** [0.20 ... 3.00]
Limit(dU)	**Maximum voltage drop** [3.0 % ... 9.0 %]
Rmin(R1,R2)	**Min. insulation resistance** [Off, 5 kΩ … 640 kΩ],
Imax(I1,I2)	**Max. fault current** [Off, 0.1 mA ... 19.9 mA]
Imax(Isc1,Isc2)	**Maximum first fault leakage current** [Off, 3.0 mA ... 19.5 mA]
Ia(Ipsc (LN))	**Minimum short circuit current for selected fuse or custom value**

1) Applicable if Fuse type is set to Off or Custom.

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

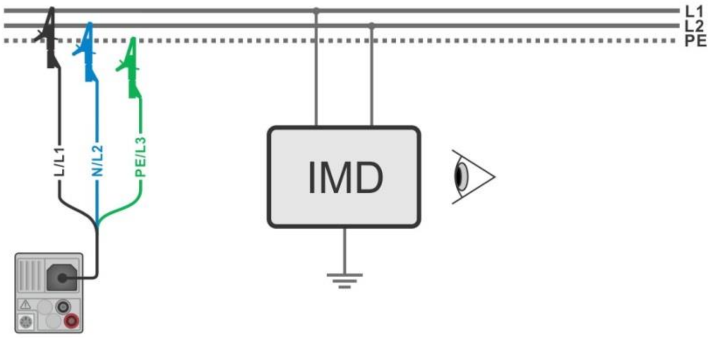


Figure 7.94: AUTO IT measurement

Measurement procedure

- Enter the **AUTO IT** function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter ***7.14 Voltage Drop***.
- Connect test cable to the instrument.
- Connect test leads to the object under test, see ***Figure 7.94***.
- Start the Auto test.
- Save results (optional).

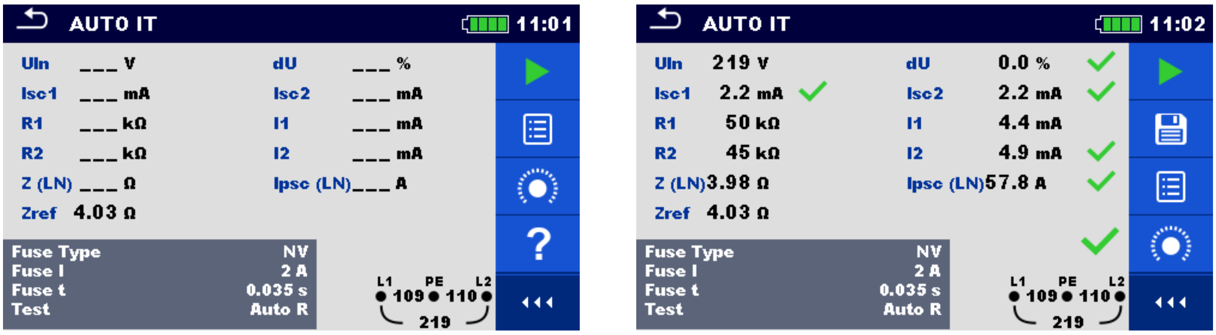


Figure 7.95: Examples of AUTO IT measurement results

Measurement results / sub-results

Uln	Voltage between phases L1 and L2
ΔU	Voltage drop
Isc1	First fault leakage current at single fault between L1/PE
Isc2	First fault leakage current at single fault between L2/PE
R1	Threshold insulation resistance between L1-PE
R2	Threshold insulation resistance between L2-PE
I1	Calculated first fault leakage current for R1
I2	Calculated first fault leakage current for R2
Z (LN)	Line impedance
Zref	Reference Line impedance
Ipsc (LN)	Prospective short-circuit current

7.29 Z auto - Auto test for fast line and loop testing

Tests / measurements implemented in Z auto test sequence

Voltage
Z line
Voltage Drop
Zs rcd
Uc

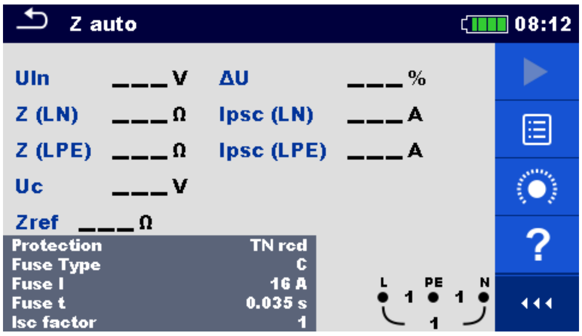


Figure 7.96: Z auto menu

Measurement parameters / limits

Protection	**Protection type** [TN, TNrcd, TTrcd]
Fuse type	**Selection of fuse type** [Off, gG, NV, B, C, D, K, Custom]
Fuse I	**Rated current of selected fuse**
Fuse t	**Maximum breaking time of selected fuse**
I (ΔU) 1)	**Rated current for ΔU measurement (custom value)**
Isc factor	**Isc factor** [0.20 ... 3.00]
I test	**Test current** [Standard, Low]
Type	**RCD type** [AC, A, F, B*, B+*,F]
I ΔN	**Rated RCD residual current sensitivity** [10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]
Selectivity	**Characteristic** [G, S]
Phase 2)	**Selection of test** [-, L1, L2, L3]
I test	**Test current** [Standard, Low]
Limit(ΔU)	**Maximum voltage drop** [3.0 % ... 9.0 %]
Ia(Ipsc (LN), Ipsc (LPE)) 3)	**Minimum short circuit current for selected fuse or custom value**
Limit Uc	**Conventional touch voltage limit** [12 V, 25 V, 50 V]

1) Applicable if Fuse type is set to Off or Custom.
2) With Plug test cable or Plug commander Z auto test is measured in the same way regardless of the setting. The parameter is meant for documentation.
3) Ipsc (LPE) is considered if Protection is set to TN or TNrcd. Ipsc(LN) is always considered.

* Model MI 3152 only

Refer to ***Fuse tables guide*** for detailed information on fuse data.

Connection diagram

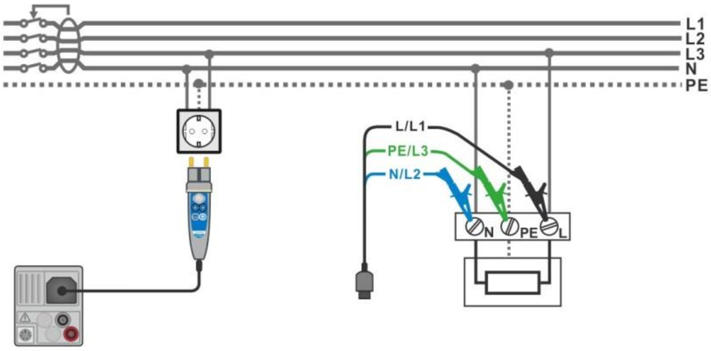


Figure 7.97: Z auto measurement

Measurement procedure

- Enter the **Z auto** function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter ***7.14 Voltage Drop***.
- Connect test cable to the instrument.
- Connect test leads or Plug commander to the object under test, see ***Figure 7.88***.
- Start the test.
- Save results (optional).

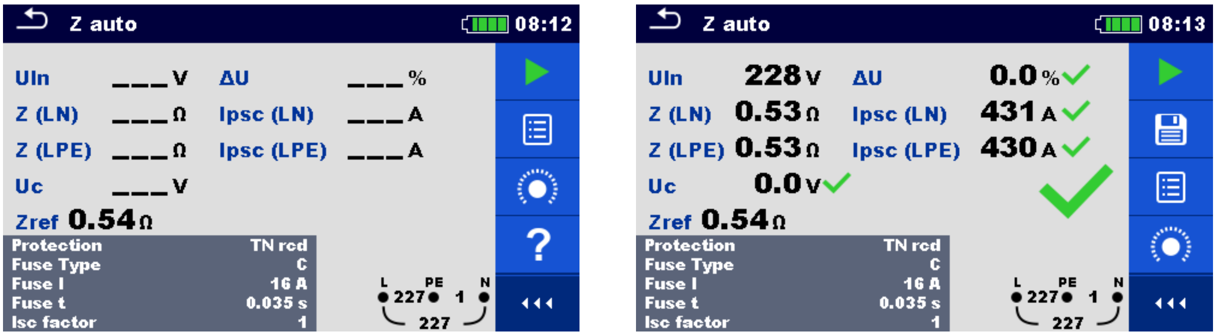


Figure 7.98: Example of Z auto measurement results

Measurement results / sub-results

UIn	Voltage between phase and neutral conductors
ΔU	Voltage drop
Z (LN)	Line impedance
Z (LPE)	Loop impedance
Zref	Reference Line impedance
Ipsc (LN)	Prospective short-circuit current
Ipsc (LPE)	Prospective fault current
Uc	Contact voltage

7.30 Locator

This function is intended for tracing mains installation, like:

- Tracing lines,
- Finding shorts, breaks in lines,
- Detecting fuses.

The instrument generates test signals that can be traced with the handheld tracer receiver R10K. See ***Appendix C – Locator receiver R10K*** for additional information.

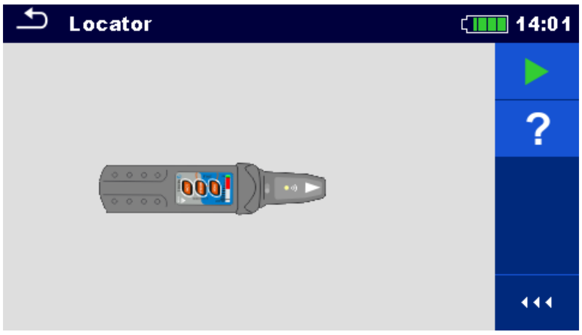


Figure 7.99: Locator main screen

Typical applications for tracing electrical installation

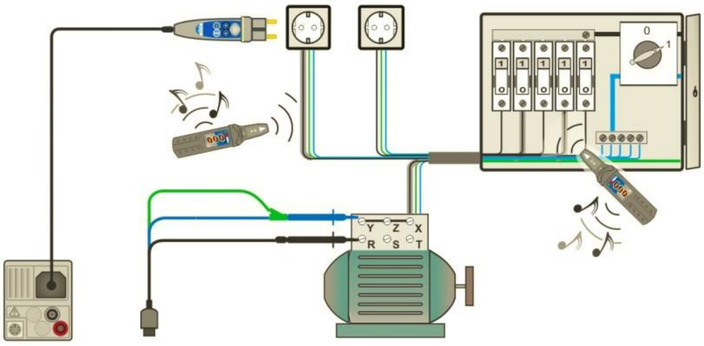


Figure 7.100: Tracing wires under walls and in cabinets

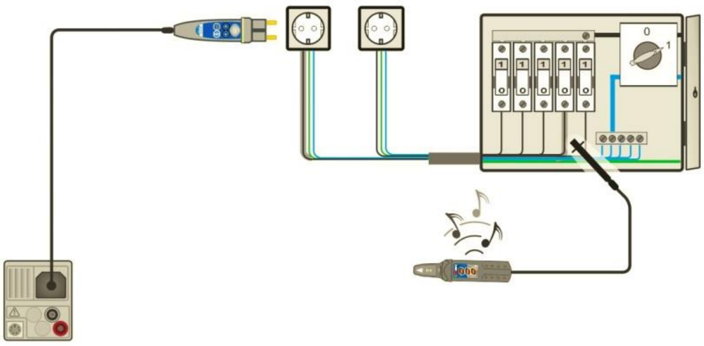


Figure 7.101: Locating individual fuses

Line tracing procedure

- Select ***Locator*** function in ***Other*** menu.
- Connect test cable to the instrument.
- Connect test leads to the tested object (see ***Figure 7.100*** and ***Figure 7.101***).
- Start the test.
- Trace lines with receiver (in IND mode) or receiver plus its optional accessory.
- Stop the test.

