EurotestXD
MI 3155
Instruction manual

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METREL®

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i. About the instruction manual

- This Instruction manual contains detailed information on the EurotestXD, 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.
- Metrel reserve the right to make technical modifications without notice as part of the further development of the product.

Table of Contents

1 General description

1.1 **Warnings and notes**

1.1.1 Safety warnings

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

- Read 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 through 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 Li-Ion battery pack. The battery pack should only be replaced with the same type as defined on the battery compartment label or as described in this manual!

- Hazardous voltages exist inside the instrument. Disconnect all test leads, remove the power supply cable and switch off the instrument before removing battery / fuse compartment cover.
- Do not connect any voltage source on C1 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.!
- CE 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

- Use only batteries and power supply adapter delivered from the manufacturer or distributer of the test equipment.
- Never dispose of the batteries in a fire as it may cause them to explode or generate a toxic gas.
- Do not attempt to disassemble, crush or puncture the batteries in any way.
- Do not short circuit or reverse polarity the external contacts on a battery.
- Avoid exposing the battery to excessive shock/impacts or vibration.
- Do not use a damaged battery.
- The Li – ion battery contains safety and protection circuit, which if damaged, may cause the battery to generate heat, rupture or ignite.
- Do not leave a battery on prolonged charge when not in use.
- If a battery has leaking fluids, do not touch any fluids.
- In case of eye contact with fluid, do not rub eyes. Immediately flush eyes thoroughly with water for at least 15 minutes, lifting upper and lower lids, until no evidence of the fluid remains. Seek medical attention.

1.1.4 Warnings related to safety of measurement functions

Insulation resistance (R iso, R iso – all)

- 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 (R low, R low 4W, Continuity)

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

1.1.5 Notes related to measurement functions

Insulation resistance (R iso, R iso – all)

- The measuring range is decreased if using Tip commander A 1401.
- If a voltage of higher than 30 V (AC or DC) is detected between test terminals, the measurement will not be performed.
- Load pretest detects possible connection of appliances to the system during test. Test eliminates possible damage to the equipment that could be connected to the system during Insulation resistance measurements.
- Load pretest is carried out between same terminals as the Insulation resistance measurement.
- Load pretest is carried out only when Uiso ≤ 1000 V.

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 :____!

Continuity functions (R low, R low 4W, 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.
- In some kind of PRCDs types (PRCD-3p and PRCD-S+), the protective conductor is monitored. For protective conductor resistance measurement, a test current of 200 mA is required. Direct application will cause tripping of PRCD, so PE conductor measurement is not possible.
  In this case use a test parameter Current set to 'ramp', where special ramp curve is used for PE conductor resistance measurement without tripping of PRCD. If Current parameter is set to 'normal', a standard test current curve is used.

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-2p, PRCD-3p, PRCD-S, PRCD-S+ and PRCD-K) 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.
- In some kind of PRCDs types (PRCD, PRCD-3p, PRCD-S+ and PRCD-K), the protective conductor is monitored and carried out in the opposite direction through current sensor circuitry. During periodic testing – when fault current flows through phase and protective conductor – this can cause misunderstanding, because PRCD reacts at half the tripping fault current. In order to

prevent this, use parameter Sensitivity set to 'Ipe monitoring', where test current will be a half of selected nominal tripping current.
If Sensitivity parameter is set to 'standard', a test current with nominal tripping current is used.

- 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.
- 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 DC test current.

Z loop, Zloop 4W, 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, Z line 4W, 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 lowest 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

- LUXmeter type B (A 1172) and LUXmeter type C (A 1173) 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.

Discharging time

- Interpretation of the 'Repeat' message:
  It is not possible to differentiate between a disconnection moment at very low voltage and a machine with a very low discharging time. In both cases the reading will be 0.0 s together with the "Repeat" warning. If after few repetitions the result is always 0.0 s with the "Repeat" message it can be considered as a valid 0.0 s result.
  A 0.0 s reading without the "Repeat" message is a valid result.
- Residual voltage is not displayed for DUTs with very low discharging time, or if detected disconnection voltage is lower than 20 V.

Z line mΩ, Z loop mΩ

- MI 3143 Euro Z 440 V, MI 3144 Euro Z 800 V or A 1143 Euro Z 290 A adapter is required for these measurements.

AutoTT, Auto TN(RCD), Auto TN, Auto IT, Zauto

- Voltage drop (dU) measurement in each Auto test is enabled only if Z_{REF} is set.
- See notes related to Zline, Zloop, Zs rcd, Voltage drop, Rpe, IMD and ISFL single tests.

Measurement functions for testing DC EVSE (IMD (DC EVSE), DC EVSE Error)

- During these measurements safety faults are simulated in order to verify the operation of charging station's protective measures.
- Some stations may enter service mode and become locked after detecting a specific fault. If there are concerns regarding this, the user should clarify in advance with the customer.

Z (DC EVSE)

- The impedance result is determined by applying a load for a brief duration and measuring the resulting voltage drop. The charger's voltage and current are electronically regulated; therefore, its response to changes in load may not be linear. Generally, the charger's impedance varies with its operating point.
  Consequently, the result cannot be regarded as the true output impedance of the charger. However, it serves a useful purpose for comparison. For instance, if the impedance increases

over time or is higher than that of other chargers of same type, it may indicate issues with contact resistance.

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.
- Auto Sequences® mode allows building custom-defined test sequences.
- See notes related to single tests in the 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 instance 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

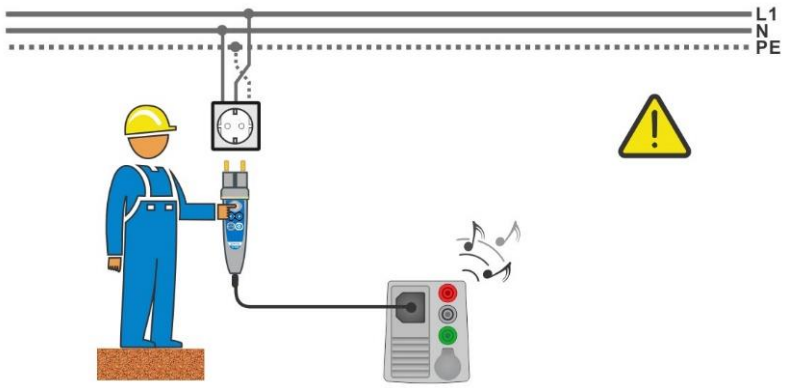


Figure 1.1: Reversed L and PE conductors (plug commander)

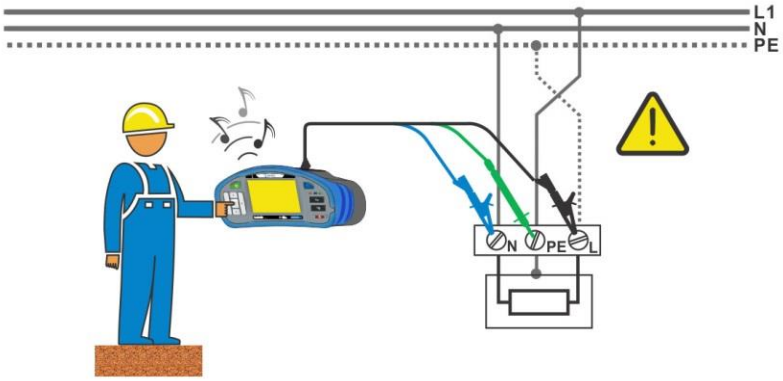


Figure 1.2: Reversed L and PE conductors (application of 3-wire test lead)

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 1 second.
  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: RCD tests, Z loop, Zs rcd, Z auto, AUTO TT, AUTO TN, AUTO TN (rcd) and Auto Sequences®.

Notes:

- PE test terminal is active in the Voltage, Rpe, RCD tests, Z loop, Zs rcd, Z auto, Z line, ΔU, AUTO TT, AUTO TN, AUTO TN (rcd), AUTO IT tests 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 probe warning (IT)'.
- For correct testing of PE terminal, the key has to be touched for at least 1 second.
- Make sure that the TEST key is grounded through 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 of Li-ion battery pack

The instrument is designed to be powered by rechargeable Li-ion battery pack. The LCD contains an indication of battery condition (upper right section of LCD). In case the battery is too weak the instrument indicates this as shown in *Figure 1.3*.

Symbol:

	Indication of low battery.

Figure 1.3: Battery test

The battery is charged whenever the power supply is connected to the instrument. The charger socket polarity is shown in *Figure 1.4*. Internal circuit controls (CC, CV) charging and assures maximum battery lifetime. Nominal operating time is declared for battery with nominal capacity of 4.4 Ah.

Figure 1.4: Charger socket polarity

The instrument automatically recognizes the connected power supply and begins charging.

Symbol:

	Indication of battery charging

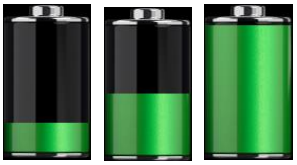


Figure 1.5: Charging indication (animation)

Battery and charging characteristic	Typical
Battery types	18650T22A2S2P 18650T22A2S4P (optional)
Charging mode	CC / CV
Nominal voltage	7,2 V
Rated capacity	4400 mAh (type: 18650T22A2S2P) 8800 mAh (type: 18650T22A2S4P)
Max charging voltage	8,0 V
Max charging current	2,2 A (type: 18650T22A2S2P) 3,0 A (type: 18650T22A2S4P)
Max discharge current	2,5 A
Typical charging time	3 hours (type: 18650T22A2S2P) 4,5 hours (type: 18650T22A2S4P)

Typical charging profile which is also used in this instrument is shown in *Figure 1.6*.

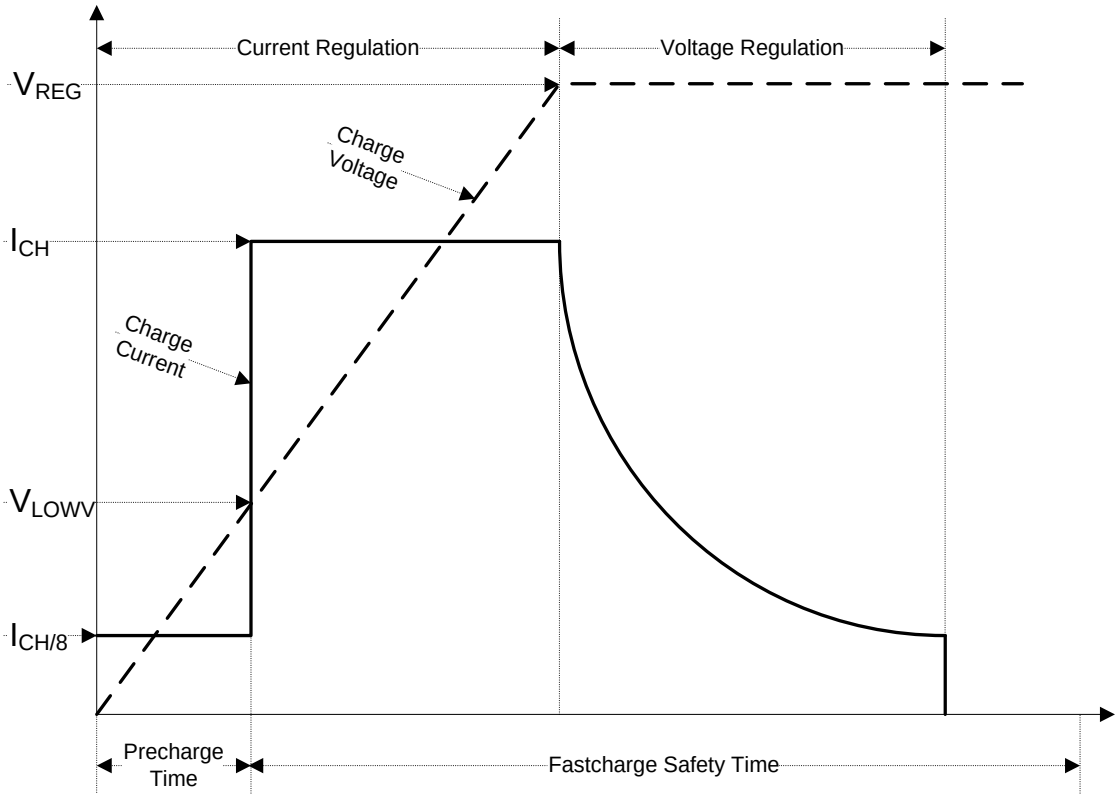


Figure 1.6: Typical charging profile

where:
V_{REG} ..... Battery charging voltage
V_{LOWV} ..... Precharge threshold voltage
I_{CH} ..... Battery charging current
$I_{CH/8}$ ..... 1/8 of the charging current

1.3.1 Precharge

On power up, if the battery voltage is below the V_{LOWV} threshold, the charger applies 1/8 of the charging current to the battery. The precharge feature is intended to revive deeply discharged battery. If the V_{LOWV} threshold is not reached within 30 minutes of initiating precharge, the charger turns off and a FAULT is indicated.

Figure 1.7: Battery fault indication (charging suspended, timer fault, battery absent)

Figure 1.8: Battery full indication (charging completed)

Note:
- As a safety backup, the charger also provides an internal 5-hour charge timer for fast charge.

Typical charging time is 3 hours (Battery type: 18650T22A2S2P) in the temperature range of 5°C to 60°C.

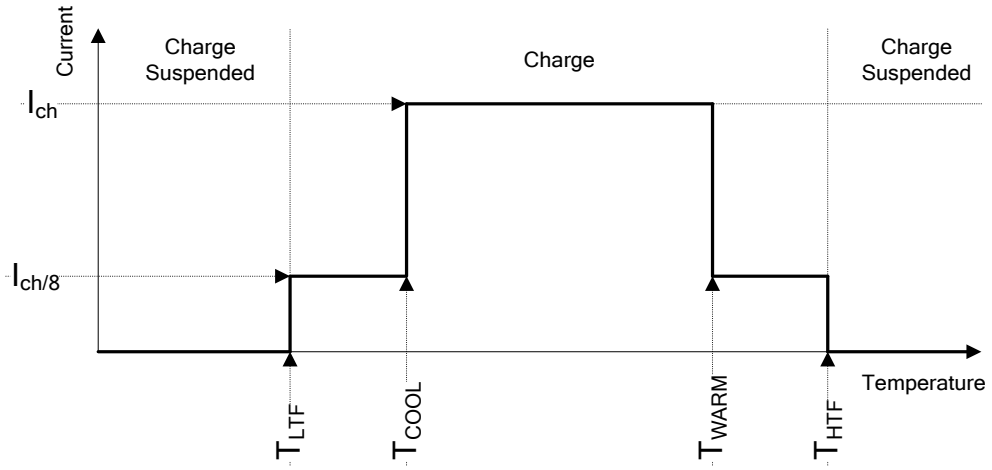


Figure 1.9: Typical charging current vs temperature profile

where:
T_{LTF}..... Cold temperature threshold (typ. -15°C)
T_{COOL} ..... Cool temperature threshold (typ. 0°C)
T_{WARM}..... Warm temperature threshold (typ. +60°C)
T_{HTF}..... Hot temperature threshold (typ. +75°C)
The charger continuously monitors battery temperature. To initiate a charge cycle, the battery temperature must be within the T_{LTF} to T_{HTF} thresholds. If battery temperature is outside of this range, the controller suspends charge and waits until the battery temperature is within the T_{LTF} to T_{HTF} range. If the battery temperature is between the T_{LTF} and T_{COOL} thresholds or between the T_{WARM} and T_{HTW} thresholds, charge is automatically reduced to $I_{CH/8}$ (1/8 of the charging current).

1.3.2 Li – ion battery pack guidelines

Li – ion rechargeable battery pack requires routine maintenance and care in their use and handling. Read and follow the guidelines in this Instruction manual to safely use Li – ion battery pack and achieve the maximum battery life cycles.
Do not leave batteries unused for extended periods of time – more than 6 months (self – discharge). When a battery has been unused for 6 months, check the charge status see chapter *4.4.2 Battery indication*. Rechargeable Li – ion battery pack has a limited life and will gradually lose their capacity to hold a charge. As the battery loses capacity, the length of time it will power the product decreases.

Storage

- Charge or discharge the instruments battery pack to approximately 50 % of capacity before storage.
- Charge the instrument battery pack to approximately 50 % of capacity at least once every 6 months.

Transportation

- Always check all applicable local, national, and international regulations before transporting a Li – ion battery pack.

Handling Warnings

- Do not disassemble, crush, or puncture a battery in any way.
- Do not short circuit or reverse polarity the external contacts on a battery.
- Do not dispose of a battery in fire or water.
- Avoid exposing the battery to excessive shock/impacts or vibration.
- Do not use a damaged battery.
- The Li **–** ion battery contains safety and protection circuit, which if damaged, may cause the battery to generate heat, rupture or ignite.
- Do not leave a battery on prolonged charge when not in use.
- If a battery has leaking fluids, do not touch any fluids.
- In case of eye contact with fluid, do not rub eyes. Immediately flush eyes thoroughly with water for at least 15 minutes, lifting upper and lower lids, until no evidence of the fluid remains. Seek medical attention.

1.4 Standards applied

The EurotestXD 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 – Part 1: General requirements
EN 61326-2-2	Electrical equipment for measurement, control and laboratory use - EMC requirements – Part 2-2: Particular requirements - Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems
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)

	Part 14: Equipment for testing the safety of electrical equipment for machinery
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 (18th edition)
AS/NZS 3017	Electrical installations – Verification guidelines
IEC 62752	In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD)
IEC 62955	Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles

Li – ion battery pack	
EN 62133-2	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary lithium cell, and for batteries made from them, for use in portable applications – Part 2: Lithium systems protection for household and similar uses

2 Instrument set and accessories

2.1 **Standard set MI 3155 EurotestXD**

- Instrument MI 3155 EurotestXD
- Soft carrying bag
- Set of carrying straps
- Earth set, 3-wire, 20 m
- Plug commander, 1.5 m + 2 batteries, size AAA
- 3-wire test lead, 3 x 1.5 m
- 4-wire test lead, 4 x 1.5 m
- 2.5 kV test lead, 2 x 1.5 m
- Test probe, 4 pcs (black, blue, green, red)
- Crocodile clip, 6 pcs (black × 2, blue, green, red × 2)
- Current clamp 1000:1
- Current clamp (low range, leakage)
- RS232-PS/2 cable
- USB cable
- Li-ion battery pack, 7.2 V , 4400 mAh (Type: 18650T22A2S2P)
- Power supply adapter 12 V, 3 A (Type: CGSW-1203000)
- CD includes:
  - PC software Metrel ES Manager
  - Instruction manual
  - "Guide for testing and verification of low voltage installations" handbook
- Quick guide
- Calibration Certificate

2.1.1 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	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.
6	GENERAL SETTINGS key Enter General settings menu.
7	OPTIONS key Show detailed view of options.
8	MEMORY ORGANIZER shortcut key Shortcut key to enter Memory organizer menu.
9	SINGLE TESTS shortcut key Shortcut key to enter Single Tests menu.
10	AUTO SEQUENCES® shortcut key Shortcut key to enter Auto Sequences® menu.
11	ESC key Back to previous menu.

3.2 Connector panel

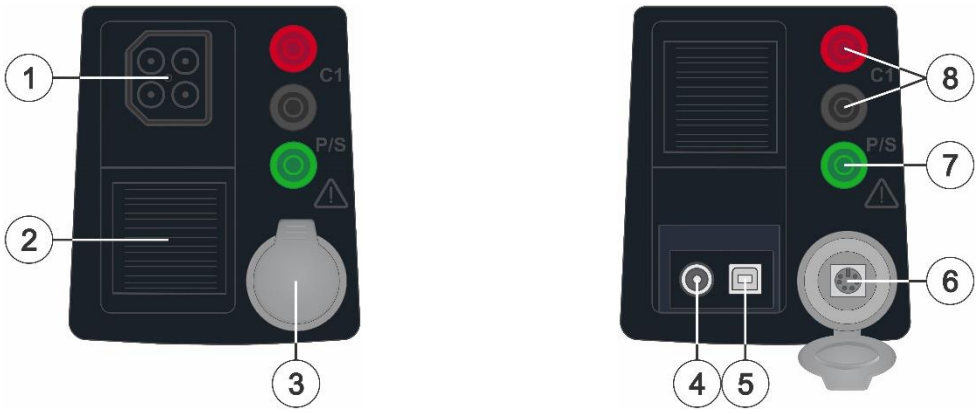


Figure 3.2: Connector panel

1	Test connector L/L1 pin – In 4-wire measurements used as a current probe C1. N/L2 pin – In 4-wire measurements used as a current probe C2. PE/L3 pin – In 4-wire measurements used as a voltage probe P2. S pin – In 4-wire measurements used as a voltage probe P1.
2	Protection cover
3	Protection cover – PS/2 communication port
4	Charger socket 
5	USB communication port Communication with PC USB (2.0) port
6	PS/2 communication port Communication with PC RS232 serial port Connection to optional measuring adapters Connection to barcode / RFID reader
7	P/S input External probe input for contact voltage measurement
8	C1 inputs Current clamp measuring input

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

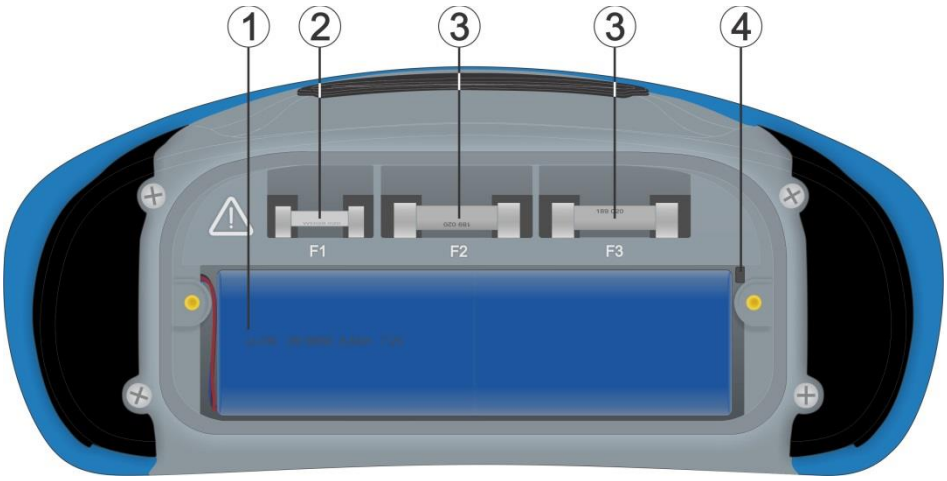
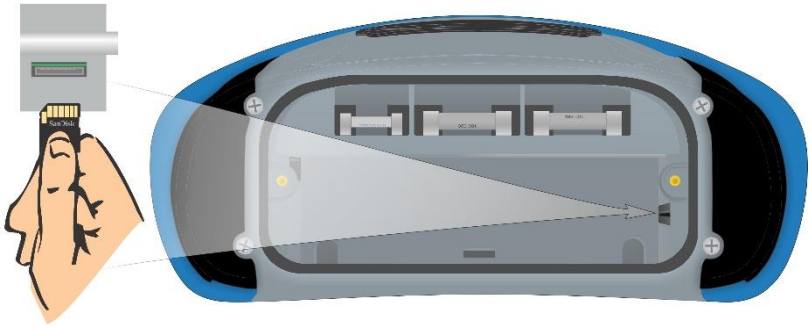


Figure 3.4: Battery and fuse compartment

1	Li-ion battery pack	Type: 18650T22A2S2P Type: 18650T22A2S4P (optional)
2	Fuse F1	M 315 mA / 250 V
3	Fuses F2 and F3	F 5 A / 500 V (breaking capacity 50 kA)

4	SD card slot



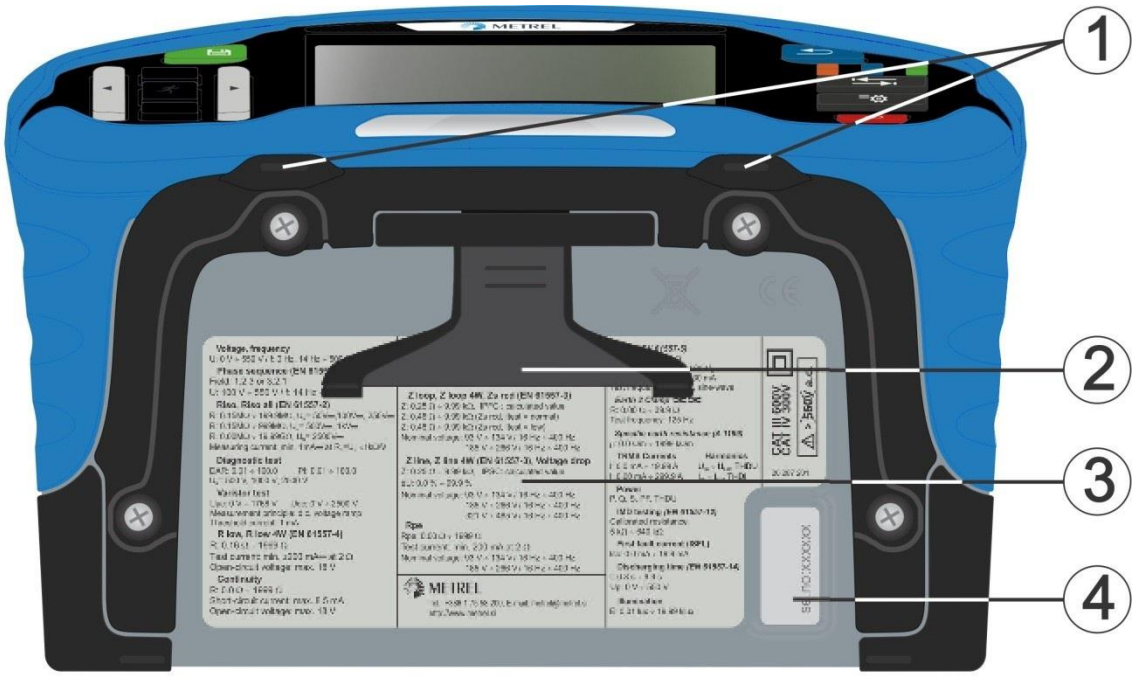
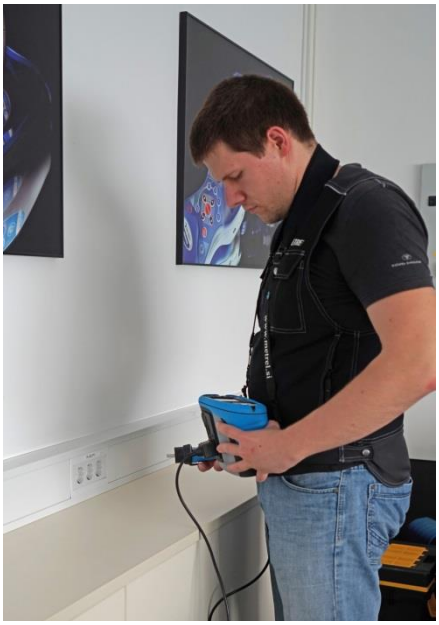


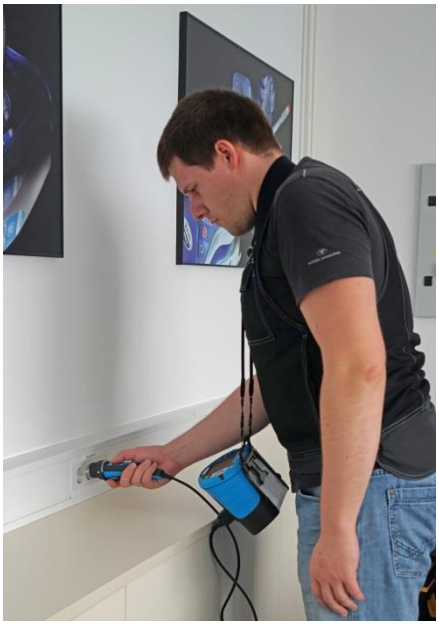
Figure 3.5: Bottom view

1	Neck belt openings
2	Stand for desktop use
3	Bottom information label
4	Serial number label

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:

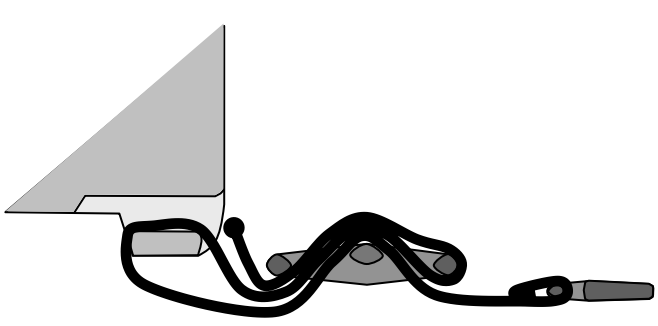


Figure 3.6: First method

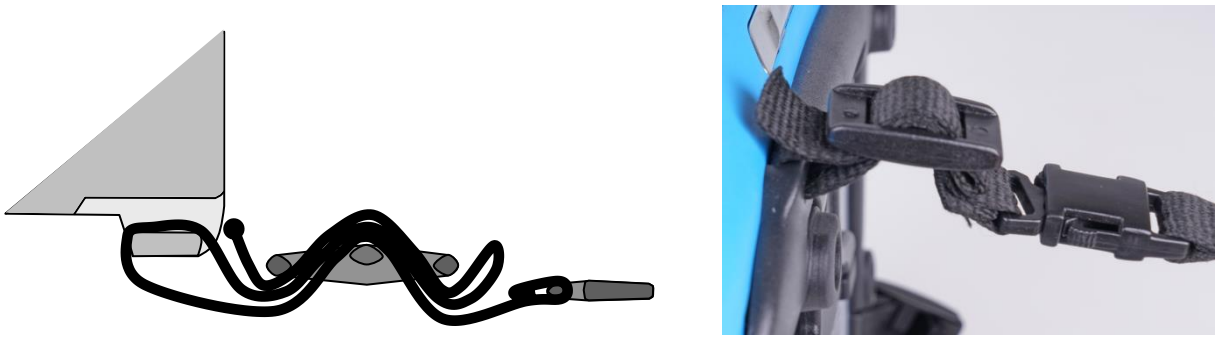


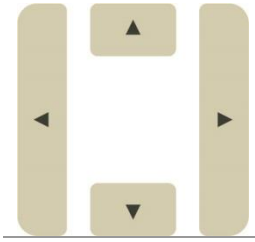
Figure 3.7: Alternative method

Please perform a periodical check of the attachment.

4 Instrument operation

The EurotestXD 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.
	Auto Sequences® key is used as: › ... shortcut key to enter Auto Sequences® menu.
	Single Tests key is used as: › shortcut key to enter Single Tests menu.
	Memory Organizer key is used as: › shortcut key to enter Memory Organizer menu.
	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

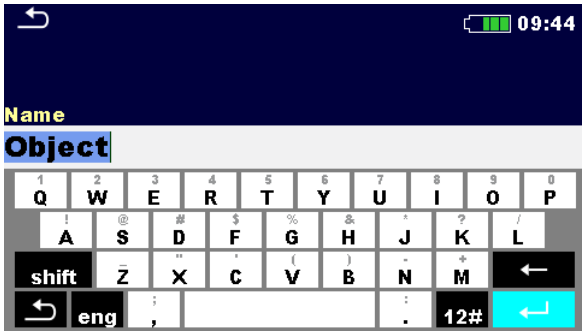


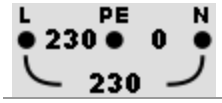
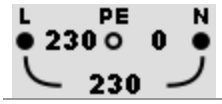
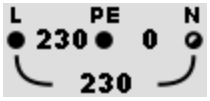
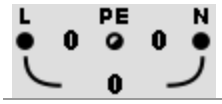
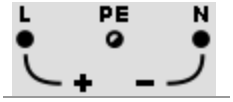
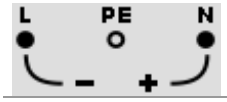
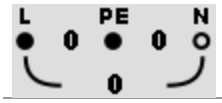
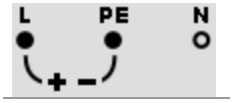
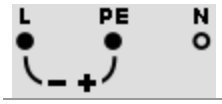
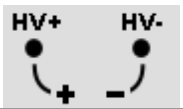
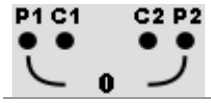
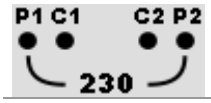
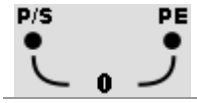
Figure 4.1: Virtual keyboard

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.
	Online voltages are displayed together with test terminal indication. 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.
	4-wire test terminal indication.
	4-wire test terminal indication with online voltage between P1 and P2 probes.
	Test terminals for Discharging time measurement.

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).
	Charging finished.

4.4.3 Bluetooth

	Bluetooth communication inactive.
	Bluetooth communication active.

4.4.4 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.
	Alternates between A 1507 3-Phase Active Switch and Plug/Tip Commander. This option is available only if A 1507 is enabled in Settings menu, see chapter *4.6.8.1 Adapters*.
	Use A 1199 Specific earth resistance adapter for this test.

	Use MI 3143 Euro Z 440 V, MI 3144 Euro Z 800 V or A 1143 Euro Z 290 A adapter for this test.
	Use A 1172 or A 1173 Illumination sensor for this test.
	A 1507 3-Phase Active Switch not connected to the instrument. Connect A 1507 test cable to the instrument. Test / Measurement cannot be performed using A 1507.
	A 1507 3-Phase Active Switch connected to the instrument via test cable and Bluetooth communication. Test / Measurement can be performed using A 1507.
	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.
	Fuse F1 is broken.

4.4.5 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!

4.4.6 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
	Overall Auto Sequence® result with empty (aborted) single tests

	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.

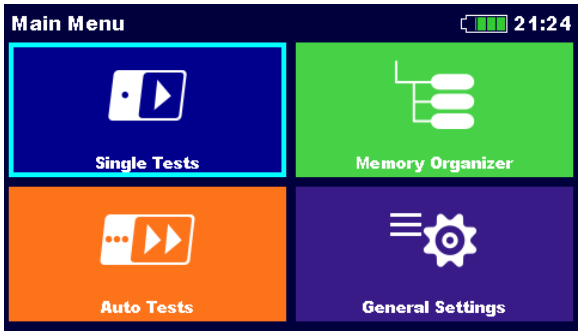
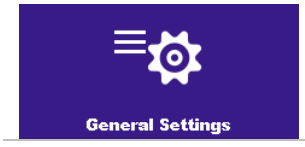


Figure 4.2: Main menu

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* for more information.
	Auto Sequences® groups Manipulation with lists of Auto Sequences®. Refer to chapter *4.9 Auto Sequence® groups* for more information.
	User accounts User accounts settings. Refer to chapter *4.6.6 User accounts* for more information.
	Connectivity Menu with QR code link for connection to Metrel Cloud app.
	Instrument Profile Selection of available instrument profiles. Refer to chapter *0* *Instrument* profiles for more information.
	Settings Refer to chapter *4.6.8 Settings* for more information.

	Devices Selection of external devices. Refer to chapter *4.6.10 Devices* for more information.
	Bluetooth initialization Reset Bluetooth settings.
	Initial Settings Factory settings.
	About Instrument info.

4.6.1 Language

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

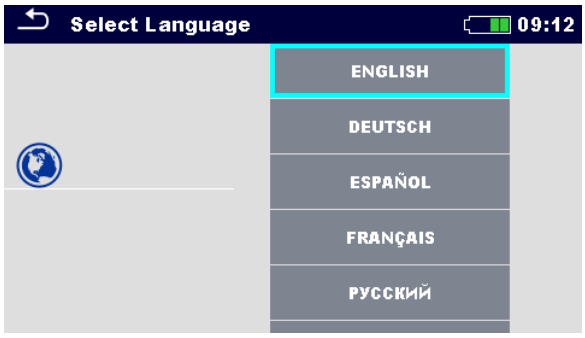


Figure 4.4: Language menu

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: approx. 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): approx. 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: 7 %

4.6.3 Date and time

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

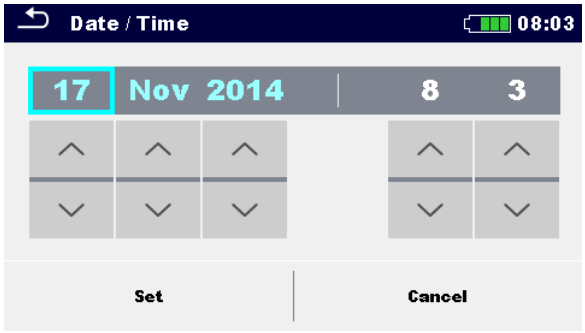


Figure 4.6: Setting date and time

Note:

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

4.6.4 Workspace manager

Refer to chapter *4.8 Workspace Manager* for more information.

4.6.5 Auto Sequences® groups

Refer to chapter *4.9 Auto Sequence® groups* for more information.

4.6.6 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.

4.6.6.1 Signing in

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

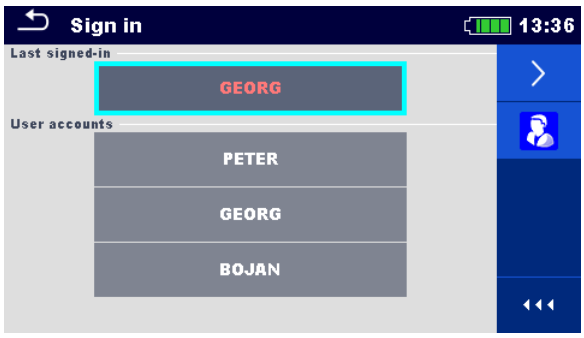
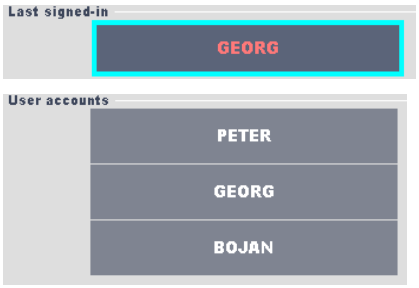
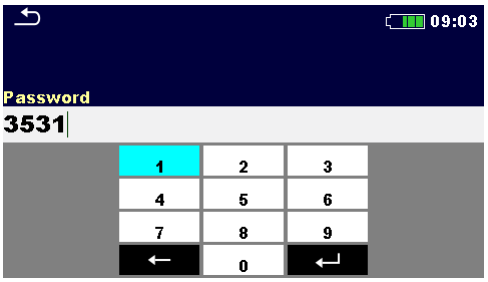


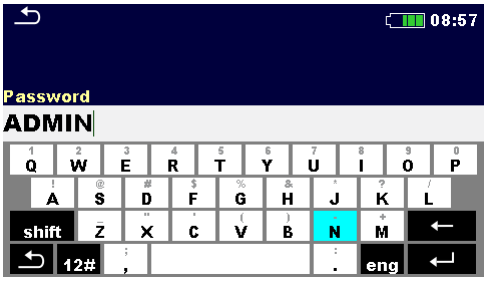
Figure 4.7: Sign in menu

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.

4.6.6.2 Changing user password, signing out

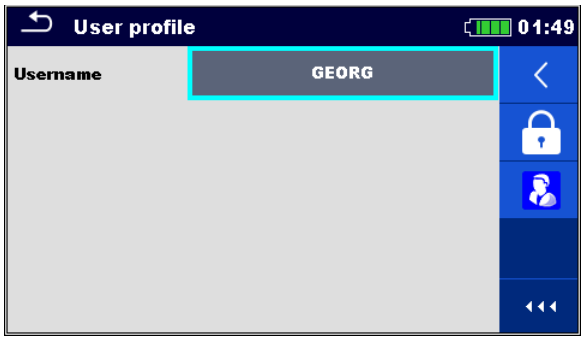
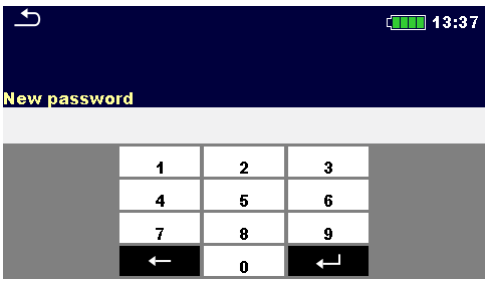


Figure 4.8: User profile menu

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.

4.6.6.3 Managing accounts

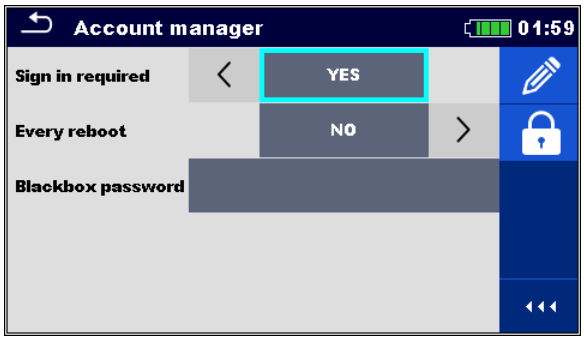
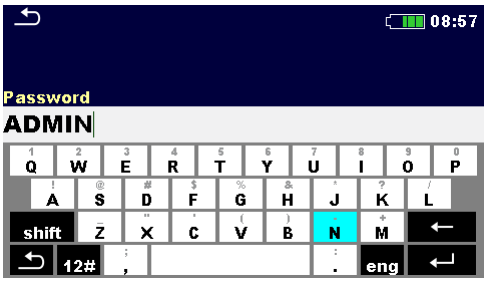


Figure 4.9: Account manager menu

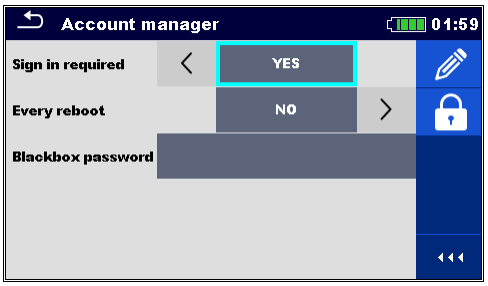
Options

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.

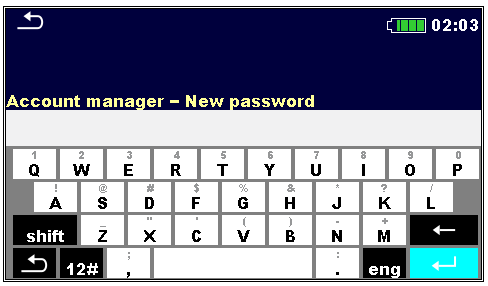
The default password is ADMIN.



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.

Field for setting Blackbox password.



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.

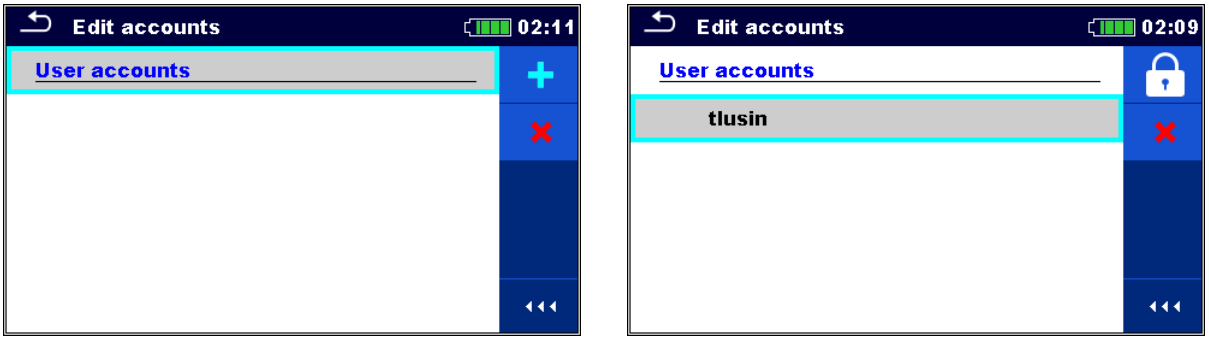
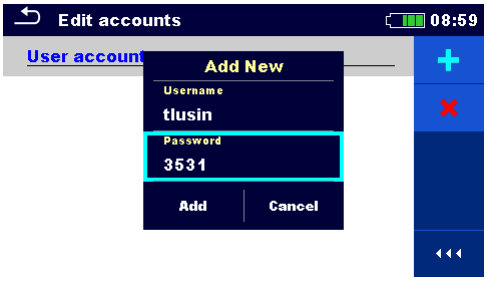
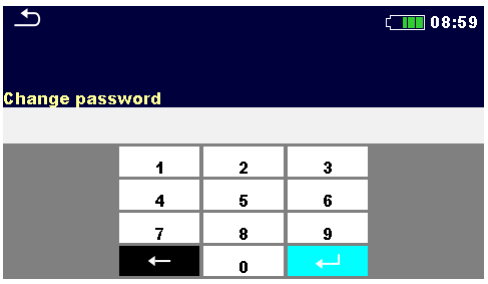


Figure 4.10: Edit accounts menu

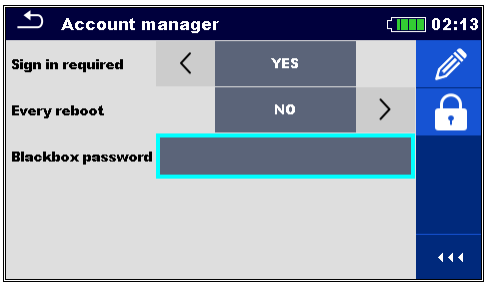
Options

	Opens the window for adding a new user.
	In the Add New window the name and initial password of the new user account 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 account.

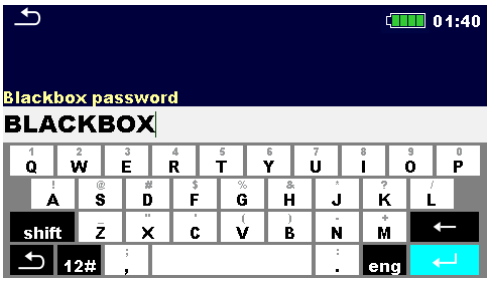
4.6.6.4 Setting Blackbox password

Blackbox password can be set by administrator from the Account manager menu. Set Blackbox password is valid for all users. Default Blackbox password is empty (disabled).

Options

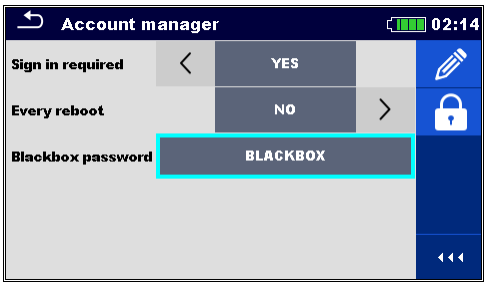


Add or edit Blackbox password. Enter to modify.



Keyboard for entering new Blackbox password is opened. Empty string disables password.

Confirm entry.



Blackbox password is changed.

4.6.7 Profiles

Refer to chapter *4.7 Instrument profiles* for more information.

4.6.8 Settings

In this menu different general parameters can be set.

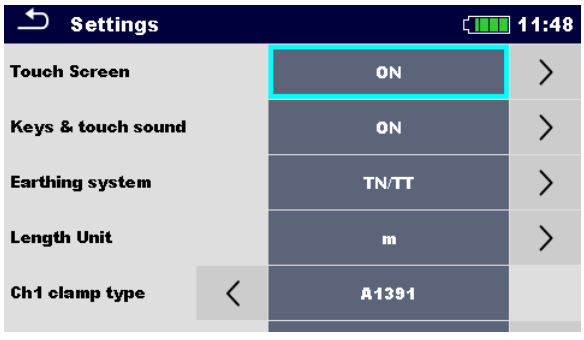


Figure 4.11: Settings menu

	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.
Isc factor	[Custom, 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.
Earthing system	[TN/TT, IT]	Terminal voltage monitor and measuring functions are suited to selected earthing system. In some measuring functions the results and parameters are suited to the selected system.
RCD Standard	[EN 61008 / EN 61009, IEC 60364-4-41 TN/IT, IEC 60364-4-41 TT, BS 7671, AS/NZS 3017, VDE 0664, VDE 0100-410 TN/IT, VDE 0100-410 TT]	Used standards 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.
EV RCD/RCM Standards	[IEC 62752, IEC 62955]	Used standards for EV RCD, MI RCD and EV RCM tests.
Length Unit	[m, ft]	Length unit for specific earth resistance measurement.
Ch1 clamp type	[A 1018, A1391]	Model of current clamp adapter.
Range	A 1018: [20 A] A 1391: [40 A, 300 A]	Measuring range of selected current clamp adapter. 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.
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.
Uc pretest (IT)	[yes, no]	[yes]: In IT earthing system the instrument will inhibit the selected measurement if result exceed set Uc limit. [no]: In IT earthing system the instrument will present warning message, if result exceed set Uc limit; operator should confirm to proceed with selected measurement
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.
Load pretest	[yes, no]	[yes]: Load pretest is enabled in Riso and Riso-all measurements. [no]: Load pretest is disabled.
External Device	[None, Commander, A 1507]	[None]: This 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. [Commander]: Working with commander enabled. [A 1507]: Working with 3-phase active switch enabled.
Limit Uc	[Custom, 12 V, 25 V, 50 V]	Contact voltage limit.

4.6.8.1 Adapters

Settings menu provide selection and configuration of Metrel measuring adapters to perform supported tests and measurements. See *Appendix G* for details on available Metrel adapters and supported tests.

	Available selection	Description
Adapter type	[none, selected adapter]	Selection from list of available adapters.
Port	[RS232, Bluetooth]	Sets communication port of selected measuring adapter. See chapter *9.3 Communication with adapters* for more details.
Bluetooth device name	Name of selected adapter	After searching is finished, list of all available Bluetooth devices is presented. Pair the instrument with selected measuring adapter.

4.6.8.2 RCD standard

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

	$½\times I_{\Delta N}$ [1)]	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$
General RCDs (non-delayed)	$t_\Delta > 300$ ms	$t_\Delta < 300$ ms	$t_\Delta < 150$ ms	$t_\Delta < 40$ ms
Selective RCDs (time-delayed)	$t_\Delta > 500$ 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)]	$½\times I_{\Delta N}$ [1)]	$I_{\Delta N}$	$2\times I_{\Delta N}$	$5\times I_{\Delta N}$

TN / IT	≤ 120 V	t_Δ > 800 ms	t_Δ ≤ 800 ms	t_Δ < 150 ms	t_Δ < 40 ms
	≤ 230 V	t_Δ > 400 ms	t_Δ ≤ 400 ms		
TT	≤ 120 V	t_Δ > 300 ms	t_Δ ≤ 300 ms		
	≤ 230 V	t_Δ > 200 ms	t_Δ ≤ 200 ms		

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

	½×$I_{\Delta N}$[1)]	$I_{\Delta N}$	2×$I_{\Delta N}$	5×$I_{\Delta N}$
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)	½×$I_{\Delta N}$[1)] t_Δ	$I_{\Delta N}$ t_Δ	2×$I_{\Delta N}$ t_Δ	5×$I_{\Delta N}$ t_Δ	Note
I	≤ 10	> 999 ms	40 ms	40 ms	40 ms	Maximum break time
II	> 10 ≤ 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	½×$I_{\Delta N}$	$I_{\Delta N}$	2×$I_{\Delta N}$	5×$I_{\Delta N}$
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	½×$I_{\Delta N}$	$I_{\Delta N}$	2×$I_{\Delta N}$	5×$I_{\Delta N}$
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 ½×$I_{\Delta N}$, 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.

Notes:

- Trip-out limit times for PRCD, PRCD-K and PRCD-S are equal to General (non-delayed) RCDs.
- The trip-out times of VDE 0664 are equal to trip-out times of EN 61008 / EN 61009.
- The trip-out times of VDE 0100-410 TN/IT are equal to trip-out times of IEC 60364-4-41 TN/IT.
- The trip-out times of VDE 0100-410 TT are equal to trip-out times of IEC 60364-4-41 TT.

4.6.8.3 EV RCD/RCM standards

Supported standards:

IEC 62752:2016	In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD)
IEC 62955:2018	Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles

Standard	6 mA ($1 \times I_{\Delta N}$)	60 mA ($10 \times I_{\Delta N}$)	200 mA ($33 \times I_{\Delta N}$)	300 mA ($50 \times I_{\Delta N}$)
IEC 62955[1)]	< 10.0 s	< 300 ms	< 100 ms	×
IEC 62752[2)]	< 10.0 s	< 300 ms	×	< 40 ms

Table 4.7: Break times for d.c. residual currents

1) IEC 62955: Table 2 – Maximum values of break times for residual direct currents
2) IEC 62752: Table 3 – Limit values of break time for smooth d.c. residual currents

Standard	30 mA ($1 \times I_{\Delta N}$)	60 mA ($2 \times I_{\Delta N}$)	150 mA ($5 \times I_{\Delta N}$)
IEC 62752[3)]	< 300 ms	< 150 ms	< 40 ms

Table 4.8: Break times for a.c. residual currents

3) IEC 62752: Table 2 – Limit values of break time for a.c. residual currents at rated frequency

Standard	Up to 30 mA ($1 \times I_{\Delta N}$)	60 mA ($2 \times I_{\Delta N}$)	150 mA ($5 \times I_{\Delta N}$)
IEC 62955[4)]	No tripping	> 300 ms	> 80 ms

Table 4.9: Non-operating times for a.c. residual currents

4) IEC 62955: Table 3 – Minimum values of non-operating time for alternating residual currents (RMS values)

4.6.9 Connectivity

In this menu QR code link for connection to Metrel Cloud app is displayed. Refer to Metrel Cloud help for more information.

Note:

- Metrel Cloud app is available for Android and iOS.

Google Play App Store

4.6.10 Devices

In this menu operation with external devices is configured.

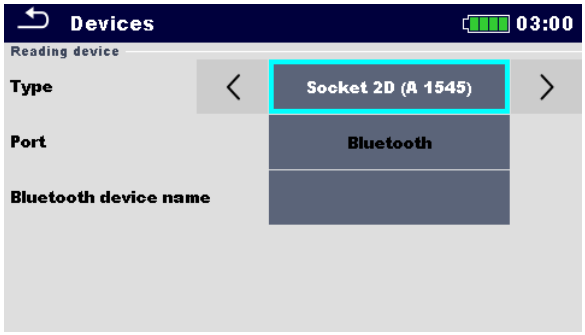


Figure 4.12: Device settings menu

Reading devices	
Type	Sets appropriate reading device (QR or barcode scanner, RFID reader, via aMESM application).
Port	Sets communication port of selected reading device.
Bluetooth device name	Goes to menu for pairing with selected Bluetooth device.

4.6.11 Bluetooth initialization

In this menu the Bluetooth module is reset.

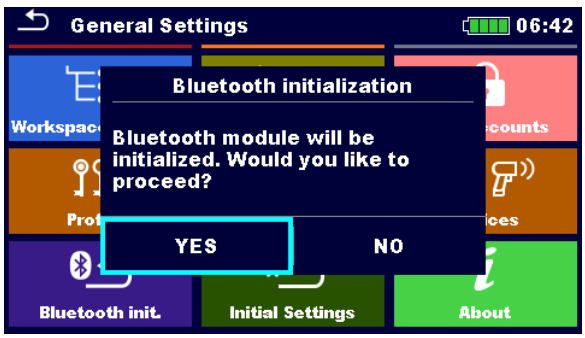


Figure 4.13: Bluetooth initialization menu

4.6.12 Initial Settings

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

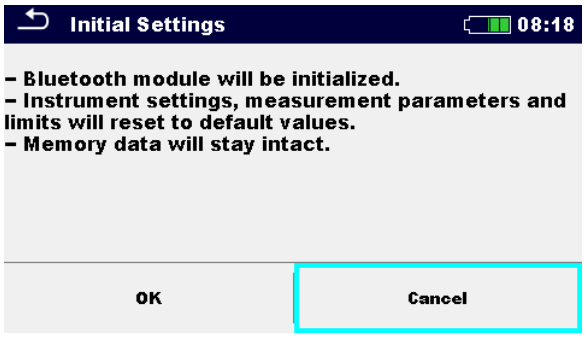


Figure 4.14: Initial settings menu

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 and Auto Sequences® group will be deselected,
- user will be signed out.

- If the battery pack is removed the custom-made settings will be lost.

Note:
Following customized settings will stay:

- profile settings,
- data in memory (Data in memory organizer, Workspaces, Auto Sequences® groups, Auto Sequences®) and
- user accounts.

4.6.13 About

In this menu instrument data (name, serial number, firmware (FW) and hardware (HW) version, FW profile, hardware documentation (HD) version, fuse version and date of calibration) can be viewed.

Figure 4.15: Instrument info screen

Note:

- Adapter info is also displayed, if connected.

4.7 Instrument profiles

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

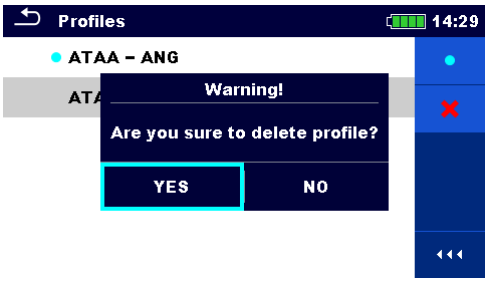
Figure 4.16: Instrument profiles menu

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

The Workspace Manager is intended to manage with different Workspaces and Exports that are stored on the SD memory card.

4.8.1 Workspaces and Exports

The works with MI 3155 EurotestXD 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 SD card on directory WORKSPACES, while Exports are stored on directory EXPORTS. Export files can be read by METREL applications that run on other devices. 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.

