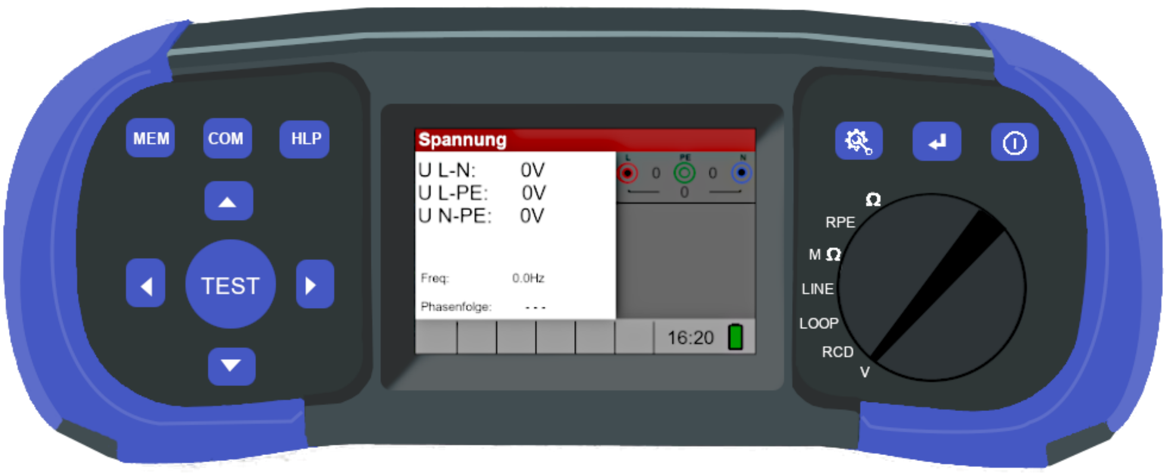
VDE Installation tester

PIT 2.0

Art.-Nr. 05106551

ID 057284



User manual

Version 1.4

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1 Foreword

Congratulations on your decision to purchase the PROTEC.class instrument with accessories from PROTEC.class. The instrument has been developed based on extensive experience gained over many years of dealing with test equipment for electrical installations.

The PROTEC.class instrument is intended as a professional, multifunctional, portable test instrument for carrying out all measurements for the comprehensive inspection of electrical installations in buildings. The following measurements and tests can be carried out:

- Voltage and frequency
- Continuity tests
- Insulation resistance test
- RCD test
- Line impedance
- Loop impedance
- Phase sequence
- Earth resistance

The backlit graphic display provides easy reading of results, indications, measurement parameters and messages. Two GOOD/BAD LED indicators are located on the sides of the LCD display. The operation of the instrument has been designed to be as clear and simple as possible and no special training is required (other than reading this instruction manual) to start using the instrument.

The instrument is equipped with all the accessories necessary for comfortable testing.

2 Safety and operating instructions

2.1 Warnings and notes

To achieve the highest level of operator safety when performing various tests and measurements, PROTEC.class recommends that you keep your PROTEC.class instrument in good condition and undamaged. When using the instrument, the following general warnings must be observed:

- **The symbol on the instrument means "Read the manual very carefully". The symbol requires the operator's intervention!**
- **The symbol on the instrument means "The mark on your instrument certifies that it meets the requirements of all applicable EU regulations".**
- **The symbol means "This appliance should be recycled as electronic waste".**
- **The symbol means "Danger due to high voltage!".**
- **The symbol means "Class II: Double insulated".**
- **If the tester is not used in the manner prescribed in this user manual, the protection provided by the unit could be compromised!**
- **Read these operating instructions carefully, otherwise the use of the unit may be dangerous for the operator, the test instrument or the test object!**
- **Do not use the meter and accessories if damage is evident!**
- **If a fuse is blown, follow the instructions in this manual to replace it!**
- **Observe all generally known precautions to avoid the risk of electric shock when handling dangerous voltages!**
- **Never use the instrument in mains with voltages higher than 550 V!**
- **Maintenance interventions or adjustments may only be carried out by competent and authorised personnel.**
- **Only use standard or special test accessories supplied by your dealer!**
- **The unit is supplied with rechargeable NiCd or NiMH battery cells. The cells should only be replaced with the same type as indicated on the battery compartment label or in this manual. Do not use standard alkaline battery cells while the power supply unit is connected, as they may explode!**
- **Dangerous voltages exist inside the instrument. Disconnect all test leads, unplug the power cord and switch off the instrument before removing the battery cover!**
- **All normal safety measures must be taken to avoid the risk of electric shock when working on electrical equipment!**

⚠ Warnings regarding the measurement functions:

Insulation resistance

- The insulation resistance measurement may only be carried out on de-energised objects!
- Do not touch the DUT during measurement or before it is completely discharged! There is a risk of electric shock!
- If an insulation resistance measurement has been performed on a capacitive object, automatic discharge may not occur immediately.
- Do not connect test terminals to external voltages above 550 V (AC or DC) to avoid damaging the test instrument.

Continuity test functions

- The contact resistance measurement may only be carried out on de-energised objects!
- The test result can be influenced by parallel impedances or transient currents.

Testing the protective conductor connection

- If phase voltage is detected at the tested protective conductor connection, immediately stop all measurements and ensure that the cause of the fault has been eliminated before carrying out any further activities!

Remarks regarding the measurement functions:

General

- The symbol "!" means that the selected measurement cannot be performed because of an irregular condition at the input terminals.
- Insulation resistance, continuity and earth resistance measurements may only be carried out on de-energised objects!
- The GOOD / BAD display is activated when the limit value is set. Set a suitable limit value for evaluating measurement results.
- If only two of three conductors are connected to the electrical installation under test, only the voltage readings between these two conductors apply.

Insulation resistance

- If voltages above 10 V (AC or DC) are detected between the test terminals, the insulation resistance measurement is not performed.
- The unit automatically discharges the test item after the measurement is completed.
- Pressing the **TEST** button twice initiates a continuous measurement.

Continuity test functions

- If the voltage between the test terminals is higher than 10 V (AC or DC), the contact resistance test is not performed.
- Before carrying out the continuity measurement, compensate the resistance of the test leads, if necessary.

RCD functions

- The parameters set for one function are also retained for other RCD functions.
- The measurement of the contact voltage does not normally trip the residual current device. However, the tripping limit of the RCD may be exceeded as a result of leakage currents flowing to the PE protective conductor or via the capacitive connection between the L and PE conductors.
- The RCD trip lock sub-function (function selector switch in LOOP position) takes longer, but provides a much higher accuracy of the measurement result for the fault loop resistance (compared to the partial result R_L for the contact voltage measurement function).
- The measurement of the RCD tripping time and tripping current is only carried out if the contact voltage during the preliminary test at the rated residual current is lower than the set limit value at the contact voltage.
- The automatic test sequence (RCD AUTO function) stops if the tripping time is outside the permissible time.

Loop impedance

- The lower limit value of the unaffected short-circuit current depends on the fuse type, the current rating and the tripping time of the fuse as well as the impedance scaling factor.
- The stated accuracy of the tested parameters is only valid if the mains voltage is stable during the measurement.
- The measurement of the fault loop resistance triggers residual current devices.
- Measuring the fault loop resistance when using the trip disable function does not normally trip the residual current device. However, the trip limit may be exceeded as a result of leakage currents flowing to the PE protective conductor or via the capacitive connection between the L and PE conductors.

Line impedance

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

2.2 Battery and charging

The battery is charged whenever the mains adapter is connected to the instrument. The polarity of the power supply socket is shown in figure 2.1. An internal circuit controls the charging process and ensures maximum battery life.

Figure 2.1: Polarity of the power supply socket

The unit automatically detects the connected mains adapter and starts charging.

- ⚠ When the instrument is connected to an installation, dangerous voltages may occur inside its battery compartment! If you want to replace battery cells or open the battery/battery/fuse compartment cover, disconnect all measuring accessories connected to the instrument and switch the instrument off.
- Make sure that you insert the cells correctly, otherwise the unit will not work and the batteries could be discharged.
- Remove all batteries from the battery compartment if the instrument will not be used for a long period of time.
- Alkaline or rechargeable NiCd or NiMH batteries of size AA can be used. PROTEC.class only recommends the use of rechargeable batteries with 2300 mAh or more.
- Do not charge alkaline battery cells!
- Only use the power supply unit supplied by the manufacturer or dealer of the tester to avoid possible fire or electric shock!

2.2.1 New batteries or batteries that have not been used for a long time

When charging new batteries or batteries that have not been used for a long time (longer than 3 months), unpredictable chemical processes may occur. Ni-MH and Ni-Cd cells may be subject to these chemical effects. For this reason, the operating time of the unit may be considerably reduced during the first charge-discharge cycles.

In this situation, PROTEC.class recommends the following procedure to improve battery life:

Procedure	***Notes***
➢ Fully **charge** the battery.	*At least 14 hours with built-in charger.*
➢ **Discharge** the battery completely.	*This can be done by using the instrument normally until it is fully discharged.*
➢ **Repeat** the charge/discharge cycle at least 2-4 times.	*Four cycles are recommended to* bring the batteries back to their normal capacity.

Notes:

- The charger in the instrument is a so-called cell pack charger. This means that the battery cells are connected in series during charging. The battery cells must be equivalent (same state of charge and type, same age).
- A deviating battery cell can cause insufficient charging as well as incorrect discharging during normal use of the entire battery pack. (This will result in heating of the battery pack, significantly reduced operating time, reversed polarity of the defective cell, etc.).
- If no improvement is achieved after several charge/discharge cycles, the condition of the individual battery cells should be checked (by comparing the battery voltages, checking in a cell charger, etc.). It is very likely that only some of the battery cells have deteriorated.
- The effects described above should not be confused with the normal decrease in battery capacity over time. A battery also loses capacity when it is repeatedly charged/discharged. The actual capacity loss over the number of charge cycles depends on the battery type. This information is included in the technical data provided by the battery manufacturer.

2.3 Applied standards

PROTEC.class instruments are manufactured and tested in accordance with the following regulations:

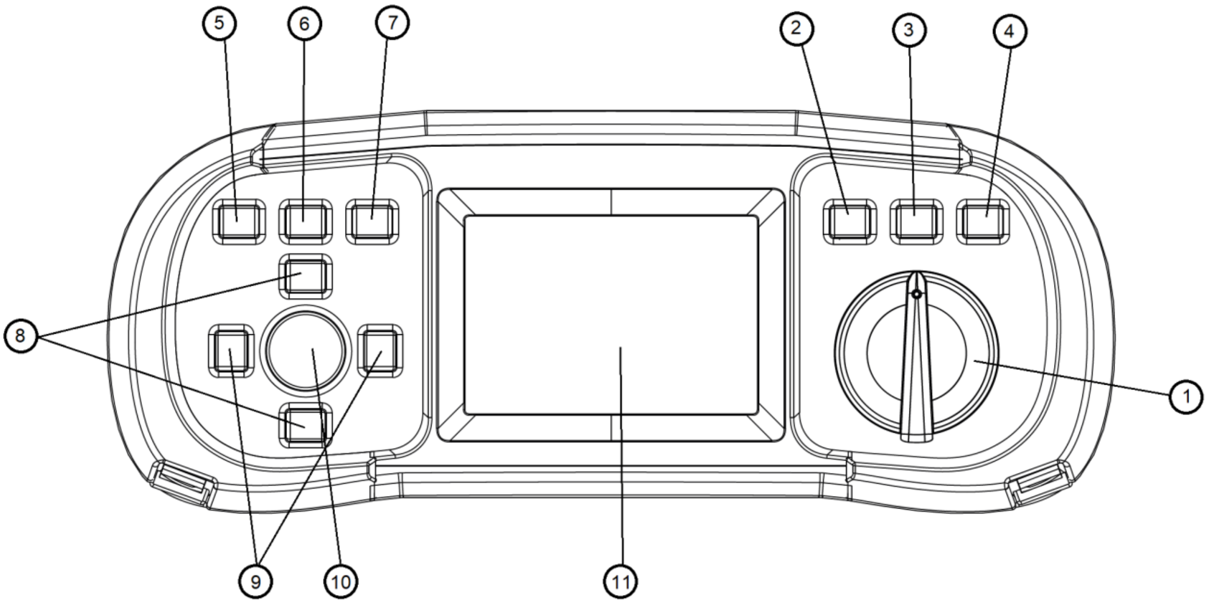
Electromagnetic compatibility (EMC)	
EN 61326	Electrical equipment for measurement, control and laboratory use - EMC requirements Class B (hand-held devices in controlled electromagnetic environments)
Safety (Low Voltage Directive)	
EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
EN 61010-031	Safety regulations for hand-held measuring accessories for measuring and testing
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-operated current probes for electrical measurements
Functionality	
EN 61557	Electrical safety in low voltage distribution systems up to AC 1000 V and DC 1500 V - Equipment for testing, measuring or monitoring of protective measures Part 1 General requirements Part 2 Isolation resistance Part 3 Loop Resistance Part 4 Resistance of the earth connection and equipotential bonding connections Part 5 Grounding resistance PROTEC.class PIT 2.0 Part 6 Efficacy of residual current devices (RCDs) in TT, TN and IT networks Part 7 Rotating field Part 10 Combined measuring instruments for testing, measuring or monitoring protective measures
Other reference standards for testing RCDs	
EN 61008	Residual current operated circuit-breakers without built-in overcurrent protection (RCCBs) for domestic installations and for similar applications
EN 61009	Residual current operated circuit-breakers with built-in overcurrent protection (RCBOs) for domestic installations and for similar applications
EN 60364-4-41	Erection of low-voltage installations Part 4-41 Protective measures - Protection against electric shock
BS 7671	IEE Wiring Regulations (17th edition) (Wiring Regulations)
AS / NZ 3760	In-service safety inspection and testing of electrical equipment

Note on EN and IEC standards:

- The text of this manual contains references to European Standards. All standards of the EN 6xxxx series (e.g. EN 61010) are equivalent to IEC standards of the same number (e.g. IEC 61010) and differ only in supplementary parts which were necessary due to the European harmonisation procedure.

3 Description of the instrument

3.1 Front

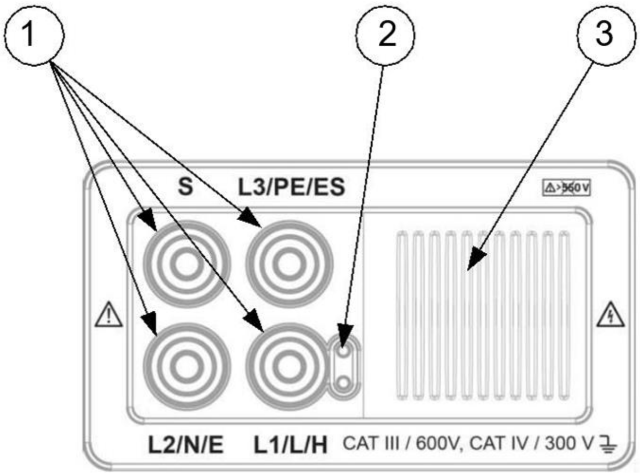


Picture 3.1: Front (Model PROTEC.class PIT 2.0)

Legend:

1	Function selector switch	Selects the desired function
2	Setup button	Displays various setting options
3	Exit/Back/Return	Exit/back
4	ON/OFF	Switches the unit on or off
5	MEM	Saves measurements
6	COM button	Compensates for measuring lead resistance
7	Help button	Opens operating help
8	Up and down buttons	Manoeuvring through menus
9	Left and right buttons	Manoeuvring through menus
10	Test button	Starts a measurement
11	TFT colour screen	Display of the selected function and measurement

3.2 Connection plate



Picture 3.2: Connection plate

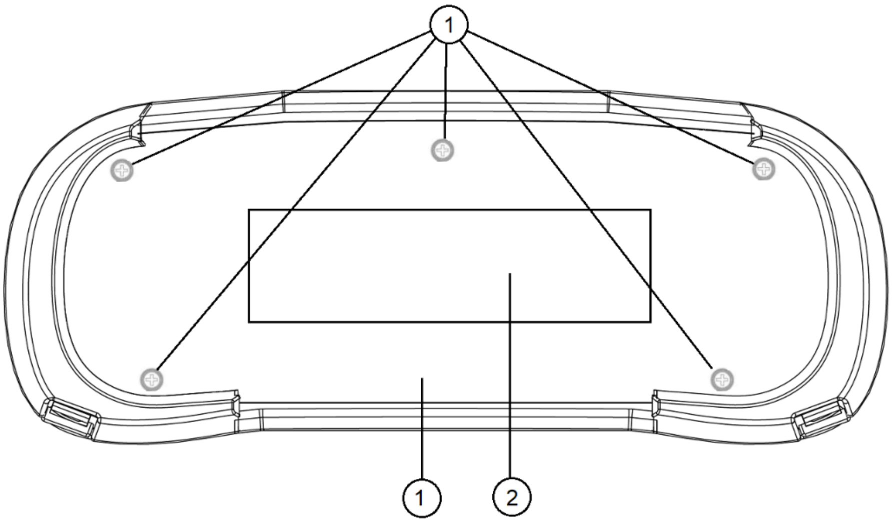
Legend:

1	Test connection	Measurement inputs / outputs
2	Socket for probe	
3	Protective flap	

Warnings!

