Manual

Elma iTest 7400 Multifunction tester

ENGLISH

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Change log

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1 Preface

Elma iTest 7400 is a professional, multifunctional, hand-held test instrument intended to perform measurements required for verification of electrical safety of installations in buildings.

The large, backlit TFT color display ensures clear visibility of results, indicators, measurement parameters, and messages.

It comes with all necessary accessories to facilitate convenient testing. The included soft carrying bag not only protects the instrument but also organizes all accessories, making it easy to transport between locations.

The following measurements and tests can be performed:

- Continuity tests,
- Insulation resistance tests,
- RCD testing,
- Line impedance measurements,
- Loop impedance measurements (with RCD trip-lock function),
- Voltage, frequency, and phase rotation tests.

Notes:

- This document is intended for technically qualified personnel responsible for the product and its operation.
- Instrument screenshots shown in this document may differ slightly from the actual instrument displays due to firmware updates or modifications.
- Elma Instruments reserves the right to implement technical changes without prior notice as part of ongoing product development.

2 Safety instructions

2.1 Warnings and notes

To maintain the highest level of operator safety while carrying out various tests and measurements, we strongly recommend keeping your Elma iTest 7400 in the best possible condition and undamaged. When using the instrument, consider the following general warnings:

To ensure maximum operator safety during tests and measurements, it is strongly advised to keep your Elma iTest 7400 in optimal condition and free from damage. Please take into account the following general warnings while using the instrument.

2.1.1 Safety warnings

- **Read the instruction manual thoroughly** to prevent potential dangers to the operator, the instrument, or the equipment under test.
- **Observe warning markings** on the instrument (details in the next chapter).
- **Avoid improper use**: Operating the instrument in a manner not specified in the manual can compromise its safety features.
- **Inspect for damage**: Do not use the instrument or accessories if any damage is detected.
- **Regular functionality checks**: Periodically verify the instrument and accessories to ensure proper operation and avoid hazards from misleading results.
- **Electric shock precautions**: Follow all known safety measures to mitigate the risk of electric shock when working with hazardous voltages.
- **Approved accessories only**: Use only standard or optional test accessories provided by the distributor.
- **Fuse replacement**: Follow the manual's instructions for, chapter 8.1 Only use fuses specified in the manual.
- **Service and calibration**: Must be performed exclusively by a competent, authorized individual.
- **Voltage limitations**: Do not use the instrument in AC systems with voltages exceeding 550 V.
- **Accessory protection categories**: Note that some accessories have lower protection categories than the instrument.
- **Battery safety**: The instrument can use alkaline or rechargeable battery cells. Replace them only with the type specified on the battery compartment label or in the manual. Do not use standard alkaline batteries when the power adapter is connected to prevent explosions!
- **Hazardous voltages inside the instrument**: Disconnect all test leads, remove the power supply cable, and power off the instrument before accessing the battery compartment.

2.1.2 Instrument markings

CE	Equipment meets requirements of all subjected EU regulations.
	Equipment shall be recycled as electronic waste.
	Danger: risk of high voltage!
	Class II: Double Insulated. No need for safety connection to Earth.
	Read the instruction manual with special care for safe operation. The symbol requires an action!

2.1.3 Warnings related to measurement functions ⚠

2.1.3.1 General

- Do not connect test terminals to external voltage higher than 550 V (AC or DC) in order not to damage the test instrument!

2.1.3.2 Insulation resistance

- Insulation resistance measurement should only be performed on de-energized objects!
- Ensure all loads are disconnected and all switches are closed when measuring insulation resistance between installation conductors.
- Avoid contact with the test object during measurement or before it is fully discharged to prevent the risk of electric shock.

2.1.3.3 Continuity functions

- Continuity measurements should only be performed on de-energized objects!
- Parallel impedances or transient currents may influence test results.

2.1.3.4 Testing PE terminal

- If phase 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!

2.1.4 Notes related to measurement functions

2.1.4.1 General

- The “!” indicator means that the selected measurement cannot be performed because of irregular conditions on input terminals.
- Insulation resistance, continuity functions and earth resistance measurements can only be performed on de-energized objects.
- PASS / FAIL indication is enabled when limit is set. Apply appropriate limit value for evaluation of measurement results.
- In the case that only two of the three wires are connected to the electrical installation under test, only voltage indication between these two wires is valid.

2.1.4.2 Insulation resistance

- If voltages of higher than 10 V (AC or DC) are detected between test terminals, the insulation resistance measurement will not be performed.

2.1.4.3 Continuity functions

- If voltages of higher than 10 V (AC or DC) are detected between test terminals, the continuity resistance test will not be performed.
- Before performing a continuity measurement, where necessary, compensate test lead resistance.

2.1.4.4 RCD functions

- Parameters set in one function are also kept for other RCD functions!
- The measurement of contact voltage does not normally trip an RCD. However, the trip limit of the RCD may be exceeded because of leakage current flowing to the PE protective conductor or a capacitive connection between L and PE conductors.
- The RCD trip-lock sub-function (function selector switch in LOOP position) takes longer to complete but offers much better accuracy of fault loop resistance (in comparison to the RI sub-result in contact voltage function).
- RCD trip-out time and RCD trip-out current 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!
- The auto-test sequence (RCD AUTO function) stops when trip-out time is out of allowable time period.

2.1.4.5 Loop impedance (with Loop RCD and/or Loop Rs option)

- Isc depends on Z, Un and scaling factor
- The current limit depends on fuse type, fuse current rating, fuse trip-out time
- The specified accuracy of tested parameters is valid only if the mains voltage is stable during the measurement.
- Fault loop impedance measurements will trip an RCD.
- The measurement of fault loop impedance using trip-lock function does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing to the PE protective conductor or a capacitive connection between L and PE conductors.

2.1.4.6 Line impedance

- Isc depends on Z, Un and scaling factor
- The current limit depends on fuse type, fuse current rating, fuse trip-out time
- The specified accuracy of tested parameters is valid only if the mains voltage is stable during the measurement.

2.2 Batteries ⚠

When connected to an installation, the instrument's battery compartment can contain hazardous voltage inside! When replacing battery cells or before opening the battery/fuse compartment cover, disconnect any measuring accessory connected to the instrument and turn off the instrument,

- Ensure that the battery cells are inserted correctly, otherwise the instrument will not operate, and the batteries could be discharged.
- If the instrument is not to be used for a long period of time, remove all batteries from the battery compartment.
- Rechargeable Ni-MH batteries (size AA) can be used. It is recommended only using of rechargeable batteries with a capacity of 2300 mAh or above.
- Do not recharge alkaline battery cells!

2.3 Charging

The batteries will begin charging whenever the power supply adapter is connected to the instrument. The built-in protection circuits control the charging procedure and assure maximum battery lifetime. The power supply socket polarity is shown in figure 2.1.

Figure 2-1 Power supply socket polarity

Note:

- Use only power supply adapter delivered from the manufacturer or distributor of the test equipment to avoid possible fire or electric shock!

2.4 Precautions on charging of new battery cells or cells unused for a longer period

Unpredictable chemical processes can occur during the charging of new battery cells or cells that have been left unused for long periods of time (more than 3 months).

When using an external intelligent battery charger, one complete discharging/charging cycle can be performed automatically. After performing this procedure, a normal battery capacity should be fully restored, and the operating time of the instrument will approximately meet the data set out in the in the technical specification.

Notes:

- The charger in the instrument is a pack cell charger. This means that the cells are connected in series during the charging so all of them must be in similar state (similarly charged, same type and age).
- If even one deteriorated battery cell (or just one of a different type e.g. capacity, chemical design) can cause disrupted charging of the entire battery pack which could lead to overheating of the battery pack and a significant decrease in the operating time.
- If no improvement is achieved after performing several charging/discharging cycles, the state of each individual battery cells should be determined (by comparing battery voltages, checking them in a cell charger, etc.). It is very likely that one or more of the battery cells could have deteriorated.
- The effects described above should not be mixed with the normal battery capacity decrease over time. All charging batteries lose some of their capacity when repeatedly charged/discharged. The actual decrease in capacity compared to the number of charging cycles depends on the battery type. This information is normally provided in the technical specification from battery manufacturer.

2.5 Standards applied

The Elma iTest 7400 is manufactured and tested in accordance with the following regulations:

Electromagnetic compatibility (EMC)

EN 61326	Electrical equipment for measurement, control and laboratory use – EMC requirements Class B (Hand-held equipment used in controlled EM environments)

Safety (LVD)

EN 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements
EN 61010-031	Safety requirements for hand-held probe assemblies for electrical measurement and test

Functionality

EN 61557	Electrical safety in low voltage distribution systems up to 1000 VAC and 1500 VAC – 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 6	Residual current devices (RCDs) in TT and TN systems
Part 7	Phase sequence
Part 10	Combined measuring equipment

EVSE

IEC 62955	Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles

Note about EN and IEC standards:

Text of this manual contains references to European standards. All standards of EN 6XXXX (e.g. EN 61010) series are equivalent to IEC standards with the same number (e.g. IEC 61010) and differ only in amended parts required by European harmonization procedure.

3 Instrument description

3.1 Front panel

Legend:

1. ON/OFF key, to switch the instrument on and off. The instrument will automatically switch off (APO) after the last key press and no voltage is applied.
2. Function selector switch
3. Navigation keys (up, down, left, right)
4. Help key
5. TEST key for starting tests
6. Memory key
7. Compensation key, to compensate for the test lead resistance in low-value resistance measurements
8. Setup key
9. ESC key
10. TFT color display

Figure 3-1 Front panel

3.2 Connector panel

Legend:

1. Test connector terminals
   Warning! Maximum allowed voltage between test terminals and ground is 600V!
   Maximum allowed voltage between test terminals is 550 V!
2. Socket for optinal probe with test push button
3. USB B connector for data transfer
4. Battery charger input

Figure 3-2 Connector panel

3.3 Back panel

Legend:

1. Battery/fuse compartment cover
2. Information label
3. Fixing screws for battery/fuse compartment cover

Figure 3-3 Back panel

Legend:

1. Fuse F1
2. Fuse F2
3. Fuse F3
4. Battery cells (size AA)

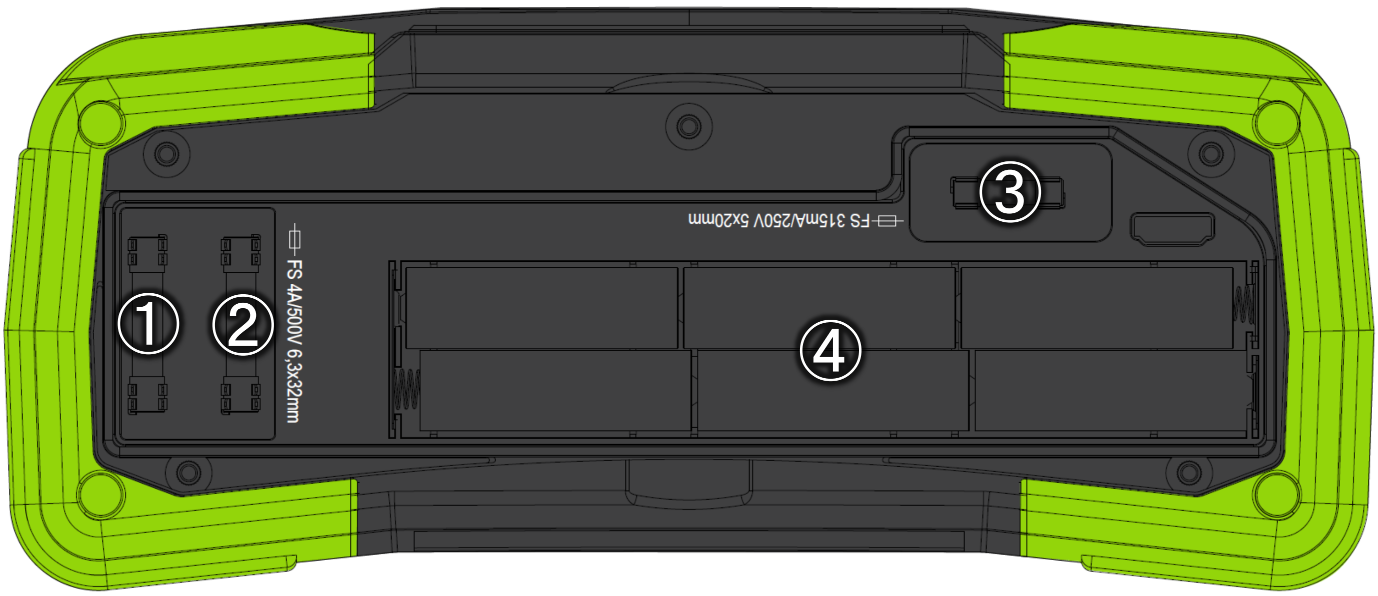

Figure 3-4 Battery and fuse compartment

3.4 Bottom view – Information label

Function	EN61557	range	Accuracy	
Continuity	-4	0.1 Ω ... 20.0 Ω 0.1 Ω ... 1999 Ω	±(3% of read. + 3 digits) ±(5% of read. + 3 digits)	Test current min. 200mA at 2 Ohm Test current max. 7 mA Open circuit voltage 5V
Insulation resistance	-2	0.1 MΩ ... 199.9 MΩ 0.1 MΩ ... 199.9 MΩ 200 MΩ ... 999 MΩ	±(5% of read. + 3 digits) ±(2% of read. + 3 digits) ±(10% of read.)	50/100/250V 500/1000V max. 15mA
RCD Time Current Contact voltage	-6	0.0 … 500ms 0.2xIΔN ... 1.1xIΔN (AC) 0.2xIΔN ... 1.5xIΔN (A), (IΔN ≥30 mA) 0.2xIΔN ... 2.2xIΔN (A), (IΔN <30 mA) 0.2xIΔN ... 2.2xIΔN (B) 3V … 99.9V	±3ms ±0.1xIΔN (-0%/±10%) of read.±5 digits	IΔN 6,10,30,100,300, 500,650,1000mA
Impedance	-3	0.25 Ω ... 9999 Ω 0.25 Ω ... 9999 Ω 0.75 Ω ... 19.99 Ω 20 Ω ... 9999 Ω	±(5% of read. + 5 digits) ±(5% of read. + 5 digits) ±(5% of read. + 10 digits) ±(10% of read.)	Z line L-L,L-N Z loop L-PE Z loop L-PE non-trip Line: 93V-134V; 185V-266V; 321V-485V; 45Hz-65Hz Loop: 93V-134V; 185V-266V; 45Hz-65Hz
Voltage Frequency	-7	0 … 550V (45-400Hz) 10.0 … 499.9Hz	±(2% of read. + 2 digits) ±(0.2% + 1digits)	TRMS
Phase rotation	-7	50 … 550VAC 45 … 400Hz		Right:1-2-3 Left:3-2-1
Earth resistance	-5	1.0 Ω ... 9999 Ω 6.0 Ω ... 9999 Ω	±(5% of read. + 5 digits)	3-wire, 4-wire Specific earth resistance f=126.9Hz

Figure 3-5 Bottom panel information label

3.5 Carrying the instrument

The neck strap supplied allows the instrument to be carried in a variety of different ways. The operator can choose the most appropriate method based on the tasks they are performing.