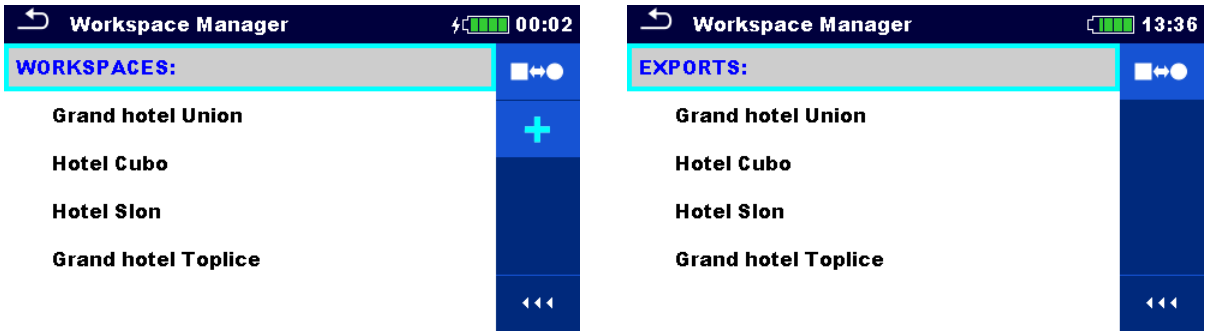


Figure 4.17: Workspace manager menu

Options

WORKSPACES:	List of Workspaces.
	Displays a list of Exports.
	Adds a new Workspace. Refer to chapter *0* *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.

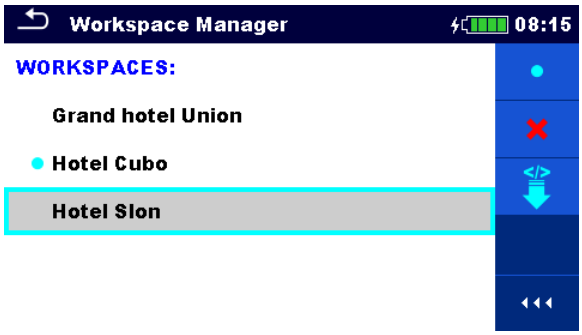


Figure 4.18: Workspaces menu

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 *0* *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

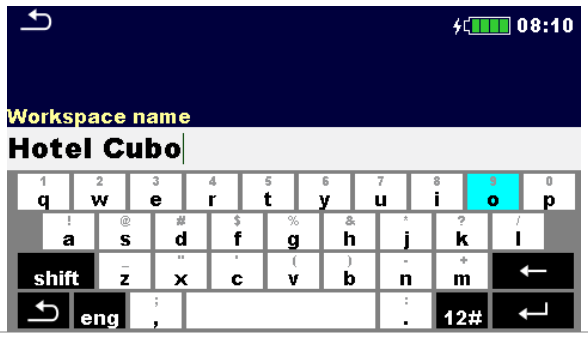
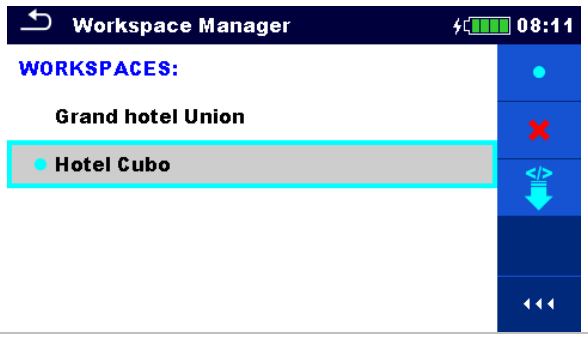
Figure 4.19: Workspace manager Exports menu

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.

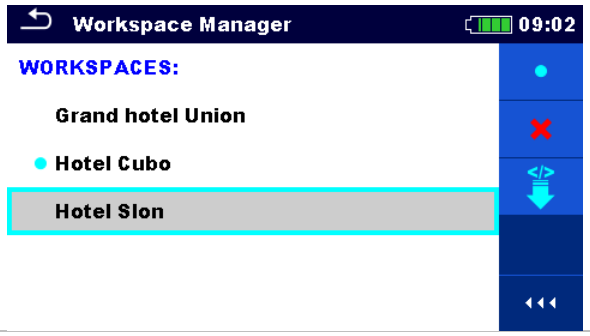
② 

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

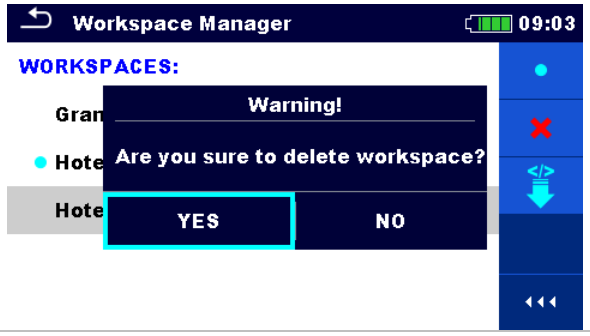
Procedure

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 deleted from the Workspace / Export list.

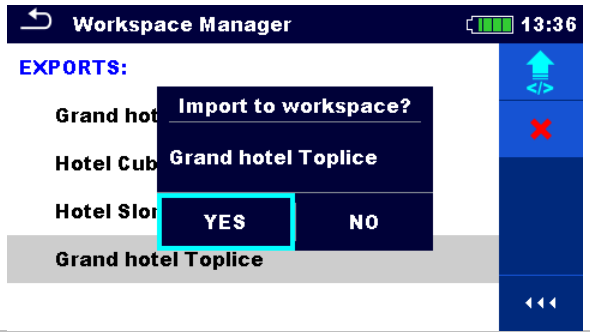
4.8.8 Importing a Workspace

①

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

②

Enters option Import.



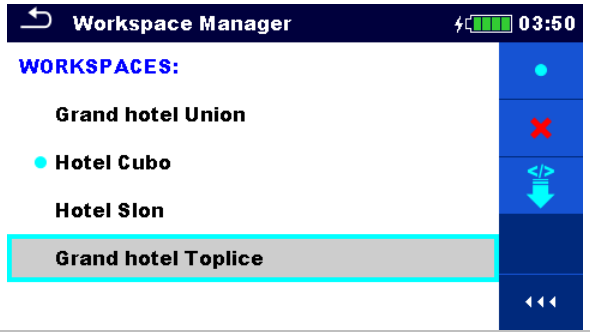
Before the import of the selected Export file the user is asked for confirmation.

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, ...).

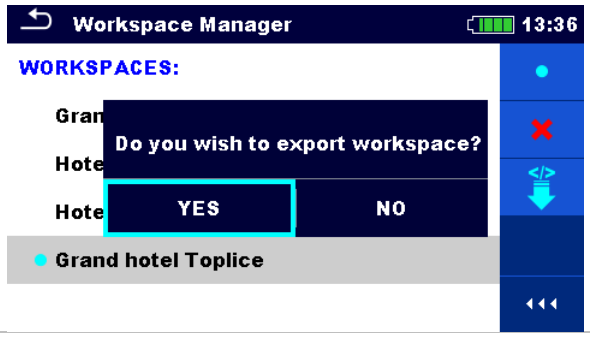
4.8.9 Exporting a Workspace

① 

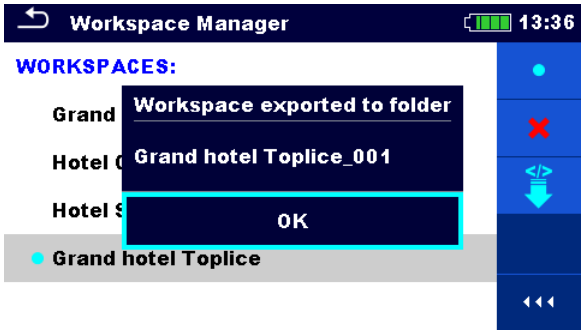
Select a Workspace from Workspace manager list to be exported to an Export file.

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 ...).

4.9 **Auto Sequence® groups**

The Auto Sequences® in MI 3155 EurotestXD can be organized by using lists. In a list a group of similar Auto Sequences® is stored. The Auto Sequence® groups menu is intended to manage with different lists of Auto Sequences® that are stored on the SD card.

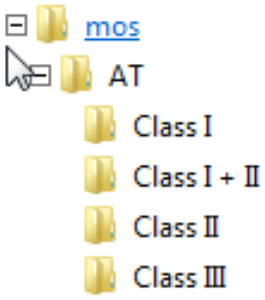


Figure 4.20: Organization of Auto Sequences® on SD card

Folders with lists of Auto Sequences® are stored in *Root*__*MOS*__*AT* on the SD card.

4.9.1 Auto Sequence® groups menu

In Auto Sequence® groups menu lists of Auto Sequences® are displayed. Only one list can be opened in the instrument at the same time. The list selected in the Auto Sequence® groups menu will be opened in the Auto Sequences® main menu.

Figure 4.21: Auto Sequences® groups menu

Operations in Auto Sequences® groups menu

	Opens the selected list of Auto Sequences®. Previously selected list of Auto Sequences® will be closed automatically. Refer to chapter *4.9.1.1 Selecting a list of Auto Sequences®* for more information.
	Deletes the selected list of Auto Sequences®. Refer to chapter *4.9.1.2 Deleting a list of Auto Sequences®* for more information.
	Opens options in control panel / expands column.

4.9.1.1 Selecting a list of Auto Sequences®

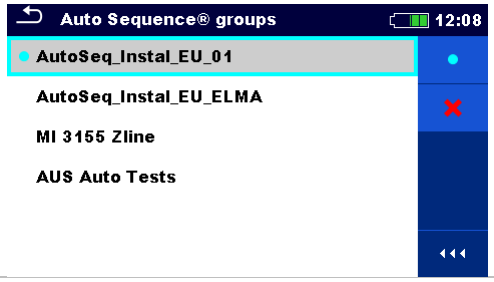
Procedure

① 

A list of Auto Sequences® can be selected from the Auto Sequence® groups menu.

②

Enters option for selecting a list.



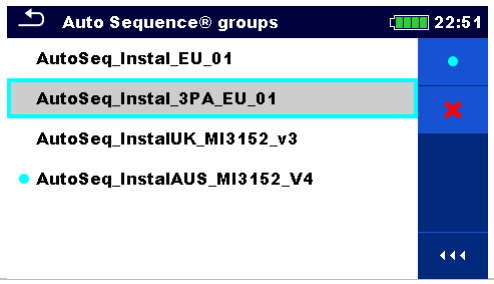
Selected list of Auto Sequences® is marked with a blue dot.

Note:

Previously selected list of Auto Sequences® is closed automatically.

4.9.1.2 Deleting a list of Auto Sequences®

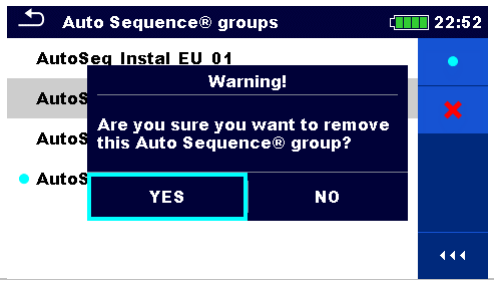
Procedure

① 

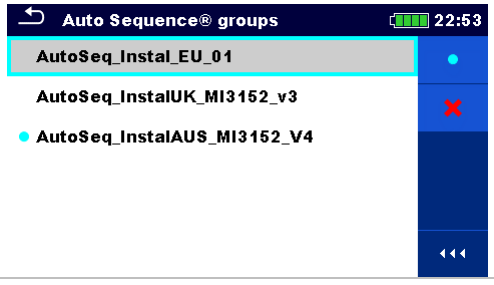
A list of Auto Sequences® to be deleted can be selected from the Auto Sequence® groups menu.

②

Enters option for deleting a list.



Before deleting the selected list of Auto Sequences® the user is asked for confirmation.

③ 

A list of Auto Sequences® is removed.

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. MI 3155 – EurotestXD Instrument has a multi-level structure. The hierarchy of Structure objects in the tree is shown on *Figure 5.1.* A list of available structure objects can be seen in *Appendix D – Structure objects*.

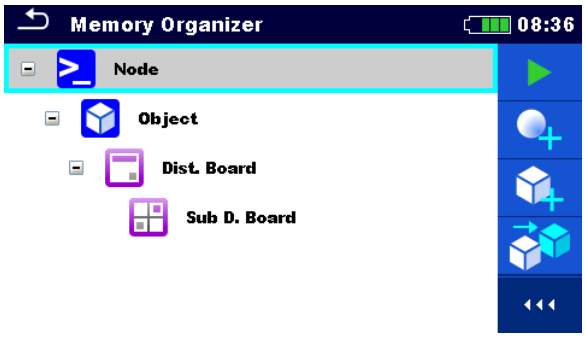


Figure 5.1: Default tree structure and its hierarchy

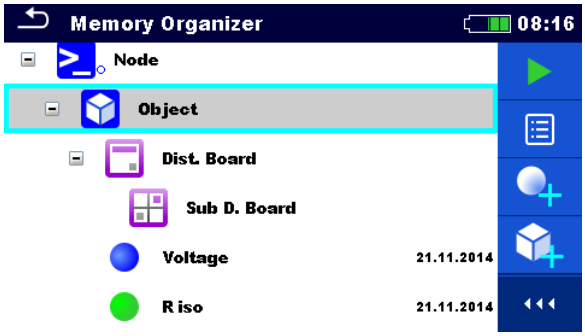


Figure 5.2: Example of a tree menu

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 Sequence®

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

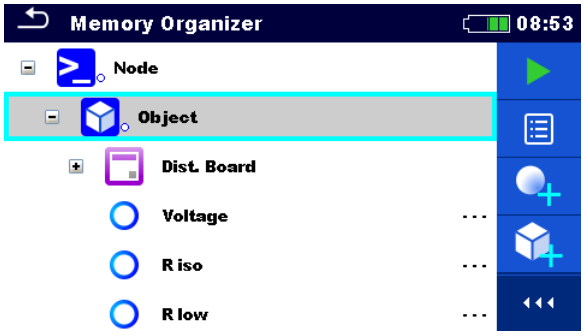
Figure 5.3: Structure object in tree menu

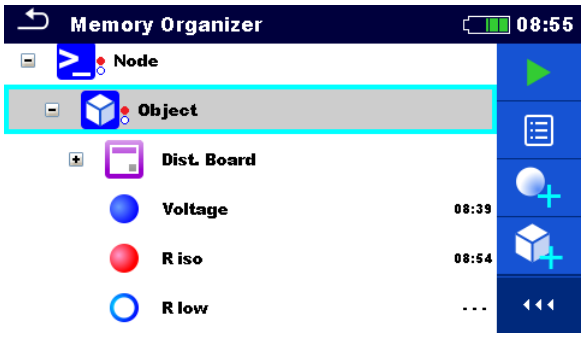
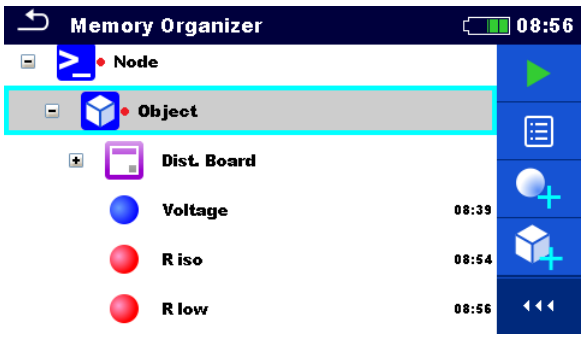
Structure objects supported by the instrument are described in *Appendix D – Structure objects*.

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.	

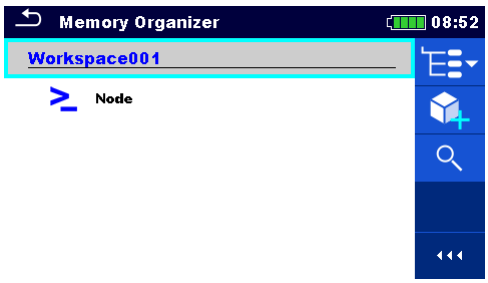
Note:

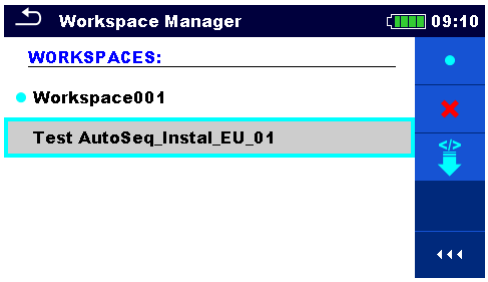
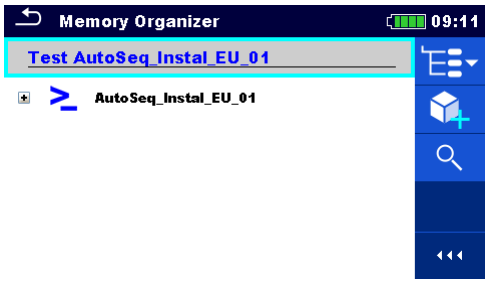
- There is no status indication if all measurement results under each structure element / sub-element have passed or if there is an empty structure element / sub-element (without measurements).

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

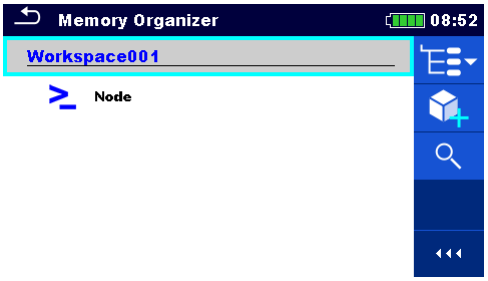
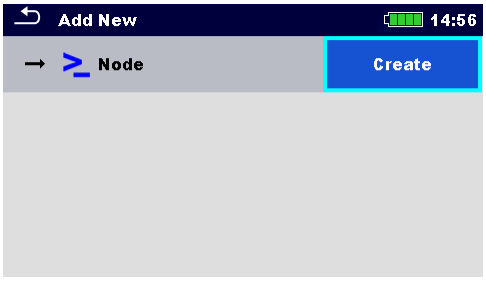
①		Press the active Workspace in Memory Organizer Menu.
②		Select List of Workspaces in Control panel.

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.

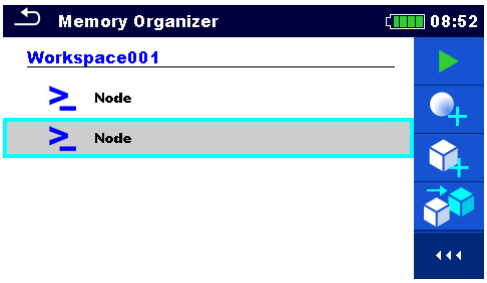
5.1.4 Adding Nodes in Memory Organizer

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		Press “Create” to confirm.

④



New Structure Element (Node) is added.

Note:
To change the name of a Node, see chapter *5.1.5.15 Rename a Structure object*

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)

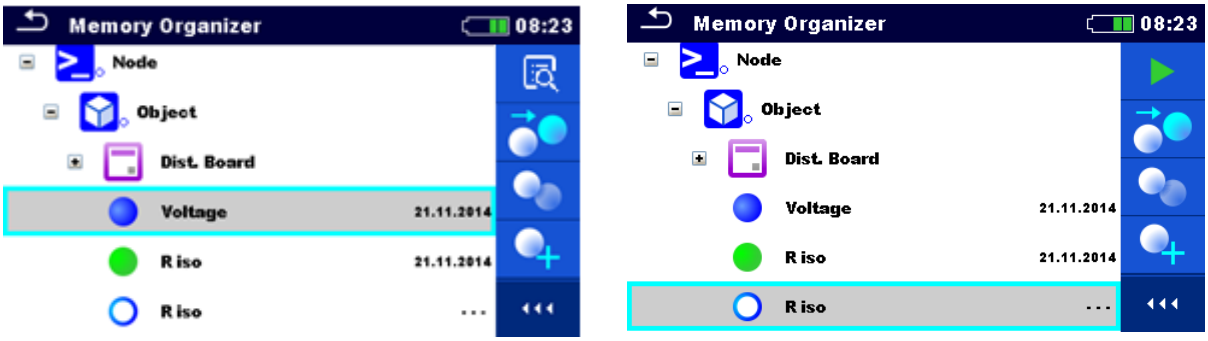


Figure 5.4: A measurement is selected in the Tree menu

Options

	Views results of measurement. The instrument goes to the measurement memory screen. Refer to chapter *6.1.9 Recall single test results screen* and *8.2.4 Auto Sequence® memory screen* for more information.
	Starts a new measurement. The instrument goes to the measurement start screen. Refer to chapter *6.1.3 Single test start screen* and *8.2.1 Auto Sequence® 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 *5.1.5.8 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 *5.1.5.11 Copy & Paste a measurement* for more information.
	Adds a new measurement. The instrument goes to the Menu for adding measurements. Refer to chapter *5.1.5.6 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 *5.1.5.14 Delete a measurement* for more information.

5.1.5.2 Operations on Structure objects

The structure object must be selected first.

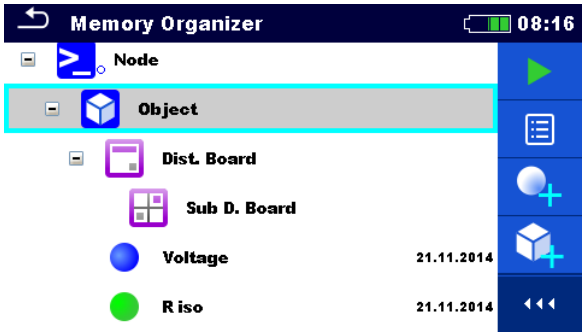


Figure 5.5: A structure object is selected in the Tree menu

Options

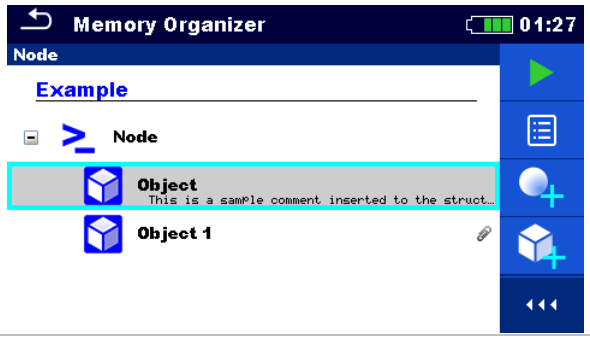
	Starts a new measurement. Type of measurement (Single test or Auto Sequence®) should be selected first. After proper type is selected, the instrument goes to Single Test or Auto Sequence® selection screen. Refer to chapters *6.1 Selection modes* and *8.1 Selection of Auto Sequences®*.
	Saves a measurement. 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 *5.1.5.6 Add a new measurement* for more information.

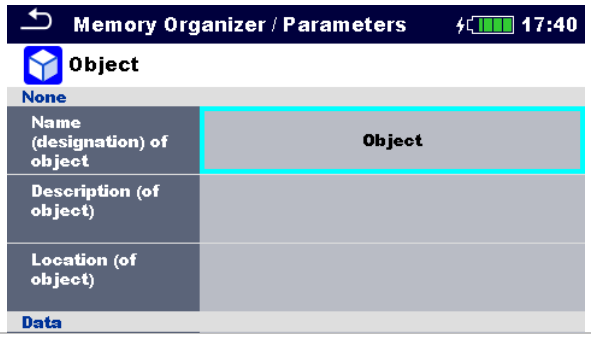
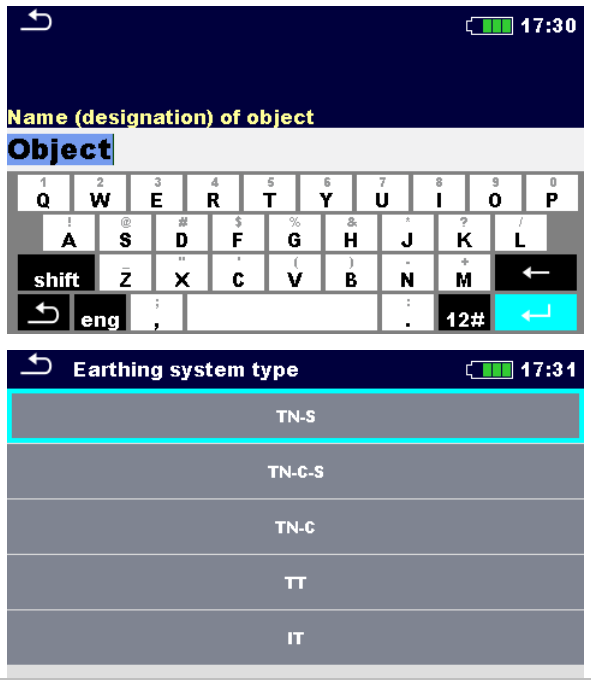
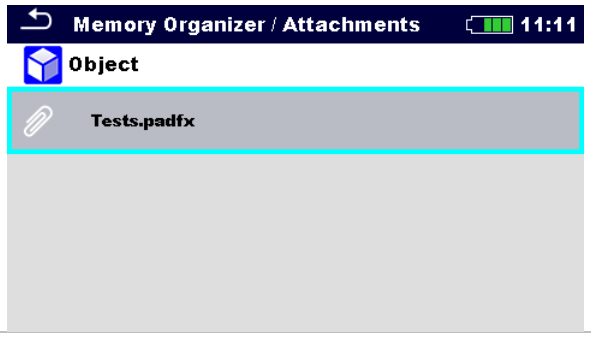
	Adds a new Structure object. A new Structure object can be added. Refer to chapter *5.1.5.5 Add a new Structure Object* for more information.
	Attachments. Name and link of attachment is displayed.
	Clones a Structure object. Selected Structure object can be copied to same level in structure tree (clone). Refer to chapter *5.1.5.7 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 *5.1.5.9 Copy & Paste a Structure object* for more information.
 	Cut & Paste a Structure. Selected Structure with child items (sub-structures and measurements) can be moved to any allowed location in structure tree. Refer to chapter *5.1.5.12 Cut & Paste a Structure object with sub-items* 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 *5.1.5.13 Delete a Structure object* for more information.
	Renames a Structure object. Selected Structure object can be renamed via keypad. Refer to chapter *5.1.5.15 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.

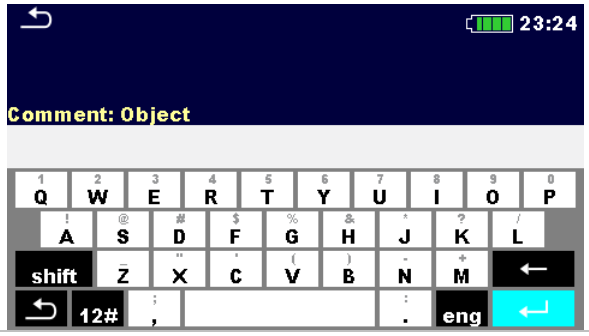
②		Select Parameters in Control panel.
③		Example of Parameters menu.
④		In menu for editing parameters the parameter's value can be selected from a dropdown list or entered via keypad. Refer to chapter *4 Instrument operation* for more information about keypad operation. Note: Some structure parameters include custom lists. See chapter *5.1.5.4 Custom lists of Structure parameter values* for details.
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 Custom lists of Structure parameter values

Some structure parameters include option to create custom lists of values for particular structure parameter. These custom values can be re-used easily, by selecting it from the custom lists, and re-typing is therefore not required.

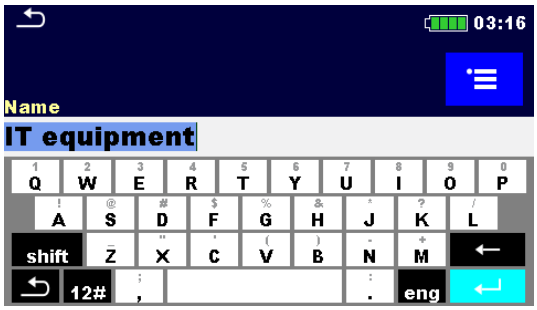
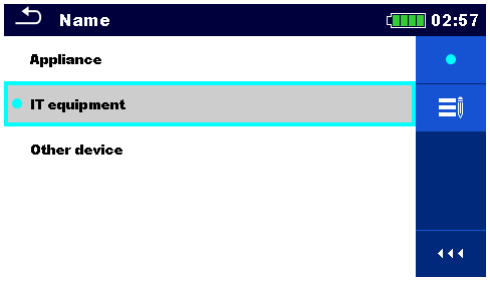
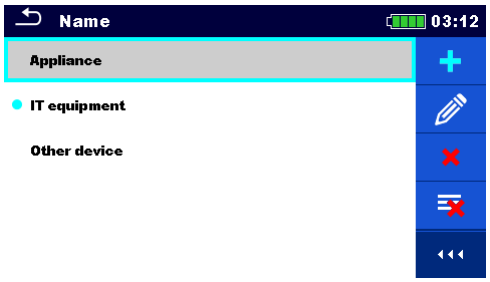


Figure 5.6: Example of Virtual keyboard with Custom list option

Procedure

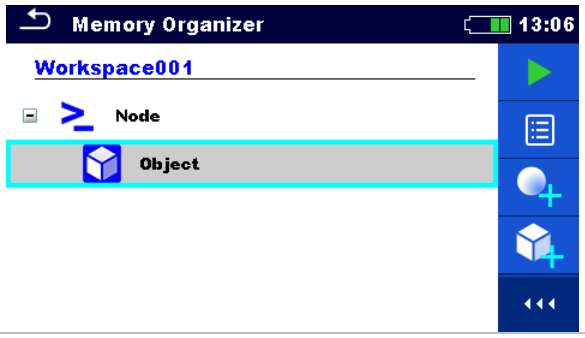
①		Select Custom list option.
②		Custom list view.
③		Select focused value from Custom list.

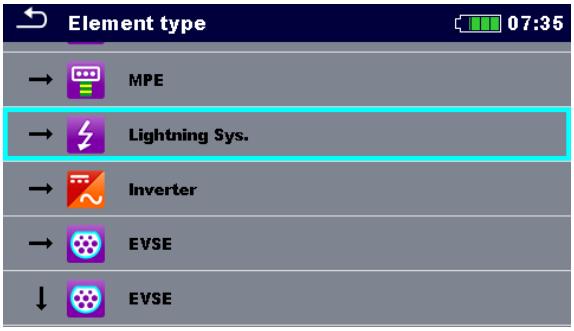
④a		Edit Custom list.
④b		Custom list Edit options.
⑤a		Add new value to the Custom list.
⑤b		Edit selected Custom list value.
⑤c		Delete selected Custom list value.
⑤d		Delete Custom list (all values).

5.1.5.5 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		Tap on a structure type selection window.



A list of available structure items is displayed. Select one from a list. Arrow indicates the position where structure item will be inserted.

→ Child item to the currently selected structure item.

↓ Structure item located in the same le

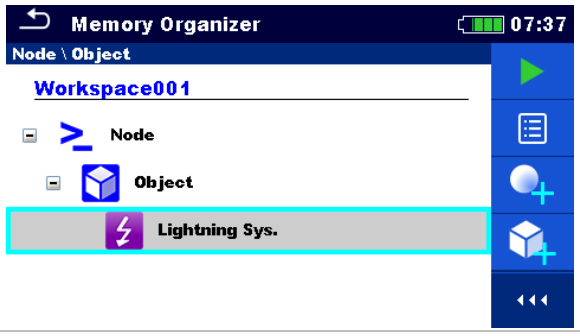
③b

In menu for editing name and 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.

④

Create new structure item.

⑤



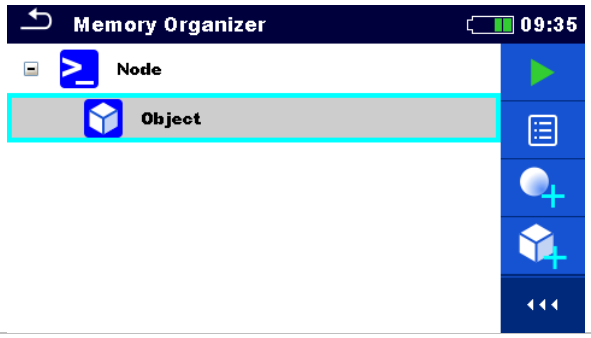
New object added.

5.1.5.6 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

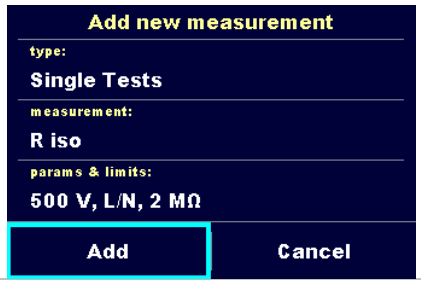


Select level in structure where measurement will be added.

②

Select Add measurement in Control panel.

③



Add new measurement menu.

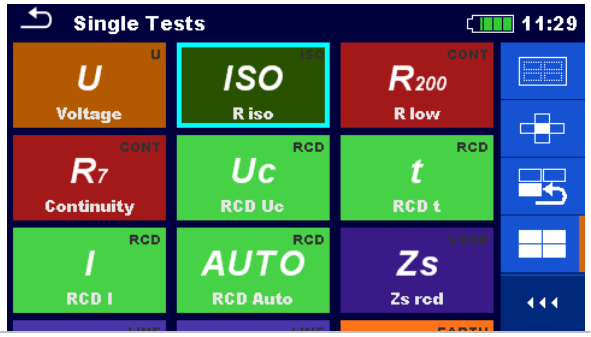
③a

Type of test can be selected from this field.

Options: (Single Tests, Auto Sequences®)

Tap on field or press the key to modify.

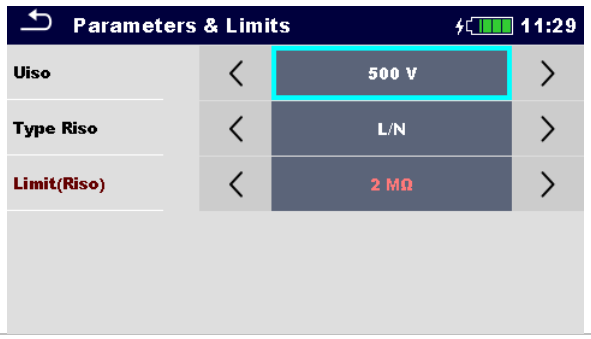
③b



Last added measurement is offered by default.

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

③c



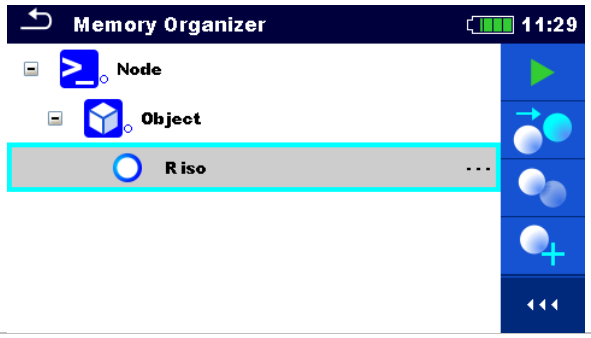
Select parameter and modify it as described earlier.

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

④

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

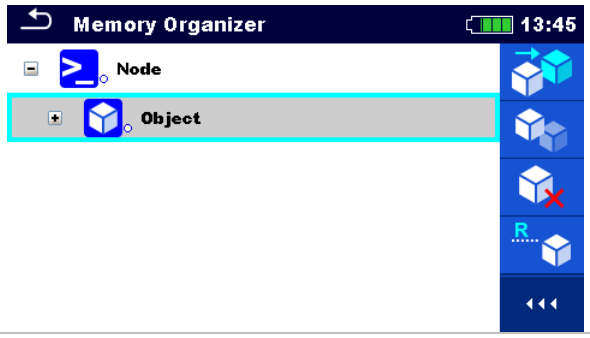
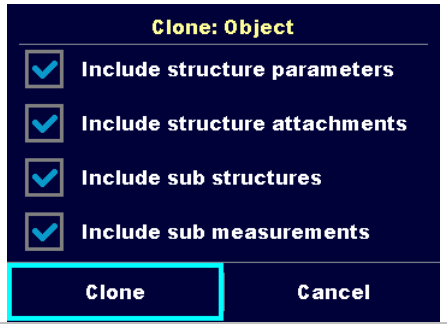
Returns to the structure tree menu without changes.

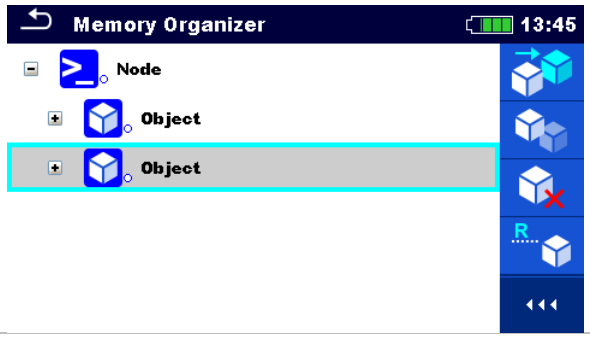
⑤		New empty measurement is added under the selected Structure object.

5.1.5.7 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

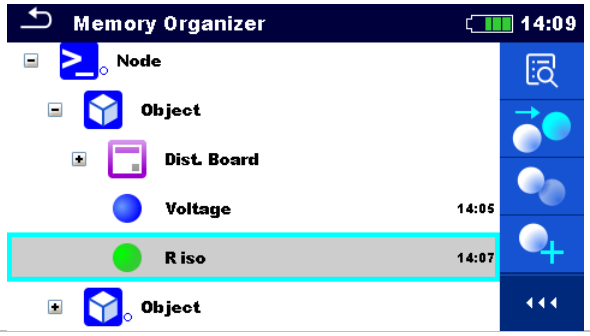
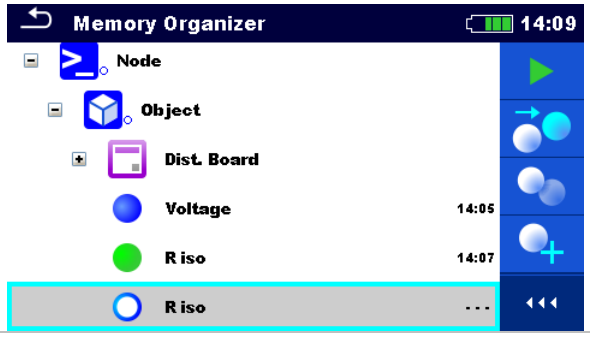
①		Select the structure object to be cloned.
②		Select Clone in Control panel.
③		The Clone Structure object menu is displayed. Sub-elements of the selected structure object can be marked or un-marked for cloning. Refer to chapter *5.1.5.10 Cloning and Pasting sub-elements of selected structure object* 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.

5.1.5.8 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. Parameters and limits of new measurement are the same as they are set in original measurement. Its parameters/limits can be changed when measurement is started.

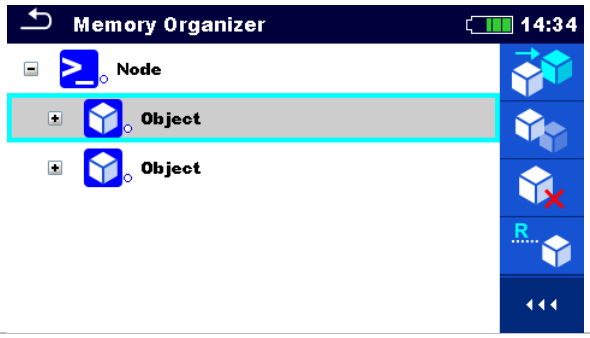
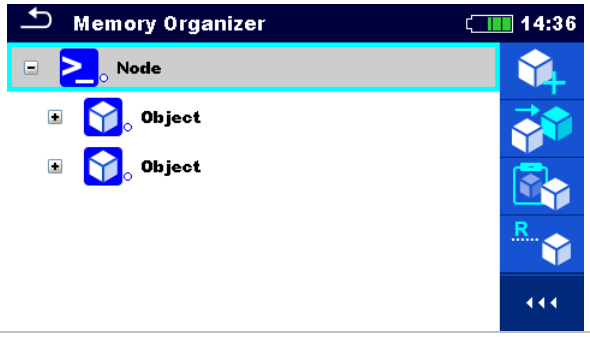
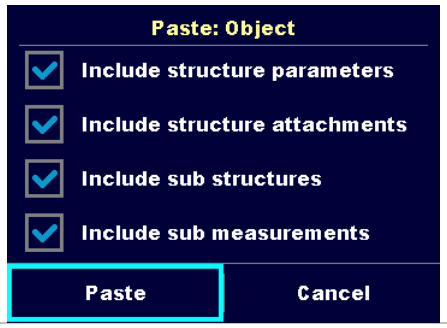
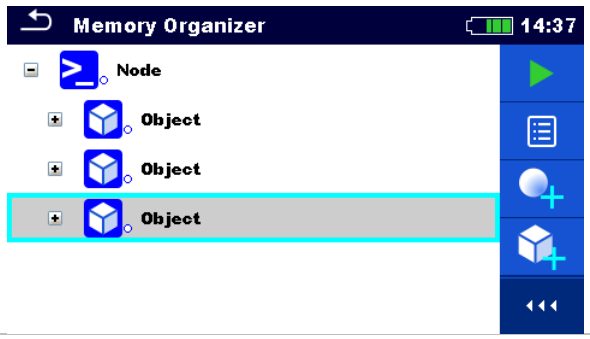
Procedure

①		Select the measurement to be cloned.
②		Select Clone in Control panel.
③		A new empty measurement is displayed.

5.1.5.9 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 *5.1.5.10 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.

5.1.5.10 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:

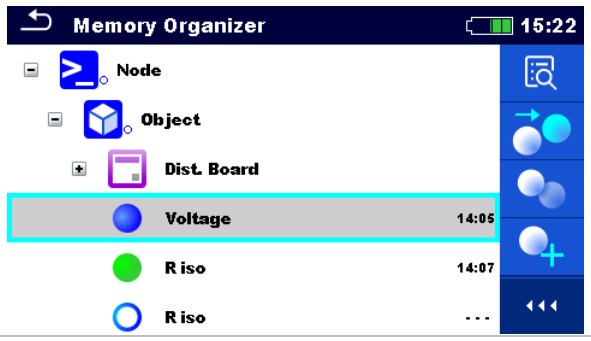
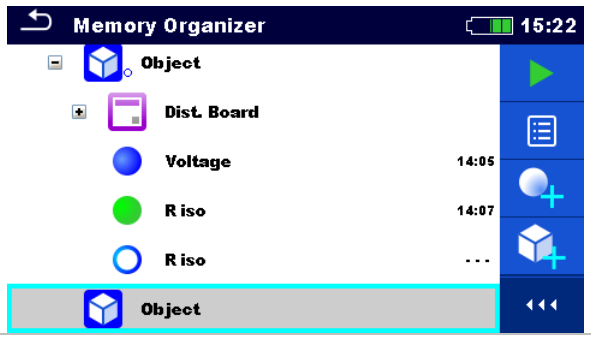
Options

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.

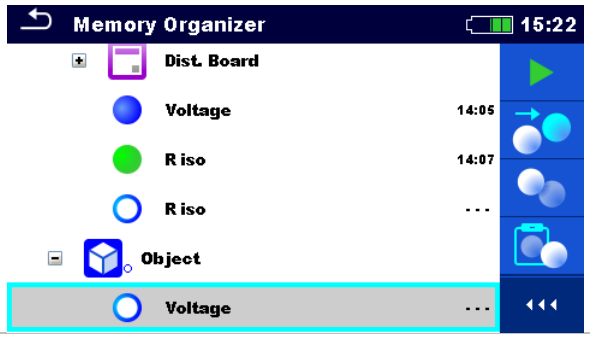
5.1.5.11 Copy & Paste a measurement

In this menu selected measurement can be copied as an empty measurement to any allowed location in the structure tree. Selected measurement can be copied multiple times to different locations in the structure tree. Parameters and limits of new measurement are the same as they are set in original measurement. Its parameters/limits can be changed when measurement is started.

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

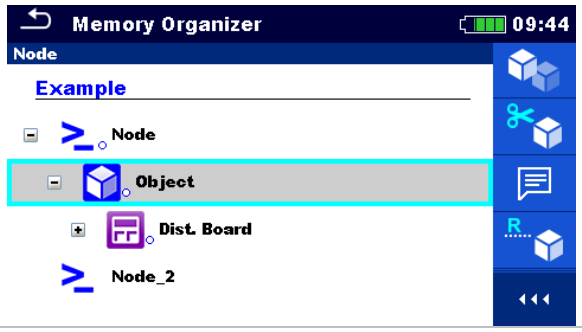
The Paste command can be executed one or more times.

5.1.5.12 Cut & Paste a Structure object with sub-items

In this menu selected Structure object with sub-items (sub-structures and measurements) can be cut and pasted (moved) to any allowed location in the structure tree.

Procedure

①

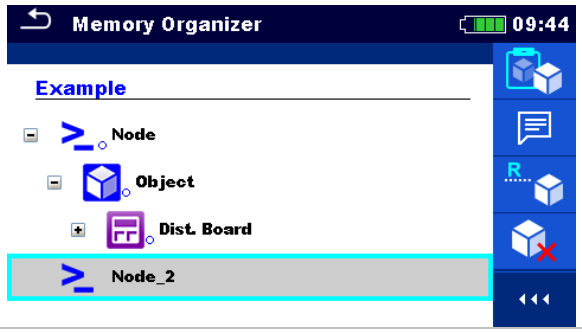


Select the structure item to be moved.

②

Select Cut option from Control panel.

③

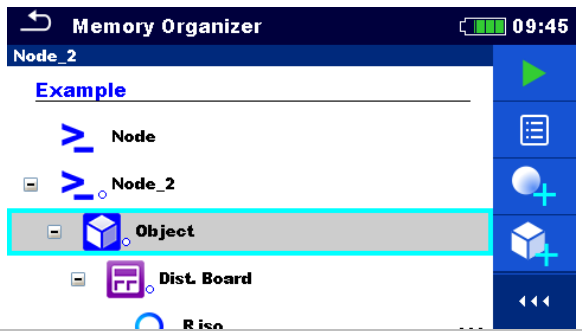


Select new location where structure object (with sub-structures and measurements) should be moved.

④

Select Paste option from Control panel.

⑤

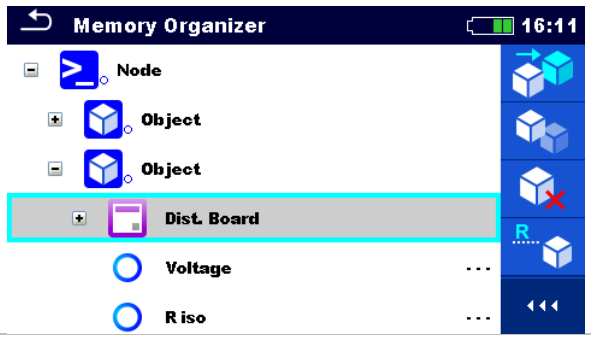
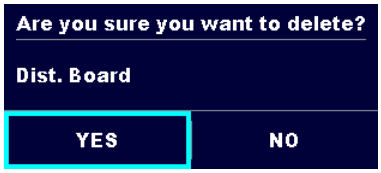
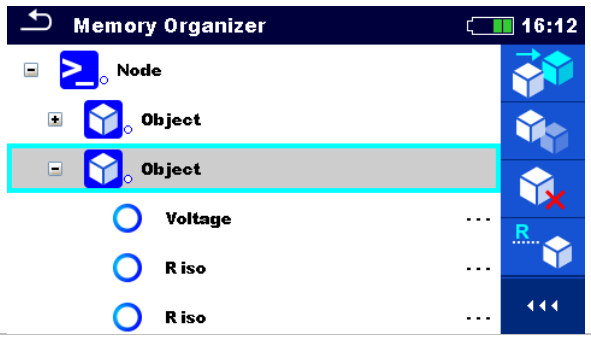


The structure object (with sub-structures and measurements) is moved to selected new location and deleted from previous location in the tree structure.

5.1.5.13 Delete a Structure object

In this menu selected Structure object can be deleted.

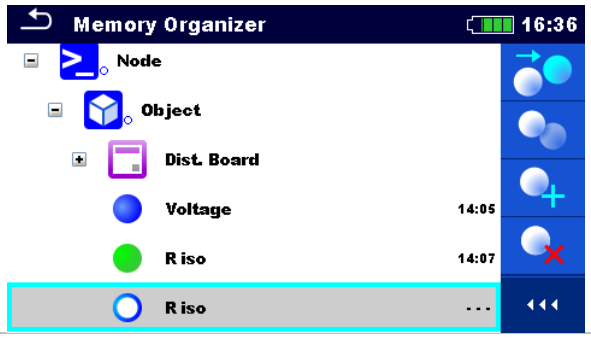
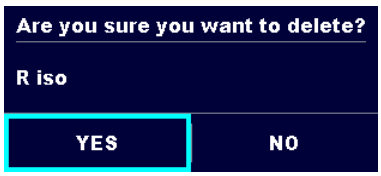
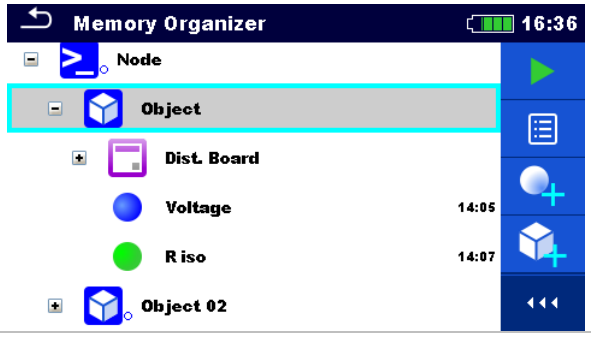
Procedure

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.

5.1.5.14 Delete a measurement

In this menu selected measurement can be deleted from selected location in the tree structure.

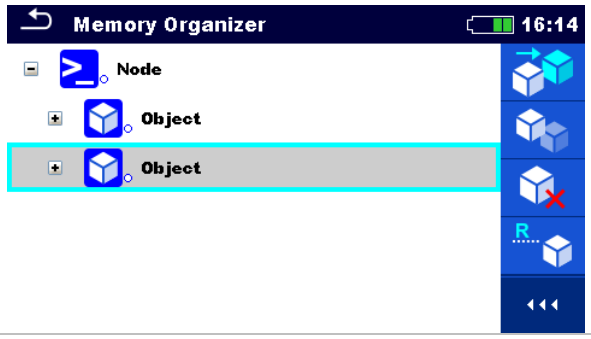
Procedure

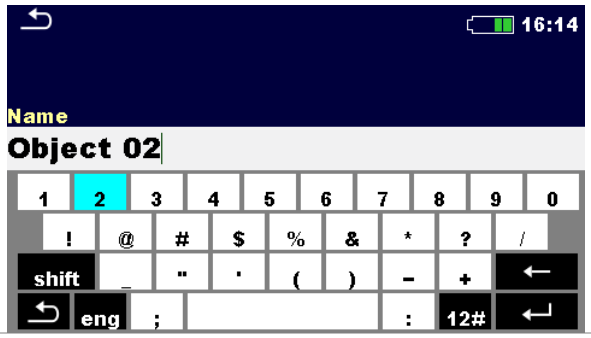
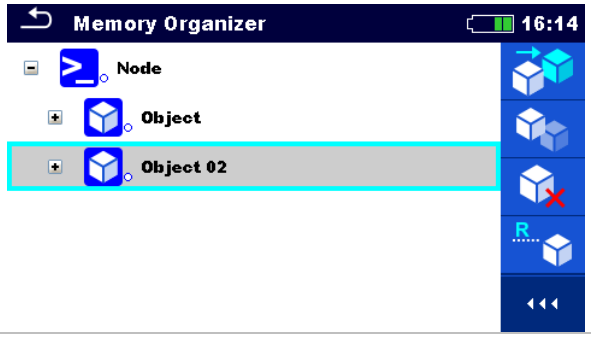
①		Select a measurement to be deleted.
②		Select Delete in Control panel.
③		A confirmation window will appear.
		Selected measurement is deleted.
		Returns to the tree menu without changes.
④		Structure without deleted measurement.

5.1.5.15 Rename a Structure object

In this menu selected Structure object can be renamed.

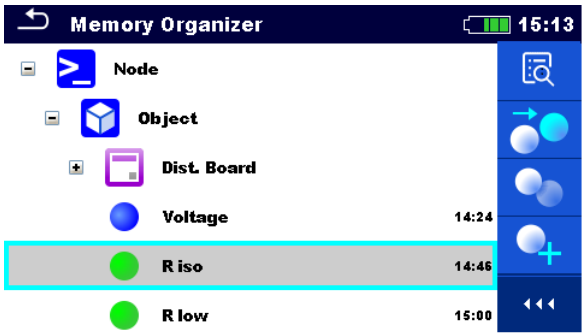
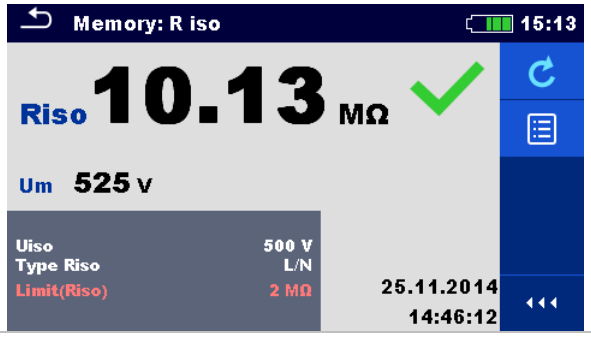
Procedure

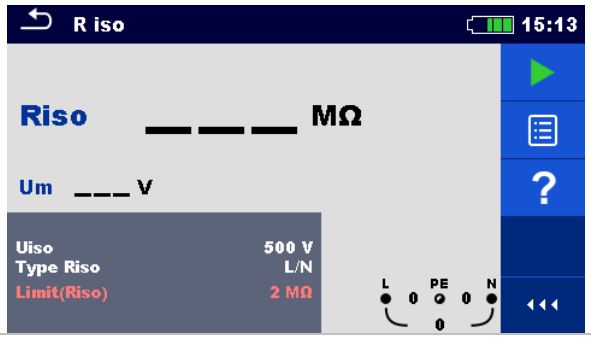
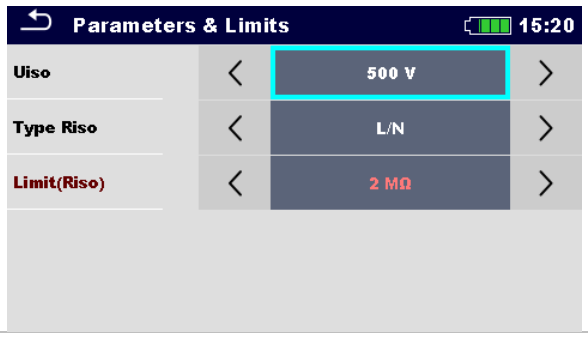
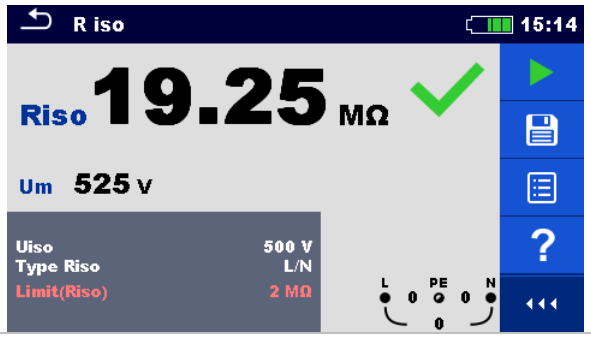
①		Select the structure object to be renamed.
②		Select Rename in Control panel.

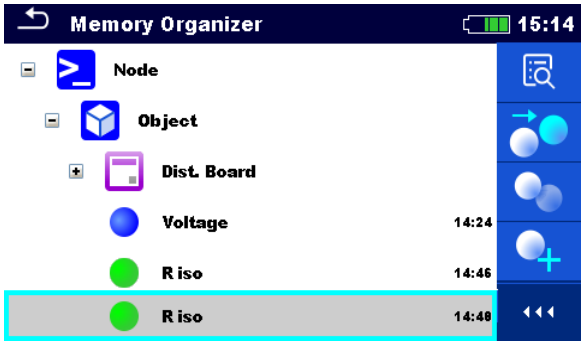
③		Virtual keypad will appear on screen. Enter new text and confirm. Refer to chapter *4.3 Virtual keyboard* for keypad operation.
④		Structure object with the modified name.

5.1.5.16 Recall and Retest selected measurement

Procedure

①		Select the measurement to be recalled.
②		Select Recall results in Control panel.
③		Measurement is recalled.

③a		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.



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 5.7*.

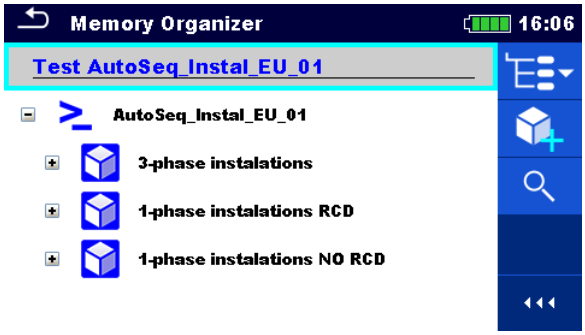
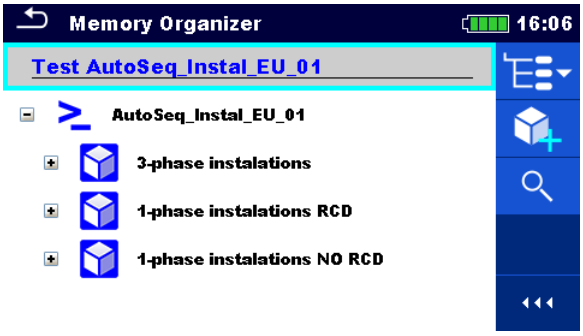


Figure 5.7: Active workspace directory

Procedure

① 

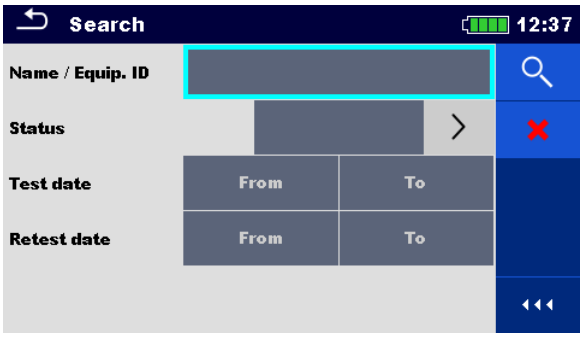
Search function is available from the active workspace directory line.