- **The maximum permissible voltage between any test terminal and earth is 600 V!**
- **The maximum permissible voltage between the test connections is 550 V!**

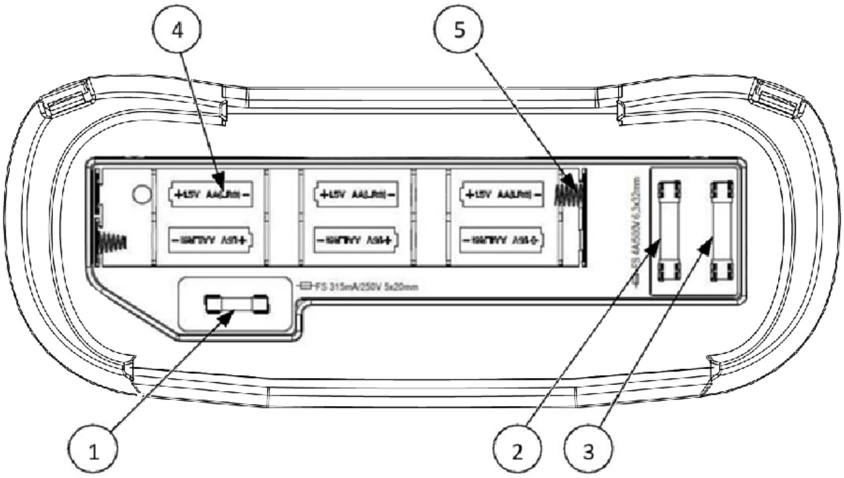
3.3 Back cover



Picture 3.3: Back

Legend:

1	Battery compartment cover
2	Information plate on the back
3	Battery/accumulator compartment cover fixing screw

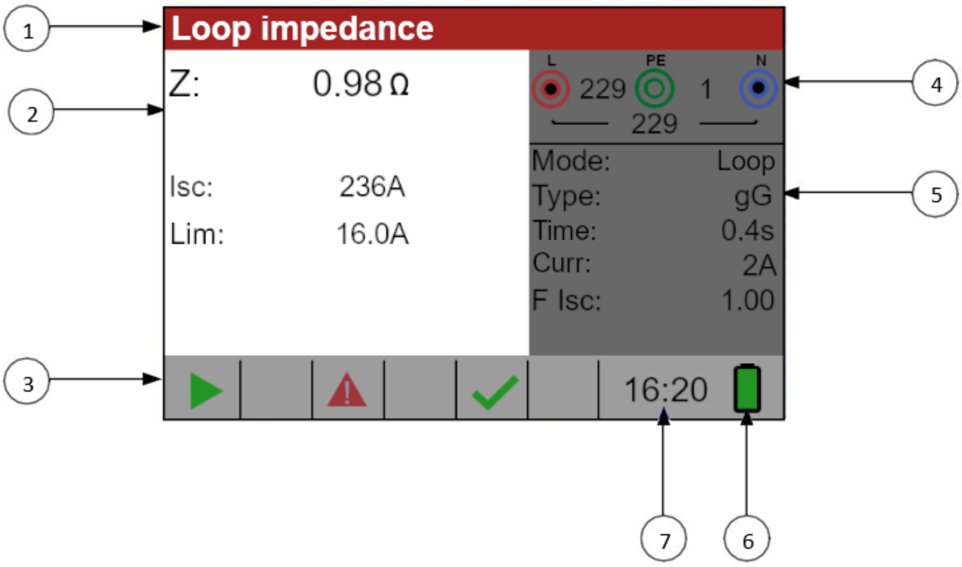


Picture 3.4: Battery compartment

Legend:

1	Fuse F1	
2	Fuse F2	
3	Fuse F3	
4	Battery cells	Size AA
5	Battery contacts	

3.4 Structure of the display



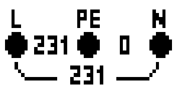
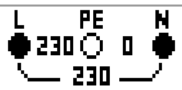
Picture 3.5: Typical function display

Legend:

1	Function line	Shows the selected function
2	Result field	Shows main and partial results of the measurement
3	Status bar	GOOD/BAD/ABORT/START/WAIT/...
4	Active voltage display	Shows symbolised connectors, names the connectors depending on the measurements, shows the actual voltages
5	Options	Shows options of the measurement
6	Battery status	Shows the current charging status of the battery
7	Time	Shows the current time

3.4.1 Terminal voltage monitoring

The terminal voltage monitor constantly displays the voltages at the test terminals as well as information about active test terminals.

	The constantly monitored voltages are displayed together with the test terminal display. All three test terminals are used for the selected measurement.
	The constantly monitored voltages are displayed together with the test terminal display. The test terminals L and N are used for the selected measurement.
	L and PE (protective earth) are active test terminals; terminal N should also be connected for correct input voltage conditions.

3.4.2 Battery indicator

The display shows the charge status of the battery and whether an external charger is connected.

	Display of the battery capacity.
	Weak battery. The battery is too weak to guarantee a correct result. Replace the batteries or recharge the batteries.

The charging process is indicated by an LED near the socket.

3.4.3 Field for messages

Warnings and messages are displayed in the field for messages.

	Dangerous voltage
COMP	Measuring leads are compensated
	Measurement cannot be started
	Dangerous voltage on PE
	Result is not in order
	Result is OK
	RCD is open or tripped
	RCD is closed
	Measurement can be started
	Temperature is too high
	Measuring lines must be replaced
	Please wait

3.4.4 Audible warnings

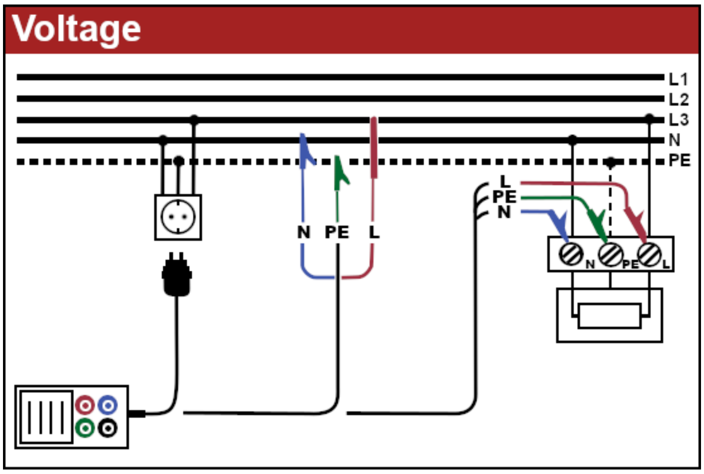
Short treble	Key pressed
Long tone	Continuity test if the resistance is <35 Ohm
Upbeat	Caution! Dangerous voltage is present
Short tone	Measurement completed
Down tone	Temperature, voltage at input, start not possible
Continuous tone	Attention! Phase voltage at the PE terminal! Stop all measurements and eliminate the fault before continuing with the work!

3.4.5 Help screens

HELP	(HELP) Opens the help screen.

There are help menus for all functions. The **help menu** contains schematic diagrams to illustrate how to connect the instrument to the electrical system. After selecting the measurement you want to perform, press the **HELP button to** view the associated **help menu.**
Buttons in the help menu:

LEFT/RIGHT	Selects the next / previous help screen.
HELP	Open/exit help screens
BACK/RETURN	Exits the help menu.



Picture 3.6: Example of help screen

3.5 Equipment set and accessories

3.5.1 Standard equipment PROTEC.class PIT 2.0

- Instrument
- Quick guide
- Product test data
- Declaration of guarantee
- Declaration of conformity
- Mains measurement cable
- Universal test cable
- Three test prods
- Three alligator clips
- Set of NiMH battery cells
- Power supply adapter
- Carrier bag
- PC software
- Soft wrist strap and carrying strap
- USB cable

3.5.2 Optional accessories

A list of optional accessories is available on request from your dealer.

- Type 2 charging pole adapter
- 20/20/5 m earthing set
- CH, UK, US Mains measurement cable

4 Operation of the instrument

4.1 Function selection

To select a test function, the **FUNCTION SELECTOR** must be used.

Keys:

FUNCTION SELECTOR SWITCH	Select the test/measurement function: ❑ **V** Voltage and frequency and phase sequence. ❑ **RCD** RCD test ❑ **LOOP** Error loop impedance ❑ **LINE** Line impedance ❑ **MΩ** insulation measurement ❑ **Ω** continuity test ❑ **RPE** Earth resistance measurement
UPWARDS/DOWNWARDS	Selects the parameter/limit value to be edited.
LEFT/ RIGHT	Changes the value for the selected parameter.
TAB	Selects the test parameter to be set or changed.
TEST	Starts the selected test/measurement function.
MEM	Saves measurement results / recalls saved results.

<u>IDs must be created</u> for saving and using the measurement data! IDs with the value "0" are automatically discarded. Before/when taking measurements, make sure that IDs are created!

<u>Example</u>:

C_ID:1	- L_ID:1	- O_ID:1
Customer (e.g. building)	- Location (e.g. room)	- Object (e.g. socket)

Further information on saving and creating IDs can be found in **Section 8** of these operating instructions.

If the calibration date has been exceeded, the unit warns with a corresponding message "Calibration date expired. Please contact us."

4.2 Settings

To access the setup menu, press the **SETUP** button. The following settings can be made in the Setup menu:

- **Date/Time:** Set internal date and **time**
- **Isc factor:** Setting the scaling factor for short/error current
- **RCD standard:** Select a national standard for RCD testing
- **ELV:** Select the voltage for the ELV warning
- **Switch-off time:** Select the time after which the unit switches off. should switch off
- **Timeout:** Select the period of time after which the measurement is is to be terminated
- **ISO timeout:** Select the time period after which the ISO-Measurement to be terminated
- **Supply system:** Select the supply network/system (e.g. IT)
- **Device information:** Displays information about the unit, (e.g. firmware)
- **Language:** Set the language
- **Buzzer:** Set the options for when the buzzer should be active. should
- **Backlight:** Adjusting the brightness of the backlight of the TFT display

5 Measurements

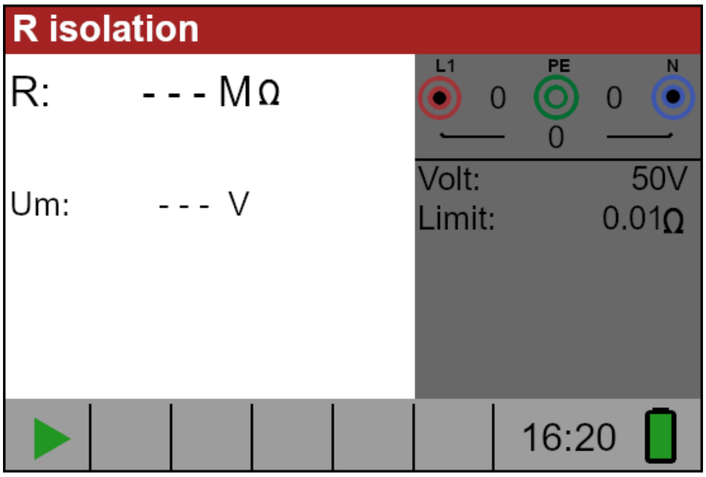
5.1 Insulation resistance

Insulation resistance measurement is performed to ensure safety from electric shocks through the insulation. It is covered by the EN 61557-2 standard. Typical applications are:

- Insulation resistance between conductors of the installation,
- Insulation resistance of non-conductive rooms (walls and floors),
- Insulation resistance of earth cables,
- Insulation resistance of weakly conductive (antistatic) floors.

To perform an insulation resistance measurement:

Step 1:
Select the function **Isolation (MΩ)** with the **function selector.** The following menu is displayed:

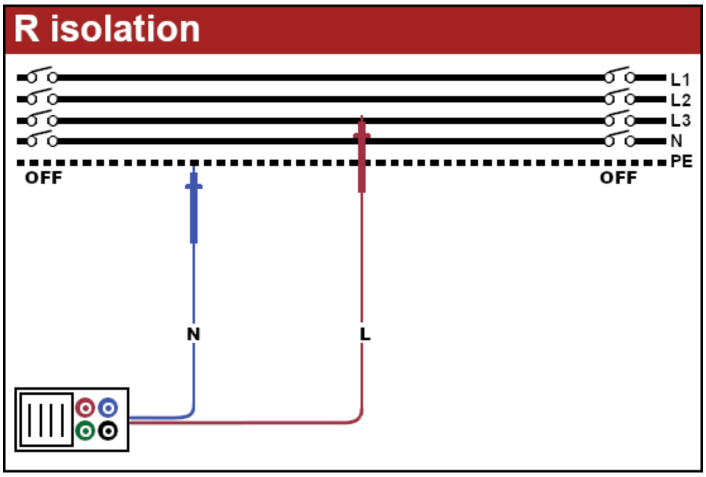


Picture 5.1: Insulation resistance

Step 2:
Set the following measurement parameters and limit values:

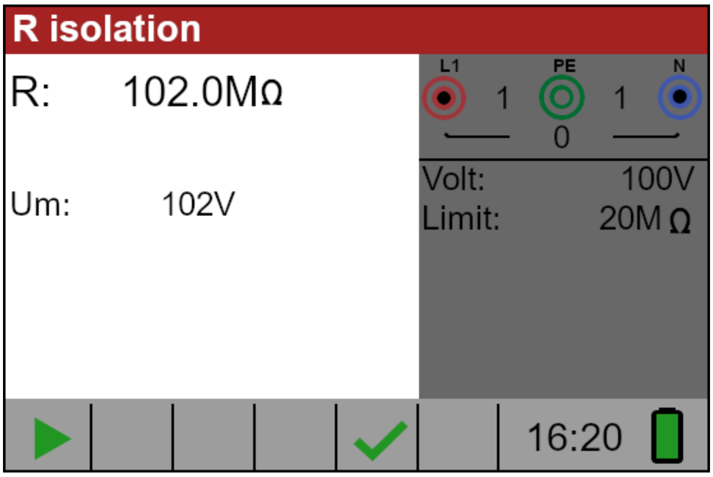
- **Volt:** Nominal test voltage
- **Limit:** Lower limit value for the resistance

Step 3:
Make sure that there are no voltages on the object under test. Connect the test leads to the PIT 2.0. Connect the test cable to the object to be tested (see figure 5.2) to test the Insulation resistance measurement to be carried out.



Picture 5.2: Connection of the universal test cable

Step 4:
Check the displayed warnings and the terminal monitor before starting the measurement. When ▶ is displayed, press the **TEST** button. When the measurement is completed, the measurement results are displayed together with the indication ✔ or ✖.



Picture 5.3: Example of insulation resistance measurement

Displayed results:
R = insulation resistance
Um = voltage actually applied to the test object

Attention!

- The measurement of the insulation resistance may only be carried out on voltage-free objects!
- When measuring the insulation resistance between the installation conductors, all consumers must be disconnected and all switches must be closed!
- Do not touch the test object during measurement or before it is completely discharged! Danger of electric shock!
- To avoid damage to the tester, do not connect the test terminals to an external voltage exceeding 550 V (AC or DC)

5.2 Continuity test

Two sub-functions are available for the continuity test:

- R Low, approx. 240 mA Continuity test with automatic polarity reversal
- Continuous continuity test with low current (approx. 4 mA), useful for testing inductive systems

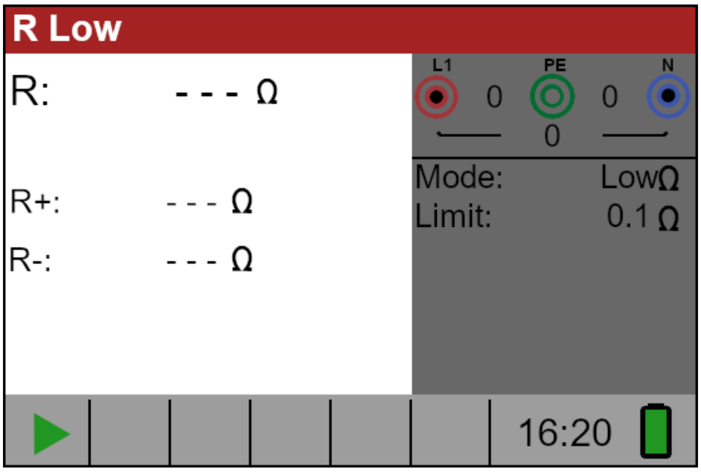
5.2.1 R Low Test

This function checks the resistance between two different points in the installation to ensure that there is a conductive path between them. The test ensures that all protective, earth or equipotential bonding conductors are correctly connected and terminated and have the correct resistance value. The R-Low resistance is measured with a test current of more than 200 mA at 2 ohms. An automatic polarity reversal of the test voltage and test current is performed during the test. This test checks for components (e.g. diodes, transistors, SCRs) that have a rectifying effect on the circuit and could cause problems when a voltage is applied.

This measurement fully complies with the EN61557-4 standard.

To perform an R-Low measurement:

Step 1:
Use the function selector to select the **continuity test** function **(Ω)** and use the navigation keys to select the **R Low** mode. The following menu is displayed:



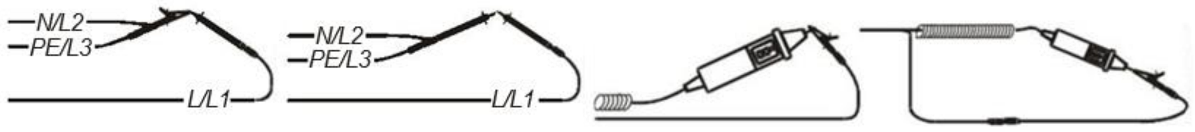
Picture 5.4: R-Low measurement menu

Step 2:
Set the following limit value with the navigation keys:

- **Limit:** Limitation of the resistance value

Step 3:
Connect the test cable to the PIT 2.0. Before performing an R Low measurement, compensate the resistance of the test leads as follows:

1. First short-circuit the test leads as shown in figure 5.5

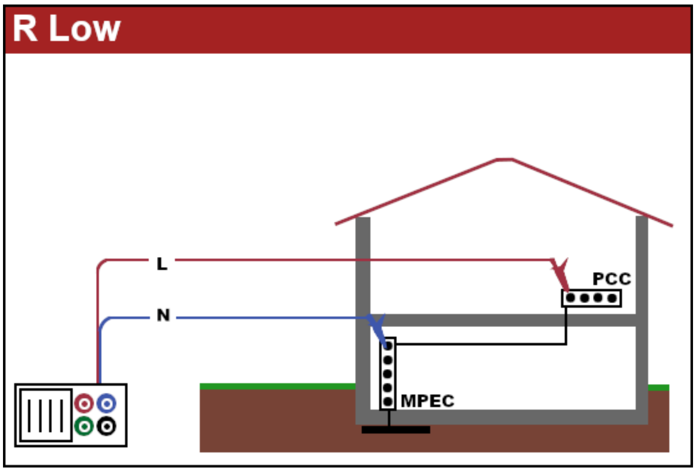


Picture 5.5: Short-circuited test leads

2. Press the **COM** key. After the test lead compensation has been carried out, the **COMP** indicator for compensated test leads is displayed in the status line.