The instrument can be hung around the operator’s neck allowing the instrument to move freely. This allows equipment to be moved quickly between test locations.

4 Instrument operation

4.1 Symbols and messages on the instrument display

The instrument display is divided into several sections.

Legend:

1. Function line
2. Result field: In this field the main result and sub-results are displayed.
3. Status fields: PASS/FAIL/ABORT/START/WAIT/WARNINGS status are displayed.
4. Online voltage and output monitor: Shows symbolized plugs, names the plugs depending on the measurements, always shows the actual voltages.
5. Test parameters
6. Battery status indication
7. Clock

Figure 4-1 Display outlook

4.2 The online voltage and output terminal monitor

Online voltages are displayed together with test terminal indication.

Figure 4-2 All three test terminals are used for selected measurement

Online voltages are displayed together with test terminal indication.

Figure 4-3 L and N test terminals are used for selected measurement

4.3 Status symbols

	Dangerous voltage
COMP	Test leads are compensated (optional)
	Measurement cannot be started
	Dangerous voltage on PE
	Result is not ok
	Result is ok
	RCD open or tripped
	RCD closed
	Measurement can be started
	Temperature too high
	Swap test leads
	Wait
	Noise on signal
	Check fuses
REF	Reference measurement (optional)
	Battery power indication
	Low battery indication. Battery pack is too weak to guarantee correct result. Replace the batteries

4.4 Sound warnings

- Short high sound: Button pressed
- Continuous sound: During continuity test when result is <35 Ohm
- Increasing sound: Attention, dangerous voltage applied
- Short sound: Power off, end of measurement
- Decreasing sound: Warnings (temperature, voltage at input, start not possible)
- Periodic sound: Warning! Phase voltage on the PE terminal! Stop all measurements immediately and eliminate the fault before proceeding with any activity!

4.5 Performing measurement

4.5.1 Measurement function/ sub-function

The following measurements can be selected with the function selector switch:

- Ω - R Low
- MΩ - R Insulation
- LINE - Line impedance and voltage drop
- LOOP - Loop impedance
- RCD
- V – Voltage/rotation/frequency measurement

The function/sub-function name is highlighted on the display by default.

4.5.2 Selecting measurement function/ sub-function

Using navigation keys ▲▼ select the parameter/limit value you want to edit. By using ◄► keys the value for the selected parameter can be set.

Once the measurement parameters are set, the settings are retained until new changes are made.

4.5.3 Performing tests

When ▶ symbol is displayed test can be started by pressing the **TEST** button. After completion of the test its result value and status will be displayed. In case of a PASSED measurement, result value will be displayed in black color along with the ✓ status symbol. In case of a NOT PASSED measurement, the result value will be marked in red color along with the ✗ symbol.

4.6 Setup menu

To enter the setup menu, press the **SETUP** key. In the setup menu, the following actions can be taken:

Submenu	Options	Description
Date/Time	Year Month Day Hour Minute	Sets internal date and time
Isc factor		Sets prospective short/fault current scaling factor
RCD standard	EN 61008/EN 61009 EN 60364-4-41 TN/IT EN 60364-4-41 TT BS 7671 AS/NZS 3017	Select national standard for RCD testing
ELV	50 V AC / 120V DC 25V AC / 60V DC	Select voltage for ELV warning
Power off time	no power off 30 s 1 min 5 min 10 min 30 min 1 h	Select time when device should switch off if not used
Continuity timeout	no power off 30 s 1 min 5 min 10 min 30 min 1 h	Select time-out when measurement should stop automatically
R insulation timeout	no power off 30 s 1 min 5 min 10 min 30 min 1 h	Select time-out when measurement should stop automatically
Supply system	TN (TT) IT Reduced low voltage (2 x 55 V)	Select supply network/system
Device info		Shows info about device, e.g. firmware version
Language	English Norwegian Swedish Danish	Sets the language
Buzzer	All sounds Alarm and errors Alarm only	Sets the options, when the buzzer should be active
Backlight		Sets the level of the TFT display backlight

4.7 Help screen

The Help screens contain diagrams that show the correct use of the device.

- Press the **HELP** key to enter the help screen.
- Press the **HELP** key or the ESC key to exit the help screen.
- Use navigation keys to switch to previous/next help screen.

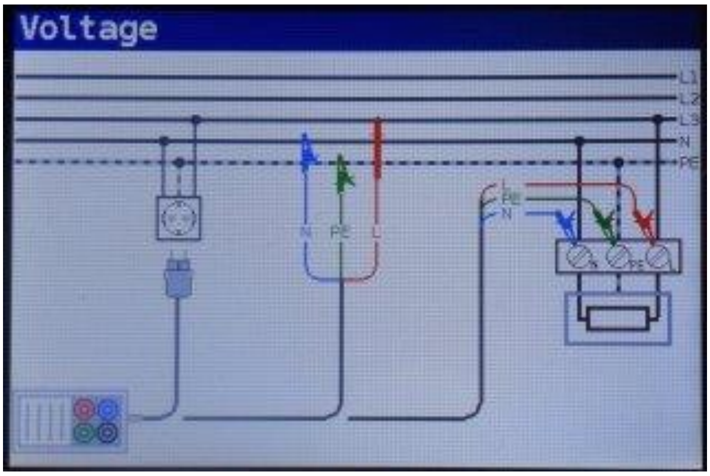

Figure 4-4 Example of help screen

5 Measurements

5.1 Insulation resistance

The insulation resistance measurement is performed in order to ensure safety against electric shock. Using this measurement, the following items can be determined:

- Insulation resistance between installation conductors,
- Insulation resistance of non-conductive rooms (walls and floors),
- Insulation resistance of ground cables,
- Resistance of semi-conductive (antistatic) floors.

5.1.1 Insulation resistance measurement

Warnings:

- Insulation resistance measurement should only be performed on de-energized objects!
- When measuring the insulation resistance between installation conductors, all loads must be disconnected, and all switches closed!
- Do not touch the test object during the measurement or before it is fully discharged! Risk of electric shock!
- In order to prevent damaging the test instrument, do not connect test terminals to an external voltage higher than 550 V (AC or DC).

1. Select **MΩ**, insulation function, with the function selector switch.
2. Set test parameters:
   Select **Volt.** to the nominal test voltage.
   Select **Limit** to set low limit insulation resistance value.

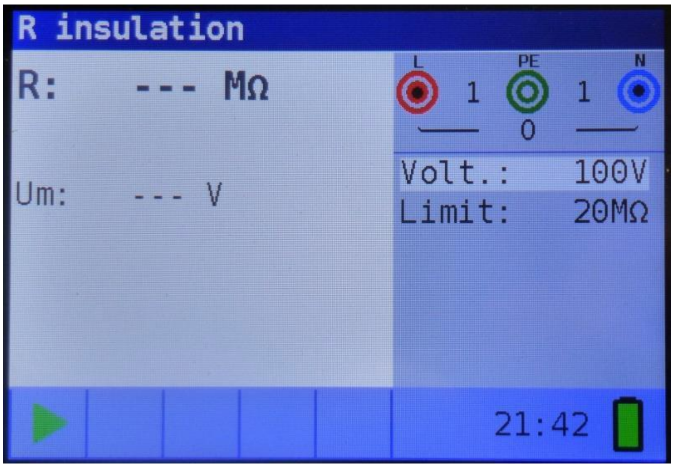

Figure 5-1 Insulation resistance measurement menu

3. Ensure that no voltages are present on the object to be tested.
4. Connect test leads.
5. Check status fields for warnings. If ▶ is displayed, test can be performed.
6. Press **TEST** to start test.

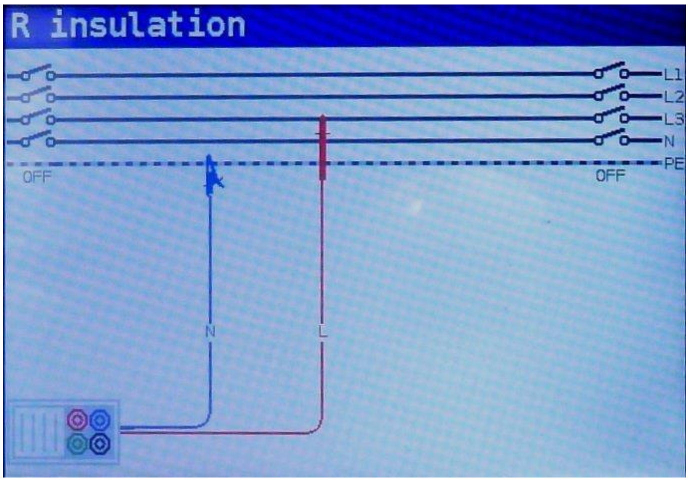

Figure 5-2 Insulation resistance test leads connection

7. After the test is done, measured results are displayed.

   ✔ Test result is ok,
   ✖ Test result is not ok,
   R: Insulation resistance,
   Um: Actual voltage applied to item under test.

Figure 5-3 Example of insulation resistance measurement results

5.2 Continuity measurement

Two continuity sub-functions are available:

- R Low, ca. 240 mA continuity test with automatic polarity reversal.
- Continuity, ca. 4 mA continuous continuity test (optional), useful when testing inductive systems.

5.2.1 R Low

This function is used to test the resistance between two different points of the installation to ensure that a conductive path exists between them. The test ensures that all protective conductors, earth conductors or bonding conductors are correctly connected, terminated and have the correct resistive value.

The measurement of the R Low resistance is performed with a test current of more than 200 mA @ 2 Ω. An automatic pole reversal of the test voltage and the test current is performed during the test. This test checks for any components (e.g. diodes, transistors, SCRs) that may have a rectifying effect on the circuit which could cause problems when a voltage is applied.

This measurement completely complies with EN 61557-4 regulations.

5.2.1.1 Low resistance measurement

Warnings:

- Low-value resistance measurements should only be performed on de-energized objects!
- Parallel impedances or transient currents may influence test results.

Note:

- If voltage between test terminals is higher than 10 V the R Low measurement will not be performed.

1. Select the **Ω**, continuity function, with the function selector switch, and select **LowΩ** mode with the navigation keys.
2. Set test parameters:
   Select **Limit** to set high limit resistance value.
3. Connect test leads to the instrument.

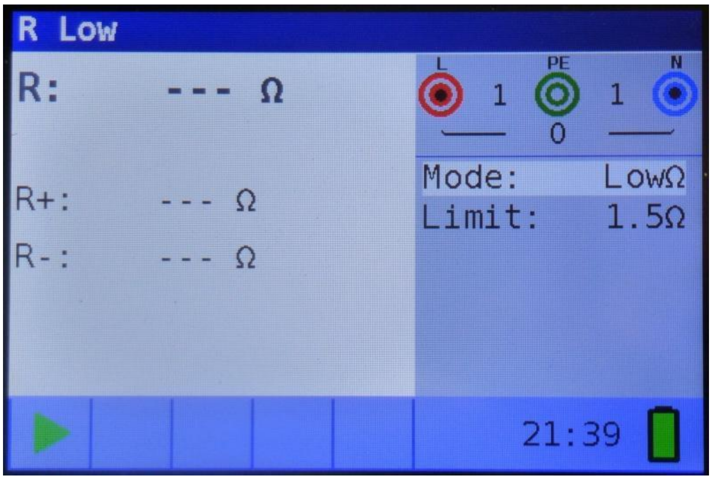

Figure 5-4 R Low resistance measurement menu

4. Short the test leads and press **ZERO** to compensate test lead resistance.
   After test lead compensation COMP will be display in the status filed.
   Press **ZERO** to remove compensation resistance value.