Use external device for data entry or follow instructions below for instrument search function.

② 

Select Search in control panel to open Search setup menu.

③

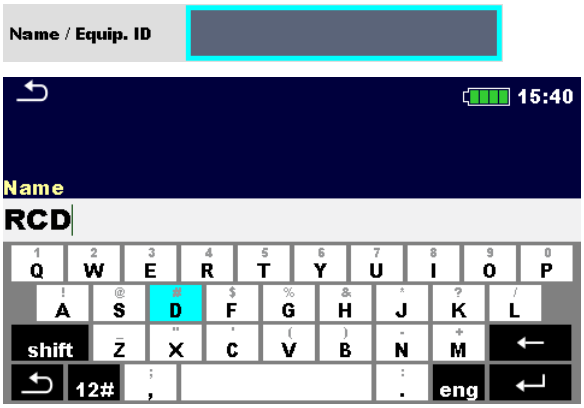


The parameter that can be searched for is displayed in the search setup menu.

Note:

- Equipment ID, Test date and Retest date (if applicable) refer only to the following structure objects: Machine, EVSE and Appliance.

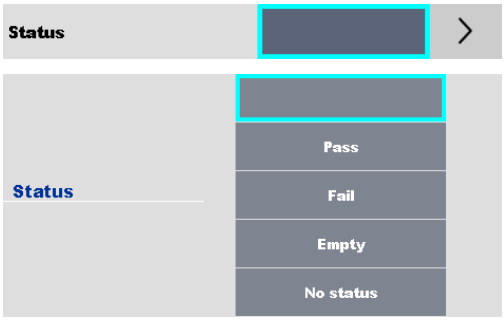
③a



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

Strings can be entered using the on-screen keyboard.

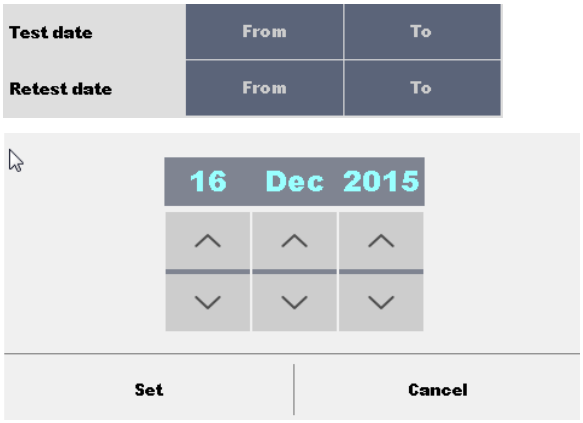
③b



The search can be narrowed on base of statuses.

If searching by status, instrument will display all structure objects that include one or more measurements with searched status.

③c



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

③d

Clears all 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 5.8*.

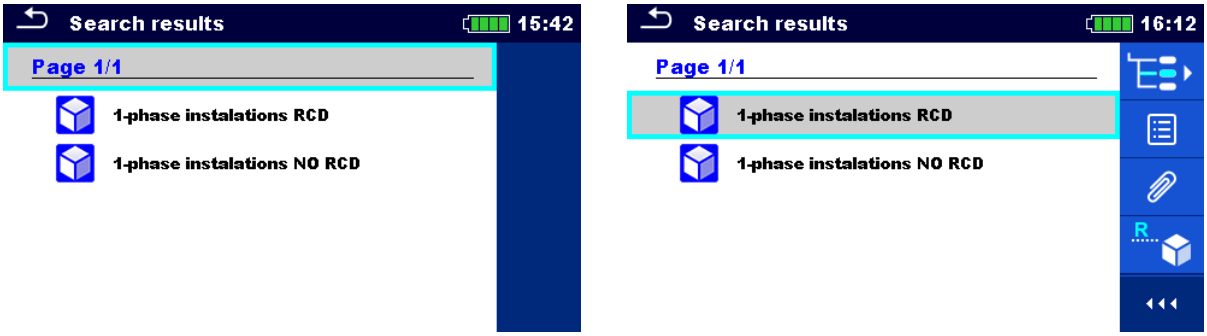


Figure 5.8: Search results screen (left), structure object selected (right)

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 *5.1.5.15 Rename a Structure object* for more information

Note:

- Search result page consist of up to 50 results.

6 Single tests

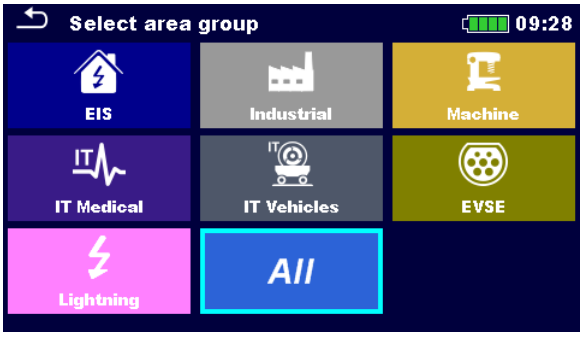
Single tests can be selected in the main Single tests menu or in Memory organizer main menu and sub-menus.

6.1 Selection modes

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

Options

Area Group

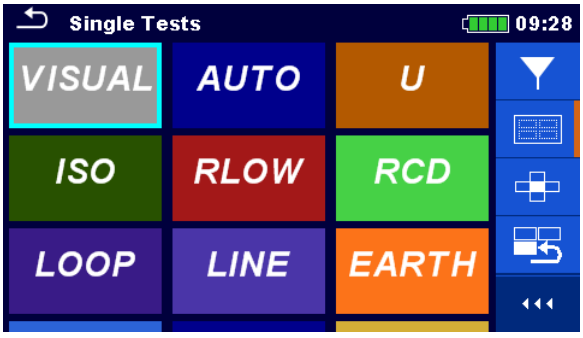


With help of area groups it is possible to limit the offered single tests. The instrument has several area groups:

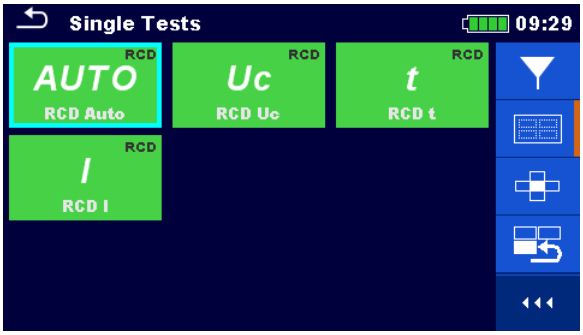
- the EIS group,
- the Industrial group,
- the Machine group,
- the IT Medical group,
- the IT Vehicles group,
- the EVSE group,
- the Lightning group.

In the All group all measurements are offered.

Groups

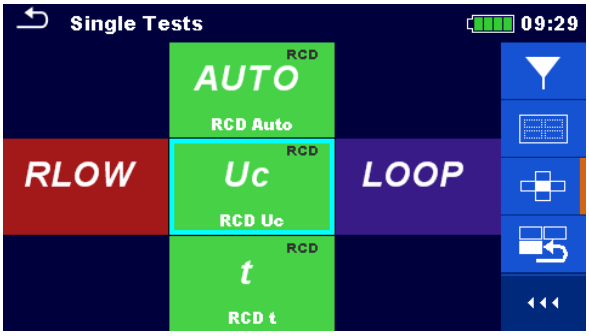


The single tests are divided into groups of similar tests.



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

Cross selector

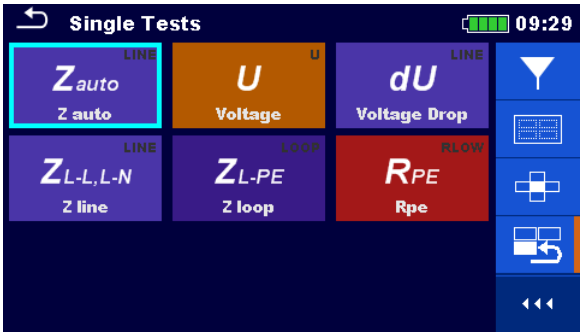


This selection mode is the fastest for working with the keypad.

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.

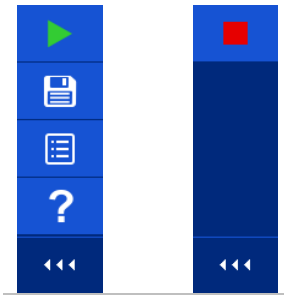
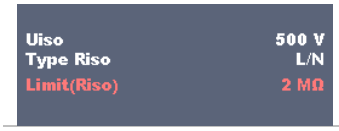
Expands control panel / open more options.

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.

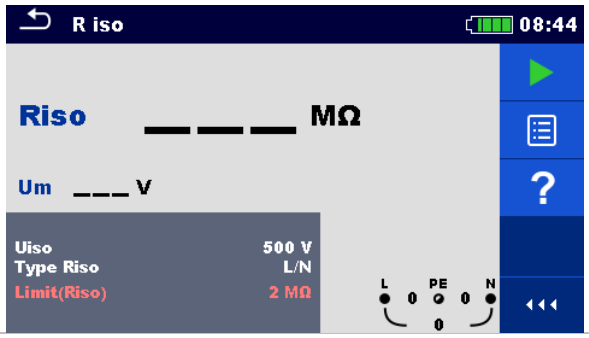
Figure 6.1: Single test screen organization, example of insulation resistance measurement

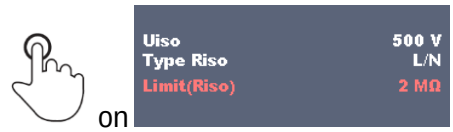
Single test screen organization

	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, limits and comments 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. Opens parameters and limits setting menu.



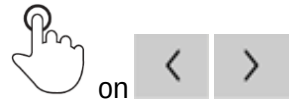
on

③

Parameters and Limits menu.

Some single tests support user comment entry.

③a



on or

Modify parameter or limit value with touchscreen or keyboard buttons.

③b

and

Select parameter to be edited or limit / comment to be set.

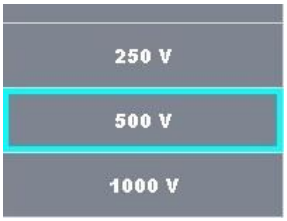
③c

on

on

Opens parameter or limit selection list or on-screen keyboard for entering comment.

④a

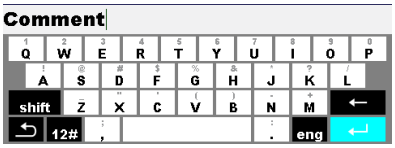


on

Select parameter or limit value from the list.
Note:
Touchscreen or keyboard selection methods can be used interchangeably;

confirm keyboard selection with .

④b



on

Enter comment and confirm with .

⑤

Accepts and set selected parameters, selected limit values and user comments and exits Single Test setting.

Note:

- Set parameters, set limits and entered user comments are saved to the memory. When same Single test is used next time, settings and comments will remain the same.

6.1.3 Single test start screen

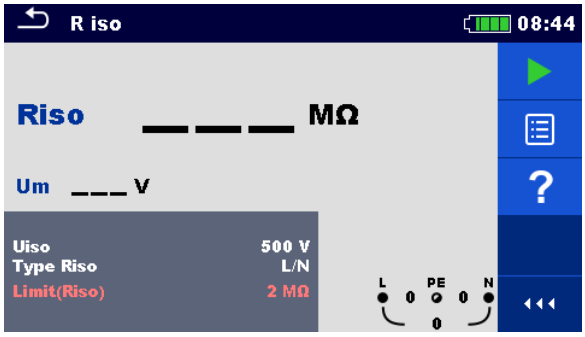


Figure 6.2: Single test start screen, example of insulation resistance measurement

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, limits and comments 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

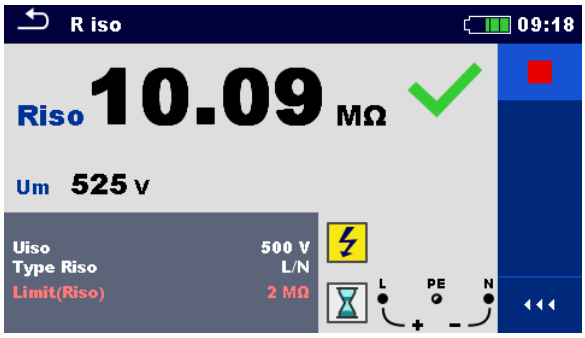


Figure 6.3: Single test is running, example of insulation resistance continuous measurement

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

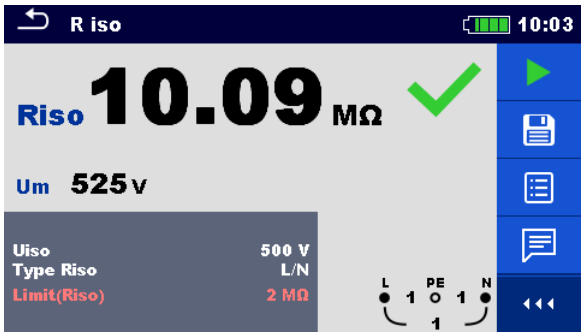


Figure 6.4: Single test results screen, example of insulation resistance measurement results

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.
  on 	Opens screen for changing parameters and limits. Refer to chapter *0* *Setting parameters, limits and comments of single tests* for more information.
	Adds comment to the measurement. The instrument opens keypad for entering a comment.

	Opens help screens.
 long on 	Enters cross selector to select test or measurement.
 	Expands column in control panel.

6.1.6 Editing graphs (Harmonics)

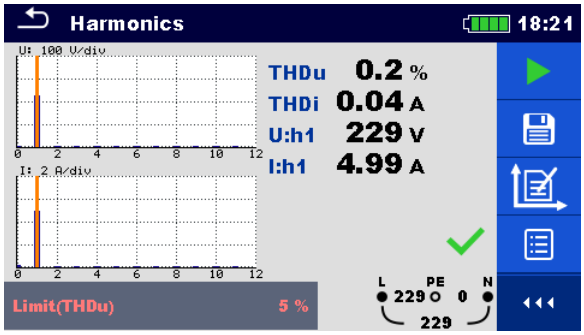


Figure 6.5: Example of Harmonics measurement results

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 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.

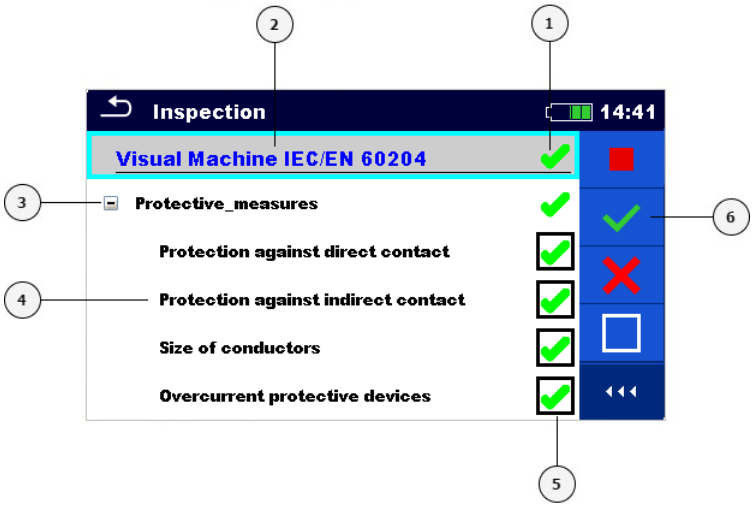


Figure 6.6: Inspection screen organisation

Legend

1 Overall status of the inspection
2 Selected inspection
3 Item
4 Child items
5 Status fields (for items and child items)
6 Control panel (available options)

6.1.7.1 Single test (inspection) start screen

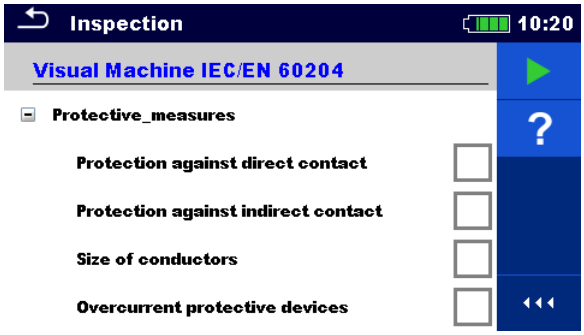


Figure 6.7: Inspection start screen

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

	Starts the inspection.
	Opens help screens. Refer to chapter *6.1.8 Help screens* for more information.

6.1.7.2 Single test (Inspection) screen during test

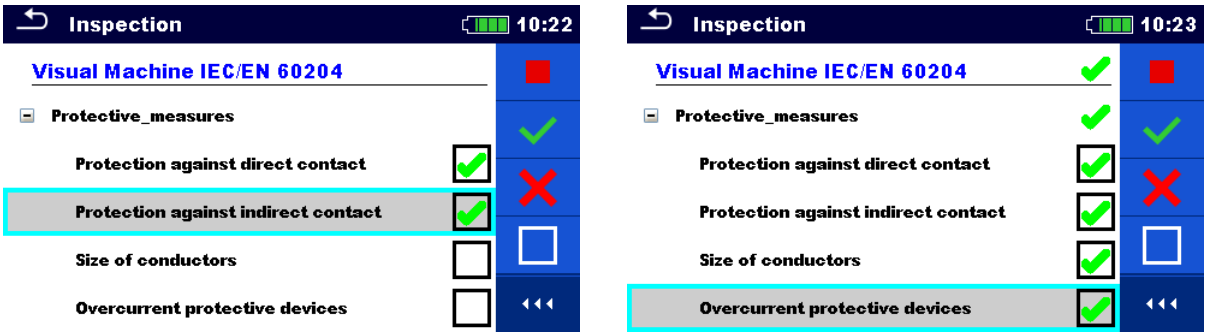
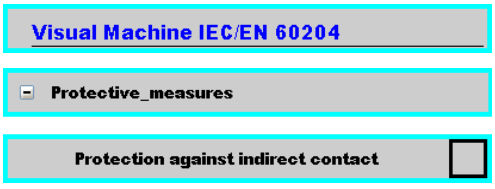


Figure 6.8: Inspection screen (during inspection)

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.

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

6.1.7.3 Single test (Inspection) result screen

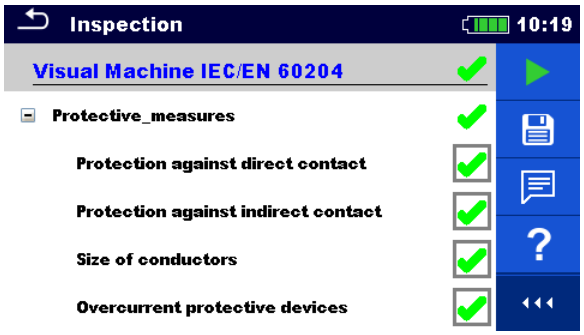


Figure 6.9: Inspection result screen

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 *6.1.8 Help screens* for more information.

6.1.7.4 Single test (inspection) memory screen

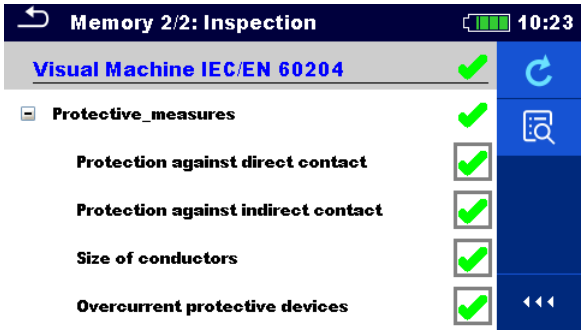


Figure 6.10: Inspection memory screen

Options

	Retest Enters screen with 'empty' measurement.
	Enters view mode.

6.1.8 Help screens

Help screens contain diagrams for proper connection of the instrument.

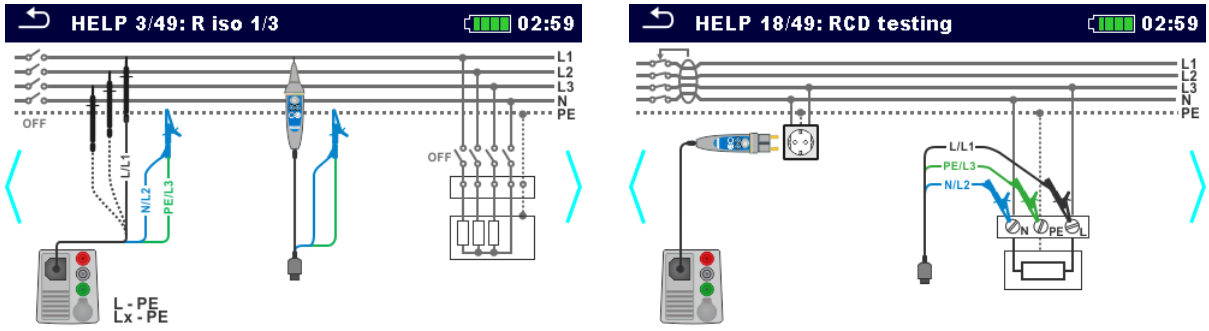


Figure 6.11: Examples of help screens

Options

	Opens help screen.
on	Goes to previous / next help screen.

Back to test / measurement menu.

6.1.9 Recall single test results screen

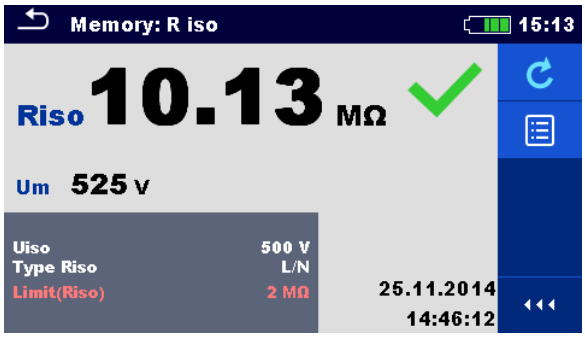


Figure 6.12: Recalled results of selected measurement, example of insulation resistance recalled results

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 0 Setting parameters, limits and comments of single tests for more information.
 	Expands column in control panel.

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

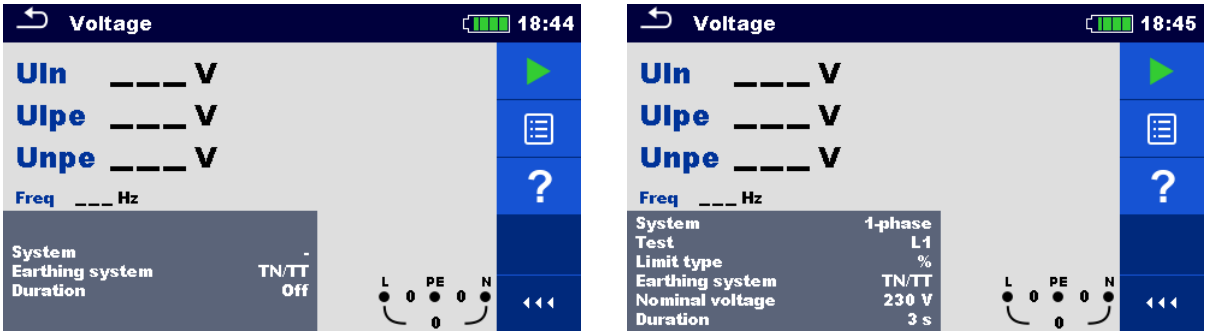


Figure 7.1: Voltage measurement menu

Measurement parameters

System[1)]	Voltage system [-, 1-phase,3-phase]
Test[3)]	Phase to be tested [-, L1, L2, L3]
Limit type	Type of limit [Voltage, %]
Earthing system	Earthing system [TN/TT, IT]
Nominal voltage[2)]	Nominal voltage [Custom, 110 V, 115 V, 190 V, 200 V, 220 V, 230 V, 240 V, 380 V, 400 V, 415 V]
Reference field[4)]	Correct phase rotation [-, 1.2.3, 3.2.1]
Duration	Test duration [Off, Custom, 1 s, 3 s, 5 s]

1) There are no limits to set if System parameter is set to '–'.
2) Active only if limit type parameter is set to %.
3) Active only when System is set to 1-phase.
4) Active only when System is set to 3-phase; set parameter (1.2.3 or 3.2.1) to verify correct phase sequence during Voltage test.

Measurement limits for TN/TT earthing system:

Low limit Uln[5)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit Uln[5)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit Uln[6)]	Min. voltage [Off, Custom, -20% ... 20%]
High limit Uln[6)]	Max. voltage [Off, Custom, -20% ... 20%]
Low limit Ulpe[5,6)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit Ulpe[5,6)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit Unpe[5,6)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit Unpe[5,6)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U12[7)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U12[7)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U13[7)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U13[7)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U23[7)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U23[7)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit Ull[8)]	Min. voltage [Off, Custom, -20% ... 20%]

High limit Ull[8)]	Max. voltage [Off, Custom, -20% ... 20%]

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

Measurement limits for IT earthing system:

Low limit U12[9,11)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U12[9,11)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U12[10)]	Min. voltage [Off, Custom, -20% ... 20%]
High limit U12[10)]	Max. voltage [Off, Custom, -20% ... 20%]
Low limit U1pe[9,10)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U1pe[9,10)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U2pe[9,10)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U2pe[9,10)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U13[11)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U13[11)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit U23[11)]	Min. voltage [Off, Custom, 0 V ... 499 V]
High limit U23[11)]	Max. voltage [Off, Custom, 0 V ... 499 V]
Low limit Ull[12)]	Min. voltage [Off, Custom, -20% ... 20%]
High limit Ull[12)]	Max. voltage [Off, Custom, -20% ... 20%]

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

Connection diagrams

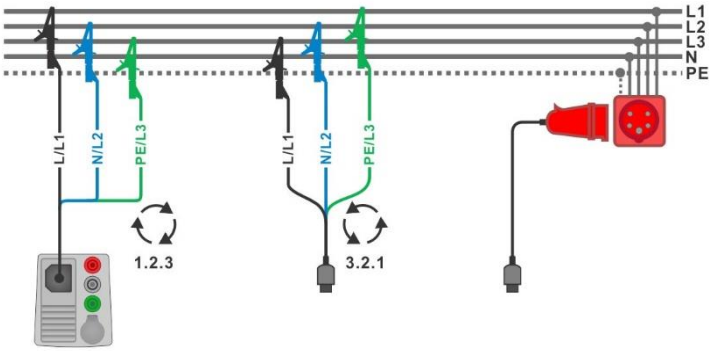


Figure 7.2: Connection of 3-wire test lead and optional adapter in three-phase system

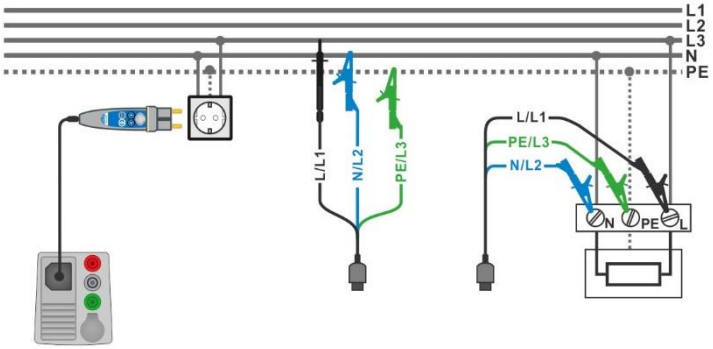


Figure 7.3: Connection of Plug commander and 3-wire test lead in single-phase system

Measurement procedure

- Enter the Voltage function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect test leads to object under test (see *Figure 7.2* and *Figure 7.3*).
- Start the measurement.
- Stop the measurement, if Duration is set to Off.
- Save results (optional).

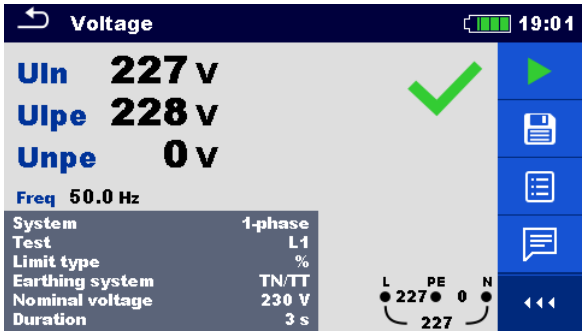


Figure 7.4: Example of Voltage measurement results in single-phase system

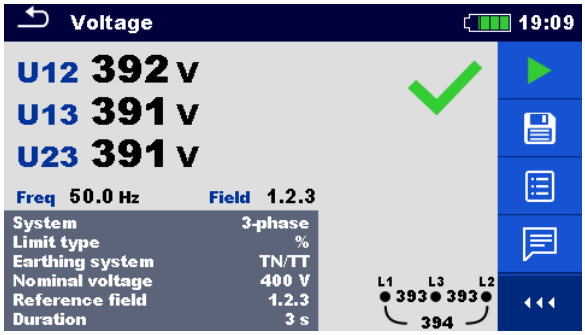


Figure 7.5: Example of Voltage measurement results in three-phase system

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 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)]	3-phase rotation sequence

[1)] For Pass test result, Field result must be equal to setting of Reference field parameter (1.2.3 or 3.2.1).

7.2 R iso – Insulation resistance

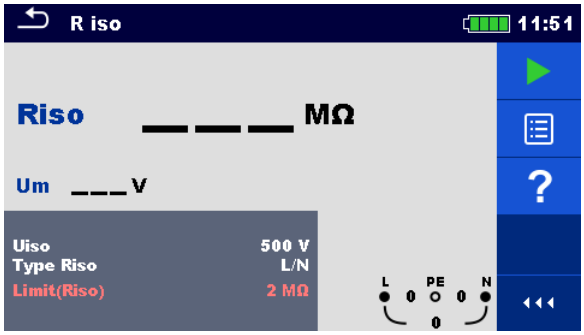


Figure 7.6: Insulation resistance measurement menu

Measurement parameters / limits

Uiso	Nominal test voltage [50 V, 100 V, 250 V, 500 V, 1000 V, 2500 V]
Type Riso[1)]	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, Custom, 0.01 MΩ ... 100 MΩ]

[1)] Insulation measurement depends on Type Riso parameter setting, see table below.

Type Riso parameter	3-wire test lead and Tip commander measuring terminals ($U_N \leq 1$ kV)	2.5 kV test lead measuring terminals (U_N =2.5 kV)
- L-N Lx-N L/L Lx-Ly	L and N	HV+ and HV-
L-PE	L and PE	

Lx-PE	
N-PE	N and PE

Table 7.1: Insulation resistance measuring terminals and Type Riso parameter dependency

Connection diagrams

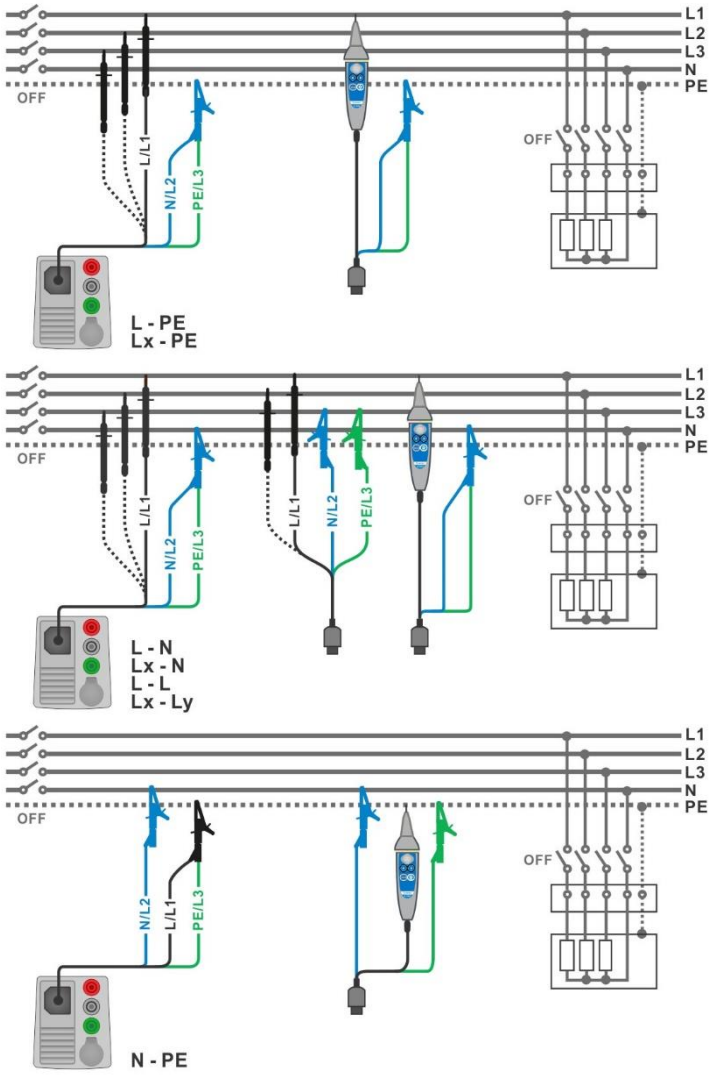


Figure 7.7: Connections of 3-wire test lead and Tip commander ($U_N \leq 1$ kV)

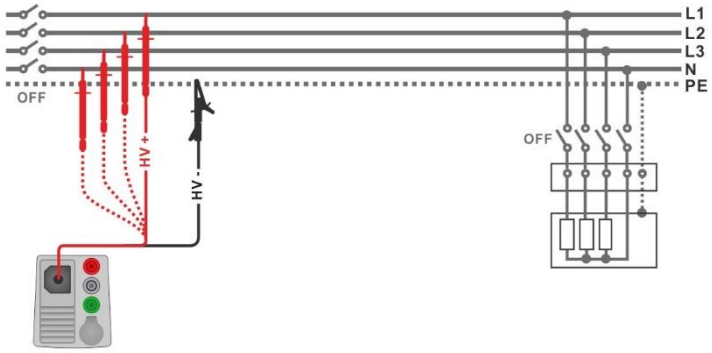


Figure 7.8: Connection of 2.5 kV test lead (U_N =2.5 kV)

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  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).

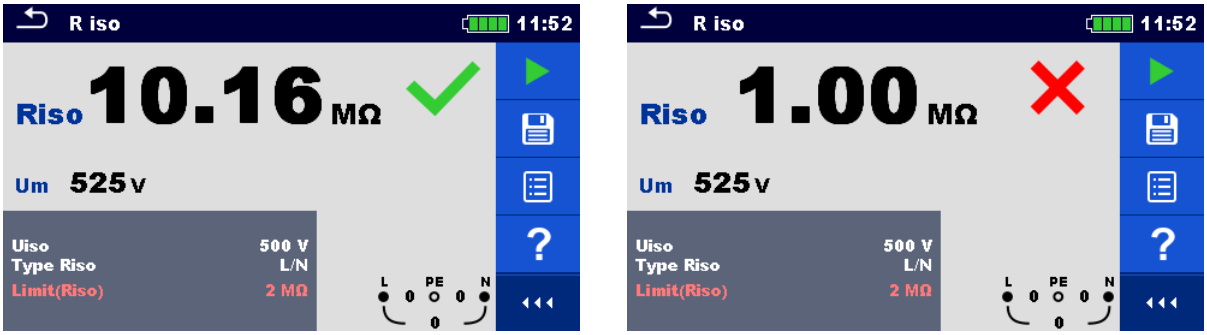


Figure 7.9: Examples of Insulation resistance measurement result

Measurement results / sub-results

Riso	Insulation resistance
Um	Actual test voltage

7.2.1 Load pretest

High Insulation voltage can potentially damage the connected appliances during the Insulation measurement. This misuse can be prevented by enabling Load pretest functionality in Settings menu. Load pretest measures the impedance on test terminals with low and safe a.c. voltage. If impedance lower than 50 kΩ is detected, warning message is displayed, allowing to disconnect the appliances before test voltage is applied (see *Figure 7.10*). Insulation measuring voltage is applied to the test terminals only after YES is selected. NO will abort the measurement.
If impedance higher than 50 kΩ is measured during the Load pretest, Insulation test will follow automatically.

Test function	Type Riso parameter	Load pretest terminals 3-wire test lead and Tip commander measuring terminals ($U_N \leq 1$ kV)	Load pretest terminals 2.5 kV test lead measuring terminals (U_N =2.5 kV)
Riso	- L/N Lx/N L/L Lx/Ly	L-N	×
	L/PE Lx/PE	L-PE	×
	N/PE	N-PE	×
Riso - all		L-N, L-PE, N-PE	×

×. .....not applicable

Table 7.2: Insulation resistance measuring terminals and Load pretest dependency

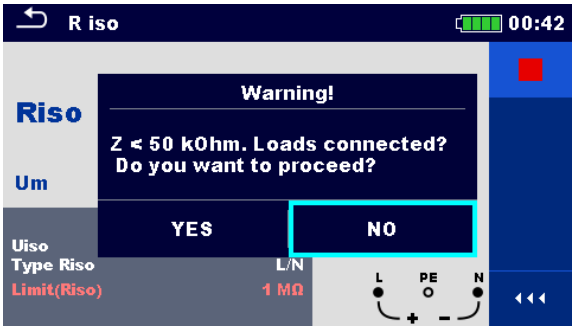


Figure 7.10: Load pretest warning message

7.3 R iso all – Insulation resistance

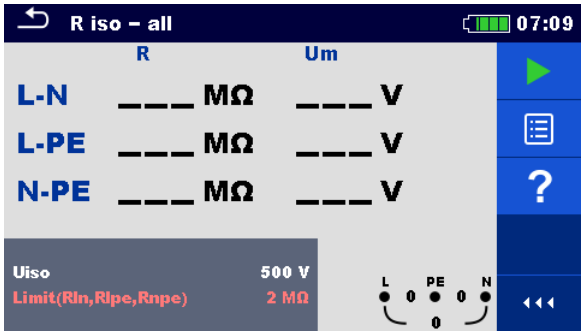


Figure 7.11: R iso - all measurement menu

Measurement parameters / limits

Uiso	Nominal test voltage [50 V, 100 V, 250 V, 500 V, 1000 V]
Limit	Min. insulation resistance [Off, Custom, 0.01 MΩ ... 100 MΩ]

Insulation is always measured between all three test leads.

Connection diagrams

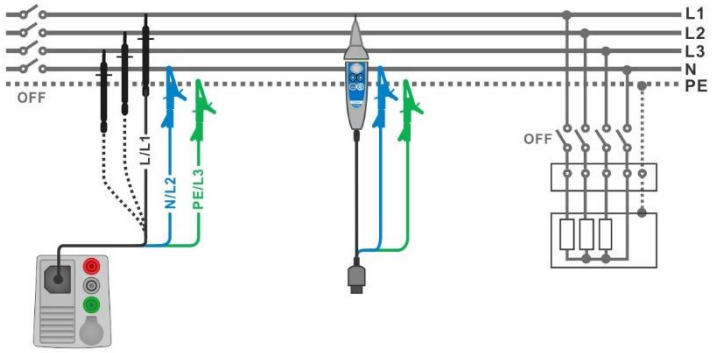


Figure 7.12: Connection of 3-wire test lead and Tip commander

Measurement procedure

- Enter the R iso - all 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 7.12*).
  The standard 3-wire test lead, Schuko test cable or Plug / Tip commanders can be used.
- Start the measurement.
- Wait until object under test is fully discharged.
- Save results (optional).

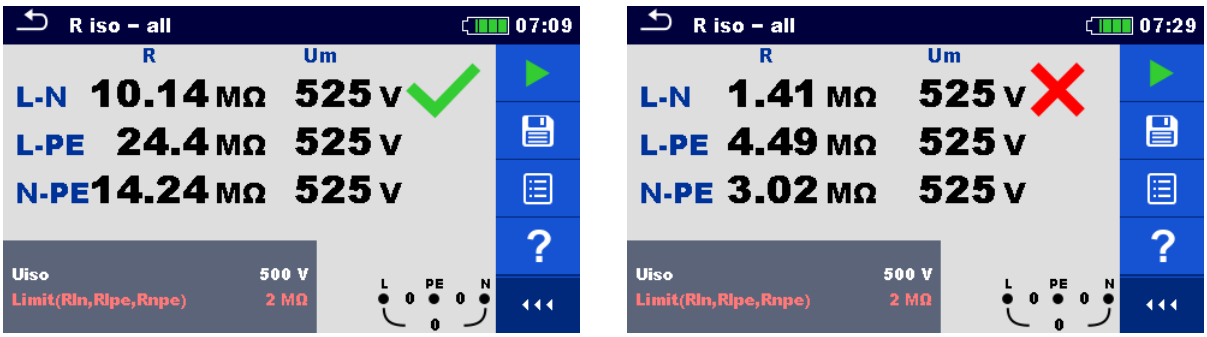


Figure 7.13: Examples of R iso - all measurement result

Measurement results / sub-results

Riso	L-N	Insulation resistance between L and N terminals
	L-PE	Insulation resistance between L and PE terminals
	N-PE	Insulation resistance between N and PE terminals
Um	L-N	Actual test voltage between L and N terminals
	L-PE	Actual test voltage between L and PE terminals
	N-PE	Actual test voltage between N and PE terminals

7.4 The DAR and PI diagnostic

DAR (Dielectric Absorption Ratio) 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 (Polarization Index) 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.

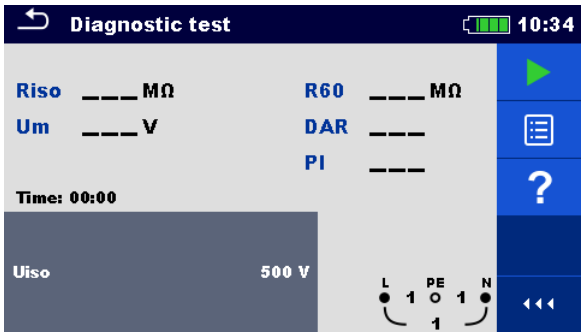


Figure 7.14: Diagnostic test menu

Measurement parameters / limits

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

Connection diagrams

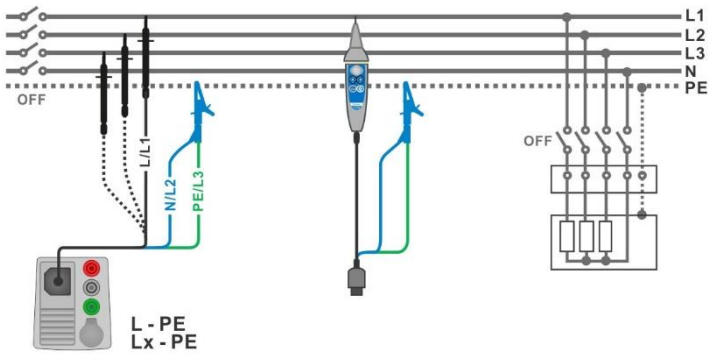


Figure 7.15: Connection of 3-wire test lead and Tip commander ($U_N \leq 1$ kV)

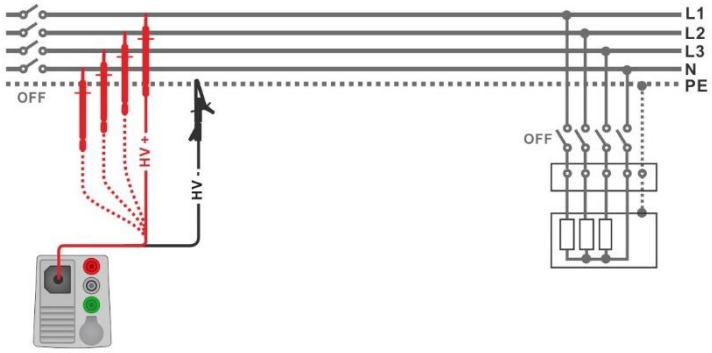


Figure 7.16: Connection of 2.5 kV test lead (U_N = 2.5 kV)

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 7.15* and *Figure 7.16*).
  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 diagnostic test with nominal test voltages ≤ 1000 V. For the 2500 V diagnostic 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).

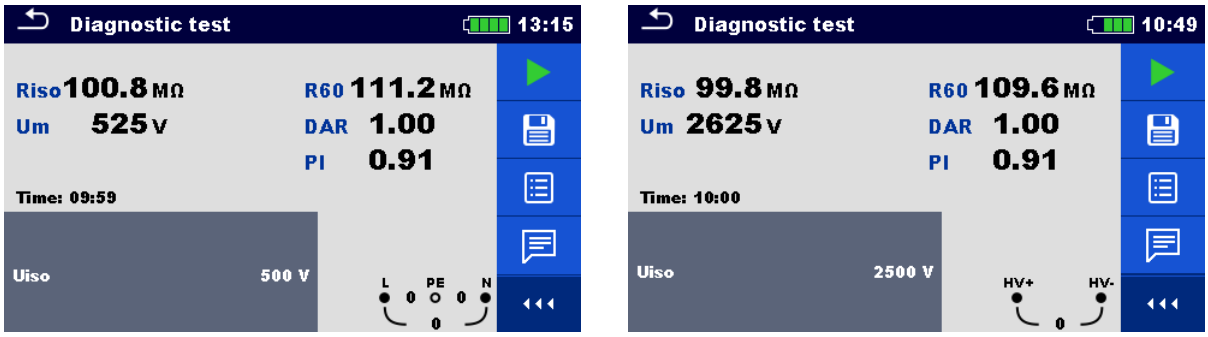


Figure 7.17: Examples of Diagnostic test result

Measurement results / sub-results

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

7.5 Varistor test

Measuring principle

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.

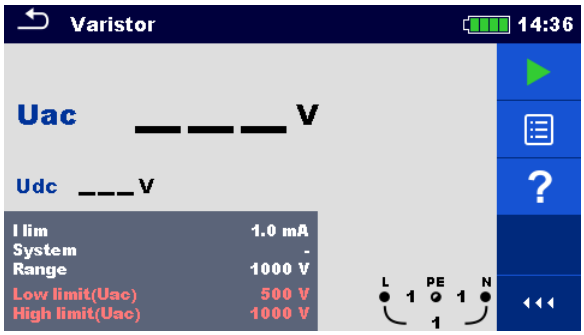


Figure 7.18: Varistor test main menu

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]

Test circuit for Varistor test

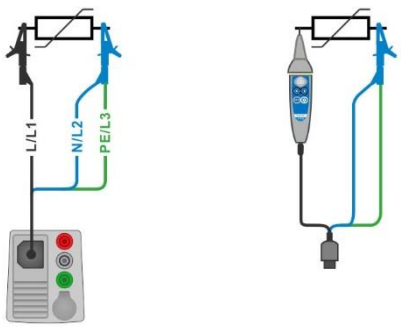


Figure 7.19: Connection of 3-wire test lead and Tip commander (Range: 1000 V)

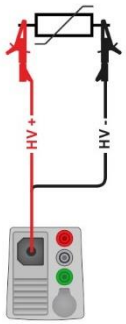


Figure 7.20: Connection of 2.5 kV test lead (Range: 2500 V)

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 7.19* and *Figure 7.20*).
  Different test cable must be used if testing at Range: 1000 V or 2500 V. Also, different test terminals are used.
  The standard 3-wire test lead, or Tip commander can be used for the Varistor test when testing at Range: 1000 V. If Range: 2500 V is selected, the two-wire 2.5 kV test lead should be used for the Varistor test.
- Start the measurement.
  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).

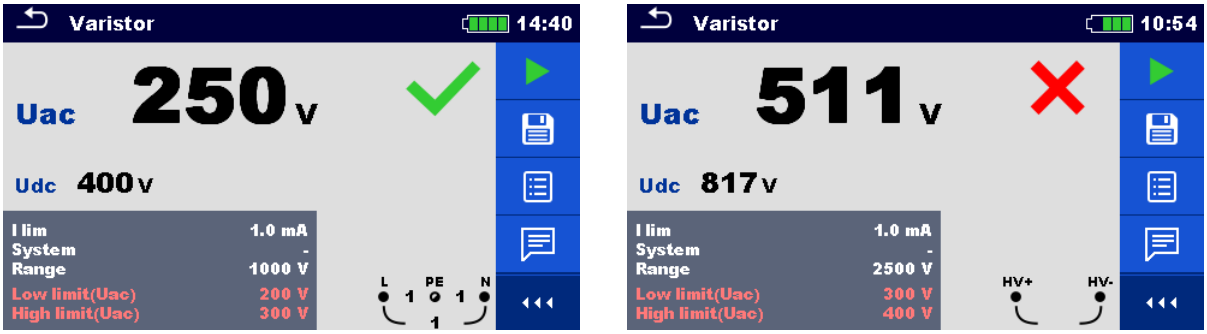


Figure 7.21: Examples of Varistor test result

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.

7.6 R low – Resistance of earth connection and equipotential bonding

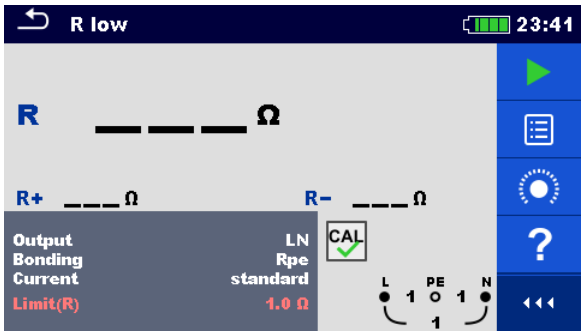


Figure 7.22: R low measurement menu

Measurement parameters / limits

Output[1)]	[LPE, LN]
Bonding	[Rpe, Local]
Current	[standard, ramp]
Limit(R)	Max. resistance [Off, Custom, 0.1 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

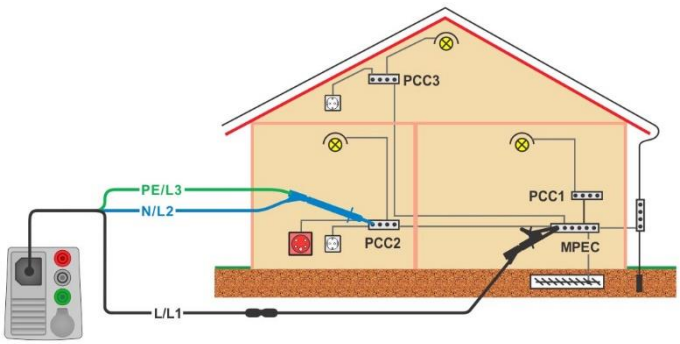


Figure 7.23: Connection of 3-wire test lead plus optional Extension lead

Measurement procedure

- Enter the R low function.
- Set test parameters / limits.
- Connect 3-wire test lead to the instrument.
- Compensate the test leads resistance, if necessary, see section *7.8.1 Compensation of test leads resistance.*
- Disconnect tested installation from mains supply and discharge insulation as required.
- Connect test leads, see *Figure 7.23.*
- Start the measurement.
- Save results (optional).

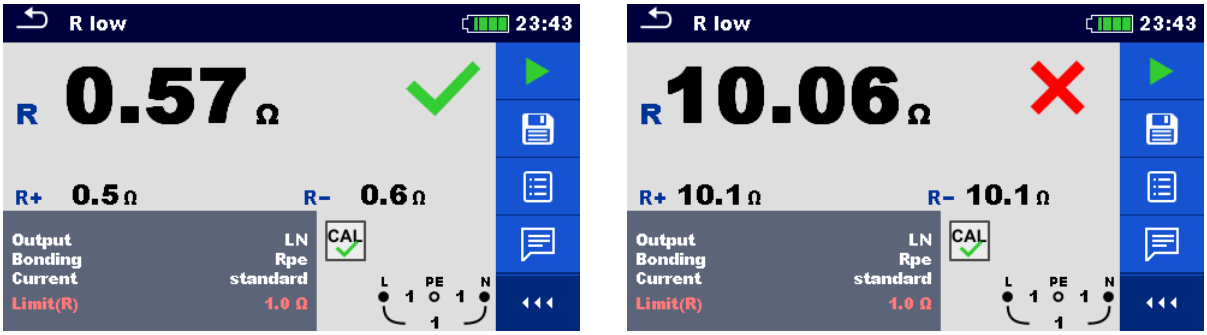


Figure 7.24: Examples of R low measurement result

Measurement results / sub-results

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

7.7 R low 4W

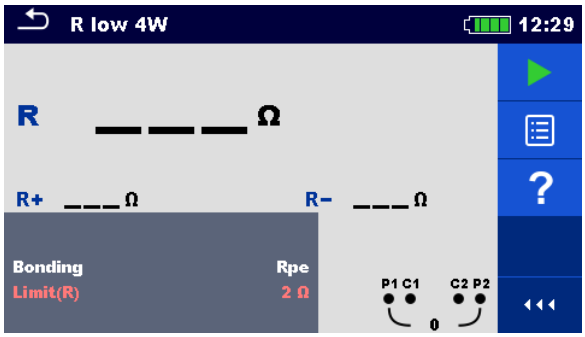


Figure 7.25: R low 4W measurement menu

Measurement parameters / limits

Bonding	[Rpe, Local]
Limit(R)	Max. resistance [Off, Custom, 0.05 Ω ... 20.0 Ω]

Connection diagram

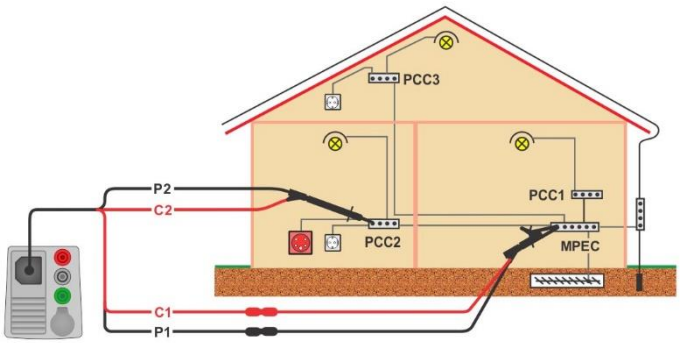


Figure 7.26: Connection of 4-wire test lead plus optional extension leads

Measurement procedure

- Enter the R low 4W function.
- Set test parameters / limits.
- Connect 4-wire test lead to the instrument.
- Disconnect tested installation from mains supply and discharge insulation as required.
- Connect test leads to device under test, see *Figure 7.26.* Use extension leads if necessary.
- Start the measurement.
- Save results (optional).

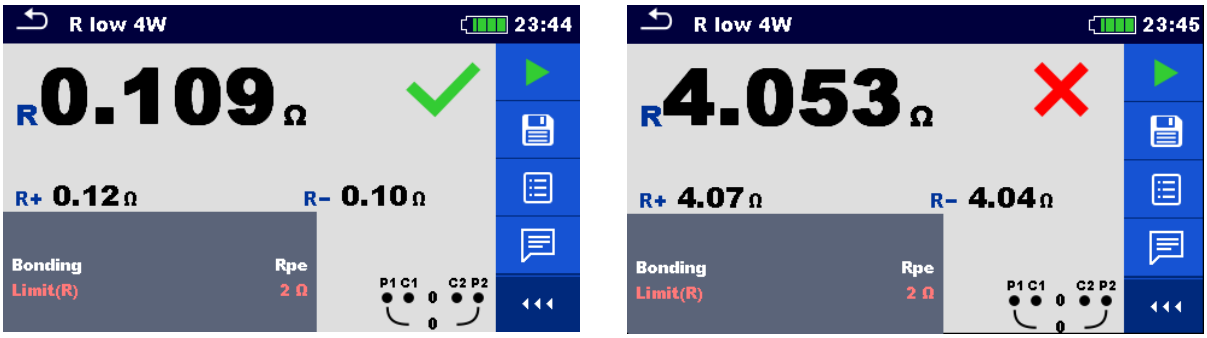


Figure 7.27: Examples of R low 4W result

Measurement results / sub-results

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

7.8 Continuity – Continuous resistance measurement with low current

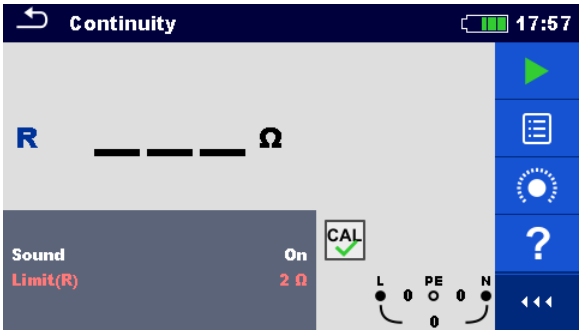


Figure 7.28: Continuity resistance measurement menu

Measurement parameters / limits

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

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

Connection diagrams

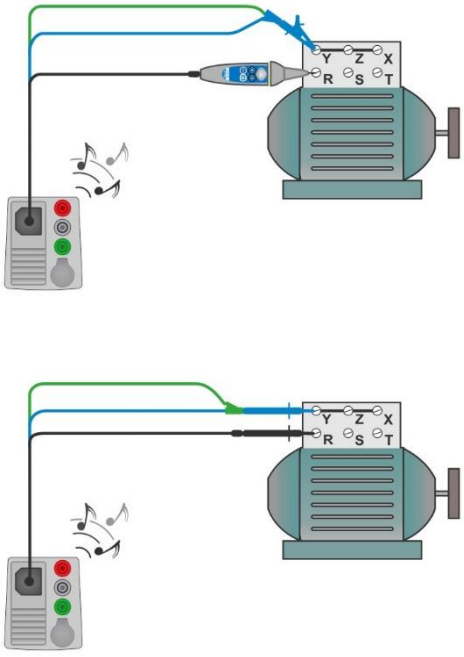


Figure 7.29: Tip commander and 3-wire test lead applications

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 *7.8.1 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 7.29.*
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

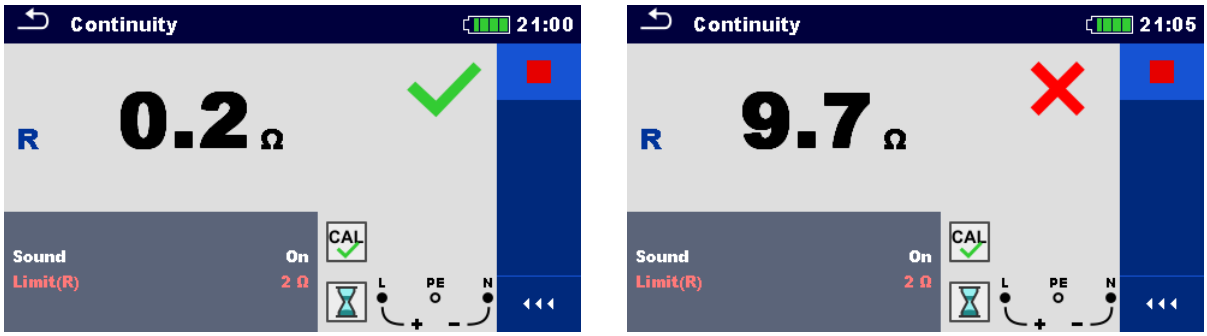


Figure 7.30: Examples of Continuity resistance measurement result

Measurement results / sub-results

R	Resistance

7.8.1 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.

