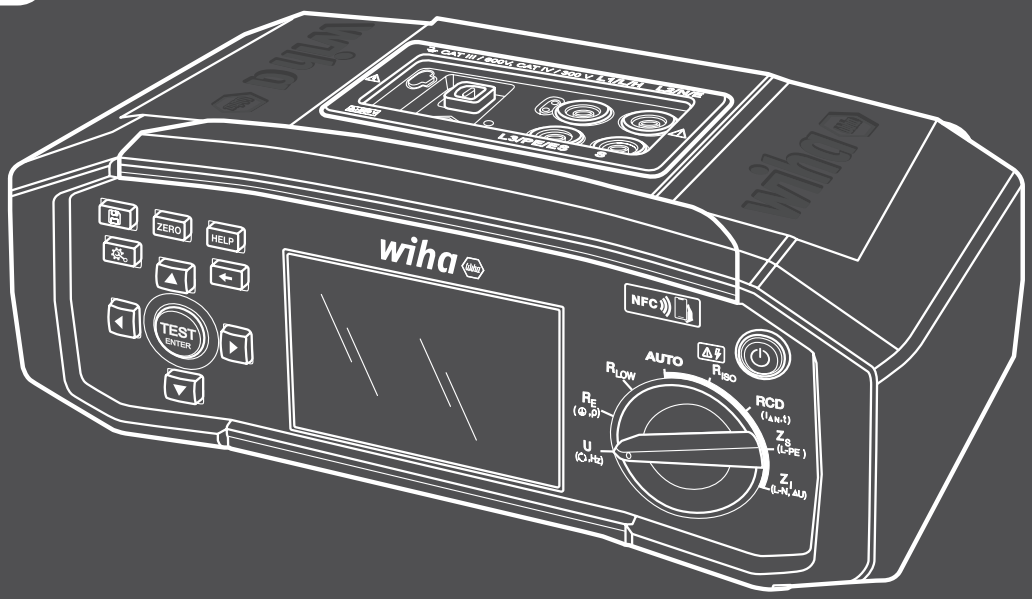
wiha
Tools that work for you

USER MANUAL
Wiha MFT one

Fig. 1: Product	Order No. EU	Order No. UK
Fig. 2: Hard-Case	47216	47217
Fig. 3: Soft-Case/Bag	47218	47219



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About these instructions

These instructions enable safe and efficient use of the MFT one installation tester. Keep these instructions for future reference! Read these instructions before starting any work. Compliance with all safety notes and operating instructions in these instructions is a prerequisite for safe working. Observe local accident prevention regulations and general safety regulations for the area of use of the installation tester.

Accompanying documents

The device has been built and tested according to the following safety regulations:

List of applicable standards, regulations	
DIN EN 60529 IEC 60529	Test equipment and test methods Protection classes due to housing (IP code)
DIN EN IEC 61326-1	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements
DIN EN IEC 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1: General requirements
DIN EN IEC 61010-031	Safety requirements for electrical equipment for measurement, control, and laboratory use Part 031: Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and measurement

List of applicable standards, regulations	
DIN EN IEC 61557-1	Electrical safety in low voltage distribution systems up to 1000 V AC and 1500 V DC – Equipment for testing, measuring or monitoring of protective measures Part 1: General requirements
IEC 62955	Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles

Delivery contents

- MFT one installation tester
- 3 × 1-m measuring lines
- Measuring cable with Schuko plug
- Power supply unit
- 3 × crocodile clips
- 6 × 1.5 V batteries
- 3 × probes
- Measuring line with test button to trigger a measurement
- Operating instructions
- Quick Start Guide

Short description

The MFT one installation tester measures all electrical safety parameters of building facilities. The following measurements and tests can be carried out:

- Insulation measurement
- Continuity test and low impedance measurement
- RCD test (residual current circuit breaker)
- Loop impedance
- Line impedance
- Voltage and frequency measurement
- Phase sequence
- Earthing resistance
- Specific earth resistance
- Auto test

Display and controls

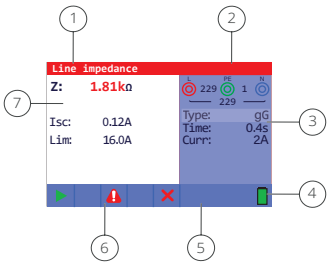

Fig. 21: Display

1. Measurement mode
2. Voltage indicator
3. Option box
4. Battery level indicator
5. Current time
6. Status field
7. Result field

Voltage indicator

The voltages applied to the MFT one installation tester are displayed. The device automatically recognises which voltage is applied to which measuring sockets and displays this in the display. All relevant measuring sockets are used for the respective measurement. The device shows a black dot in the respective measuring socket on the display to indicate which measuring sockets must be connected to the system to be tested with the help of the measuring lines.