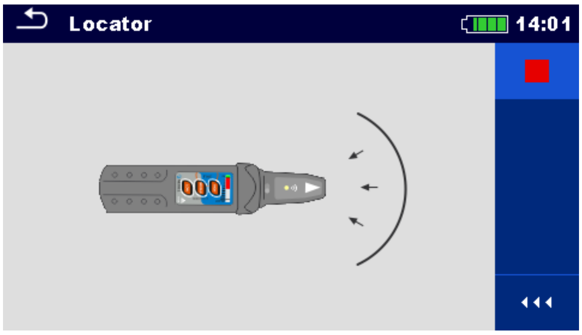


Figure 7.102: Locator active

7.31 Functional inspections

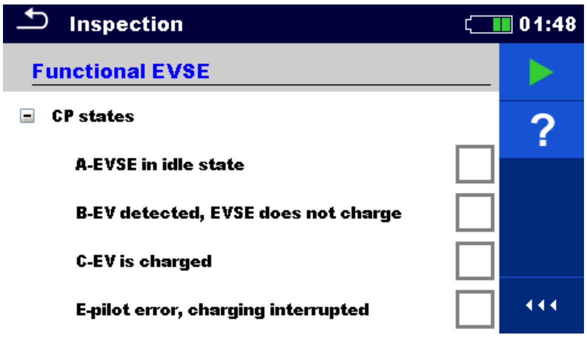


Figure 7.103: Example of Functional inspection menu

Inspection

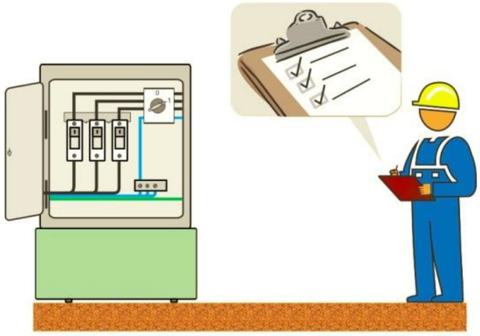


Figure 7.104: Functional inspection test circuit

Functional inspection procedure

- Select the appropriate Functional Inspection test from **Function** menu.
- Start the inspection.
- Perform the inspection of the item under test.
- Apply appropriate ticker(s) to items of inspection.
- End inspection.
- Save results (optional).

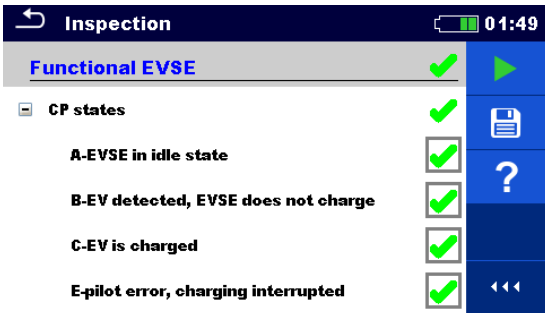


Figure 7.105: Example of Functional inspection results

8 Auto Sequences®

Pre-programmed sequences of measurements can be carried out in Auto Sequences® menu. The results of an Auto Sequence® can be stored in the memory together with all related information.

8.1 Selection of Auto Sequences®

The Auto Sequence® to be carried out can be selected from the Main Auto Sequences® menu. This menu is organized in a structural manner with folders, sub-folders and Auto sequences®. An Auto Sequence® in the structure can be the original Auto sequence® or a shortcut to the original Auto Sequence®.
Auto Sequences marked as shortcuts and the original Auto Sequences® are coupled. Changing of parameters or limits in any of the coupled Auto Sequences® will influence on the original Auto Sequence® and all its shortcuts.

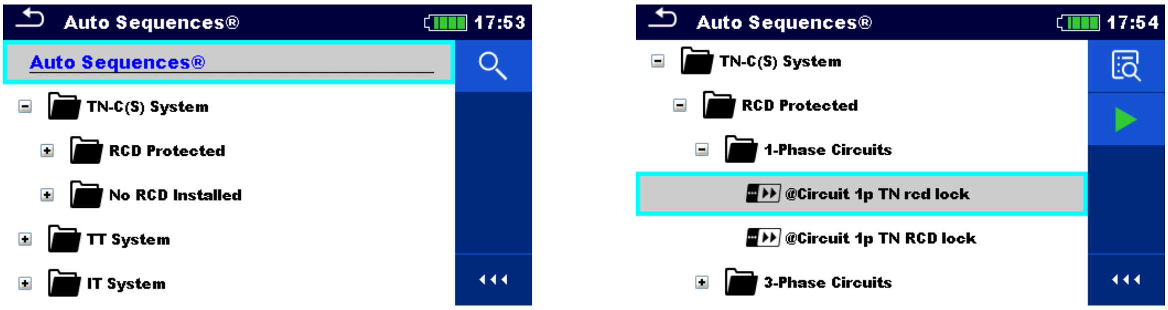
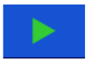


Figure 8.1: Examples of organized Auto Sequences® in Main Auto Sequences® menu

Options

Auto Sequence®	The original Auto Sequence®
Auto Sequence®	A shortcut to the original Auto Sequence®
	Enters menu for more detail view of selected Auto Sequence®. This option should also be used if the parameters / limits of the selected Auto Sequence® have to be changed. Refer to chapter ***8.2.1 Auto Sequences® view* menu** for more information.
	Starts the selected Auto Sequence®. The instrument immediately starts the Auto Sequence®.
	Searches within the Auto Sequences® menu. Refer to chapter ***8.1.1 Searching in Auto Sequences® menu*** for more information.

Note

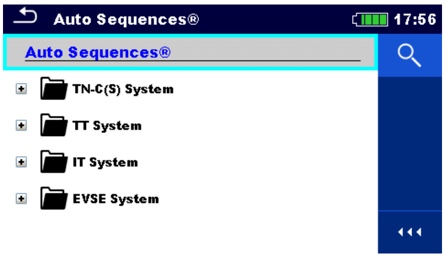
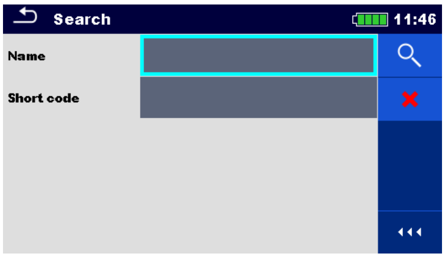
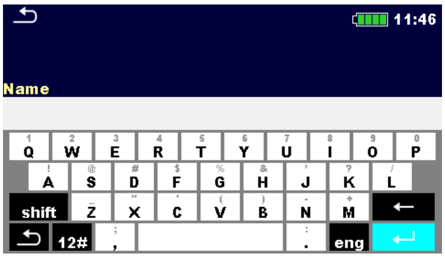
- The content of preprogramed Auto Sequences® depends on the selected instrument profile.

- It is not possible to add user defined Auto Sequences® to MI 3152 or MI 3152H. Only pre-programed / profile Auto Sequences® are available for these two instruments.

8.1.1 Searching in Auto Sequences® menu

In Auto Sequences® menu it is possible to search for Auto Sequences® on base of their Name or Short code.

Procedure

①		Search function is available from the Auto Sequences® header line.
②		Select Search in control panel to open Search setup menu.
③		The parameters that can be searched for are displayed in the Search setup menu.
③**a**		The search can be narrowed by entering a text in the Name and Short code fields. Strings can be entered by using the on-screen keyboard.
③**b**		Clears all filters.
④		Searches through the Auto Sequences® menu according to the set filters. The results are shown in the Search results screen presented on ***Figure 8.2*** and ***Figure 8.3.***

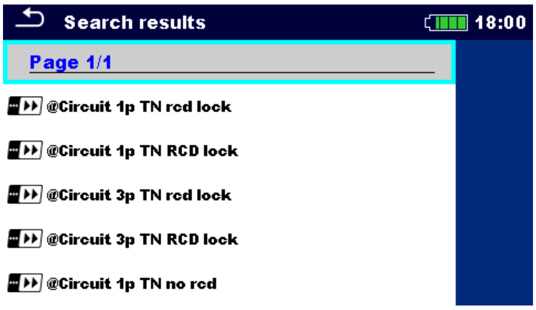


Figure 8.2: Search results screen – Page view

Options	
	Next page (if available).
	Previous page (if available).

Note

- Search result page consist of up to 50 results.

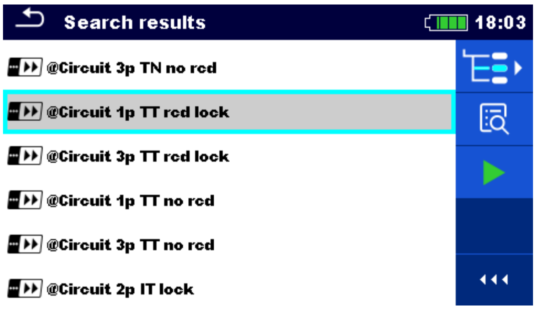
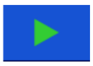


Figure 8.3: Search results screen with Auto Sequences® selected

Options

	Goes to location in Auto Sequences® menu.
	Goes to Auto Sequences® view menu.
	Starts the selected Auto Sequence®.

8.2 Organization of an Auto Sequence®

An Auto Sequence® is divided into three phases:

- Before starting the first test the Auto Sequence® view menu is shown (unless it was started directly from the Main Auto Sequences® menu). Parameters and limits of individual measurements can be set in this menu.
- During the execution phase of an Auto Sequence®, pre-programmed single tests are carried out.
- After the test sequence is finished the Auto Sequence® result menu is shown. Details of individual tests can be viewed and the results can be saved to Memory organizer.

8.2.1 Auto Sequences® view menu

In the Auto Sequence® view menu, the header and the single tests of selected Auto Sequence® are displayed. The header contains Name, Short code and description of the Auto Sequence®. Before starting the Auto Sequence®, test parameters / limits of individual measurements can be changed.

Note

- Once fuse and RCD parameters are changed in active Auto Sequence®, the new settings are distributed through all single tests within active Auto Sequence® and stored for next use of same Auto Sequence®.

8.2.1.1 Auto Sequence® view menu (Header is selected)

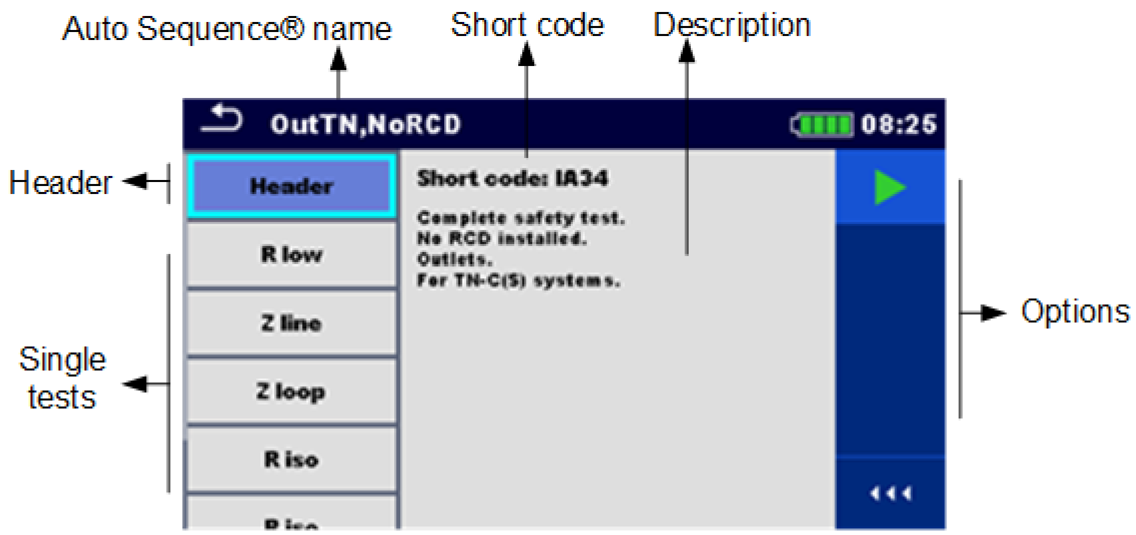


Figure 8.4: Auto Sequence® view menu – Header selected

Options

	Starts the Auto Sequence®.