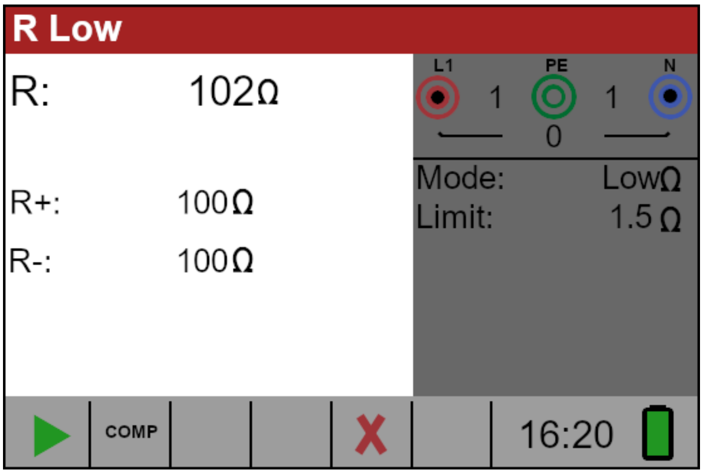
3. To remove the test lead resistance compensation, simply press the **COM** button again. After removing the test lead compensation, the compensation display will disappear from the status line.

Step 4:
Make sure that the item under test is disconnected from any voltage source and is fully discharged. Connect the test leads to the item under test. Follow the connection diagrams in figures 5.6 and 5.7 to perform an R Low measurement.



Picture 5.6: Short-circuited test leads

Step 5:
Before starting the measurement, check whether warnings and terminal monitoring are shown on the display. If everything is OK and ▶ is displayed, press the **TEST** key. After the measurement has been carried out, the results appear on the display together with the indication ✔ or ✖ .



Picture 5.7: Short-circuited test leads

Displayed results:
R................Main result of the LowΩ-resistance (average of R+ and R-)
R+.............Low-resistance partial result with positive voltage at the L terminal
R-...............Low impedance partial result with positive voltage at N terminal

Attention!

- Low-impedance measurements should only be carried out on voltage-free objects!
- Parallel impedances or transient currents can influence the test results.

Remark:

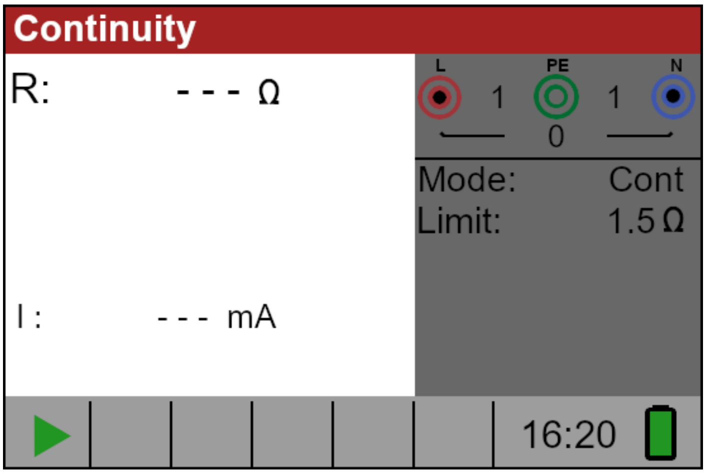
- If the voltage between the test terminals is more than 10 V, the R Low measurement is not performed.

5.2.2 Continuity test

Continuous low-value resistance measurements can be made without reversing the polarity of the test voltages and with a lower test current (a few mA). In general, the function serves as an ordinary Ω-meter with low test current. The function can also be used to test inductive components such as motors and spiral cables.

To perform a low current continuity measurement

Step 1:
Select **Continuity Test (Ω)** with the function selector and select **Cont** mode with the navigation keys. The following menu is displayed:

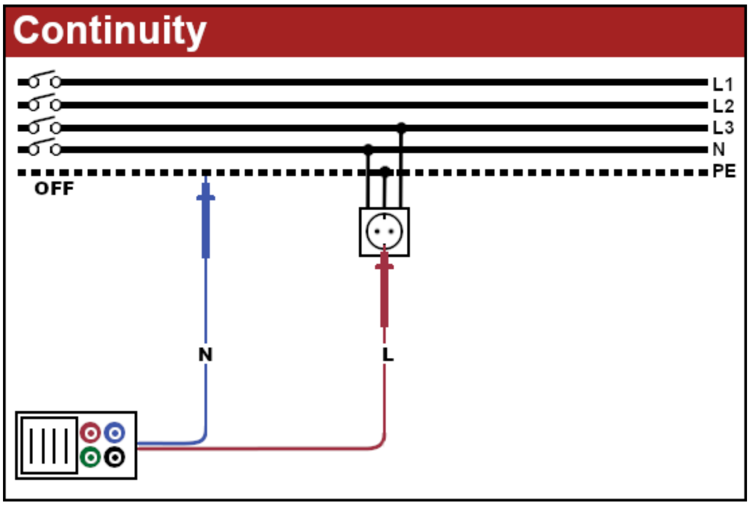


Picture 5.8: Short-circuited test leads

Step 2:
Set the following limit value with the navigation keys:

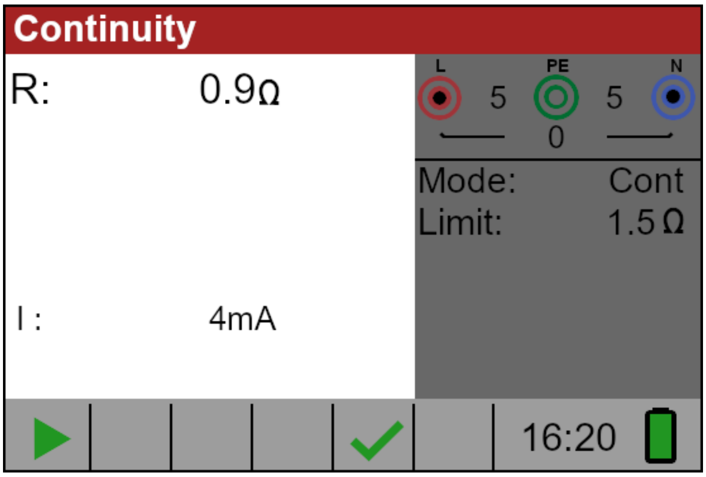
- **Limit:** Limitation of the resistance value

Step 3:
Connect the test cable to the unit and the object to be tested. Follow the connection diagram shown in figure 5.9 to perform the continuity measurement.



Picture 5.9: Connection of the universal test cable

Step 4:
Check the warnings and terminal monitoring on the display before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button to start the measurement. The current measurement result is shown during the measurement with the display ✓ or ✖. As this is a continuous test, the function must be stopped. To stop the measurement at any time, press the **TEST** button again. The last measured result is shown together with the display ✓ or ✖.



Picture 5.10: Example of the result of a low-current continuity measurement

Displayed result:

R................Low current resistance as
I.................Current used for the measurement

Warning:

- Low-current continuity measurements should only be carried out on voltage-free objects!

Notes:

- If there is a voltage of more than 10 V between the test terminals, the continuity measurement will not be carried out. Before performing a continuity measurement, compensate the test lead resistance. The compensation is carried out in the sub-function **Continuity R Low.**

5.3 RCD test

When testing RCDs/FI circuit breakers, the following sub-functions can be performed:

- Contact voltage measurement
- Measurement of the release time
- Measurement of the tripping current
- RCD automatic test

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

- Limit contact voltage
- Nominal differential RCD tripping current
- Multiplier of the rated differential RCD tripping current
- RCD type
- Checking the polarity of the starting current

5.3.1 Contact voltage

The contact voltage is limited to 50 VAC in normal living areas. In special environments (hospitals, damp rooms, etc.) contact voltages of up to 25 VAC are permissible. The contact voltage can only be set in the contact voltage **Uc** function!

5.3.2 Rated differential current

The rated differential current is the tripping current of an RCD/FI circuit breaker. The following RCD current values can be set: 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 650 mA and 1000 mA.

5.3.3 Multiplier of the rated residual current

The selected rated differential current can be multiplied by ½, 1, 2 or 5.

5.3.4 RCD type and test current from polarity

The PIT 2.0 enables testing of general (instantaneous) and selective (time-delayed) RCDs. It is suitable for testing the following types of SRCDs, among others:

- Alternating fault current (AC type)
- Pulsating DC fault current (type A)
- Pure or almost pure DC fault current (type B)

The start polarity of the test current can be started with the positive half-wave at 0° or with the negative half-wave at 180°.

Positive start polarity (180°) Negative start polarity (0°)

Picture 5.11: Test current with positive or negative half-wave

5.3.5 Testing of selective (time-delayed) RCDs

Selective RCDs have a delayed response behaviour. The tripping behaviour is influenced by the bias voltage during the measurement of the contact voltage. To eliminate the bias voltage, a time delay of 30 s is inserted before the tripping test.

5.3.6 Contact voltage

The leakage current flowing to the PE terminal causes a voltage drop across the earthing resistor, which is called the contact voltage (Uc). This voltage is applied to all accessible parts connected to the PE terminal and should be lower than the safety limit voltage. The contact voltage parameter is measured without the RCD/FI circuit breaker tripping. RL is a fault loop resistance and is calculated as follows:

$$R_L = \frac{U_C}{I_{\Delta N}}$$

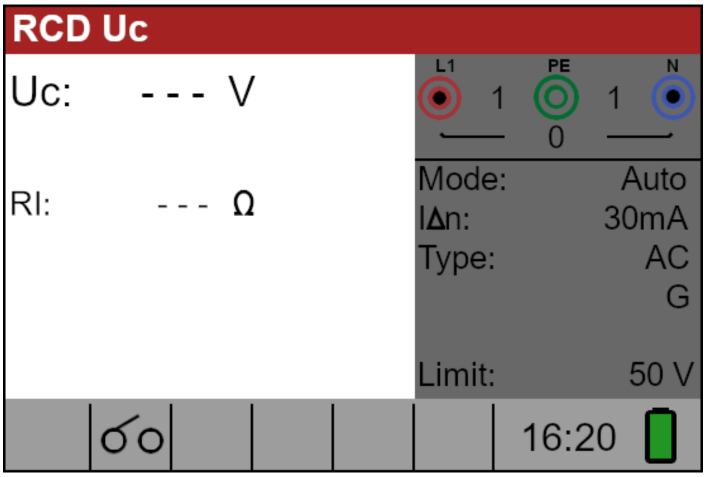
The displayed contact voltage refers to the rated residual current of the RCD and is multiplied by a safety factor. See table 5.1 for a detailed calculation of the contact voltage.

RCD type	Contact voltage Uc
G G	Uc∝ 1.05xIΔN
S S	Uc∝ 1.05x2xIΔN
G G	Uc∝ 1.05x√2xIΔN
S S	UC∝ 1.05x2x√2xIΔN

Figure 5.1: Relationship between Uc and IΔN

To perform a contact voltage measurement

Step 1:
Select the **RCD function** with the function selector switch and the **Uc mode** with the navigation keys. The following menu is displayed:

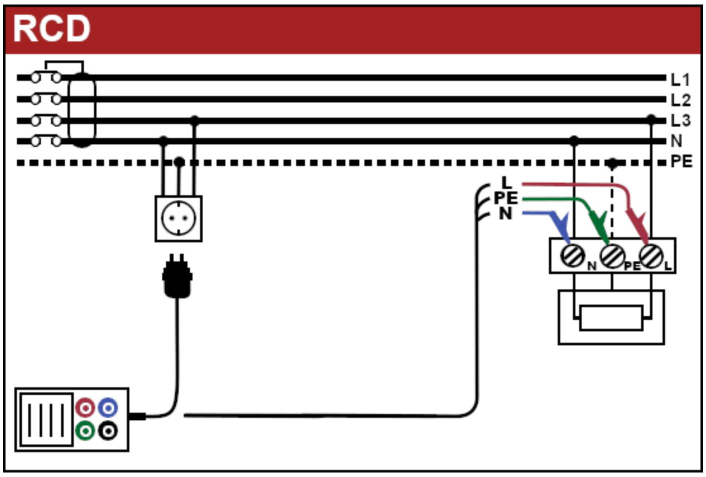


Picture 5.12: contact voltage measurement menu

Step 2:
Set the following measurement parameters and limit values:

- **IΔn**: Rated residual current
- **Type**: RCD type
- **Limit**: Limitation of the contact voltage

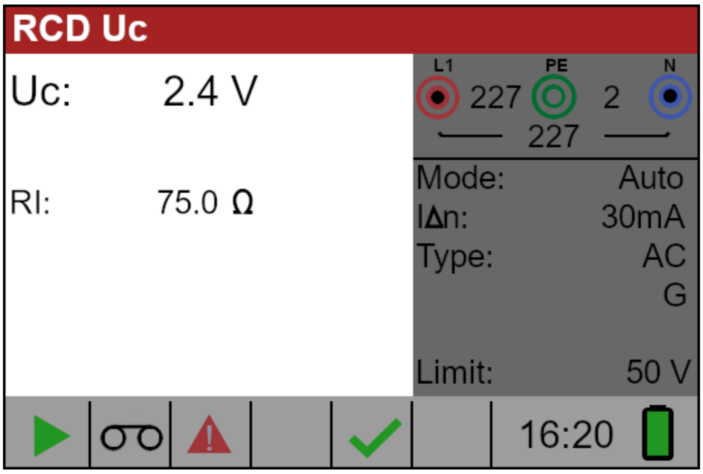
Step 3:
Connect the test leads to the unit and follow the connection diagram in figure 5.13 to perform a contact voltage measurement.



Picture 5.13: Connecting plug test cable or universal test cable

Step 4:

Check for any warnings and check the terminal monitor on the display before starting the measurement. If everything is OK and the ▶ is displayed, press the **TEST** button. After the measurement has been taken, the results appear on the display together with ✔ or ✖ .



Picture 5.14: Example of the results of the contact voltage measurement

Displayed result:
Uc................Contact voltage
RI.................Resistance of the error loop
Limit........... Limit value for the earth fault loop resistance according to BS 7671.

Notes:

- The parameters set in this function are also retained for all other RCD functions!
- Measuring the contact voltage does not normally cause an RCD/FI switch to trip. However, the tripping limit can be exceeded by leakage currents via the PE protective conductor or a capacitive connection between L and PE conductor.
- The RCD trip inhibit sub-function (function selected for the **LOOP RCD** option) requires more time, but provides a much higher accuracy of the result for the fault loop resistance (compared to the RL sub-result in the contact voltage function).

5.3.7 RCD tripping time (RCD Time)

The purpose of measuring the tripping time is to check the effectiveness of an RCD. This is achieved by a test in which a suitable fault condition is simulated. The tripping times vary depending on the standard and are listed below.

Tripping times in accordance with BS EN 61008 / BS EN 61009:

	½xIΔN *	IΔN	2xIΔN	5xIΔN
Normal (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

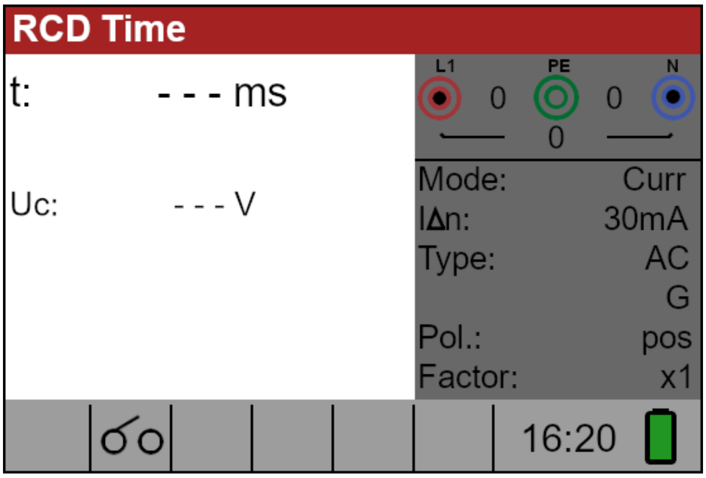
Trip times according to BS 7671:

	½xIΔN *	IΔN	2xIΔN	5xIΔN
Normal (non-delayed) RCDs	tΔ > 1999 ms	tΔ < 300 ms	tΔ < 150 ms	tΔ < 40 ms
Selective (time-delayed) RCDs	tΔ > 1999 ms	130 ms < tΔ < 500 ms	60 ms < tΔ < 200 ms	50 ms < tΔ < 150 ms

* A test current of ½IΔN cannot cause the RCDs to trip.

To carry out the measurement of the release time

Step 1:
Select the **RCD function** with the function selector and select the **time mode (Time)** with the navigation keys. The following menu is displayed:



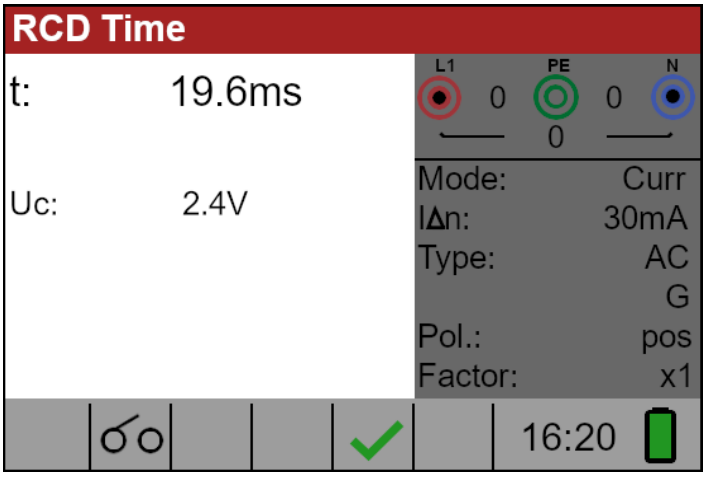
Picture 5.15: Menu for measuring the release time

Step 2:
Set the following measurement parameters:

- **IΔn**: Rated current of the differential release
- **Type**: RCD type
- **Factor**: Nominal multiplier of the RCD
- **Pole**: Start polarity of the test current

Step 3:
Connect the leads to the unit and follow the connection diagram shown in figure 5.13 (see chapter 5.3.6 Contact voltage) to perform the measurement.

Step 4:
Check for any warnings and check the terminal monitoring on the display before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button to start the measurement. The current measurement result is shown after the measurement with the display ✓ or ✗.