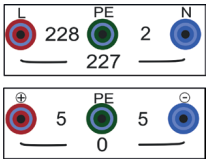

Fig. 22: Input monitoring

Connections

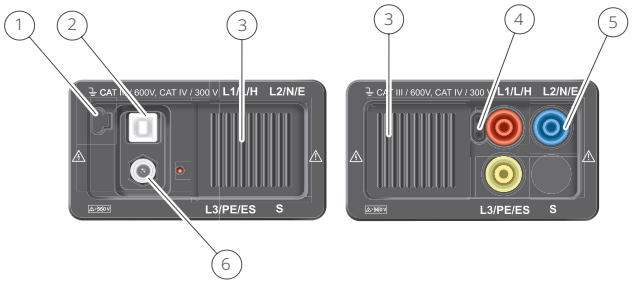

Fig. 23: Connections

1. USB-C port for manufacturer's calibration
2. USB-B port for manufacturer's calibration
3. Sliding protective cover over USB port
4. Socket for probe with test push button
5. Measuring connection sockets
6. Mains connection socket

Controls

Button	Description	Function
	Save	Save measurement or setting
ZERO	Line compensation	Compensates the measuring resistivity for low impedance measurements
HELP	Help	Open the help function
	Settings	Open **Settings** menu
	ESC/Back	Exit the menu and return to the previous menu
	Up	Scroll up
	Down	Scroll down
	Left	Decrease value/one level back
	Right	Increase value/one level forward
TEST	TEST/ENTER	Start measurement/open submenu/confirm input
	ON/OFF	Press briefly: switch on the device Press and hold: switch off the device The device switches off automatically after the last operation when no more voltage is applied. You can change the switch-off time in the **Settings** menu.

Symbols in these instructions

WARNING!
This combination of symbol and signal word indicates a potentially dangerous situation that could result in death or serious injury if not avoided.

CAUTION!
This symbol indicates dangerous voltage and the risk of electric shock.

ENVIRONMENTAL PROTECTION!
This symbol indicates potential hazards to the environment.

INFO!
This symbol highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

Symbols on your device

Rear of the device (type plate)

Warning of a hazardous area. Follow the operating instructions.

Caution! Dangerous voltage, risk of electric shock.

Continuous double or reinforced insulation according to category II DIN EN 61140.

The device complies with European regulations.

Do not dispose of the device and accessories as household waste (see chapter “Disposal” on page 62).

Display

Battery is not sufficiently charged

Battery is sufficiently charged

Dangerous voltage

COMP Measuring lines are compensated

Unable to start measurement

Dangerous voltage at the earthing point

Result not OK

Result OK

RCD open or tripped

RCD closed

Measurement can start

Temperature too high

Replace measuring lines

Service

Signal noise

Check fuses

Audible warnings

Sound	Description
Short, high pitched tone	Button pressed
Bright, ringing tone	Device charging
Continuous tone	During the continuity test: Result < 35 Ω
Ascending sound	Dangerous voltage
Short tone	Switch off, end of measurement
Descending sound	Warnings (temperature, voltage and input, start not possible)
Periodic tone	Phase voltage at the PE terminal. Immediately interrupt all measurements.

Intended use

The MFT one installation tester is a multifunctional, portable installation tester for all measurements for standard-compliant testing of the electrical safety of systems and buildings. The installation tester is designed for the following measurement types:

- Insulation measurement
- Continuity test and low impedance measurement
- RCD test (residual current circuit breaker)
- Loop impedance
- Line impedance
- Voltage and frequency measurement
- Phase sequence
- Earthing resistance
- Specific earth resistance
- Auto test

Any use of the device that is not described in these operating instructions is considered to be improper. The function of the device must be adapted to the individual requirements of the site during commissioning.
Only operate the device within the characteristics specified in the technical specifications (“TECHNICAL SPECIFICATIONS” on page 63). Any use beyond or other than the intended purpose shall be considered misuse.

Danger of misuse!
Misuse of the device can lead to dangerous situations.

- Do not operate the device in potentially explosive atmospheres.
- Only operate the device in accordance with the technical specifications, the limits of use, the contractually agreed specifications and the delivery conditions with the supplied accessories.
- Do not make unauthorised changes, manipulations or conversions.
- Never use the device for purposes other than checking the electrical safety of systems and buildings.

Claims of any kind due to misuse are excluded.

Requirements for the user

Users must be electrically skilled persons or qualified persons who are appropriately trained and who are familiar with the hazards associated with the process and how to avoid these when operating the device.

Only persons who can be expected to perform their work reliably are permitted as users. Persons whose responsiveness is affected, e.g. by drugs, alcohol or medication, are not permitted.

Thanks to their training, knowledge and experience, as well as
knowledge of the relevant standards and regulations, users are able to carry out work with the device in a professional and safe manner. Users are also able to independently identify and avoid hazards associated with this work.

Residual risks

The device complies with the state of the art and current safety requirements. Nevertheless, residual risks remain that require prudent action.

Observe all safety notes, instructions, illustrations and technical specifications provided with this device. Failure to comply with the following instructions may result in electric shock, fire and/or serious injury. Keep all safety notes and instructions for future reference.

Danger to life due to electrical voltage!
In the event of contact with live parts, there is an immediate danger of death by electric shock.

- If the insulation is damaged, de-energise the device immediately and do not continue to use the defective device.
- Do not repair the device yourself, contact customer service instead (see “Service and warranty” on page 62).
- Keep the device away from moisture and dampness to avoid short-circuiting.
- Do not touch the test object during or immediately after the measurement.
- Before starting the measurement, make sure that the test object is de-energised.

Risk of injury if batteries are handled incorrectly!
If handled incorrectly, batteries may explode or harmful fluid may leak. If batteries come into contact with this fluid, there is a risk of injury and death.

- Do not short-circuit the “+” and “-” battery contacts.
- Do not expose the battery to liquids or moisture.
- If the device is not used for a long time, remove all batteries from the battery compartment.
- Do not change the shape of the battery, do not open or disassemble the battery.
- Keep the battery away from hot surroundings.
- If your skin comes into contact with leaked fluid, wash the affected area thoroughly with water.
- In the event of eye contact with leaked liquid, rinse the eye with clear water and contact a doctor.
- If you swallow leaked liquid, rinse your mouth, drink plenty of water and contact a doctor. Do not induce vomiting.
- Rechargeable Ni-MH batteries (size AA) can be used in the device. Do not charge alkaline batteries!