8.2.1.2 Auto Sequence® view menu (measurement is selected)

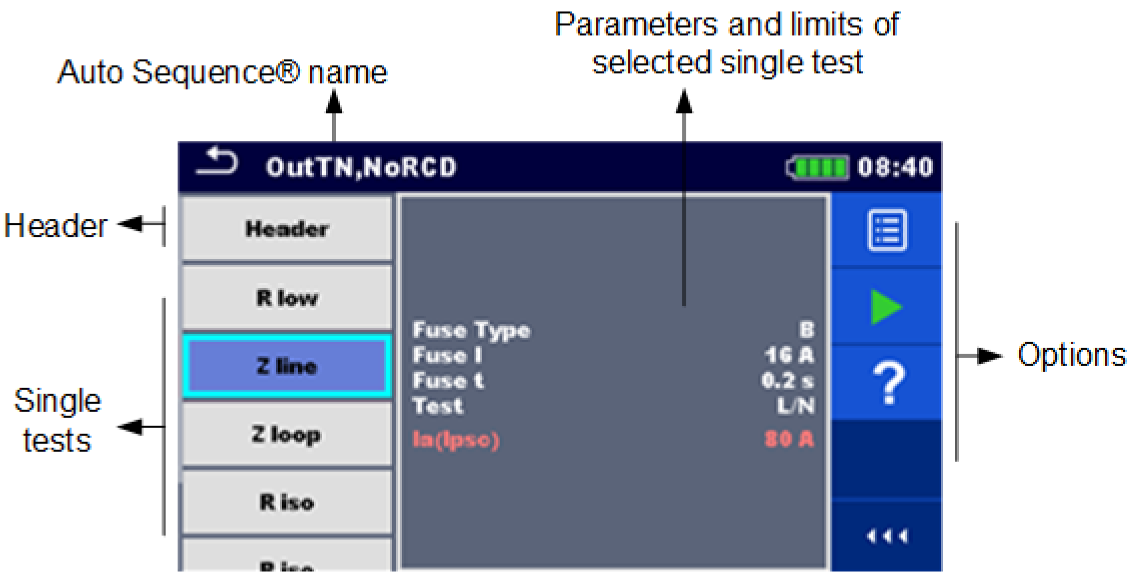
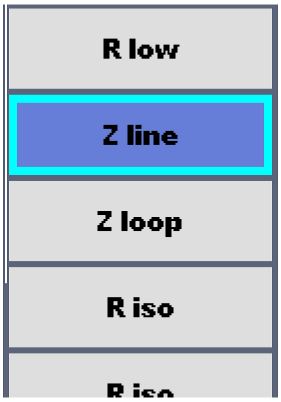
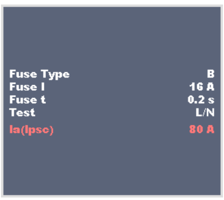


Figure 8.5: Auto Sequence® view menu – measurement selected

Options

	Selects single test.
  on 	Opens menu for changing parameters and limits of selected measurements. Refer to chapter ***6.1.2 Setting parameters and limits of single tests*** for more information how to change measurement parameters and limits.
	Starts the Auto Sequence®.
	Opens help screens. Refer to chapter ***6.1.9 Help screens*** for more information.

8.2.1.3 Indication of Loops

The attached ‘x3’ at the end of single test name indicates that a loop of single tests is programmed. This means that the marked single test will be carried out as many times as the number behind the ‘x’ indicates. It is possible to exit the loop before, at the end of each individual measurement.

8.2.2 Step by step execution of Auto Sequences®

While the Auto Sequence® is running it is controlled by pre-programmed flow commands. Examples are:

- pauses during the test sequence
- proceeding of test sequence in regard to measured results
- etc.

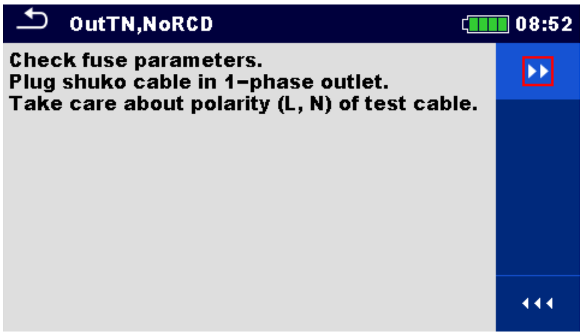


Figure 8.6: Auto Sequence® – Example of a pause with message

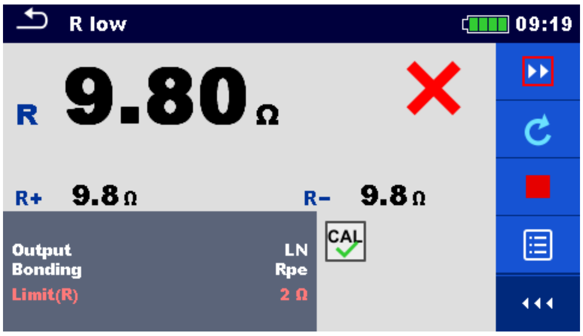


Figure 8.7: Auto Sequence® – Example of a finished measurement with options for proceeding

Options (during execution of an Auto Sequence®)

	Proceeds to next step in the test sequence.
	Repeats the measurement. Displayed result of a single test will not be stored.

Ends the Auto Sequence® and goes to Auto Sequence® result screen. Refer to chapter ***8.2.3 Auto Sequence® result screen*** for more information.

Exits the loop of single tests and proceeds to the next step in the test sequence.

The offered options in the control panel depend on the selected single test, its result and the programmed test flow.

8.2.3 Auto Sequence® result screen

After the Auto Sequence® is finished the Auto Sequence® result screen is displayed.
At the left side of the display the single tests and their statuses in the Auto Sequence® are shown.

In the middle of the display the header of the Auto Sequence® with Short code and description of the Auto Sequence® is displayed. At the top the overall Auto sequence result status is displayed. Refer to chapter ***5.1.1 Measurement statuses*** for more information.

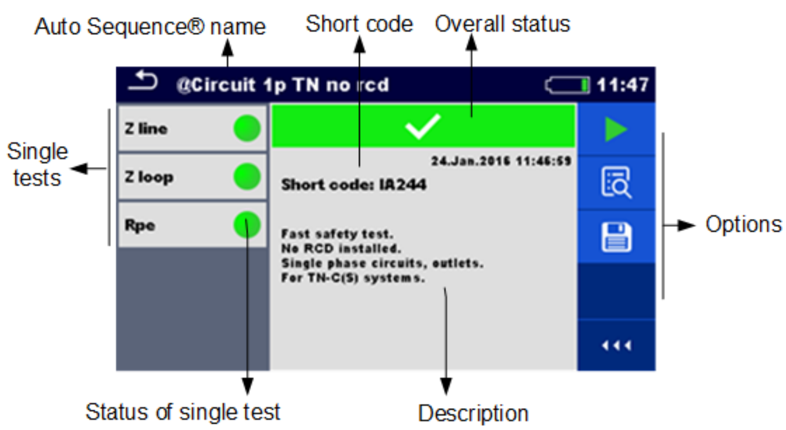


Figure 8.8: Auto Sequence® result screen

Options

Starts a new Auto Sequence®.

View results of individual measurements.

The instrument goes to menu for viewing details of the Auto Sequence®.

Saves the Auto Sequence® results.

A new Auto Sequence® was selected and started from a Structure object in the structure tree:

- The Auto Sequence® will be saved under the selected Structure object.

A new Auto Sequence® was started from the Auto Sequence® main menu:

- Saving under the last selected Structure object will be offered by default. The user can select another Structure object or create a new Structure object. By pressing  in Memory organizer menu the Auto Sequence® is saved under selected location.

An empty measurement was selected in structure tree and started:

- The result(s) will be added to the Auto Sequence®. The Auto Sequence® will change its overall status from ‘empty’ to ‘finished’.

An already carried out Auto Sequence® was selected in structure tree, viewed and then restarted:

- A new Auto Sequence® will be saved under the selected Structure object.

 Adds comment to the Auto Sequence®. The instrument opens keypad for entering a comment.

Options (menu for viewing details of Auto Sequence® results)

 Details of selected single test in Auto Sequence® are displayed.

 View parameters and limits of selected single test.

 Adds comment to the selected single test in Auto Sequence®. The instrument opens keypad for entering a comment.

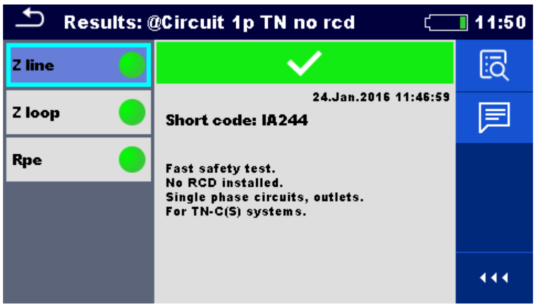


Figure 8.9: Details of menu for viewing details of Auto Sequence® results

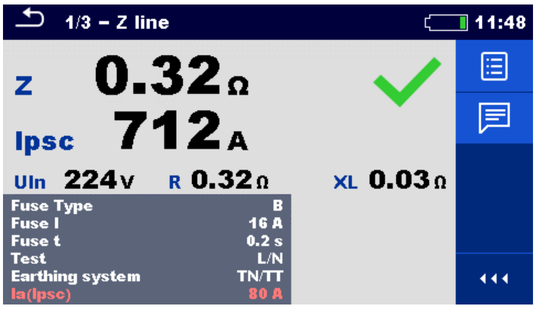


Figure 8.10: Details of single test in Auto Sequence® result menu

8.2.4 Auto Sequence® memory screen

In Auto Sequence® memory screen details of the Auto Sequence® results can be viewed and a new Auto Sequence® can be restarted.

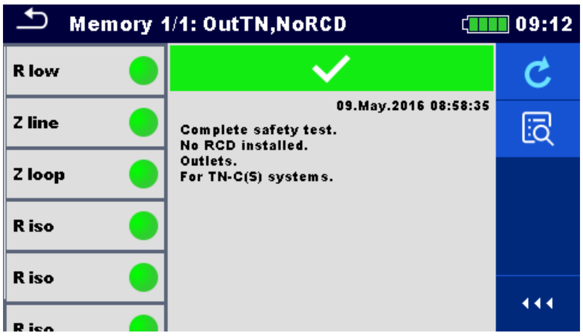


Figure 8.11: Auto Sequence® memory screen

Options

	Retest the Auto Sequence®. Enters menu for a new Auto Sequence®.
	Enters menu for viewing details of the Auto Sequence®. Refer to chapter **8.2.3 *Auto Sequence® result* screen** for more information.

9 Communication

The instrument can communicate with the Metrel ES Manager PC software. The following action is supported:

- Saved results and Tree structure from Memory organizer can be downloaded and stored to a PC.
- Tree structure from Metrel ES Manager PC software can be uploaded to the instrument.