Picture 5.16: Example of the results of the release time

Displayed result:
t....................triggeringtime
Uc.................Contact voltage

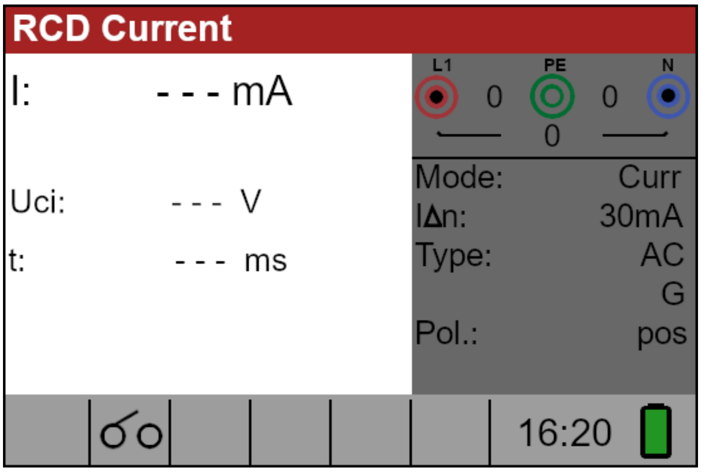
Notes:
- The parameters set in this function are also transferred to all other RCD functions.
- The measurement of the tripping time of the RCD/FI circuit breaker is only carried out if the contact voltage at rated differential current is lower than the limit value specified in the contact voltage setting!
- Measuring the contact voltage during the pre-test does not normally cause an RCD/FI switch to trip. However, the tripping limit can be exceeded by a leakage current flowing through the PE protective conductor or by a capacitive connection between the L and PE conductors.

5.3.8 RCD tripping current (RCD Current)

This test is used to determine the minimum current required to trip the RCD. circuit breaker is required. After starting the measurement, the test current generated by the unit is continuously increased, starting at 0.2xIΔN up to 1.1xIΔN (up to 1.5xIΔN / 2.2xIΔN (IΔN =10 mA) for pulsating DC fault currents). Until the RCD trips.

To carry out the measurement of the trip current

Step 1:
Select the **RCD function** with the function selector and the **ramp mode (Ramp)** with the navigation keys. The following menu is displayed:



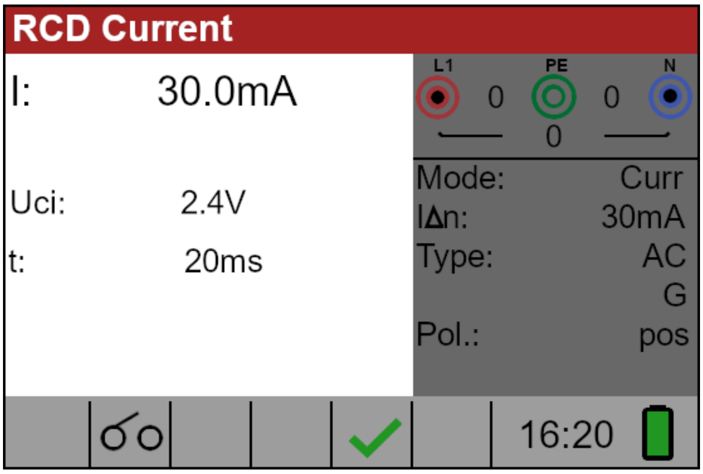
Picture 5.17: Menu for trigger current measurement

Step 2:
Use the navigation keys to set the following parameters for this measurement:

- **IΔn**: Rated residual current
- **Type**: RCD type
- **Pole**: Start polarity of the test current

Step 3:
Connect the leads to the unit and follow the connection diagram shown in figure 5.13 (see chapter 5.3.6 Contact voltage) to perform the measurement.

Step 4:
Check any warnings and check the terminal monitoring on the display before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button to start the measurement. The current measurement result is shown after the measurement with the display ✔ or ✖.



Picture 5.18: Example of the result of a trip current measurement

Displayed result:

I....................Cut-off current
Uci...............Contact voltage
t....................Release time

Notes:

- The parameters set in this function are also transferred to all other RCD functions.
- Measurement of the tripping current of the RCD/FI circuit breaker is only carried out if the contact voltage at rated differential current is lower than the set limit contact voltage!
- Measuring the contact voltage during the pre-test does not normally cause an RCD/FI switch to trip. However, the tripping limit can be exceeded by a leakage current flowing through the PE protective conductor or by a capacitive connection between the L and PE conductors.

5.3.9 Automatic test

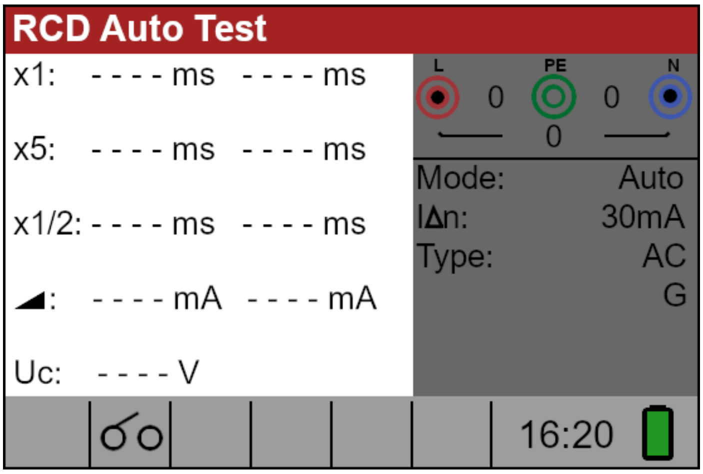
The purpose of the automatic test function is to perform a complete RCD test and measurement of the main associated parameters (contact voltage, fault loop resistance and tripping time at different fault currents) with a single keystroke. If a faulty parameter is detected during the autotest, the test is stopped to indicate the need for further investigation.

Notes:

- Measuring the contact voltage during the pre-test does not normally cause an RCD/FI switch to trip. However, the tripping limit can be exceeded by a leakage current flowing through the PE protective conductor or by a capacitive connection between the L and PE conductors.
- The automatic test sequence stops if the trigger time is outside the permissible period.

To perform the RCD automatic test

Step 1:
Select the **RCD** function with the function selector and the **Auto** mode with the navigation keys. The following menu is displayed:



Picture 5.19: RCD automatic test menu

Step 2:
Set the following measurement parameters:

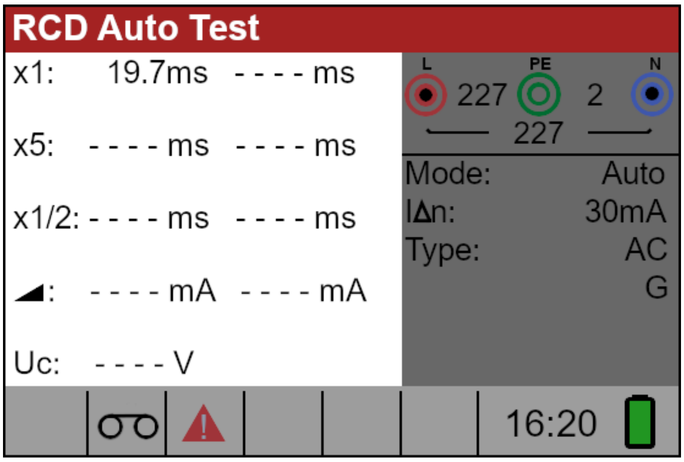
- **IΔN**: Rated current of the RCD
- **Type**: RCD type

Step 3:
Connect the leads to the unit and follow the connection diagram shown in figure 5.13 (see chapter 5.3.6 Contact voltage) to perform the measurement.

Step 4:
Check any warnings and check the terminal monitoring on the display before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button to start the measurement. The automatic test sequence then starts to run as follows:

1. Measurement of the release time with the following measurement parameters:
   - Test current of IΔN
   - The test current starts with the positive half-wave at 0°.

   The measurement normally triggers an RCD/FI circuit breaker within the permissible time period. The following menu is displayed:

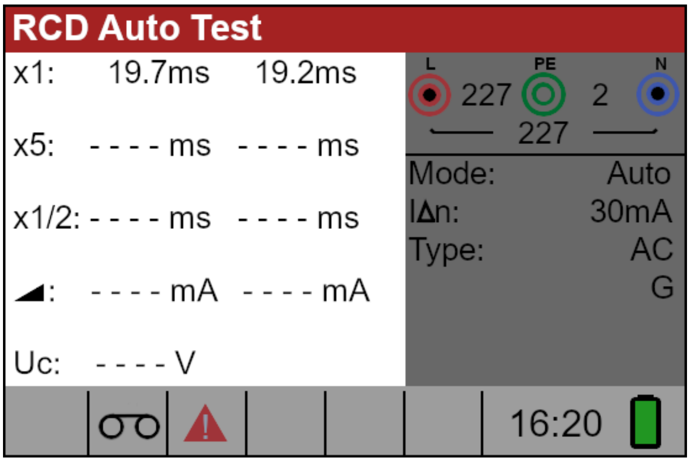


Picture 5.20: Step 1 RCD automatic test results

After the RCD is switched on again, the automatic test sequence automatically continues with step 2.

2. Measurement of the release time with the following measurement parameters:
   - Test current of IΔN
   - The test current is started with the negative half-wave at 180°.

   The measurement normally triggers an RCD/FI circuit breaker.
   The following menu is displayed:

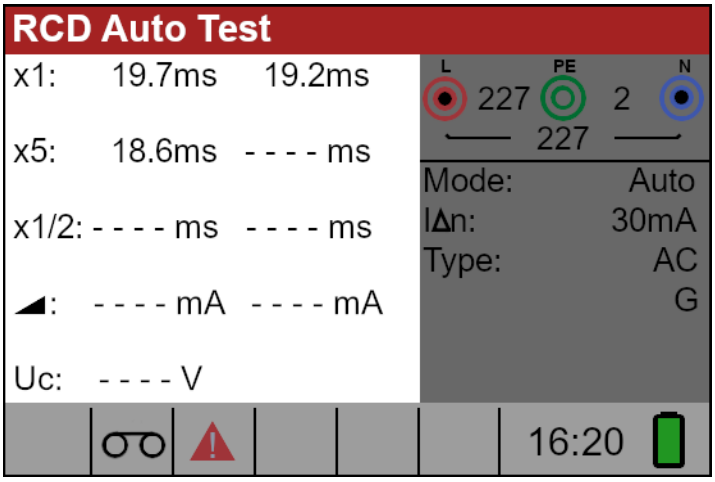


Picture 5.21: Step 2 RCD automatic test results

After the RCD is switched on again, the automatic test sequence automatically continues with step 3.

3. Measurement of the release time with the following measurement parameters:
   - Test current of 5xIΔN
   - The test current starts with the positive half-wave at 0°.

   The measurement normally triggers an RCD/FI circuit breaker within the permissible time period. The following menu is displayed:

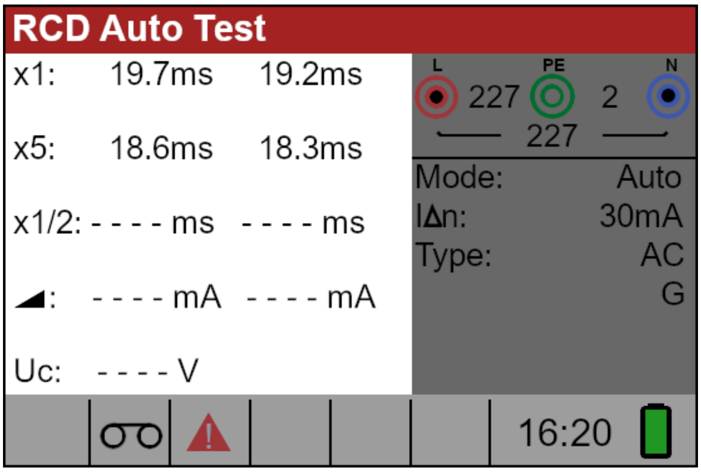


Picture 5.22: Step 3 RCD automatic test results

After the RCD/FI circuit breaker is switched on again, the automatic test sequence automatically continues with step 4.

4. Measurement of the release time with the following measurement parameters:
   - Test current of 5xIΔN
   - The test current is started with the negative half-wave at 180°.

   The measurement normally triggers an RCD/FI circuit breaker within the permissible time period. The following menu is displayed:

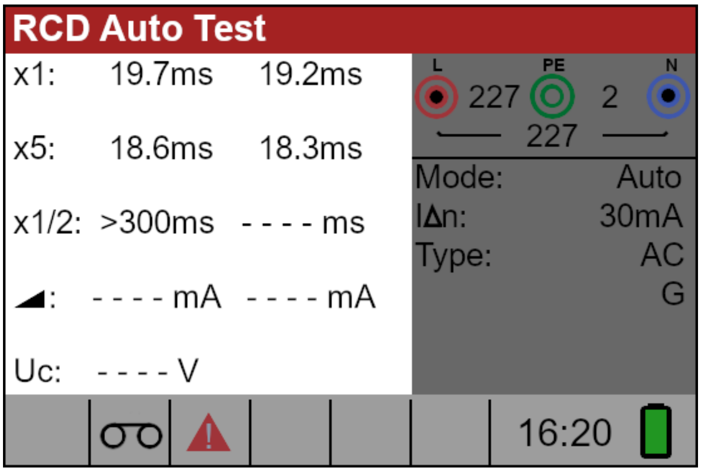


Picture 5.23: Step 4 RCD automatic test results

After the RCD/FI circuit breaker is switched on again, the automatic test sequence automatically continues with step 5.

5. Measurement of the release time with the following measurement parameters:
   - Test current of ½xIΔN
   - The test current is started with the positive half-wave at 0°.

   The measurement does **not** normally trigger **an** RCD/FI circuit breaker. The following menu is displayed:

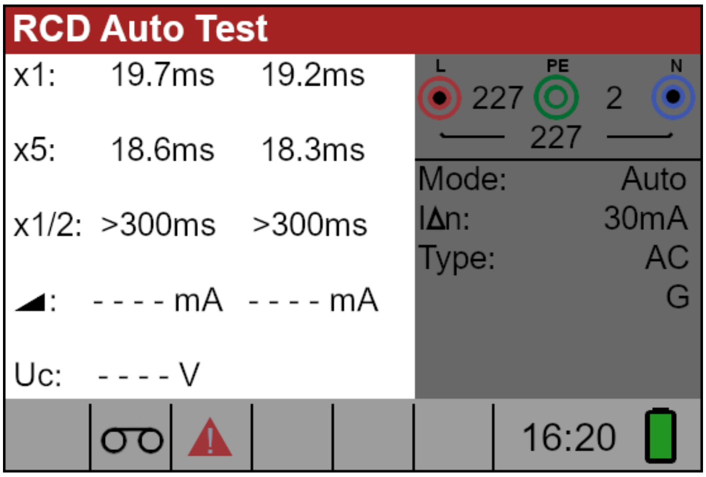


Picture 5.24: Step 5 RCD automatic test results

After performing step 5, the automatic test sequence of the RCD/FI circuit breaker continues with step 6.

6. Measurement of the release time with the following measurement parameters:
   - Test current of ½xIΔN
   - The test current is started with the negative half-wave at 180°.

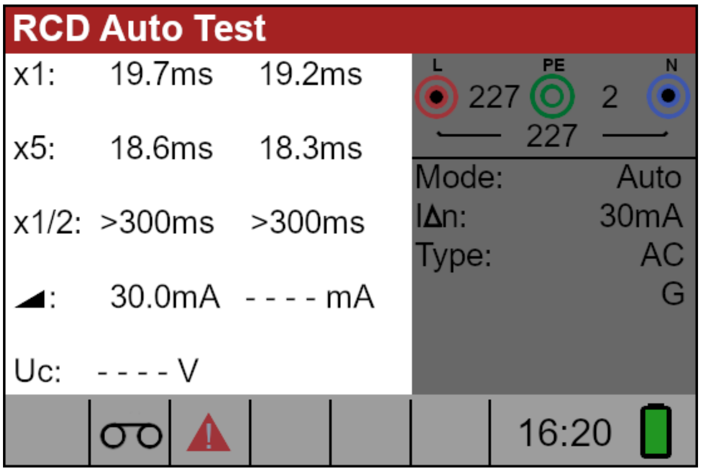
   The measurement does **not** normally trigger **an** RCD/FI circuit breaker. The following menu is displayed:



Picture 5.25: Step 6 RCD automatic test results

7. Ramp test measurement with the following measurement parameters:
   - The test current is started with the positive half-wave at 0°.

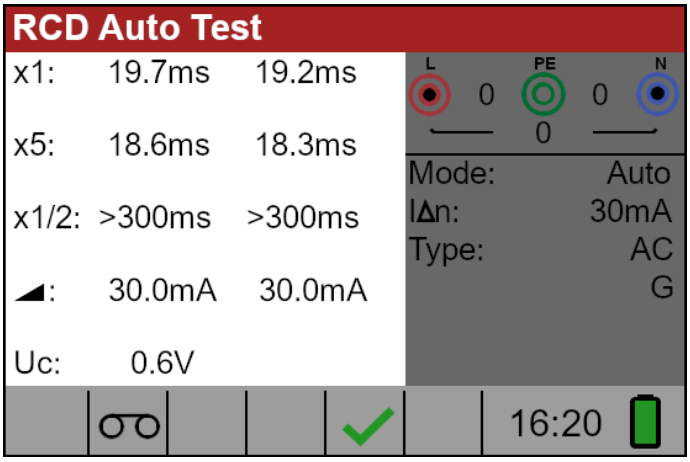
   This measurement determines the minimum current required to trip the RCD/FI circuit breaker. After the measurement has been started, the test current generated by the unit is continuously increased until the RCD/FI circuit breaker trips. The following menu is displayed:



Picture 5.26: Step 7 RCD automatic test results

8. Ramp test measurement with the following measurement parameters:
   - The test current is started with the negative half-wave at 180°.

   This measurement determines the minimum current required to trip the RCD/FI circuit breaker. After the measurement has been started, the test current generated by the unit is continuously increased until the RCD/FI circuit breaker trips. The following menu is displayed:



Picture 5.27: Step 8 RCD automatic test results

Displayed results:
x1 (left)............. Result of the triggering time of stage 1, t3 (IΔN, 0°),
x1 (right)........... Result of the triggering time of stage 2, t4 (IΔN, 180°),
x5 (left)............. Result of the triggering time of stage 3, t5 (5xIΔN, 0°),
x5 (right)........... Result of the triggering time of stage 4, t6 (5xIΔN, 180°),
x½ (left)............ Step 5 Result of the release time, t1 (½xIΔN, 0°),
x½ (right).......... Step 6 Result of the release time, t2 (½xIΔN, 180°),
IΔ (+) .... Stage 7 Tripping current ((+) positive polarity)
IΔ (-)................. Stage 8 Tripping current ((-) negative polarity)
Uc..................... Contact voltage for nominal IΔN.

Notes:

- The x1 auto tests are automatically skipped for RCD type B with rated residual currents of IΔN = 1000 mA.
- The x5 autotests are 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 automatic test is passed when the results t1 to t4 are passed and the display does not show t5 and t6.