Risk of accident due to the use of an incorrect fuse!
If an incorrect fuse is used, there is a risk of fire and a risk that safety devices will fail due to overloading.

- Always replace defective fuses with new fuses of the same type.

Danger to life due to magnetic fields!
When operating the installation tester, the magnetic cable holders generate magnetic fields that can interfere with the function of pacemakers and other metallic implants.

- Avoid operating the device and staying in the immediate vicinity if you are wearing a pacemaker or a metallic implant.
- Make sure that no affected persons are in the danger area before using the device.
- Avoid using the holding magnets in magnetically sensitive areas, such as in rooms with magnetic resonance tomographs or other medical equipment that may be disturbed by magnetic fields or attract metallic objects.

Danger of malfunctions due to electromagnetic fields when using NFC!
Electromagnetic fields in the environment can interfere with NFC communication and lead to erroneous measurement results.

- Only use the NFC function in a trouble-free environment.
- Do not operate the device near strong electromagnetic fields.

Risk of malfunctions due to outdated batteries!
An outdated battery can impair the device function or lead to unexpected failures.

- Check the battery regularly and replace it at least every five years.

Carrying out measurements

Measurement functions

With the rotary switch (5) you can select the following measurements:

- Insulation resistance R_{ISO}
- Continuity test and low impedance measurement (R_{Low})
- RCD (touch voltage Ub, tripping time, tripping current, RCD auto test)
- Loop impedance (Z_s)
- Line impedance (Z_L)
- Voltage, rotating field direction, frequency (U)
- Earthing resistance (R_E) / specific earth resistance (R_O)
- Auto test (AUTO)

The name of the selected function is highlighted on the display.

Selecting the measurement function

You can use the buttons to select a parameter or limit value. You can use the buttons to set the limit value for the selected parameter. The settings remain valid until changes are made again.

Carrying out measurements

If the display shows ▶, you can start a measurement by pressing the button. The measurement is considered passed if the set limit value is not exceeded. In this case, the result value and the status ✓ are displayed. If the limit value is exceeded, the measurement is considered to have failed. Then the result value and status ✗ are displayed.

Measurement settings

Parameter	Description
Mode	Defines the measurement mode
Threshold	Defines the limit
Distance	Earthing resistance R_O: Defines the distance “a” between test probes
Type	Defines the RCD type
Time	Limit value for tripping depending on the characteristics of the overcurrent protection device
Curr	Rated current of the overcurrent protection device
F I_{sc}	Scaling factor
$I_{\Delta n}$	Defines the rated differential current
Factor	Rated differential current
Pol.	Defines the initial polarity of the test current
Volt.	Defines the nominal test voltage
Freq	Frequency
Rotating field	Rotating field

Settings menu

1. Press  to open the **Settings** menu.
2. Use  to select the desired submenu.
3. Press  to open the submenu.
4. Use  to change the value.

Submenu	Value	Description
Date/time	Year	Setting the date and time
	Month	
	Day	
	Hour	
	Minute	
ISC factor		Defines a factor for scaling the expected residual current/short-circuit current
RCD limit	EN 61008/EN 61009	Select the national limit value for RCD test
	EN 60364-4-41 TN/IT	
	BS 7671	
	AZ NZS 3017	
	EN 60364-4-41 TT	

Submenu	Value	Description
Auto test limits	Z_I	Select limit values for the auto test
	Z_S	
	MCB type	
	MCB time	
	MCB current	
	RCD I	
	RCD t	
	RCD type	
	RCD $I_{\Delta N}$	
	Riso	
	Riso volt.	
Max. touch voltage	50 V_{AC} / 120 V_{DC}	Select the upper limit for maximum touch voltage
	25 V_{AC} / 60 V_{DC}	
Switch-off time	Do not switch off	Defines the time period until the device is automatically switched off
	30 s	
	1 min	
	5 min	
	10 min	
	30 min	
	1 h	

Submenu	Value	Description
Continuity check timeout	No timeout	Defines the permissible timeout until the measurement mode is automatically switched off
	30 s	
	1 min	
	5 min	
	10 min	
	30 min	
	1 h	
Insulation resistance test timeout	No timeout	Defines the permissible timeout until the measurement mode is automatically switched off
	30 s	
	1 min	
	5 min	
	10 min	
	30 min	
	1 h	
Network configuration	TN (TT)	Select the network configuration
	IT	
	Simplified low voltage (2 × 55 V)	
Device information		Display available device information: Serial number, firmware, next calibration

Submenu	Value	Description
Language	English	Changes the display language of the device
	German	
	Dutch	
	French	
	Spanish	
	Italian	
	Portuguese	
Sound	Alarm and error messages	Specifies when to generate an audible warning signal
	Alarms only	
	All	
Backlight		Changes the brightness of the display

Get help

The help provides graphical support when using the device in different measurement scenarios.

1. Press HELP to access the help.
2. Press ▭ to go to the previous help view.
3. Press ▭ to go to the next help view.
4. Press HELP or ← to close the help.