Metrel ES Manager is a PC software running on Windows 7, Windows 8, Windows 8.1 and Windows 10.
There are three communication interfaces available on the instrument: RS-232, USB and Bluetooth. Instrument can also communicate to various external devices (android devices, test adapters, scanners,…).

9.1 USB and RS232 communication

The instrument automatically selects the communication mode according to detected interface. USB interface has priority.

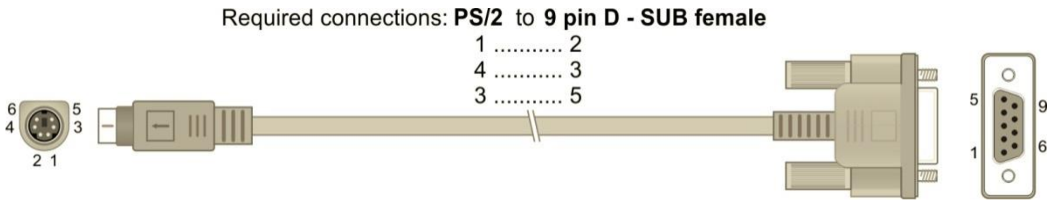


Figure 9.1: Interface connection for data transfer over PC COM port

How to establish an USB or RS-232 link:

- RS-232 communication: connect a PC COM port to the instrument PS/2 connector using the PS/2 - RS232 serial communication cable;
- USB communication: connect a PC USB port to the instrument USB connector using the USB interface cable.
- Switch on the PC and the instrument.
- Run the *Metrel ES Manager* software.
- Select communication port (COM port for USB communication is identified as 'Measurement Instrument USB VCom Port'.
- The instrument is prepared to communicate with the PC.

9.2 Bluetooth communication

The internal Bluetooth module enables easy communication via Bluetooth with PC and Android devices.

How to configure a Bluetooth link between instrument and PC

- Switch On the instrument.
- On PC configure a Standard Serial Port to enable communication over Bluetooth link between instrument and PC. Usually no code for pairing the devices is needed.

- Run the *Metrel ES Manager* software.
- Select configured communication port.
- The instrument is prepared to communicate with the PC.

How to configure a Bluetooth link between instrument and Android device

- Switch On the instrument.
- Some Android applications automatically carry out the setup of a Bluetooth connection. It is preferred to use this option if it exists. This option is supported by Metrel's Android applications.
- If this option is not supported by the selected Android application then configure a Bluetooth link via Android device's Bluetooth configuration tool. Usually no code for pairing the devices is needed.
- The instrument and Android device are ready to communicate.

Notes

- Sometimes there will be a demand from the PC or Android device to enter the code. Enter code 'NNNN' to correctly configure the Bluetooth link.
- The name of correctly configured Bluetooth device must consist of the instrument type plus serial number, e.g. *MI 3152-12240429I*. If the Bluetooth module got another name, the configuration must be repeated.
- In case of serious troubles with the Bluetooth communication it is possible to reinitialize the internal Bluetooth module. The initialization is carried out during the Initial settings procedure. In case of a successful initialization "INITIALIZING… OK!" is displayed at the end of the procedure. See chapter ***4.6.7 Initial Settings***.
- Check if Metrel Android applications are available for this instrument.

9.3 Bluetooth and RS232 communication with scanners

EurotestXC instrument can communicate with supported Bluetooth and serial scanners. Serial scanner should be connected to the instruments PS/2 serial port. Contact Metrel or your distributor which external devices and functionalities are supported. See chapter ***4.6.6 Devices*** for details how to set the external Bluetooth or serial device.

10 Upgrading the instrument

The instrument can be upgraded from a PC via the RS232 or USB communication port. This enables to keep the instrument up to date even if the standards or regulations change. The firmware upgrade requires internet access and can be carried out from the ***Metrel ES Manager*** software with a help of special upgrading software – ***FlashMe*** which will guide you through the upgrading procedure. For more information refer to Metrel ES Manager Help file.

11 Maintenance

Unauthorized persons are not allowed to open the EurotestXC instrument. There are no user replaceable components inside the instrument, except the battery and fuses under back cover.

11.1 Fuse replacement

There are three fuses under back cover of the EurotestXC instrument.

F1	M 0.315 A / 250 V, 20×5 mm This fuse protects internal circuitry for continuity functions if test probes are connected to the mains supply voltage by mistake during measurement.
F2, F3	F 4 A / 500 V, 32×6.3 mm (breaking capacity: 50 kA) General input protection fuses of test terminals L/L1 and N/L2.

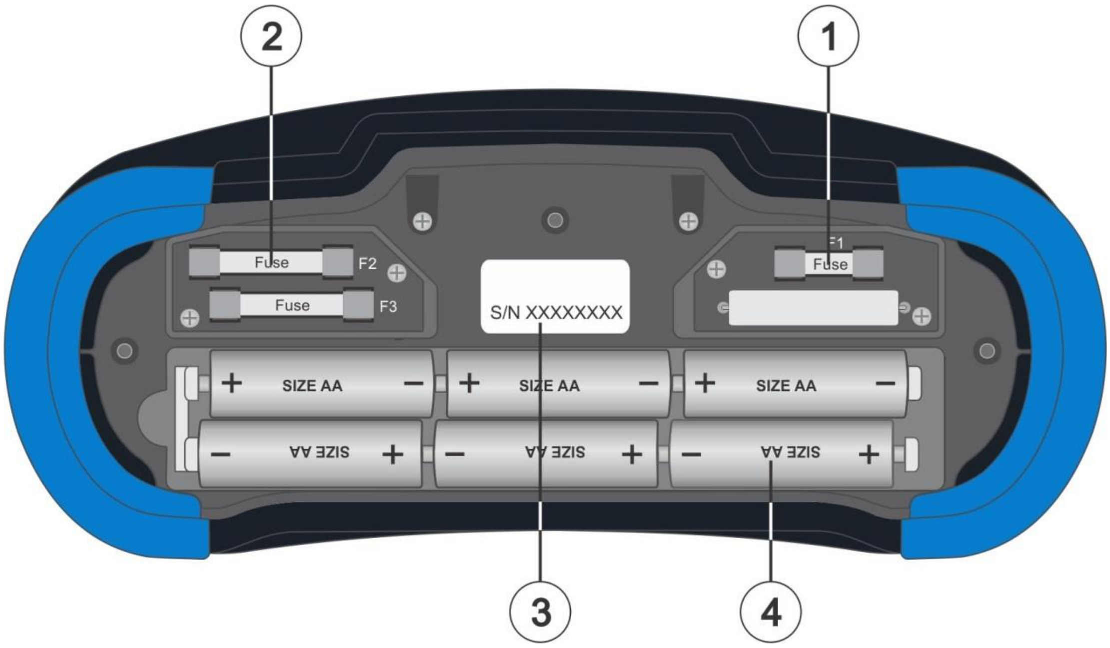


Figure 11.1: Fuses

Warnings!

- Switch off the instrument and disconnect all measuring accessory before opening battery / fuse compartment cover, hazardous voltage inside!
- Replace blown fuse with original type only, otherwise the instrument or accessory may be damaged and / or operator’s safety impaired!

11.2 Cleaning

No special maintenance is required for the housing. To clean the surface of the instrument or accessory use a soft cloth slightly moistened with soapy water or alcohol. Then leave the instrument or accessory to dry totally before use.

Warnings!

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

11.3 Periodic calibration

It is essential that the test instrument is regularly calibrated in order that the technical specification listed in this manual is guaranteed. We recommend an annual calibration. Only an authorized technical person can do the calibration. Please contact your dealer for further information.

11.4 Service

For repairs under warranty, or at any other time, please contact your distributor.

12 Technical specifications

12.1 R iso – Insulation resistance

Uiso: 50 V, 100 V and 250 V
Riso – Insulation resistance
Measuring range according to EN 61557 is 0.15 MΩ … 199.9 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.00 ... 19.99	0.01	±(5 % of reading + 3 digits)
20.0 ... 99.9	0.1	±(10 % of reading)
100.0 ... 199.9		±(20 % of reading)

Uiso: 500 V and 1000 V
Riso – Insulation resistance
Measuring range according to EN 61557 is 0.15 MΩ … 999 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.00 ... 19.99	0.01	±(5 % of reading + 3 digits)
20.0 ... 199.9	0.1	±(5 % of reading)
200 ... 999	1	±(10 % of reading)

Uiso: 2500V (MI 3152H only)
Riso – Insulation resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 M ... 19.99 M	0.01 M	±(5 % of reading + 3 digits)
20.0 M ... 199.9 M	0.1 M	±(5 % of reading)
200 M ... 999 M	1 M	±(10 % of reading)
1.00 G ... 19.99 G	0.01 G	±(10 % of reading)

Um – Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ... 2700	1	±(3 % of reading + 3 digits)

Nominal voltages Uiso ....50 V_{DC}, 100 V_{DC}, 250 V_{DC}, 500 V_{DC}, 1000 V_{DC}, 2500 V_{DC} (MI 3152H only)
Open circuit voltage................................-0 % / +20 % of nominal voltage
Measuring current...................................min. 1 mA at $R_N = U_N \times 1$ kΩ/V
Short circuit current .... max. 3 mA
The number of possible tests................. > 700, with a fully charged battery

Auto discharge after test.

Specified accuracy is valid if 3-wire test lead is used while it is valid up to 100 MΩ if Tip commander is used.
Specified accuracy is valid up to 100 MΩ if relative humidity is > 85 %.
In case the instrument gets moistened, the results could be impaired. In such case, it is recommended to dry the instrument and accessories for at least 24 hours.
The error in operating conditions could be at most the error for reference conditions (specified in the manual for each function) ±5 % of measured value.

12.2 Diagnostic test (MI 3152H only)

Uiso: 500V, 1000 V, 2500 V

DAR – Dielectric absorption ratio

Measuring range	Resolution	Accuracy
0.01 ... 9.99	0.01	±(5 % of reading + 2 digits)
10.0 ... 100.0	0.1	±(5 % of reading)

PI – Polarization index

Measuring range	Resolution	Accuracy
0.01 ... 9.99	0.01	±(5 % of reading + 2 digits)
10.0 ... 100.0	0.1	±(5 % of reading)

For **Riso**, **R60,** and **Um** sub-results technical specifications defined in chapter ***12.1 R iso – Insulation resistance*** apply.

12.3 R low – Resistance of earth connection and equipotential bonding

Measuring range according to EN 61557 is 0.16 Ω ... 1999 Ω.

R – Resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 19.99	0.01	±(3 % of reading + 3 digits)
20.0 ... 199.9	0.1	±(5 % of reading)
200 ... 1999	1	

R+, R – Resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.0 ... 199.9	0.1	±(5 % of reading + 5 digits)
200 ... 1999	1	

Open-circuit voltage................................6.5 VDC ... 18 VDC
Measuring current...................................min. 200 mA into load resistance of 2 Ω
Test lead compensation..........................up to 5 Ω
The number of possible tests..................> 1400, with a fully charged battery

Automatic polarity reversal of the test voltage.