Warning:

- Leakage currents in the circuit after the residual current device (RCD) can influence the measurements.
- Special conditions in residual current devices (RCD) of a certain type, e.g. type S (selective and impulse current resistant), must be taken into account.
- Devices in the circuit after the residual current device (RCD) can cause significant extension of the operating time. Examples of such equipment can be connected capacitors or running motors.

5.4 Fault loop impedance and fault current

The loop impedance function has three sub-functions:

The LOOP IMPEDANCE sub-function performs a fast measurement of the fault loop impedance in supply systems that do not contain RCD protection. The LOOP **IMPEDANCE RCD sub-function performs a** measurement of the fault loop impedance in supply systems protected by RCDs. **LOOP IMPEDANCE Rs** is a sub-function with configurable RCD value and performs fault loop impedance measurement in supply systems protected by RCDs.

5.4.1 Fault loop impedance measurement

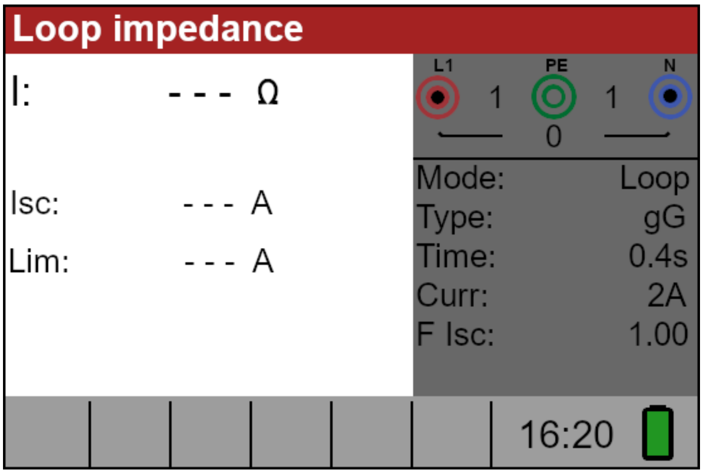
The fault loop impedance measures the impedance of the fault loop in case a short circuit to an exposed conductive part occurs (i.e. a conductive connection between phase conductor and protective earth conductor). To measure the loop impedance, the unit uses a high test current. The prospective fault current (IPFC) is calculated based on the measured resistance as follows:

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

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)

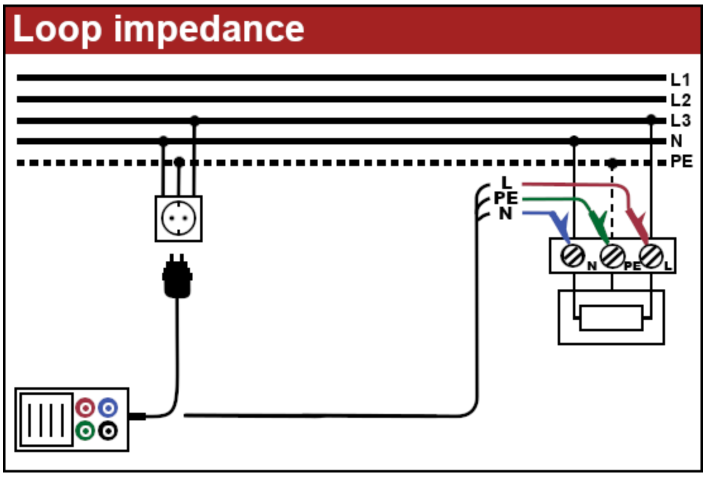
To perform the fault loop impedance measurement

Step 1:
Select the LOOP function with the function selector and the desired LOOP mode with the navigation keys. Then use the navigation keys to select the desired values for the Type, Time and Current options. The following menu is displayed:



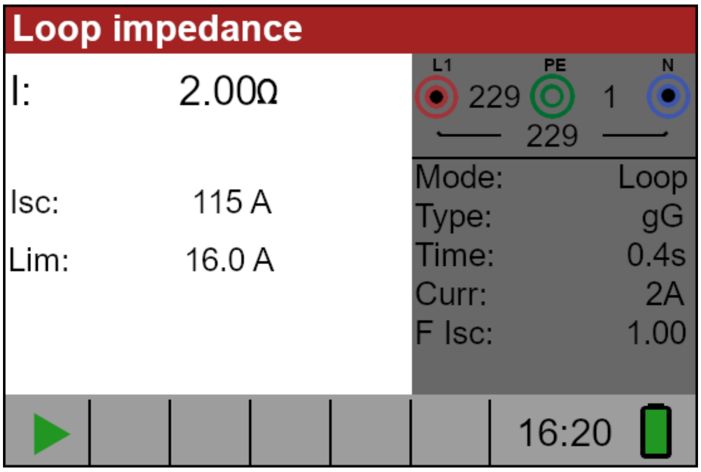
Picture 5.28: Loop impedance measurement menu

Step 2:
Connect the test leads to the unit and follow the wiring diagram shown in Figure 5.29 to measure the fault loop impedance.



Picture 5.29: Connection of plug cable and universal test cable

Step 3:
Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button. After the measurement has been carried out, the results are shown on the display:



Picture 5.30: Example of the results of the loop impedance measurement

Displayed results:
Z......................Fault loop impedance
ISC..................Predicted fault current (displayed in amperes)

Notes:

- The specified accuracy of the test parameters is only valid if the mains voltage is stable during the measurement.
- The impedance measurement of the fault loop triggers RCD-protected circuits.

5.4.2 Fault loop impedance test RCD

The fault loop impedance is measured with a low test current to avoid tripping of the RCD/FI circuit breaker. This function can also be used to measure the fault loop impedance in systems equipped with RCDs that have a rated tripping current of 30 mA and more.

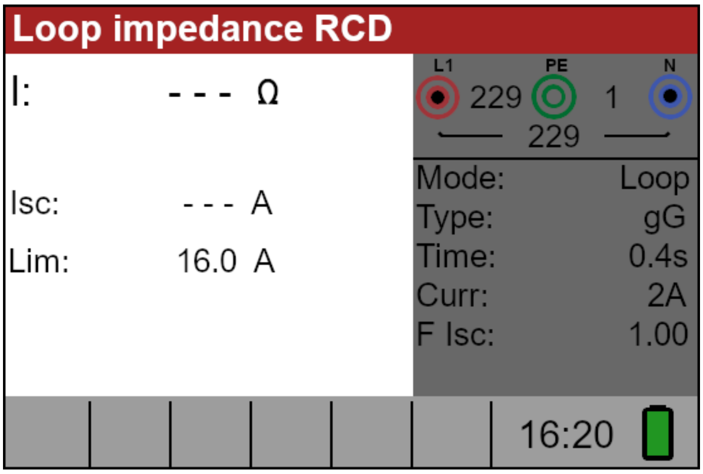
The prospective fault current (IPFC) is calculated based on the measured resistance as follows:

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

Nominal input voltage UN	Voltage range
115 V	(93 V ≤ UL-PE < 134 V)
230 V	(185 V ≤ UL-PE ≤ 266 V)

Measurement of the RCD trip limit

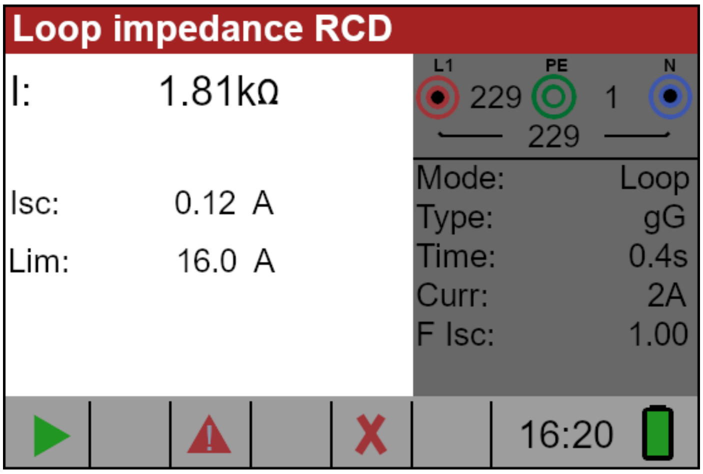
Step 1:
Select the **LOOP** function with the function selector and the RCD mode with the navigation keys. Then use the navigation keys to select the desired values for the **Type**, **Time** and **Current** options. The following menu is displayed:



Picture 5.31: Menu of the loop impedance RCD

Step 2:
Connect the appropriate test leads to the unit and follow the connection diagram shown in Fig. 5.29 to perform an RCD trip limit measurement.

Step 3:
Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button. After the measurement has been carried out, the results are shown on the display:



Picture 5.32: Example of results of loop impedance measurement RCD

Displayed result:
Z..................Loop impedance
ISC.............Predicted fault current

Notes:

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

5.4.3 The loop impedance measurement Rs (for adjustable current)

The loop impedance measurement Rs is measured with a low test current to avoid tripping the RCD/FI circuit breaker. It is possible to set the value of the RCD while the test current depends on the selected value. With this function it is possible to test each RCD type with the maximum possible current without tripping the RCD.

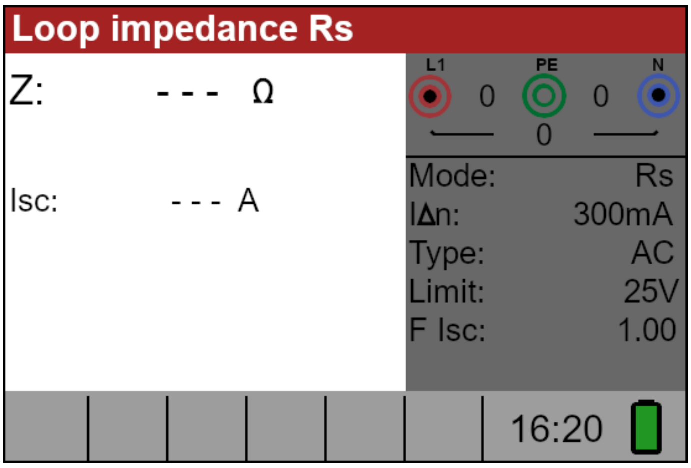
The prospective fault current (IPFC) is calculated based on the measured resistance as follows:

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

Nominal input voltage UN	Voltage range
115 V	(93 V ≤ UL-PE < 134 V)
230 V	(185 V ≤ UL-PE ≤ 266 V)

To perform the loop impedance measurement RS

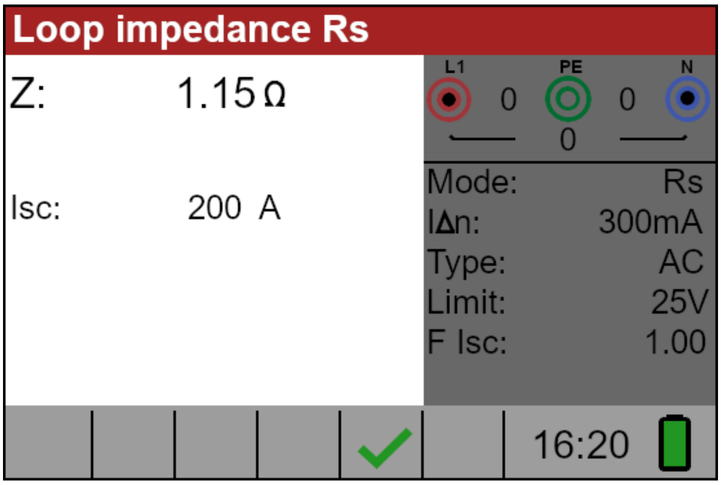
Step 1:
Select the **LOOP** function with the function selector and select the Rs mode with the navigation keys. Then select the desired option values for current, limit and scaling factor with the navigation keys. The following menu is displayed:



Picture 5.33: Function menu loop impedance RS

Step 2:
Connect the appropriate test leads to the unit and follow the connection diagram shown in Figure 5.29 to perform a loop impedance Rs measurement.

Step 3:
Check if warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button. After the measurement has been carried out, the results are shown on the display:



Picture 5.34: Example of results of loop impedance measurement RS

Displayed result:
Z................loopimpedance
ISC............Predicted fault current

5.5 Line impedance and expected short circuit current

Line impedance is a measurement of the impedance of the current loop at a
Short-circuit to the neutral conductor (conductive connection between phase conductor and
neutral conductor in a single-phase system or between two phase conductors in a three-phase system). For the measurement of the line impedance, a high test current is used.
used.

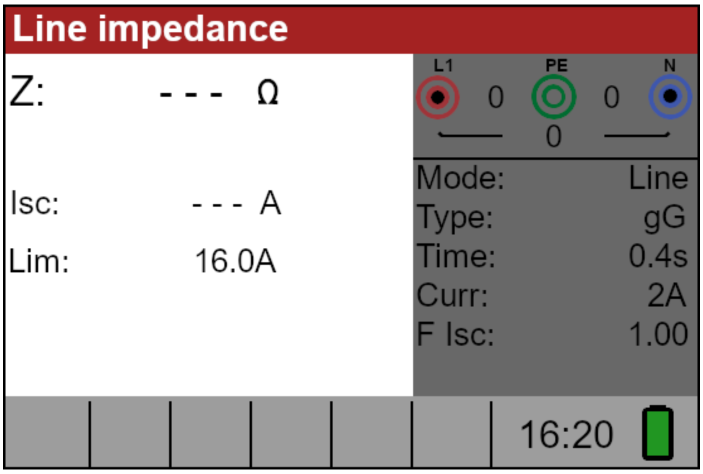
The expected short-circuit current is calculated as follows:

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

Nominal input voltage UN	Voltage range
115 V	(93 V ≤ UL-PE < 134 V)
230 V	(185 V ≤ UL-PE ≤ 266 V)
400 V	(321 V ≤ UL-PE ≤ 485 V)

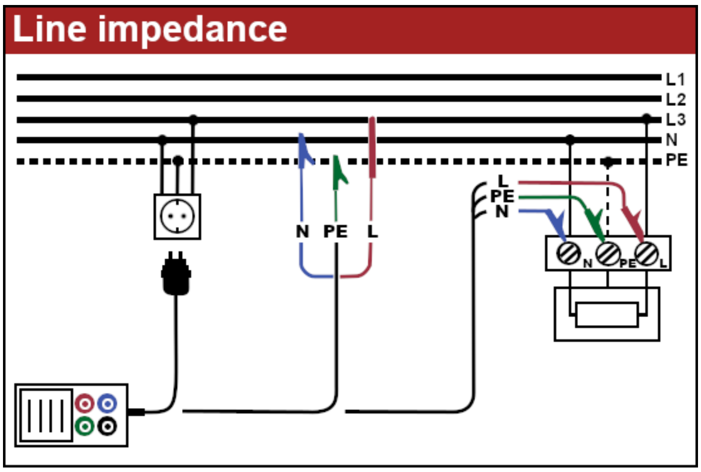
To perform the line impedance measurement:

Step 1:
Select the **LINE** function with the function selector. Then select the desired values for type, time and current with the navigation keys. The following menu is displayed.



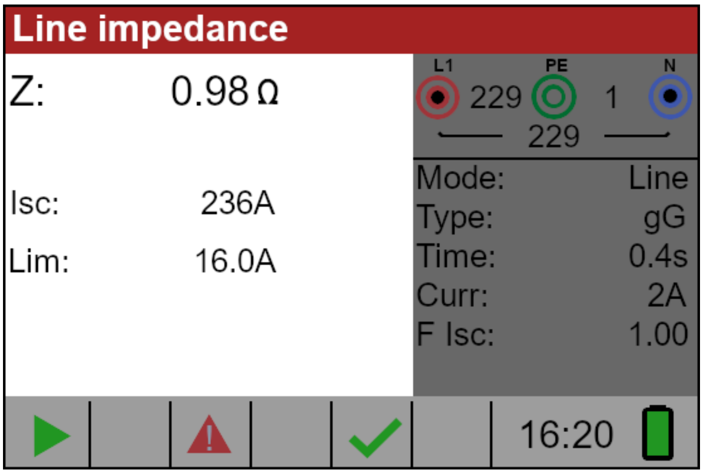
Picture 5.35: Menu for measuring the line impedance

Step 2:
Connect the appropriate test leads to the unit and follow the connection diagram shown in Figure 5.36 to perform a phase-neutral. Or phase-phase line impedance measurement.



Picture 5.36: Measuring the line impedance

Step 3:
Check if warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button. After the measurement has been carried out, the results are shown on the display:



Picture 5.37: Example of the results of the line impedance measurement

Displayed result:
Z.................Line impedance
ISC.............Expected short-circuit current

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

5.5.1 Voltage drop test

The voltage drop function is a measurement of the line impedance (see chapter 5.5) and the result is compared with a reference value previously measured at another point in the installation (usually at the feed point, as this point has the lowest impedance). The voltage drop in %, the impedance and the expected short-circuit current are displayed.

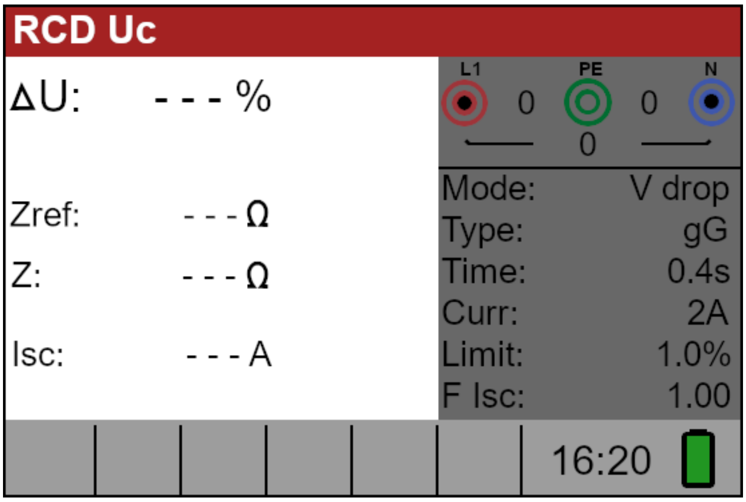
The voltage drop in % is calculated as follows:

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

To perform the line impedance measurement:

Step 1:
Select the **LINE** function with the function selector and select **Voltage drop (V drop)**

with the navigation keys. Then select the desired values for options Type, Time and Current with the navigation keys. The following menu is displayed:

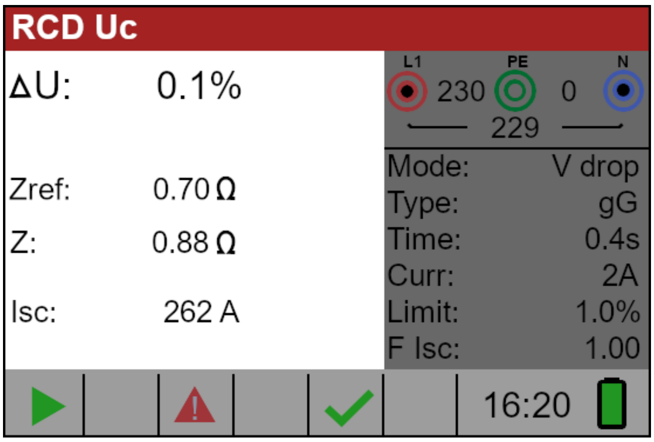


Picture 5.38: Voltage drop measurement menu

Step 2:
Connect the appropriate test leads from the reference point to the unit and follow the connection diagram shown in Figure 5.36 to perform a phase-neutral or phase-phase line impedance measurement.