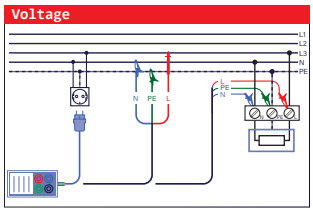

Fig. 24: Example of Help display

Insulation resistance measurement

Insulation resistance measurement is performed to ensure safety against electric shock. With this measurement, the following values can be determined:

- Insulation resistance between installation conductors
- Insulation resistance of non-conductive spaces (walls and floors)
- Insulation resistance of earthing cables
- Resistance of semiconducting (antistatic) floors

Measuring the insulation resistance

Danger of electric shock!

- Never touch the test object during measurement and before full discharge.
- Before measuring the insulation resistance, make sure that the test object is de-energised.
- Before measuring the insulation resistance between conductors, ensure that all consumers are disconnected and all switching contacts are closed.

Damage to the device due to impermissible voltage!

Measurements outside the permissible voltage range lead to damage to the device and accessories.

- Observe the maximum permissible external voltage of 550 V (AC or DC) when connecting the test terminals.

The measurement results are adversely affected by excessive moisture formation on the device. If necessary, allow the device and all accessories to dry completely over a period of at least 24 hours.

1. Use the rotary switch to select $\mathbf{R_{ISO}}$.
2. Set the following measurement parameters and limits:
   - Volt: Test voltage
   - Limit: Lower limit value for the insulation resistance
3. Make sure that the test object is de-energised.
4. Connect the measuring lines to the device.
5. Connect the measuring lines to the test object.
6. Check in the status field whether warning messages are displayed.
7. If ▶ appears, press ◯. The test is being carried out. The test result is displayed.

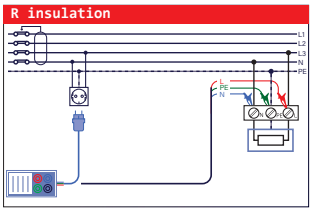

Fig. 25: Connection diagram for insulation resistance (R_{ISO})

Result	Description
✓	Result OK
✗	Result not OK
R	Insulation resistance
Um	Test voltage on the test object

Continuity test

Two test functions are available here:

- Low impedance measurement (approx. 240 mA) with automatic polarity reversal
- Low current continuity test (approx. 4 mA, optional), especially for measurements in inductive systems

Low impedance measurement

This function makes it possible to measure the resistance and thus the conductivity between two points in a system. The measurement can be used to ensure that all protective, earthing and equipotential bonding conductors are correctly connected and have the correct resistance value.

Low impedance measurements are carried out with a test current of at least 200 mA. During the measurement, an automatic pole reversal of the test voltage and the test current takes place. The measurement allows conclusions to be drawn about a possible rectifying effect of components (e.g. diodes, transistors, SCRs) in a circuit that could lead to problems when applying a voltage.

Carrying out a low impedance measurement

Danger of electric shock!
Parallel resistors and transient currents can negatively affect the test results.

- Before carrying out a measurement, ensure that the test object is de-energised.

From a voltage of 10 V (AC or DC) between the test terminals, no measurement can be triggered.

1. Use the rotary switch to select **R_{low}**.
2. Select **Low** mode.
3. Use **Limit** to set a limit for the resistance.
4. Connect the measuring lines to the device.
5. Short-circuit the measuring lines.
6. Press ZERO to start measuring resistivity compensation. After successful compensation, **zero** is displayed in the status field.
7. Press ZERO again to exit the function. After exiting the function, **zero** disappears from the status field.
8. Make sure that the test object is de-energised.
9. Connect the measuring lines to the test object.
10. Check in the status field whether warning messages are displayed.
11. If ▶ appears, press ◎. The test is being carried out. The test result is displayed.

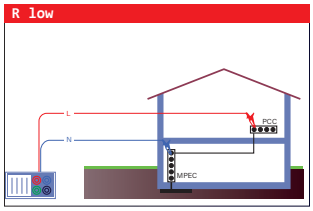

Fig. 26: Connection diagram for low impedance measurement (R_{LOW}) – LOW

Result	Description
✓	Result OK
✗	Result not OK
R	Result of the low impedance measurement (average value R+/R-)
R+	Partial result of low resistance measurement with positive voltage on L
R-	Partial result of low impedance measurement with negative voltage on N

Continuity test

Low impedance continuity tests can be carried out without pole reversal of the test voltages and with very low test current. The device only measures the resistance Ω at low test current. The function can also be used to test inductive components such as motors and spiral cables.

Checking continuity

Danger of electric shock!
Parallel resistances and transient currents can negatively affect the measurement results.

- Before carrying out a measurement, ensure that the test object is de-energised.

From a voltage of 10 V (AC or DC) between the test terminals, no measurement can be triggered.

1. Use the rotary switch to select **R_{low}**.
2. Select **Cont** mode.
3. Use **Limit** to set a limit for the resistance.
4. Connect the measuring lines to the device.
5. Make sure that the test object is de-energised.
6. Connect the measuring lines to the test object.
7. Check in the status field whether warning messages are displayed.
8. If ▶ appears, press ◎.
9. Press ◎ to end the measurement. The test result is displayed.