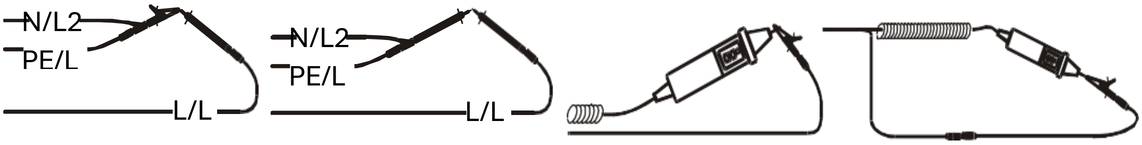

Figure 5-5 Shorted test leads

5. Ensure that no voltages are present on the object to be tested.
6. Connect test leads to object.
7. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
8. Press **TEST** to start test.

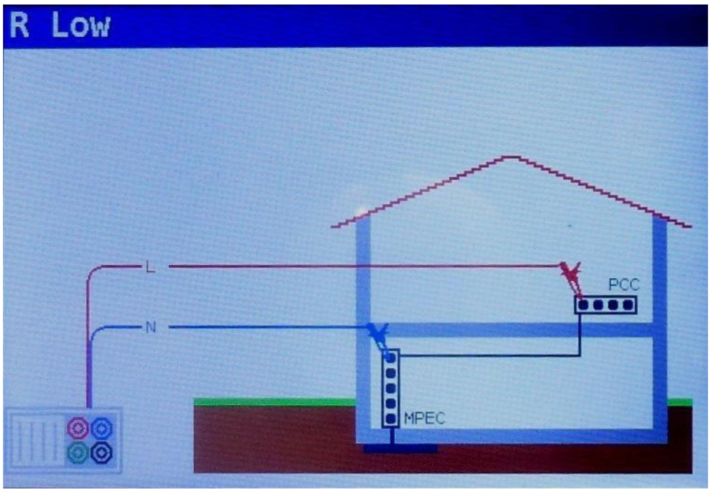

Figure 5-6 R Low test leads connection

9. After the test is done, measured results are displayed.

   ✔ Test result is ok,
   ✖ Test result is not ok,
   R: LowΩ resistance result (average of R+ and R- results),
   R+: LowΩ resistance sub-result with positive voltage at L terminal,
   R-: LowΩ resistance sub-result with positive voltage at N terminal.

Figure 5-7 Examples of R Low resistance measurement results

5.2.2 Continuity test

Continuous low-value resistance measurements can be performed without pole reversal of the test voltages and a lower test current (a few mA). In general, the function serves as an ordinary ohmmeter with low-test current. The function can also be used to test inductive components such as motors and coiled cables.

Warning:

- Low current continuity measurement should only be performed on de-energized objects!

Notes:

- If a voltage of higher than 10 V exists between test terminals, the continuity measurement will not be performed.
- Before performing a continuity measurement, compensate for the test lead resistance (if necessary).

5.2.2.1 Continuity measurement

1. Select the **Ω**, continuity function, with the function selector switch, and select **Cont** mode with the navigation keys.
2. Set test parameters:
   Select **Limit** to set high limit resistance value.
3. Connect test leads to the instrument and compensate test leads if applicable.

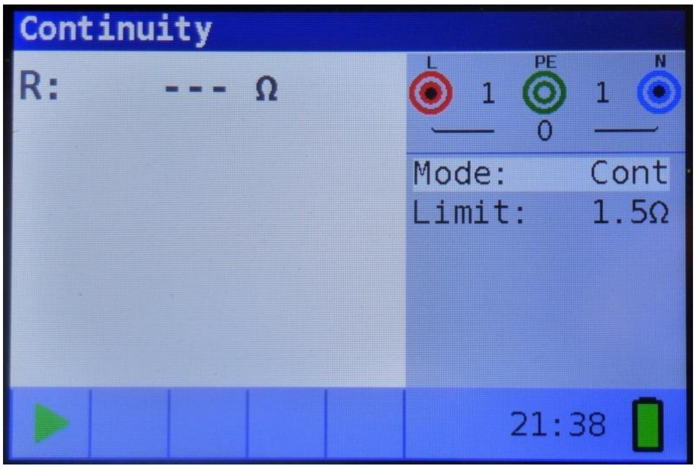

Figure 5-8 Continuity measurement menu

4. Ensure that no voltages are present on the object to be tested.
5. Connect test leads to object.
6. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
7. Press **TEST** to start test.

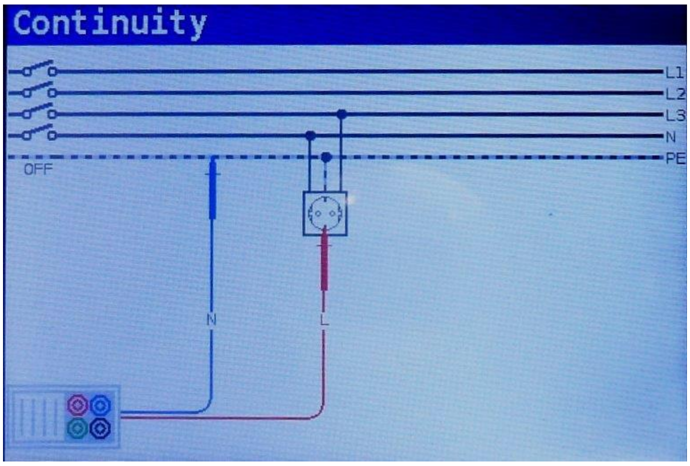

Figure 5-9 Continuity test leads connection

8. After the test is done, measured results are displayed.

   ✓ Test result is ok,
   ✗ Test result is not ok,
   R: Continuity resistance result,
   I: Current used in the measurement

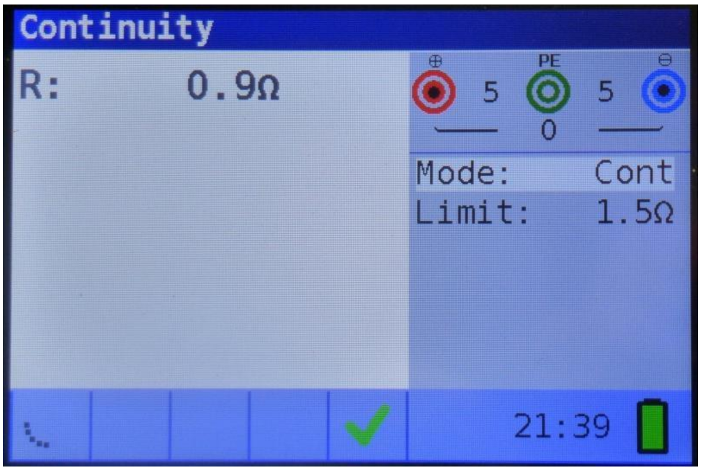

Figure 5-10 Example of Low current continuity measurement result

5.3 Testing RCDs

When testing RCDs, the following sub-functions can be performed:

- Contact voltage measurement,
- Trip-out time measurement,
- Trip-out current measurement,
- RCD autotest.

In general, the following parameters and limits can be set when testing RCDs:

- Limit contact voltage,
- Nominal differential RCD trip-out current,
- Multiplier of nominal differential RCD trip-out current,
- RCD type,
- Test current starting polarity.

For possible parameters that could be set look into specification tables at the end of this manual.

5.3.1 Limit contact voltage

Safety contact voltage is limited to 50 V AC for standard domestic area. In special environments (hospitals, wet places, etc.) contact voltages up to 25 V AC are permitted. Limit contact voltage can be set in contact voltage Uc function only!

5.3.2 Nominal differential trip-out current

The nominal differential current is the rated trip-out current of an RCD. The following RCD current ratings can be set: 6 mA, 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 650 mA and 1000 mA.

5.3.3 Multiplier of nominal residual current

For trip-out time measurement selected nominal differential current can be multiplied by ½, 1, 2 or 5.

5.3.4 RCD type and test current starting polarity

Elma iTest 7400 enables testing of general (non-delayed) and selective (time-delayed) RCDs. The types of RCD the instrument is suitable for testing include:

- Alternating residual currents (AC type),
- Alternating residual currents and residual pulsating direct currents (A type),
- Pure or nearly pure DC residual current (B type),
- Special RCDs for EVSE applications (RDC-DD).

Test current starting polarity can be started with the positive half-wave at 0° or with the negative half-wave at 180°.

Figure 5-11 Test current started with positive or negative half-wave

5.3.5 Testing selective (time-delayed) RCDs [S]

Selective RCDs demonstrate delayed response characteristics. Trip-out performance is influenced due to pre-loading during measurement of contact voltage. In order to eliminate the pre-loading a time delay of 30 s is inserted before performing the trip-out test.

5.3.6 Testing RCDs for EVSE applications

Mode 3 EVSE use residual current detection devices (RDC-DD) to ensure RCD types A and F are not impaired by residual DC currents exceeding 6 mA. RDC-DD include monitoring devices (RDC-MD) that detect and switch 6 mA DC currents, or protective devices (RDC-PD) that detect, evaluate, and switch AC, pulsating DC, and 6 mA DC currents. Note that RDC-MD has non-operating times, see Table 5-5.

5.3.7 Contact voltage, Uc

Leakage current flowing to the PE terminal causes a voltage drop across the earth resistance, which is called contact voltage (Uc). This voltage is present on all accessible parts connected to the PE terminal and should be lower than the safety limit voltage.

Contact voltage measurement is performed with a low current to avoid tripping the RCD.

The contact voltage results correspond to the RCD nominal differential current.

Type	IΔn	Contact voltage, Uc
AC		Uc ∝ 1.05 × IΔn
A, F	≥ 30 mA	Uc ∝ 1.05 × IΔn × 1.4
A, F	< 30 mA	Uc ∝ 1.05 × IΔn × 2
B, B+		Uc ∝ 1.05 × IΔn × 2
EVSE	30 mA AC	Uc ∝ 1.05 × IΔn
EVSE	6 mA DC	Uc ∝ 1.05 × IΔn × 2

Table 5-1 Relation between Uc and IΔn for general RCDs

Type	IΔn	Contact voltage, Uc
AC		Uc ∝ 1.05 × IΔn × 2
A, F	≥ 30 mA	Uc ∝ 1.05 × IΔn × 1.4 × 2
A, F	< 30 mA	Uc ∝ 1.05 × IΔn × 2 × 2
B, B+		Uc ∝ 1.05 × IΔn × 2 × 2

Table 5-2 Relation between Uc and IΔn for selective RCDs

R_L is a fault loop resistance and is calculated as follows:

$$R_L = \frac{Uc}{I\Delta n}$$

Warnings:

- Leakage currents in the circuit following the residual current device (RCD) may influence the measurements.
- Special conditions in residual current devices (RCD) of a particular design, for example of type S (selective and resistant to impulse currents) shall be taken into consideration.
- Equipment in the circuit following the residual current device (RCD) may cause a considerable extension of the operating time. Examples of such equipment might be connected capacitors or running motors.

5.3.7.1 Contact voltage measurement

Notes:

- Parameters set in this function are also kept for all other RCD functions!
- The measurement of contact voltage does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage currents flowing through the PE conductor or a capacitive connection between the L and PE conductor.
- RCD trip-lock sub-function (function selected to LOOP RCD option) takes longer to complete but offers much better accuracy of a fault loop resistance result (in comparison with the Rl sub-result in Contact voltage function).

1. Select the **RCD** function, with the function selector switch, and select **Uc** mode with the navigation keys.
2. Set test parameters:
   Select **IΔn** to set nominal residual current value.
   Select **Type** to set RCD Type.
   Select **Limit** to set contact voltage high limit value.

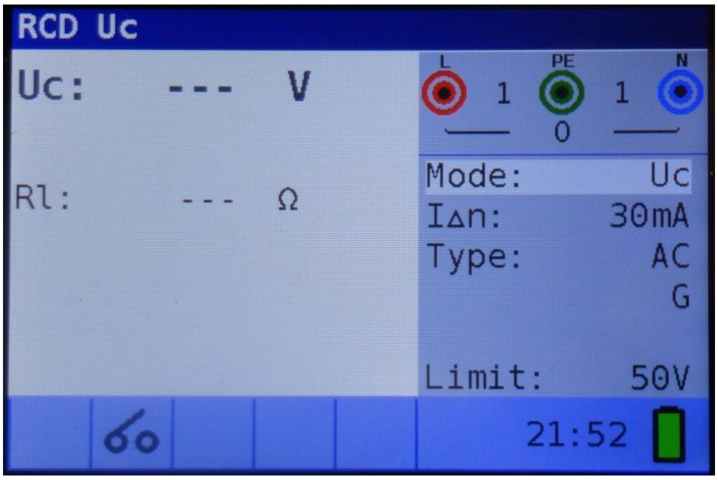

Figure 5-12 Contact voltage measurement menu

3. Connect test leads.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.

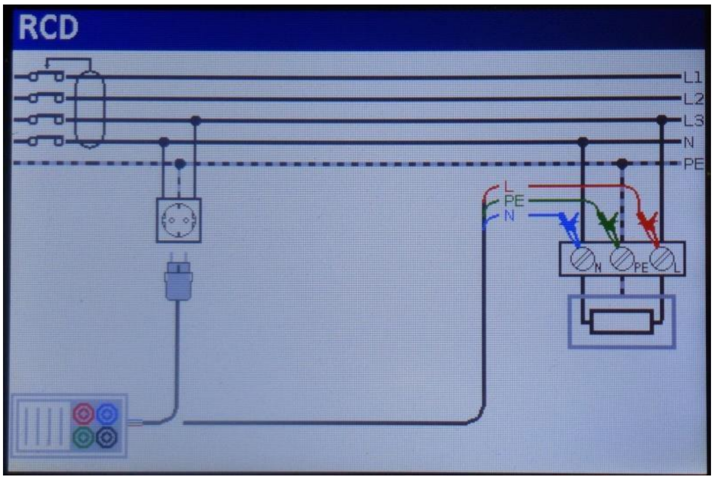

Figure 5-13 RCD functions test leads connection

6. After the test is done, measured results are displayed.

   ✔ Test result is ok,
   ✖ Test result is not ok,
   Uc: Contact voltage,
   Rl: Fault loop resistance.