Step 3:
Press the **COM button** and "**REF**" appears in the display. The unit is now ready to perform the measurement of the reference position in the installation. Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button. After performing the measurement, the result for Zref appears on the display.

Step 4:
Connect the appropriate test leads from the tested point to the unit and follow the connection diagram shown in Figure 5.36 to perform the phase-neutral or phase-phase line impedance measurement. Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button. After performing the measurement, the results are shown on the display.



Picture 5.39: Example of measurement results of the voltage drop measurement

Displayed results:
ΔU..............Voltage drop of the test point compared to the reference point
Zref............Line impedance of the reference point
Z.................Line impedance of the test point
ISC.............Projected short-circuit current of the test point

Notes:

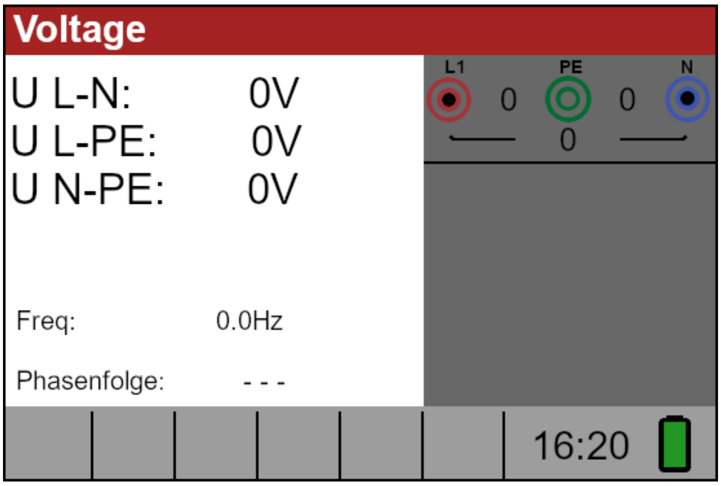
- The specified accuracy of the test parameters is only valid if the mains voltage is stable during the measurement.

5.6 Phase sequence check

In practice, we often have to deal with the connection of three-phase consumers (motors and other electromechanical machines) to the three-phase mains. Some consumers (fans, conveyors, motors, electromechanical machines, etc.) require a certain phase rotation and some may even be damaged if the rotation is reversed. For this reason, it is advisable to check the phase rotation before connecting.

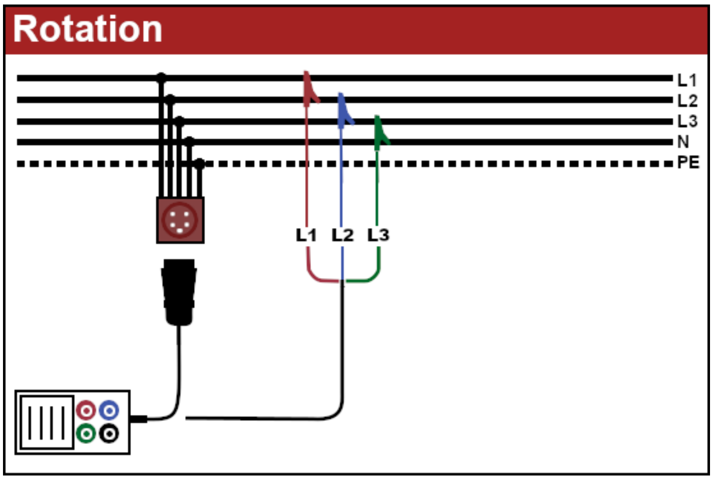
To check the phase sequence:

Step 1:
Select **voltage, frequency and phase sequence (V)** with the function selector switch. The following menu is displayed.



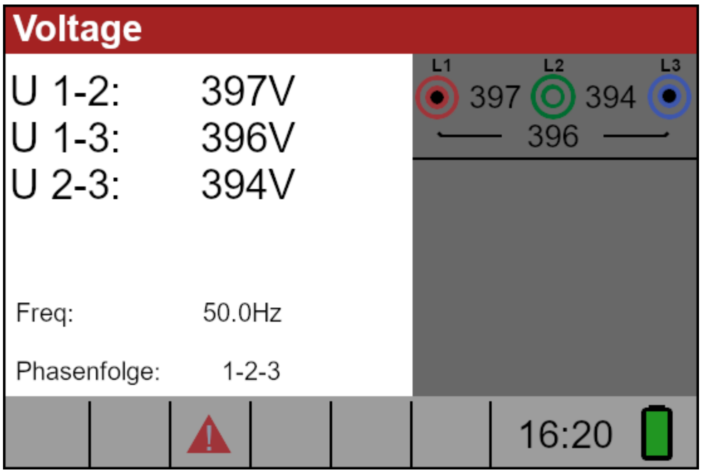
Picture 5.40: Phase sequence menu

Step 2:
Connect the test cable to the unit and follow the connection diagram shown in Figure 5.41 to check the phase sequence.



Picture 5.41: Connection diagram of the test cable

Step 3:
Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. The phase sequence test is a continuously running test, therefore the results are displayed as soon as the test lead is fully connected to the unit under test. All three-phase voltages are displayed in their order represented by the numbers 1, 2 and 3.



Picture 5.42: Example of a phase sequence test result

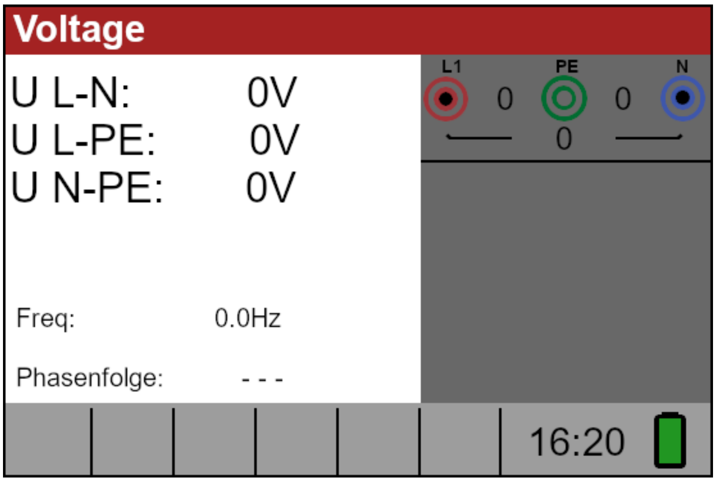
Displayed results:
Freq....................Frequency
Rotation.............Phase sequence
-.-.- ....Faulty measurement

5.7 Voltage and frequency

Voltage measurements should be taken regularly when working with electrical equipment (performing various measurements and tests, searching for fault locations, etc.). Frequency is measured, for example, when determining the source of the mains voltage (transformer or individual generator).

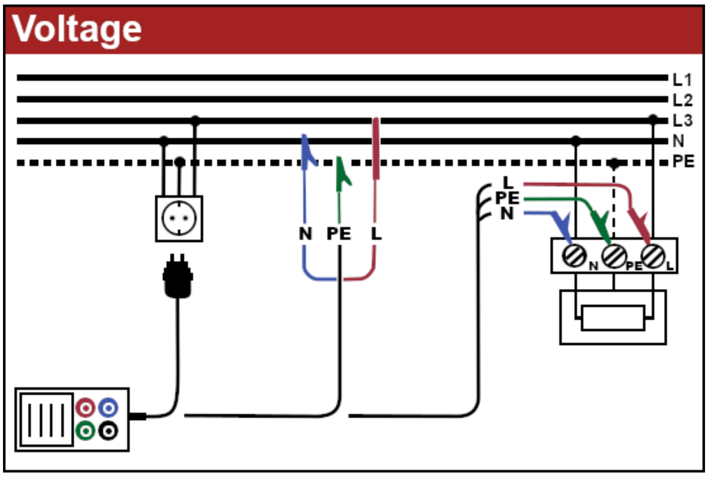
To perform the voltage measurement:

Step 1:
Select the function **voltage, frequency and phase sequence (V)** with the function selector switch. The following menu is displayed:



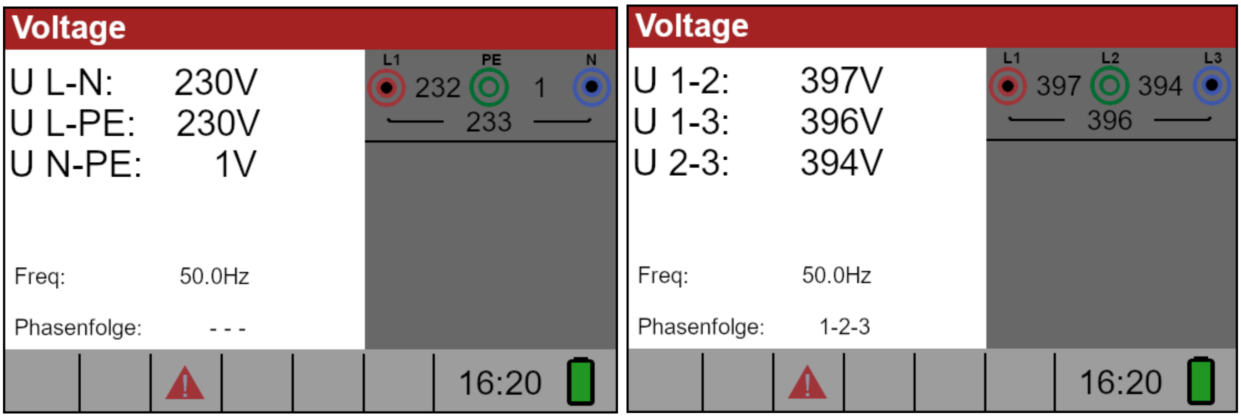
Picture 5.43: Voltage and frequency measurement menu

Step 2:
Connect the test cable to the unit and follow the connection diagram in Figure 5.44 to perform a voltage and frequency measurement.



Picture 5.44: Wiring diagram for voltage and frequency measurements

Step 3:
Check if warnings are shown on the screen and check the terminal monitor before starting the measurement. The voltage and frequency measurement runs continuously and shows the fluctuations that occur; these results are shown on the display during the measurement.



Picture 5.45: Example results for voltage and frequency measurements

Displayed results:
U L-N.........Voltage between phase and neutral conductor
U L-PE.......Voltage between phase and protective conductors
U N-PE.......Voltage between neutral conductor and protective conductor

When testing a three-phase system, the following results are displayed:
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,

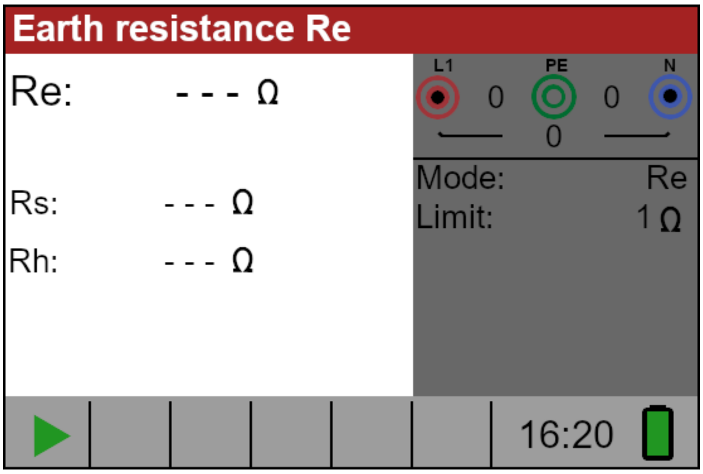
5.8 Earth resistance measurement

5.8.1 Earth resistance (Re) 3-wire and 4-wire measurement method

The PIT 2.0 enables earth resistance measurement with the 3-wire and 4-wire measurement method.

To perform an earth resistance measurement:

Step 1:
Select the function **Earth resistance measurement (RPE)** with the function selector switch and select the mode **Re with the** navigation keys. The following menu is displayed:

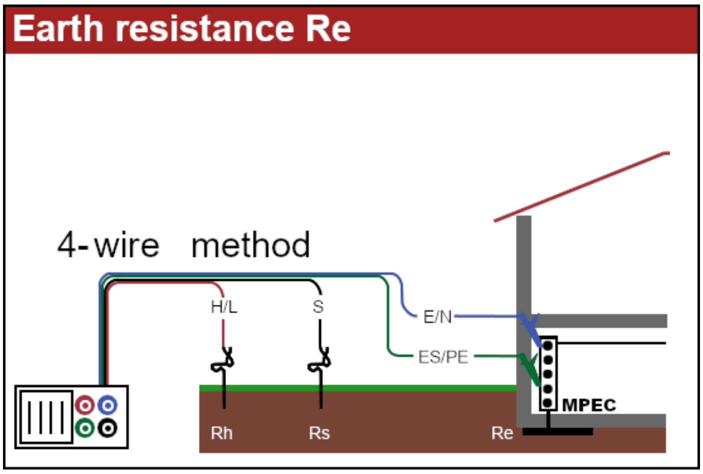


Picture 5.46: Earth resistance measurement menu

Step 2:
Set the following limit value using the navigation keys:

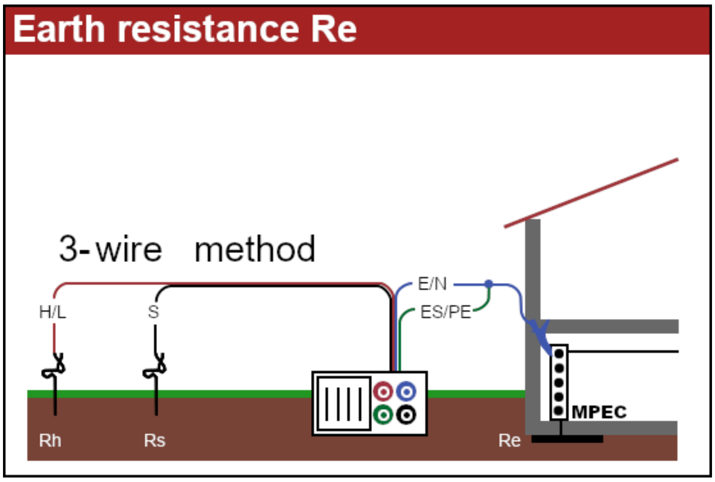
- **Limit:** Limitation of the resistance value

Step 3:
Follow the connection diagram shown in Figure 5.47 to perform the earth resistance measurement with 4 conductors.



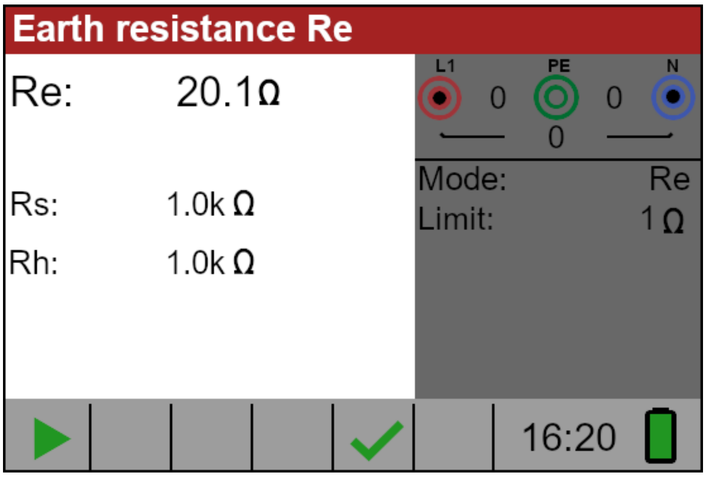
Picture 5.47: 4-wire connection diagram

Follow the connection diagram shown in figure 5.48 to start the measurement. of the earth resistance with 3 conductors (ES connected to E).



Picture 5.48: 3-wire connection diagram

Step 4:
Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the **TEST** button to start the measurement. The current measurement result is displayed after the measurement with the display ✓ or ✖.



Picture 5.49: Example results of an earth resistance measurement

Displayed result:
Re.................Resistance to earth.
Rs.................Resistance of the S (potential) probe
Rh ....Resistance of the H probe (current)

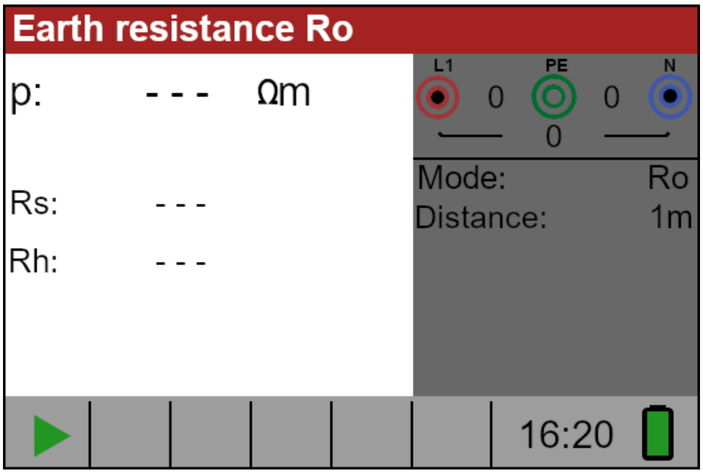
Notes:
- If there is a voltage of more than 10 V between the test terminals, the earth resistance measurement will not be carried out.

5.8.2 Specific earth resistance (Ro)

It is advisable to measure the earthing resistance when determining the parameters of the earthing system (required length and surface of the earth electrodes, suitable installation depth of the earthing system, etc.) in order to obtain more accurate calculations.