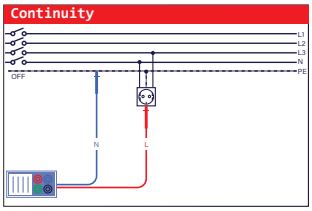

Fig. 27: Connection diagram for continuity test (R_{LOW}) – continuity

Result	Description
✔	Result OK
✖	Result not OK
R	Result of the low current continuity test
I	Test current

RCD test

Subfunctions of the RCD test:

- Measuring the touch voltage
- Measuring the tripping time
- Measuring the tripping current
- Automatic RCD check

Touch voltage

Leakage currents in the direction of the PE connection are referred to as touch voltage (U_b). Touch voltage causes voltage drops at the earthing resistance and is applied to all accessible components connected to the PE terminal. The touch voltage should be lower than the safety limit voltage. The touch voltage is measured without triggering the RCD. RL denotes the fault loop resistance and is calculated as follows:

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

Measuring the touch voltage

Adjustment values are generally accepted for all RCD functions!
When measuring the touch voltage, the RCD usually does not trip. However, due to the leakage currents flowing to the PE protective conductor or via the capacitive connection between the L and PE conductors, the measurement voltage may be above the tripping limit of the RCD.

When using the RCD trip lock sub-function (rotary switch in position **RCD**), the total duration for determining the fault loop resistance is extended, but you get a more precise measurement result compared to the **touch voltage** function.

1. Use the rotary switch to select **RCD**.
2. Select **U_b** mode.
3. Select **$I_{\Delta N}$** and set a value for the rated differential current.
4. Use Type to specify the RCD type.
5. Use **Limit** to set a limit for the touch voltage.
6. Connect the measuring lines to the device.
7. Connect the measuring lines to the test object.
8. Check in the status field whether warning messages are displayed.
9. If ▶ appears, press ⏺. The test is being carried out. The test result is displayed.

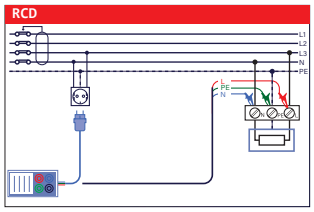

Fig. 28: Circuit diagram for touch voltage (RCD – U_b)

Result	Description
✓	Result OK
✗	Result not OK
U_b	Touch voltage
Rl	Fault loop impedance
Threshold	Limit for fault loop impedance

Tripping time

The effectiveness of an RCD is checked by measuring the tripping time. A typical fault state is simulated here.

Measuring the tripping time

Adjustment values are generally accepted for all RCD functions!
The tripping time of RCDs is only measured if the touch voltage at the rated differential current is below the limit value set for the touch voltage. When measuring the touch voltage, the RCD usually does not trip. However, due to the leakage currents flowing to the PE protective conductor or via the capacitive connection between the L and PE conductors, the measurement voltage may be above the tripping limit of the RCD.

1. Use the rotary switch to select **RCD**.
2. Select **time** mode.
3. Select **$I_{\Delta N}$** and set a value for the rated differential current.
4. Select **Factor** and set the multiplier for the rated differential current.
5. Use **Type** to specify the RCD type.
6. Select **Pol.** and set the initial polarity of the test current.
7. Connect the measuring lines to the device.
8. Connect the measuring lines to the test object.
9. Check in the status field whether warning messages are displayed.
10. If ▶ appears, press ⏺. The test is being carried out. The test result is displayed.

Result	Description
✓	Result OK
✗	Result not OK
t	Tripping time
U_b	Touch voltage

Tripping current

During this measurement, the current required to trip the RCD is determined. After the start of the measurement, the test current generated by the device is continuously increased, starting at 0.2 $I_{\Delta N}$ to 1.1 $I_{\Delta N}$ (to 1.5 $I_{\Delta N}$ / 2.2 $I_{\Delta N}$, $I_{\Delta N}$ =10 mA for pulsed DC fault currents), until the RCD trips.

Measuring the tripping current

Adjustment values are generally accepted for all RCD functions!
The tripping time of RCDs is only measured if the touch voltage at the rated differential current is below the limit value set for the touch voltage.
When measuring the touch voltage, the RCD usually does not trip. However, due to the leakage currents flowing to the PE protective conductor or via the capacitive connection between the L and PE conductors, the measurement voltage may be above the tripping limit of the RCD.

1. Use the rotary switch to select **RCD**.
2. Select **current** mode.
3. Select **$I_{\Delta N}$** and set a value for the rated differential current.
4. Use **Type** to specify the RCD type.
5. Select **Pol.** and set the initial polarity of the test current.
6. Connect the measuring lines to the device.
7. Connect the measuring lines to the test object.
8. Check in the status field whether warning messages are displayed.
9. If ▶ appears, press . The test is being carried out. The test result is displayed.

Result	Description
✓	Result OK
✗	Result not OK
I	Tripping current
U_b	Touch voltage
t	Tripping time

Automatic RCD check

The auto test checks the most important parameters for RCDs: Touch voltage, tripping current and tripping time at different fault currents. If a measurement result deviates from the limit value, the auto test is interrupted and the need for additional measurements is indicated.

Carrying out an RCD auto test

Danger of electric shock!
Leakage currents that occur in the circuit after the RCD can negatively affect the measurement result.
Other devices that are integrated in the circuit downstream of the RCD to be measured may significantly extend the test duration. These include, for example, capacitors or running motors.

- Observe in particular special requirements with regard to the relevant RCD protective device (e.g. type S, selective and surge current resistant).

During the previous measurement of the touch voltage, the RCD usually does not trip. However, due to the leakage currents flowing to the PE protective conductor or via the capacitive connection between the L and PE conductors, the measurement voltage may be above the tripping limit of the RCD. The auto test is stopped if the tripping time is outside the allowed period. In the case of type B RCDs, at a nominal differential current $I_{\Delta N}$ = 1000 mA, the auto test is automatically skipped one time.