12.4 Continuity – Continuous resistance measurement with low current

R – Continuity resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.0 ... 19.9	0.1	±(5 % of reading + 10 digits)
20 ... 1999	1	

Open-circuit voltage................................6.5 VDC ... 18 VDC
Short-circuit current ....max. 8.5 mA

Test lead compensation..........................up to 5 Ω

12.5 RCD testing

General data

Nominal residual current (A,AC) ....10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA
Nominal residual current accuracy..........-0 / +0.1·IΔ; IΔ = IΔN, 2×IΔN, 5×IΔN
-0.1·IΔ / +0; IΔ = 0.5×IΔN
AS/NZS 3017 selected: ± 5 %
Test current shape..................................Sine-wave (AC), pulsed (A, F), smooth DC (B, B+)
DC offset for pulsed test current ....6 mA (typical)
RCD type...(non-delayed), S (time-delayed), PRCD, PRCD-K, PRCD-S
Test current starting polarity .... 0º or 180º
Voltage range...93 V ... 134 V (45 Hz ... 65 Hz)
185 V ... 266 V (45 Hz ... 65 Hz)

RCD test current in relation to RCD type, nominal RCD current and multiplication factor

	$I_{\Delta N}$ × 1/2 (mA)			$I_{\Delta N}$ × 1 (mA)			$I_{\Delta N}$ × 2 (mA)			$I_{\Delta N}$ × 5 (mA)			RCD I_{Δ}		
$I_{\Delta N}$ (mA)	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+
10	5	3.5	5	10	20	20	20	40	40	50	100	100	✓	✓	✓
30	15	10.5	15	30	42	60	60	84	120	150	212	300	✓	✓	✓
100	50	35	50	100	141	200	200	282	400	500	707	1000	✓	✓	✓
300	150	105	150	300	424	600	600	848	×	1500	×	×	✓	✓	✓
500	250	175	250	500	707	1000	1000	1410	×	2500	×	×	✓	✓	✓
1000	500	350	500	1000	1410	×	2000	×	×	n.a.	×	×	✓	✓	×

× ....not applicable
✓..applicable
AC type..sine wave test current
A, F types…… ....pulsed current
B, B+ types..smooth DC current (MI 3152 only)

RCD test current in relation to MI / EV RCD type and multiplication factor

	$I_{\Delta N}$ × 1/2 (mA)	$I_{\Delta N}$ × 1 (mA)	$I_{\Delta N}$ × 2 (mA)	$I_{\Delta N}$ × 5 (mA)	RCD I_{Δ}	
$I_{\Delta N}$ (mA)	MI / EV a.c.	MI / EV a.c.	MI / EV a.c.	MI / EV a.c.	MI / EV a.c.	MI / EV d.c.
30 a.c.	15	30	60	150	✓	×
6 d.c.	×	×	×	×	×	✓

×. ....not applicable
✓..applicable
MI / EV types (a.c. part) ....sine-wave test current
MI / EV types (d.c. part) ....smooth DC current

12.5.1 RCD Uc – Contact voltage

Measuring range according to EN 61557 is 20.0 V ... 31.0 V for limit contact voltage 25 V
Measuring range according to EN 61557 is 20.0 V ... 62.0 V for limit contact voltage 50 V

Uc – Contact voltage

Measuring range (V)	Resolution (V)	Accuracy
0.0 ... 19.9	0.1	(-0 % / +15 %) of reading ± 10 digits
20.0 ... 99.9	0.1	(-0 % / +15 %) of reading

The accuracy is valid if mains voltage is stabile during the measurement and PE terminal is free of interfering voltages. Specified accuracy is valid for complete operating range.

Test current .... max. $0.5\times I_{\Delta N}$
Limit contact voltage.............................. 12 V, 25 V, 50 V

12.5.2 RCD t – Trip-out time

Complete measurement range corresponds to EN 61557 requirements.
Maximum measuring times set according to selected reference for RCD testing.

t ∆N –Trip-out time

Measuring range (ms)	Resolution (ms)	Accuracy
0.0 ... 40.0	0.1	±1 ms
0.0 ... max. time*	0.1	±3 ms

* For max. time see normative references in chapter ***4.6.5.1 RCD standard***. This specification applies to max. time >40 ms.

Test current .... $\frac{1}{2}\times I_{\Delta N}$, $I_{\Delta N}$, $2\times I_{\Delta N}$, $5\times I_{\Delta N}$
$5\times I_{\Delta N}$ is not available for $I_{\Delta N}$=1000 mA (RCD type AC) or $I_{\Delta N} \geq$ 300 mA (RCD types A, F).
$2\times I_{\Delta N}$ is not available for $I_{\Delta N}$=1000 mA (RCD types A, F).
Specified accuracy is valid for complete operating range.

12.5.3 RCD I – Trip-out current

Complete measurement range corresponds to EN 61557 requirements.

I∆ – Trip-out current

Measuring range	Resolution I_{Δ}	Accuracy
$0.2\times I_{\Delta N}$ ... $1.1\times I_{\Delta N}$ (AC, MI / EV a.c. types)	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$
$0.2\times I_{\Delta N}$ ... $1.5\times I_{\Delta N}$ (A type, $I_{\Delta N}\geq$30 mA)	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$
$0.2\times I_{\Delta N}$ ... $2.2\times I_{\Delta N}$ (A type, $I_{\Delta N}$<30 mA)	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$
$0.2\times I_{\Delta N}$ … $2.2\times I_{\Delta N}$ (B, B+ types, MI / EV d.c. types)	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$

t I∆ – Trip out-time

Measuring range (ms)	Resolution (ms)	Accuracy
0 ... 300	1	±3 ms

Uc, Uc I∆ – Contact voltage

Measuring range (V)	Resolution (V)	Accuracy
0.0 ... 19.9	0.1	(-0 % / +15 %) of reading ± 10 digits
20.0 ... 99.9	0.1	(-0 % / +15 %) of reading

Limit contact voltage (Uc, Uc IΔ)............ 12 V, 25 V, 50 V

The accuracy is valid if mains voltage is stabile during the measurement and PE terminal is free of interfering voltages. Specified accuracy is valid for complete operating range.
Trip-out measurement is not available for $I_{\Delta N}$=1000 mA (RCD types B, B+).

12.6 RCD Auto

Refer to chapter ***12.5 RCD testing*** for technical specification of individual RCD tests.

12.7 Z loop – Fault loop impedance and prospective fault current

Z – Fault loop impedance
Measuring range according to EN 61557 is 0.25 Ω ... 9.99 kΩ.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 9.99	0.01	±(5 % of reading + 5 digits)
10.0 ... 99.9	0.1	
100 ... 999	1	± 10 % of reading
1.00 k ... 9.99 k	10	

Ipsc – Prospective fault current

Measuring range (A)	Resolution (A)	Accuracy
0.00 ... 9.99	0.01	Consider accuracy of fault loop resistance measurement
10.0 ... 99.9	0.1	
100 ... 999	1	
1.00 k ... 9.99 k	10	
10.0 k ... 23.0 k	100	

Ulpe – Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ... 550	1	±(2 % of reading + 2 digits)

The accuracy is valid if mains voltage is stabile during the measurement.

Test current (at 230 V)........................... 6.5 A (10 ms)
Nominal voltage range........................... 93 V ... 134 V (45 Hz ... 65 Hz)
185 V ... 266 V (45 Hz ... 65 Hz)
R, X_L values are indicative.

12.8 Zs rcd – Fault loop impedance and prospective fault current in system with RCD

Z – Fault loop impedance

Measuring range according to EN 61557 is 0.46 Ω ... 9.99 kΩ for I test = standard and 0.48 Ω ... 9.99 kΩ for I test = low.

Measuring range (Ω)	Resolution (Ω)	Accuracy I test = standard	Accuracy I test = low
0.00 ... 9.99	0.01	±(5 % of reading + 10 digits)	±(5 % of reading + 12 digits)
10.0 ... 99.9	0.1		
100 ... 999	1	± 10 % of reading	± 10 % of reading
1.00 k ... 9.99 k	10		

Accuracy may be impaired in case of heavy noise on mains voltage.

Ipsc – Prospective fault current

Measuring range (A)	Resolution (A)	Accuracy
0.00 ... 9.99	0.01	Consider accuracy of fault loop resistance measurement
10.0 ... 99.9	0.1	
100 ... 999	1	
1.00 k ... 9.99 k	10	
10.0 k ... 23.0 k	100	

Ulpe – Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ... 550	1	±(2 % of reading + 2 digits)

Uc – Contact voltage

Refer to chapter ***12.5.1 RCD Uc – Contact voltage*** for detailed technical specification.

Nominal voltage range........................... 93 V ... 134 V (45 Hz ... 65 Hz)
185 V ... 266 V (45 Hz ... 65 Hz)

No trip out of RCD. R, X_L values are indicative.

12.9 Z loop mΩ – High precision fault loop impedance and prospective fault current

Refer to ***A 1143 – Euro Z 290 A adapter Instruction manual*** for detailed technical specification.

12.10 Z line – Line impedance and prospective short-circuit current

Z – Line impedance

Measuring range according to EN 61557 is 0.25 Ω ... 9.99 kΩ.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 9.99	0.01	±(5 % of reading + 5 digits)
10.0 ... 99.9	0.1	
100 ... 999	1	± 10 % of reading
1.00 k ... 9.99 k	10	

Ipsc – prospective short-circuit current
Imax – Maximal single-phase prospective short-circuit current
Imax2p – Maximal two-phases prospective short-circuit current
Imax3p – Maximal three-phases prospective short-circuit current

Measuring range (A)	Resolution (A)	Accuracy
0.00 ... 0.99	0.01	Consider accuracy of line resistance measurement
1.0 ... 99.9	0.1	
100 ... 999	1	
1.00 k ... 99.99 k	10	
100 k ... 199 k	1000	

Uln – Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ... 550	1	±(2 % of reading + 2 digits)

Test current (at 230 V)........................... 6.5 A (10 ms)
Nominal voltage range........................... 93 V ... 134 V (45 Hz ... 65 Hz)
185 V ... 266 V (45 Hz ... 65 Hz)
321 V ... 485 V (45 Hz ... 65 Hz)
R, X_L, Imin, Imin2p, Imin3p values are indicative.

12.11 Z line mΩ – High precision line impedance and prospective short-circuit current

Refer to ***A 1143 – Euro Z 290 A adapter Instruction manual*** for detailed technical specification.

12.12 Voltage Drop

ΔU – Voltage drop

Measuring range (%)	Resolution (%)	Accuracy
0.0 ... 99.9	0.1	Consider accuracy of line impedance measurement(s)*

Uln, Ipsc, Zref, Z

Refer to chapter ***12.10 Z line – Line impedance and prospective short-circuit current*** for technical specification.

Z_{REF} measuring range .... 0.00 Ω ... 20.0 Ω

Test current (at 230 V)........................... 6.5 A (10 ms)
Nominal voltage range........................... 93 V ... 134 V (45 Hz ... 65 Hz)
185 V ... 266 V (45 Hz ... 65 Hz)
321 V ... 485 V (45 Hz ... 65 Hz)

*See chapter ***7.14 Voltage Drop*** for more information about calculation of voltage drop result.

12.13 Z auto, AUTO TT, AUTO TN, AUTO TN (RCD), AUTO IT

Refer to chapters listed below for detailed technical specification:

12.5.1 RCD Uc – Contact voltage,

12.7 Z loop – Fault loop impedance and prospective fault current,

12.8 Zs rcd – Fault loop impedance and prospective fault current in system with RCD,

12.10 Z line – Line impedance and prospective short-circuit current,

12.12 Voltage Drop,

12.14 Rpe – PE conductor resistance,

12.23 ISFL – First fault leakage current (MI 3152 only) and

12.24 IMD (MI 3152 only),

12.14 Rpe – PE conductor resistance

RCD: No
R – PE conductor resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 19.99	0.01	±(5 % of reading + 5 digits)
20.0 ... 99.9	0.1	
100.0 ... 199.9	0.1	± 10 % of reading
200 ... 1999	1	

Measuring current..................................min. 200 mA into PE resistance of 2 Ω

RCD: Yes, no trip out of RCD
R – PE conductor resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 19.99	0.01	±(5 % of reading + 10 digits)
20.0 ... 99.9	0.1	
100.0 ... 199.9	0.1	± 10 % of reading
200 ... 1999	1	

Accuracy may be impaired in case of heavy noise on mains voltage.