CAL symbol is displayed if the compensation was carried out successfully.

Connections for compensating the resistance of test leads

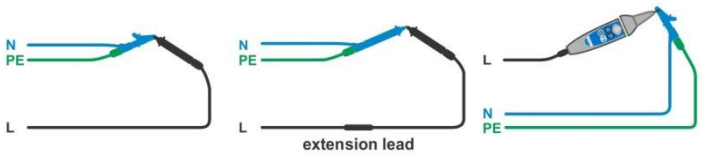


Figure 7.31: Shorted test leads

Compensation of test leads resistance procedure

- Enter R low or Continuity function.
- Connect test cable to the instrument and short all test leads together, see *Figure 7.31.*
- Touch the key to compensate leads resistance.

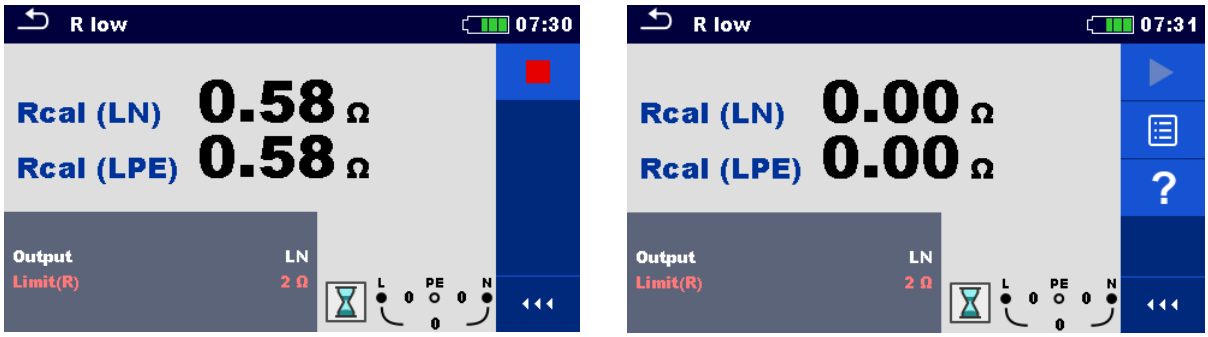


Figure 7.32: Result with old and new calibration values

7.9 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.

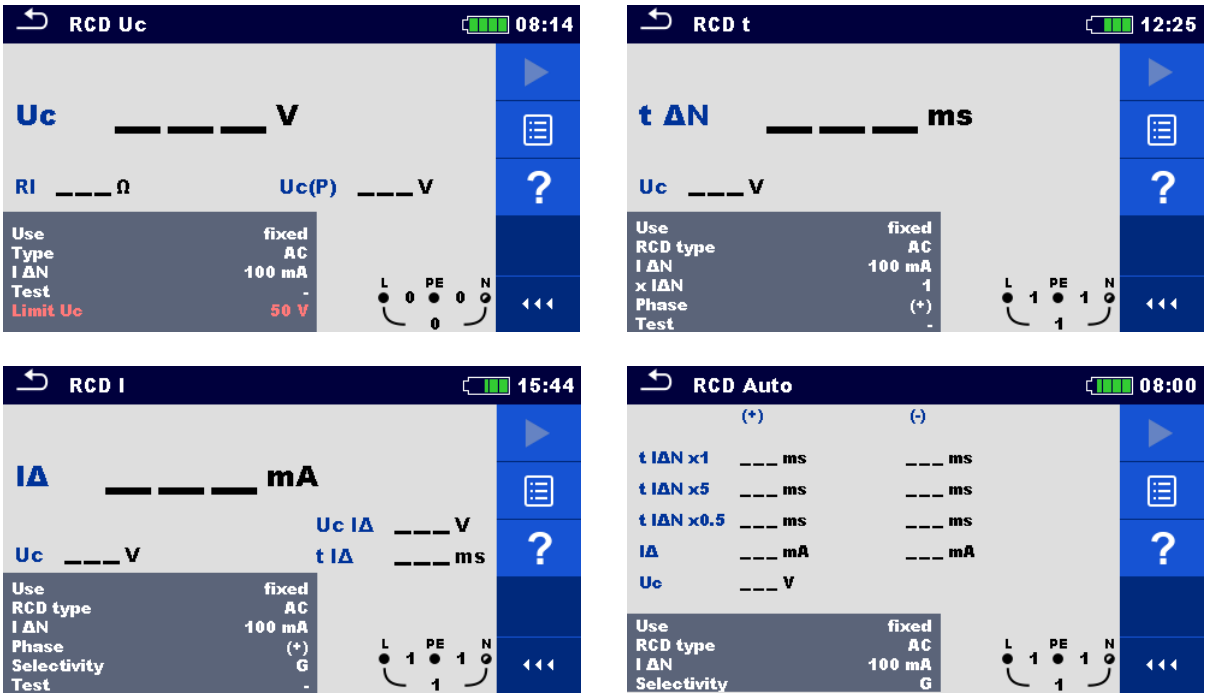


Figure 7.33: RCD menus

Test parameters / limits

I ΔN	Rated RCD residual current sensitivity [10 mA, 15 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., - / 6 mA d.c.] [1]
RCD type	RCD type [AC, A, F, B, B+, EV RCD[1], MI RCD[1], EV RCM[1]]
Use	RCD / PRCD selection [fixed, PRCD, PRCD-2p, PRCD-3p, PRCD-S, PRCD-S+, PRCD-K, other]
Selectivity	Characteristic [G, S]
x IΔN	Multiplication factor for test current [0.5, 1, 2, 5]
x IΔN d.c.	Multiplication factor for d.c. test current [0.5, 1, 10, 33.33, 50] [1]
Phase	Starting polarity [(+), (-), (+,-)]
Test	Test [-, L/PE, L1/PE, L2/PE, L3/PE]
Test	Test current shape [a.c., d.c.] [2]
Sensitivity	Sensitivity [standard, Ipe monitoring] [3]
Uc (P)	Contact voltage, external probe [On, Off]
Limit Uc	Conventional touch voltage limit [Custom, 12 V, 25 V, 50 V]
RCD Standard	Refer to chapter *4.6.8.2 RCD standard* for more information.
EV RCD/RCM Standard	Refer to chapter *4.6.8.3 EV RCD/RCM standards* for more information.
Earthing system	Refer to chapter *4.6.8 Settings* for more information.

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

[2] Parameter is available only when RCD I or RCD t test is selected and parameter Use is set to 'other'.

[3] Parameter is available only when parameter 'Use' is set to PRCD, PRCD-3p, PRCD-S+ or PRCD-K.

Connection diagrams

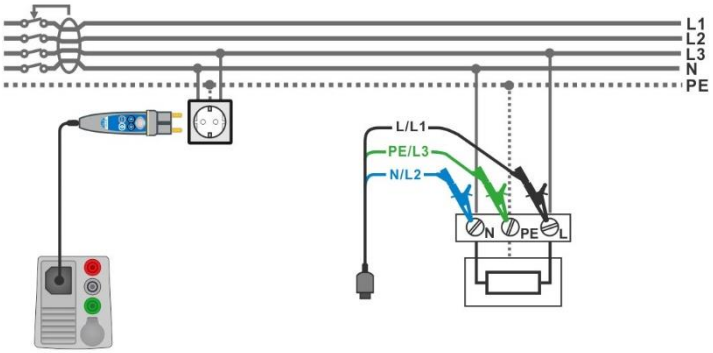


Figure 7.34: Connecting the Plug commander and the 3-wire test lead

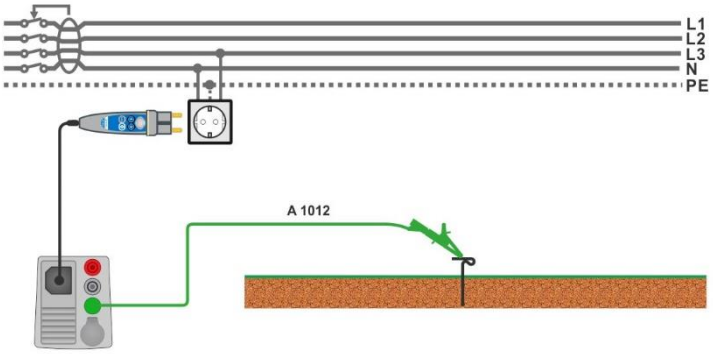


Figure 7.35: Connection for Uc(P) measurement

7.9.1 RCD Uc – Contact voltage

Measuring current up to $\frac{1}{3}$ of nominal residual current is used for measurement of contact voltage.

Contact voltage measurement is performed before trip-out time/current tests. If limit voltage (e.g. 50 V) is reached during this pre-test, trip-out test is aborted for safety reason.

7.9.1.1 RCD Uc(P) – Contact voltage with external probe

Contact voltage measurement can also be performed using external test probe. Place external probe to reference earth potential.
For connection see *Figure 7.35 Connection for Uc(P) measurement*.
Before the contact voltage measurement make sure that Uc(P) parameter is set to On.

Test procedure

- Enter the RCD Uc function.
- Set test parameters / limits.
- Connect test cables to the instrument.
- Connect L, N and PE of 3-wire test lead or Plug commander to the object under test, see *Figure 7.34*.
- Connect test lead to P/S terminal and external earthed point (optional, see *Figure 7.35*).
- Start the measurement.
- Save results (optional).

The contact voltage results Uc and Uc(P) relate to the rated nominal residual current of the RCD and are 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 7.3* for detailed contact voltage calculation factors.

RCD type		Contact voltages Uc and Uc(P) proportional to	Rated $I_{\Delta N}$
AC, EV, MI (a.c. part)	G	$1.05\times I_{\Delta N}$	any
AC	S	$2\times1.05\times I_{\Delta N}$	
A, F	G	$1.4\times1.05\times I_{\Delta N}$	≥ 30 mA
A, F	S	$2\times1.4\times1.05\times I_{\Delta N}$	
A, F	G	$2\times1.05\times I_{\Delta N}$	< 30 mA
A, F	S	$2\times2\times1.05\times I_{\Delta N}$	
B, B+	G	$2\times1.05\times I_{\Delta N}$	any
B, B+	S	$2\times2\times1.05\times I_{\Delta N}$	

Table 7.3: Relation between Uc, Uc(P) and $I_{\Delta N}$

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

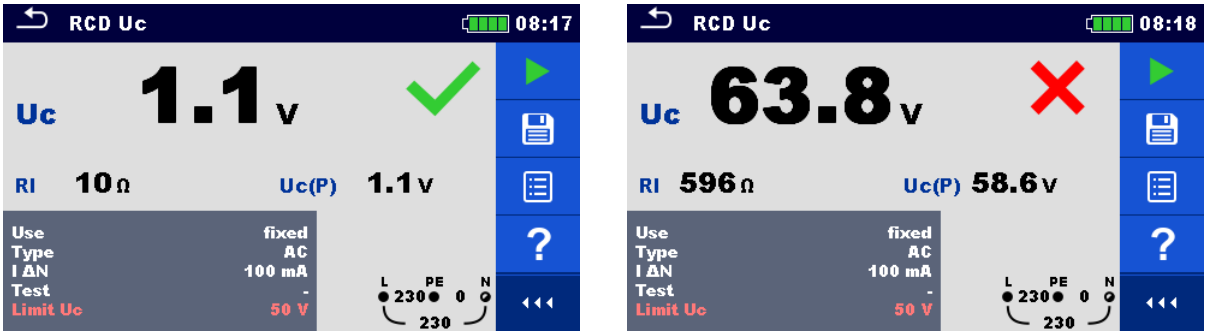


Figure 7.36: Examples of Contact voltage measurement result

Test result / sub-results

Uc	Contact voltage
Uc(P) – if selected	Contact voltage, external probe
RI	Fault loop resistance

7.9.2 RCD t – Trip-out time

Test procedure

- Enter the RCD t function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.34*.
- Start the measurement.
- Save results (optional).

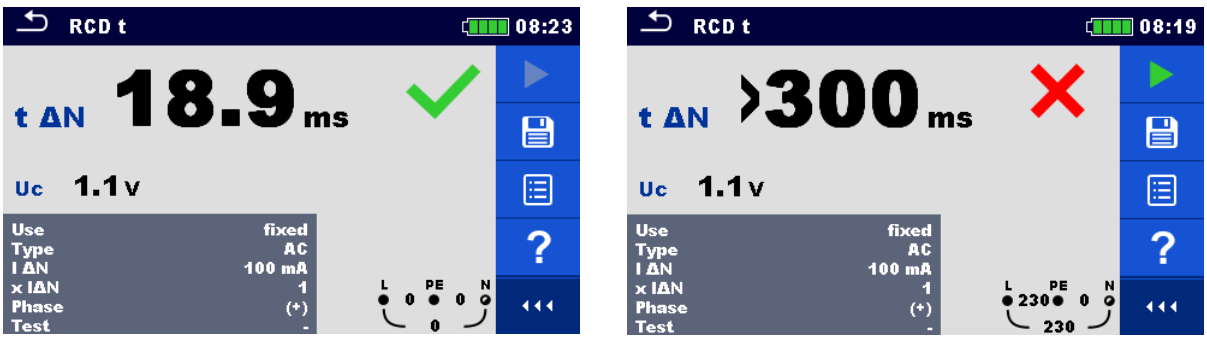


Figure 7.37: Examples of Trip-out time measurement result

Test results / sub-results

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

7.9.3 RCD I – Trip-out current

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

RCD type	Slope range		Waveform
	Start value	End value	
AC	0.2×$I_{\Delta N}$	1.1×$I_{\Delta N}$	Sine
IEC 62752: EV RCD, EV RCM, MI RCD (a.c. part)	0.2×$I_{\Delta N}$	1.0×$I_{\Delta N}$	Sine
IEC 62955: EV RCD, EV RCM, MI RCD (a.c. part)	0.2×$I_{\Delta N}$	1.0×$I_{\Delta N}$	Sine
A, F ($I_{\Delta N}$≥ 30 mA)	0.2×$I_{\Delta N}$	1.5×$I_{\Delta N}$	Pulsed
A, F ($I_{\Delta N}$ = 10 mA)	0.2×$I_{\Delta N}$	2.2×$I_{\Delta N}$	
B, B+	0.2×$I_{\Delta N}$	2.2×$I_{\Delta N}$	DC
IEC 62752: EV RCD, EV RCM, MI RCD (d.c. part)	1.2 mA	6.0 mA	DC
IEC 62955: EV RCD, EV RCM, MI RCD (d.c. part)	1.2 mA	6.0 mA	DC

Table 7.4: Relation 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 3-wire test lead or Plug commander to the object under test, see *Figure 7.34.*
- Start the measurement.
- Save results (optional).

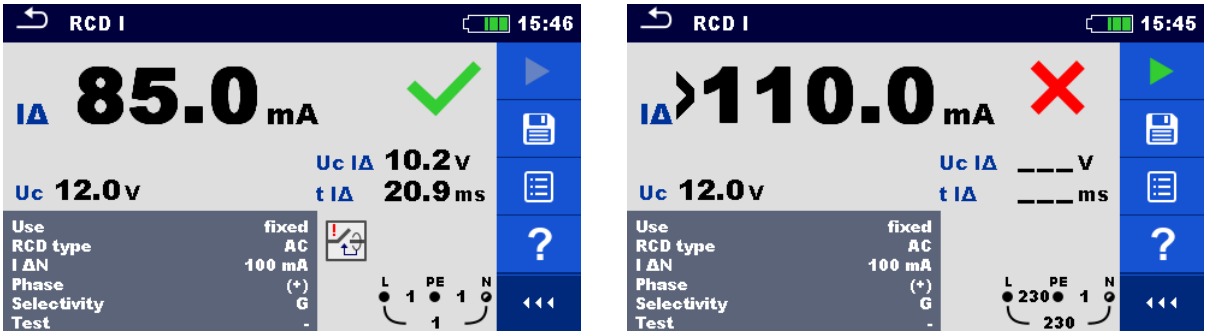


Figure 7.38: Examples of Trip-out current measurement result

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

7.10 **RCD Auto – RCD Auto test**

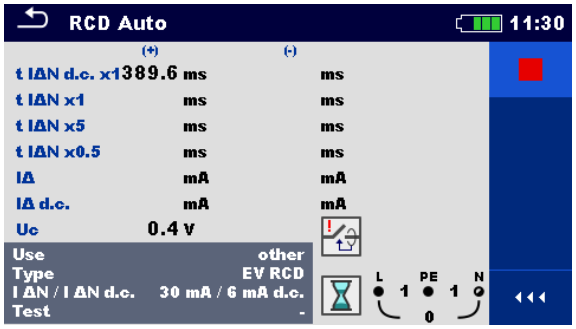
RCD Auto test function performs a complete RCD test (trip-out time at different residual currents, trip-out current and contact voltage) in one set of automatic tests, guided by the instrument.

RCD Auto test procedure

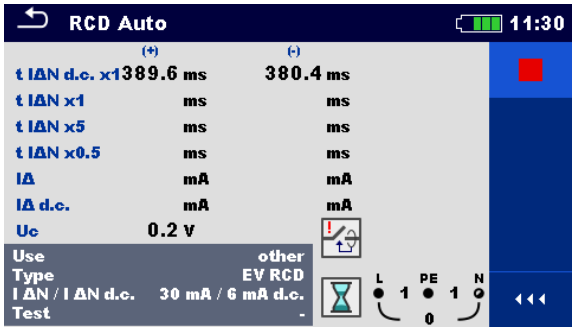
RCD Auto test steps	Notes
‣ Enter the RCD Auto function. ‣ Set test parameters / limits. ‣ Connect test cable to the instrument. ‣ Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.34* ‣ Start the measurement.	Start of test
Test with $I_{\Delta N}$ d.c., (+) positive polarity (step 1) [1].	RCD should trip-out
‣ Re-activate RCD. Test with $I_{\Delta N}$ d.c., (-) negative polarity (step 2) [1].	RCD should trip-out
‣ Re-activate RCD.	
Test with $I_{\Delta N}$, (+) positive polarity (step 3) [2].	RCD should trip-out RCD should not trip-out during non-operating time for a.c. residual current (IEC 62955).
‣ Re-activate RCD if required. Test with $I_{\Delta N}$, (-) negative polarity (step 4) [2].	RCD should trip-out RCD should not trip-out during non-operating time for a.c. residual current (IEC 62955).
‣ Re-activate RCD if required. Test with $5\times I_{\Delta N}$, (+) positive polarity (step 5) [2].	RCD should trip-out
‣ Re-activate RCD. Test with $5\times I_{\Delta N}$, (-) negative polarity (step 6) [2].	RCD should trip-out
‣ Re-activate RCD. Test with $½\times I_{\Delta N}$, (+) positive polarity (step 7) [2]. Test with $½\times I_{\Delta N}$, (-) negative polarity (step 8) [2].	RCD should not trip-out RCD should not trip-out
Trip-out current test, (+) positive polarity (step 9) [2].	RCD should trip-out
‣ Re-activate RCD. Trip-out current test, (-) negative polarity (step 10) [2].	RCD should trip-out
‣ Re-activate RCD[1]. Trip-out current test for d.c. part, (+) polarity (step 11).	RCD should trip-out
‣ Re-activate RCD[1]. Trip-out current test for d.c. part, (-) polarity (step 12).	RCD should trip-out
‣ Re-activate RCD. Save results (optional).	End of test

[1] Steps 1, 2 11 and 12 are performed only when parameter Use is set to 'other' and parameter Type is set to 'EV RCD', 'EV RCM' or 'MI RCD'. Trip-out times are measured according to IEC 62752 or IEC 62955.

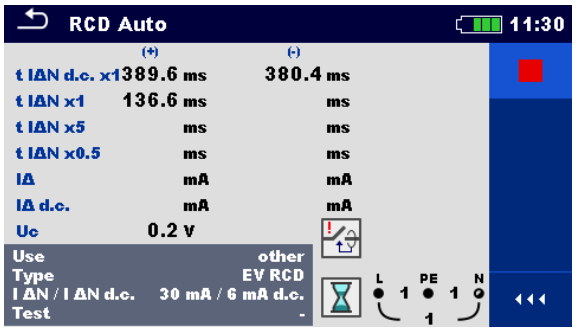
[2] When parameter Use is set to 'other' and parameter Type is set to 'EV RCD', 'EV RCD' or 'MI RCD', trip-out times or non-operating times for a.c. residual current are measured according to IEC 62752 or IEC 62955.



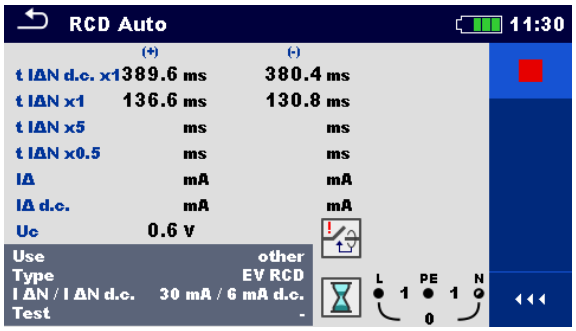
Step 1



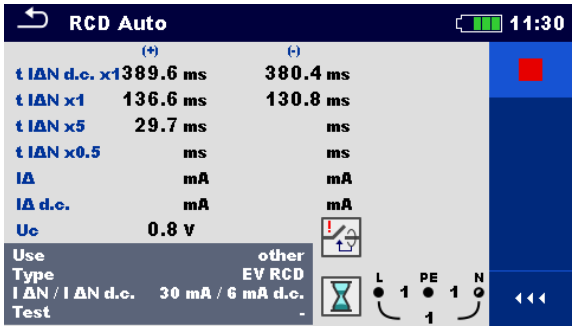
Step 2



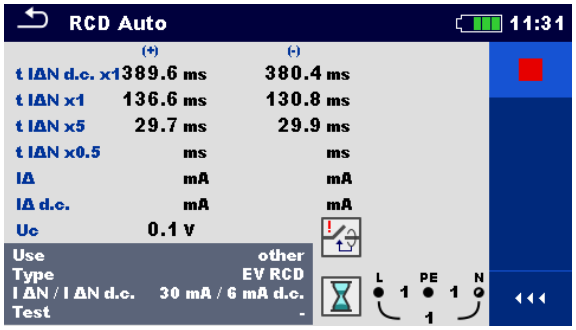
Step 3



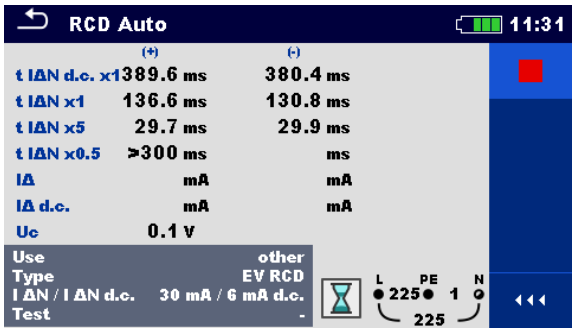
Step 4



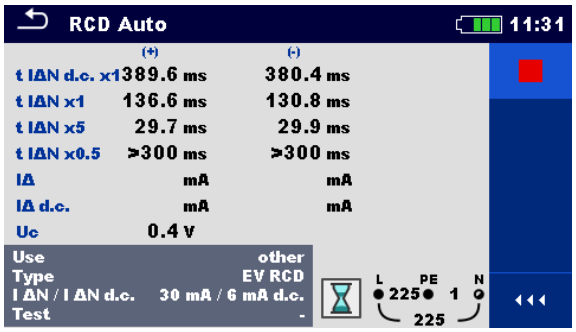
Step 5



Step 6



Step 7



Step 8

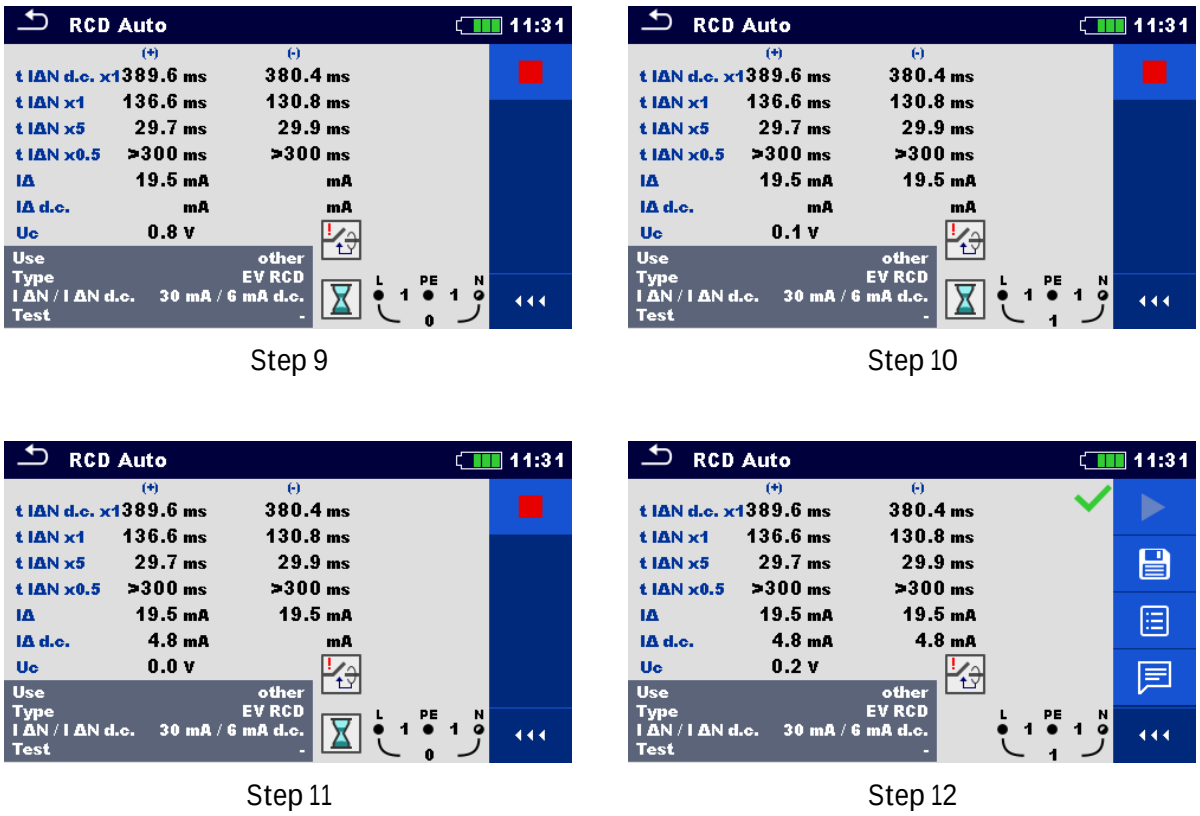


Figure 7.39: Individual steps in RCD Auto test, example on testing EV RCD

Test results / sub-results

t IΔN d.c. x1, (+) [1)]	Step 1 trip-out time (IΔ=IΔN d.c., (+) positive polarity)
t IΔN d.c. x1, (-) [1)]	Step 2 trip-out time (IΔ=IΔN d.c., (-) negative polarity)
t IΔN x1, (+)	Step 3 trip-out time ($I_Δ=I_{ΔN}$, (+) positive polarity) Non-operating time for a.c. current (IEC 62955).
t IΔN x1, (-)	Step 4 trip-out time ($I_Δ=I_{ΔN}$, (-) negative polarity) Non-operating time for a.c. current (IEC 62955).
t IΔN x5, (+)	Step 5 trip-out time ($I_Δ=5×I_{ΔN}$, (+) positive polarity)
t IΔN x5, (-)	Step 6 trip-out time ($I_Δ=5×I_{ΔN}$, (-) negative polarity)
t IΔN x0.5, (+)	Step 7 trip-out time ($I_Δ=½×I_{ΔN}$, (+) positive polarity)
t IΔN x0.5, (-)	Step 8 trip-out time ($I_Δ=½×I_{ΔN}$, (-) negative polarity)
IΔ (+)	Step 9 trip-out current ((+) positive polarity)
IΔ (-)	Step 10 trip-out current ((-) negative polarity)
IΔ d.c. (+)[1)]	Step 11 trip-out current ((+) positive polarity)
IΔ d,c, (-)[1)]	Step 12 trip-out current ((-) negative polarity)
Uc	Contact voltage for rated $I_{ΔN}$

[1)] Result is displayed only when parameter Use is set to 'other' and parameter Type to 'EV RCD', 'EV RCM' or 'MI RCD'.

7.11 Z loop – Fault loop impedance and prospective fault current

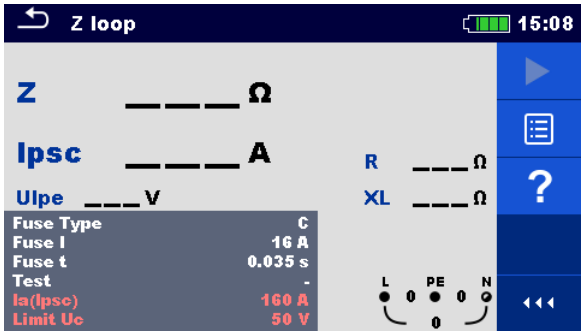


Figure 7.40: Z loop menu

Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I	Rated current of selected fuse
Fuse t	Maximum breaking time of selected fuse
Isc factor	Isc factor [Custom, 0.20 ... 3.00]
Test[1)]	Selection of test [-, L/PE, L1/PE, L2/PE, L3/PE]
Uc (P)	Contact voltage measurement with external probe [Off, On]
Earthing system	Refer to chapter *4.6.8 Settings* for more information.
Ia(Ipsc)	Minimum fault current for selected fuse or custom value
Limit Uc	Contact voltage Uc (P) limit [Custom, 12 V, 25 V, 50 V]

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 diagrams

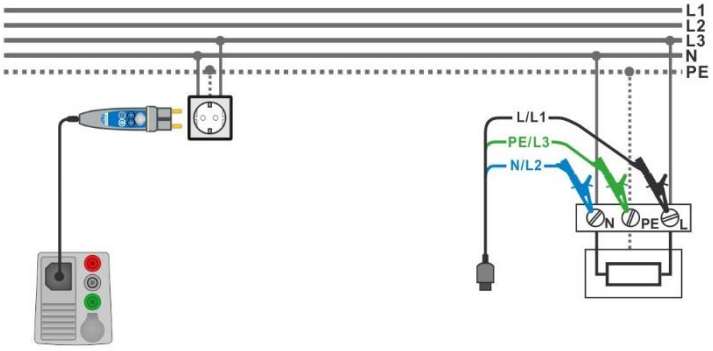


Figure 7.41: Connection of Plug commander and 3-wire test lead

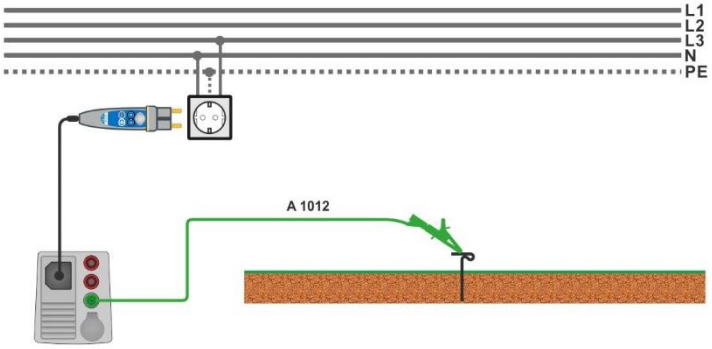


Figure 7.42: Connection for Uc(P) measurement

Measurement procedure

- Enter the Z loop function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.41.*
- Connect test lead P/S to external earthed point (optional), see *Figure 7.42*.
- Start the measurement.
- Save results (optional).

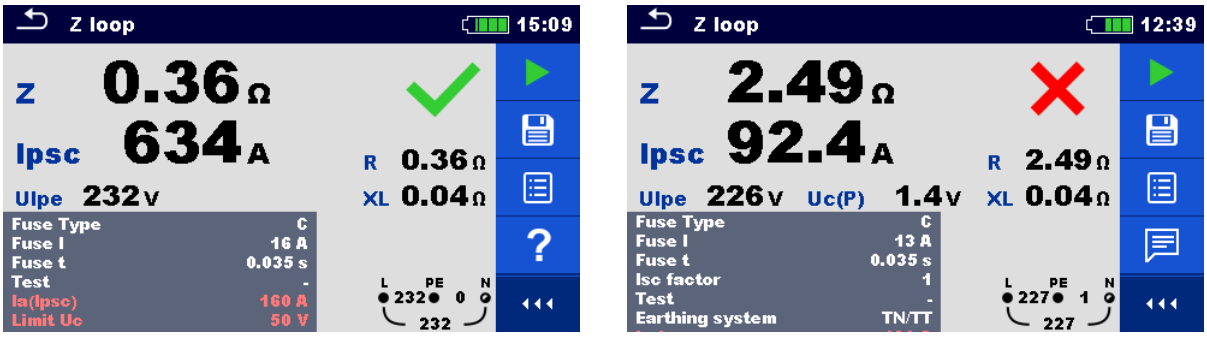


Figure 7.43: *Examples of Loop impedance measurement result*

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
Uc (P)	Contact voltage at prospective fault current (external probe)

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

$$I_{\mathrm{PSC}} = \frac{U_{\mathrm{n}} \cdot k_{\mathrm{sc}}}{Z}$$

where:
U_n ..... Nominal $U_{L\text{-}PE}$ voltage (see table below),
k_{sc} ..... Correction factor (Isc factor) for I_{PSC}. Refer to chapter *4.6.8 Settings* for more information.
Uc(P)..... Voltage between external earthed point and main earthing point (P/S and PE terminals), see calculation below

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

Table 7.5: Relation between Input voltage – $U_{L\text{-}PE}$ and nominal voltage – U_n used for calculation

Uc(P) calculation

$$U_C(P) = Z_{PE-P/S} \times I_{PSC}$$

7.12 Z loop 4W – Fault loop impedance and prospective fault current

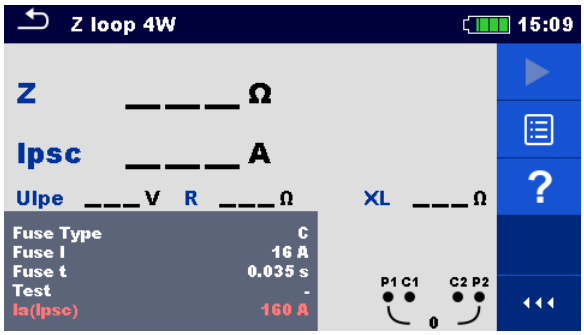


Figure 7.44: Z loop 4W menu

Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I	Rated current of selected fuse
Fuse t	Maximum breaking time of selected fuse
Isc factor	Isc factor [Custom, 0.20 ... 3.00]
Test	Selection of test [-, L-PE, L1-PE, L2-PE, L3-PE]
Ia (Ipsc)	Minimum short circuit current for selected fuse or custom value

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

Connection diagram

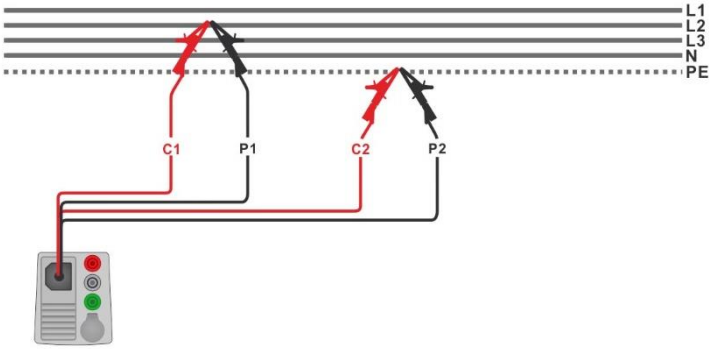


Figure 7.45: Connection of 4-wire test lead

Measurement procedure

- Enter the Z loop 4W function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 4-wire test lead to the object under test, C1, P1 terminals to phase and C2, P2 terminals to PE; see *Figure 7.45*.
- Start the measurement.
- Save results (optional).

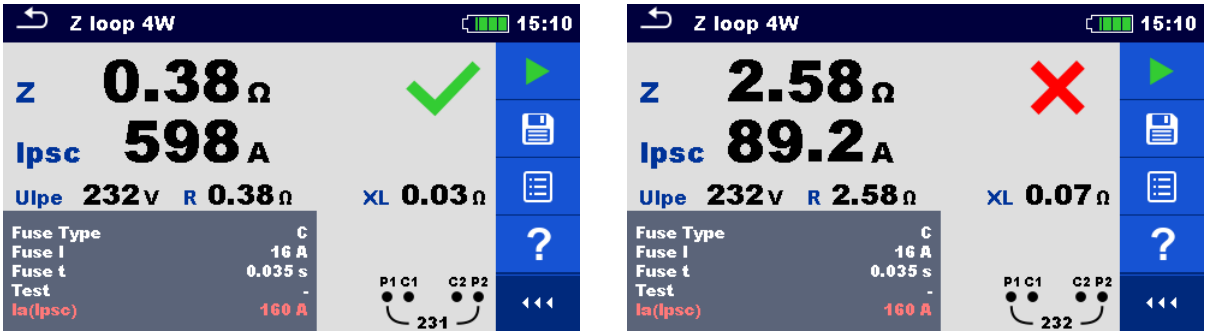


Figure 7.46: *Example of Z loop 4W measurement result*

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:

$$I_{PSC} = \frac{U_n \cdot k_{sc}}{Z}$$

where:
U_n ..... Nominal $U_{L\text{-}PE}$ voltage (see table below),
k_{sc} ..... Correction factor (Isc factor) for I_{PSC}. Refer to chapter *4.6.8 Settings* for more information.

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

Table 7.6: Relation between Input voltage – $U_{L\text{-}PE}$ and nominal voltage – U_n used for calculation

7.13 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.

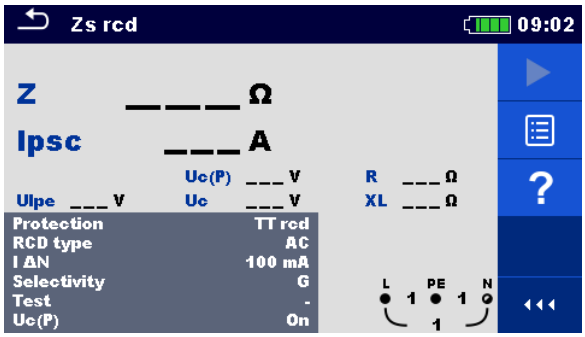


Figure 7.47: Zs rcd menu

Measurement parameters / limits

Protection	Protection type [TN, TTrcd]
Fuse Type[1)]	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I[1)]	Rated current of selected fuse
Fuse t[1)]	Maximum breaking time of selected fuse
Ia(Ipsc)[1)]	Minimum fault current for selected fuse or custom value
Isc factor	Isc factor [Custom, 0.20 ... 3.00]
Test [3)]	Selection of test [-, L-PE, L1-PE, L2-PE, L3-PE]
I ΔN [2)]	Rated RCD residual current sensitivity [10 mA, 15 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]
RCD type[2)]	RCD type [AC, A, F, B, B+]
Selectivity[2)]	Characteristic [G, S]
Uc (P)	Contact voltage measurement with external probe [On, Off]
I test	Test current [Standard, Low]
Limit Uc[2)]	Contact voltage limit [Custom, 12 V, 25 V, 50 V]

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.

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

Connection diagrams

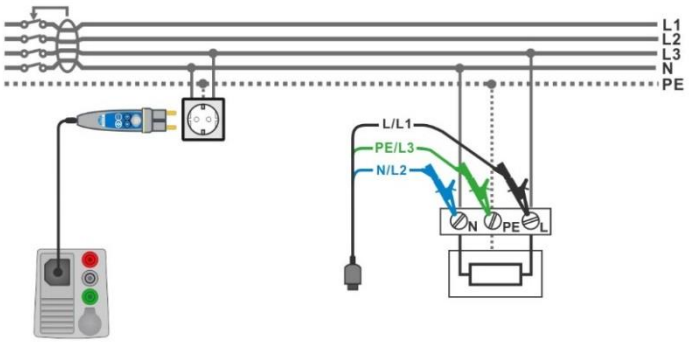


Figure 7.48: Connection of Plug commander and 3-wire test lead

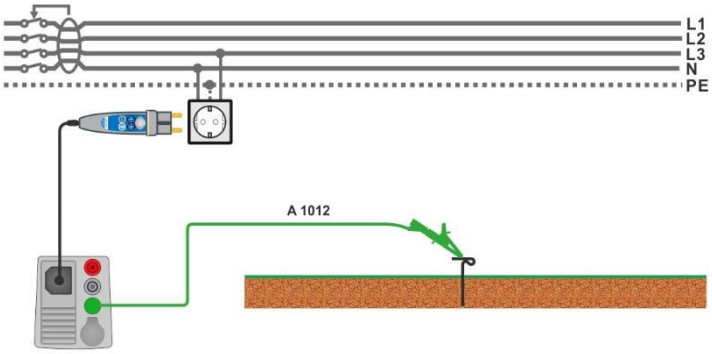


Figure 7.49: Connection for Uc(P) measurement

Measurement procedure

- Enter the Zs rcd function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.48.*
- Connect test lead P/S to external earthed point (optional), see *Figure 7.49.*
- Start the measurement.
- Save results (optional).

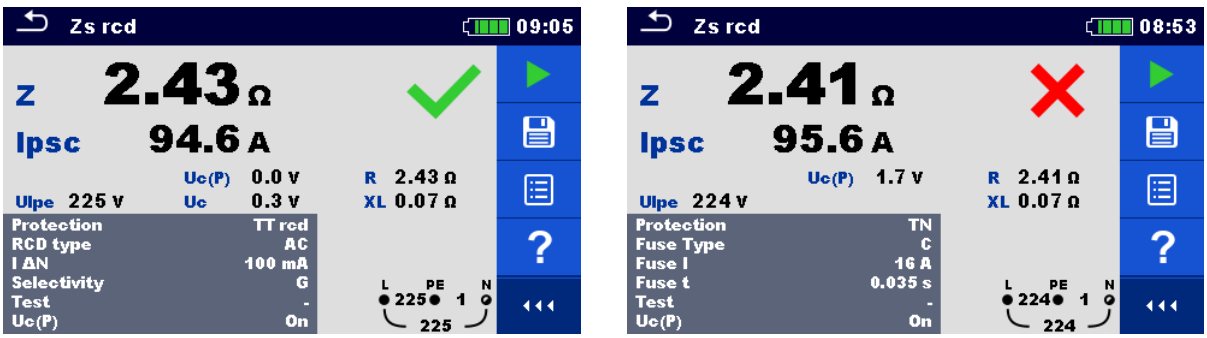


Figure 7.50: Examples of Zs rcd measurement result

Measurement results / sub-results

Z	Loop impedance
Ipsc	Prospective fault current
Ulpe	Voltage L-PE
Uc [1)]	Contact voltage at nominal residual current
Uc (P)	Contact voltage at prospective fault current (external probe) [2)] Contact voltage at nominal residual current (external probe) [3)]
R	Resistance of loop impedance
XL	Reactance of loop impedance

1) Result is presented only if Protection is set to TTrcd.
2) Protection type parameter set to TN.
3) Protection type parameter set to TTrcd.

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

$$I_{\mathrm{PSC}} = \frac{U_{\mathrm{n}} \cdot k_{\mathrm{sc}}}{Z}$$

where:
U_{n} ..... Nominal $U_{L\text{-}PE}$ voltage (see table below),
k_{sc} ..... Correction factor (Isc factor) for I_{PSC}. Refer to chapter *4.6.8 Settings* for more information.
Uc(P)..... Voltage between external earthed point and main earthing point (P and PE terminals), see calculation below

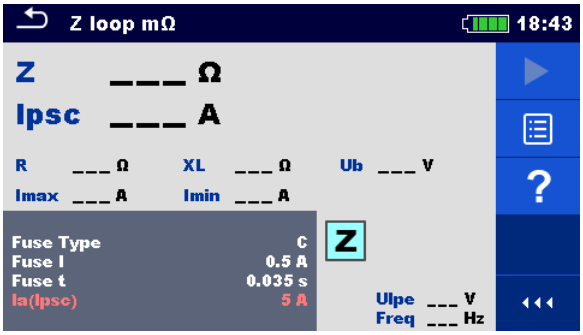
Un	Input voltage range (L-PE)
110 V	(93 V ≤ $U_{L\text{-}PE}$ ≤ 134 V)
230 V	(185 V ≤ $U_{L\text{-}PE}$ ≤ 266 V)

Table 7.7: Relation between Input voltage – $U_{L\text{-}PE}$ and nominal voltage – U_n used for calculation

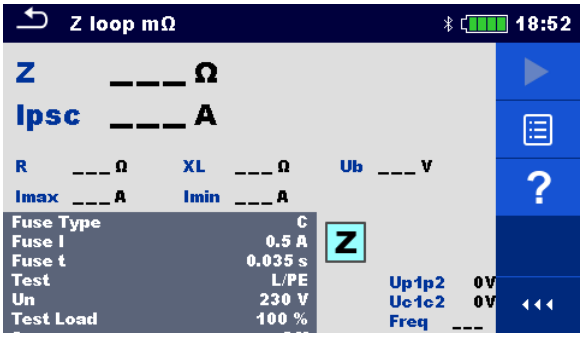
Uc(P) calculation

$$U_{\mathrm{C}}(\mathrm{P}) = \begin{cases} Z_{\mathrm{PE-P/S}} \times I_{\Delta \mathrm{N}}, & \text{Protection} = \text{TTrcd} \\ Z_{\mathrm{PE-P/S}} \times I_{\mathrm{PFC}}, & \text{Protection} = \text{TN} \end{cases}$$

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



A 1143



MI 3143 or MI 3144

Figure 7.51: Z loop mΩ menu

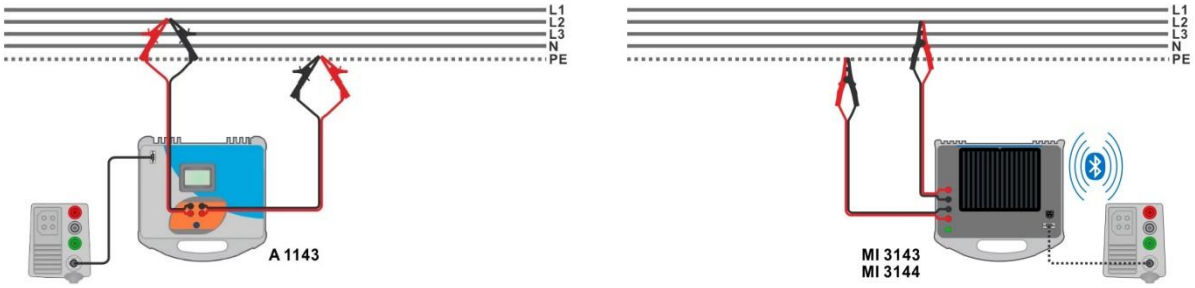
Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I	Rated current of selected fuse
Fuse t	Maximum breaking time of selected fuse
Ia(Ipsc)	Minimum fault current for selected fuse or custom value
Test[1)]	Test [-, L/PE, L1/PE, L2/PE, L3/PE]
Un[2)]	Nominal voltage [Custom, 110 V, 115 V, 127 V, 220 V, 230 V, 240 V, 290 V, 400 V, 460 V]
Tolerance[2)]	MI 3143 & MI 3144: Nominal voltage tolerance [6 %, 10 %]
Test Load[2)]	MI 3143: Test Load [33.3 %, 66.6 %, 100 %] MI 3144: Test Load [16.6 %, 33.3 %, 50.0 %, 66.6 %, 83.3 %, 100 %]
Average[2)]	MI 3143 & MI 3144: Average [Off, 2, 4, 6]
Isc factor[2)]	Isc factor [Custom, 0.2 ... 3]

1) The measurement doesn't depend on the setting. The parameter is meant for documentation.
2) Parameter is available only if MI 3143 or MI 3144 Euro Z instrument is selected.

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

Connection diagram



Connection of A 1143 Connection of MI 3143 and MI 3144

Figure 7.52: High precision loop impedance measurement

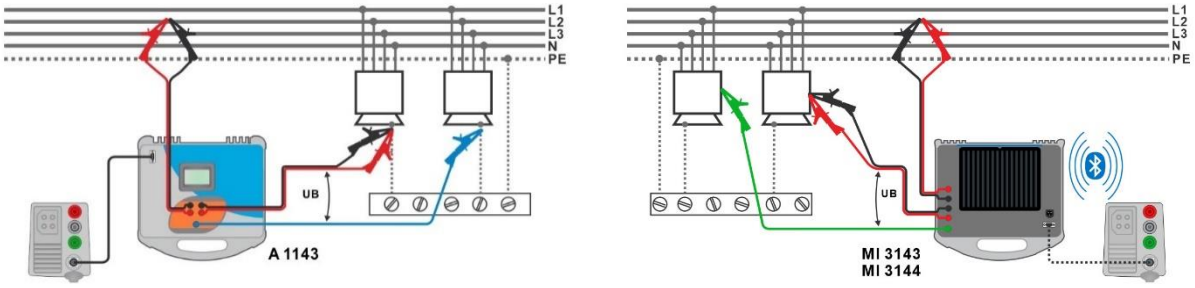
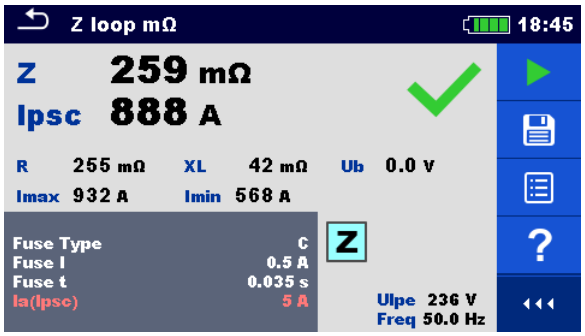


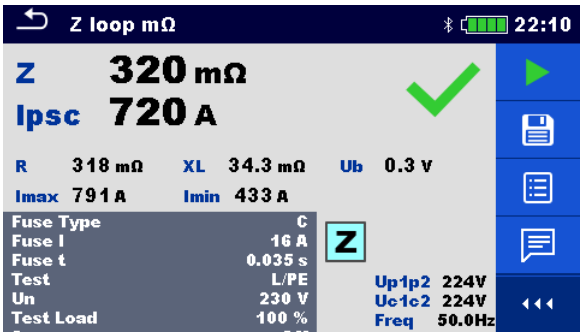
Figure 7.53: Contact voltage measurement

Measurement procedure

- Connect MI 3155 instrument with A 1143, MI 3143 or MI 3144 Euro Z adapter / instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the Z loop mΩ function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3143 or MI 3144 Euro Z instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads to A 1143, MI 3143 or MI 3144 Euro Z adapter / instrument.
- Connect test leads to the object under test, see *Figure 7.52* and *Figure 7.53.*
- Start the measurement using  or  button.
- Save results (optional).



Result screen using A 1143



Result screen using MI 3143 or MI 3144

Figure 7.54: 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

Voltage monitor using A 1143:

Ulpe	Voltage L-PE
Freq	Frequency

Voltage monitor using MI 3143 or MI 3144:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *A 1143 – Euro Z 290 A, MI 3143 – Euro Z 440 V* and *MI 3144 – Euro Z 800 V Instruction manuals* for detailed information.

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

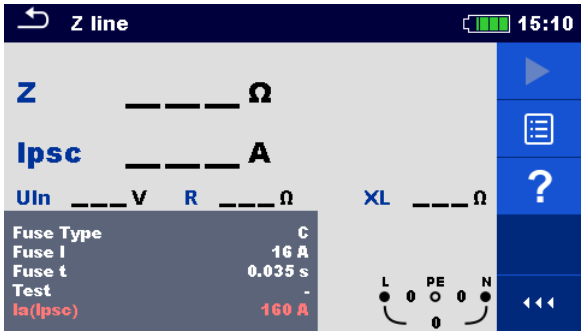


Figure 7.55: Z line measurement menu

Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I	Rated current of selected fuse
Fuse t	Maximum breaking time of selected fuse
Isc factor	Isc factor [Custom, 0.20 ... 3.00]
Test[1)]	Test [-, L/N, L/L, L1/N, L2/N, L3/N, L1/L2, L1/L3, L2/L3]
Earthing system	Refer to chapter *4.6.8 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

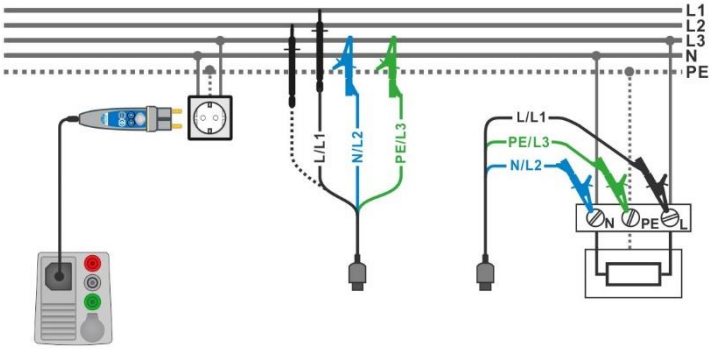


Figure 7.56: Phase-neutral or phase-phase line impedance measurement – connection of Plug commander and 3-wire test lead

Measurement procedure

- Enter the Z line function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.56.*
- Start the measurement.
- Save results (optional).

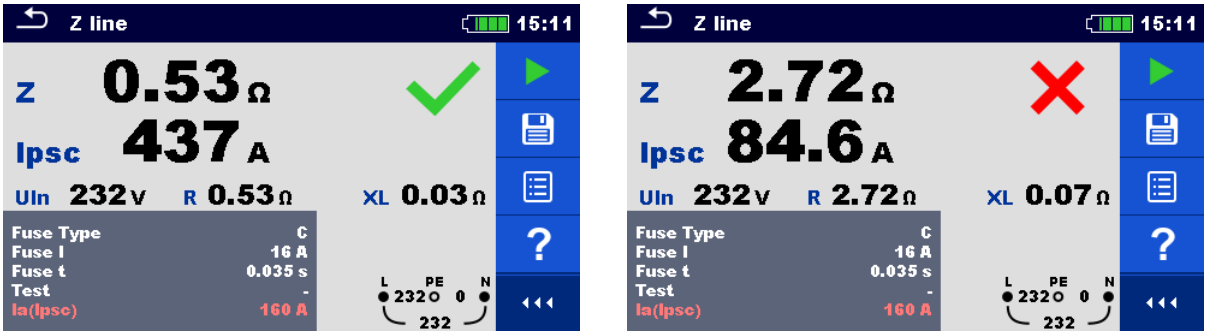


Figure 7.57: Examples of Line impedance measurement result

Measurement results / sub-results

Z	Line impedance
Ipsc	Prospective short-circuit current
Uln	Voltage measured between L and N 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:

$$I_{\mathrm{PSC}} = \frac{U_{\mathrm{n}} \cdot k_{\mathrm{sc}}}{Z}$$

where:
U_{n} ..... Nominal $U_{L\text{-}N}$ or $U_{L\text{-}L}$ voltage (see table below),
k_{sc} ..... Correction factor (Isc factor) for I_{PSC}. Refer to chapter *4.6.8 Settings* for more information.