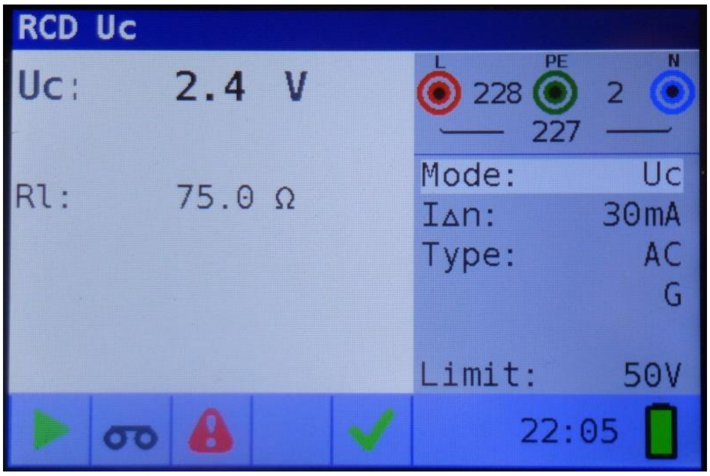

Figure 5-14 Example of contact voltage measurement results

5.3.8 RCD trip-out time, RCD t

Trip-out time measurement is used to verify the effectiveness of an RCD. This is achieved by a test simulating an appropriate fault condition. Trip-out times vary between standards and are listed below.

	½ × IΔn	IΔn	2 × IΔn	5 × IΔn
General (non-delayed) RCDs	tΔ > 300 ms	tΔ < 300 ms	tΔ < 150 ms	tΔ < 40 ms
Selective (time-delayed) RCDs	tΔ > 500 ms	130 ms < tΔ < 500 ms	60 ms < tΔ < 200 ms	50 ms < tΔ < 150 ms

Table 5-3 Trip-out times according to EN 61008 / EN 61009

EVSE (RDC-PD, RDC-MD)	IΔn	10 × IΔn	33 × IΔn
6 mA DC	10.0 s	0.3 s	0.1 s

Table 5-4 Maximum trip-out times according to IEC 62955

EVSE (RDC-MD)	IΔn	2 × IΔn	5 × IΔn
30 mA AC	no trip	0.3 s	0.08 s

Table 5-5 Non-operating times according to IEC 62955

5.3.8.1 RCD trip-out time measurement

Notes:

- Parameters set in this function are also transferred onto all other RCD functions!
- RCD trip-out time measurement will be performed only if the contact voltage at nominal differential current is lower than the limit set in the contact voltage setting!
- The measurement of the contact voltage in pre-test does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.

1. Select the **RCD** function, with the function selector switch, and select **Time** mode with the navigation keys.
2. Set test parameters:
   Select **IΔn** to set nominal residual current value.
   Select **Type** to set RCD Type.
   Select **Pol.** to set test current starting polarity.
   Select **Factor** to set nominal differential trip-out current multiplier.

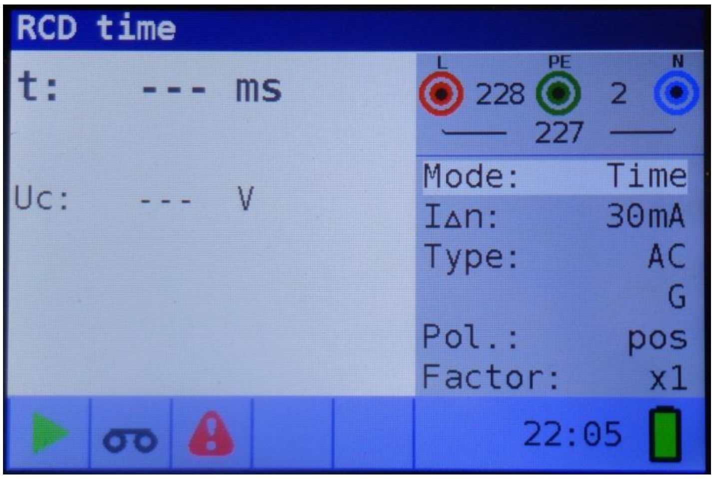

Figure 5-15 Trip-out time measurement menu

3. Connect test leads. See Figure 5-13 RCD functions test leads connection.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.

6. After the test is done, measured results are displayed.

   ✔ Test result is ok,
   ✘ Test result is not ok,
   t: Trip-out time,
   Uc: Contact voltage.

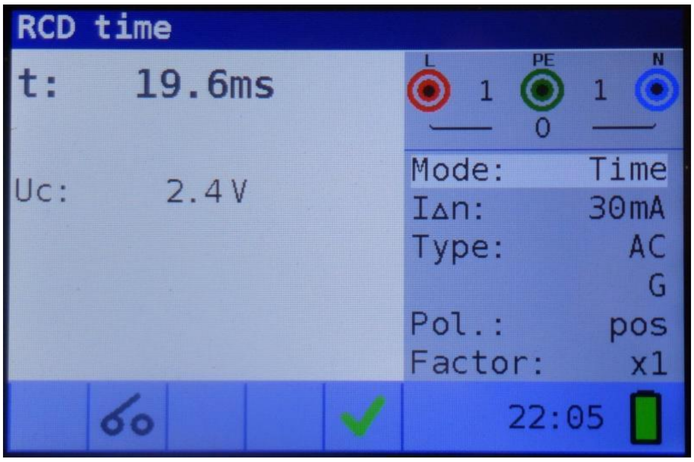

Figure 5-16 Example of trip-out time measurement results

5.3.9 RCD trip-out current, RCD I

This test is used to determine the minimum current required to trip the RCD. After the measurement has been started, the test current generated by the instrument is continuously increased, starting at 0.2 x IΔn to 1.1 x IΔn (to 1.5 x IΔn / 2.2 x IΔn (IΔn = 10 mA) for pulsating DC residual currents), until the RCD trips.

5.3.9.1 RCD trip-out current measurement

Notes:

- Parameters set in this function are also kept for other RCD functions!
- RCD trip-out current measurement will be performed only if the contact voltage at nominal differential current is lower than set limit contact voltage!
- The measurement of contact voltage in the pre-test does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.

1. Select the **RCD** function, with the function selector switch, and select **Current** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set RCD Type.
   Select **IΔn** to set nominal residual current value.
   Select **Pol.** to set test current starting polarity.

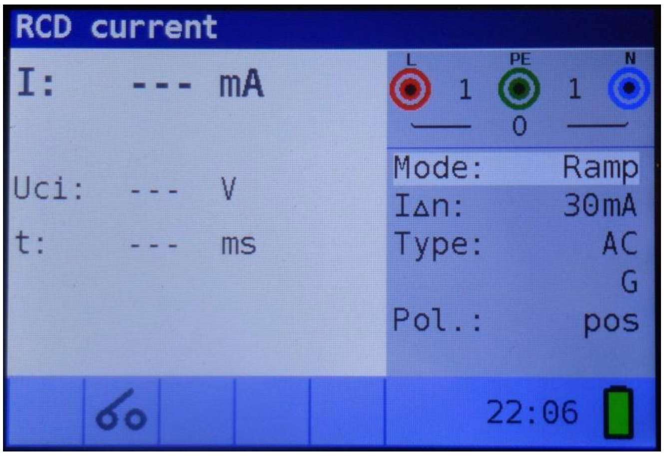

Figure 5-17 Trip-out current measurement menu

3. Connect test leads. See Figure 5-13 RCD functions test leads connection.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.

6. After the test is done, measured results are displayed.

✓ Test result is ok,
✗ Test result is not ok,
I: Trip-out current,
Uci: Contact voltage,
t: Trip-out time.

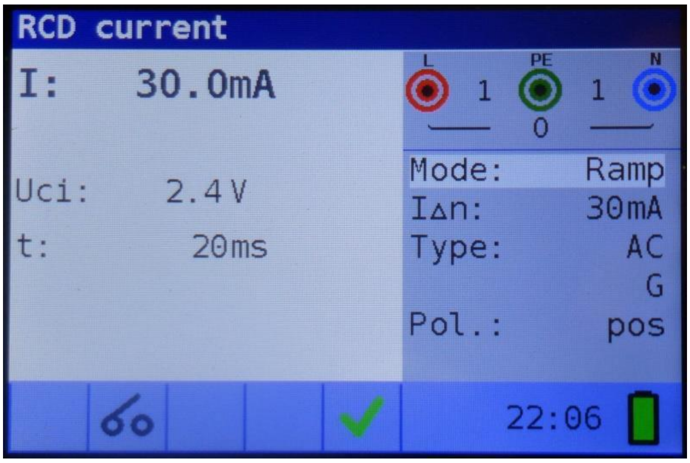

Figure 5-18 Example of trip-out current measurement result

5.3.10 Autotest

The purpose of the autotest function is to perform a complete RCD testing and measurement of most important associated parameters (contact voltage, fault loop resistance and trip-out time at different fault currents) with one press of a button. If a faulty parameter is noticed during the autotest, the test will stop to highlight the need for further investigation.

Notes:

- The measurement of contact voltage in the pre-test does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.
- The autotest sequence stops when the trip-out time is out of allowed time period.

5.3.10.1 RCD autotest

1. Select the **RCD** function, with the function selector switch, and select **Auto** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set RCD Type.
   Select **IΔn** to set nominal residual current value.

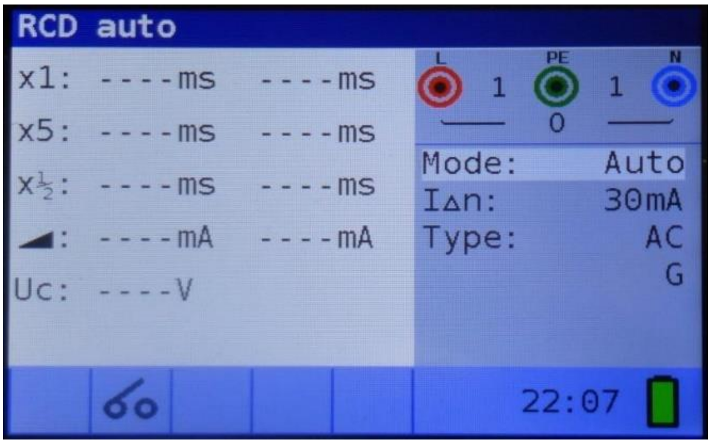

Figure 5-19 RCD autotest menu

3. Connect test leads.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test sequence.
   Test sequence will normally trip RCD six times.
6. Re-activate tripped RCD to continue test sequence.

See Figure 5-13 RCD functions test leads connection.

7. After the test is done, measured results are displayed.

   ✔ Test result is ok,
   ✖ Test result is not ok,
   x1 (+): Trip-out time (1×IΔn, 0°),
   x1 (-): Trip-out time (1×IΔn, 180°),
   x5 (+): Trip-out time (5×IΔn, 0°),
   x5 (-): Trip-out time (5×IΔn, 180°),
   x½ (+): Trip-out time (½×IΔn, 0°),
   x½ (-): Trip-out time (½×IΔn, 180°),
   IΔ (+): Trip-out current (0°),
   IΔ (-): Trip-out current (180°),
   Uc: Contact voltage for rated IΔn.

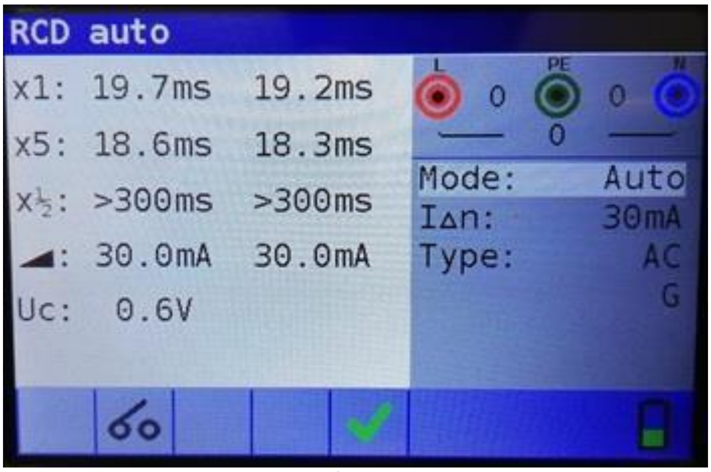

Figure 5-20 RCD autotest results

Note:

- the x1 autotests will be automatically skipped for RCD type B with rated residual currents of IΔn = 1000 mA
- the x5 autotests will be automatically skipped in the following cases:
  - RCD type AC with rated residual currents of IΔn = 1000 mA
  - RCD type A and B with rated residual currents of IΔn ≥ 300 mA
- In these cases, the autotest result is considered ok if the x1 and x½ results are ok, while the x5 tests are omitted.