To perform an earth resistivity measurement:

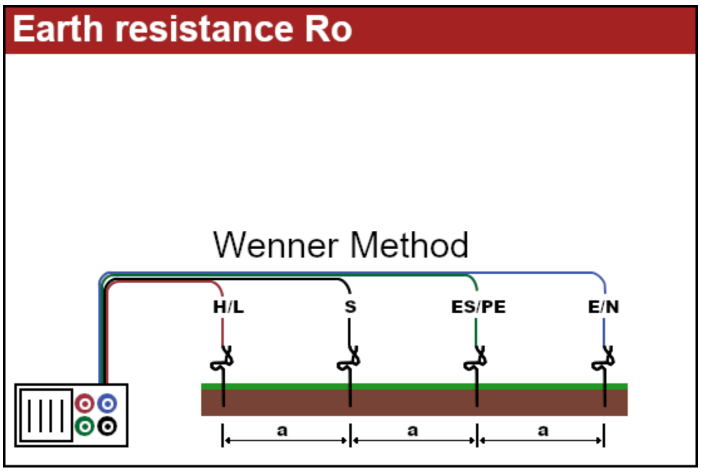
Step 1:
Select the function **Earth resistance measurement (RPE)** with the function selector switch and select the mode **Ro** with the navigation keys. The following menu is displayed:



Picture 5.50: Earth resistance measurement menu

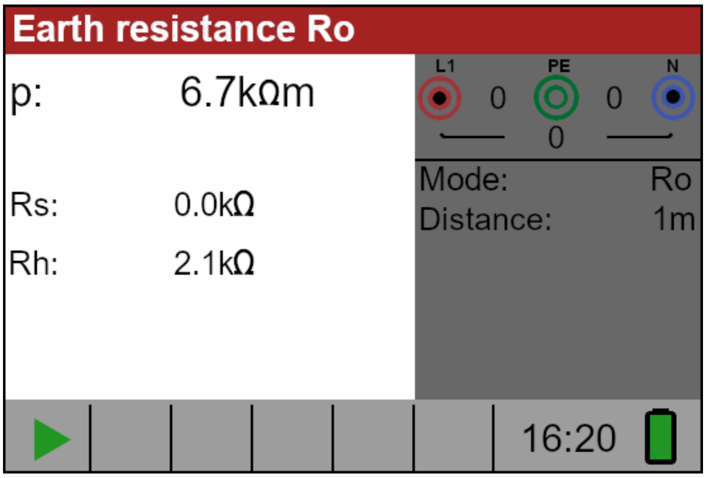
Step 2:
Set the following limit value with the navigation keys:
- Distance: Set the distance between the test points.

Step 3:
Follow the connection diagram shown in Figure 5.51 to perform the measurement.



Picture 5.51: Wiring diagram

Step 4:
Check if any warnings are displayed on the screen and check the terminal monitor before starting the measurement. If everything is OK and ▶ is displayed, press the TEST button to start the measurement. The current measurement result is displayed after the measurement with the display ✔ or ✖.



Picture 5.52: Example results of the earth resistivity measurement

Displayed result:
Re.................specific earth resistance.
Rs.................Resistance of the S (potential) probe
Rh ....Resistance of the H probe (current)

Notes:
- If there is a voltage of more than 10 V between the test terminals, the earth resistance measurement will not be carried out.

6 Maintenance

6.1 Replacing fuses

There are three fuses under the rear battery cover of the PIT 2.0.

- F3
  M 0.315 A / 250 V, 205 mm
  This fuse protects the internal circuits of the low-impedance function if the test probes are accidentally connected to the mains voltage.
- F1, F2
  F 4 A / 500 V, 326.3 mm
  General input protection fuses for test terminals L/L1 and N/L2.

⚠ **Warning:**
Disconnect any measuring accessories from the unit and make sure the unit is switched off before opening the battery/fuse compartment cover, as dangerous voltages may be present in this compartment!

- ❑ Replace blown fuses with fuses of the same type. Failure to do so may damage the unit and/or affect the safety of the operator!

The position of the fuses can be seen in figure 3.3 in chapter 3.3 Rear.

6.2 Cleaning

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

Warning:

- ❑ Do not use any liquids based on petrol or hydrocarbons!
- ❑ Do not spill any cleaning liquids on the unit!

6.3 Regular calibration

Regular calibration of the tester is essential to ensure the technical specifications listed in this manual. We recommend annual calibration. Calibration should only be performed by an authorised technical person. Please contact your dealer for more information.

6.4 Warranty and repair

For repairs under warranty or afterwards, please contact your dealer. Unauthorised persons are not allowed to open the unit. There are no user-replaceable components inside the unit, except for the three fuses in the battery compartment.

7 Technical data

7.1 Replacing the fuse

Insulation resistance (nominal voltages 50 VDC)
Measuring range according to EN61557 from 50 kΩ - 80 MΩ

Measuring range (MΩ)	Resolution (MΩ)	Tolerance
0.1 - 80 MΩ	(0,100 ... 1,999) 0,001 (2,00 ... 80,00) 0,01	± (5 % + 3 digits)

Insulation resistance (nominal voltages 100 VDC and 250 VDC)
Measuring range according to 61557 from 100 kΩ - 199.9 MΩ

Measuring range (MΩ)	Resolution (MΩ)	Tolerance
0.1 - 199.9 MΩ	(0,100 ... 1,999) 0,001 (2,00 ... 99,99) 0,01 (100,0 ... 199,9) 0,1	± (5 % + 3 digits)

Insulation resistance (rated voltages 500 VDC and 1000 VDC)
Measuring range according to EN61557 from 500 kΩ - 199.9 MΩ

Measuring range (MΩ)	Resolution (MΩ)	Tolerance
0.1 - 199.9 MΩ	(0,100 ... 1,999) 0,001 (2,00 ... 99,99) 0,01 (100,0 ... 199,9) 0,1	± (2 % + 3 digits)
200 - 999	(200 ... 999) 1	± (10 %)

Voltage

Measuring range (V)	Resolution (V)	Tolerance
0 - 1200	1	± (3 % + 3 digits)

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

If the unit becomes damp, the results may be affected. In such a case, it is recommended to dry the unit and accessories for at least 24 hours.

7.2 Contact resistance

7.2.1 Niederohm

Measuring range according to EN61557-4 from 0.1 Ω - 1999 Ω

Measuring range (Ω)	Resolution (Ω)	Tolerance
0,1 - 20,0	(0.10 Ω ... 19.99 Ω) 0.01 Ω	± (3 % + 3 digits)
20,0 - 1999	(20.0 Ω ... 99.9 Ω) 0.1 Ω (100 Ω ... 1999 Ω) 1 Ω	± (5 %)

Open circuit voltage.................................5 VDC
Measuring current....................................min. 200 mA with a load resistance of 2 Ω
Compensation of the measuring line.........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.

7.2.2 Low-current passage

Measuring range (Ω)	Resolution (Ω)	Tolerance
0,1 - 1999	(0.1 Ω ... 99.9 Ω) 0.1 Ω (100.0 Ω ... 1999 Ω) 1 Ω	± (5 % + 3 digits)

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

7.3 RCD test

7.3.1 General data

Rated residual current...............................6 mA, 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 650 mA, 1000 mA
Rated residual current tolerance...............-0 / +0.1x IΔ; IΔ = IΔN, 2x IΔN, 5x IΔN
-0.1x IΔ / +0; IΔ = ½x IΔN
Form of test current.....................Sine wave (AC), DC (B), pulsed (A)
RCD type....................................general (G, instantaneous), selective (S, time-delayed)
Test current Start polarity............0° or 180°
Voltage range..............................93 V - 134 V, 185 V - 266 V, 45 Hz - 65 Hz

Selection of the RCD test current (effective value calculated on 20 ms) according to IEC 61009:

	½ IΔN			1xIΔN			2xIΔN			5xIΔN			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	**)	1500	**)	**)	√	√	√
500	250	175	250	500	707	1000	1000	1410	**)	2500	**)	**)	√	√	√
650	325	228	325	650	919	1300	1300	**)	**)	**)	**)	**)	√	√	√
1000	500	350	500	1000	1410	**)	2000	**)	**)	**)	**)	**)	√	√	√

**) not available

7.3.2 Contact voltage

The measuring range according to EN61557-6 is 3.0 V - 49.0 V at contact voltage 25V.
The measuring range according to EN61557-6 is 3.0 V - 99.0 V at contact voltage 50V.

Measuring range (V)	Resolution (V)	Tolerance
3,0 - 9,9	0,1	-0%/+10% + 5 digits
10,0 - 99,9	0,1	-0%/+10% + 5 digits

Test current..max. 0.5x IΔN
Contact voltage..25 V, 50 V
The resistance of the fault loop at contact voltage is calculated as R^UC.

7.3.3 Release time

The entire measuring range complies with the requirements of EN61557-6. The specified tolerances apply to the entire operating range.

Measuring range (ms)	Resolution (ms)	Tolerance
0,0 - 500,0	0,1	±3 ms

Test current... ½x IΔN, 1x IΔN, 2x IΔN, 5x IΔN
Multipliers not available see test current selection table

7.3.4 Tripping current

The measuring range complies with EN61557-6 for IΔN ≥10mA. The specified Accuracies apply to the entire operating range.

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

Release time

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

Contact voltage

Measuring range (V)	**Resolution (V)**	**Tolerance**
3,0 - 9,9	0,1	-0%/+10% + 5 digits
10,0 - 99,9	0,1	-0%/+10% + 5 digits

7.4 Fault loop impedance and fault current

Zloop L-PE, hypofunction Ipfc
The measuring range corresponds to EN 61557-3 for 0.25 - 1999 Ω

Measuring range (Ω)	**Resolution (Ω)**	**Tolerance**
0,2 - 9999	(0,20 ... 19,99) 0,01 (20,0 ... 99,9) 0,1 (100 ... 9999) 1	±5% + 5 digits

Fault current (calculated value)

Measuring range (A)	**Resolution (A)**	**Tolerance**
0,00 - 19,99	0,01	Consider tolerance of the 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 sine wave (10 ms ≤ tLOAD ≤ 15 ms)
Rated voltage range........................93 V - 134 V, 185 V - 266 V (45 Hz - 65 Hz)

Zloop L-PE RCD and Rs, Ipfc
The measuring range corresponds to EN61557 for 0.75 Ω - 1999 Ω

Measuring range (Ω)	**Resolution (Ω)**	**Tolerance*)**
0,4 - 19,99	(0,40 ... 19,99) 0,01	±5% +10 digits
20,0 - 9999	(20,0 ... 99,9) 0,1 (100 ... 9999) 1	±10%

*) The tolerance can be affected by strong noise in the mains voltage.

Predicted fault current (calculated value)

Measuring range (A)	**Resolution (A)**	**Tolerance**
0,00 - 19,99	0,01	Consider tolerance of the fault loop resistance measurement
20,0 - 99,9	0,1	
100 - 999	1	
1.00k - 9.99k	10	
10.0k - 100.0k	100	

Rated voltage range...........................93 V - 134 V, 185 V - 266 V (45 Hz - 65 Hz)

7.5 Line impedance and short circuit current

Line impedance
The measuring range corresponds to EN61557 for 0.25 Ω - 1999 Ω
ZLine, L-L, L-N, Ipsc

Measuring range (Ω)	**Resolution (Ω)**	**Tolerance**
0,2 - 9999	(0,20 ... 19,99) 0,01 (20,0 ... 99,9) 0,1 (100 ... 9999) 1	±5% +5 digits

Short circuit current (calculated value)

Measuring range (A)	**Resolution (A)**	**Tolerance**
0,00 - 19,99	0,01	Take into account the tolerance of the line resistance measurement
20,0 - 99,9	0,1	
100 - 999	1	
1k - 9.99k	10	
10.0k - 100.0k	100	

Test current (at 230 V) ....3.4 A, 50Hz sine wave (10 ms ≤ tLOAD ≤ 15 ms)

Rated voltage range.......................93V - 134V; 185V - 266V; 321V - 485V (45Hz - 65Hz)

Voltage drop

Measuring range (%)	**Resolution (%)**	**Tolerance**
0 - 9,9	0,1	Take into account the tolerance of the line resistance measurement

7.6 Phase sequence

Measurement according to EN61557-7
Nominal voltage range.........................50 VAC - 550 VAC
Nominal frequency range....................45 - 400 Hz
Displayed result...................................Right: 1-2-3; Left: 3-2-1

7.7 Voltage and frequency

Measuring range (V)	**Resolution (V)**	**Tolerance**
0 - 550	1	±2% +2 digits

Frequency range..0 Hz, 45 Hz - 400 Hz

Measuring range (Hz)	**Resolution (Hz)**	**Tolerance**
10 - 499	0,1	±0.2 % +1 digit

Nominal voltage range.................................10 V - 550 V

7.8 Earth resistance

Measurement according to EN61557-5 for 100 - 1999 Ω

Measuring range (Ω)	Resolution (Ω)	Tolerance
1,0 - 9999	(1,00 - 19,99) 0,01 (20,0 - 199,9) 0,1 (200,0 - 9999) 1	±5% +5 digits

Max. Auxiliary earth electrode resistance Rh............100 x RE or 50 kΩ (the lower value)
Max. Probe resistance Rs..100 x RE or 50 kΩ (the lower value)
The values for Rh and Rs are approximate.

Additional tolerance of the probe resistance at Rhmax or Rsmax.........±10 % +10 digits
Additional tolerance at 3 V voltage noise (50 Hz)..................................±5 % +10 digits

Open circuit voltage..< 30 VAC
Short circuit current...< 30 mA
Frequency of the test voltage...................................126.9 Hz
Form of the test voltage..Sine wave

Automatic measurement of the resistance of the auxiliary earth electrode and the probe resistance.

Ro - Specific earth resistance

Measuring range	Resolution (Ωm)	Tolerance
6.0 - 99.9 Ωm	0.1 Ωm	±5 % +5 digits
100 - 999 Ωm	1 Ωm	±5 % +5 digits
1.00 - 9.99 kΩm	0.01 kΩm	±10 % at 2 - 19.99 kΩ
10.0 - 99.9 kΩm	0.1 kΩm	±10 % at 2 - 19.99 kΩ
100 - 9999 kΩm	1 kΩm	±20 % at >20 kΩ

The values for Rh and Rs are approximate.

7.9 General data

Power supply voltage...9 VDC (61.5-V battery cells, size AA)
Power supply adapter..12 VDC / 1000 mA
Battery charging current.......................................< 600 mA
Voltage of charged batteries..................................9 VDC (61.5 V, in fully charged state)
Charging time...6 h
Operating time...15 h
Overvoltage category..CAT III / 600 V, CAT IV / 300 V
Protection class...double insulation
Pollution level...2
Protection class...IP 42
Display...480x320 TFT LCD
COM port...USB
Dimensions (W/H/D)..25x10,7x13,5 cm
Weight (without batteries)......................................1.3 kg
Reference temperature range...............................10 - 30 °C
Reference humidity range......................................40 % RH - 70 % RH
Operating temperature range.................................0 - 40 °C
Operating humidity..95 %
Storage temperature..-10 - 70 °C
Storage humidity..90 % RF (-10 - 40 °C)
80 % RH (40 - 60 °C)

The error under operating conditions must not exceed the error for reference conditions (specified in the manual for each function) + 1 % of the measured value + 1 digit, unless otherwise specified.

8 Saving measurements

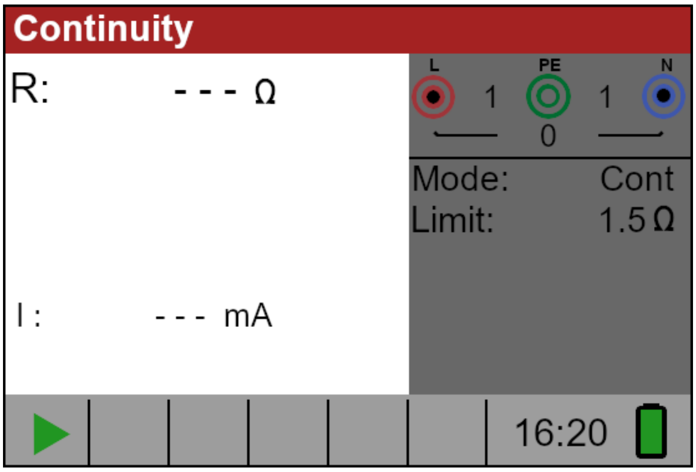
After completion of the measurement, the results can be stored in the internal memory of the unit together with the partial results and function parameters.

IDs must be created for saving and using the measurement data! IDs with the value "0" are automatically discarded. Before/when taking measurements, make sure that IDs are created!

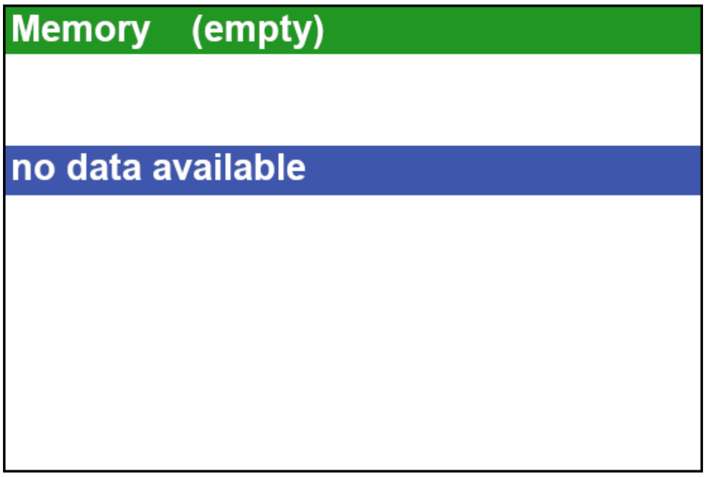
8.1 Overview

- The PIT 2.0 can store up to 1000 measurements
- The list of records can be worked through step by step
- A single record or all records can be deleted
- The IDs for customer, location and object can be edited

If no current measurement is being taken and the **MEM button is** pressed and no records are stored, an empty memory screen is displayed (Figure 8.2).