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

Table 7.8: Relation between Input voltage – $U_{L\text{-}N(L)}$ 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	$Z_{(L-N)hot} = \sqrt{(1.5 \times R_{(L-N)})^2 + X_{(L-N)}^2}$ $C_{\min} = \begin{cases} 0.95; & U_{n(L-N)} = 230\ V\ \pm 10\ \% \\ 1.00; & \text{otherwise} \end{cases}$
$I_{\max} = \frac{C_{\max} U_{n(L-N)}}{Z_{(L-N)}}$	where	$Z_{(L-N)} = \sqrt{R_{(L-N)}^2 + X_{(L-N)}^2}$ $C_{\max} = \begin{cases} 1.05; & U_{n(L-N)} = 230\ V\ \pm 10\ \% \\ 1.10; & \text{otherwise} \end{cases}$
$I_{min2p} = \frac{C_{\min} U_{n(L-L)}}{Z_{(L-L)hot}}$	where	$Z_{(L-L)hot} = \sqrt{(1.5 \times R_{(L-L)})^2 + X_{(L-L)}^2}$ $C_{\min} = \begin{cases} 0.95; & U_{n(L-L)} = 400\ V\ \pm 10\ \% \\ 1.00; & \text{otherwise} \end{cases}$
$I_{max2p} = \frac{C_{\max} U_{n(L-L)}}{Z_{(L-L)}}$	where	$Z_{(L-L)} = \sqrt{R_{(L-L)}^2 + X_{(L-L)}^2}$ $C_{\max} = \begin{cases} 1.05; & U_{n(L-L)} = 400\ V\ \pm 10\ \% \\ 1.10; & \text{otherwise} \end{cases}$
$I_{min3p} = \frac{C_{\min} \times U_{n(L-L)}}{\sqrt{3}} \frac{2}{Z_{(L-L)hot}}$	where	$Z_{(L-L)hot} = \sqrt{(1.5 \times R_{(L-L)})^2 + X_{(L-L)}^2}$ $C_{\min} = \begin{cases} 0.95; & U_{n(L-L)} = 400\ V\ \pm 10\ \% \\ 1.00; & \text{otherwise} \end{cases}$
$I_{max3p} = \frac{C_{\max} \times U_{n(L-L)}}{\sqrt{3}} \frac{2}{Z_{(L-L)}}$	where	$Z_{(L-L)} = \sqrt{R_{(L-L)}^2 + X_{(L-L)}^2}$ $C_{\max} = \begin{cases} 1.05; & U_{n(L-L)} = 400\ V\ \pm 10\ \% \\ 1.10; & \text{otherwise} \end{cases}$

7.16 Z line 4W – Line impedance and prospective short-circuit current

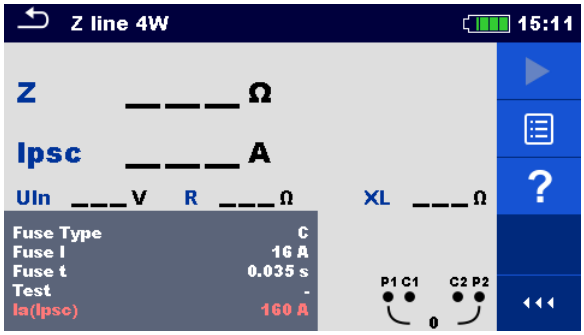


Figure 7.58: Z line 4 W measurement menu

Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I	Rated current of selected fuse
Fuse t	Maximum breaking time of selected fuse

Isc factor	Isc factor [Custom, 0.20 ... 3.00]
Test[1)]	Test [-, L/N, L/L, L1/N, L2/N, L3/N, L1/L2, L1/L3, L2/L3]
Earthing system	Refer to chapter *4.6.8 Settings* for more information.
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

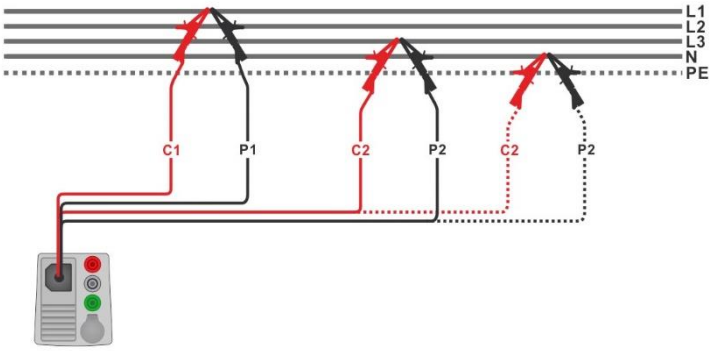


Figure 7.59: Phase-phase or phase-neutral 4-wire line impedance measurement

Measurement procedure

- Enter the Z line 4W function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 4-wire test lead to the object under test, see *Figure 7.59.*
- Start the measurement.
- Save results (optional).

Figure 7.60: Examples of Z line 4W measurement result

Measurement results / sub-results

Z	Line impedance
Ipsc	Prospective short-circuit current
Uln	Voltage measured between C1 and C2 terminals
R	Resistance of line impedance
XL	Reactance of line impedance

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

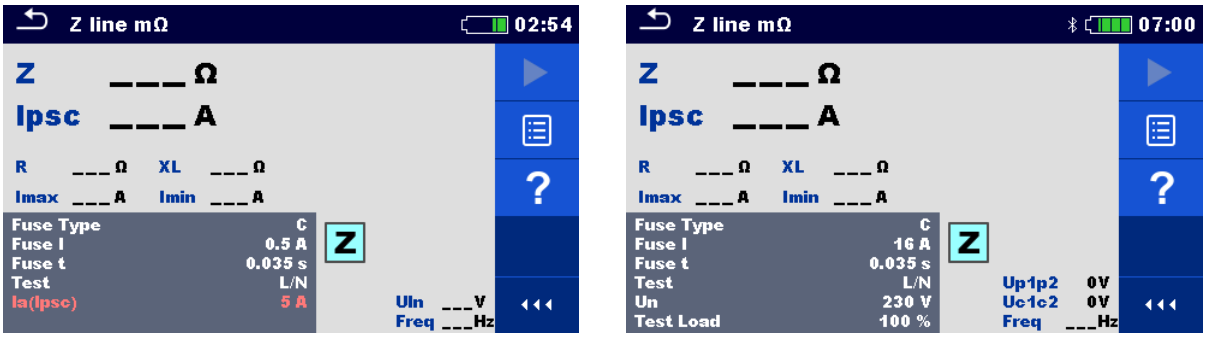
$$I_{\mathrm{PSC}} = \frac{U_{\mathrm{n}} \cdot k_{\mathrm{sc}}}{Z}$$

where:
U_{n} ..... Nominal L-N or L-L voltage (see table below),
k_{sc} ..... Correction factor for Isc. Refer to chapter *4.6.8 Settings* for more information.

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

Table 7.9: Relation between Input voltage – $U_{L\text{-}N(L)}$ and nominal voltage – U_n used for calculation

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



A 1143 MI 3143 or MI 3144

Figure 7.61: Z line mΩ menu

Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
Fuse I	Rated current of selected fuse
Fuse t	Maximum breaking time of selected fuse
Ia(Ipsc)	Minimum short circuit current for selected fuse or custom value
Test[1)]	Test [-, L-N, L/L, L1-N, L2-N, L3-N, L1-L2, L1-L3, L2-L3]
Un[2)]	Test=[-, L/N, L1/N, L2/N, L3/N]: Nominal voltage [Custom, 110 V, 115 V, 127 V, 220 V, 230 V, 240 V, 290 V, 400 V, 460 V] Test=[L/L, L1/L2, L1/L3, L2/L3]: Nominal voltage [Custom, 190 V, 200 V, 220 V, 380 V, 400 V, 415 V, 500 V, 690 V, 800 V]
Tolerance[2)]	MI 3143 & MI 3144: Nominal voltage tolerance [6 %, 10 %]
Test Load[2)]	MI 3143: Test Load [33.3 %, 66.6 %, 100 %] MI 3144: Test Load [16.6 %, 33.3 %, 50.0 %, 66.6 %, 83.3 %, 100 %]

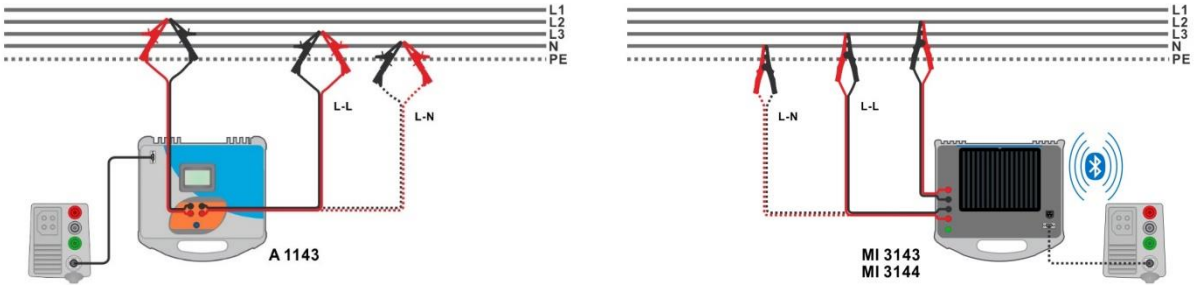
Average[2)]	MI 3143 & MI 3144: Average [Off, 2, 4, 6]
Isc factor[2)]	Isc factor [Custom, 0.20 ... 3.00]

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

[2)] Parameter is available only if MI 3143 or MI 3144 Euro Z instrument is selected.

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

Connection diagram

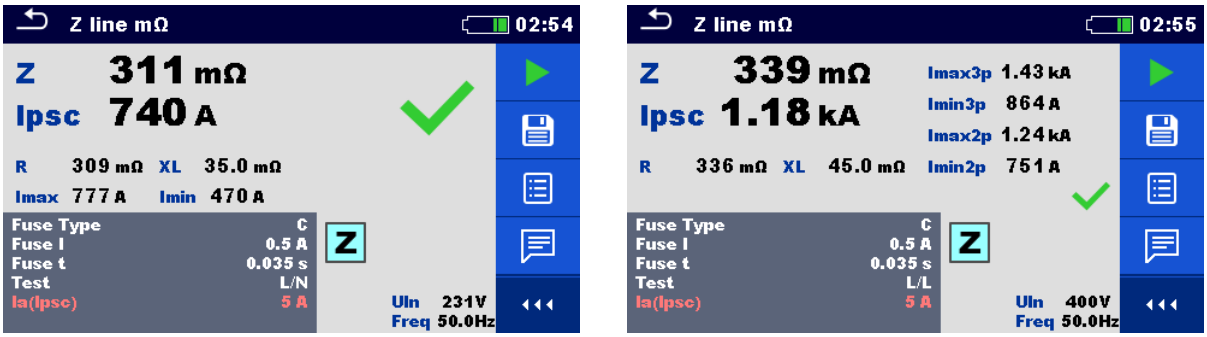


Connection of A 1143 Connection of MI 3143 or MI 3144

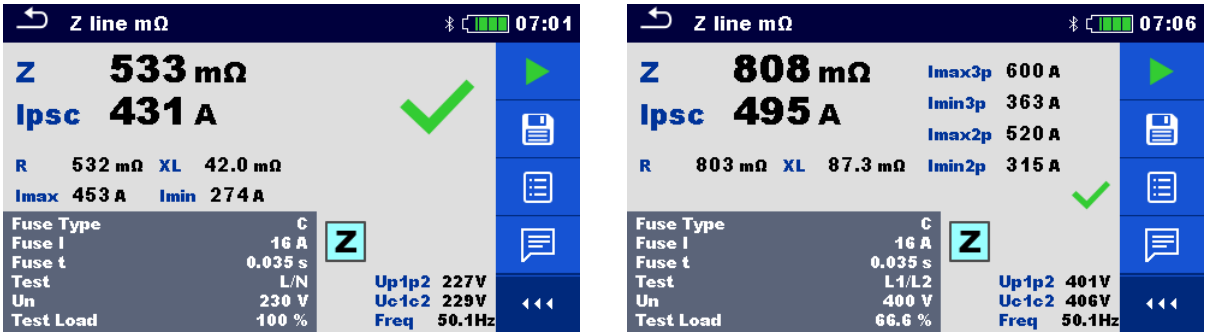
Figure 7.62: Phase-neutral or phase-phase high precision Line impedance measurement

Measurement procedure

- Connect MI 3155 instrument with A 1143, MI 3143 or MI 3144 Euro Z adapter / instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters.*
- Enter the Z line mΩ function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3143 or MI 3144 Euro Z instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads to A 1143, MI 3143 or MI 3144 Euro Z adapter / instrument.
- Connect test leads to the object under test, see *Figure 7.62.*
- Start the measurement using or button.
- Save results (optional).



Result screens using A 1143



Result screens using MI 3143 or MI 3144

Figure 7.63: 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

Voltage monitor using A 1143:

Uln	Voltage L-N or L-L
Freq	Frequency

Voltage monitor using MI 3143 or MI 3144:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *A 1143 – Euro Z 290 A*, *MI 3143 – Euro Z 440 V* and *MI 3144 – Euro Z 800 V Instruction manuals* for detailed information.

7.18 High Current (MI 3143 and MI 3144)

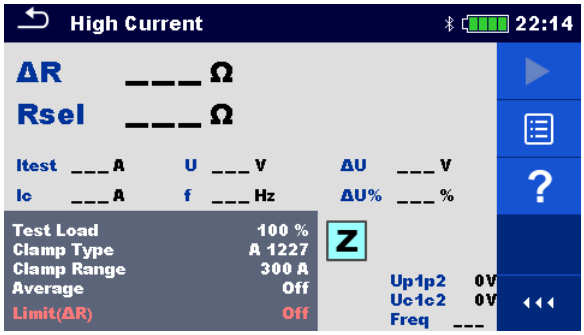


Figure 7.64: High Current menu

Measurement parameters / limits

Test Load	MI 3143: Test load [33.3 %, 66.6 %, 100 %] MI 3144: Test load [16.6 %, 33.3 %, 50.0 %, 66.6 %, 83.3 %, 100 %]
Clamp Type[1)]	Clamp type [A 1227, A 1281, A 1609]
Clamp Range[1)]	Range @ A 1227, A 1609 [30 A, 300 A, 3000 A] Range @ A 1281 [0.5 A, 5 A, 100 A, 1000 A]
Average	Average [Off, 2, 4, 6]
Limit (ΔR)	Limit [Off, Custom, 0.01 Ω ... 19 Ω]

[1)] Measurement with current clamps is supported by MI 3144 – Euro Z 800 V instrument only.

Connection diagram

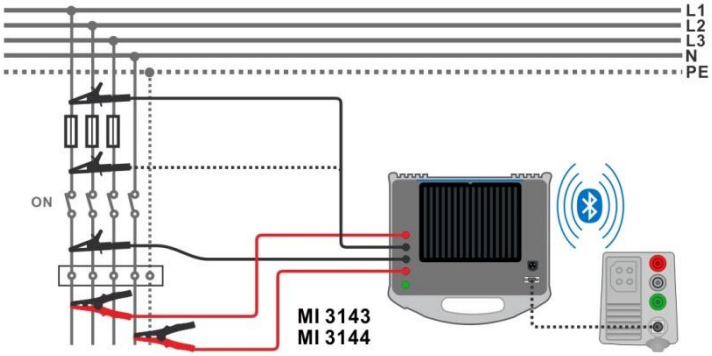


Figure 7.65: High Current resistance measurement

Measurement procedure

- Connect MI 3155 instrument with MI 3143 or MI 3144 Euro Z adapter / instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters.*
- Enter the High Current function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3143 or MI 3144 Euro Z instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads to MI 3143 or MI 3144 Euro Z instrument.
- Connect test leads to the object under test. See *Figure 7.65.*
- Refer to *MI 3143 – Euro Z 440 V* or *MI 3144 – Euro Z 800 V Instruction manual* for detailed information.
- Start the measurement using  or  button.
- Save results (optional).

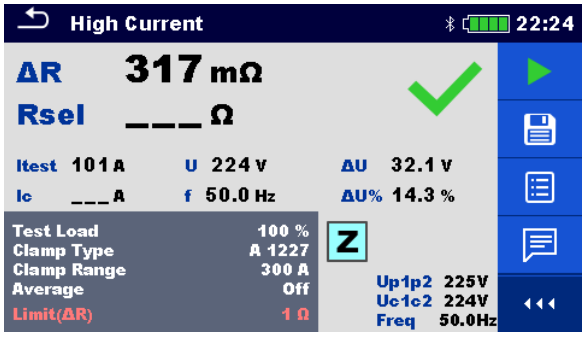


Figure 7.66: Example of High Current measurement result

Measurement results / sub-results

ΔR	Resistance
Rsel[1)]	Resistance (calculated from Clamp current)
Itest	Test current
Ic[1)]	Clamp current
U	Voltage
f	Frequency
ΔU	Voltage dip
ΔU%	Voltage dip in percentage [ΔU (%) = (ΔU / U_unloaded) x 100 %]

1) Measurement with current clamps is supported by MI 3144 – Euro Z 800 V instrument only.

Voltage monitor:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *MI 3143 – Euro Z 440 V* and *MI 3144 – Euro Z 800 V Instruction manuals* for detailed information.

7.19 **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).

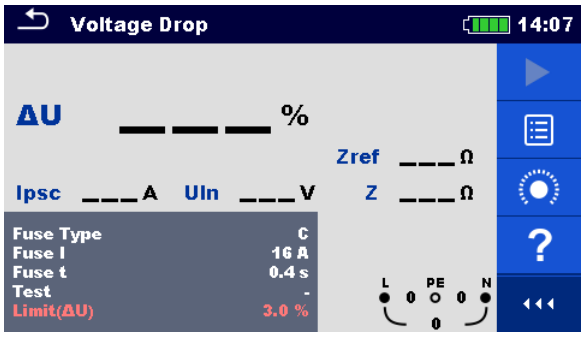


Figure 7.67: Voltage drop menu

Measurement parameters / limits

Fuse Type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
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 [Custom, 0.20 ... 3.00]
Test [2)]	Test [-, L/N, L/L, L1/N, L2/N, L3/N, L1/L2, L1/L3, L2/L3]
Earthing system	Refer to chapter *4.6.8 Settings* for more information.
Limit(ΔU)	Maximum voltage drop [Off, Custom, 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

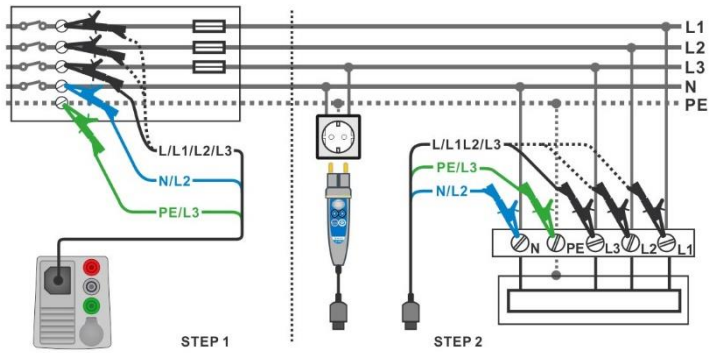


Figure 7.68: Voltage drop measurement – connection of Plug commander and 3-wire test lead

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 3-wire test lead to the origin of electrical installation, see *Figure 7.68.*
- 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 3-wire test lead or Plug commander to the tested points, see *Figure 7.68*.
- Start the measurement.
- Save results (optional).

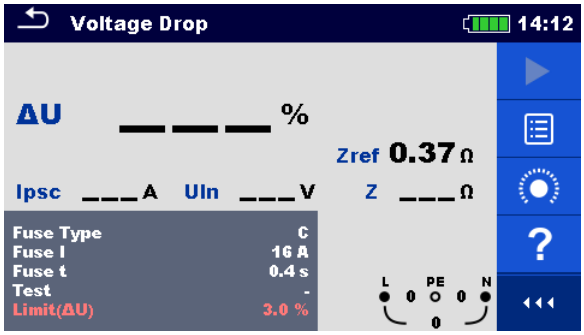


Figure 7.69: Example of Zref measurement result (Step 1)

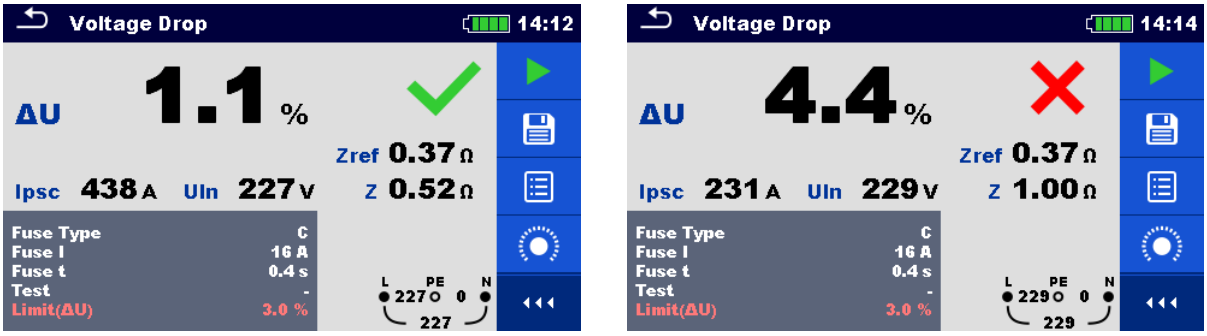


Figure 7.70: Examples of Voltage drop measurement result (Step 2)

Measurement results / sub-results

ΔU	Voltage drop
Ipsc	Prospective short-circuit current
Uln	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 7.10: Relation between Input voltage – $U_{L-N(L)}$ and nominal voltage – U_n used for calculation

7.20 U touch – Touch voltage (MI 3143 and MI 3144)

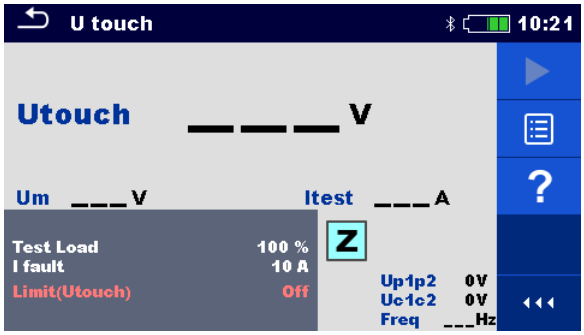


Figure 7.71: Touch voltage menu

Measurement parameters / limits

Test Load	MI 3143: Test load [33.3 %, 66.6 %, 100 %] MI 3144: Test load [16.6 %, 33.3 %, 50.0 %, 66.6 %, 83.3 %, 100 %]
I fault	Fault current [Custom, 10 A ... 200 kA]
Limit(Utouch)	Limit [Off, Custom, 25 V, 50 V]

Connection diagram

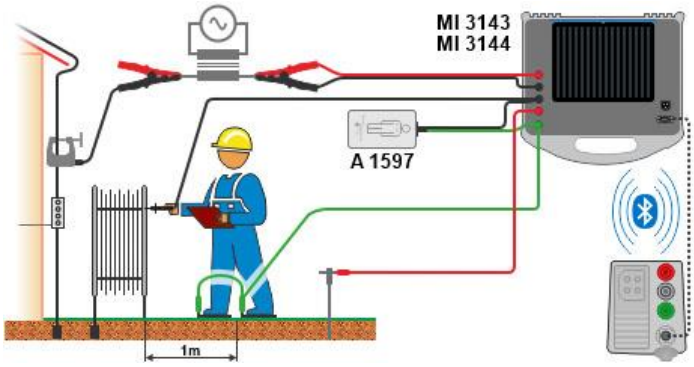


Figure 7.72: Touch voltage measurement – Connection of MI 3143 or MI 3144

Refer to *MI 3143 – Euro Z 440 V* and *MI 3144 – Euro Z 800 V Instruction manual* for detailed information.

Measurement procedure

- Connect MI 3155 instrument with MI 3143 or MI 3144 Euro Z instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the U touch function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3143 or MI 3144 Euro Z instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads and A 1597 adapter to MI 3143 or MI 3144 Euro Z instrument.
- Connect test leads to the object under test.
  Refer to *MI 3143 Euro Z 440 V* or *MI 3144 Euro Z 800 V Instruction manual* for detailed information.
- Start the measurement using or button.

- Save results (optional).

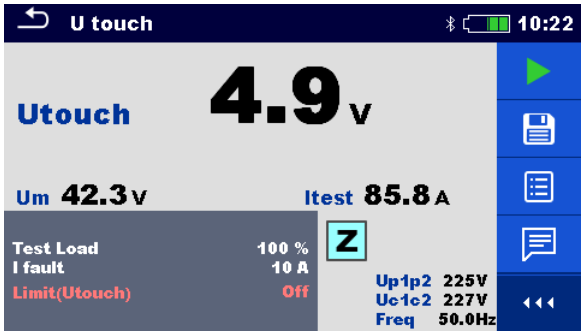


Figure 7.73: Example of Touch voltage measurement result

Measurement results / sub-results

Utouch	Calculated touch voltage
Um	Measured voltage drop
Itest	Test current

Voltage monitor:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *MI 3143 Euro Z 440 V* and *MI 3144 Euro Z 800 V Instruction manuals* for detailed information.

7.21 Z auto - Auto test sequence for fast line and loop testing

Tests / measurements implemented in Z auto test sequence

Voltage
Z line
Voltage Drop
Zs rcd
Uc

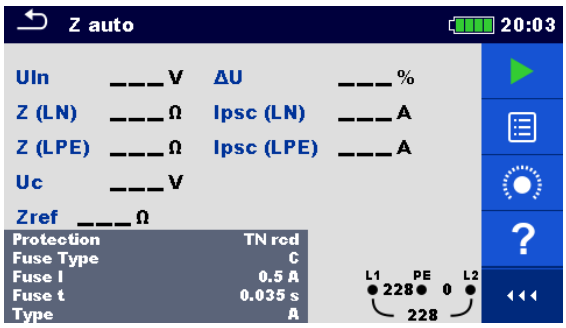


Figure 7.74: Z auto menu

Measurement parameters / limits

Protection	Protection type [TN, TNrcd, TTrcd]
Fuse type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
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 [Custom, 0.20 ... 3.00]
RCD Type	RCD type [AC, A, F, B, B+]
I ΔN	Rated RCD residual current sensitivity [10 mA, 15 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 [Off, Custom, 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 [Custom, 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 RCD tests are 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 TNrcd. Ipsc(LN) is always considered.

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

Connection diagram

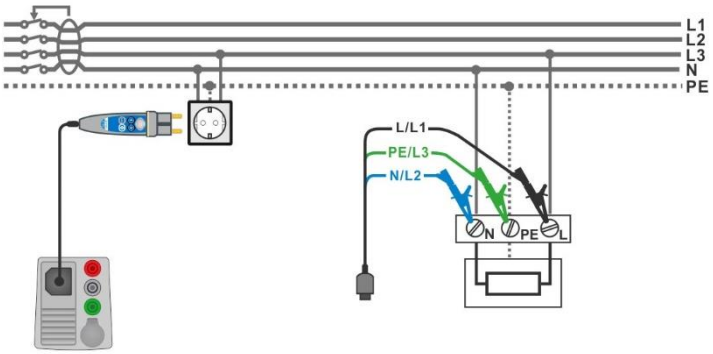


Figure 7.75: Z auto measurement

Measurement procedure

- Enter the Z auto function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter *7.19 Voltage Drop*.
- Connect test cable to the instrument.
- Connect 3 wire test lead or Plug commander to the object under test, see *Figure 7.75*.
- Start the Auto test.
- Save results (optional).

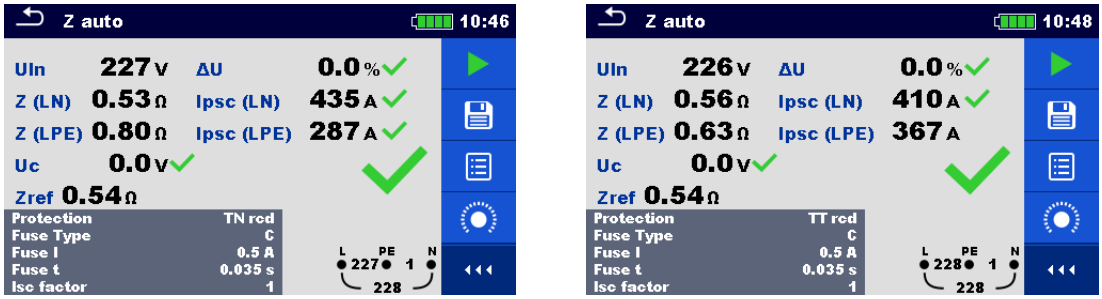


Figure 7.76: Examples of Z auto measurement results

Measurement results / sub-results

Uln	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

7.22 R line mΩ – DC resistance measurement (MI 3144)

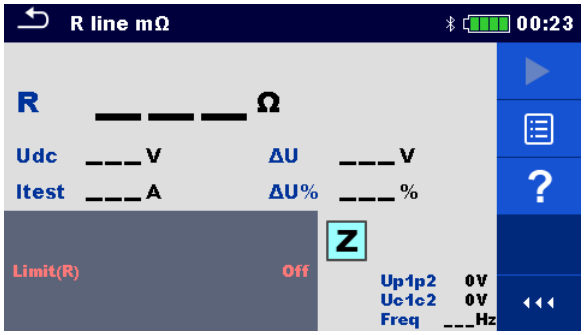


Figure 7.77: R line mΩ menu

Measurement parameters / limits

Limit (R)	Limit [Off, Custom, 0.01 Ω ... 19 Ω]

Connection diagram

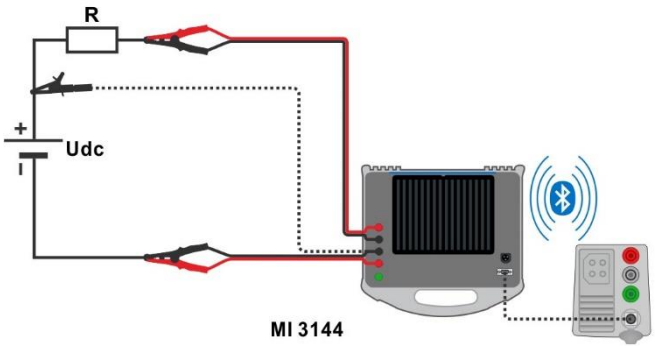


Figure 7.78: R line mΩ – Connection of MI 3144

Measurement procedure

- Connect MI 3155 instrument with MI 3144 Euro Z 800 V instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the R line mΩ function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3144 Euro Z 800 V instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads to MI 3144 Euro Z 800 V instrument.
- Connect test leads to the object under test.
  Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.
- Start the measurement using  or  button.
- Save results (optional).

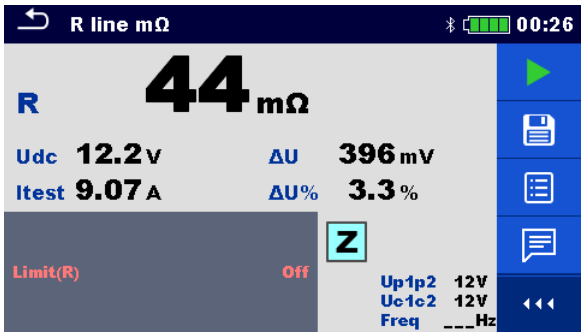


Figure 7.79: Example of R line mΩ measurement result

Measurement results / sub-results

R	Line resistance
Itest	Test current
Udc	Voltage
ΔU	Voltage drop
ΔU%	Voltage drop in percentage

Voltage monitor:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

7.23 ELR Current Injection Test (MI 3144)

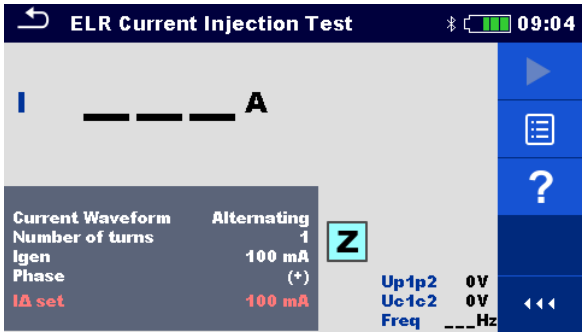


Figure 7.80: ELR Current Injection Test menu

Measurement parameters / limits

Current Waveform	Current waveform [Alternating, Pulsating, DC]
Number of turns	Number of turns [1 ... 10]
I gen	Current [3 mA, 5 mA, 6 mA, 10 mA, 15 mA, 30 mA, 50 mA, 100 mA, 150 mA, 250 mA, 300 mA, 500 mA]
Phase	Phase [(+), (-)]
IΔ set	Current limit for selected generated current and number of turns.

Connection diagram

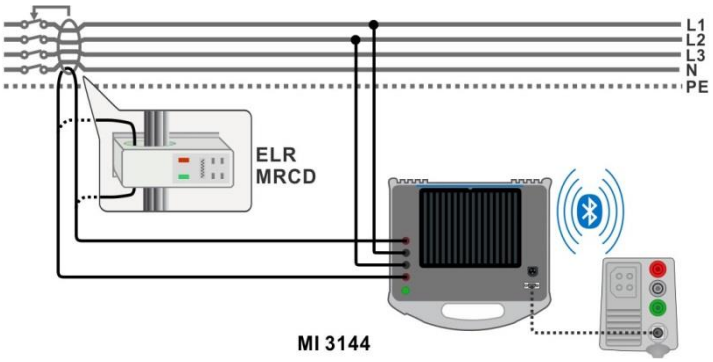


Figure 7.81: ELR Current Injection Test / Combination Time Test connection

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

Measurement procedure

- Connect MI 3155 instrument with MI 3144 Euro Z 800 V instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the ELR Current Injection Test function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3144 Euro Z 800 V instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads to MI 3144 Euro Z 800 V instrument.
- Connect test leads to the object under test. See *Figure 7.81*.

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

- Start the measurement using  or  button.
- Use  to select PASS / FAIL / NO STATUS indication.
- Press  or the  key to confirm selection and complete the measurement.
- Save results (optional).

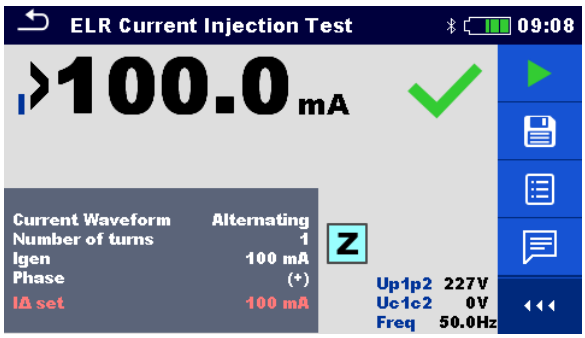


Figure 7.82: Examples of high precision Line impedance measurement result

Measurement result

I	Current

Voltage monitor:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

7.24 ELR Combination Time Test (MI 3144)

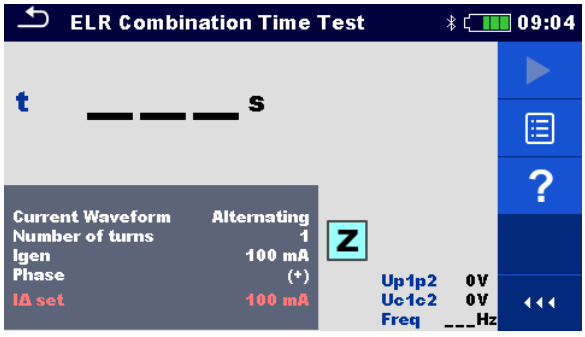


Figure 7.83: ELR Combination Time Test menu

Measurement parameters / limits

Current Waveform	Current waveform [Alternating, Pulsating, DC]
Number of turns	Number of turns [1 ... 10]
I gen	Current [3 mA, 5 mA, 6 mA, 10 mA, 15 mA, 30 mA, 50 mA, 100 mA, 150 mA, 250 mA, 300 mA, 500 mA]
Phase	Phase [(+), (-)]
Test duration	Duration [0.3 s, 0.5 s, 1 s, 2 s, 5 s, 10 s, 20 s]
IΔ set	Current limit for selected generated current and number of turns.

Connection diagram

See *Figure 7.81*.
Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

Measurement procedure

- Connect MI 3155 instrument with MI 3144 Euro Z 800 V instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the ELR Combination Time Test function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3144 Euro Z 800 V instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect test leads to MI 3144 Euro Z 800 V instrument.
- Connect test leads to the object under test. See *Figure 7.81*.
  Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.
- Start the measurement using  or  button.
- Use  to select PASS / FAIL / NO STATUS indication.
- Press  or the  key to confirm selection and complete the measurement.
- Save results (optional).

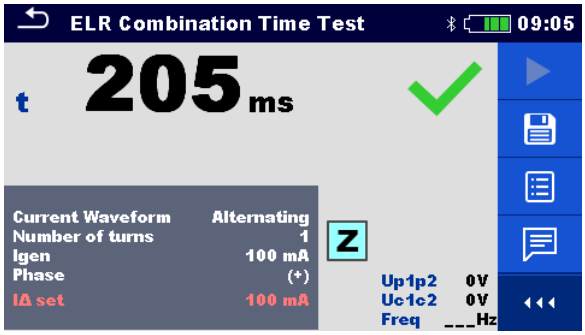


Figure 7.84: Example of ELR Combination Time Test result

Measurement result

t	Time

Voltage monitor:

Up1p2	Voltage P1-P2
Uc1c2	Voltage C1-C2
Freq	Frequency

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

7.25 **EVSE Diagnostic Test (A 1632)**

EVSE Diagnostic Test should be performed with A 1632 eMobility Analyser connected with MI 3155 instrument via Bluetooth communication.

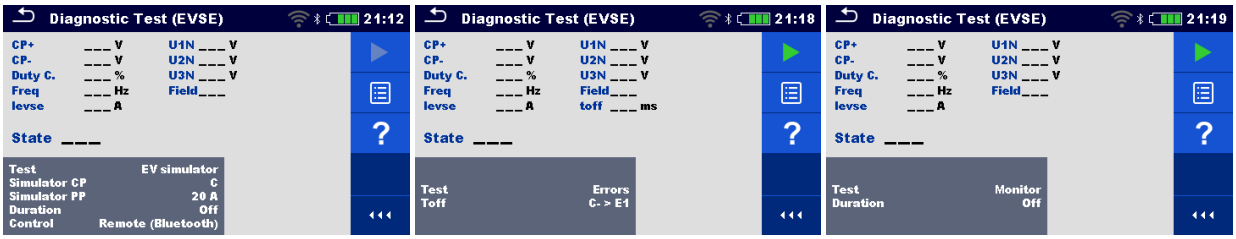


Figure 7.85: Diagnostic Test (EVSE) start screens – EV simulator, Errors and Monitor

Measurement parameters / limits

With selection of the Test parameter on the start screen, three diagnostic sub-tests can be set.

Test	Test [EV simulator, Monitor, Errors]	
	EV simulator	- Simulation of Electrical Vehicle
	Monitor	- Monitoring of EVSE – EV interconnection and signalling
	Errors	- Simulation of CP Errors
Toff	Simulated CP errors [C->E1, C->E2, C->E3, D->E1, D->E2, D->E3]	
Simulator CP	CP (control pilot) state setting [nc, A, B, C, D]	
Simulator PP	PP (proximity pilot) state setting [nc, 13 A, 20 A, 32 A, 63 A, 80 A]	
Duration	Test duration [Off, 2 s, 3 s, 5 s, 10 s, 30 s, 60 s, 90 s, 120 s, 180 s]	
Control	Analyser control [Remote (Bluetooth), Manual (A 1632)]	

Connection diagrams

Refer to *A 1632 – eMobility Analyser Instruction manual* for detailed information.

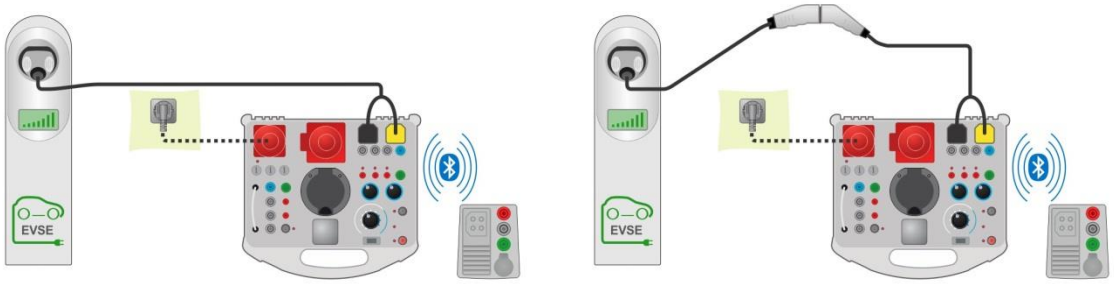


Figure 7.86: Diagnostic test - EV simulator and Errors sub-tests - connection to EVSE

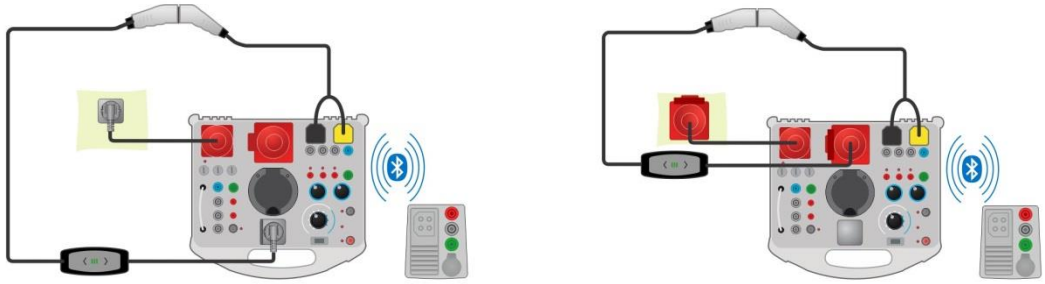


Figure 7.87: Diagnostic test - EV simulator and Errors sub-tests - connection to Mode 2 charging cable powered from Analyser

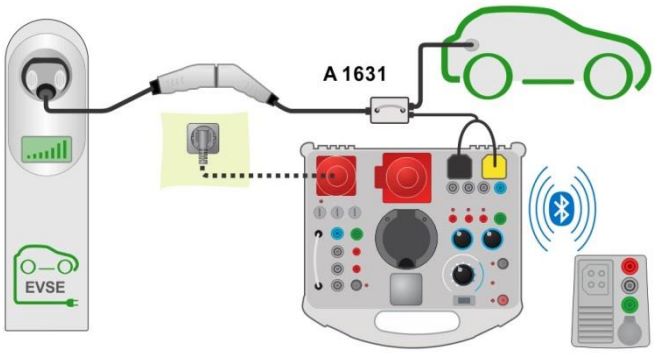


Figure 7.88: Diagnostic test (EVSE) - Monitor sub-test - connection to EVSE or charging cable

Diagnostic test procedure

- Pair and connect MI 3155 with A 1632 eMobility Analyzer instrument via Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the Diagnostic test (EVSE) function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if A 1632 eMobility Analyzer is connected to MI 3155 instrument via Bluetooth communication.
- Connect the charging cable / station to A 1632 eMobility Analyzer adapter. See *Figure 7.86*, *Figure 7.87* and *Figure 7.88*.
  Refer to *A 1632 eMobility Analyzer Instruction manual* for detailed information.
- Start the measurement using or button.
- Manually apply status (optional).
- Save results (optional).

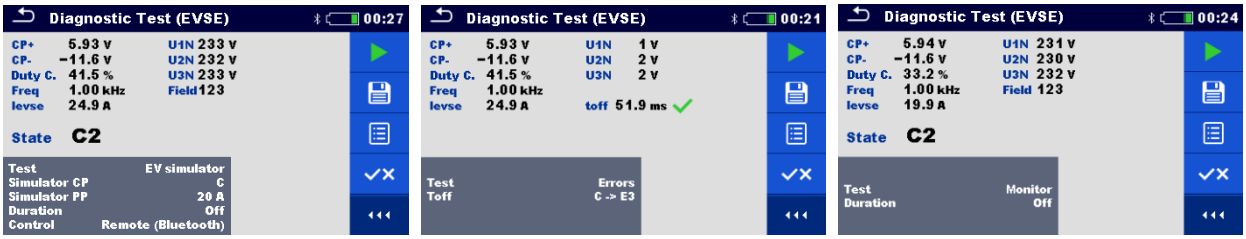


Figure 7.89: Examples of Diagnostic Test (EVSE) measurement results – EV simulator, Errors and Monitor

Measurement results / sub-results

CP+	Maximal value of CP (control pilot) signal
CP-	Minimal value of CP (control pilot) signal
Duty C.	Duty cycle of CP (control pilot) signal
Freq	Frequency of CP (control pilot) signal
Ievse	Charging current available by charging cable / EVSE
U1N	Voltage UL1-N on the output of charging cable / EVSE
U2N	Voltage UL2-N on the output of charging cable / EVSE
U3N	Voltage UL3-N on the output of charging cable / EVSE
Field	1.2.3 – correct connection – CW rotation sequence 3.2.1 – invalid connection – CCW rotation sequence
toff	Disconnection time of charging cable / EVSE
State	System state

Refer to *A 1632 eMobility Analyzer Instruction manual* for detailed information.

7.26 Earth – Earth **resistance (3-wire test)**

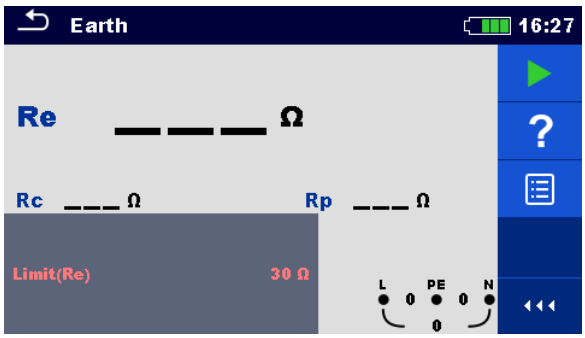


Figure 7.90: Earth menu

Measurement parameters / limits

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

Connection diagrams

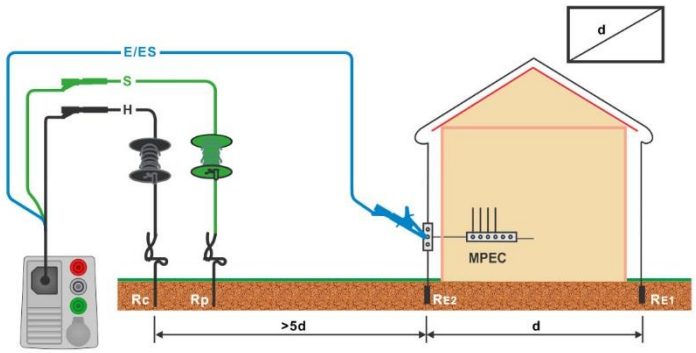


Figure 7.91: Resistance to earth, measurement of main installation earthing and lighting protection system

Measurement procedure

- Enter the Earth function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead to the object under test, see *Figure 7.91*.
- Start the measurement.
- Save results (optional).

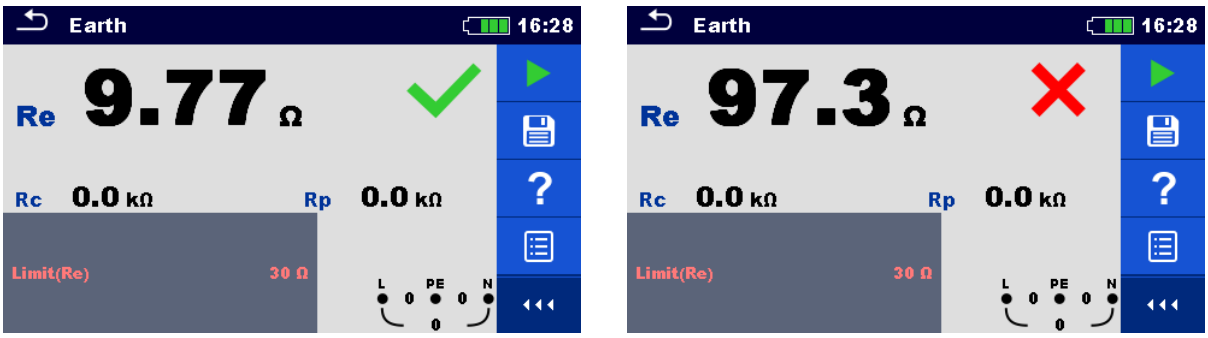


Figure 7.92: Examples of Earth resistance measurement result

Measurement results / sub-results

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

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

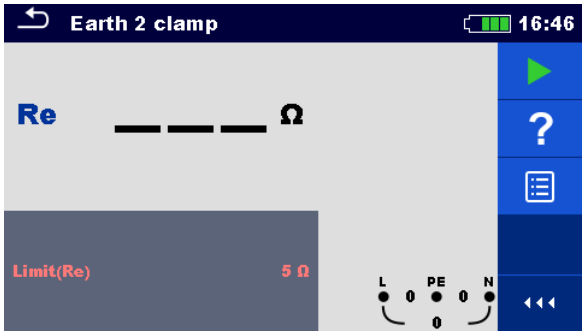


Figure 7.93: Earth 2 clamps menu

Measurement parameters / limits	
Limit(Re)	Maximum resistance [Off, Custom, 1 Ω ... 30 Ω]

Connection diagram

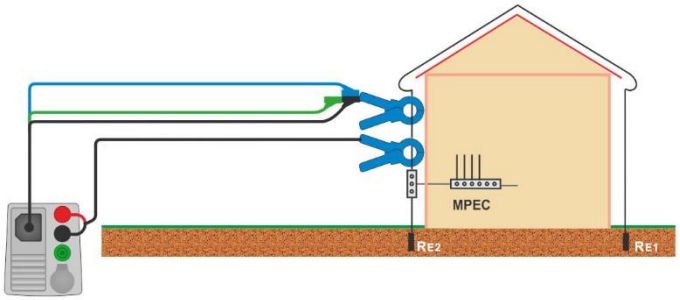


Figure 7.94: Contactless earthing resistance measurement

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 7.94*.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

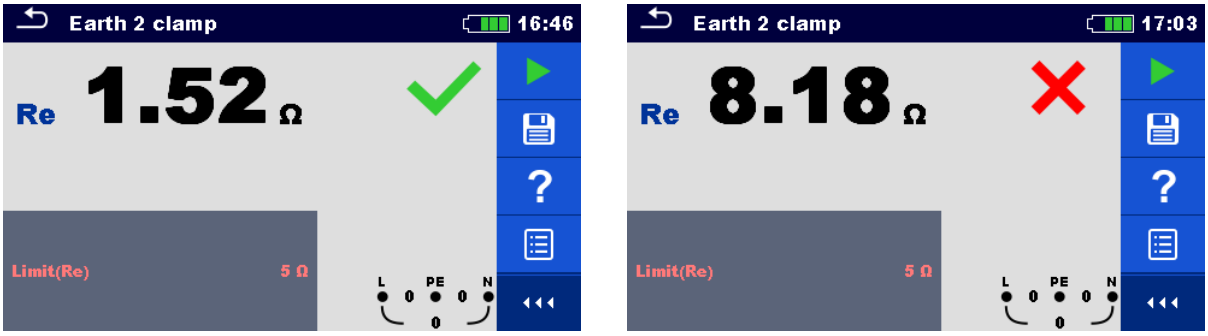


Figure 7.95: Examples of Contactless earthing resistance measurement result

Measurement results / sub-results

Re	Earth resistance

7.28 Ro – Specific earth resistance (A 1199)

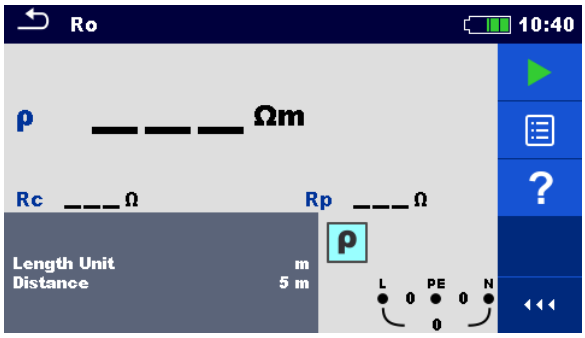


Figure 7.96: Earth Ro menu

Measurement parameters / limits

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

Connection diagram

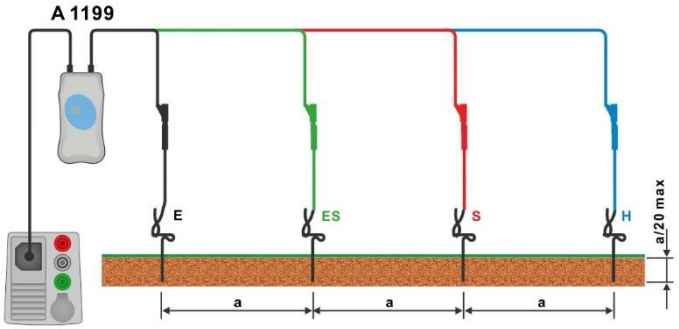


Figure 7.97: Specific earth resistance measurement

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 7.97*.
- Start the measurement.
- Save results (optional).

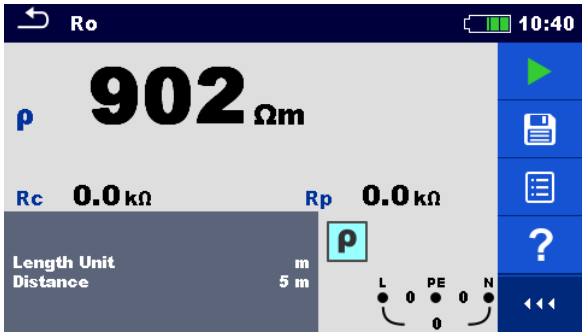


Figure 7.98: Example of Specific earth resistance measurement result

Measurement results / sub-results

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

7.29 **Power**

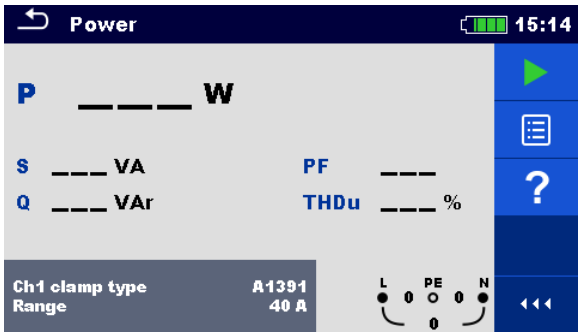


Figure 7.99: Power menu

Measurement parameters / limits

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

Connection diagram

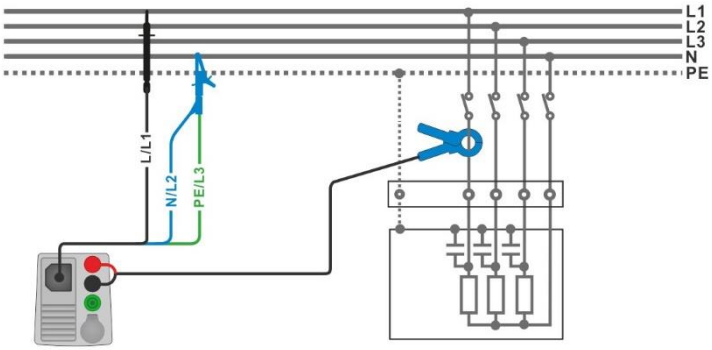


Figure 7.100: Power measurement

Measurement procedure

- Enter the Power function.
- Set parameters / limits.
- Connect the 3-wire test lead and current clamp to the instrument.
- Connect the 3-wire test lead and current clamp to the item to be tested (see *Figure 7.100*).
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

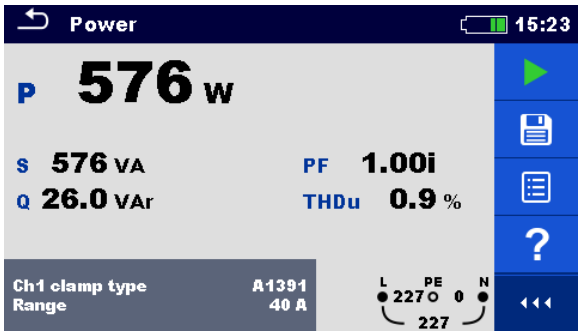


Figure 7.101: Example of Power measurement result

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

7.30 Harmonics

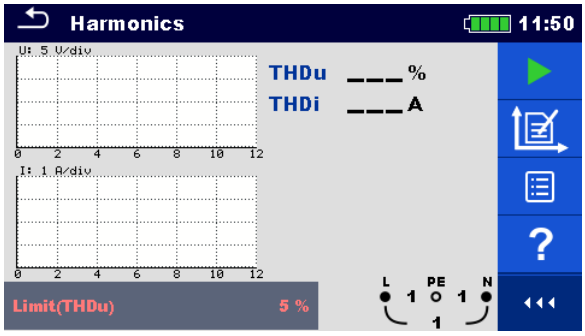


Figure 7.102: Harmonics menu

Measurement parameters / limits

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

Connection diagram

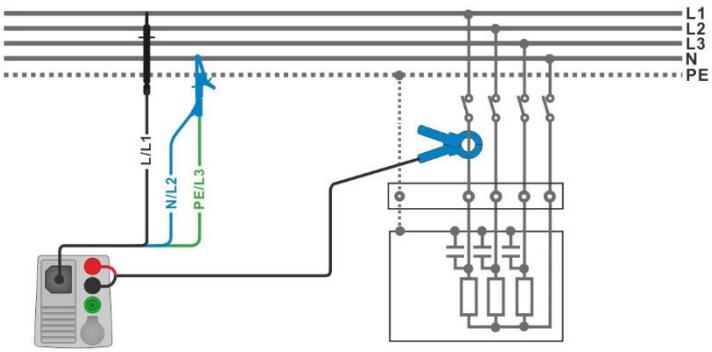


Figure 7.103: Harmonics measurement

Measurement procedure

- Enter the Harmonics function.
- Set parameters / limits.
- Connect 3-wire test lead and current clamp to the instrument.
- Connect 3-wire test lead and current clamp to the item to be tested, see *Figure 7.103*.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

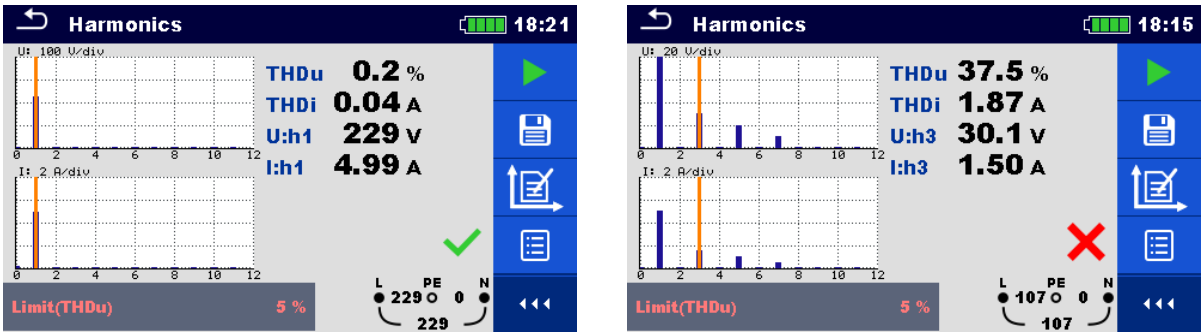


Figure 7.104: Examples of Harmonics measurement results

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

7.31 **Currents**

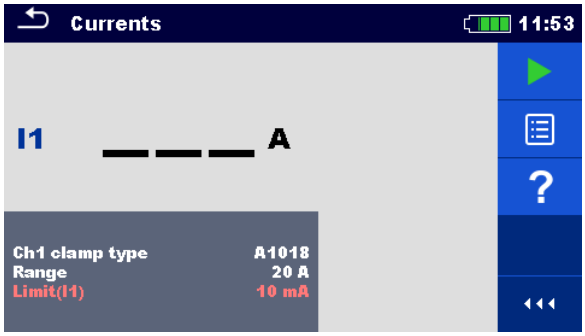


Figure 7.105: Current menu

Measurement parameters / limits

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

Connection diagram

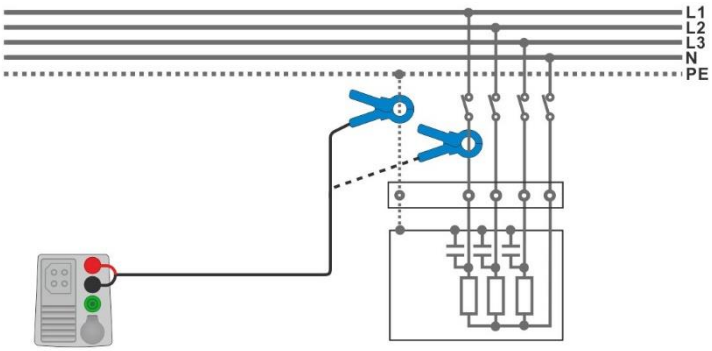


Figure 7.106: PE leakage and load current measurements

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 7.106*.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

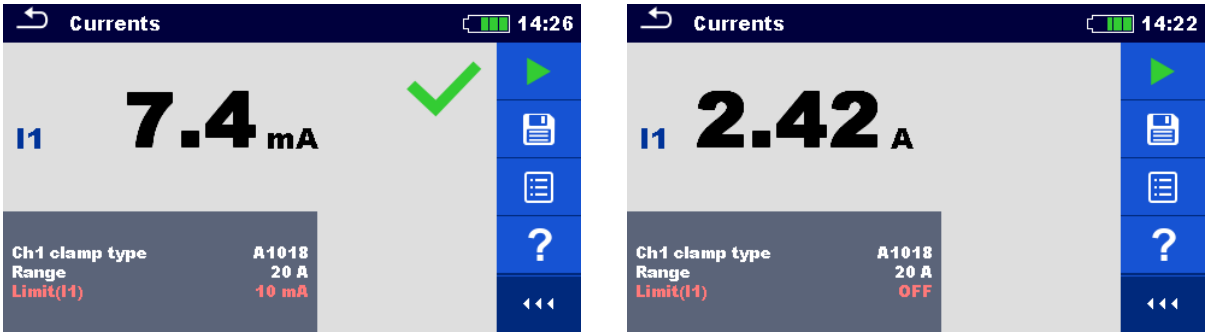


Figure 7.107: Examples of Current measurement result

Measurement results / sub-results

I1	PE leakage or load current

7.32 Current Clamp Meter (MI 3144)

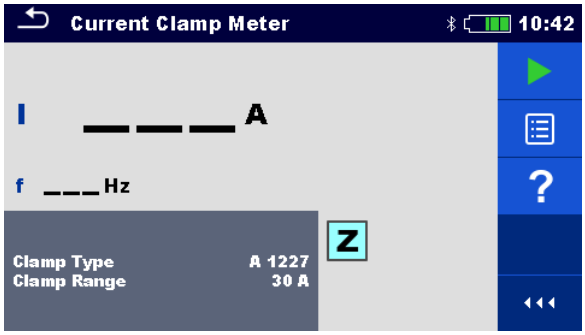


Figure 7.108: Current Clamp Meter menu

Measurement parameters / limits

Clamp Type	Clamp type [A 1227, A 1281, A 1609]
Clamp Range	Range Clamp type A 1227, A 1609: [30 A, 300 A, 3000 A] Clamp type A 1281: [0.5 A, 5 A, 100 A, 1000 A]

Connection diagram

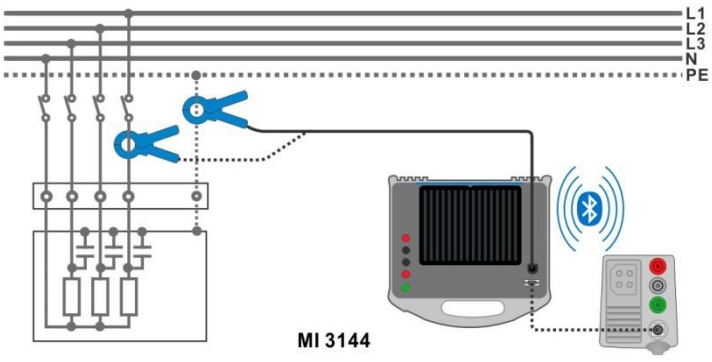


Figure 7.109: Current Clamp Meter measurement

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

Measurement procedure

- Connect MI 3155 instrument with MI 3144 Euro Z instrument via serial RS232 or pair them using Bluetooth communication. See chapter *4.6.8.1 Adapters*.
- Enter the Current Clamp Meter function.
- Set test parameters / limits.
- Check Bluetooth communication active sign if MI 3144 Euro Z 800 V instrument is connected to MI 3155 instrument via Bluetooth communication.
- Connect current clamp to MI 3144 Euro Z 800 V instrument.
- Wrap the object under test with the measuring clamp. See *Figure 7.109*.
  Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.
- Start the continuous measurement using  or  button.
- Stop the measurement.
- Save results (optional).