5.4 Fault loop impedance and prospective fault current

The loop impedance function has three sub-functions available:

- LOOP IMPEDANCE sub-function performs a fast fault loop impedance measurement on supply systems which do not contain RCD protection.
- LOOP IMPEDANCE RCD trip-lock sub-function performs fault loop impedance measurement on supply systems which are protected by RCDs.
- LOOP IMPEDANCE Rs sub-function with configurable RCD-value performs fault loop impedance measurement on supply systems which are protected by RCDs.

5.4.1 Loop impedance

The fault loop impedance measures the impedance of the fault loop in the event that a short-circuit to an exposed conductive part occurs (i.e. a conductive connection occurs between the phase conductor and protective earth conductor). In order to measure loop impedance, the instrument uses a high test current.

Prospective fault current (I_{PFC}) is calculated on the basis of the measured resistance as follows:

$$I_{PFC} = \frac{U_N \times scaling\ factor}{Z_{L-PE}}$$

Nominal input voltage U_N	Voltage range
115 V	(93 V ≤ U_{L-PE} < 134 V)
230 V	(185 V < U_{L-PE} < 266 V)

5.4.1.1 Loop impedance measurement

1. Select the **LOOP** function, with the function selector switch, and select **Loop** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set fuse/MCB type.
   Select **Time** to set disconnection time limit.
   Select **Curr** to set nominal fuse/MCB value.
   Select **F Isc** to set Isc factor.

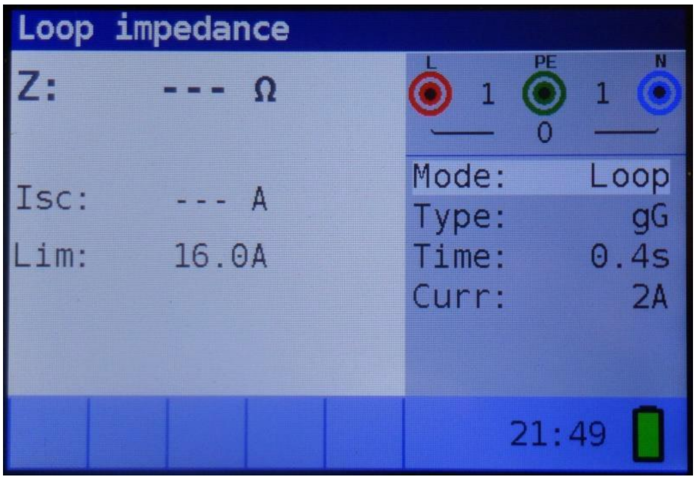

Figure 5-21 Loop impedance measurement menu

3. Connect test leads.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.

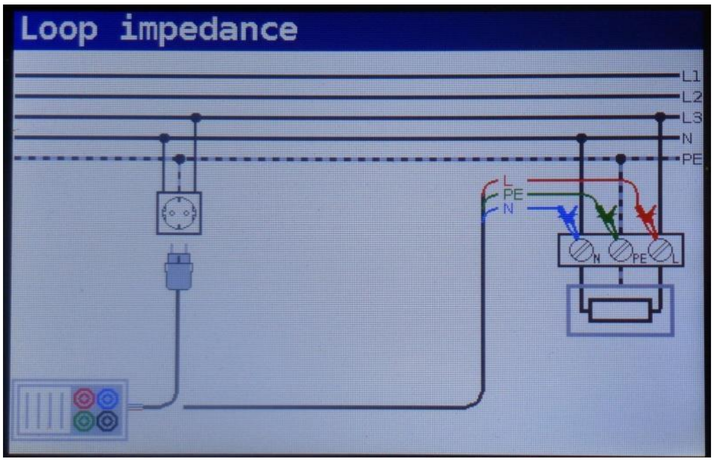

Figure 5-22 Loop impedance test leads connection

6. After the test is done, measured results are displayed.

   ✓ Test result is ok,
   ✗ Test result is not ok,
   Z: Fault loop impedance,
   Isc: Prospective fault current,
   Lim: Calculated fault current limit.

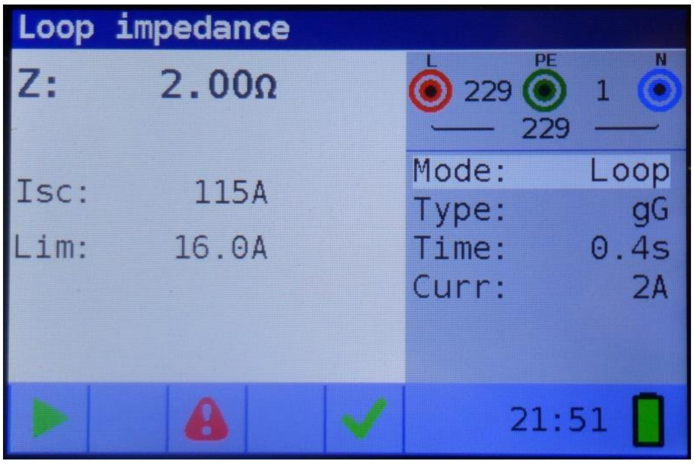

Figure 5-23 Example of loop impedance measurement results

5.4.2 Loop impedance RCD

The fault loop impedance is measured with a low test current to avoid tripping the RCD. This function can also be used for fault loop impedance measurement in systems equipped with RCDs which have a rated trip-out current of 30 mA and above.

Prospective fault current (I_{PFC}) is calculated on basis of measured resistance as follows:

$$I_{PFC} = \frac{U_N \times scaling\ factor}{Z_{L-PE}}$$

Nominal input voltage U_N	Voltage range
115 V	(93 V $\leq U_{L-PE} <$ 134 V)
230 V	(185 V $\leq U_{L-PE} \leq$ 266 V)

5.4.2.1 Loop impedance RCD trip-lock measurement

Notes:

- The measurement of fault loop impedance using trip-lock function does not normally trip an RCD. However, if the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.
- The specified accuracy of test parameter is valid only if mains voltage is stable during the measurement.

1. Select the **LOOP** function, with the function selector switch, and select **RCD** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set fuse/MCB type.
   Select **Time** to set disconnection time limit.
   Select **Curr** to set nominal fuse/MCB value.
   Select **F Isc** to set Isc factor.

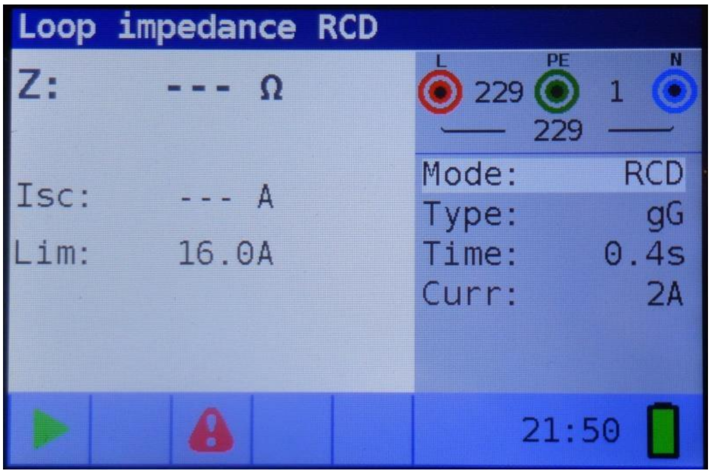

Figure 5-24 Loop impedance RCD menu

3. Connect test leads.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.
6. After the test is done, measured results are displayed.

See Figure 5-22 Loop impedance test leads connection.

✓ Test result is ok,
✗ Test result is not ok,
Z: Fault loop impedance,
Isc: Prospective fault current,
Lim: Calculated fault current limit.

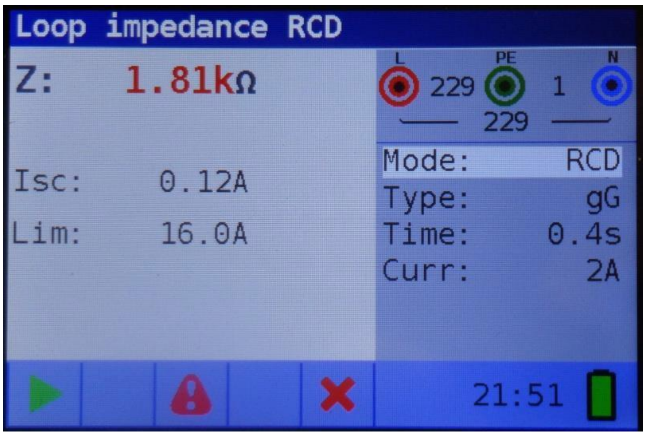

Figure 5-25 Example of loop impedance RCD measurement results

5.4.3 Loop impedance Rs (for adjustable current)

The fault loop impedance is measured with a low test current to avoid tripping the RCD. It is possible to adjust the value of the RCD, while the test current depends on the chosen value. With this function it is possible to test each RCD-type with the maximum possible current without tripping the RCD.

Prospective fault current (I_{PFC}) is calculated on basis of measured resistance as follows:

$$I_{PFC} = \frac{U_N \times scaling\ factor}{Z_{L-PE}}$$

Nominal input voltage U_N	Voltage range
115 V	(93 V ≤ U_{L-PE} < 134 V)
230 V	(185 V ≤ U_{L-PE} ≤ 266 V)

5.4.3.1 Loop impedance Rs trip-lock measurement

Notes:

- The measurement of fault loop impedance using trip-lock function does not normally trip an RCD. However, if the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.
- The specified accuracy of test parameter is valid only if mains voltage is stable during the measurement.

1. Select the **LOOP** function, with the function selector switch, and select **RCD** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set RCD type.
   Select **IΔn** to set nominal residual current.
   Select **Limit** to set contact voltage limit value.
   Select **F Isc** to set Isc factor.

Figure 5-26 Loop impedance Rs menu

3. Connect test leads.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.
6. After the test is done, measured results are displayed.

See Figure 5-22 Loop impedance test leads connection.

✔ Test result is ok,
✖ Test result is not ok,
Z: Fault loop impedance,
Isc: Prospective fault current.

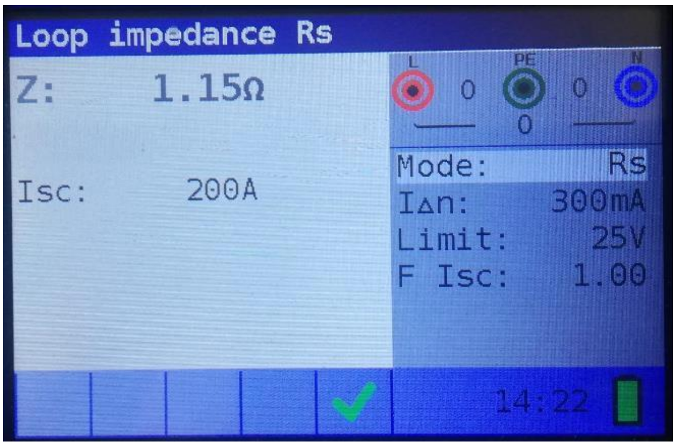

Figure 5-27 Example of loop impedance Rs measurement results

5.5 Line impedance and prospective short-circuit current

5.5.1 Line impedance

The line impedance is a measurement of the impedance of the current loop when a short-circuit to the neutral conductor occurs (conductive connection between phase conductor and neutral conductor in single-phase system or between two phase conductors in three- phase system). A high test current is used to perform the line impedance measurement.

Prospective short circuit current is calculated as follows:

$$I_{PFC} = \frac{U_N \times scaling\ factor}{Z_{L-N(L)}}$$

Nominal input voltage U_N	Voltage range
115 V	(93 V $\le U_{L-PE}$ < 134 V)
230 V	(185 V $\le U_{L-PE} \le$ 266 V)
400 V	(321V $\le U_{L-PE} \le$ 485 V)

5.5.1.1 Line impedance measurement

Notes:

- The specified accuracy of the test parameter is valid only if mains voltage is stable during the measurement.

1. Select the **LINE** function, with the function selector switch, and select **Line** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set fuse/MCB type.
   Select **Time** to set disconnection time limit.
   Select **Curr** to set nominal fuse/MCB value.
   Select **F Isc** to set Isc factor.