The auto test is automatically skipped five times in the following cases:

- RCD type AC with rated leakage current $I_{\Delta N}$ = 1000 mA
- RCD type A and B with rated leakage current $I_{\Delta N}$ ≥ 300 mA

In both cases, the auto test is considered passed if t_1 to t_4 were evaluated as passed. t_5 and t_6 are hidden on the display, see table “Result of tripping time step 1, t3 (IΔN, 0°)” on page 51.

1. Use the rotary switch to select **RCD.**
2. Select **AUTO** mode.
3. Select **$I_{\Delta N}$** and set a value for the rated differential current.
4. Use **Type** to specify the RCD type.
5. Connect the measuring lines to the device.
6. Connect the measuring lines to the test object.

7. Check in the status field whether warning messages are displayed.
8. If ▶ appears, press ◯. The auto test starts.

Auto test

1. Measurement of the tripping time based on the following parameters:
   - Test current $I_{\Delta N}$
   - Initial test current with positive half-wave at 0°

   RCD usually trips within the permissible period. After the RCD is reset, the auto test automatically continues with step 2.

2. Measurement of the tripping time based on the following parameters:
   - Test current $I_{\Delta N}$
   - Initial test current with negative half-wave at 180°

   RCD usually trips within the permissible period. After the RCD is reset, the auto test automatically continues with step 3.

3. Measurement of the tripping time based on the following parameters:
   - Test current 5 × $I_{\Delta N}$
   - Initial test current with negative half-wave at 0°

   RCD usually trips within the permissible period. After the RCD is reset, the auto test automatically continues with step 4.

4. Measurement of the tripping time based on the following parameters:
   - Test current 5 × $I_{\Delta N}$
   - Initial test current with negative half-wave at 180°

   RCD usually trips within the permissible period. After the RCD is reset, the auto test automatically continues with step 5.

5. Measurement of the tripping time based on the following parameters:
   - Test current ½ × $I_{\Delta N}$
   - Initial test current with negative half-wave at 0°

   The auto test automatically continues with step 6.

6. Measurement of the tripping time based on the following parameters:
   - Test current ½ × $I_{\Delta N}$
   - Initial test current with negative half-wave at 180°

   The auto test automatically continues with step 7.

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

   During this measurement, the current required to trip the RCD is determined. After triggering the measurement, the test current generated by the device is continuously increased until the RCD triggers. After the RCD is reset, the auto test automatically continues with step 8.

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

   During this measurement, the current required to trip the RCD is determined. After triggering the measurement, the test current generated by the device is continuously increased until the RCD triggers. The measurement results are displayed.

Result	Description
✔	Result OK
✖	Result not OK
× 1 (left)	Result of tripping time step 1, t_3 ($I_{\Delta N}$, 0°)
× 1 (right)	Result of tripping time step 2, t_4 ($I_{\Delta N}$, 180°)
× 5 (left)	Result of tripping time step 3, t_5 (5 × $I_{\Delta N}$, 0°)
× 5 (right)	Result of tripping time step 4, t_6 (5 × $I_{\Delta N}$, 180°)
× ½ (left)	Result of tripping time step 5, t_1 (½ × $I_{\Delta N}$, 0°)
× ½ (right)	Result of tripping time step 6, t_2 (½ × $I_{\Delta N}$, 180°)
I_Δ (+)	Tripping current (+) step 7, positive polarity
I_Δ (-)	Tripping current (-) step 8, negative polarity
U_b	Calculated touch voltage $I_{\Delta N}$

Loop impedance

Fault loop impedance and expected short-circuit current

Loop impedance measurement options:

- Loop impedance option
  Fast measurement of fault loop impedance in systems without RCD
- Loop impedance option with RCD type A, 30 mA, trip inhibit (no trip)
  Measurement of fault loop impedance in systems with RCD
- Loop impedance option with different RCD type and trip inhibit (no trip)
  Measurement of fault loop impedance in systems with RCD

Z_s (L-PE, mode: no RCD), I_k (with RCD tripping)

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to EN 61557-3: 0.25 Ω – 1999 Ω		
0.2 – 9999	(0.20 – 19.99) 0.01 (20 – 99.9) 0.1 (100 – 9999) 1	± (5% of M. + 5 digit)

Measuring range (A)	Resolution (A)	Accuracy
Expected short-circuit current (calculated value)		
0.00 – 19.99	0.01	Observe the accuracy of the fault loop impedance measurement
20.00 – 99.9	0.1	
100 – 999	1	
1.00 k – 9.99 k	10	
10.0 k – 100 k	100	

Specification	Value
Test current (at 230 V)	3.4 A, 50Hz sine wave (10 ms ≤ t_{LOAD} ≤ 15 ms)
Rated voltage range	93 V – 134 V; 185 V – 266 V (45 Hz – 65 Hz)

Z_s (L-PE, mode: std.RCD & alt.RCD), I_k (without RCD tripping)

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to EN 61557-3: 0.75 Ω – 1999 Ω		
0.4 – 19.99	(0.40 – 19.99) 0.01	± (5% of M. + 10 digit)
20.0 – 9999	(20 – 99.9) 0.1 (100 – 9999) 1	± 10% of M.

Measuring range (A)	Resolution (A)	Accuracy
Expected short-circuit current (calculated value)		
0.00 – 19.99	0.01	Observe the accuracy of the fault loop impedance measurement
20.00 – 99.9	0.1	
100 – 999	1	
1.00 k – 9.99 k	10	
10.0 k – 100 k	100	

Specification	Value
Rated voltage range	93 V – 134 V; 185 V – 266 V (45 Hz – 65 Hz)

Fault loop impedance

In this measurement, the loop impedance is determined in the event of a short circuit on conductive components that can be touched (e.g. conductive connection between phase and protective conductor). The loop impedance is measured with a high test current.