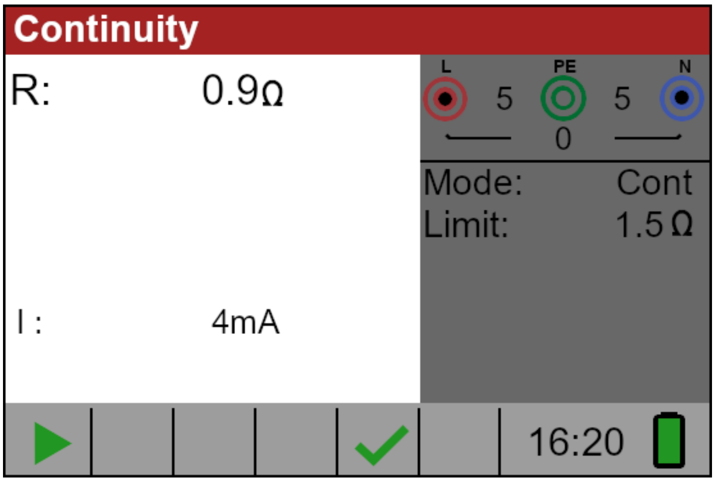
Picture 8.1: no result



Picture 8.2: empty memory

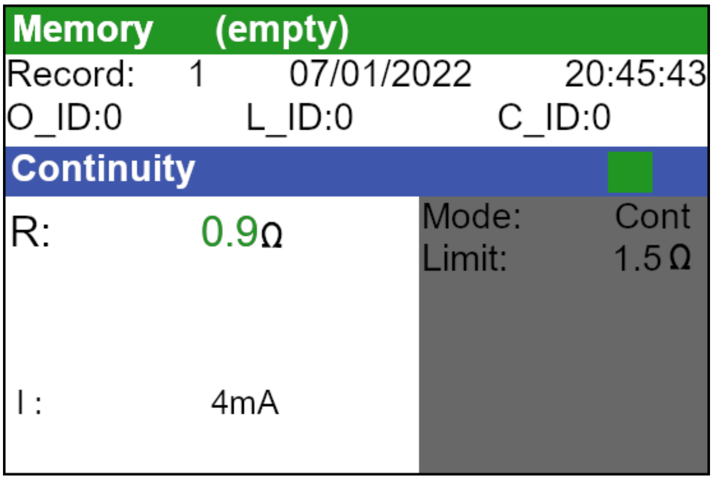
8.2 Saving results

Step 1:
When the measurement is complete (Figure 8.3), the results are displayed on the screen.



Picture 8.3: Last results

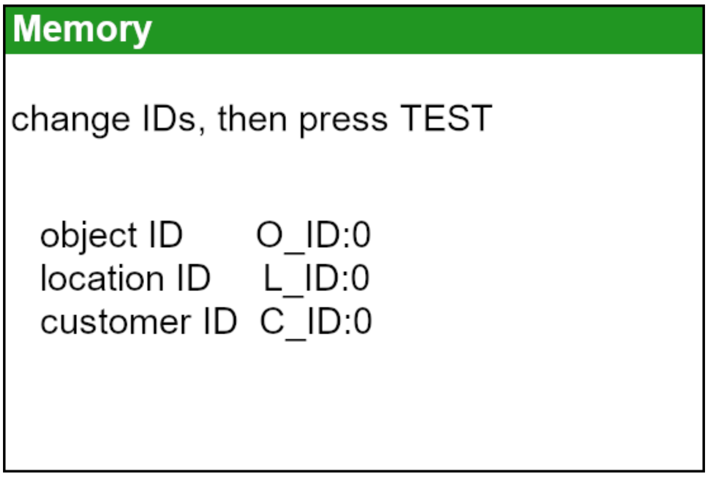
Step 2:
Press the **MEM** button. The following is now displayed (Figure 8.4):



Picture 8.4: Saving results

- Current storage space in red font
- Current date (day/month/year)
- Time (hour:minutes:seconds)
- Object ID (O_ID)
- Location ID (L_ID)
- Customer ID (C_ID)
- Measuring function
- Results of the measurement
- Measuring mode
- Measurement limit / limit value

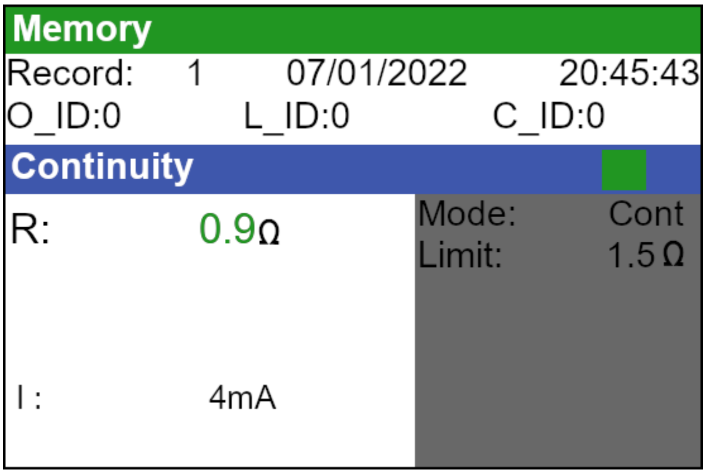
Step 3:
To change the client ID, location ID or object ID, press the **LEFT** button. The following screen is displayed (Figure 8.5):



Picture 8.5: ID editor

Use the navigation keys to select the ID type and change the value of the ID.
Press the **Exit/Back/Return** button to return to the recording screen without changing IDs. Press **TEST** to save the IDs in the current record. These IDs will also be used for the following new records.

Step 4:
To save the result of the last measurement, press the **TEST** button. The following is displayed (Figure 8.6)



Picture 8.6: Saved results

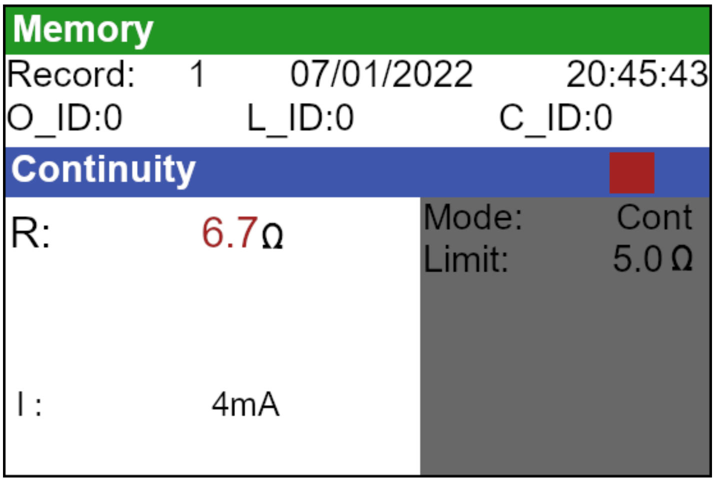
The record number changes from red to black. This means that this result is stored in memory as record 2.

Each individual result can be displayed in coloured letters:

- Green: measured and passed
- Red: measured but not passed
- Black: measured but not assessed

In addition, the blue function bar receives a coloured field that displays the overall result of the measurement:

- Green: measured and passed
- Red: measured but not passed
- Brown: measured but not evaluated



Picture 8.7: Failed result

To cancel saving the record, press **MEM** or the **Exit/Back/Return** button instead of **TEST and the** last measurement screen will be displayed.

Step 4:
Press the **MEM** or **Exit/Back/Return button** to return to the last measurement screen, or the navigation buttons to display a record from the list.

8.3 Call results

Step 1:
To access the memory screen, press the **MEM** button. If no measurement has been taken, a screen like the one in figure 8.8 is displayed. Then press the **UP** and **DOWN** navigation keys to access the record list.

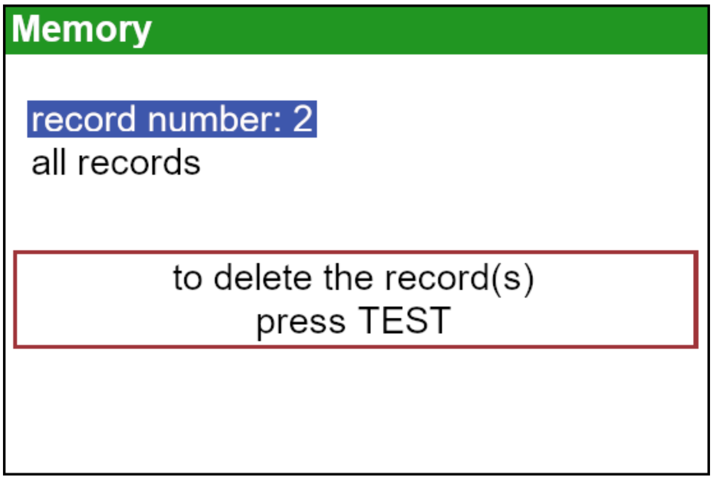
Step 2:
Press the **UP** and **DOWN** navigation keys to scroll through the records.

It is possible to change the IDs of an existing record. Press the **LEFT** navigation key to call up the ID editor, change the IDs and save them. These IDs will no longer be used for the following new records.

8.4 Deleting results

Step 1:
To call up the memory screen, press the **MEM** key. If no measurement has been taken, the last record is displayed directly. If a measurement has been taken, a screen like the one in figure 8.4 is displayed. Then press the **UP** or **DOWN** navigation key to call up the data set list.

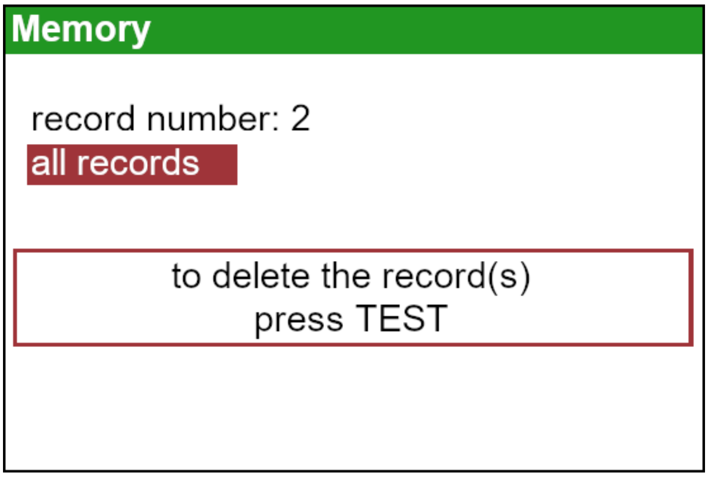
Step 2:
Press the **UP** or **DOWN** navigation key to find the record you want to delete.
Step 3:
Press the **RIGHT** navigation button, the following screen is displayed (Figure 8.8).



Picture 8.8: Failed result

Step 4:
Press the **TEST** key to delete the selected record and return to the record list, or

Step 5:
Press the **DOWN** navigation key to select all records (Figure 8.9)



Picture 8.9: Delete screen

Then press the **TEST** button to clear all records and return to the measurement screen.

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

When all records are deleted, all memory is released and all IDs and numbers are reset.

9 USB communication

The stored results can be sent to the PC for further activity such as creating a simple report and/or further analysis in an Excel spreadsheet. The PIT 2.0 is connected to the PC via a USB connection.

9.1 PC software

The download of the stored data sets of the PIT 2.0 to the PC is done with the PC application. The records are saved on the PC in the form of a *. csv file. The records can also be exported to an Excel spreadsheet (*.xlsx) for quick reporting and further analysis if required.

The PC software runs on Windows platforms. To install the software and the required USB drivers, the installation package (setup.exe) must be started.

9.2 Downloading records to PC

Step 1:
Disconnect all connection cables and test objects from the unit.

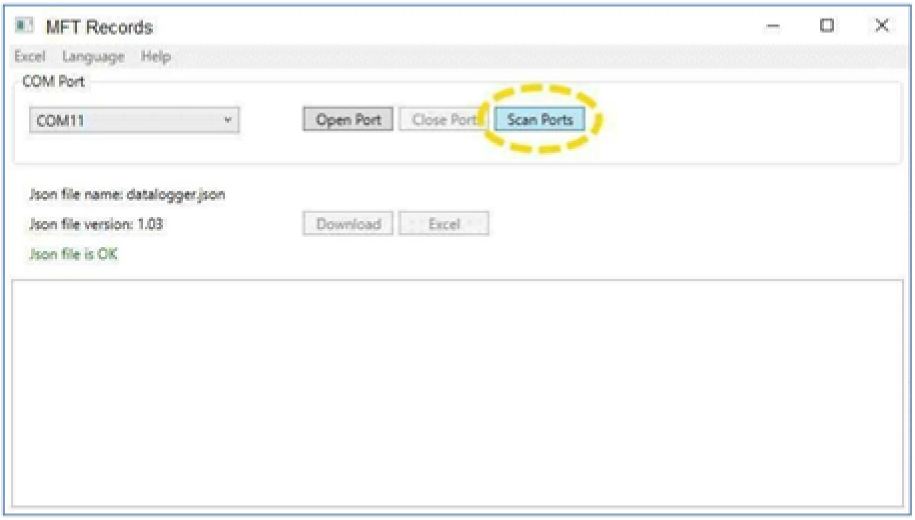
Step 2:
Connect the PIT 2.0 to your PC at the USB Port (Fig. 9.1) using the USB cable.

Picture 9.1: The USB port on the top of the unit

The USB driver is automatically installed on a free COM port and a confirmation follows that the new hardware can be used. The specified COM port number can be viewed via the device manager of your system.

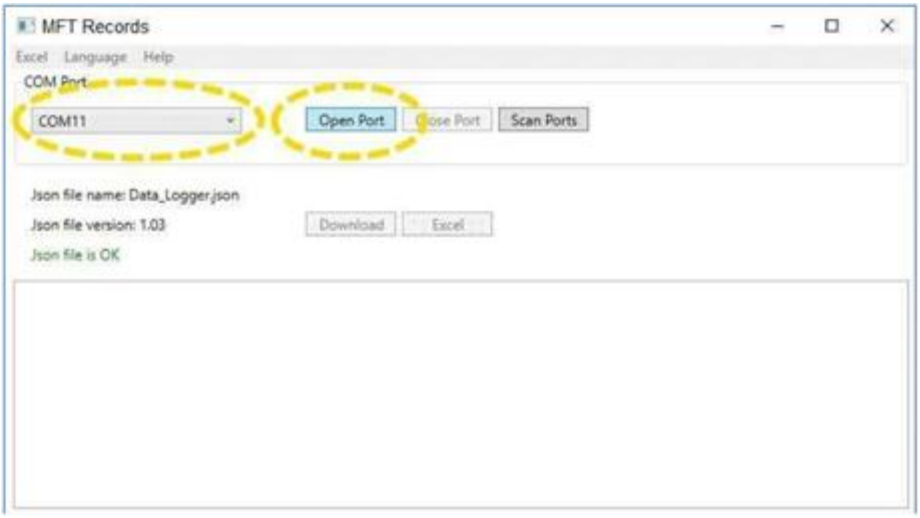
Step 3:
Start the programme by double-clicking on the desktop shortcut icon.

Step 4:
Click on "**Scan Ports**" (Picture 9.2).



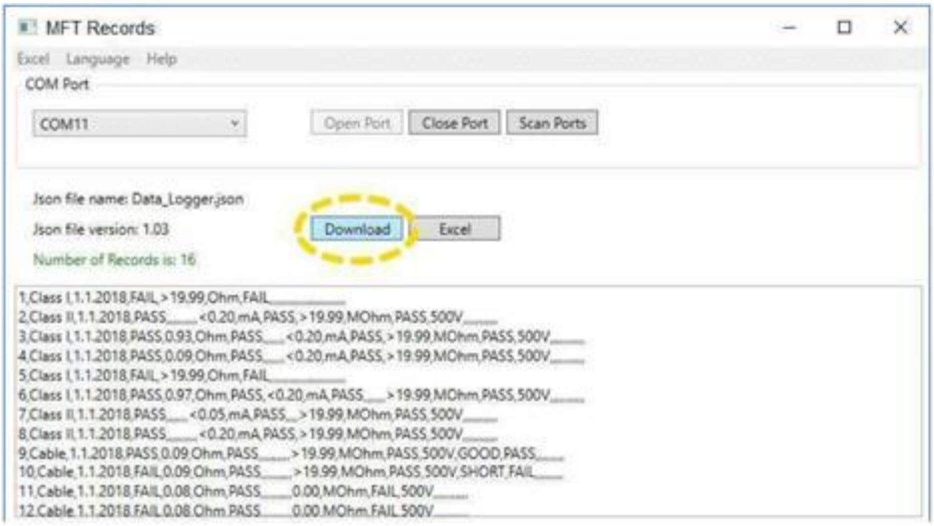
Picture 9.2: Scan ports

Step 5:
Select the corresponding connection and click on "**Open connection**" (Figure 9.3).



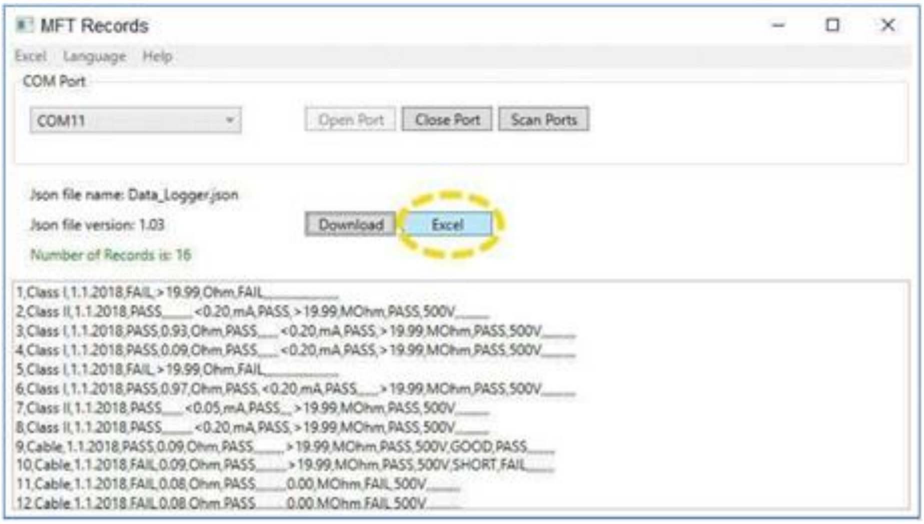
Picture 9.3: opening of the connection

Step 6:
Click on "**Download**" to start the data transfer (Figure 9.4). When the records are downloaded, a *.csv file is automatically created.



Picture 9.4: Downloading data

Step 7:
Click on the "**Excel**" button to export all data sets to an Excel file (Figure 9.5). The exported files are saved by default under "Documents".



Picture 9.5: Creating an Excel file

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CE The CE mark on your appliance confirms that this appliance meets the EU (European Union) requirements for safety and electromagnetic compatibility.