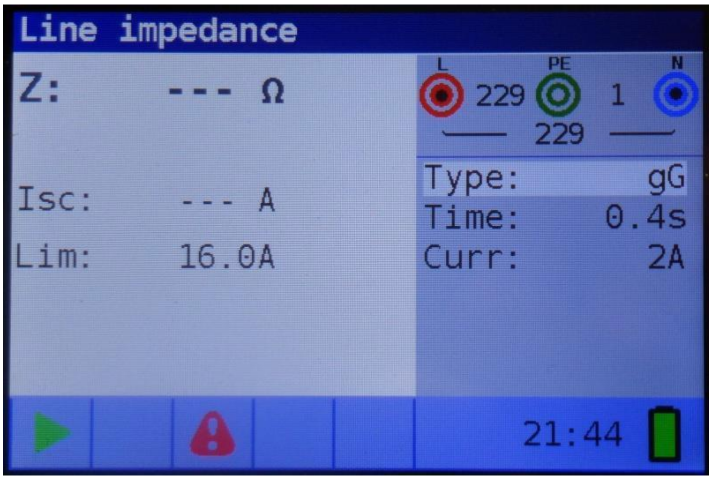

Figure 5-28 Line impedance measurement menu

3. Connect test leads.
4. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
5. Press **TEST** to start test.

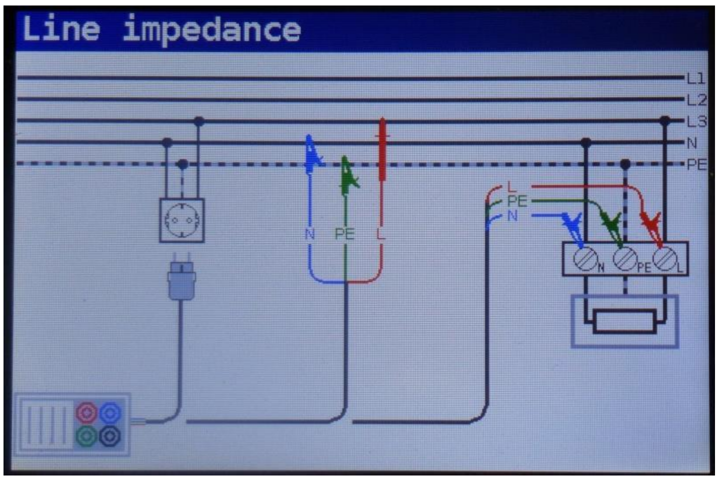

Figure 5-29 Line impedance measurement connection

6. After the test is done, measured results are displayed.

   ✓ Test result is ok,
   ✗ Test result is not ok,
   Z: Fault loop impedance,
   Isc: Prospective short-circuit current,
   Lim: Calculated fault current limit.

Figure 5-30 Example of line impedance measurement results

5.5.2 Voltage drop

The voltage drop function is a measurement of the line impedance (see chapter 5.5) and result is compared to a reference result which has been taken before on some other point of the installation (usually the entry point since this point has the lowest impedance). The voltage drop in %, the impedance and the prospective short circuit current are shown.

The voltage drop in % is calculated as follows:

$$\Delta U = \frac{(Z - Z_{REF}) \times I_N}{U_N}$$

5.5.2.1 Voltage drop measurement

Notes:

- The specified accuracy of the test parameter is valid only if mains voltage is stable during the measurement.

1. Select the **LINE** function, with the function selector switch, and select **V drop** mode with the navigation keys.
2. Set test parameters:
   Select **Type** to set fuse/MCB type.
   Select **Time** to set disconnection time limit.
   Select **Curr** to set nominal fuse/MCB value.
   Select **Limit** to set voltage drop high limit.
   Select **F Isc** to set Isc factor.

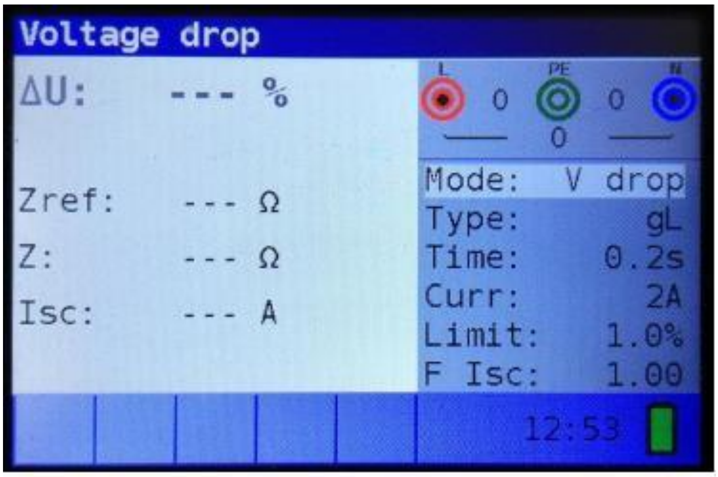

Figure 5-31 Voltage drop measurement menu

3. Connect test leads to instrument and reference point.
4. Press **ZERO** and REF will be shown in the display to indicate instrument is ready to record reference value.
5. Check status fields for warnings.
   If ▶ is displayed, reference value, Zref, can be recorded by pressing TEST.
6. Press **TEST** to record Zref.
7. Connect test leads to instrument and test point.

See Figure 5-29 Line impedance measurement connection.

8. Check status fields for warnings.
   If ▶ is displayed, test can be performed.
9. After the test is done, measured results are displayed.

   ✔ Test result is ok,
   ✖ Test result is not ok,
   ΔU: Voltage drop at the test point compared to the reference point,
   Zref: Line impedance at the reference point,
   Z: Line impedance at the test point,
   Isc: Prospective short-circuit current at the test point.

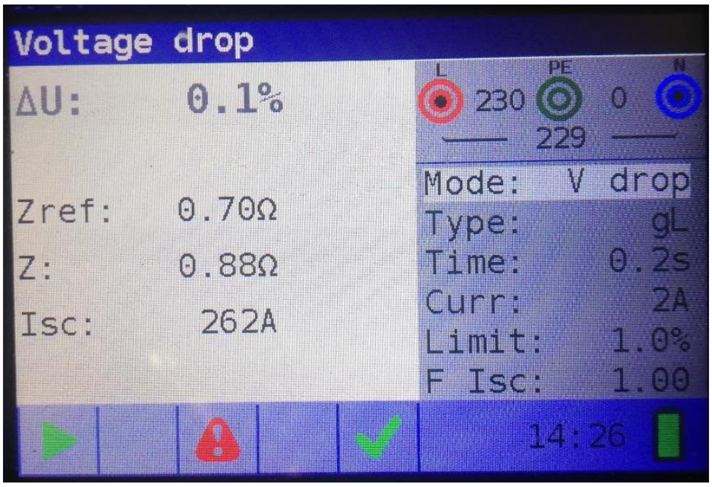

Figure 5-32 Example of voltage drop measurement results

5.6 Voltage and phase rotation

5.6.1 Single phase voltage and frequency

Voltage measurements should be carried out regularly while dealing with electric installations (carrying out different measurements and tests, looking for fault locations, etc.). Frequency is measured for example when establishing the source of mains voltage (power transformer or individual generator).

5.6.1.1 Voltage and frequency measurement

1. Select the **V**, voltage function, with the function selector switch.

Figure 5-33 Voltage measurement menu

2. Connect test leads.
3. Check status fields for warnings.
   If ▶ is displayed, test can be performed.

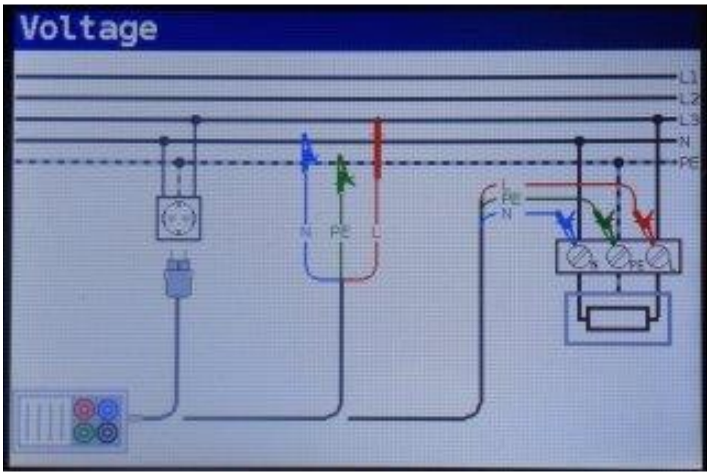

Figure 5-34 Voltage measurement connection

4. The voltage and frequency test operates continuously, capturing and displaying fluctuations in real-time during the measurement.

   U L-N: Voltage between phase and neutral conductors,
   U L-PE: Voltage between phase and protective conductors,
   U N-PE: Voltage between neutral and protective conductors.

Figure 5-35 Examples of voltage and frequency measurements

5.6.2 Three-phase voltage and rotation

In practice, we often deal with the connection of three-phase loads (motors and other electro- mechanical machines) to three-phase mains installation. Some loads (ventilators, conveyors, motors, electro-mechanical machines, etc.) require a specific phase rotation and some may even be damaged if the rotation is reversed. This is why it is advisable to test phase rotation before connection is made.

5.6.2.1 Phase rotation

1. Select the **V**, voltage function, with the function selector switch.
2. Connect test leads.
3. Check status fields for warnings. If ▶ is displayed, test can be performed.

See Figure 5-33 Voltage measurement menu.

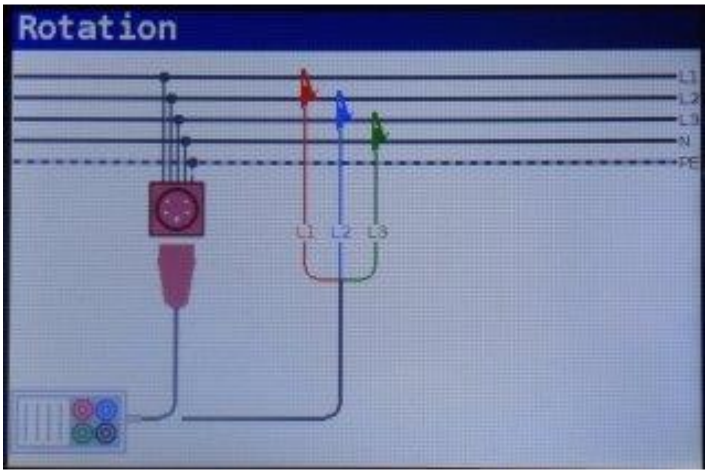

Figure 5-36 Three-phase voltage and rotation connection

4. The voltage and frequency test operates continuously, capturing and displaying fluctuations in real-time during the measurement.

   U 1-2: Voltage between phases L1 and L2,
   U 1-3: Voltage between phases L1 and L3,
   U 2-3: Voltage between phases L2 and L3,
   Freq: Frequency,
   Rotation: Phase sequence,
   -.- Irregular rotation value.

Figure 5-37 Example of three-phase voltage measurement and rotation

6 Storing measurements

After the measurement is completed, results can be stored in the internal memory of the instrument together with the sub-results and function parameters.

6.1 Overview

- The instrument can store up to 1000 measurements
- The list of records can be stepped through
- A single record or all records can be deleted
- The IDs for customer, location and object can be edited

- If there is no actual measurement made and the **MEM** key is pressed, and there are no records stored, an empty memory screen is displayed.

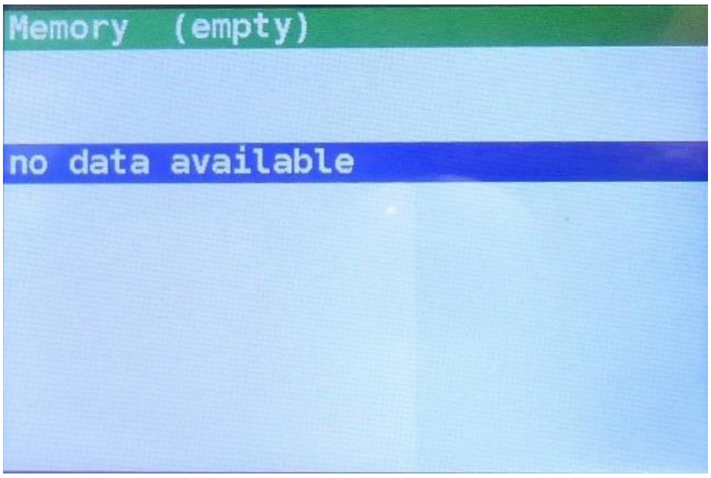

Figure 6-1 Empty memory

6.2 Saving results

- Perform measurement.

Figure 6-2 Example of measurement result

- Press **MEM** to enter memory storage menu.

Record: Next record number in red letters,
Date: Measurement date (dd/mm/yyyy),
Time: Measurement time (hh:mm:ss)
O_ID: Object ID number
L_ID: Location ID number
C_ID: Customer ID number
Measurement function
Measurement results
Measurement parameters (mode, type, etc.)

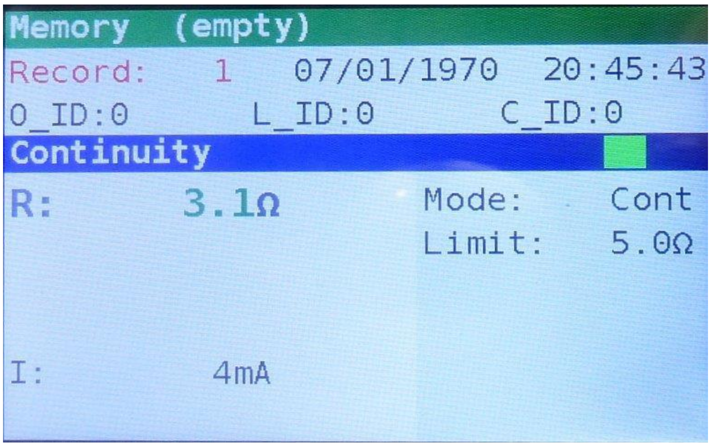

Figure 6-3 Memory storage menu

- Press ◀ key to enter ID editor menu.
- Use ▲▼ navigation keys to select the ID type.
- Use ◀▶ navigation keys to change the value of the ID.
- Press the **ESC** to return to the memory menu without changing the IDs.
- Press **TEST** to save the IDs to the record. These IDs will also be used for the following new records.