Measuring current.................................. < 15 mA

Nominal voltage range........................... 93 V ... 134 V (45 Hz ... 65 Hz)
185 V ... 266 V (45 Hz ... 65 Hz)

12.15 Earth – Earth resistance (3-wire measurement)

Re – Earth resistance
Measuring range according to EN61557-5 is 0.20 Ω ... 1999 Ω.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 19.99	0.01	±(5 % of reading + 5 digits)
20.0 ... 199.9	0.1	
200 ... 9999	1	

Max. auxiliary earth electrode resistance R_C...........100×R_E or 50 kΩ (whichever is lower)
Max. probe resistance R_P ....100×R_E or 50 kΩ (whichever is lower)

Rc and Rp values are indicative.

Additional probe resistance error at R_{Cmax} or $R_{Pmax.}$.±(10 % of reading + 10 digits)

Additional error at 3 V voltage noise (50 Hz)...........±(5 % of reading + 10 digits)
Open circuit voltage..< 30 VAC
Short circuit current ....< 30 mA
Test voltage frequency ....125 Hz
Test voltage shape ....sine wave
Noise voltage indication threshold ....1 V (< 50 Ω, worst case)

Automatic measurement of auxiliary electrode resistance and probe resistance.
Automatic measurement of voltage noise.

12.16 Earth 2 clamp – Contactless earthing resistance measurement (with two current clamps)

Re – Earth resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy*)
0.00 ... 19.99	0.01	±(10 % of reading + 10 digits)
20.0 ... 30.0	0.1	±(20 % of reading)
30.1 ... 39.9	0.1	±(30 % of reading)

*) Distance between current clamps > 30 cm.

Additional error at 3 V voltage noise (50 Hz)...........±10 % of reading
Test voltage frequency ....125 Hz
Noise current indication ....yes
Low clamp current indication ....yes
Additional clamp error has to be considered.

12.17 Ro – Specific earth resistance

ρ – Specific earth resistance

Measuring range (Ωm)	Resolution (Ωm)	Accuracy
0.0 ... 99.9	0.1	See accuracy note
100 ... 999	1	
1.00 k ... 9.99 k	0.01 k	
10.0 k ... 99.9 k	0.1 k	
100 k ... 9999 k	1 k	

ρ – Specific earth resistance

Measuring range (Ωft)	Resolution (Ωft)	Accuracy
0.0 ... 99.9	0.1	See accuracy note
100 ... 999	1	
1.00 k ... 9.99 k	0.01 k	
10.0 k ... 99.9 k	0.1 k	
100 k ... 9999 k	1 k	

Principle:
$\rho = 2 \cdot \pi \cdot d \cdot Re$,
where Re is a measured resistance in 4-wire method and d is distance between the probes.

Accuracy note:
Accuracy of the specific earth resistance result depends on measured earth resistance Re as follows:

Re – Earth resistance

Measuring range (Ω)	Accuracy
1.00 ... 1999	±5 % of measured value
2000 ... 19.99 k	±10 % of measured value
>20 k	±20 % of measured value

Rc and Rp values are indicative.

Additional error:
See *Earth resistance three-wire method.*

12.18 Voltage, frequency, and phase rotation

12.18.1 Phase rotation

Nominal system voltage range............... 100 V_{AC} ... 550 V_{AC}
Nominal frequency range....................... 14 Hz ... 500 Hz
Result displayed .... 1.2.3 or 3.2.1

12.18.2 Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ... 550	1	±(2 % of reading + 2 digits)

Result type .... True r.m.s. (TRMS)
Nominal frequency range....................... 0 Hz, 14 Hz ... 500 Hz

12.18.3 Frequency

Measuring range (Hz)	Resolution (Hz)	Accuracy
0.00 ... 9.99	0.01	±(0.2 % of reading + 1 digit)
10.0 ... 499.9	0.1	

Nominal voltage range........................... 20 V ... 550 V

12.18.4 Online terminal voltage monitor

Measuring range (V)	Resolution (V)	Accuracy
10 ... 550	1	±(2 % of reading + 2 digits)

12.19 Currents

Instrument
Maximum voltage on C1 measuring input........3 V
Nominal frequency................................ ....0 Hz, 40 Hz ... 500 Hz

Ch1 clamp type: A1018
Range: 20 A
I1 – Current

Measuring range (A)	Resolution (A)	Accuracy*
0.0 m ... 99.9 m	0.1 m	±(5 % of reading + 5 digits)
100 m ... 999 m	1 m	±(3 % of reading + 3 digits)
1.00 ... 19.99	0.01	±(3 % of reading)

Ch1 clamp type: A1019
Range: 20 A
I1 – Current

Measuring range (A)	Resolution (A)	Accuracy*
0.0 m ... 99.9 m	0.1 m	indicative
100 m ... 999 m	1 m	±(5 % of reading)
1.00 ... 19.99	0.01	±(3 % of reading)

Ch1 clamp type: A1391
Range: 40 A
I1 – Current

Measuring range (A)	Resolution (A)	Accuracy*
0.00 ... 1.99	0.01	±(3 % of reading + 3 digits)
2.00 ... 19.99	0.01	±(3 % of reading)
20.0 ... 39.9	0.1	±(3 % of reading)

Ch1 clamp type: A1391
Range: 300 A
I1 – Current

Measuring range (A)	Resolution (A)	Accuracy*
0.00 ... 19.99	0.01	indicative
20.0 ... 39.9	0.1	
40.0 ... 299.9	0.1	±(3 % of reading + 5 digits)

* Accuracy at operating conditions for instrument and current clamp is given.

12.20 Power

Measurement characteristics

Function symbols	Class according to IEC 61557-12	Measuring range
P – Active power	2.5	5 % ... 100 % I_{Nom} *)
S – Apparent power	2.5	5 % ... 100 % I_{Nom} *)
Q – Reactive power	2.5	5 % ... 100 % I_{Nom} *)
PF – Power factor	1	- 1 ... 1
THDu	2.5	0 % ... 20 % U_{Nom}

*) I_{Nom} depends on selected current clamp type and selected range as follows:
A 1018: [20 A]
A1019: [20 A]
A 1391: [40 A, 300 A]

Function	Measuring range
Power (P, S, Q)	0.00 W (VA, Var) ... 99.9 kW (kVA, kVar)
Power factor	-1.00 ... 1.00
Voltage THD	0.1 % ... 99.9 %

Error of external voltage and current transducers is not considered in this specification.

12.21 Harmonics

Measurement characteristics

Function symbols	Class according to IEC 61557-12	Measuring range
Uh	2.5	0 % ... 20 % U_{Nom}
THDu	2.5	0 % ... 20 % U_{Nom}
Ih	2.5	0 % ... 100 % I_{Nom} *)
THDi	2.5	0 % ... 100 % I_{Nom} *)

*) I_{Nom} depends on selected current clamp type and selected range as follows:
A 1018:[20 A]
A1019: [20 A]
A 1391: [40 A, 300 A]

Function	Measuring range
Voltage harmonics	0.1 V ... 500 V
Voltage THD	0.1 % ... 99.9 %
Current harmonics and Current THD	0.00 A ... 199.9 A

Error of external voltage and current transducers is not considered in this specification.

12.22 Varistor test

Udc – DC Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 … 1000 (2500)*	1	±(3 % of reading + 3 digits)

Uac – AC voltage

Measuring range (V)	Resolution (V)	Accuracy
0 … 625 (1562)*	1	Consider accuracy of Udc

* MI 3152H only

Measurement principle .... d.c. voltage ramp
Test voltage slope .... Nominal test voltage up to 1000 Vdc : 100 Vdc/s
Nominal test voltage 2500 Vdc : 350 Vdc/s (MI 3152H only)
Threshold current .... 1 mA

12.23 ISFL – First fault leakage current (MI 3152 only)

Isc1, Isc2 – First fault leakage current

Measuring range (mA)	Resolution (mA)	Accuracy
0.0 ... 19.9	0.1	±(5 % of reading + 3 digits)

Measuring resistance................................. approx. 390 Ω
Nominal voltage ranges .... $93\ V \le U_{L1-L2} < 134\ V$
$185\ V \le U_{L1-L2} \le 266\ V$

12.24 IMD (MI 3152 only)

R1, R2 – Threshold insulation resistance

R (kΩ)	Resolution (kΩ)	Note
5 ... 640	5	up to 128 steps

I1, I2 – First fault leakage current at threshold insulation resistance

I (mA)	Resolution (mA)	Note
0.0 ... 19.9	0.1	calculated value*)

t1, t2 – Activation / disconnection time of IMD

t1, t2 (s)	Resolution (s)	Accuracy
0.00 ... 19.99	0.01	± 0.01 s
20.0 … 99.9	0.1	± 0.1 s

Nominal voltage ranges .... $93\ V \le U_{L1-L2} \le 134\ V$
$185\ V \le U_{L1-L2} \le 266\ V$

*)See chapter ***7.22 IMD – Testing of insulation monitoring devices (MI 3152 only)*** for more information about calculation of first fault leakage current at threshold insulation resistance.

12.25 Illumination

Illumination (A 1172)

Specified accuracy is valid for complete operating range.

Measuring range (lux)	Resolution (lux)	Accuracy
0.01 ... 19.99	0.01	±(5 % of reading + 2 digits)
20.0 ... 199.9	0.1	±(5 % of reading)
200 ... 1999	1	
2.00 ... 19.99 k	10	

Measurement principle ....silicon photodiode with $V(\lambda)$ filter
Spectral response error ....< 3.8 % according to CIE curve
Cosine error...< 2.5 % up to an incident angle of $\pm 85^{O}$
Overall accuracy....................................matched to DIN 5032 class B standard

Illumination (A 1173)

Specified accuracy is valid for complete operating range.

Measuring range (lux)	Resolution (lux)	Accuracy
0.01 ... 19.99	0.01	±(10 % of reading + 3 digits)
20.0 ... 199.9	0.1	±(10 % of reading)
200 ... 1999	1	
2.00 ... 19.99 k	10	

Measurement principle ....silicon photodiode
Cosine error...< 2.5 % up to an incident angle of $\pm 85^{O}$
Overall accuracy....................................matched to DIN 5032 class C standard

12.26 Auto Sequences®

Refer to each individual test (measurement) for detailed technical specification.

12.27 General data

Power supply.. 6 x 1.2 V Ni-MH battery cells, size AA
Operation... typical 9 h

Charger socket input voltage .... 12 V ± 10 %
Charger socket input current................. 1000 mA max.
Battery charging current .... 125 mA (normal charging mode)
725 mA (fast charging mode)

Measuring category .... 600 V CAT III
300 V CAT IV
Protection classification .... double insulation
Pollution degree.................................... 2
Protection degree .... IP 40

Display .... 4.3 inch (10.9 cm) 480x272 pixels TFT colour display with touch screen

Dimensions (w × h × d) .... 23 cm × 10.3 cm × 11.5 cm
Weight .... 1.3 kg, without battery cells

Reference conditions
Reference temperature range................ 10 °C ... 30 °C
Reference humidity range...................... 40 %RH ... 70 %RH

Operation conditions
Working temperature range .... 0 °C ... 40 °C
Maximum relative humidity .... 95 %RH (0 °C ... 40 °C), non-condensing

Storage conditions
Temperature range................................ -10 °C ... +70 °C
Maximum relative humidity .... 90 %RH (-10 °C ... +40 °C)

Locator
Locator .... supports inductive mode
Maximum operation voltage................... 440 V a.c.