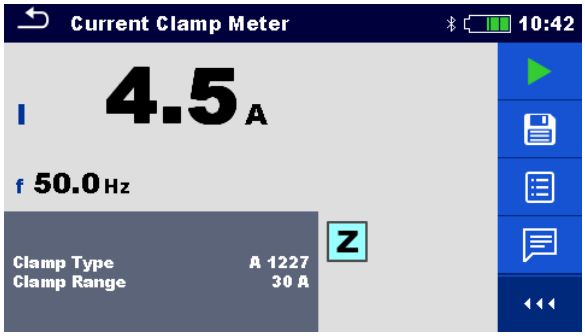


Figure 7.110: Example of Current Clamp Meter measurement result

Measurement results / sub-results

I	Current
f	Frequency

Refer to *MI 3144 Euro Z 800 V Instruction manual* for detailed information.

7.33 ISFL – First fault leakage current

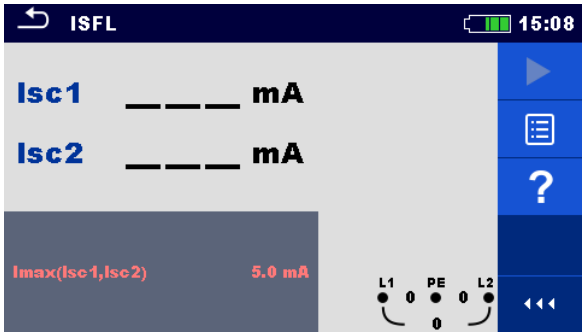


Figure 7.111: ISFL measurement menu

Measurement parameters / limits

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

Connection diagrams

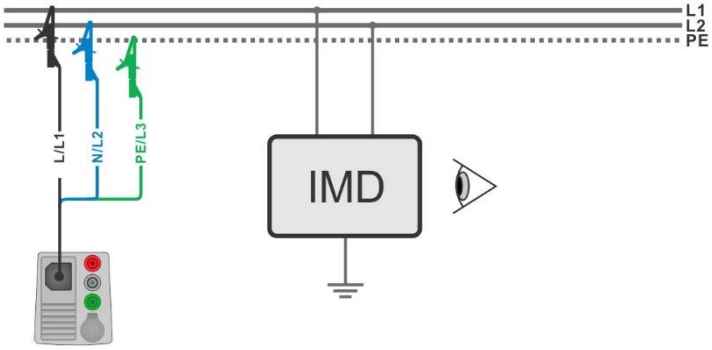


Figure 7.112: Measurement of highest First fault leakage current with 3-wire test lead

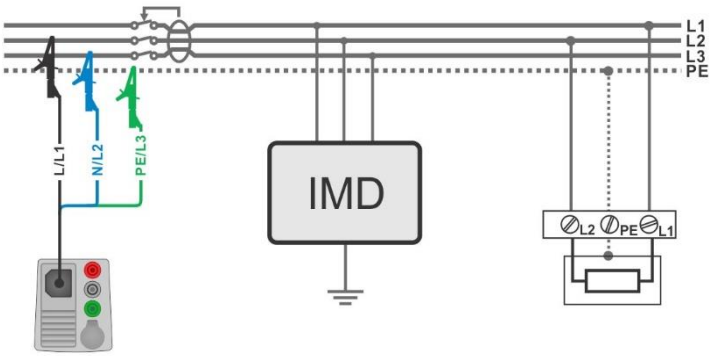


Figure 7.113: Measurement of First fault leakage current for RCD protected circuit with 3-wire test lead

Measurement procedure

- Enter the ISFL function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead to the object under test, see *Figure 7.112* and *Figure 7.113.*
- Start the measurement.
- Save results (optional).

Figure 7.114: 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

7.34 IMD – Testing of insulation monitoring devices

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

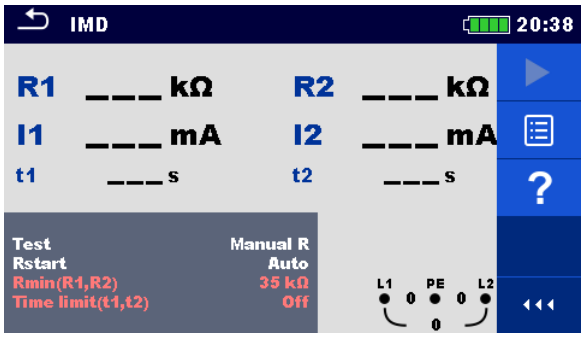


Figure 7.115: IMD test menu

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]

Connection diagram

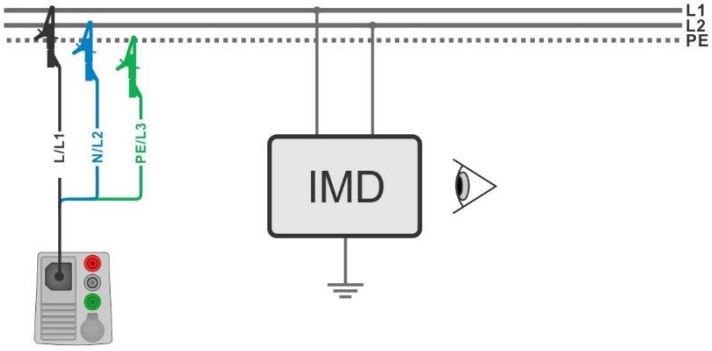


Figure 7.116: Connection with 3-wire test lead

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 3-wire test lead to the object under test, see *Figure 7.116.*
- Start the measurement.
- Use the  or  keys to change insulation resistance[1)] 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[1)] 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 3-wire test lead to the object under test, see *Figure 7.116.*
- Start the measurement.
  Insulation resistance between L1-PE is decreased automatically according to limit value[1)] 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[1)] 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 7.11: 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 7.12: Starting / ending insulation resistance values for MANUAL I and AUTO I sub-functions

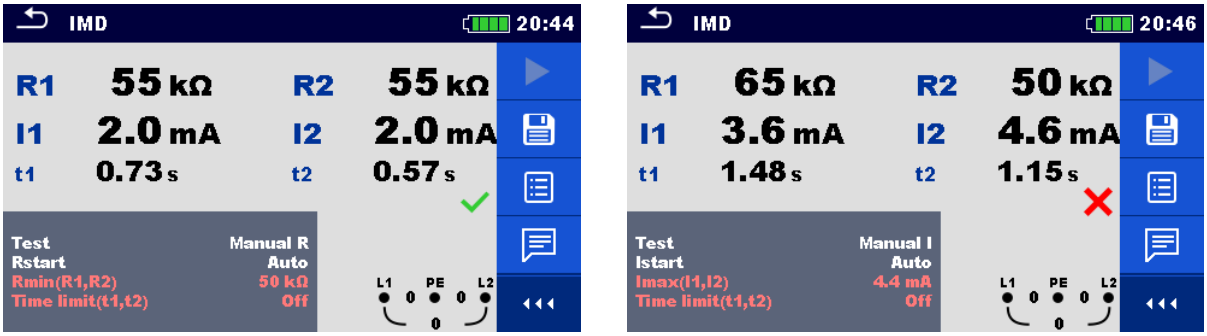


Figure 7.117: Examples of IMD test result

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.

7.35 Rpe – PE conductor resistance

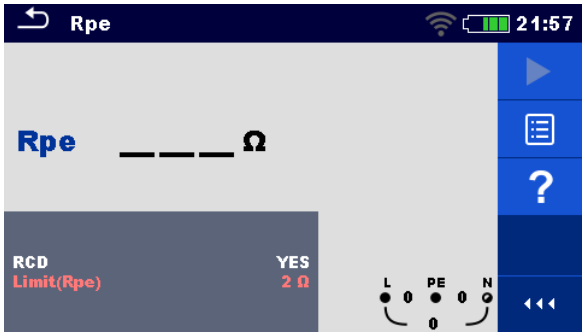


Figure 7.118: PE conductor resistance measurement menu

Measurement parameters / limits

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

Connection diagram

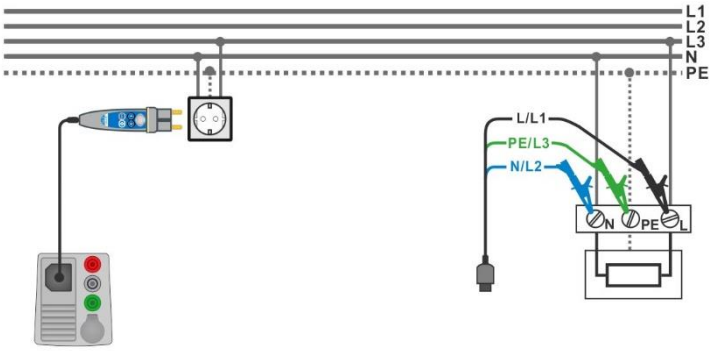


Figure 7.119: Connection of Plug commander and 3-wire test lead

Measurement procedure

- Enter the Rpe function.
- Set test parameters / limits.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.119*.
- Start the measurement.
- Save results (optional).

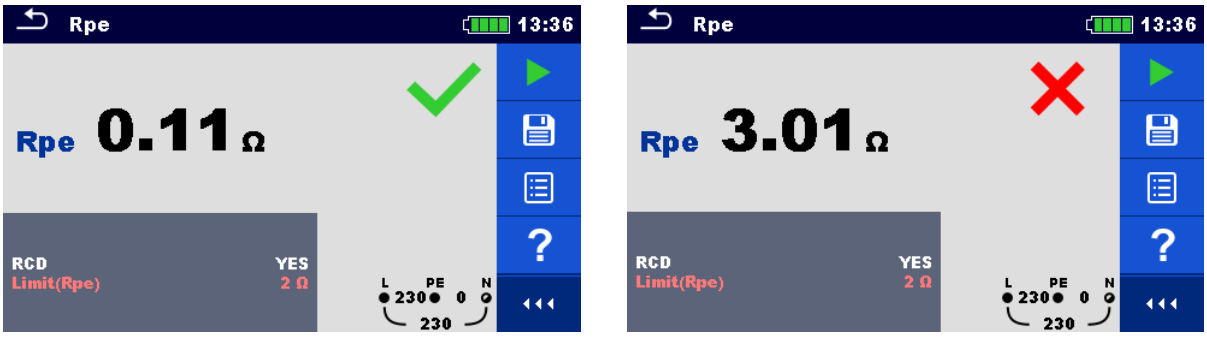


Figure 7.120: Examples of PE conductor resistance measurement result

Measurement results / sub-results

Rpe	PE conductor resistance

7.36 Illumination

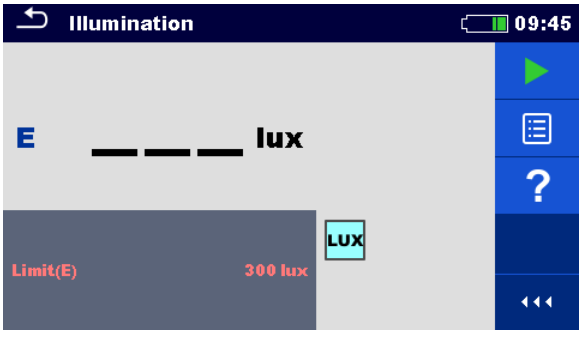


Figure 7.121: Illumination measurement menu

Measurement parameters / limits

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

Probe positioning

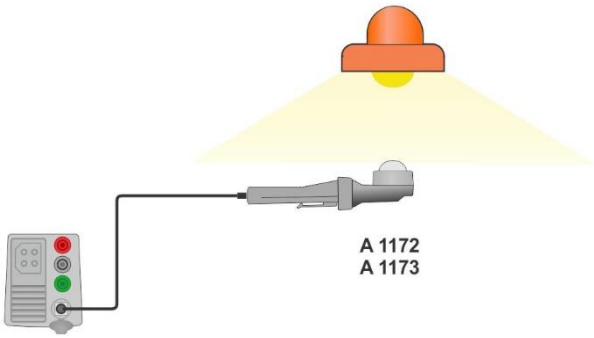


Figure 7.122: LUXmeter probe positioning

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 7.122*.
  Make sure that LUXmeter probe is turned on.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

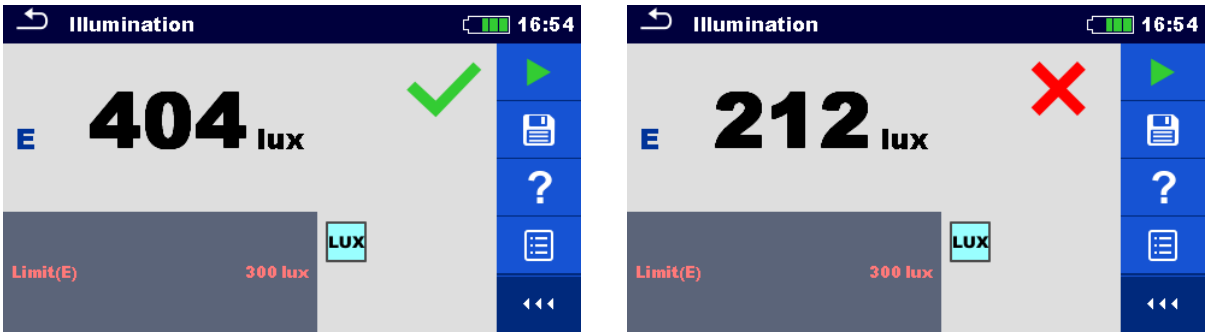


Figure 7.123: Examples of Illumination measurement result

Measurement results / sub-results

E	Illumination

7.37 **Discharging time**

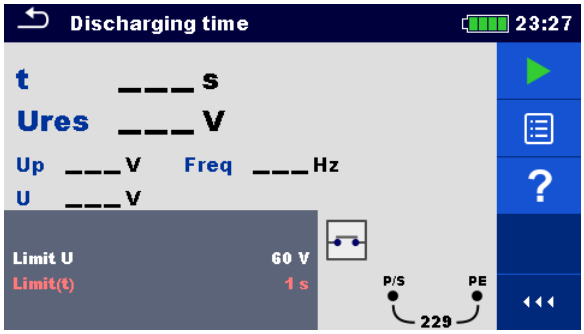


Figure 7.124: Discharging time measurement menu

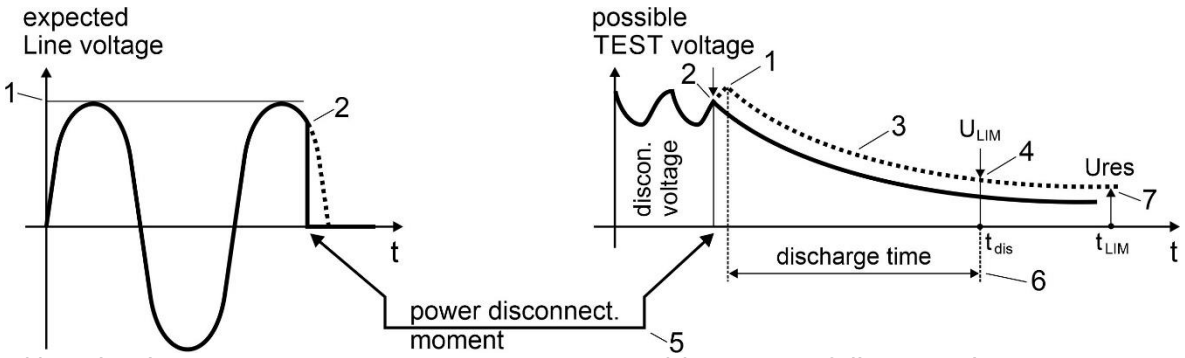
Measurement parameters / limits

Limit U	Voltage limit [34 V, 60 V, 120 V]
Limit (t)	Time limit [1 s, 5 s]

Measuring principle

The measuring principle of the discharging time function is as following:

Step 1:	The DUT is connected to supply voltage via an external socket. The instrument monitors the voltage (on supply or internal connections) and internally stores the peak voltage, r.m.s. voltage and frequency values.
Step 2:	The DUT is disconnected from the supply and the voltage at the test terminals starts to fall. Once the rms voltage falls for 10 V the instrument starts to measure discharging time.
Step 3:	After the voltage drops below an internally calculated voltage value the timer is stopped. The instrument re-calculates the measured time and residual voltage to values as they would be, if the disconnection occurred at the maximum voltage value.



(1) peak voltage
(2) voltage at disconnection time
(3) calculated voltage value
(4) Voltage limit - U_{LIM} (34 V, 60 V or 120 V)
(5) moment of disconnection
(6) discharging time @ U_{LIM}
(7) residual voltage @ t_{LIM} = 1 s (5 s)

Figure 7.125: Discharging time measuring principle

Connection diagram

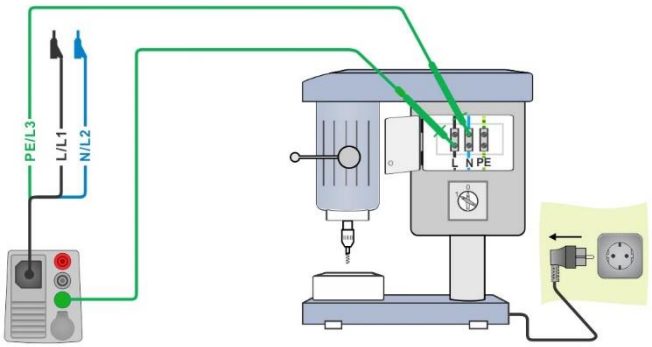


Figure 7.126: Discharging time measurement

Measurement procedure

- Enter the Discharging time function.
- Set test parameters / limits.
- Connect 3-wire test lead to the instrument and on the DUT, see *Figure 7.126*.
- Connect DUT to the mains supply and Switch it ON, see *Figure 7.126*.
- Start the measurement.
- Measurement will stop automatically when disconnecting DUT from mains supply.
- Save results (optional).

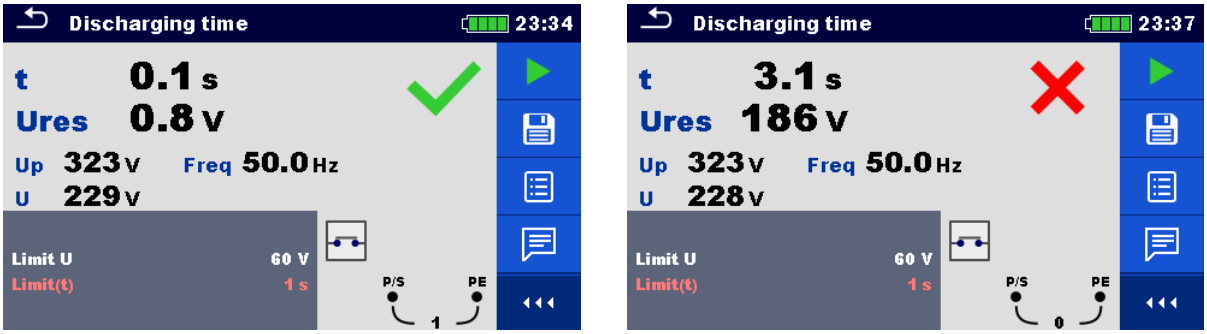


Figure 7.127: Discharging time results

Measurement results / sub-results

t	Discharging time
Ures	Residual voltage
Up	Peak value of supply voltage at disconnection time
U	RMS voltage
Freq	Frequency

7.38 AUTO TT – Auto test sequence for TT earthing system

Tests / measurements implemented in AUTO TT sequence

Voltage
Z line
Voltage Drop
Zs rcd
RCD Uc

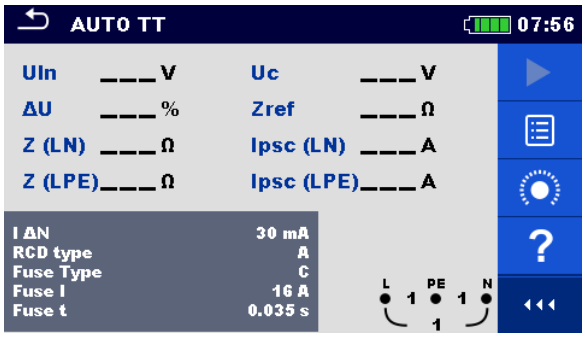


Figure 7.128: AUTO TT menu

Measurement parameters / limits

I ΔN	Rated RCD residual current sensitivity [10 mA, 15 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA]
RCD type	RCD type [AC, A, F, B, B+]
Selectivity	Characteristic [G, S]
Fuse type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
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 [Custom, 0.20 ... 3.00]
I test	Test current [Standard, Low]
Limit(ΔU)	Maximum voltage drop [Off, Custom, 3.0 % ... 9.0 %]
Limit Uc	Conventional touch voltage limit [Custom, 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.

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

Connection diagram

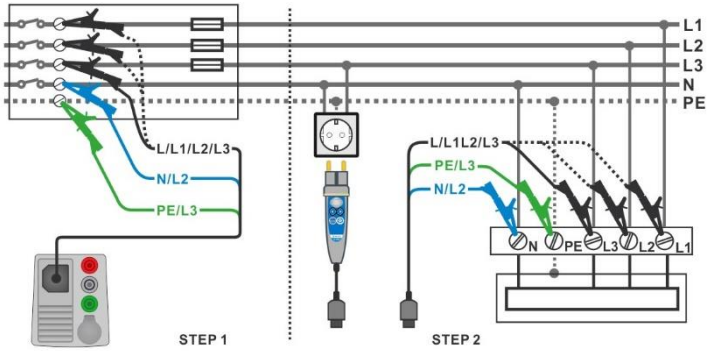


Figure 7.129: AUTO TT measurement

Measurement procedure

- Enter the AUTO TT function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter *7.19 Voltage Drop*.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.129*.
- Start the Auto test.
- Save results (optional).

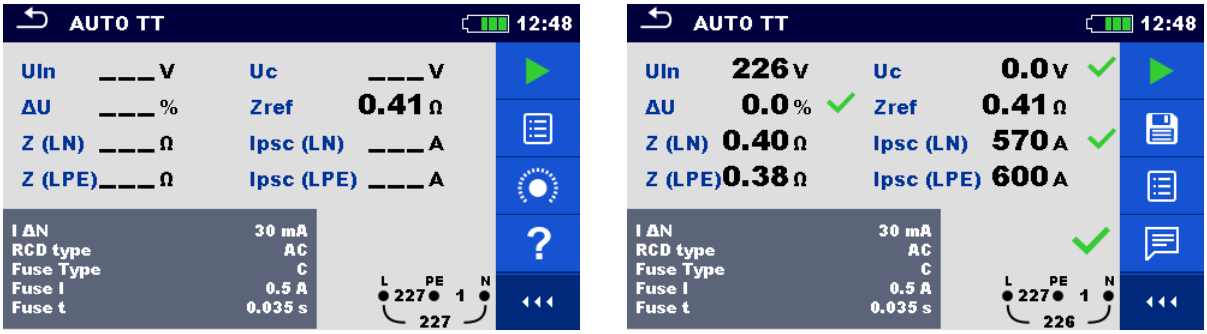


Figure 7.130: Examples of AUTO TT measurement results

Measurement results / sub-results

Uln	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

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

Tests / measurements implemented in AUTO TN (RCD) sequence

Voltage
Z line
Voltage Drop
Zs rcd
Rpe rcd

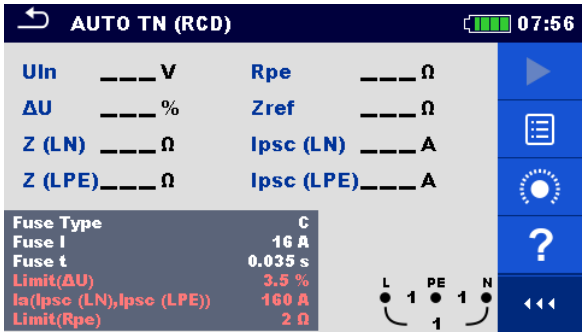


Figure 7.131: AUTO TN (RCD) menu

Measurement parameters / limits

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

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

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

Connection diagram

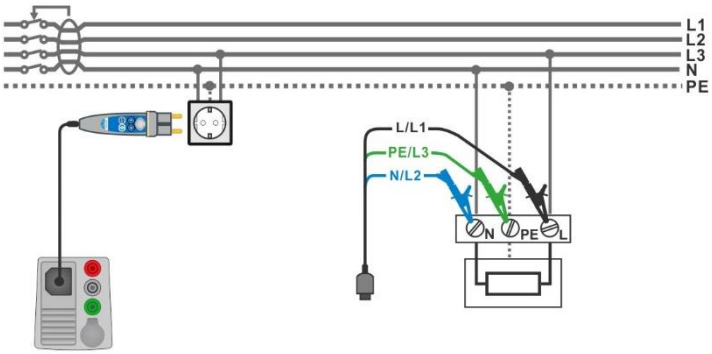


Figure 7.132: AUTO TN (RCD) measurement

Measurement procedure

- Enter the AUTO TN (RCD) function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter *7.19 Voltage Drop*.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.132*.
- Start the Auto test.
- Save results (optional).

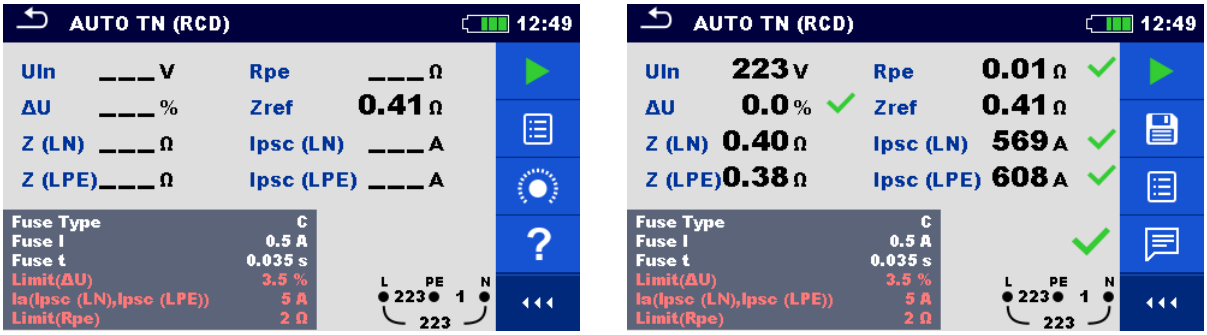


Figure 7.133: Examples of AUTO TN (RCD) measurement results

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

7.40 AUTO TN – Auto test sequence for TN earthing system without RCD

Tests / measurements implemented in AUTO TN sequence

Voltage
Z line
Voltage Drop
Z loop
Rpe

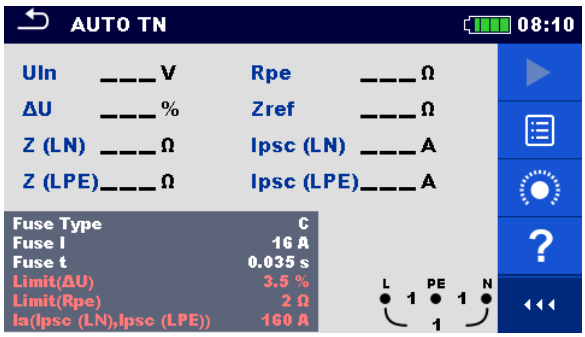


Figure 7.134: AUTO TN menu

Measurement parameters / limits

Fuse type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]

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)
Limit(ΔU)	Maximum voltage drop [Off, Custom, 3.0 % ... 9.0 %]
Limit(Rpe)	Max. resistance [Off, Custom, 0.1 Ω ... 20.0 Ω]
Ia(Ipsc (LN), Ipsc (LPE))	Minimum short circuit current for selected fuse or custom value
Isc factor	Isc factor [Custom, 0.20 ... 3.00]

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

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

Connection diagram

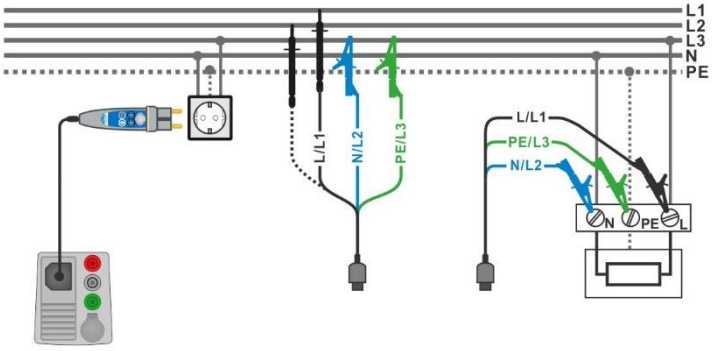


Figure 7.135: AUTO TN measurement

Measurement procedure

- Enter the AUTO TN function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter *7.19 Voltage Drop*.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the object under test, see *Figure 7.135*.
- Start the Auto test.
- Save results (optional).

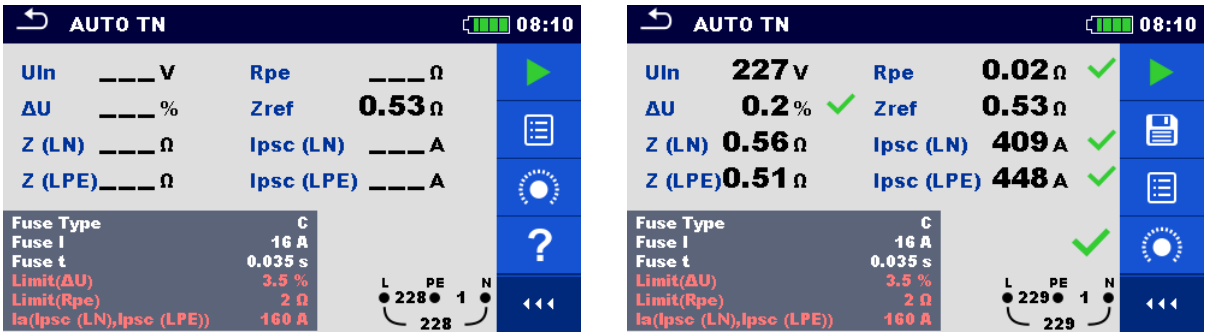


Figure 7.136: Examples of AUTO TN measurement results

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

7.41 AUTO IT – Auto test sequence for IT earthing system

Tests / measurements implemented in AUTO IT sequence

Voltage
Z line
Voltage Drop
ISFL
IMD

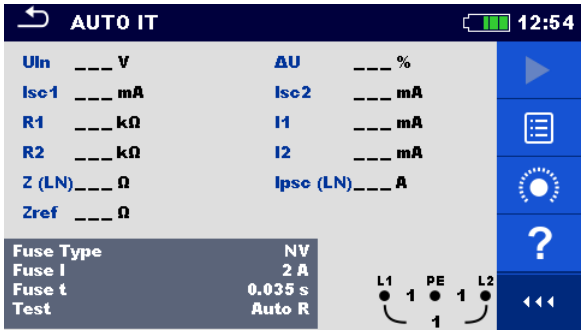


Figure 7.137: AUTO IT menu

Measurement parameters / limits

Fuse type	Selection of fuse type [Off, Custom, gG, NV, B, C, D, K, Z, L, U]
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 [Custom, 0.20 ... 3.00]
Limit(ΔU)	Maximum voltage drop [Off, Custom, 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, Custom, 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

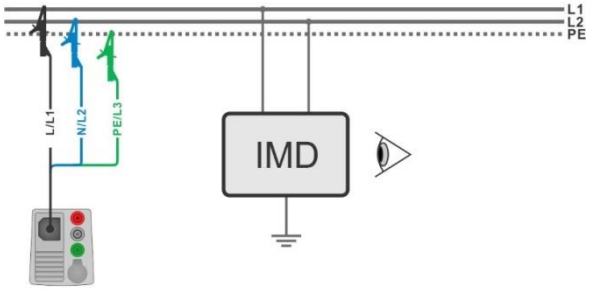


Figure 7.138: AUTO IT measurement

Measurement procedure

- Enter the AUTO IT function.
- Set test parameters / limits.
- Measure the impedance Zref at origin (optional), see chapter *7.19 Voltage Drop*.
- Connect test cable to the instrument.
- Connect 3-wire test lead to the object under test, see *Figure 7.138*.
- Start the Auto test.
- Save results (optional).

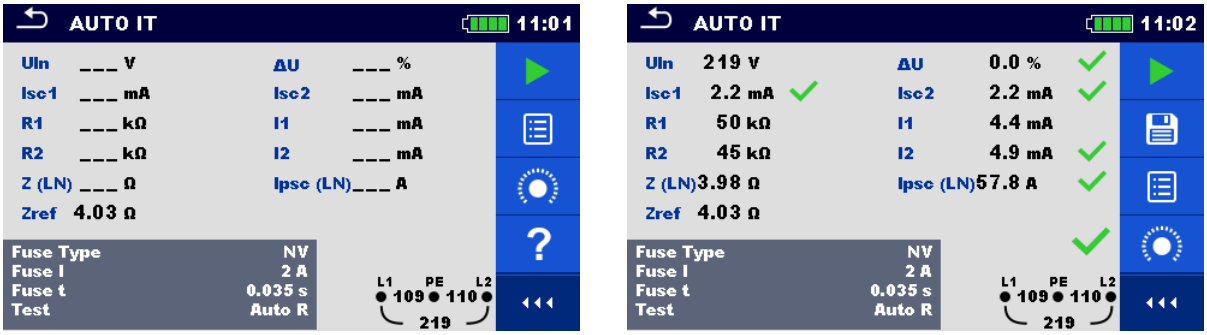


Figure 7.139: Examples of AUTO IT measurement results

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

7.42 **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 7.140: Locator main screen

Typical applications for tracing electrical installation

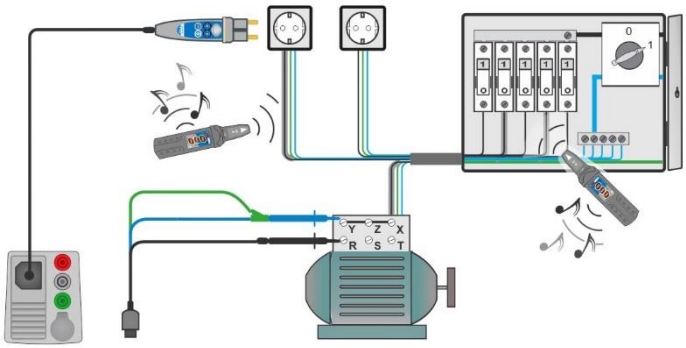


Figure 7.141: Tracing wires under walls and in cabinets

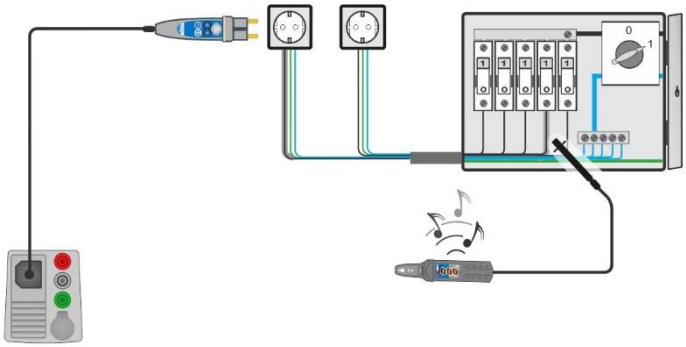


Figure 7.142: Locating individual fuses

Line tracing procedure

- Select *Locator* function in *Other* menu.
- Connect test cable to the instrument.
- Connect 3-wire test lead or Plug commander to the tested object (see *Figure 7.141* and *Figure 7.142*).
- Press the key.
- Trace lines with receiver (in IND mode) or receiver plus its optional accessory.
- To stop tracing press the key again.

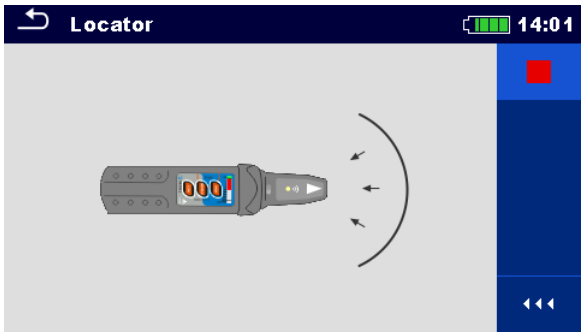


Figure 7.143: Locator active

7.43 Visual and Functional inspections

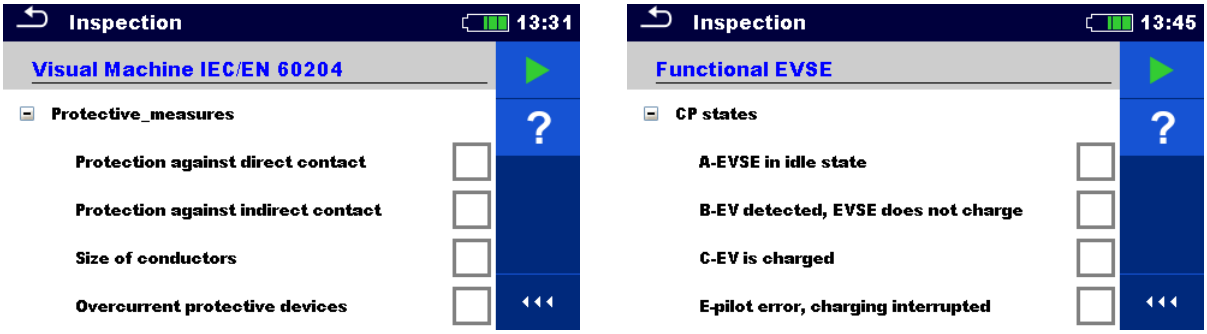


Figure 7.144: Examples of Visual / Functional inspection menu

Inspection

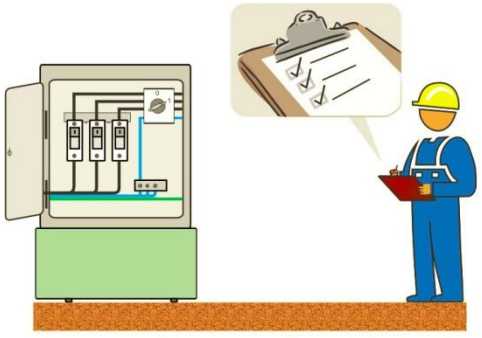


Figure 7.145: Visual / Functional inspection test circuit

Visual / Functional inspection procedure

- Select the appropriate inspection test from *Visual* or *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).

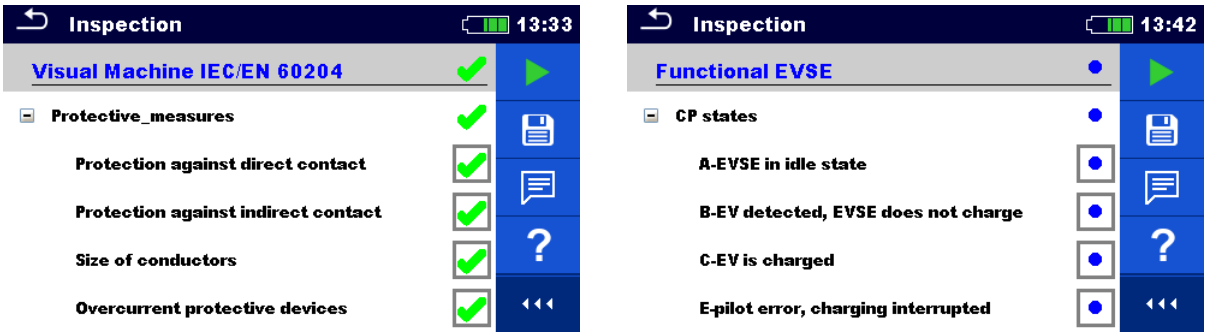


Figure 7.146: Examples of Visual / Functional inspection results

7.44 Measurements using adapter MD 9273

Clamp MD 9273 can be used as an adapter connected via Bluetooth® communication with EurotestXD in manner to expand it Power quality Test range. Supported test measurements and signal recordings are:

- P – Power CLAMP
- U – Voltage CLAMP
- I – Current CLAMP
- Imax – Inrush CLAMP
- h_n – Harmonics U CLAMP
- h_n – Harmonics I – CLAMP

Required test is selected from the CLAMP section of the Single Tests menu, see *Figure 7.147* below. Menu is available only when Adapter MD 9273 is set, see chapters *4.6.8 Settings* and *9.3 Communication with adapters* for details.

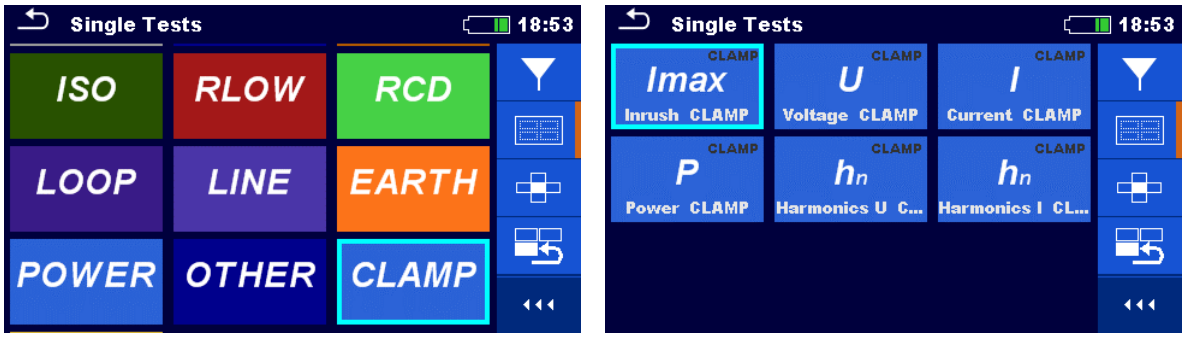


Figure 7.147: CLAMP single test selection menu

Selected test is configured from EurotestXD. Adapter MD 9273 acquires test signals, process measurements and send results to the EurotestXD. Results are presented on the instrument screen and can be saved to the Workspace memory for later use.

7.44.1 Power CLAMP

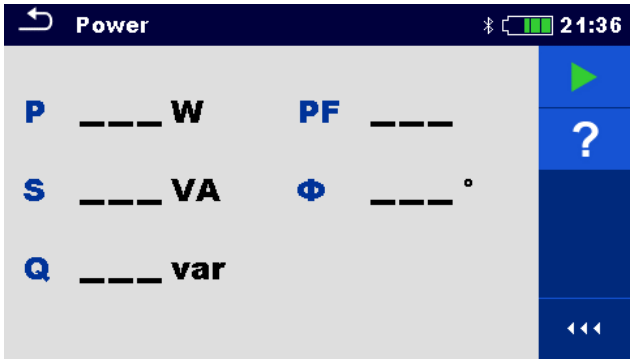


Figure 7.148: Power CLAMP menu

Measurement parameters

There are no parameters to be set.

Connection diagram

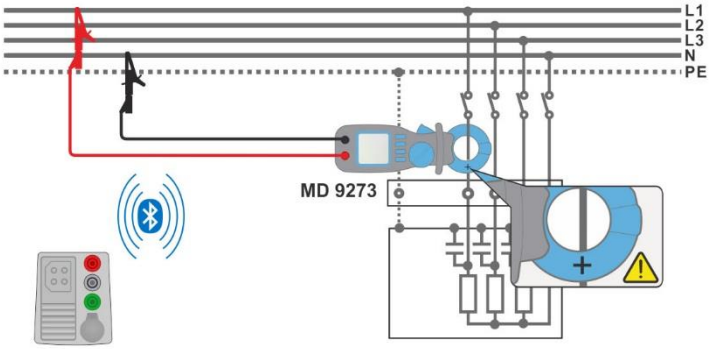


Figure 7.149: Power CLAMP connection

Measurement procedure

- Connect MD 9273 to the item to be tested and set Bluetooth® mode.
- Enter the Power CLAMP function and wait for active Bluetooth® communication sign.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

Figure 7.150: Power CLAMP results

Measurement results / sub-results	
P	Active power
S	Apparent power
Q	Reactive power (capacitive or inductive)
PF	Power factor (capacitive or inductive)
Φ	Phase displacement between voltage and current in degrees

Note:

Voltage test terminals connection and current flow toward load should be taken into account; the red voltage terminal should be connected to the Line terminal and the jaw should be correctly oriented, to obtain positive sign of Power test result. If Power test result has negative sign, connection of voltage terminal or jaw orientation are opposite and the result of phase displacement angle has opposite sign too. Consequently, load character determination (capacitive or inductive) is mismatched.

7.44.2 Voltage CLAMP

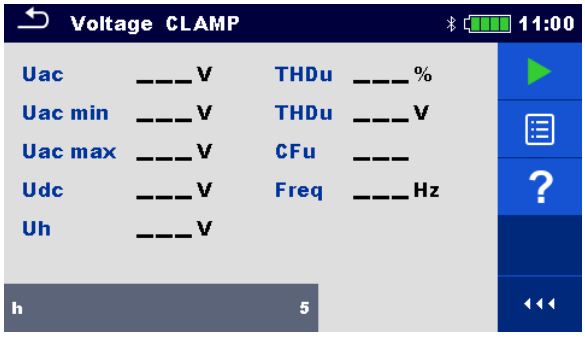


Figure 7.151: Voltage CLAMP menu

Measurement parameters	
h	Harmonic setup [1 to 19, 1st is fundamental frequency]

Connection diagram

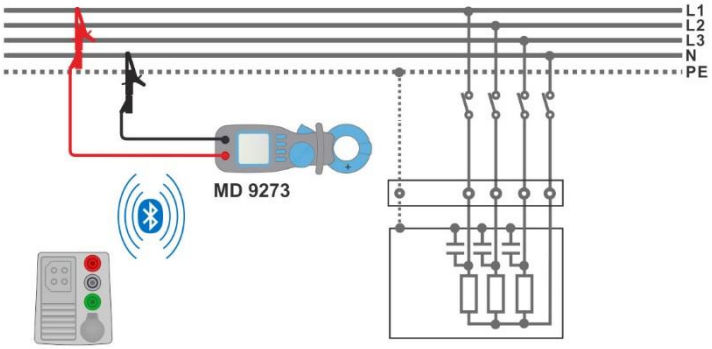


Figure 7.152: Voltage CLAMP connection

Measurement procedure

- Connect MD 9273 to the item to be tested and set Bluetooth® mode.
- Enter the Voltage CLAMP function and wait for active Bluetooth® communication sign.
- Set test parameter.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

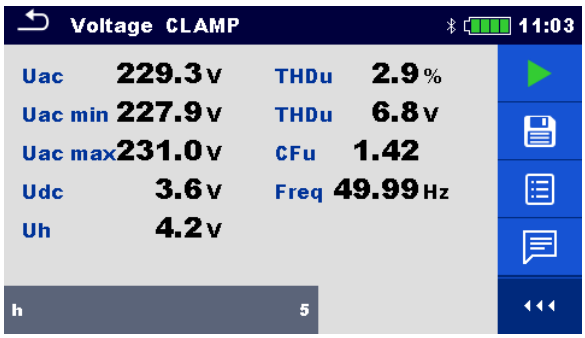


Figure 7.153: Voltage CLAMP results

Measurement results / sub-results

Uac	Effective ac voltage value – last obtained result
Uac min	Minimum effective ac voltage value during measurement time duration
Uac max	Maximum effective ac voltage value during measurement time duration
Udc	DC voltage value
THDu [V]	Effective voltage value of all harmonics (without voltage value at fundamental frequency)
THDu [%]	Total harmonic distortion
Uh	Effective voltage value of set harmonic
CFu	Voltage Crest factor – peak voltage to effective ac voltage ratio
Freq	Fundamental frequency

7.44.3 Current CLAMP

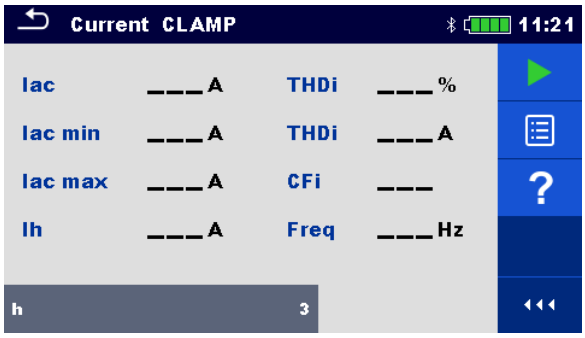


Figure 7.154: Current CLAMP menu

Measurement parameters

h	Harmonic setup [1 to 19, 1st is fundamental frequency]

Connection diagram

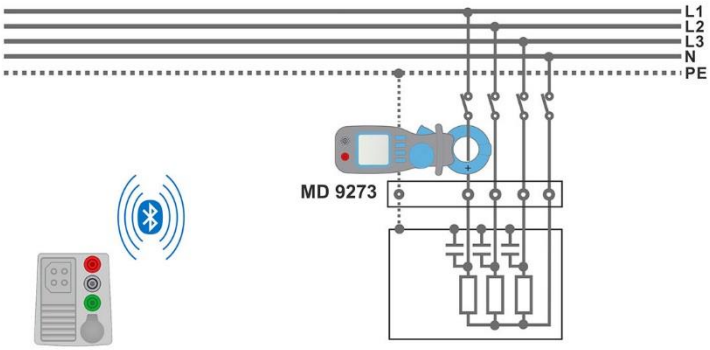


Figure 7.155: Current CLAMP connection

Measurement procedure

- Connect MD 9273 to the item to be tested and set Bluetooth® mode.
- Enter the Current CLAMP function and wait for active Bluetooth® communication sign.
- Set test parameter.
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

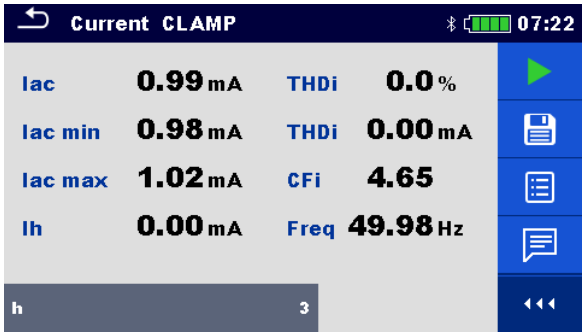


Figure 7.156: Current CLAMP results

Measurement results / sub-results

Iac	Effective ac current value – last obtained result
Iac min	Minimum effective ac current value during measurement time duration
Iac max	Maximum effective ac current value during measurement time duration
THDi [A]	Effective current value of all harmonics (without current value at fundamental frequency)
THDi [%]	Total harmonic distortion
Ih	Effective current value of set harmonic
CFi	Current Crest factor – peak current to effective current ratio
Freq	Fundamental frequency

7.44.4 Inrush CLAMP

Inrush CLAMP function records current and voltage transients that occur when load is turned on. Recorded values are presented on the screen of the instrument in separate charts. Two event triggers can be set, Voltage dip or Inrush current. Only one trigger can be active at the same time; when one is set, the other is switched off automatically. Voltage dip trigger is effective only if MD 9273 Voltage input is connected to supply circuit. Minimum effective circuit voltage is calculated during recorded transient and compared with set voltage threshold. Inrush current trigger is effective only if the wire with flowing current is embraced with MD 9273 jaws. Maximum effective ac circuit current is calculated during recorded transient and compared with set Inrush threshold.
After Inrush Test is started, MD 9273 starts to record signals and waits for trigger event to occur, which is symbolised with sign  on the bottom right of the screen. Displayed chart is divided in Pre-trigger area, presenting first second of total set chart duration time and transient event area – rest of the chart duration time.
Trigger event occur automatically, when one of the recorder signals achieve set threshold level or can be initiated manually by tapping on the  icon within command menu on the right of the screen, see right screen picture of the figure below.