The expected short-circuit current (I_k) is calculated based on the measured resistance as follows:

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

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

Measuring the fault loop impedance

The specified accuracy of the test parameters is only guaranteed if the mains voltage remains stable during the measurement.
When measuring the fault loop impedance, the RCD trips.
The value I_k is dependent on Z, U_n and the scaling factor.
The current limit depends on the fuse type, the corresponding rated current and the tripping behaviour.

1. Use the rotary switch to select **Z_s**.
2. Select **without RCD** mode.
3. Use **Type** to set the desired tripping characteristics.
4. Use **Time** to set a value for the multiple of the rated current.
5. Use **Current** to set the rated current of the fuse.
6. Connect the measuring lines to the device.
7. Connect the measuring lines to the test object.
8. Check in the status field whether warning messages are displayed.
9. If ▶ appears, press ◯. The test is being carried out. The test result is displayed.

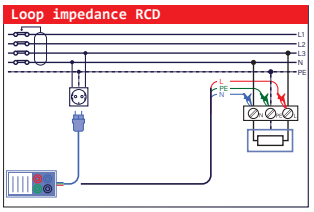

Fig. 29: Connection pattern for fault loop impedance (Zs)

Result	Description
✓	Result OK
✗	Result not OK
Z_s	Fault loop impedance
I_{SC}	Expected short-circuit current

Fault loop impedance in systems with RCD (type A, 30 mA)

The measurement of the fault loop impedance is carried out with a low test current in order to avoid tripping of the RCD. The function is also suitable for RCDs with a tripping current of 30 mA and higher.

The expected short-circuit current (I_k) is calculated based on the measured resistance as follows:

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

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

Measuring the RCD loop impedance

Using “Mode: std. RCD” makes it possible to measure the loop impedance without tripping the standard RCD type A, 30 mA. However, due to operational leakage currents in the system that preload the RCD, or due to capacitive coupling from the phase to the protective conductor, it is still possible for the built-in RCD to trip.
The specified limit values of the test parameters depend on a constant mains voltage. Measured values may otherwise deviate.

1. Use the rotary switch to select **Z_s**.
2. Select **std. RCD** mode.
3. Use **Time** to set a value for the multiple of the rated current.
4. Use **Type** to set the desired fuse type.
5. Use **Current** to set the rated current of the fuse.
6. Connect the measuring lines to the device.
7. Connect the measuring lines to the test object.
8. Check in the status field whether warning messages are displayed.
9. If ▶ appears, press ◎. The test is being carried out. The test result is displayed.

Result	Description
✓	Result OK
✗	Result not OK
Z	Fault loop impedance
I_k	Expected short-circuit current (in amperes)

Fault loop impedance (for adjustable rated differential current)

The measurement of the fault loop impedance is carried out with a low test current in order to avoid tripping of the RCD. The test current depends on the setting of the RCD. This option makes it possible to determine the maximum current of all RCD types without tripping.

The expected short-circuit current (I_k) is calculated based on the measured resistance as follows:

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

Rated input voltage U_N	Voltage range
115 V	93 V ≤ $U_{L\text{-}PE}$ < 134 V
230 V	185 V ≤ $U_{L\text{-}PE}$ ≤ 266 V

Checking the Rs fault loop impedance

Using “Mode: alt. RCD” makes it possible to measure the loop impedance for RCDs that correspond to a different type or rated differential current. The measurement usually does not trigger the RCD. However, due to operational leakage currents in the system that preload the RCD, or due to capacitive coupling from the phase to the protective conductor, it is still possible for the built-in RCD to trip.

The specified limit values of the test parameters depend on a constant mains voltage. Measured values may otherwise deviate.

1. Use the rotary switch to select **Z_s**.
2. Select alt. **RCD** mode.
3. Use **Type** to set the desired type.
4. Use **$I_{\Delta N}$** to set a value for the rated differential current.
5. Use **Limit** to define a touch voltage.
6. Use **F I_k** to set the scaling.
7. Connect the measuring lines to the device.
8. Connect the measuring lines to the test object.
9. Check in the status field whether warning messages are displayed.
10. If ▶ appears, press ◎. The test is being carried out. The test result is displayed.

Result	Description
✓	Result OK
✗	Result not OK
Z	Fault loop impedance
I_k	Expected short-circuit current (in amperes)

Line impedance

Line impedance and expected short-circuit current

When measuring the network impedance, the impedance at the feed-in point of the system or of a circuit is determined in the event of a short circuit on the neutral conductor (conductive connection between phase and neutral conductor in a single-phase system or between phases in a three-phase system). Measurements of the Line impedance are carried out with a high test current.

The expected short-circuit current is calculated as follows:

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

Measuring the Line impedance

The specified accuracy of the test parameters is only guaranteed if the mains voltage remains stable during the measurement.
The value I_k is dependent on Z, U_n and the scaling factor.
The current limit depends on the fuse type, the corresponding rated current and the tripping behaviour.

1. Use the rotary switch to select **Z_I**.
2. Select **Mains** mode.
3. Use **Type** to set the desired tripping characteristics.
4. Use **Time** to set a value for the multiple of the rated current.
5. Use **Current** to set the rated current of the fuse.
6. Connect the measuring lines to the device and measure the Line impedance phase-neutral or between phases.
7. Connect the measuring lines to the test object.
8. Check in the status field whether warning messages are displayed.
9. If ▶ appears, press . The test is being carried out. The test result is displayed.