Communication ports, memory
RS 232 .... 115200 bits/s, 8N1 serial protocol
USB.. USB 2.0 Hi speed interface
with USB type B receptacle connector
Data storage capacity............................ 8 GB internal memory
Bluetooth module................................... Class 2

The error in operating conditions could be at most the error for reference conditions (specified in the manual for each function) +1 % of measured value + 1 digit, unless otherwise specified in the manual for particular function.

Appendix A – Profile Notes

Instrument supports working with multiple Profiles. This appendix contains collection of minor modifications related to particular country requirements. Some of the modifications mean modified listed function characteristics related to main chapters and others are additional functions. Some minor modifications are related also to different requirements of the same market that are covered by various suppliers.

A.1 Profile Austria (ALAJ)

Testing special delayed G type RCD supported.

Modifications in chapter ***7.7 Testing RCDs***.

Special delayed G type RCD selection added in the **Selectivity** parameter in **Test Parameters / Limits** section as follows:

Selectivity	**Characteristic** [--, S, G]

Time limits are the same as for general type RCD and contact voltage is calculated the same as for general type RCD.

Selective (time delayed) RCDs and RCDs with (G) - time delayed characteristic demonstrate delayed response characteristics. They contain residual current integrating mechanism for generation of delayed trip out. However, contact voltage pre-test in the measuring procedure also influences the RCD and it takes a period to recover into idle state. Time delay of 30 s is inserted before performing trip-out test to recover S type RCD after pre-tests and time delay of 5 s is inserted for the same purpose for G type RCD.

Table 7.1: Relationship between Uc and $I_{\Delta N}$ changed as follows:

RCD type		**Contact voltage Uc proportional to**	**Rated $I_{\Delta N}$**	**Notes**
AC, EV, MI (a.c. part)	-- G	1.05×$I_{\Delta N}$	any	All models
AC	S	2×1.05×$I_{\Delta N}$		
A, F	-- G	1.4×1.05×$I_{\Delta N}$	≥ 30 mA	
A, F	S	2×1.4×1.05×$I_{\Delta N}$		
A, F	-- G	2×1.05×$I_{\Delta N}$	< 30 mA	
A, F	S	2×2×1.05×$I_{\Delta N}$		
B, B+	--	2×1.05×$I_{\Delta N}$	any	Model MI 3152 only
B, B+	S	2×2×1.05×$I_{\Delta N}$		

Technical specifications unchanged.

A.2 Profile Hungary (profile code ALAD)

Fuse type gR added to the fuse tables. Refer to ***Fuse tables guide*** for detailed information on fuse data.

New Single test function **Visual Test** added.

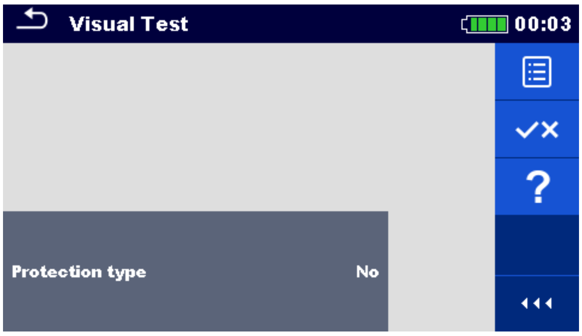


Figure A.1: Visual Test menu

Measurement parameters / limits

Protection type	**Protection type** [No, Automatic disconnection, Class II, Electrical separation, SELV,PELV]

Measurement procedure

- Enter the **Visual Test** function.
- Set test parameters / limits.
- Perform the visual inspection on tested object.
- Use  to select PASS / FAIL / NO STATUS indication.
- Save results (optional).

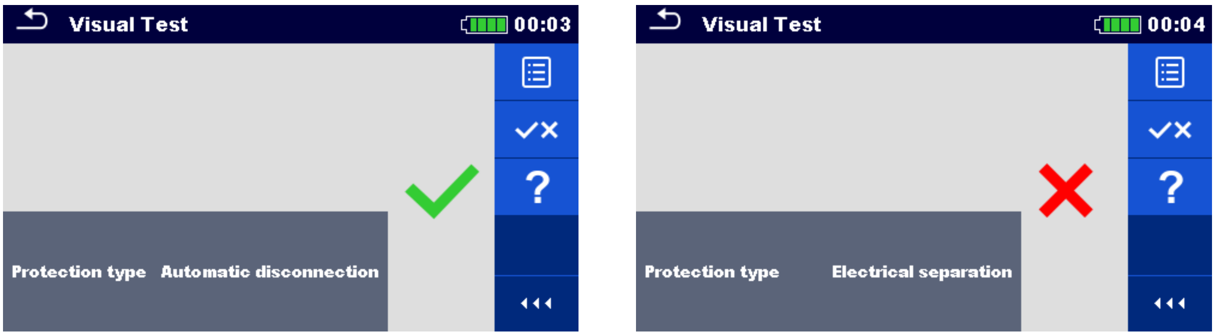


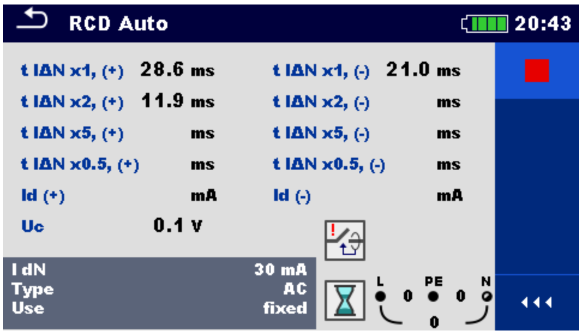
Figure A.2: Examples of Visual Test result

Modifications in chapter ***7.8 RCD Auto – RCD Auto test***

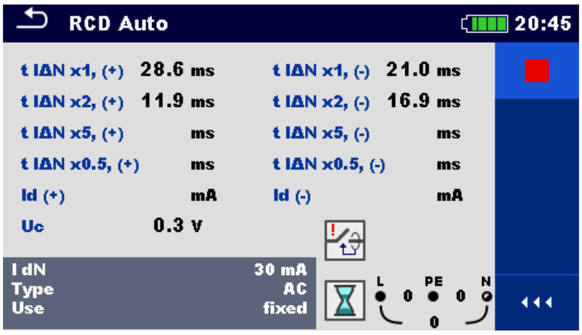
Added tests with multiplication factor 2.

Modification of RCD Auto test procedure

RCD Auto test inserted steps	Notes
‣ **Re-activate RCD**. Test with $2\times I_{\Delta N}$, (+) positive polarity (new step 3).	RCD should trip-out
‣ **Re-activate RCD**. Test with $2\times I_{\Delta N}$, (-) negative polarity (new step 4).	RCD should trip-out



Inserted new Step 3



Inserted new Step 4

Figure A.3: Example of individual steps in RCD Auto test – Inserted 2 new steps

Test results / sub-results

t IΔN x1 (+)	Step 1 trip-out time ($I_{\Delta}=I_{\Delta N}$, (+) positive polarity)
t IΔN x1 (-)	Step 2 trip-out time ($I_{\Delta}=I_{\Delta N}$, (-) negative polarity)
t IΔN x2 (+)	Step 3 trip-out time ($I_{\Delta}=2\times I_{\Delta N}$, (+) positive polarity)
t IΔN x2 (-)	Step 4 trip-out time ($I_{\Delta}=2\times I_{\Delta N}$, (-) negative polarity)
t IΔN x5 (+)	Step 5 trip-out time ($I_{\Delta}=5\times I_{\Delta N}$, (+) positive polarity)
t IΔN x5 (-)	Step 6 trip-out time ($I_{\Delta}=5\times I_{\Delta N}$, (-) negative polarity)
t IΔN x0.5 (+)	Step 7 trip-out time ($I_{\Delta}=½\times I_{\Delta N}$, (+) positive polarity)
t IΔN x0.5 (-)	Step 8 trip-out time ($I_{\Delta}=½\times I_{\Delta N}$, (-) negative polarity)
IΔ (+)	Step 9 trip-out current ((+) positive polarity)
IΔ (-)	Step 10 trip-out current ((-) negative polarity)
IΔ d.c. (+)	Step 11 trip-out current ((+) positive polarity) [1)]
IΔ d,c, (-)	Step 12 trip-out current ((-) negative polarity) [1)]
Uc	Contact voltage for rated $I_{\Delta N}$

[1)] Steps 11 and 12 are performed if parameter Use is set to 'other' and Type to EV RCD or MI RCD.

A.3 Profile Finland (profile code ALAC)

Ia(Ipsc) limit modified in fuse types gG, NV, B, C, D and K.
Refer to ***Fuse tables guide*** for detailed information on fuse data.

A.4 Profile France (profile code ALAG)

Modifications in chapters:

7.7 Testing RCDs;
7.10 Zs rcd – Fault loop impedance and prospective fault current in system with RCD;
7.25 AUTO TT – Auto test for TT earthing system;
7.29 Z auto - Auto test for fast line and loop testing.

650 mA added in the **I ΔN** parameter in **Test Parameters / Limits** section as follows:

I ΔN	**Rated RCD residual current sensitivity** [10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 650 mA, 1000 mA]

Modifications in chapter ***12.5 RCD testing***

Nominal residual current (A,AC) ....10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 650 mA, 1000 mA

RCD test current in relation to RCD type, nominal RCD current and multiplication factor

	$I_{\Delta N}$ × 1/2 (mA)			$I_{\Delta N}$ × 1 (mA)			$I_{\Delta N}$ × 2 (mA)			$I_{\Delta N}$ × 5 (mA)			RCD I_{Δ}		
$I_{\Delta N}$ (mA)	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+
10	5	3.5	5	10	20	20	20	40	40	50	100	100	✓	✓	✓
30	15	10.5	15	30	42	60	60	84	120	150	212	300	✓	✓	✓
100	50	35	50	100	141	200	200	282	400	500	707	1000	✓	✓	✓
300	150	105	150	300	424	600	600	848	×	1500	×	×	✓	✓	✓
500	250	175	250	500	707	1000	1000	1410	×	2500	×	×	✓	✓	✓
650	325	227.5	250	650	916.5	1300	1300	×	×	×	×	×	✓	✓	✓
1000	500	350	500	1000	1410	×	2000	×	×	×	×	×	✓	✓	×

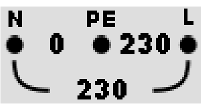
×. ....not applicable
✓..applicable
AC type...sine wave test current
A, F types…… ....pulsed current
B, B+ types..smooth DC current

Other technical specifications remain unchanged.

A.5 Profile Switzerland (profile code ALAI, AMAD)

Modifications in Chapter ***4.4.1 Terminal voltage monitor***
In the Terminal voltage monitor the positions of L and N indications are opposite to standard version.

Voltage monitor example:



Online voltages are displayed together with test terminal indication. All three test terminals are used for selected measurement.

Modifications in chapters:

7.7 Testing RCDs;
7.10 Zs rcd – Fault loop impedance and prospective fault current in system with RCD;
7.25 AUTO TT – Auto test for TT earthing system;
7.29 Z auto - Auto test for fast line and loop testing.