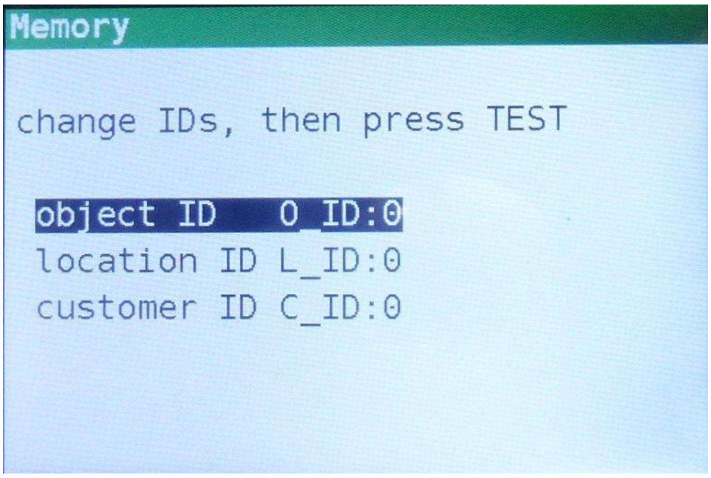

Figure 6-4 ID editor

- Press **TEST** to save the latest measurement.
Upon saving the record number will change from red to black.

Press **MEM** or **ESC** to return to exit without saving.

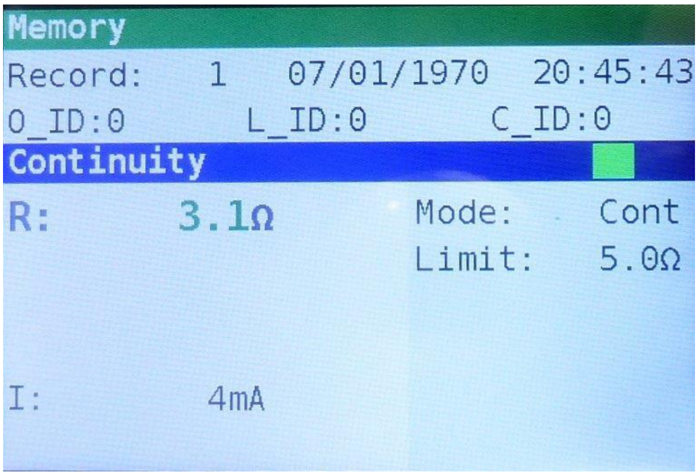

Figure 6-5 Example of saved result

Each measurement result is displayed in coloured letters:
Green: Result is ok
Red: Result is not ok
Black: Result is without pass/fail criteria

The function bar has a coloured field indicating the overall measurement result:
Green: Result is ok
Red: Result is not ok
Brown: Result is without pass/fail criteria

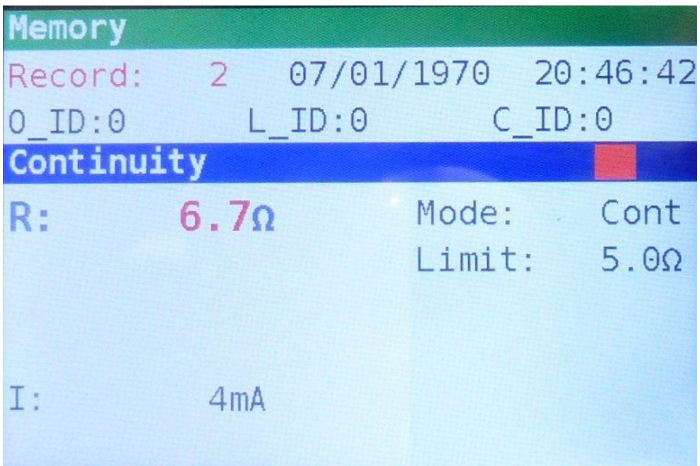

Figure 6-6 Example of failed result

6.3 Recalling saved results

1. Press **MEM** to enter memory menu.
   Last saved record will be shown.
2. Use ▲▼ navigation keys to step through records.

   Existing records' IDs can be changed by pressing the ◀ key.

See Figure 6-3 Memory storage menu.

6.4 Deleting results

When a single record is deleted, its space in memory is freed and can be reused. The record number of the deleted record however is not used for new records.

When all records are deleted, the complete memory space is free, and all IDs and numbers are reset.

1. Press **MEM** to enter memory menu.
   Last saved record will be shown.
2. Use ▲▼ navigation keys to step through records and find the record to be deleted.
3. Press the ▶ key to enter deletion menu.
4. Press **TEST** to delete the selected record and return to the previous screen.

   Press **ESC** to return without deleting.

See Figure 6-3 Memory storage menu.

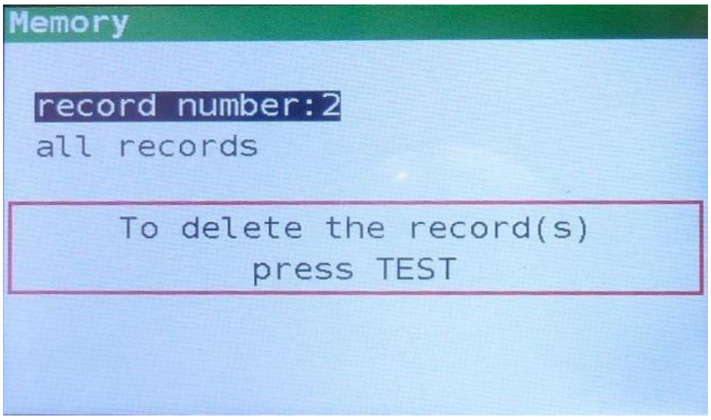

Figure 6-7 Deletion menu

5. Press ▼ to select all records.
6. Press **TEST** to delete all records.

   Press **ESC** to return without deleting.

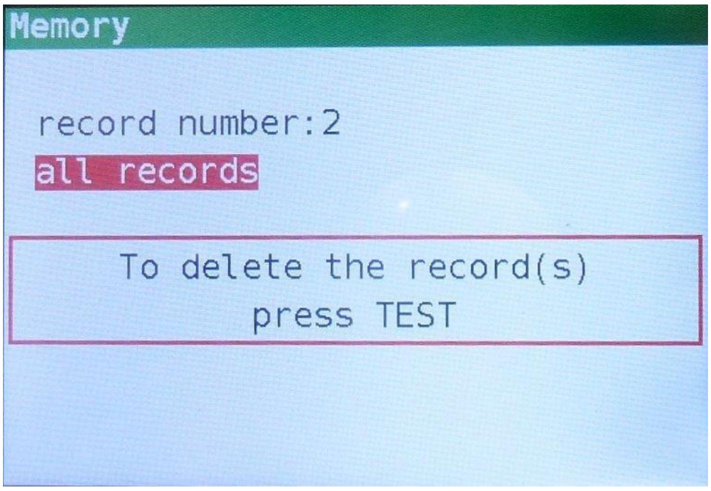

Figure 6-8 Deletion menu, all records

7 Data transfer

Stored results can be transferred to a PC for tasks such as creating simple reports or performing further analysis in Excel. The instruments connects to the PC using USB communication.

7.1 MFT Records - PC software

Transferring stored records from the instrument to a PC is managed through the MFT Records application. Records are saved on the PC in a *.csv file format and can also be exported to an Excel spreadsheet (*.xlsx) for easy report generation and further analysis if needed.

MFT Records is PC software designed to run on the Windows platform.

7.1.1 Downloading records to PC

1. Disconnect all connection cables and test objects from the instrument.
2. Connect the instrument to a PC by means of USB cable.
3. Start the MFT Records program by clicking on the Desktop shortcut icon.
4. Click Scan Ports to automatically find COM port, or select COM port manually.

Figure 7-1 MFT Records desktop icon

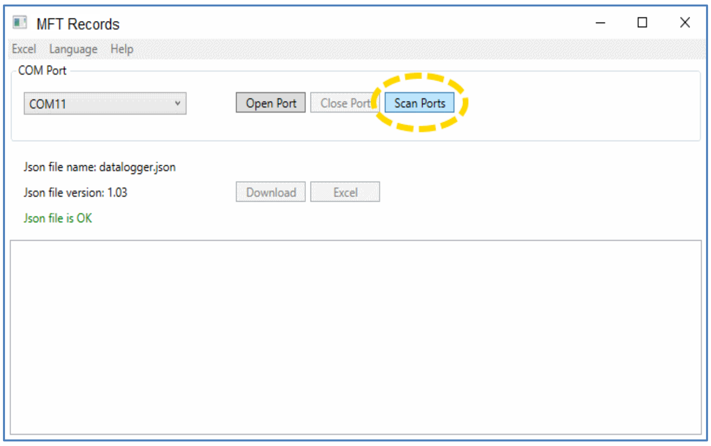

Figure 7-2 Scanning ports

5. Select and click Open Port.

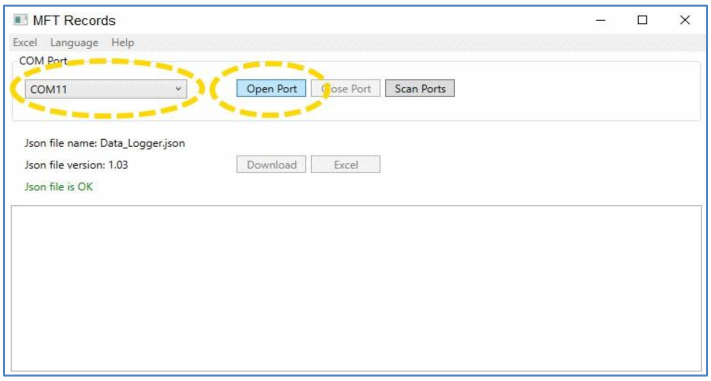

Figure 7-3 Select and open port

6. Click Download to initiate data transfer. When records are downloaded, a .csv file is automatically created.

   Default location for saving .csv files is Documents/MFT/CsvRecords/.

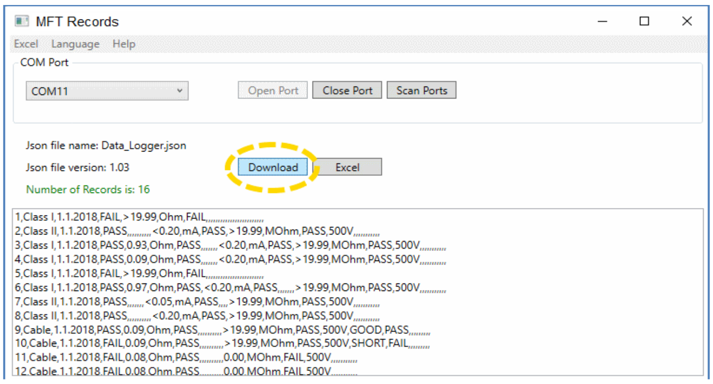

Figure 7-4 Download records

7. Click Excel to export all records to Excel file.

   Default location for saving.xlsx files is Documents/MFT/.

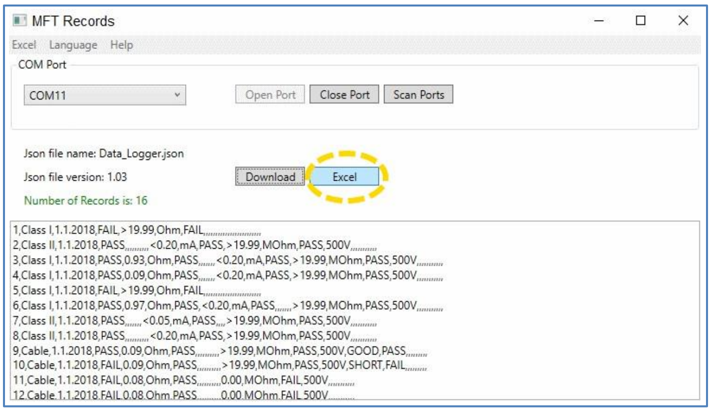

Figure 7-5 Export records to Excel file

Record number	Date	Time	Supply system	Test mode	Test result	Limit	Re	Rs	Rh
1	01/10/2019	12:44:05	TN/TT	Earth resistance - Re	PASS	1Ω	0.09Ω	0.0kΩ	0.0kΩ

Record number	Date	Time	Supply system	Test mode	Test result	Limit	Re	Rs	Rh
2	01/10/2019	12:45:05	TN/TT	Earth resistance - Re	FAIL	1Ω	>9999Ω	>60.0kΩ	>60.0kΩ

Record number	Date	Time	Supply system	Test mode	Test result	Distance	p	Rs	Rh
3	01/10/2019	12:47:23	TN/TT	Earth resistance - Ro	PASS	1m	0.09Ωm	0.0kΩ	0.0kΩ

Record number	Date	Time	Supply system	Test mode	Test result	Limit	R
4	01/10/2019	13:12:07	TN/TT	Continuity - Cont	PASS	20.0Ω	0.7Ω

Record number	Date	Time	Supply system	Test mode	Test result	Limit	R
5	01/10/2019	13:14:26	TN/TT	Continuity - Cont	FAIL	20.0Ω	25.7Ω

Record number	Date	Time	Supply system	Test mode	Test result	Limit	R	R+	R-	I
6	01/10/2019	13:15:11	TN/TT	Continuity - LowΩ	PASS	20.0Ω	0.09Ω	0.09Ω	0.09Ω	200mA

Record number	Date	Time	Supply system	Test mode	Test result	Voltage	Limit	R	Um
7	01/10/2019	13:15:11	TN/TT	R insulation	PASS	500V	0.95MΩ	1.508MΩ	551V

Record number	Date	Time	Supply system	Test mode	Test result	Type	Time	Current	Limit	Z	Isc
8	01/10/2019	13:15:11	TN/TT	Line impedance - Line	PASS	gG	0.4s	2A	16.0A	220.2Ω	25.5A

Record number	Date	Time	Supply system	Test mode	Test result	R	Isc
9	01/10/2019	14:06:10	LV	Line impedance - Line LV	PASS	220.2Ω	25.5A

Record number	Date	Time	Supply system	Test mode	Test result	Type	Time	Current	Limit	Z	Isc
10	01/10/2019	13:15:11	TN/TT	Loop impedance - Loop	PASS	gG	0.4s	2A	16.0A	220.2Ω	25.5A

Record number	Date	Time	Supply system	Test mode	Test result	R1	I1	R2	I2
11	01/10/2019	14:06:10	LV	Loop impedance - Loop LV	PASS	220.2Ω	25.5A	220.2Ω	25.5A

Record number	Date	Time	Supply system	Test mode	Test result	Type	Time	Current	Limit	Z	Isc
12	01/10/2019	15:15:11	TN/TT	Loop impedance - RCD	PASS	gG	0.4s	2A	16.0A	220.2Ω	25.5A

Figure 7-6 Example of generated Excel file

8 Maintenance

8.1 Replacing fuses

There are three fuses under the back battery cover of Elma iTest 7400.