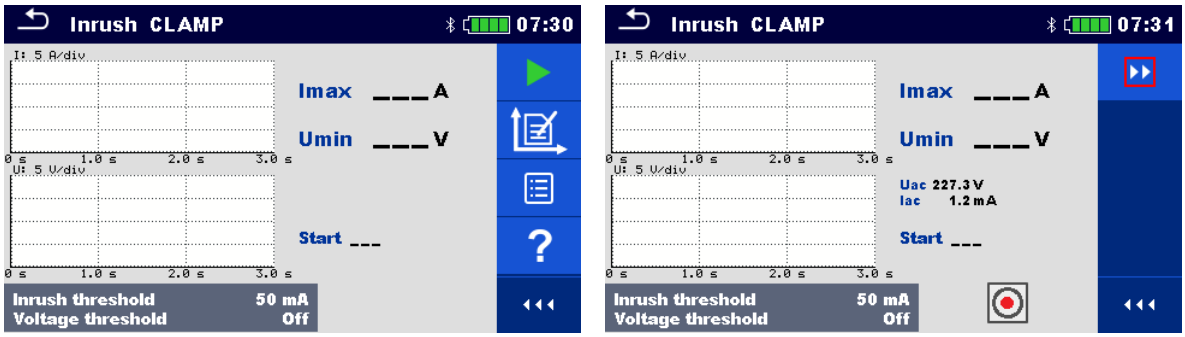


Figure 7.157: Inrush CLAMP menu – setup on the left, waiting for trigger on the right

Test parameters

Inrush threshold	Inrush current threshold setting [Off, 5 mA ... 90 A]
Voltage threshold	Voltage dip threshold setting [Off, 50 V ... 500 V]
Duration	Recording duration [3 s, 10 s]

Connection diagram

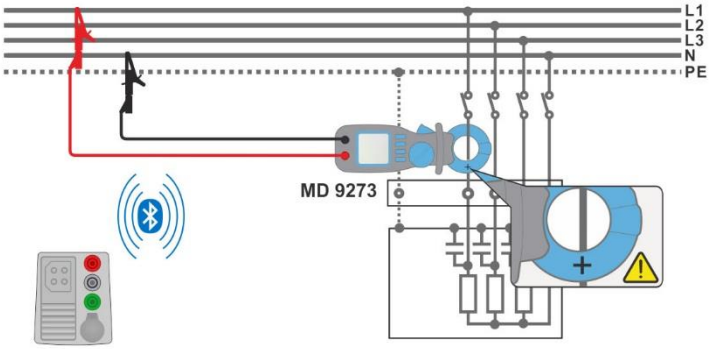


Figure 7.158: Inrush CLAMP connection

Test procedure

- Connect MD 9273 to the item to be tested and set Bluetooth® mode.
- Enter the Inrush CLAMP function and wait for active Bluetooth® communication sign.
- Set test parameters.
- Set charts Y value range[1)] within expected values (optional; could be set later, after the test)
- Start the test.
- Initiate set threshold event or manually trigger test recording.
- Save results (optional) after test is finished and results and recorded charts are presented on the screen.

1) Chart range selection:
   - Voltage range [100 mV/div ... 100 V/div]
   - Current range [10 mA/div ... 200 A/div]

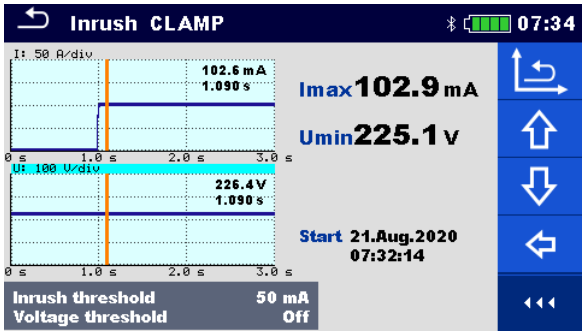


Figure 7.159: Inrush CLAMP results

Test results / sub-results

I:	Inrush current chart [2)] range
	Recorded effective ac current value at cursor position
	Relative time of recorded data at cursor position
U:	Circuit voltage chart [2)] range
	Recorded effective ac voltage value at cursor position
	Relative time of recorded data at cursor position

Imax	Inrush current maximum value of recorded data
Umin	Circuit voltage dip minimum value of recorded data
Uac	Effective ac voltage (within the measurement)
Iac	Effective ac current (within the measurement)
Start	Inrush test start recording time (from Master Instrument)

[2] Tap on chart area or drag graph line cursor to present chart value at chosen time. Use left / right arrow keys for smooth setting.

7.44.5 Harmonics U CLAMP

Harmonics (1 through to 19) are measured and displayed in the chart as an absolute magnitude of the signal or as a percentage of the signal value at the fundamental frequency (the 1st harmonic h1). Absolute magnitude or percent value display is chosen by Type parameter setting.

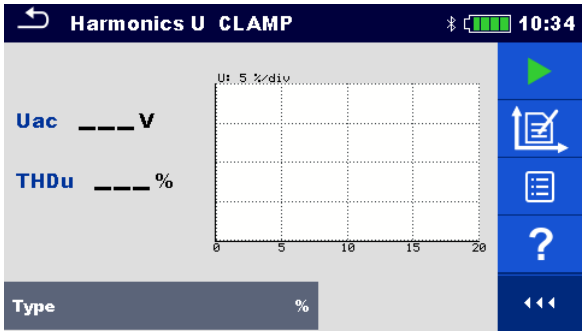


Figure 7.160: Harmonics U CLAMP menu

Measurement parameters

Type	[%, V] % – harmonics and distortion are displayed as relative value V – harmonics and distortion are displayed as absolute value

Connection diagram

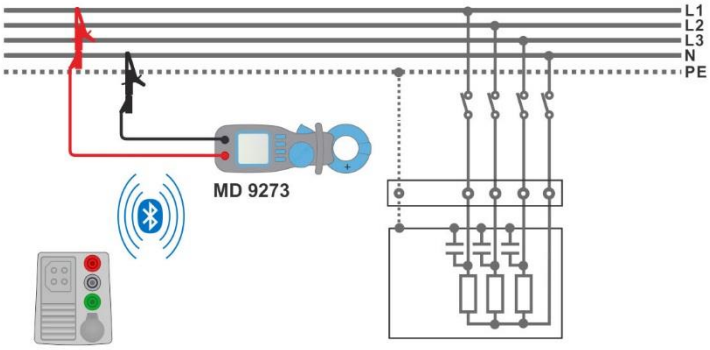


Figure 7.161: Harmonics U CLAMP connection

Measurement procedure

- Connect MD 9273 to the item to be tested and set Bluetooth® mode.
- Enter the Harmonics U CLAMP function and wait for active Bluetooth® communication.
- Set Type parameter.

- Set charts Y value range[3] within expected values (optional; could be set later, after the test).
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

[3] Chart Voltage range selection: [100 mV/div ... 100 V/div]

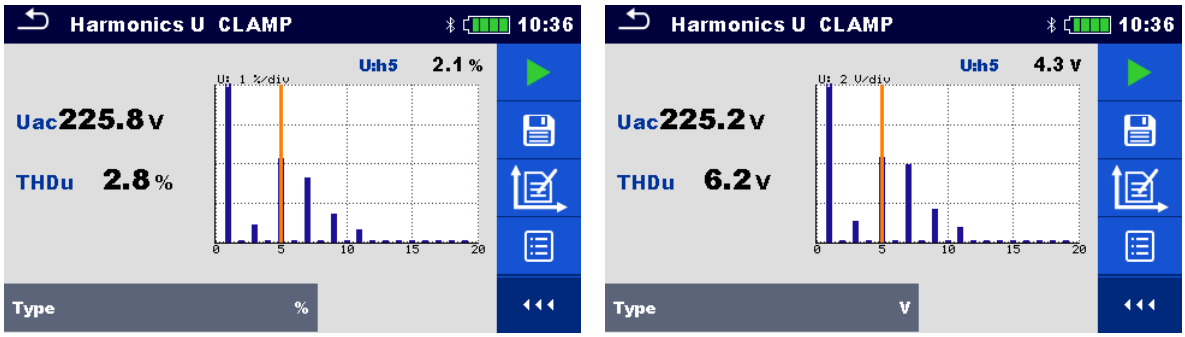


Figure 7.162: Harmonics U CLAMP results

Measurement results / sub-results

U:	Harmonics chart range
Uac	Effective ac voltage value
THDu [%]	Total harmonic distortion
THDu [V]	Effective voltage value of all harmonics (without voltage value at fundamental frequency)
U:h5 [%]	Relative value of 5th harmonic [4]
U:h5 [V]	Absolute voltage of 5th harmonic [4]

[4] Tap on chart area at chosen harmonic to present its value.

7.44.6 Harmonics I CLAMP

Harmonics (1 through to 19) are measured and displayed in the chart as an absolute magnitude of the signal or as a percentage of the signal value at the fundamental frequency (the 1st harmonic h1). Absolute magnitude or percent value display is chosen by Type parameter setting.

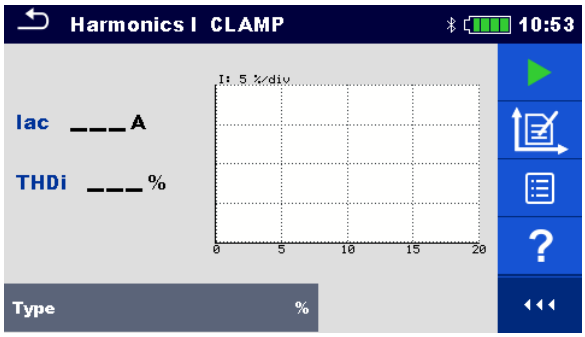


Figure 7.163: Harmonics I CLAMP menu

Measurement parameters

Type	[%, A] % – harmonics and distortion are displayed as relative value A – harmonics and distortion are displayed as absolute value

Connection diagram

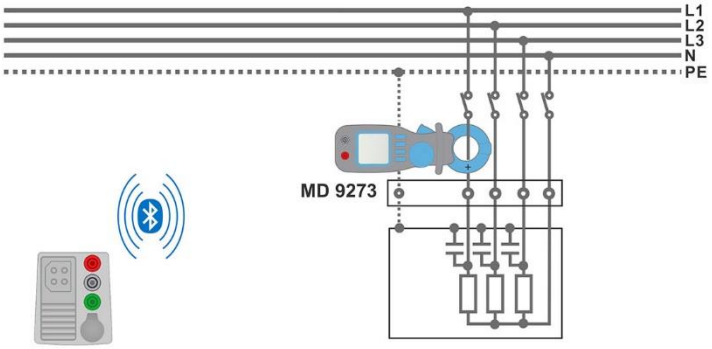


Figure 7.164: Harmonics I CLAMP connection

Measurement procedure

- Connect MD 9273 to the item to be tested and set Bluetooth® mode.
- Enter the Harmonics I CLAMP function and wait for active Bluetooth® communication.
- Set Type parameter.
- Set charts Y value range within expected values (optional; could be set later, after the test).
- Start the continuous measurement.
- Stop the measurement.
- Save results (optional).

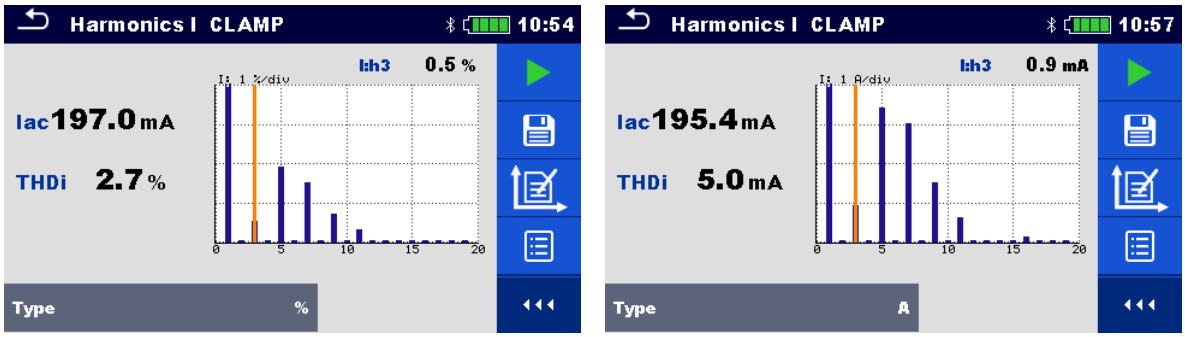


Figure 7.165: Harmonics I CLAMP results

Measurement results / sub-results

I	Harmonics chart
Iac	Effective ac current value
THDi [%]	Total harmonic distortion
THDi [A]	Effective current value of all harmonics (without current value at fundamental frequency)
I:h3 [%]	Relative value of 3rd harmonic [5)]
I:h3 [A]	Absolute current value of 3rd harmonic [5)]

[5)] Tap on chart area at chosen harmonic to present its value.

7.45 Measurements using DC EVSE adapter A 1732

In combination with DC EVSE adapter A 1732, the instrument enables testing of DC charging stations. See *A 1732 DC EVSE adapter Instruction manual* for more information.

The instrument and adapter must be connected via Bluetooth. See chapter *4.6.8.1 Adapters* for more information.

7.45.1 Indication of charging states

During a charging process the EVSE goes through different states. The momentary charging state is displayed in the yellow box. See chapter *Charging sequence states* in *A 1732 DC EVSE adapter Instruction manual* for more information.

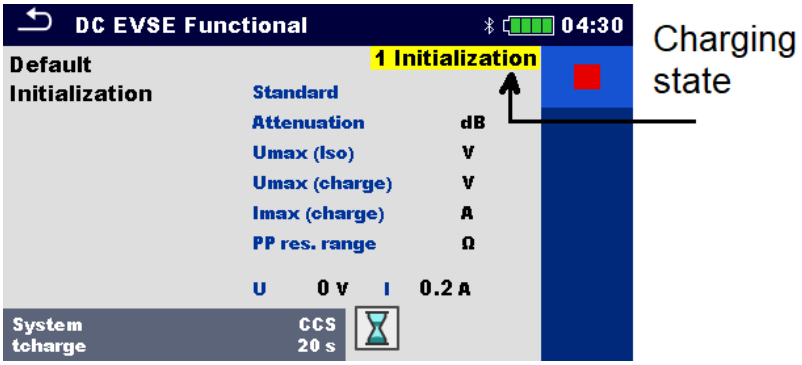


Figure 7.166: Indication of charging states

For the measurements, the EVSE must be in the correct charging state to enable testing and obtain results. Please refer to Measurement Procedure for each specific measurement.

7.45.2 Z (DC EVSE)

Test results / sub-results

Z	Impedance between DC+, DC-
Ipsc	Prospective short circuit current
U DC	Measured voltage between DC+ and DC-

Test parameters

System	System [CCS, CHAdeMO]

Test limits

Limit	Limit (Z) [Off, Custom]

Test circuit

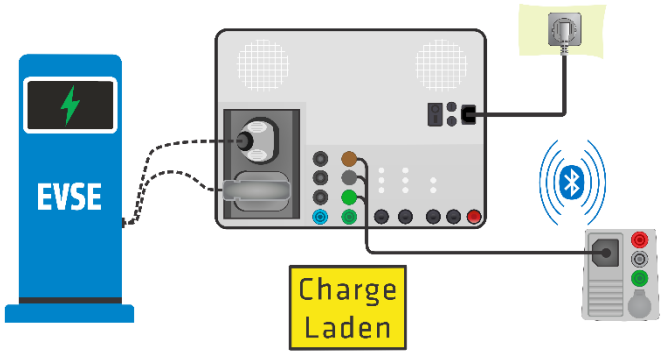


Figure 7.167: Z (DC EVSE) connection

Note

- The result cannot be regarded as the true output impedance result.
  See chapter *1.1.5 Notes related to measurement functions* for more information.

Measurement procedure

- Set parameters/ limits on the instrument.
- Connect instrument test leads to the adapter.
- Insert charging plug in the appropriate charging inlet on the adapter.
- Press RUN key on the instrument.
- Authorize and follow instructions on the EVSE.
- Press START on the EVSE, (if needed).
- Check progress of the charging sequence on the EVSE and instrument.
- The Z (DC EVSE) test will be carried out automatically 5 seconds after the Charge (CCS) / Energy transfer (CHAdeMO) has started.
- Check that the EVSE has stopped charging.
- Save results (optional).

7.45.3 Riso (DC EVSE)

Test results / sub-results

DC+ / DC-	Insulation resistance between DC+, DC-
DC+ / PE	Insulation resistance between DC+ and PE
DC- / PE	Insulation resistance between DC- and PE
Um (DC+ / DC-, DC+ / PE, DC- / PE)	Test voltages between DC+, DC-, PE

Test parameters

System	System [CCS, CHAdeMO]
Uiso	Test voltage [500 V, 1000 V]

Test limits

Limit Riso (+,PE), Riso (-,PE)	Limit (Riso) [Off, Custom, 500 kΩ ... 2 MΩ]
Limit Riso (+,-)	Limit (Riso) [Off, Custom, 500 kΩ ... 2 MΩ]

Test circuit

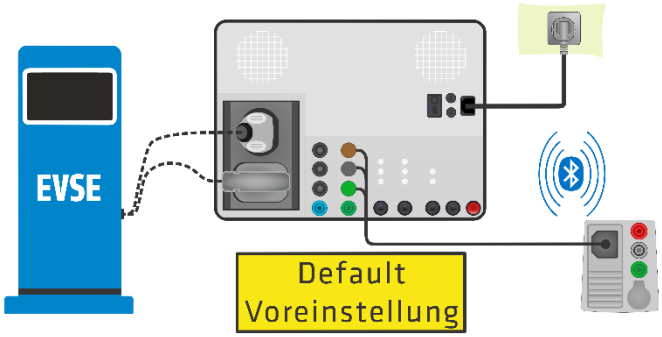


Figure 7.168: Riso (DC EVSE) connection

Measurement procedure

- Set parameters/ limits on the instrument.
- Connect instrument test leads to the adapter.
- Insert charging plug in the appropriate charging inlet on the adapter.
- The Riso (DC EVSE) test should be carried out while the EVSE is in idle state (charging sequence not started).
- Press RUN key on the instrument.
- Save results (optional).

7.45.4 RIow (DC EVSE)

Test results / sub-results

R	Resistance
R+	Resistance (positive polarity)
R-	Resistance (negative polarity)

Test parameters

System	System [CCS, CHAdeMO]

Test limits

Limit	Limit (R) [Off, Custom, 0.05 Ω ... 20.0 Ω]

Test circuit

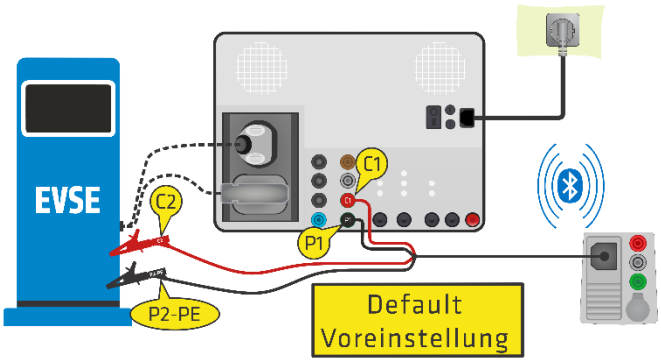


Figure 7.169: RIow (DC EVSE) connection

Measurement procedure

- Set parameters / limits on the instrument.
- Connect instrument test leads to the adapter and to the accessible metal parts of the EVSE.
- Insert charging plug in the appropriate charging inlet on the adapter.
- The RIow (DC EVSE) test can be carried out while the EVSE is in idle state (charging sequence not started).
- Press RUN key on the instrument.
- Save results (optional).

7.45.5 IMD (DC EVSE)

Test results / sub-results

t	Charger's IMD disconnection time
Message	Error, Warning (if EVSE sent message via communication)

Test parameters

System	System [CCS, CHAdeMO]
R	Simulated insulation resistance [20 kΩ ... 640 kΩ]
Test	Connection of resistor [(+,PE), (-,PE)]

tcharge	Duration of charging [10 s, 15 s, 20 s, 30 s]

Test limits

There are no limits to be set.

Test circuit

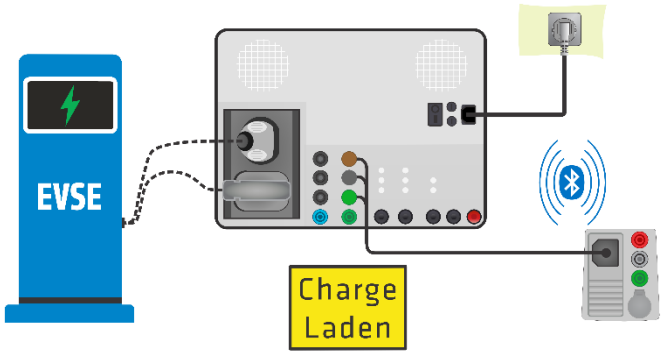


Figure 7.170: IMD (DC EVSE) connection

Measurement procedure

- Set parameters/ limits on the instrument.
- Connect instrument test leads to the adapter.
- Insert charging plug in the appropriate charging inlet on the adapter.
- Press RUN key on the instrument.
- Authorize and follow instructions on the EVSE.
- Press START on the EVSE, (if needed).
- Check progress of the charging sequence on the EVSE and adapter.
- The IMD test resistance will be applied and the disconnection time will be measured automatically 5 s after the Charge (CCS) / Energy transfer (CHAdeMO) has started.
- The Charging process will stop automatically when the EVSE shut down or after set tcharge will expire.
- Check that the EVSE has stopped charging and for error messages on EVSE.
- Save results (optional).

WARNING

- EVSE may become locked.
  See chapter *1.1.5 Notes related to measurement functions* for details.

7.45.6 Discharging time - Tdisch (DC EVSE)

Test results / sub-results

t	Discharging time (time at voltage limit)

Ures	Residual voltage (voltage at time limit)
U	RMS voltage

Test parameters

System	System [CCS, CHAdeMO]
Limit	Limit voltage [60 V]

Test limits

Limit (t)	Limit (t) [1 s, 5 s]

Test circuit

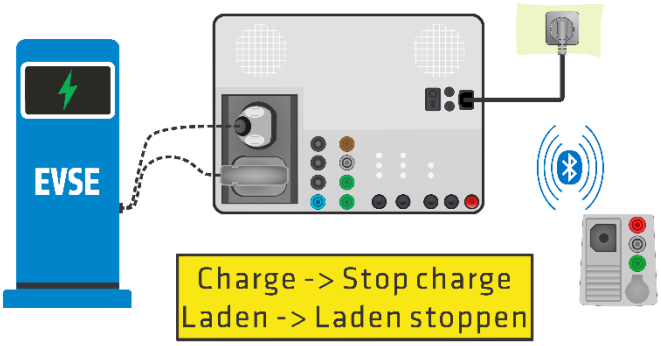


Figure 7.171: Tdisch (DC EVSE) connection

Measurement procedure

- Set parameters/ limits on the instrument.
- Insert charging plug in the appropriate charging inlet on the adapter.
- Press RUN key on the instrument.
- Authorize and follow instructions on the EVSE.
- Press START on the EVSE, (if needed).
- Check progress of the charging sequence on the EVSE and the LEDs on the adapter.
- The Discharging time test will be carried out automatically 5 seconds after the Charge (CCS) / Energy transfer (CHAdeMO) has started.
- Check that the EVSE has stopped charging.
- Save results (optional).

7.45.7 DC EVSE Functional test

Test results / sub-results

System: CCS

CCS charging sequence states	[Default, Initialization, Authentication, Parameter, Isolation, Precharge, Charge, Stop charge, Session stop, Shutoff, Error]
Standard	Communication standard used
Attenuation	Strength of communication signal
Umax (Iso)	Maximum voltage DC+ DC- during Isolation check
Umax (charge)	Maximum charging voltage DC+ DC-
Imax (charge)	Maximum charging current
PP res. range	Range of measured PP resistor
U	Momentary voltage DC+ DC-
I	Momentary charging current

System: CHAdeMO

CHAdeMO charging sequence states	[Default, Vehicle unconnected A, Initialization B1, Initialization B2, Initialization B3, Initialization B4, Energy transfer C, Shutdown B1, Shutdown B2, Shutdown B3, Shutdown B4, Error initialization B, Error E]
Umax (Iso)	Maximum voltage DC+ DC- during Isolation check
Umax (charge)	Maximum charging voltage DC+ DC-
Imax (charge)	Maximum charging current
U	Momentary voltage DC+ DC-
I	Momentary charging current

System: AC

AC charging sequence states	[State A, State B, State C, Error]
PP value	PP current value
Duty C.	Duty cycle of Control Pilot (CP)
Ievse	Charging current available by charging cable / EVSE

Test parameters

System	System [CCS, CHAdeMO, AC]
tcharge	Duration of charging [5 s ... 30 s]

Test limits

There are no limits to be set.

Test circuit

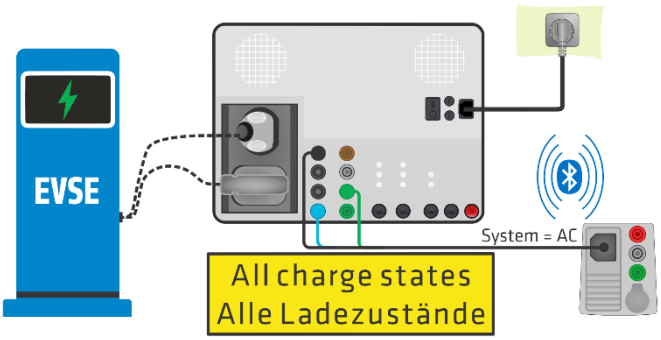


Figure 7.172: DC EVSE Functional test connection

Measurement procedure

- Set parameters/ limits on the instrument.
- Connect instrument test leads to the adapter, applies only for AC charging system.
- Insert charging plug in the appropriate charging inlet on the adapter.
- Press RUN key on the instrument.
- Authorize and follow instructions on the EVSE.
- Press START on the EVSE, (if needed).
- Progress of the charging sequence on the EVSE is shown on the instrument.
- The measurement will be stopped automatically after tcharge set time will expire.
- Check that the EVSE has stopped charging.
- Save results (optional).

Note

- Attenuation of communication signal should be >45 dB.

7.45.8 DC EVSE Error

Test results / sub-results

toff	EVSE shutdown time

Test parameters

System: CCS

Fault	Simulated fault [CP open, PE open, CP short]

System: CHAdeMO

Fault	Simulated fault [CP 3 open, PE open, CAN stop]

System: AC

Fault	Simulated fault [CP open, PEopen, CP short]

Test limits

System: CCS, CHAdeMO

Limit (toff)	Limit (t) [Off, Custom, 0.1 s]

Test circuit

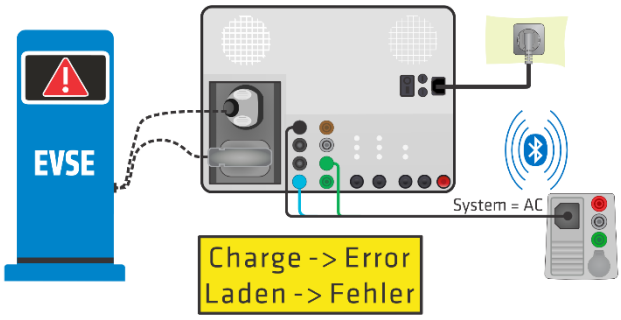


Figure 7.173: DC EVSE Error test connection

Measurement procedure

- Set parameters/ limits on the instrument.
- Insert charging plug in the appropriate charging inlet on the adapter.
- Press RUN key on the instrument.
- Authorize and follow instructions on the EVSE.
- Press START on the EVSE, (if needed).
- Check progress of the charging sequence on the EVSE and information on the instrument.
- The fault will be activated automatically 5 seconds after start of charging and the measurement will stop 5 s (for CCS/CHAdeMO) or 30 s (for AC) after the fault was activated.
- Check the response of the EVSE – charging sequence must be stopped and appropriate Error message must be shown on EVSE.
- Save results (optional).

WARNING

- EVSE may become locked.
  See chapter *1.1.5 Notes related to measurement functions* for details.

8 Auto Sequences®

Pre-programmed sequences of measurements can be carried out in Auto Sequences® menu. The sequence of measurements, their parameters and flow of the sequence can be programmed. The results of an Auto sequence® can be stored in the memory together with all related information. Auto Sequences® can be pre-programmed on PC with the Metrel ES Manager software and uploaded to the instrument. Refer to chapter *Appendix F Programming of Auto Sequences® on Metrel ES Manager* for detailed information on programming Auto Sequences®.

On the instrument parameters and limits of individual single test in the Auto Sequence® can be changed / set.

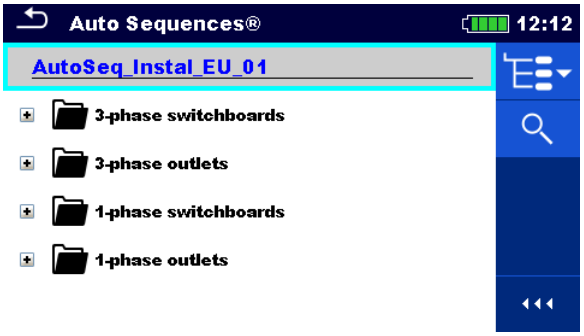
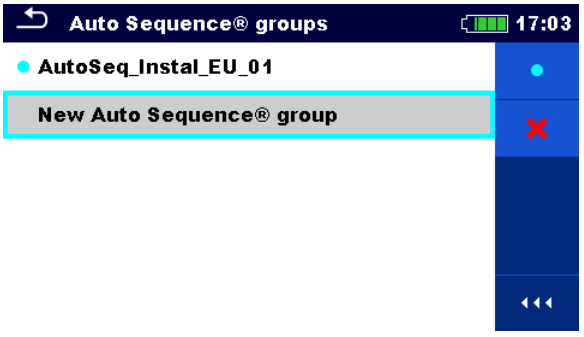
8.1 Selection of Auto Sequences®

The Auto Sequence® list from Auto Sequence® groups menu should be selected first. Refer to chapter *4.9 Auto Sequence® groups* for more details.

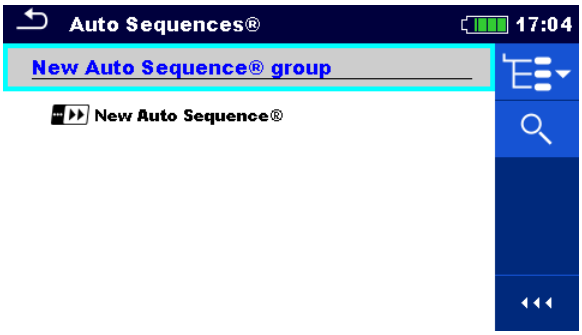
8.1.1 Selecting an active Auto Sequence® group in Auto Sequences® menu

Auto Sequences® and Auto Sequence® group menus are interconnected so an active Auto Sequence® group can be selected also in the Auto Sequences® menu.

Procedure

①		Tap on the active Auto Sequence® group header in Auto Sequences® Menu.
②		Opens a list of Auto Sequence® groups in Control panel.
③		Selects desired Auto Sequence® group from a list of groups.
④		Confirms a new selection.

⑤



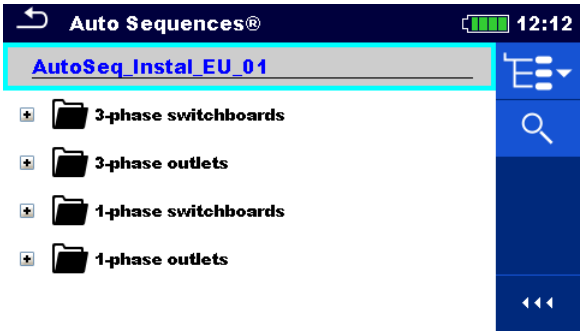
New Auto Sequence® group is selected and all Auto Sequences® within that group are displayed on the screen.

8.1.2 Searching in Auto Sequences® menu

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

Procedure

①

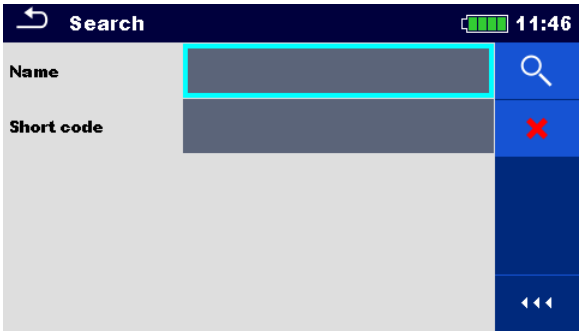


Search function is available from the active Auto Sequence® group header line.

②

Select Search in control panel to open Search setup menu.

③

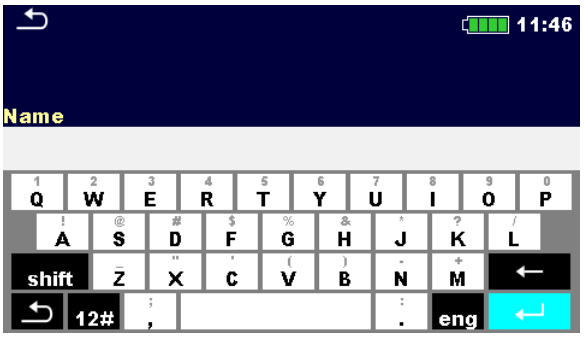


The parameters that can be searched for are displayed in the Search setup menu.

③a

The parameters that can be searched for are displayed in the Search setup menu.

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.

③b

Clears all filters. Sets filters to default value.

④

Searches through the active Auto Sequence® group according to the set filters.

The results are shown in the Search results screen presented on *Figure 8.1*.

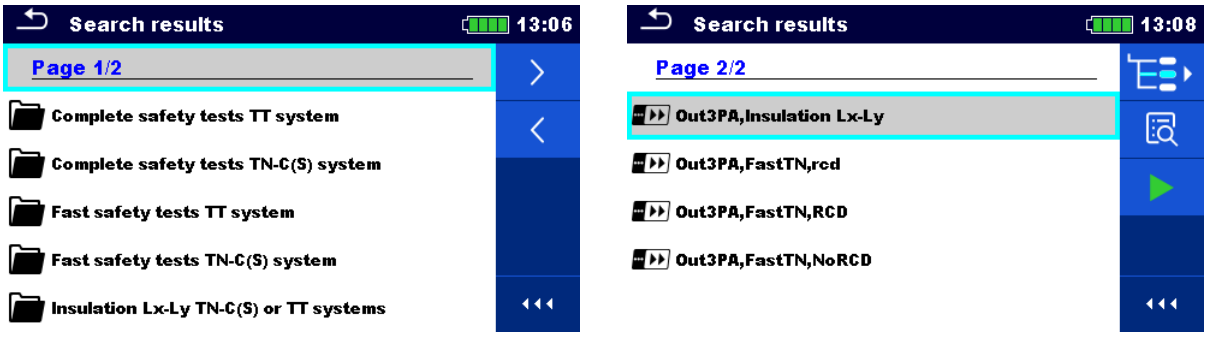


Figure 8.1: Search results screen (left), Auto Sequence selected (right)

Options

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

Note:

- Search result page consist of up to 50 results.

8.1.3 Organization of Auto Sequences® in Auto Sequences® menu

The Auto Sequences® to be carried out can be selected from the Main Auto Sequences® menu. This menu can be organized in a structural manner with folders, sub-folders and Auto Sequences®. 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.

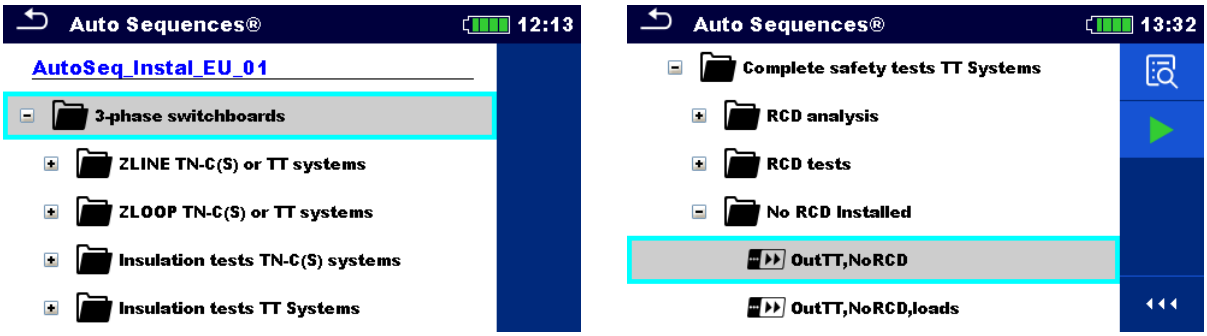


Figure 8.2: Examples of organized Auto Sequences® in main Auto Sequences® menu

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 Sequence® 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 *8.1.2 Searching in Auto Sequences® menu* for more information.

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. The sequence of single tests is controlled by pre-programmed flow commands.

- 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 Sequence® 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 the active Auto Sequence® and stored for next use of the same Auto Sequence®.

8.2.1.1 Auto Sequence® view menu (Header is selected)

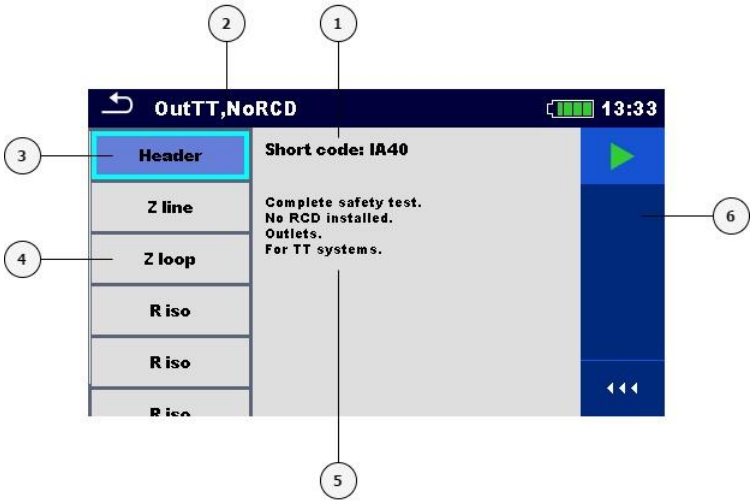


Figure 8.3: Screen organization in Auto Sequence® view menu – Header selected

Legend

1	Short code
2	Auto Sequence® name
3	Header
4	Single tests
5	Description
6	Control panel (available options)

Option

	Starts the Auto Sequence®.

8.2.1.2 Auto Sequence® view menu (measurement is selected)

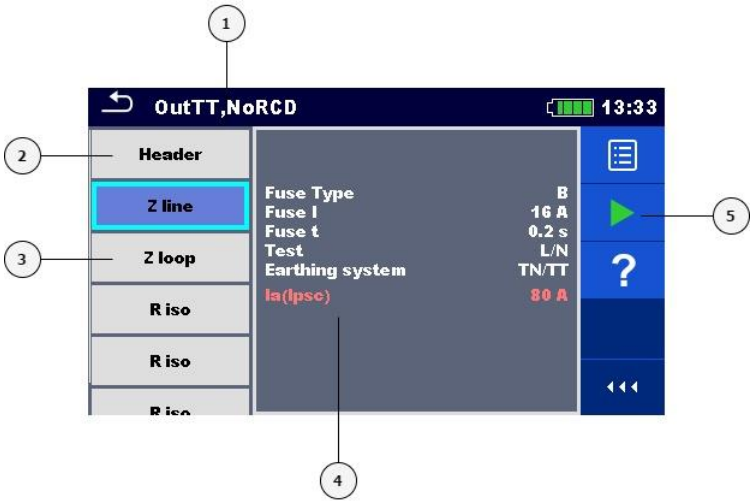


Figure 8.4: Screen organization in Auto Sequence® view menu – measurement selected

Legend

1 Auto Sequence® name

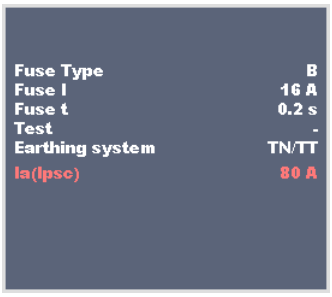
2 Header

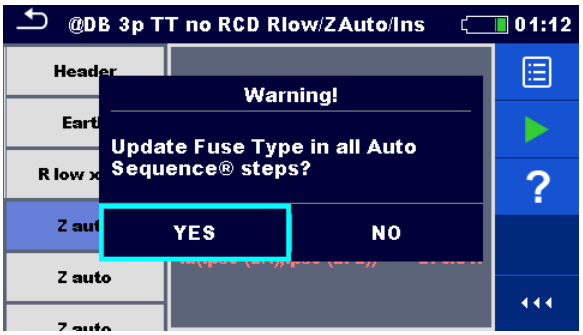
3 Single tests

4 Parameters / limits of selected single test

5 Control panel (available options)

Options

	Selects single test.
	Opens menu for changing parameters and limits of selected measurements. Refer to chapter *0* *Setting parameters, limits and comments of* single tests for more information how to change measurement parameters and limits.
 on 	

	User must decide whether the changes in global parameter(s) apply to all single tests within the selected Auto Sequence® containing the modified parameter(s), or only for the edited one.
	Starts the Auto Sequence®.
	Opens help screens. Refer to chapter *6.1.8 Help screens* for more information.

8.2.1.3 Indication of Loops

The attached 'x3' at the end of a 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 of actions controlled by flow commands are:

- pauses during the Auto Sequence®,
- buzzer/ PASS/FAIL sound after the tests,
- proceeding of test sequence in regard to measured results,
- etc.

The actual list of flow commands is available on chapter *F.7 – Description of flow commands*.

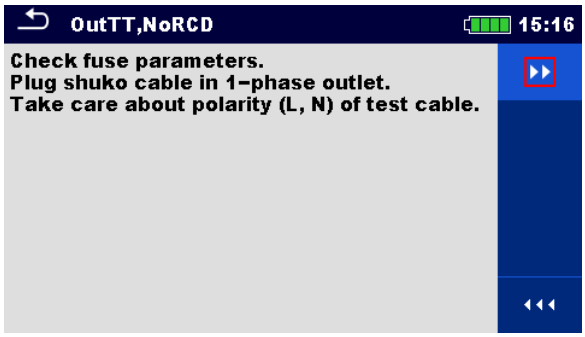


Figure 8.5: Auto Sequence® – Example of a pause with message

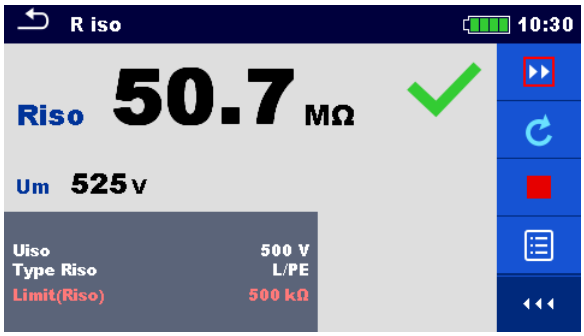


Figure 8.6: Auto Sequence® – Example of a finished measurement with options for proceeding

Options (during execution of an Auto Sequence®):

	Proceeds to the 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 Auto Sequence®.

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

Notes:

- During Auto Sequences® the popup Warning messages are displayed only before the single test inside one Auto Sequence®. This default setting can be changed with appropriate flow command. For more information about programming Auto Sequences® refer to chapter *Appendix F – Programming of Auto Sequences® on Metrel ES Manager.*

8.2.3 Auto Sequence® result screen

After the Auto Sequence® is finished the Auto Sequence® result screen is displayed.
On 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.

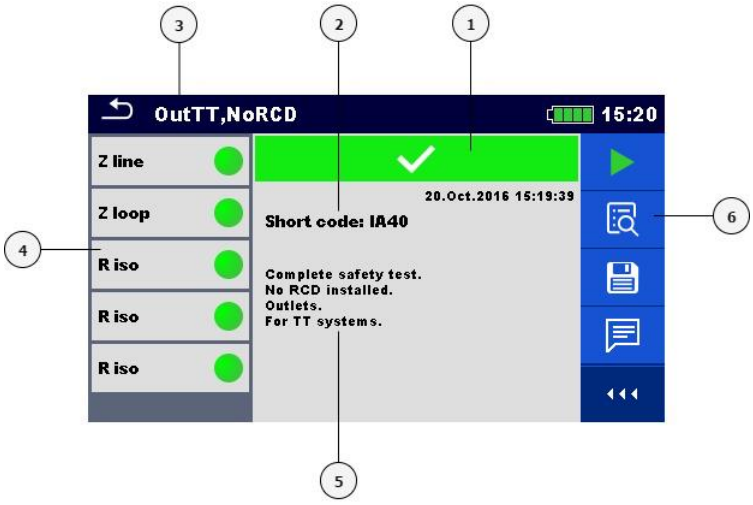


Figure 8.7: Auto Sequence® result screen

Legend

1	Overall PASS / FAIL status
2	Short code
3	Auto Sequence® name
4	Single tests with individual PASS / FAIL statuses
5	Description
6	Control panel (available options)

Options

	Starts a new Auto Sequence®.
	View results of individual measurements. The instrument goes to the 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® result 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 result 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® result 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® and single test results)

Details of a 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.

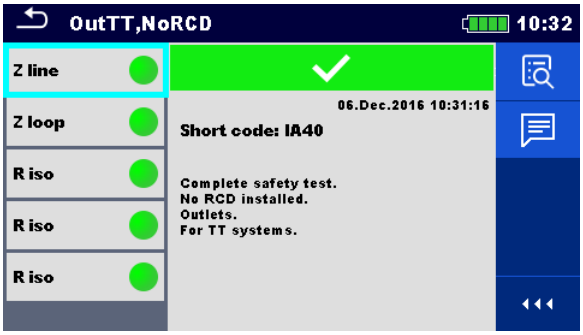


Figure 8.8: Details of menu for viewing details of Auto Sequence® results

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.

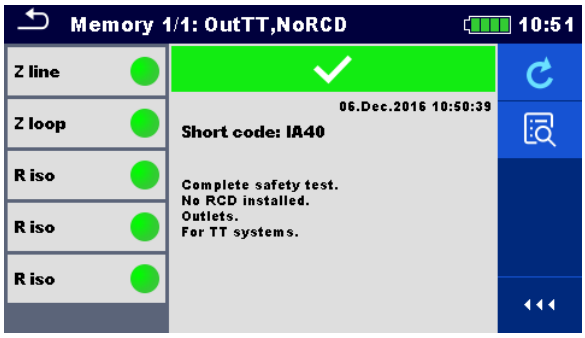


Figure 8.9: Auto Sequence® memory screen

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 and aMESM android application. The following action is supported:

- Saved results and Tree structure from Memory organizer can be downloaded and stored to a PC or android device.
- Tree structure from Metrel ES Manager PC software or aMESM android aplication can be uploaded to the instrument.
- Custom Auto Sequences® can be uploaded to the instrument or downloaded and stored to a PC.

Metrel ES Manager is a PC software running on Windows 8.1, Windows 10 and Windows 11.
There are three communication interfaces available on the instrument:

- RS-232
- USB
- Bluetooth.

Instrument can also communicate to various external 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.

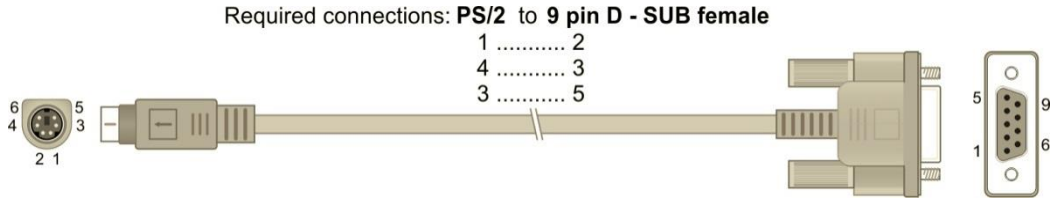


Figure 9.1: Interface connection for data transfer over PC COM port

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 with Android devices

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

How to configure a Bluetooth link between instrument and an 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 Android device to enter the code. Enter code '1234' 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 3155-12240429I*. 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 *4.6.12 Initial Settings*.
- Metrel android application aMESM is available for download from Google play store:

9.3 Communication with adapters

EurotestXD can communicate with Metrel test and measurement adapters through wired RS232 port or wireless Bluetooth communication port.
Adapter can be selected from the list of adapters from *General Settings / Settings / Adapters section* menu, see *Figure 9.2* below.

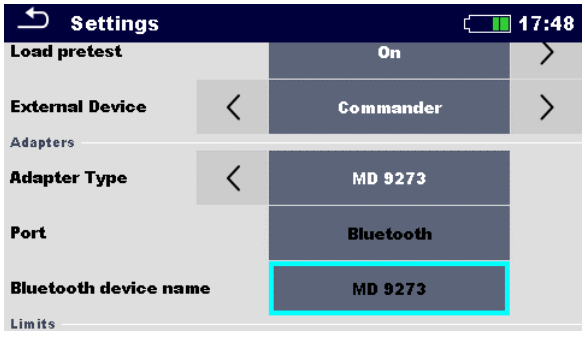


Figure 9.2: Adapters section menu

When adapter is selected from the list, supported communication port is automatically offered.
To establish Bluetooth communication, adapter must be paired with EurotectXD.

Procedure:

1. Adapter: switch it ON and select BT mode, if not already automatically selected.
2. EurotestXD: Open General Settings / Settings menu and navigate to the Adapters section.
3. Adapter type: select adapter by using left / right arrows or tap on the field and select it from the list of adapters
4. Port: Bluetooth or RS232, which one is supported by the adapter, is automatically offered. Connect serial cable or proceed with pairing procedure
5. Bluetooth device name: select field and instrument start searching for Bluetooth devices; when finished, list of available devices is presented on the screen
6. Select Adapter name from the list: pairing procedure is finished.

When test supported by the adapter is selected on EurotestXD, active BT communication is indicated with sign  on the right – top of the screen.

Note:

Pairing between same Metrel adapter and same EurotestXD is necessary only when adapter is first time used. If communication is not established when supported test is selected, adapter is probably switched OFF or Bluetooth link is out of range.

9.4 Bluetooth and RS-232 communication with scanners

EurotestXD instrument can communicate with supported Bluetooth and serial scanners. Serial scanner should be connected to the instrument via PS/2 serial port. Contact Metrel or your distributor which external devices and functionalities are supported. See chapter *4.6.10 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 EurotestXD instrument. There are no user replaceable components inside the instrument, except the battery and fuses under back cover.

Figure 11.1: Position of screws to open battery / fuse compartment

11.1 Fuse replacement

There are three fuses under back cover of the EurotestXD 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 5 A / 500 V, 32×6.3 mm (breaking capacity: 50 kA) General input protection fuses of test terminals L/L1 and N/L2.

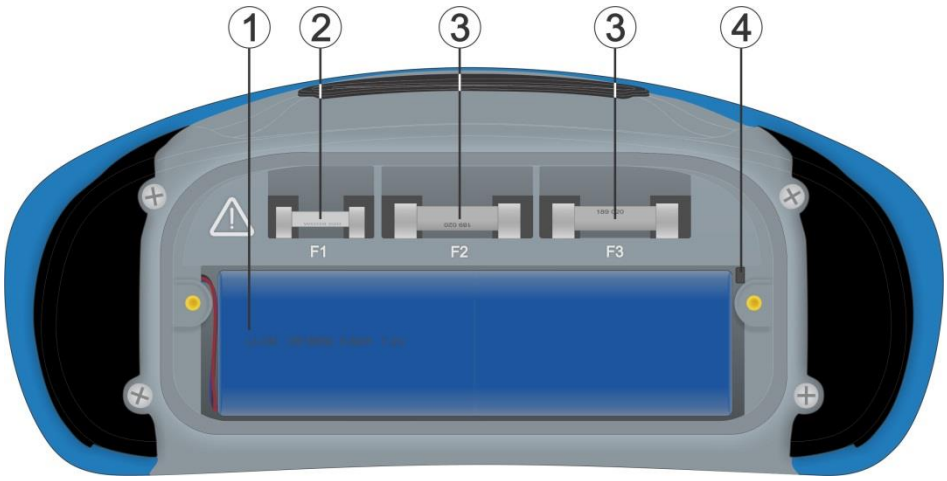


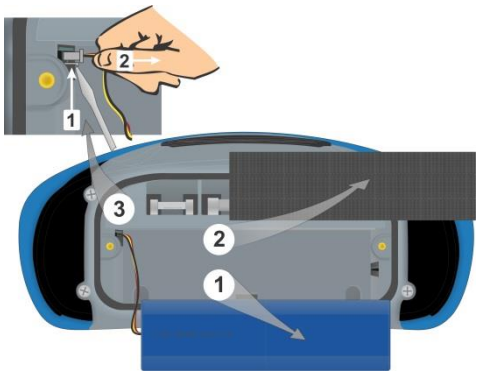
Figure 11.2: Fuses

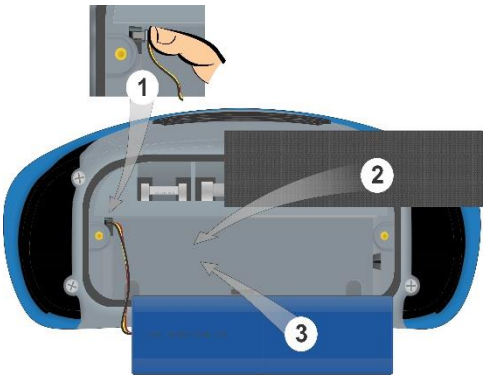
Warnings:

- Disconnect all measuring accessory and switch off the instrument 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 Battery pack insertion / replacement

Procedure:

①	Remove the battery pack from battery compartment.	
②	Remove foam if were inserted under the battery pack.	
③	Press to unlock the connector (1) and pull the wires (2) to disconnect the battery pack from the instrument.	

①	Connect the new battery pack to the instrument.	
②	For standard capacity pack use a foam (2) to fill empty space.	
③	Insert the battery pack in battery compartment and close the battery / fuse compartment cover. Note:	

	When placing high-capacity battery pack make sure that protection circuit module of the battery pack is placed at top inner side of the compartment.	

Warnings:

- Disconnect all measuring accessory and switch off the instrument before opening battery / fuse compartment cover, hazardous voltage inside!
- Replace battery pack with original type only, otherwise the instrument may be damaged and / or operator's safety impaired!
- Ensure batteries are used and disposed of in accordance with Manufacturers guidelines and in accordance with Local and National Authority guidelines.

11.3 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!

11.4 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.

11.5 Service

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

12 Technical specifications

12.1 R iso, R iso all – Insulation resistance

Uiso: 50 V, 100 V and 250 V (R iso, R iso all)
Riso – Insulation resistance (R iso)
R L-N, R L-PE, R N-PE – Insulation resistance (R iso all)
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 (R iso, R iso all)
Riso – Insulation resistance (R iso)
R L-N, R L-PE, R N-PE – Insulation resistance (R iso all)
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: 1000 V (R iso, R iso all)
Riso – Insulation resistance (R iso)
R L-N, R L-PE, R N-PE – Insulation resistance (R iso all)
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 ... 199.9	0.1	±5 % of reading
200 ... 999	1	indicative

Uiso: 2500V (R iso)
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 (Riso, Riso all)

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}
Open circuit voltage .....-0 % / +20 % of nominal voltage
Measuring current.....min. 1 mA at $R_N = U_N \times 1\ k\Omega/V$
Short circuit current ..... max. 3 mA
Load pretest voltage..... < 20 V_{AC}, 125 Hz

Load pretest warning ..... < 50 kΩ
The number of possible tests
(R iso, Riso all) ..... up to 1000, with a fully charged battery (type: 18650T22A2S2P)
up to 2000, with a fully charged battery (type: 18650T22A2S4P)

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

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, R iso* all – Insulation resistance apply.

12.3 R low – Resistance of earth connection and equipotential bonding

Measuring range according to EN 61557 is 0.12 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 (Rlow).....up to 5 Ω
The number of possible tests:
(Rlow (Current = standard), Rlow 4W).....up to 1700, with a fully charged battery (type: 18650T22A2S2P)
up to 3400, with a fully charged battery (type: 18650T22A2S4P)
Rlow (Current = ramp).....up to 1000, with a fully charged battery (type: 18650T22A2S2P)
up to 2000, with a fully charged battery (type: 18650T22A2S4P)

Automatic polarity reversal of the test voltage.

12.4 R low 4W – Resistance of earth connection and equipotential bonding

Measuring range according to EN 61557 is 0.100 Ω ... 1999 Ω.

R – Resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.000 ... 0.049	0.001	±(30 digits)
0.050 ... 19.999	0.001	±(3 % of reading + 10 digits)
20.00 ... 199.99	0.01	±5 % of reading
200.0 ... 1999.9	0.1	

R+, R – Resistance

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

Open-circuit voltage.....6.5 VDC ... 18 VDC
Measuring current.....min. 200 mA into load resistance of 2 Ω
The number of possible tests: .....up to 1700, with a fully charged battery (type: 18650T22A2S2P)
up to 3400, with a fully charged battery (type: 18650T22A2S4P)
Automatic polarity reversal of the test voltage.

12.5 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 + 3 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

12.6 **RCD testing**

12.6.1 General data

Nominal residual current (A,AC).....10 mA, 15 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 %

Sensitivity parameter supported.....PRCD, PRCD-3p, PRCD-2p, PRCD-S+, PRCD-K

Nominal residual current accuracy by using parameter Sensitivity:
Sensitivity: standard.....-0 / +0.1·IΔ; IΔ = IΔN, 2×IΔN, 5×IΔN
-0.1·IΔ / +0; IΔ = 0.5×IΔN
Sensitivity: Ipe monitoring.....-0 / +0.1·IΔ; IΔ = 0.5×IΔN, 2×0.5×IΔN, 5×0.5×IΔN
-0.1·IΔ / +0; IΔ = 0.5×0.5×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.....< 2 mA (typical)
RCD type.....(non-delayed), S (time-delayed), PRCD, PRCD-2p, PRCD-3p, PRCD-S, PRCD-S+, PRCD-K, EV RCD, EV RCM, MI RCD
Test current starting polarity .....0º or 180º
Voltage range.....93 V ... 134 V (16 Hz ... 400 Hz)
185 V ... 266 V (16 Hz ... 400 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	✓	✓	✓
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

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)	$I_{\Delta N}$ × 10 (mA)	$I_{\Delta N}$ × 33.33 (mA)	$I_{\Delta N}$ × 50 (mA)	RCD I_{Δ}	
$I_{\Delta N}$ (mA)	MI / EV a.c., d.c.	MI / EV a.c., d.c.	MI / EV a.c.	MI / EV a.c.	MI / EV d.c.	MI / EV d.c. (IEC 62955)	MI / EV d.c. (IEC 62752)	MI / EV a.c.	MI / EV d.c.
30 a.c.	15	30	60	150	×	×	×	✓	×
6 d.c.	3	6	×	×	60	200	300	×	✓

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

12.6.2 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, Uc(P) – Contact voltage, external probe

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 (Uc, Uc(P))..... Custom, 12 V, 25 V, 50 V

12.6.3 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 ΔN –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 *4.6.8.2 RCD standard*. This specification applies to max. time >40 ms.