15 mA added in the **I ΔN** parameter in **Test Parameters / Limits** section as follows:

I ΔN	**Rated RCD residual current sensitivity** [10 mA, 15 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]

Modifications in chapter ***12.5 RCD testing***

Nominal residual current (A,AC) ....10 mA, 15 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA

RCD test current in relation to RCD type, nominal RCD current and multiplication factor

	$I_{\Delta N}$ × 1/2 (mA)			$I_{\Delta N}$ × 1 (mA)			$I_{\Delta N}$ × 2 (mA)			$I_{\Delta N}$ × 5 (mA)			RCD I_{Δ}		
$I_{\Delta N}$ (mA)	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+	AC	A, F	B, B+
10	5	3.5	5	10	20	20	20	40	40	50	100	100	✓	✓	✓
15	7.5	5.3	7.5	15	30	30	30	60	60	75	150	150	✓	✓	✓
30	15	10.5	15	30	42	60	60	84	120	150	212	300	✓	✓	✓
100	50	35	50	100	141	200	200	282	400	500	707	1000	✓	✓	✓
300	150	105	150	300	424	600	600	848	×	1500	×	×	✓	✓	✓
500	250	175	250	500	707	1000	1000	1410	×	2500	×	×	✓	✓	✓
1000	500	350	500	1000	1410	×	2000	×	×	×	×	×	✓	✓	×

×. ....not applicable
✓...applicable
AC type...sine wave test current
A, F types…… ....pulsed current
B, B+ types...smooth DC current

Other technical specifications remain unchanged.

Appendix B – Commanders (A 1314, A 1401)

B.1 ⚠ Warnings related to safety

Measuring category of commanders

Plug commander A 1314 ....300 V CAT II

Tip commander A 1401
(cap off, 18 mm tip) ....1000 V CAT II / 600 V CAT II / 300 V CAT II
(cap on, 4 mm tip) ....1000 V CAT II / 600 V CAT III / 300 V CAT IV

- Measuring category of commanders can be lower than protection category of the instrument.
- If dangerous voltage is detected on the tested PE terminal, immediately stop all measurements, find and remove the fault!
- When replacing battery cells or before opening the battery compartment cover, disconnect the measuring accessory from the instrument and installation.
- Service, repairs or adjustment of instruments and accessories is only allowed to be carried out by competent authorized personnel!

B.2 Battery

The commander uses two AAA size alkaline or rechargeable Ni-MH battery cells.
Nominal operating time is at least 40 h and is declared for cells with nominal capacity of 850 mAh.

Notes

- If the commander is not used for a long period of time, remove all batteries from the battery compartment.
- Alkaline or rechargeable Ni-MH batteries (size AAA) can be used. Metrel recommends only using rechargeable batteries with a capacity of 800 mAh or above.
- Ensure that the battery cells are inserted correctly otherwise the commander will not operate and the batteries could be discharged.

B.3 Description of commanders

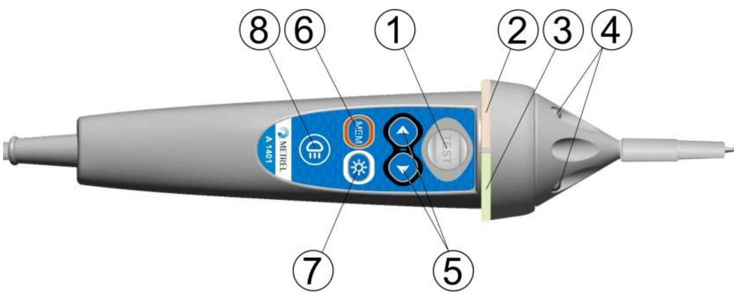


Figure B.1: Front side Tip commander (A 1401)

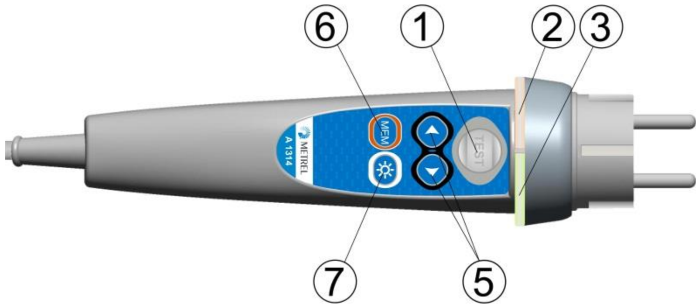


Figure B.2: Front side Plug commander (A 1314)

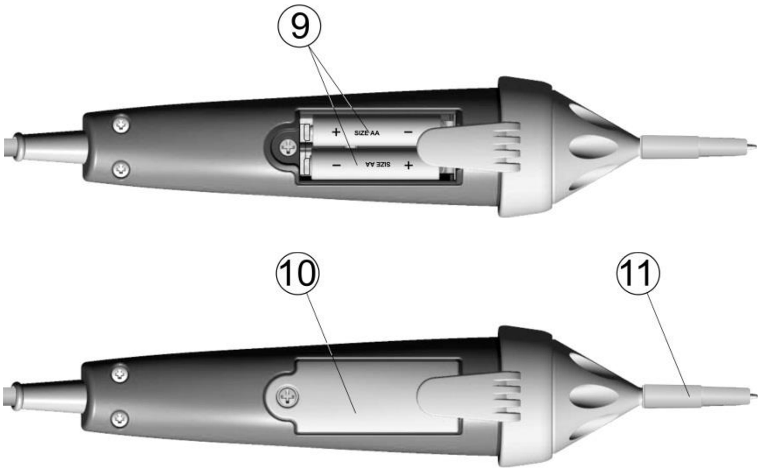


Figure B.3: Back side

1	TEST	TEST	Starts measurements. Acts also as the PE touching electrode.
2	LED	Left status RGB LED	
3	LED	Right status RGB LED	
4	LEDs	Lamp LEDs (Tip commander)	
5	Function selector	Selects test function.	
6	MEM	Store / recall / clear tests in memory of instrument.	
7	BL	Switches On / Off backlight on instrument	
8	Lamp key	Switches On / Off lamp (Tip commander)	
9	Battery cells	Size AAA, alkaline / rechargeable Ni-MH	
10	Battery cover	Battery compartment cover	
11	Cap	Removable CAT IV cap (Tip commander)	

B.4 Operation of commanders

Both LED yellow	Warning! Dangerous voltage on the commander's PE terminal!
Right LED red	Fail indication
Right LED green	Pass indication
Left LED blinks blue	Commander is monitoring the input voltage
Left LED orange	Voltage between any test terminals is higher than 50 V
Both LEDs blink red	Low battery
Both LEDs red and switch off	Battery voltage too low for operation of commander

Appendix C – Locator receiver R10K

The highly sensitive hand-held **receiver R10K** detects the fields caused by the currents in the traced line. It generates sound and visual output according to the signal intensity. The operating mode switch in the head detector should always be set in IND (inductive) mode. The CAP (capacitive) operating mode is intended for operating in combination with other Metrel measuring equipment.
The built in field detector is placed in the front end of the receiver. External detectors can be connected via the rear connector.
Traced object must be energized when working with the EurotestXC.

Detectors	**Operation**
In built inductive sensor (**IND**)	Tracing hidden wires.
Current clamp (optional)	Connected through the rear connector. Locating wires.
Selective probe	Connected through the rear connector. Locating fuses in fuse cabinets.

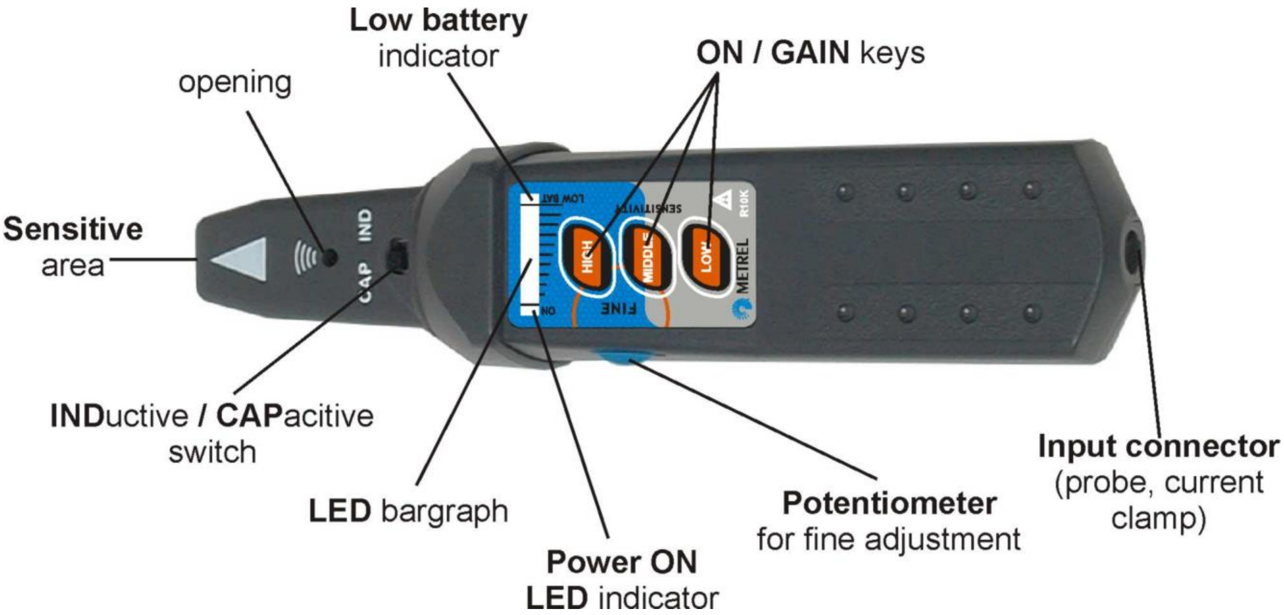


Figure C.1: Receiver R10K

The user can choose between three sensitivity levels (low, middle and high). An extra potentiometer is added for fine sensitivity adjustment. A buzzer sound and 10-level LED bar graph indicator indicates the strength of the magnetic field e.g. proximity of the traced object.

Note

- The field strength can vary during tracing. The sensitivity should always be adjusted to optimum for each individual tracing.

Appendix D – Structure objects

Structure elements used in Memory Organizer are instrument's Profile dependent.

Symbol	Default name	Description
	Node	Node
	Object	Object
	Dist. board	Distribution board
	Sub D. Board	Sub Distribution board
	Local bonding	Local equipotential bonding
	Water Service	Protective conductor for Water service
	Oil service	Protective conductor for Oil service
	Lightn. protect.	Protective conductor for Lightning protection
	Gas service	Protective conductor for Gas service
	Struct. steel	Protective conductor for Structural steel
	Other service	Protective conductor for Other incoming service
	Earthling cond.	Earthing conductor
	Circuit	Circuit
	Connection	Connection
	Socket	Socket
	Connection 3-ph	Connection - 3 phase
	Light	Light
	Socket 3-ph	Socket - 3 phase
	RCD	RCD
	MPE	MPE

Symbol	Default name	Description
	Foundation gr.	Protective conductor for Foundation ground
	Equip. bond. rail	Equipotential bonding rail
	House water m.	Protection conductor for House water meter
	Main water p.	Protection conductor for Main water pipes
	Main gr. cond.	Main grounding conductor
	Inter. gas inst.	Protective conductor for Interior gas installation
	Heat.inst.	Protective conductor for Heating installation
	Air cond. inst.	Protective conductor for Air conditioning installation
	Lift inst.	Protective conductor for Lift installation
	Data proc. Inst.	Protective conductor for Lift Data processing installation
	Teleph. Inst.	Protective conductor for Telephone installation
	Lightn. prot. syst.	Protective conductor for Lightning protection system
	Antenna inst.	Protective conductor for Antenna installation
	Build. Constr.	Protective conductor for Building construction
	Other conn.	Other connection
	Earth electrode	Earth electrode
	Lightning Sys.	Lightning System
	Lightning. electr.	Lightning electrode
	Inverter	Inverter
	String	String array
	Panel	Panel
	EVSE	Electro-Vehicle supply Equipment

Symbol	Default name	Description
	Level 1	Level 1
	Level 2	Level 2
	Level 3	Level 3
	Varistor	Varistor
	LS connection	LS connection
	Machine	Machine