- F3: M 0.315 A / 250 V, 20 x 5 mm
  This fuse protects internal circuitry of low-value resistance function if test probes are connected to the mains supply voltage by mistake.
- F1, F2: F 4 A / 500 V, 32 x 6.3 mm
  General input protection fuses for the L/L1 and N/L2 test terminals.

Warnings:

Disconnect any measuring accessory from the instrument and ensure that the instrument is turned off before opening the battery/fuse compartment cover, hazardous voltage can exist inside this compartment!

- Replace any blown fuses with exactly the same type of fuse. The instrument can be damaged and/or operator's safety impaired if this is not performed!

The Position of fuses can be seen in figure 3.4 in chapter 3.3 Back panel.

8.2 Cleaning

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

Warnings:

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

8.3 Periodic calibration

It is essential that the test instrument is regularly calibrated for the technical specification listed in this manual to be guaranteed. We recommend an annual calibration. The calibration should be done by an authorized technical person only. Please contact your dealer for further information.

8.4 Service

For repairs under warranty, or at any other time, please contact your distributor. Unauthorized persons are not allowed to open the Elma iTest 7400. There are no user-replaceable components inside the instrument, except for the three fuses inside the battery compartment, refer to chapter 8.18.1.

8.5 Batteries

- Prevent Memory Effect:
  Discharge and recharge the nickel-metal hydride battery's full once in a while. This helps to keep the battery healthy by avoiding crystal development in discharged areas.
- Exercise the Battery:
  Do not leave the battery unused for a longer period. This allows crystals to develop, which reduces the battery's ability to hold a charge. A new battery break-in procedure should be applied to a dormant battery to regain its ability to work properly.
- New Battery Break-in
  New batteries must be fully charged before use since they are bought in discharged conditions. It is essential to charge and discharge the battery completely so that it can regain its maximum rated capacity.

9 Technical specifications

9.1 Insulation resistance

Insulation resistance (nominal voltage 50 VDC)

Measurement range according to 61557 is 50 kΩ - 80 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.100 - 1.999	0.001	± (5 % of reading + 3 digits)
2.00 - 80.00	0.01	

Insulation resistance (nominal voltages 100 VDC and 250 VDC)

Measurement range according to 61557 is 100 kΩ - 199.9 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.100 - 1.999	0.001	± (5 % of reading + 3 digits)
2.00 - 99.99	0.01	
100.0 - 199.9	0.1	

Insulation resistance (nominal voltages 500 VDC and 1000 VDC)

Measurement range according to 61557 is 500 kΩ - 199.9 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.100 - 199.9	0.001 0.01 0.1	± (2 % of reading + 3 digits)
200 - 999	1	± (10 % of reading)

Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 - 1200	1	± (3 % of reading + 3 digits)

Nominal voltages	50 VDC, 100 VDC, 250 VDC, 500 VDC, 1000 VDC
Open circuit voltage	-0 % / +20 % of nominal voltage
Measuring current	min. 1 mA at RN = UN × 1 kΩ/V
Short circuit current	max. 15 mA
The number of possible tests with a new set of batteries	up to 1000 (with 2300 mAh battery cells)
Auto discharge after test	

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.

9.2 Continuity resistance

9.2.1 R Low

Measuring range according to EN61557-4 is 0.1 Ω - 1999 Ω.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.10 - 19.99	0.01	± (3 % of reading + 3 digits)
20.0 - 99.9	0.1	± (5% of reading)
100 - 1999	1	

Open-circuit voltage	5 VDC
Measuring current	min. 200 mA into load resistance of 2 Ω
Test lead compensation	up to 5 Ω
The number of possible tests with a new set of batteries	up to 1400 (with 2300mAh battery cells)
Automatic polarity reversal of the test voltage	

9.2.2 Low current continuity

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.1 - 99.9	0.1	± (5 % of reading + 3 digits)

Open-circuit voltage	5 VDC
Measuring current	max. 7 mA
Test lead compensation	up to 5 Ω

9.3 RCD testing

9.3.1 General data

Nominal residual current	6 mA, 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 650 mA, 1000 mA
Nominal residual current accuracy	-0 / +0.1 x IΔ; IΔ = IΔn, 2 × IΔn, 5 × IΔn -0.1 x IΔ / +0; IΔ = ½ x IΔn
Test current shape	Sinewave (AC), pulsed (A), DC (B)
RCD type	General (G, non-delayed), Selective (S, time-delayed), EVSE
Test current starting polarity	0° or 180°
Voltage range	93 V - 134 V (45 Hz - 65 Hz) 185 V - 266 V (45 Hz - 65 Hz)

RCD test current selection (r.m.s. value calculated to 20 ms) according to IEC 61009:

	½ × IΔn			1 × IΔn			2 × IΔn			5 × IΔn			RCD IΔ		
IΔN (mA)	AC	A	B	AC	A	B	AC	A	B	AC	A	B	AC	A	B
6	3	2,1	3	6	12	12	12	24	24	30	60	60	✓	✓	✓
10	5	3,5	5	10	20	20	20	40	40	50	100	100	✓	✓	✓
30	15	10,5	15	30	42	60	60	84	120	150	212	300	✓	✓	✓
100	50	35	50	100	141	200	200	282	400	500	707	1000	✓	✓	✓
300	150	105	150	300	424	600	600	848	na	1500	na	na	✓	✓	✓
500	250	175	250	500	707	1000	1000	1410	na	2500	na	na	✓	✓	✓
650	325	228	325	650	919	1300	1300	na	na	na	na	na	✓	✓	✓
1000	500	350	500	1000	1410	na	2000	na	na	na	na	na	✓	✓	✓

(na) not available

EVSE RCD test current selection according to IEC 62955:

IΔn (mA) DC	½ × IΔn	1 × IΔn	2 × IΔn	5 × IΔn	10 × IΔn	33 × IΔn	RCD IΔ
6	3	6	na	na	60	200	✓

IΔn (mA) AC	½ × IΔn	1 × IΔn	2 × IΔn	5 × IΔn	10 × IΔn	33 × IΔn	RCD IΔ
30	15	30	60	150	na	na	✓

9.3.2 Contact voltage

Measuring range according to EN61557-6 is 3.0 V - 49.0 V for limit contact voltage 25 V.

Measuring range according to EN61557-6 is 3.0 V - 99.0 V for limit contact voltage 50 V.

Measuring range (V)	Resolution (Ω)	Accuracy
3.0 - 9.9	0.1	(-0%/+10%) of reading + 5 digits

Test current max. 0.5 × IΔn
Limit contact voltage 25 V, 50 V
Fault loop resistance at contact voltage is calculated as

$$R_L = \frac{Uc}{I\Delta n}$$

9.3.3 Trip-out time

Complete measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

Measuring range (ms)	Resolution (ms)	Accuracy
0.0 - 500.0	0.1	± 3 ms

Test current ½ × IΔn, IΔn, 2 × IΔn, 5 × IΔn
Multipliers not available see test current selection table.

9.3.4 Trip-out current

Measurement range corresponds to EN61557-6 for IΔn ≥ 10 mA. Specified accuracies are valid for complete operating range.

Trip-out current

Measuring range IΔ	Resolution IΔ	Accuracy
0.2 x IΔn - 1.1 x IΔn (AC type)	0.05 x IΔn	± 0.1 x IΔn
0.2 x IΔn - 1.5 x IΔn (A type, IΔn ≥ 30 mA)		
0.2 x IΔn - 2.2 x IΔn (A type, IΔn = 10 mA)		
0.2 x IΔn - 2.2 x IΔn (B type)		

Trip-out time

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

Contact voltage

Measuring range (V)	Resolution (V)	Accuracy
3.0 - 9.9	0.1	(-0%/+10%) of reading + 5 digits
10.0 - 99.9		

9.4 Fault loop impedance and prospective fault current

9.4.1 Loop impedance

Loop impedance

Measuring range according to EN61557-3 is 0.25 Ω - 1999 Ω.

Measuring range (Ω)	Resolution (Ω) (*)	Accuracy
0.20 - 19.99	0.01	± (5 % of reading + 5 digits)
20 - 99.9	0.1	
100 - 9999	1	

Prospective fault current, Ipfc (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 - 19.99	0.01	Consider accuracy of fault loop resistance measurement
20.0 - 99.9	0.1	
100 - 999	1	
1.00k - 9.99k	10	
10.0k - 100.0k	100	

Test current (at 230 V)	3.4 A, 50 Hz Sinewave (10 ms < tLOAD < 15 ms)
Nominal voltage range	93 V -134 V (45 Hz - 65 Hz) 185 V - 266 V (45 Hz - 65 Hz)

9.4.2 Loop impedance RCD and Rs

Loop impedance RCD and Rs, Ipfc, trip-lock subfunction

Measuring range according to EN61557 is 0.75 Ω - 1999 Ω.

Measuring range (Ω)	Resolution (Ω)	Accuracy *)
0.40 -19.99	0.01	± (5 % of reading + 10 digits)
20.0 - 99.9	0.1	
100 - 9999	1	± 10 % of reading

*) Acccuracy may be impaired in case of heavy noise on mains voltage.

Prospective fault current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 - 19.99	0.01	Consider accuracy of fault loop resistance measurement
20.0 - 99.9	0.1	
100 - 999	1	
1.00k - 9.99k	10	
10.0 - 100.0k	100	

No trip-out of RCD	
Nominal voltage range	93 V -134 V (45 Hz - 65 Hz) 185 - 266 V (45 Hz - 65 Hz)

9.5 Line impedance and prospective short-circuit current

Line impedance

Measuring range according to EN61557-3 is 0.25 Ω – 1999 Ω.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.20 - 19.99	0.01	± (5 % of reading + 5 digits)
20.0 - 99.9	0.1	
100 - 9999	1	

Prospective short-circuit current, Ipsc (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 - 9.99	0.01	Consider accuracy of line resistance measurement
20.0 - 99.9	0.1	
100 - 999	1	
1.00k - 9.99k	10	
10.0 - 100.0	100	

Test current (at 230 V) 3.4 A, 50 Hz Sinewave (10 ms < tLOAD < 15 ms)

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

Voltage drop

Measuring range (%)	Resolution (%)	Accuracy
0.0 - 9.9	0.1	Consider accuracy of the line measurement (only calculated value)

9.6 Voltage, frequency, and phase rotation

9.6.1 Phase rotation

Measuring according to EN61557-7

Nominal mains voltage range 50 V AC - 550 V AC
Nominal frequency range 45 Hz - 400 Hz
Result displayed Right:1 2-3; Left: 3-2-1

9.6.2 Voltage

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

Frequency range 0 Hz, 45 Hz - 400 Hz

9.6.3 Frequency

Measuring range (Hz)	Resolution (Hz)	Accuracy
10 - 499	0.1	± (0.2% + 1 digit)

Nominal mains voltage range 10 - 550 V

9.7 General data

Power supply voltage	9 V DC (6 × 1.5 V battery cells, size AA)
Power supply adapter	12 V DC / 1000 mA
Battery charging current	< 600 mA (internally regulated)
Voltage of charged batteries	9 V DC (6 × 1.5 V, at fully charged state)
Charging duration time	typical 6 h
Operation	typical 15 h
Overvoltage category	CAT III 600 V; CAT IV 300 V
Protection classification	double insulation
Pollution degree	2
Protection degree	IP 42
Display	480×320 TFT LCD
COM-port	USB
Dimensions (w x h x d)	250 mm x 107 mm x 135 mm
Weight (without battery)	1.30 kg

Reference conditions

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

Operating conditions

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

Storage conditions

Temperature range	-10 °C - +70 °C
Maximum relative humidity	90 %RH (-10 °C - +40 °C), 80 %RH (40 °C - 60 °C)

The maximum error under operating conditions is the error for reference conditions (specified in the manual for each function) + 1 % of measured value + 1 digit, unless otherwise specified.

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