Test current ..... $½ \times I_{\Delta N}$, $I_{\Delta N}$, $2 \times I_{\Delta N}$, $5 \times I_{\Delta N}$
$5 \times I_{\Delta N}$ is not available for $I_{\Delta N}$=1000 mA (RCD type AC) or $I_{\Delta N} \geq$ 300 mA (RCD types A, F, B, B+).
$2 \times I_{\Delta N}$ is not available for $I_{\Delta N}$=1000 mA (RCD types A, F) or $I_{\Delta N} \geq$ 300 mA (RCD types B, B+).
$1 \times I_{\Delta N}$ is not available for $I_{\Delta N}$=1000 mA (RCD types B, B+).
Specified accuracy is valid for complete operating range.

12.6.4 RCD I – Trip-out current

Complete measurement range corresponds to EN 61557 requirements.

IΔ – Trip-out current

Measuring range	Resolution I_Δ	Accuracy
$0.2\times I_{\Delta N}$ ... $1.1\times I_{\Delta N}$ (AC type)	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$
$0.2\times I_{\Delta N}$ ... $1.0\times I_{\Delta N}$ (IEC 62752: EV RCD, EV RCM, MI RCD (a.c. part))	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$
$0.2\times I_{\Delta N\_d.c.}$ ... $1.0\times I_{\Delta N\_d.c.}$ (IEC 62752: EV RCD, EV RCM, MI RCD (d.c. part))	$0.05\times I_{\Delta N\_d.c.}$	$\pm 0.1\times I_{\Delta N\_d.c.}$
$0.2\times I_{\Delta N}$ ... $1.0\times I_{\Delta N}$ (IEC 62955: EV RCD, EV RCM, MI RCD (a.c. part))	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$
$0.2\times I_{\Delta N\_d.c.}$ ... $1.0\times I_{\Delta N\_d.c}$ (IEC 62955: EV RCD, EV RCM, MI RCD (d.c. part))	$0.05\times I_{\Delta N\_d.c.}$	$\pm 0.1\times I_{\Delta N\_d.c.}$
$0.2\times I_{\Delta N}$ ... $1.5\times I_{\Delta N}$ (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 type)	$0.05\times I_{\Delta N}$	$\pm 0.1\times I_{\Delta N}$

t IΔ – Trip out-time

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

Uc, Uc IΔ – 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)..... Custom, 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+).

12.6.5 RCD Auto

For technical specification refer to chapter *12.6 RCD testing* for technical specification of individual RCD tests.

12.7 Z loop, Z loop 4W – Fault loop impedance and prospective fault current

Z – Fault loop impedance
Measuring range according to EN 61557 is 0.12 Ω ... 9.99 kΩ.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 9.99	0.01	±(3 % of reading + 3 digits)
10.0 ... 99.9	0.1	
100 ... 999	1	

1.00 k ... 9.99 k	10	±10 % of reading

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(P) – Contact voltage at Ipsc, external probe

Measuring range (V)	Resolution (V)	Accuracy
0.0 ... 99.9	0.1	(-0 % / +15 %) of reading ± 0.02 Ω × Ipsc

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

Test current (at 230 V) ..... 20 A (10 ms)
Nominal voltage range.....93 V ... 134 V (16 Hz ... 400 Hz)
185 V ... 266 V (16 Hz ... 400 Hz)

R and 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(P) – Contact voltage at Ipsc (Protection = TN), external probe

Measuring range (V)	Resolution (V)	Accuracy
0.0 ... 99.9	0.1	(-0 % / +15 %) of reading ± 0.02 Ω × Ipsc

Uc(P) – Contact voltage at IΔN (Protection = TT rcd), external probe

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

Uc – Contact voltage

Refer to chapter *12.6.2 RCD Uc – Contact voltage* for detailed technical specification.

Nominal voltage range.....93 V ... 134 V (16 Hz ... 400 Hz)
185 V ... 266 V (16 Hz ... 400 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

This test is performed in combination with an external test adapter / instrument.

For technical specification refer to *A 1143 Euro Z 290 A*, *MI 3143 Euro Z 440 V* and *MI 3144 Euro Z 800 V Instruction manual.*

12.10 U touch – Touch voltage (MI 3143 and MI 3144)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *MI 3143 Euro Z 440 V* and *MI 3144 Euro Z 800 V Instruction manual.*

12.11 Z line, Z line 4W – Line impedance and prospective short-circuit current

Z – Line impedance
Measuring range according to EN 61557 is 0.12 Ω ... 9.99 kΩ.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 9.99	0.01	±(3 % of reading + 3 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) ..... 20 A (10 ms)
Nominal voltage range .....93 V ... 134 V (16 Hz ... 400 Hz)
185 V ... 266 V (16 Hz ... 400 Hz)
321 V ... 485 V (16 Hz ... 400 Hz)
R, X_L, Imin, Imin2p, Imin3p values are indicative.

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 *12.13 Z line mΩ – High precision line impedance and prospective fault current* for technical specification.

Z_{REF} measuring range .....0.00 Ω ... 20.0 Ω
Test current (at 230 V) ..... 20 A (10 ms)
Nominal voltage range.....93 V ... 134 V (16 Hz ... 400 Hz)
185 V ... 266 V (16 Hz ... 400 Hz)
321 V ... 485 V (16 Hz ... 400 Hz)
*See chapter *7.19 Voltage Drop* for more information about calculation of voltage drop result.

12.13 Z line mΩ – High precision line impedance and prospective fault current

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *A 1143 Euro Z 290 A*, *MI 3143 Euro Z 440 V* and *MI 3144 Euro Z 800 V Instruction manual.*

12.14 High current (MI 3143 and MI 3144)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *MI 3143 Euro Z 440 V* and *MI 3144 Euro Z 800 V Instruction manual.*

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

Refer to following chapters for detailed technical specification:

12.6.2 RCD Uc – Contact voltage,

12.7 Z loop, Z loop 4W – Fault loop impedance and prospective fault current,

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

12.11 Z line, Z line 4W – Line impedance and prospective short-circuit current,

12.12 Voltage Drop,

12.16 Rpe – PE conductor resistance,

12.26 ISFL – First fault leakage current and

12.27 IMD.

12.16 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 (16 Hz ... 400 Hz)
185 V ... 266 V (16 Hz ... 400 Hz)

12.17 **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)
R_C and R_P 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.

12.18 **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.

12.19 **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	

R_C and R_P values are indicative.

Principle:
ρ = 2· π·d·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

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

12.20 **Voltage, frequency, and phase rotation**

12.20.1 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

12.20.2 Voltage / Online terminal voltage monitor

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

12.20.3 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

12.21 **Varistor test**

Udc – DC voltage

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

Uac – AC voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ... 1562	1	Consider accuracy of DC voltage

Measurement principle ..... d.c. voltage ramp
Test voltage slope ..... Nominal test voltage 1000 V: 100 V/s
Nominal test voltage 2500 V: 350 V/s
Threshold current ..... 1 mA

12.22 **Currents**

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: 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.

12.23 Current clamp meter (MI 3144)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *MI 3144 Euro Z 800 V Instruction manual.*

12.24 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]
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.

12.25 **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]
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.

12.26 **ISFL – First fault leakage current**

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 ≤ U_{L1-L2} < 134 V
185 V ≤ U_{L1-L2} ≤ 266 V

12.27 **IMD**

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	± 0.02 s
20.0 ... 99.9	0.1	± 0.1 s

Nominal voltage ranges .....93 V ≤ U_{L1-L2} ≤ 134 V
185 V ≤ U_{L1-L2} ≤ 266 V

*)See chapter *7.34 IMD – Testing of insulation monitoring devices* for more information about calculation of first fault leakage current at threshold insulation resistance.

12.28 **Illumination**

E – 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 k ... 19.99 k	10	

Measurement principle .....silicon photodiode with V(λ) filter
Spectral response error .....< 3.8 % according to CIE curve
Cosine error.....< 2.5 % up to an incident angle of ± 85°
Overall accuracy .....matched to DIN 5032 class B standard

E – 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 k ... 19.99 k	10	

Measurement principle .....silicon photodiode
Cosine error.....< 2.5 % up to an incident angle of ± 85°
Overall accuracy .....matched to DIN 5032 class C standard

12.29 **Discharging time**

t – Discharging time
Measuring range according to EN 61557-14 is 0.8 s ... 9.9 s.

Range (s)	Resolution (s)	Accuracy
0.0 s ... 9.9	0.1	±(5 % of reading + 2 digits)

Ures – Residual voltage

Range (V)	Resolution (V)	Accuracy
0.0 ... 99.9	0.1	±(5 % of reading + 3 digits)
100 ... 372	1	

Up – Peak voltage

Range (V)	Resolution (V)	Accuracy
0 ... 372	1	±(5 % of reading + 3 digits)

U – RMS voltage

Range (V)	Resolution (V)	Accuracy
70.0 ... 99.9	0.1	±(2 % of reading + 2 digits)
100 ... 263	1	

Freq – Frequency

Range (Hz)	Resolution (Hz)	Accuracy
45.0 ... 65.0	0.1	±(0.2 % of reading + 1 digit)

Nominal frequency range ..... d.c.,45 Hz – 65 Hz
High limits ..... 1 s, 5 s
Threshold voltage ..... 34 V, 60 V, 120 V
Input resistance ..... 20 MΩ

12.30 Auto Sequences®

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

12.31 R line mΩ - DC resistance measurement (MI 3144)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *MI 3144 Euro Z 800 V Instruction manual.*

12.32 ELR Current injection (MI 3144)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *MI 3144 Euro Z 800 V Instruction manual.*

12.33 ELR Combination time test (MI 3144)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *MI 3144 Euro Z 800 V Instruction manual.*

12.34 EVSE Diagnostic test (A 1632)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to *A 1632 eMobility Analyzer Instruction manual.*

12.35 Power CLAMP (MD 9273)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to MD 9273 Leakage Clamp meter with Bluetooth® Communication Instruction manual.

12.36 Voltage CLAMP (MD 9273)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to MD 9273 Leakage Clamp meter with Bluetooth® Communication Instruction manual.

12.37 Current CLAMP (MD 9273)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to MD 9273 Leakage Clamp meter with Bluetooth® Communication Instruction manual.

12.38 Inrush CLAMP (MD 9273)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to MD 9273 Leakage Clamp meter with Bluetooth® Communication Instruction manual.

12.39 Harmonics U CLAMP (MD 9273)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to MD 9273 Leakage Clamp meter with Bluetooth® Communication Instruction manual.

12.40 Harmonics I CLAMP (MD 9273)

This test is performed in combination with an external test adapter / instrument.
For technical specification refer to MD 9273 Leakage Clamp meter with Bluetooth® Communication Instruction manual.

12.41 Z (DC EVSE) (A 1732)

This test is performed in combination with the external test adapter A 1732 DC EVSE Adapter.

Z

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ... 9.99	0.01	±(3 % of reading + 3 digits)
10.0 ... 99.9	0.1	
100 ... 999	1	±10 % of reading
1.00 k ... 1.99 k	10	

Ipsc

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	

U DC

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

Test current (at 300 V) ..... 26 A
Nominal test voltage .....300 V_{DC}

12.42 Riso (DC EVSE) (A 1732)

This test is performed in combination with an external test adapter A 1732DC EVSE Adapter.

Uiso: 500 V (Riso – DC+/DC-, DC+/ PE, DC-/ PE)
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: 1000 V (Riso – DC+/DC-, DC+/ PE, DC-/ PE)
Measuring range according to EN 61557 is 0.15 MΩ ... 999.9 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	indicative

Um (Voltage - DC+/DC-, DC+/ PE, DC-/ PE)

Measuring range (V)	Resolution (V)	Accuracy
0 ... 1300	1	±(3 % of reading + 3 digits)

Nominal voltages Uiso .....500 V_{DC}, 1000 V_{DC}
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
(R iso, Riso all)..... up to 1000, with a fully charged battery (type: 18650T22A2S2P)
up to 2000, with a fully charged battery (type: 18650T22A2S4P)

Auto discharge after test.

Internal resistances of adapter A 1732 is not considered.
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.

12.43 **RIow (DC EVSE) (A 1732)**

This test is performed in combination with the external test adapter A 1732 DC EVSE Adapter.

Measuring range according to EN 61557 is 0.100 Ω ... 1999 Ω.

R – Resistance

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.000 ... 0.049	0.001	±30 digits
0.050 ... 19.999	0.001	±(3 % of reading + 10 digits)
20.00 ... 199.99	0.01	±5 % of reading
200.0 ... 1999.9	0.1	

R+, R – Resistance

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

Open-circuit voltage.....6.5 V_{DC} ... 18 V_{DC}
Measuring current.....min. 200 mA into load resistance of 2 Ω
The number of possible tests: .....up to 1700, with a fully charged battery (type: 18650T22A2S2P)
up to 3400, with a fully charged battery (type: 18650T22A2S4P)
Automatic polarity reversal of the test voltage.

12.44 IMD (DC EVSE) (A 1732)

This test is performed in combination with an external test adapter A 1732 DC EVSE Adapter.

R – simulated fault resistor

R (kΩ)	Resolution (kΩ)	Note
20 ... 640	5 - 10	up to 128 steps

t – Activation / disconnection time of IMD

t (s)	Resolution (s)	Accuracy
0.00 ... 19.99	0.01	± 0.02 s
20.0 ... 99.9	0.1	± 0.1 s

Nominal voltage.....300 V_{DC}

12.45 Discharging time (DC EVSE) (A 1732)

This test is performed in combination with an external test adapter A 1732 DC EVSE Adapter.
For technical specification refer to *A 1732 DC EVSE Adapter Instruction manual*.

12.46 DC EVSE Functional test (A 1732)

This test is performed in combination with an external test adapter A 1732 DC EVSE Adapter.
For technical specification refer to *A 1732 DC EVSE Adapter Instruction manual*.

12.47 DC EVSE Error (A 1732)

This test is performed in combination with an external test adapter A 1732 DC EVSE Adapter.
For technical specification refer to *A 1732 DC EVSE Adapter Instruction manual*.

12.48 General data

Power supply ..... Li-Ion battery pack 7.2 V,
4400 mAh (type: 18650T22A2S2P)

	8800 mAh (type: 18650T22A2S4P) optional
Operation	Typical 16 h (type: 18650T22A2S2P) Typical 32 h (type: 18650T22A2S4P)
Charger socket input voltage	12 V ± 10 %
Charger socket input current	3000 mA max.
Battery charging current	up to 2200 mA (Battery type: 18650T22A2S2P) up to 3000 mA (Battery type: 18650T22A2S4P)
Measuring category	600 V CAT III 300 V CAT IV
Protection classification	double insulation
Pollution degree	2
Protection degree	56 (with protective covers on USB, Charger and PS/2 terminals)
Altitude	≤ 2000 m
Display	4.3 inch (10.9 cm) 480x272 pixels TFT colour display with touch screen
Dimensions (w × h × d)	252 mm × 111 mm × 165 mm
Weight	1.78 kg, with battery pack (type: 18650T22A2S2P)
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
Operation	Indoor use
Storage conditions	
Temperature range	-10 °C ... +70 °C
Maximum relative humidity	90 %RH (-10 °C ... +40 °C) 80 %RH (40 °C ... 60 °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 SD memory card
Bluetooth module	Class 2
EMC	
Emission	Class B
Immunity	Basic electromagnetic environment (Portable test and measurement equipment)

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 (ATAF)**

Testing special delayed G type RCD supported.

Modifications in chapter *7.9 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 7.3: Relation between Uc, Uc(P) and $I_{\Delta N}$ changed as follows:

RCD type		Contact voltages Uc and Uc(P) proportional to	Rated $I_{\Delta N}$
AC, EV, MI (a.c. part)	-- G	$1.05\times I_{\Delta N}$	any
AC	S	$2\times1.05\times I_{\Delta N}$	
A, F	-- G	$1.4\times1.05\times I_{\Delta N}$	≥ 30 mA
A, F	S	$2\times1.4\times1.05\times I_{\Delta N}$	
A, F	-- G	$2\times1.05\times I_{\Delta N}$	< 30 mA
A, F	S	$2\times2\times1.05\times I_{\Delta N}$	
B, B+	--	$2\times1.05\times I_{\Delta N}$	any
B, B+	S	$2\times2\times1.05\times I_{\Delta N}$	

Technical specifications unchanged.

A.2 Profile Hungary (ATAG)

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.

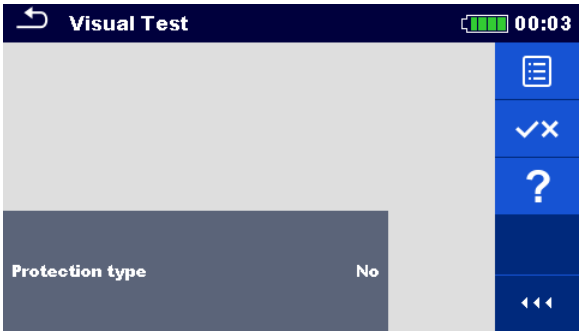


Figure A.1: Visual Test menu

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).

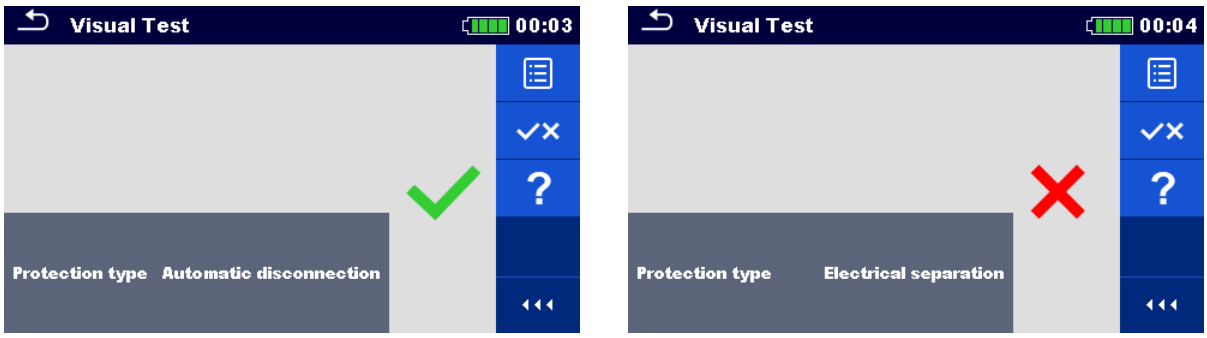


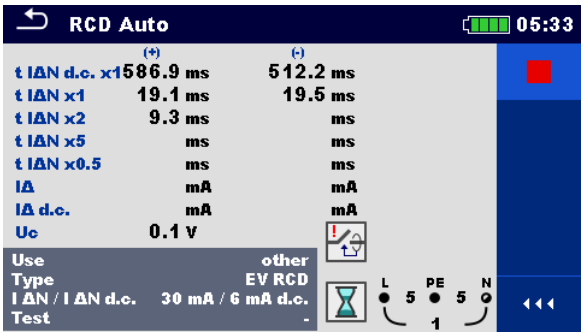
Figure A.2: Examples of Visual Test result

Modifications in chapter *7.10 RCD Auto – RCD Auto test*

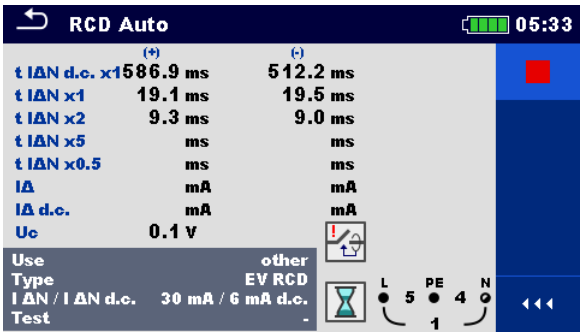
Added tests with multiplication factor 2.

Modification of RCD Auto test procedure

RCD Auto test inserted steps	Notes
‣ Re-activate RCD. Test with 2×$I_{\Delta N}$, (+) positive polarity (new step 5).	RCD should trip-out
‣ Re-activate RCD. Test with 2×$I_{\Delta N}$, (-) negative polarity (new step 6).	RCD should trip-out



Inserted new Step 5



Inserted new Step 6

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

Test results / sub-results

t IΔN d.c. x1, (+) [1)]	Step 1 trip-out time (IΔ=IΔN d.c., (+) positive polarity)
t IΔN d.c. x1, (-) [1)]	Step 2 trip-out time (IΔ=IΔN d.c., (-) negative polarity)
t IΔN x1, (+)	Step 3 trip-out time (I_Δ=$I_{\Delta N}$, (+) positive polarity) Non-operating time for a.c. current (IEC 62955).
t IΔN x1, (-)	Step 4 trip-out time (I_Δ=$I_{\Delta N}$, (-) negative polarity) Non-operating time for a.c. current (IEC 62955).
t IΔN x2, (+)	Step 5 trip-out time (I_Δ=2×$I_{\Delta N}$, (+) positive polarity)
t IΔN x2, (-)	Step 6 trip-out time (I_Δ=2×$I_{\Delta N}$, (-) negative polarity)
t IΔN x5, (+)	Step 7 trip-out time (I_Δ=5×$I_{\Delta N}$, (+) positive polarity)
t IΔN x5, (-)	Step 8 trip-out time (I_Δ=5×$I_{\Delta N}$, (-) negative polarity)
t IΔN x0.5, (+)	Step 9 trip-out time (I_Δ=½×$I_{\Delta N}$, (+) positive polarity)
t IΔN x0.5, (-)	Step 10 trip-out time (I_Δ=½×$I_{\Delta N}$, (-) negative polarity)
IΔ (+)	Step 11 trip-out current ((+) positive polarity)
IΔ (-)	Step 12 trip-out current ((-) negative polarity)
IΔ d.c. (+)[1)]	Step 13 trip-out current ((+) positive polarity)
IΔ d,c, (-)[1)]	Step 14 trip-out current ((-) negative polarity)
Uc	Contact voltage for rated $I_{\Delta N}$

[1)] Result is displayed only when parameter Use is set to 'other' and parameter Type to 'EV RCD', 'EV RCM' or 'MI RCD'.

A.3 **Profile Finland (ATAH)**

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 (ATAI)**

Modifications in chapters:

7.9 Testing RCDs;
7.13 Zs rcd – Fault loop impedance and prospective fault current in system with RCD;
7.21 Z auto - Auto test sequence for fast line and loop testing;
7.38 AUTO TT – Auto test sequence for TT earthing system.

650 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, 650 mA, 1000 mA]

Modifications in chapter *12.6 RCD testing*

Nominal residual current (A,AC).....10 mA, 15 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

	$I_{\Delta N} \times 1/2$ (mA)			$I_{\Delta N} \times 1$ (mA)			$I_{\Delta N} \times 2$ (mA)			$I_{\Delta N} \times 5$ (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	×	×	✓	✓	✓
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.
;
7.38 AUTO TT – Auto test sequence for TT earthing system.

650 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, 650 mA, 1000 mA]

Modifications in chapter *12.6 RCD testing*

Nominal residual current (A,AC).....10 mA, 15 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	✓	✓	✓
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	×	×	✓	✓	✓
650	325	227.5	250	650	916.5	1300	1300	×	×	×	×	×	✓	✓	✓
1000	500	350	500	1000	1410	×	2000	×	×	×	×	×	✓	✓	×

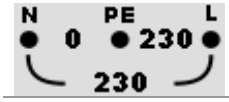
×.....not applicable
✓.....applicable
AC type .....sine wave test current
A, F types.....pulsed current
B, B+ types.....smooth DC current

Other technical specifications remain unchanged.

A.5 **Profile Switzerland (ATAJ)**

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.

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

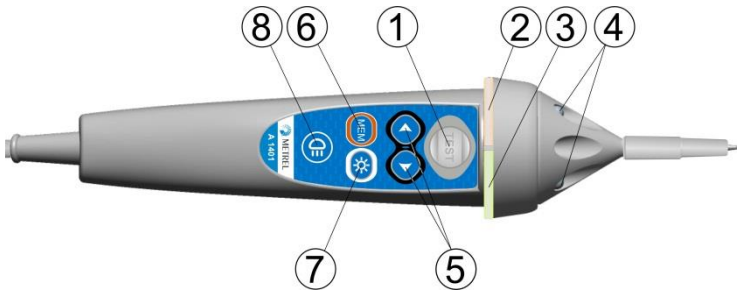


Figure B.1: Front side Tip commander (A 1401)

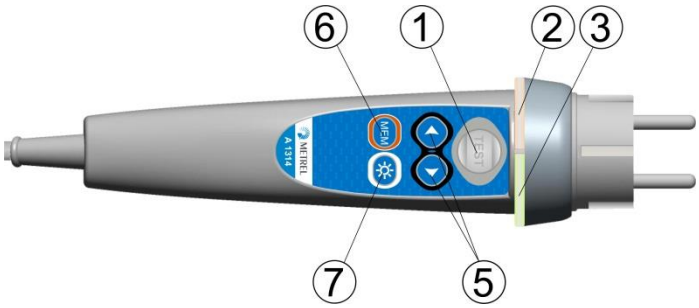


Figure B.2: Front side Plug commander (A 1314)

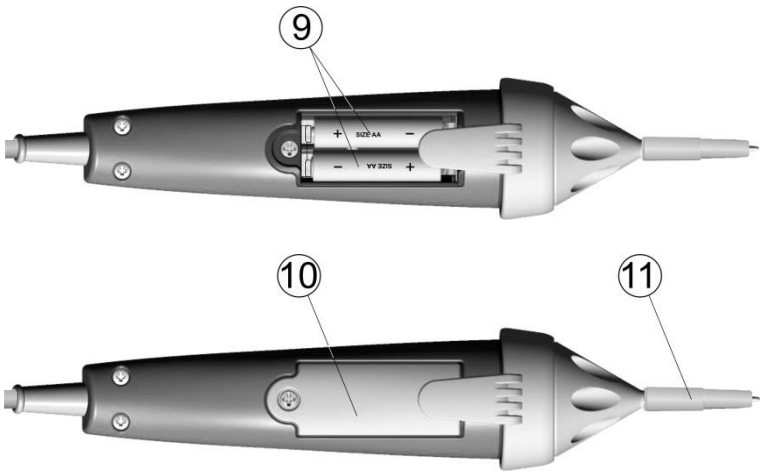


Figure B.3: Back side

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 EurotestXD.

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.

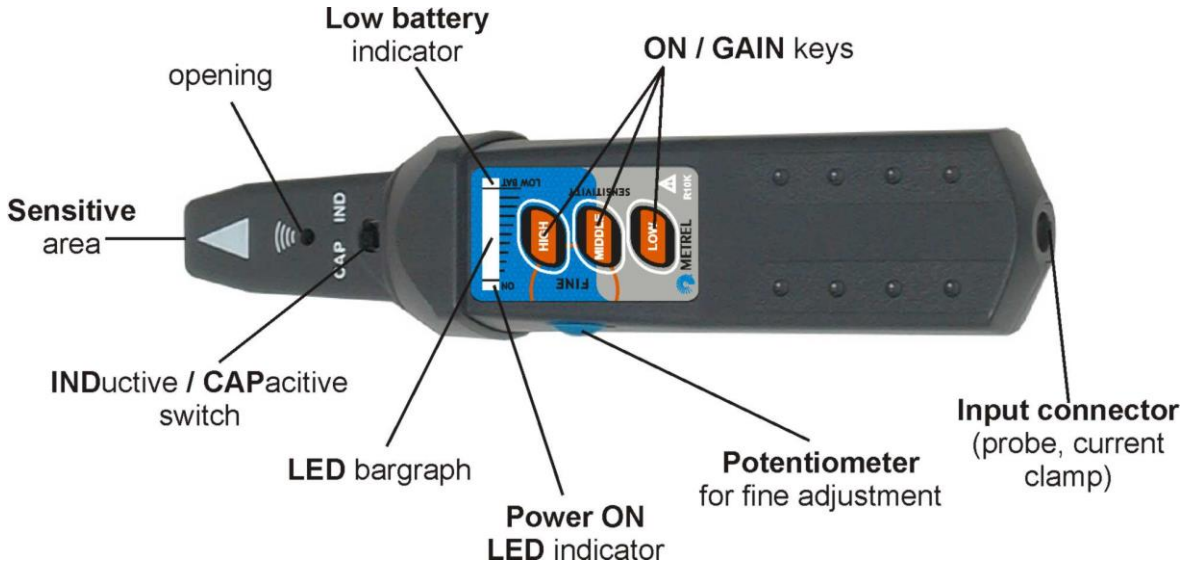


Figure C.1: Receiver R10K

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
	Module	Module
	EVSE	Electro-Vehicle supply Equipment
	AC	EVSE AC output
	CCS	EVSE CCS output

Symbol	Default name	Description
	CHAdeMO	EVSE CHAdeMO output
	Level 1	Level 1
	Level 2	Level 2
	Level 3	Level 3
	Varistor	Varistor
	LS connection	LS connection
	Machine	Machine
	Appliance	Appliance (PRCD)

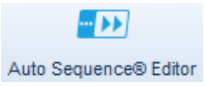
Appendix E Default list of Auto Sequences®

Default list of Auto Sequences® for MI 3155 – Eurotest XD instrument is available on Metrel home page www.metrel.si.

Appendix F Programming of Auto Sequences® on Metrel ES Manager

The Auto Sequence® editor is a part of the Metrel ES Manager software. In Auto Sequence® editor Auto Sequence® can be pre-programmed and organized in groups, before uploaded to the instrument.

F.1 **Auto Sequence® Editor workspace**

To enter Auto Sequence® editor's workspace, select 

in Home Tab of Metrel ES Manager PC SW. Auto Sequence® editor workspace is divided in four main areas. On the left side (1),structure of selected group of Auto Sequence® is displayed. In the middle part of the workspace (2), the elements of the selected Auto Sequence® are shown. On the right side, list of available Single tests (measurements and inspections) (3) and list of Flow commands (4) are shown.

Single test area contain three tabs: Measurements, Inspections and Custom Inspections tab. Custom Inspections and their tasks are programmed by user, see chapter *F.8 Custom Inspections programming* for procedure.

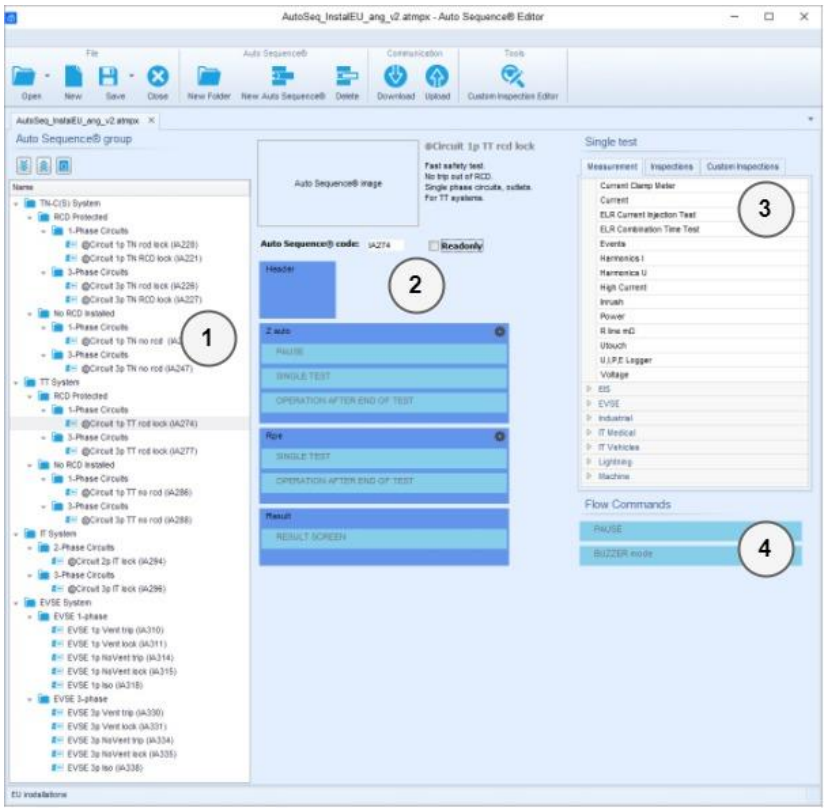


Figure F.1: Auto Sequence® Editor workspace

An Auto Sequence® (2) begins with Name, Description and Image, followed by the first step (Header), one or more measuring steps and ends with the last step (Result). By inserting appropriate Single tests (measurements and inspections) (3) and Flow commands (4) and setting their parameters, arbitrary Auto Sequences® can be created.

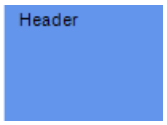


Figure F.2: Example of an empty Auto Sequence® header

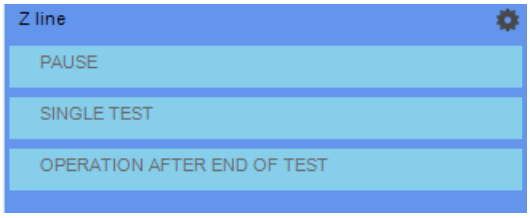


Figure F.3: Example of a measurement step

Figure F.4: Example of an Auto Sequence® result

F.2 Managing groups of Auto Sequences®

The Auto Sequences® can be divided into different user defined groups of Auto Sequences®. Each group of Auto Sequences® is stored in a file. More files can be opened simultaneously in Auto Sequence® editor.
Within Group of Auto Sequences®, tree structure can be organized, with folders / subfolders containing Auto Sequences®. The three structure of currently active Group of Auto Sequences® is displayed on the left side of the Auto Sequence® Editor workspace, see *Figure F.5*.

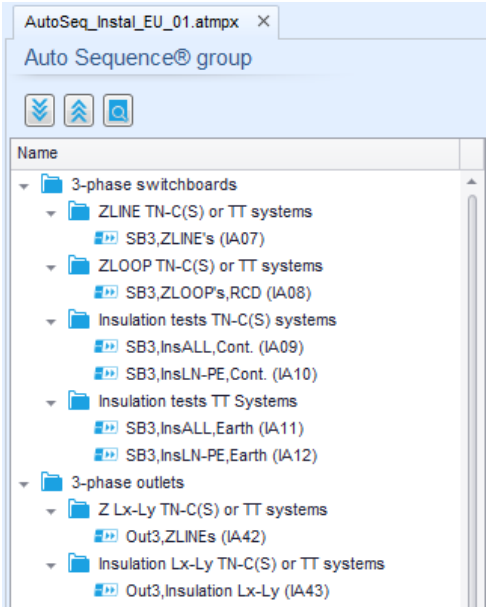


Figure F.5: Group of Auto Sequences® tree organization

Operation options on Group of Auto Sequences® are available from menu bar at the top of Auto Sequence® Editor workspace.

File operation options:

	Opens a file (Group of Auto Sequences®).
	Creates a new file (Group of Auto Sequences®).
	Saves / Saves as the opened Group of Auto sequences® to a file.
	Closes the file (Group of Auto Sequences®).

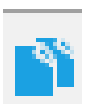
Group of Auto Sequences® view options:

	Expand all folders / subfolders / Auto Sequences®.
	Collapse all folders / subfolders / Auto Sequences®.
	Toggle between Search by name within Auto Sequence® group and normal view. See chapter *F.4 Search within selected Auto Sequence® group* for details.

Group of Auto Sequences® operation options (also available by right clicking on Folder or Auto Sequence®):

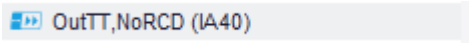
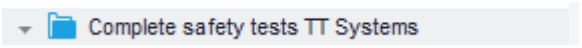
	Adds a new folder / subfolder to the group
	Adds a new Auto Sequence® to the group.
	Deletes: - the selected Auto Sequence® - the selected folder with all subfolders and Auto Sequences®

Right click on the selected Auto Sequence® or Folder opens menu with additional possibilities:

	Auto Sequence®: Edit Name, Description and Image (see *Figure F.6.*) Folder: Edit folder name
	Auto Sequence®: Copy to clipboard Folder: Copy to clipboard including subfolders and Auto Sequences®

	Auto Sequence®: Paste it to selected location Folder: Paste it to selected location
	Auto Sequence®: Creates shortcut to selected Auto Sequence®

Double click on the object name allows it name edit:

DOUBLE CLICK	Auto Sequence® name: Edit Auto Sequence® name  Folder name: Edit folder name 

Drag and drop of the selected Auto Sequence® or Folder / Subfolder moves it to a new location:

DRAG & DROP	'Drag and drop' functionality is equivalent to 'cut' and 'paste' in a single move.  move to folder  insert

F.3 Auto Sequence® Name, Description and Image editing

When EDIT function is selected on Auto Sequence®, menu for editing presented on *Figure F.6* appear on the screen. Editing options are:

Name: Edit or change the name of Auto Sequence®.
Description: Any text for additional description of Auto Sequence® can be entered.
Image: Image presenting Auto sequence® measuring arrangement can be entered or deleted.

	Enters menu for browsing to Image location.
	Deletes the Image from Auto Sequence®.

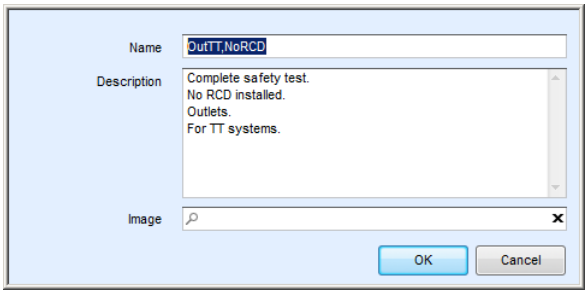


Figure F.6: Editing the Auto Sequence® Name, Description and Image

F.4 Search within selected Auto Sequence® group

When  function is selected, Search menu as presented on *Figure F.7* appear on the screen. By entering the text into search box, found results are automatically highlighted with yellow background. Search functionality is implemented in Folders, Subfolders and Auto Sequences® of selected Auto Sequence® Group. Search text can be cleared by selecting the Clear button.

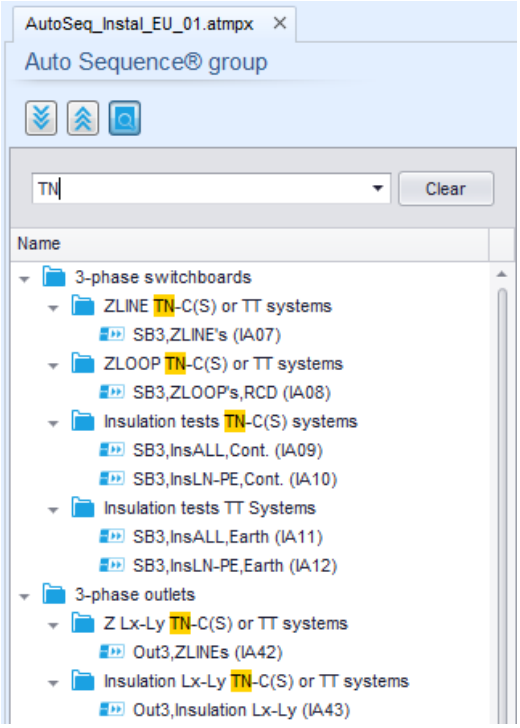


Figure F.7: Example of Search result within Auto Sequence® group

F.5 Elements of an Auto Sequence®

F.5.1 Auto Sequence® steps

There are three kinds of Auto Sequence® steps.

Header

The Header step is empty by default.

Flow commands can be added to the Header step.

Measurement step

The Measurement step contains a Single test and the Operation after end of test flow command by default. Other Flow commands can also be added to the Measurement step.

Result

The Result step contains the Result screen flow command by default. Other Flow commands can also be added to the Result step.

F.5.2 Single tests

Single tests are the same as in Metrel ES Manager Measurement menu.

Limits and parameters of the measurements can be set. Results and sub-results can't be set.

F.5.3 Flow commands

Flow commands are used to control the flow of measurements. Refer to chapter *F.7 Description of flow commands* for more information.

F.5.4 Number of measurement steps

Often the same measurement step has to be performed on multiple points on the device under test. It is possible to set how many times a Measurement step will be repeated. All carried out individual Single test results are stored in the Auto Sequence® result as if they were programmed as independent measuring steps.

F.6 **Creating / modifying an Auto Sequence®**

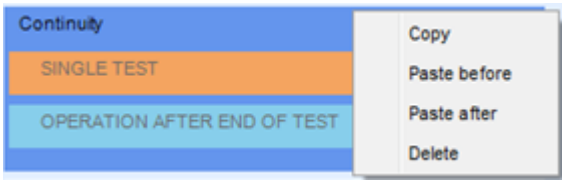
If creating a new Auto Sequence® from scratch, the first step (Header) and the last step (Result) are offered by default. Measurement steps are inserted by the user.

Options

Adding a measurement step	By double clicking on a Single test a new measurement step will appear as the last of measurement steps. It can also be dragged and dropped on the appropriate position in the Auto Sequence®.
Adding flow commands	Selected flow command can be dragged from the list of Flow Commands and dropped on the appropriate place in any Auto Sequence® step.
Changing position of flow command within measurement step	By a click on an element and use of  and  keys.
Viewing / changing parameters of flow commands or single tests.	By a double click on the element.
Setting number of measurement step repetitions.	By setting a number in the  field.

Touch pre-test disable / enable (not available in all functions)	By setting True / False in the  field. (Default value is False – Touch pre-test is enabled)

Right click on the selected measurement step / flow command:



Copy – Paste before

A measurement step / flow command can be copied and pasted above selected location on the same or on another Auto Sequence®.

Copy – Paste after

A measurement step / flow command can be copied and pasted under selected location on the same or on another Auto Sequence®.

Delete

Deletes the selected measurement step / flow command.

F.7 Description of flow commands

Double click on inserted Flow Command opens menu window, where text or picture can be entered, external commands can be activated and parameters can be set.

Flow commands Operation after end of test and Results screen are entered by default, others are user selectable from Flow Commands menu.

Pause

A Pause command with text message or picture can be inserted anywhere in the measuring steps. Warning icon can be set alone or added to text message. Arbitrary text message can be entered in prepared field Text of menu window.

Parameters

Pause type	Show text and/or warning ( check to show warning icon). Show picture ( browse for image path).
Duration	Number in seconds, infinite (no entry).

Buzzer mode

Passed or failed measurement is indicated with beeps.

- Pass – double beep after the test
- Fail – long beep after the test

Beep happens right after single test measurement.

Parameters

State	On – enables Buzzer mode
	Off – disables Buzzer mode

Operation after end of test

This flow command controls the proceeding of the Auto Sequence® in regard to the measurement results.

Parameters

Operation after end of test - pass - fail - no status	The operation can be individually set for the case the measurement passed, failed or ended without a status.	
	Manual:	The test sequence stops and waits for appropriate command (RUN key, external command ...) to proceed.
	Auto:	The test sequence automatically proceeds.

Result screen

This flow command controls the proceeding after the Auto Sequence® has ended.

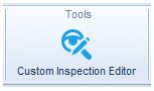
Parameters

☑ Auto save	Auto Sequence® results are stored in the momentary workspace. A new Node with the current month and year will be created. Under the Node Auto Sequence® results will be stored. Up to 100 Auto Sequence® results can be automatically stored under the same node. If more results are available, they are split to multiple nodes. Auto Save Flow setting is disabled by default. Note - This flow command is active only if Auto Sequence® is started from the Auto Sequence® Main menu (not from the Memory organizer).

F.8 Custom Inspections programming

Arbitrary set of tasks dedicated to specific user defined Inspections can be programmed with application of Custom Inspection Editor Tool, accessible from Auto Sequence® Editor workspace. Custom Inspections are stored in dedicated file *.indf with user defined name. For application of Custom Inspections as a single test within Auto Sequence® group, appropriate file containing specific Custom Inspection should be opened first.

F.8.1 Creating and editing Custom Inspections

Custom Inspection Editor workspace is entered by selecting 

icon from Auto Sequences® main menu. It is divided in two main areas, as presented on *Figure F.8*:

1 Custom Inspection Name and Scope of inspection (Visual or Functional)

2 Name of Custom Inspection Item tasks and Type of Item Pass / Fail checkbox marking

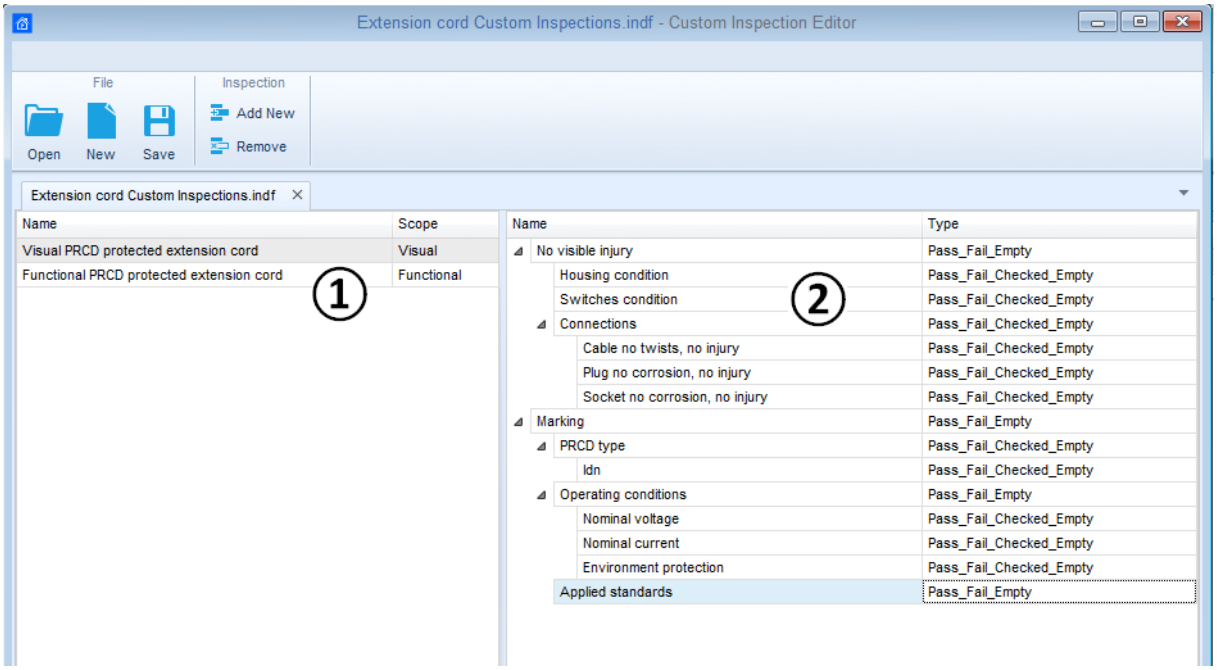


Figure F.8: Custom Inspection Editor workspace

Custom Inspection Editor Main menu options:

	Opens existing Custom Inspection Data file. By selecting, menu for browsing to location of *.indf file containing one or more Custom Inspections data appear on the screen. Selected file is opened in dedicated tab marked with file name.
	Creates a new Custom Inspection Data file. New tab with empty workspace is opened. Default name of the new tab is *Inspection Data File*; it could be renamed during Save procedure.

Saves / Saves as Custom Inspection Data file opened on active tab.

Menu for browsing to the folder location and editing of file name is opened. Browse to the location, confirm overwriting, if file already exists or edit file name to save it as a new Custom Inspection Data file.

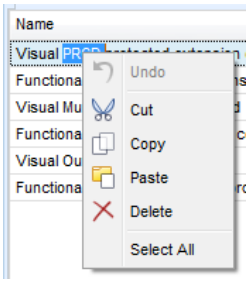
Add New Custom Inspection.

New inspection with default name *Custom Inspection* and default scope *Visual* appear on the editor workspace. It contains one Item task with default name *Custom Inspection* and default Type *Pass_Fail_Checked_Empty*. Default Name and Type can be edited – changed.

Remove selected custom inspection.

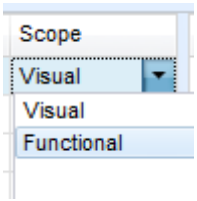
To select inspection, click to the inspection Name field. To remove it, select icon from editor main menu. Before removal, user is asked to confirm deletion.

Edit Name and Scope of Inspection



Inspection Name edit:

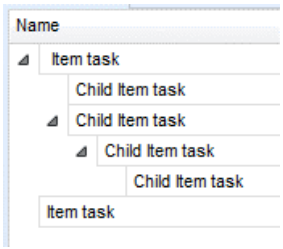
Click to the Inspection Name field to start editing it.
Drag cursor, with left mouse button pressed, to select letters and words.
Position cursor and double-click to select word of the name. Actions could be performed with keyboard also.
Press right mouse button to activate Edit menu and select appropriate action as presented on the left figure. Menu is case sensitive; options currently not available are greyed out.



Inspection Scope edit:

Click to Inspection Scope field to open selection menu presented on left figure.
Options:
Visual is intended for observation of test object
Functional allows functional test of observed object

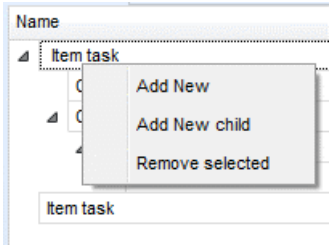
Edit Item task structure of Inspection



Item tasks of the selected Inspection are listed in Name column on the right side of Editor workspace.

Each Item task can have Child Item tasks, Child Item can have its own Child Item tasks and so on.

Arbitrary tree structure of Item tasks and subtasks can be built as presented on left figure.



ADD New Item task procedure:

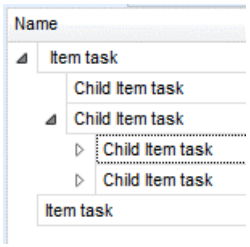
Position cursor above Item task Name and apply right mouse click to select Item task and open menu with options:

Add New: new Item task is added on the top tree level

Add New Child: new child Item task is added under selected Item

Remove selected: delete selected Item task with all subtasks

Default Name of New Item task is *Custom Inspection,* default Type *Pass_Fail_Checked_Empty* and both can be edited – changed.



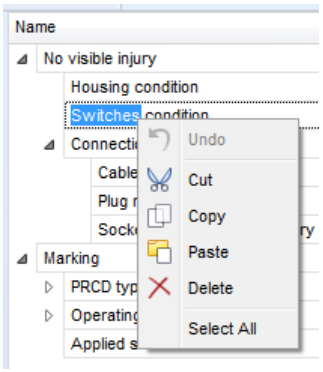
Item tasks containing Child Item tasks are marked with triangle in front of their Name.

Click on triangle mark:

collapse Item task tree structure

expands Item task tree structure

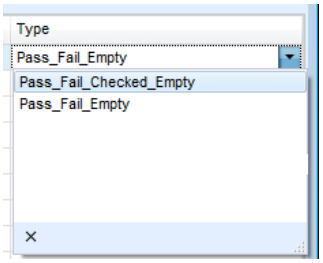
Edit Name and Type of Item task



Edit Name of Item task:

Click to the Item task Name field to start editing it.

Drag cursor, with left mouse button pressed, to select letters and words. Position cursor and double-click to select word of the name. Actions could be performed with keyboard also.
Press right mouse button to activate Edit menu and select appropriate action as presented on the left figure. Menu is case sensitive; options currently not available are greyed out.



Edit Type of Item task:

Click to Item Type field to open selection menu presented on left figure. Selectable checkbox status assignment options are:

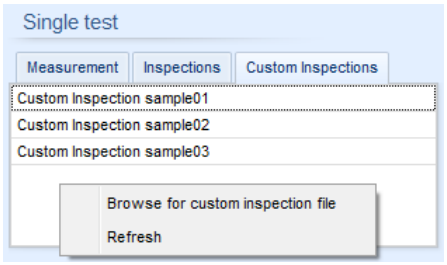
Pass_Fail_Checked_Empty: Pass, Fail, Checked, Empty (default)

Pass_Fail_Empty: Pass, Fail selection, Empty (default) value

F.8.2 Applying Custom Inspections

Custom inspections can be applied in Auto Sequences®. Direct assignment of Custom inspection to the Metrel ES manager structure objects is not possible.
After custom created Inspection Data file is opened, available inspections are listed in Custom Inspections tab of Single test area of Auto Sequence® Editor, see chapter *F.1 Auto Sequence® Editor workspace* for details.
Custom Inspection is added to Auto sequence as a Single test, see chapter *F.6 Creating / modifying an Auto Sequence®* for details.

Opening / changing Inspection Data File

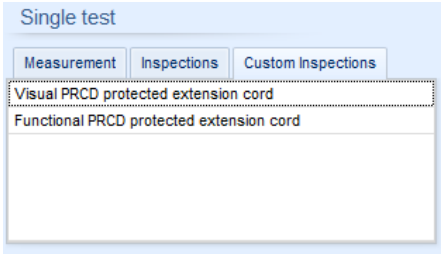


Position cursor within Custom inspections List area and apply mouse right click to open Option menu:

Refresh: Refresh content of already opened Inspection Data file

Browse for custom Inspection file:

Menu for browsing to folder location of new Inspection Data file is opened.



After confirmation of selection, new Inspection Data file is opened and list of available Custom Inspections is changed.

Note:

- If Metrel ES Manager Work scope is changed, opened Inspection Data file remains active and available Custom Inspections remains the same.

Appendix G Tests and Measurements with adapters

		 A 1507 3-phase active switch	 A 1143 Euro Z 290 A	 MI 3143 Euro Z 440 V	 MI 3144 Euro Z 800 V	 A 1632 eMobility Analyser	 MD 9273 Leakage Clamp meter with Bluetooth	 A 1732 DC EVSE adapter
Voltage	1-phase (TN/TT)	●	-	-	-	-	-	-
	1-phase (IT)	-	-	-	-	-	-	-
	3-phase	●	-	-	-	-	-	-
Socket test basic(live)		-	-	-	-	-	-	-
Riso	50 V – 1000 V	●	-	-	-	-	-	-
	2500 V	-	-	-	-	-	-	-
Riso all		-	-	-	-	-	-	-
Diagnostic test	50 V – 1000 V	-	-	-	-	-	-	-
	2500 V	-	-	-	-	-	-	-
Varistor		-	-	-	-	-	-	-
R low		●	-	-	-	-	-	-
Rlow 4W		-	-	-	-	-	-	-
Continuity		-	-	-	-	-	-	-
Ring Continuity		-	-	-	-	-	-	-
Socket		-	-	-	-	-	-	-
Rpe		●	-	-	-	-	-	-
RCD Auto		●	-	-	-	-	-	-
RCD Uc		●	-	-	-	-	-	-
RCD t		●	-	-	-	-	-	-
RCD I		●	-	-	-	-	-	-
Zs rcd		●	-	-	-	-	-	-
Z loop		●	-	-	-	-	-	-
Z loop 4W		-	-	-	-	-	-	-
Z loop mOhm		-	●	●	●	-	-	-
Z line mOhm		-	●	●	●	-	-	-
High Current		-	-	●	●	-	-	-
Current clamp Meter		-	-	-	●	-	-	-
Rline mOhm		-	-	-	●	-	-	-
ELR Current Injection Test		-	-	-	●	-	-	-
ELR Combination Time Test		-	-	-	●	-	-	-
Utouch		-	-	●	●	-	-	-
Z auto		●	-	-	-	-	-	-
Z line		●	-	-	-	-	-	-
Z line 4W		-	-	-	-	-	-	-
Voltage Drop		●	-	-	-	-	-	-
Earth 3W		-	-	-	-	-	-	-

	 A 1507 3-phase active switch	 A 1143 Euro Z 290 A	 MI 3143 Euro Z 440 V	 MI 3144 Euro Z 800 V	 A 1632 eMobility Analyser	 MD 9273 Leakage Clamp meter with Bluetooth	 A 1732 DC EVSE adapter
Earth 2 clamps	-	-	-	-	-	-	-
Ro	-	-	-	-	-	-	-
Power	-	-	-	-	-	-	-
Harmonics	-	-	-	-	-	-	-
Currents	-	-	-	-	-	-	-
IMD	-	-	-	-	-	-	-
ISFL	-	-	-	-	-	-	-
Locator	-	-	-	-	-	-	-
Discharging Time	-	-	-	-	-	-	-
Illumination	-	-	-	-	-	-	-
Diagnostic Test (EVSE)	-	-	-	-	●	-	-
Power CLAMP	-	-	-	-	-	●	-
Voltage CLAMP	-	-	-	-	-	●	-
Current CLAMP	-	-	-	-	-	●	-
Inrush CLAMP	-	-	-	-	-	●	-
Harmonics U CLAMP	-	-	-	-	-	●	-
Harmonics I CLAMP	-	-	-	-	-	●	-
Z (DC EVSE)	-	-	-	-	-	-	●
Riso (DC EVSE)	-	-	-	-	-	-	●
RIow (DC EVSE)	-	-	-	-	-	-	●
IMD (DC EVSE)	-	-	-	-	-	-	●
Tdisch (DC EVSE)	-	-	-	-	-	-	●
DC EVSE Functional	-	-	-	-	-	-	●
DC EVSE Error	-	-	-	-	-	-	●