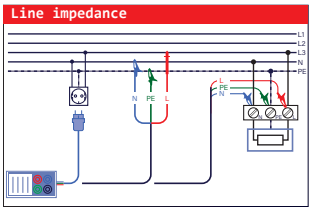

Fig. 30: Connection diagram for mains impedance (Z)

Result	Description
✓	Result OK
✗	Result not OK
Z_i	Line impedance
I_k	Expected short-circuit current

Measuring the voltage drop

When measuring the voltage drop, the Line impedance is determined and the result is referenced to a further measurement at another point of the system (usually the feed-in point, as this has the lowest impedance). The voltage drop as a %, the impedance and the expected short-circuit current are displayed.

The voltage drop as a % is calculated as follows:

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

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

1. Use the rotary switch to select **Z_I**.
2. Select **V.drop** mode.
3. Use **Type** to set the desired tripping characteristics.
4. Use **Time** to set a value for the multiple of the rated current.
5. Use **Current** to set the rated current of the fuse.
6. Use **Limit** to define an upper limit for the voltage drop.
7. Use **F I_k** to set the scaling.
8. Connect the device to a reference point using suitable measuring lines and measure the Line impedance phase-neutral or between phases.
9. Press ZERO. **REF** is displayed. The device is ready to measure the reference point of the system.
10. Check in the status field whether warning messages are displayed.

    After the reference value has been set, the measuring lines can be connected to the corresponding circuit to carry out the actual measurement. The reference value only needs to be set once per system. Press for each new measured value per measuring point.
11. If ▶ appears, press. The test is being carried out. The test result is displayed.

Result	Description
✓	Result OK
✗	Result not OK
ΔU	Voltage drop at the measuring point compared to the reference point
Z_{ref}	Line impedance at reference point
Z	Line impedance
I_k	Expected short-circuit current

Voltage and frequency measurement

Voltage measurements should be carried out at regular intervals in electrical installations (various measurements and tests, identifying potential sources of error etc.). The frequency must be measured, for example, when determining the mains voltage source.

Measuring the voltage and frequency

If phase voltage is detected at the tested PE terminal, all measurements must be terminated immediately. Further measurements may only be carried out after the cause of the fault has been rectified!

1. Use the rotary switch to select **U**.
2. Connect the measuring lines to the device.
3. Connect the measuring lines to the test object.
4. Check in the status field whether warning messages are displayed.
5. The test is being carried out. The rotating field is automatically displayed when the voltage is measured at 400 V.
   The display shows “123” for a clockwise rotating field and “321” for an anticlockwise rotating field.

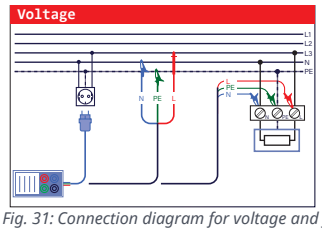

Fig. 31: Connection diagram for voltage and frequency measurement (U)

Result	Description
U L-N	Voltage between phase and neutral conductor
U L-PE	Voltage between phase and protective conductor
U N-PE	Voltage between neutral and protective conductor

Result	Description
Three-phase test	
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

Result	Description
✓	Result OK
✗	Result not OK
Freq	Frequency
Rotation	Phase sequence

Phase sequence check

In practice, three-phase consumers such as motors, fans, conveyors and other electromechanical machines are often connected to a three-phase network installation. Some of these consumers require a certain phase sequence and can be damaged if the direction of rotation is reversed. Therefore, check the phase sequence before connecting.

Checking the phase sequence

1. Use the rotary switch to select **U**.
2. Connect the measuring lines to the test object.
3. Check in the status field whether warning messages are displayed.
4. If ▶ appears, press ◯. The test is being carried out. The test result is displayed.

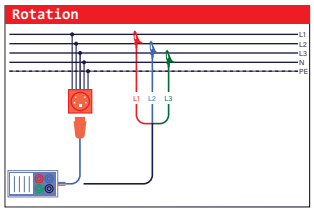

Fig. 32: Connection diagram for phase sequence

Earthing resistance measurement

Earthing resistance measurement (R_E), 3-wire, 4-wire
Measuring the earthing resistance

If the voltage between the test terminals is 10 V or more, no earthing resistance measurement is carried out.

1. Use the rotary switch to select $\mathbf{R_E}$.
2. Select ⏚ mode.
3. Use **Limit** to set a limit for the earthing resistance.
4. Connect the measuring lines to the device.
5. Connect the measuring probes to the test points.
6. Check in the status field whether warning messages are displayed.
7. If ▶ appears, press ◯. The test is being carried out. The test result is displayed.

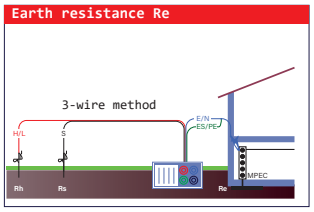

Fig. 33: Connection diagram for earthing resistance (R_E), 3-wire

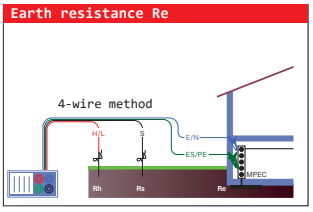

Fig. 34: Connection diagram for earthing resistance (R_E), 4-wire

Result	Description
✓	Result OK
✗	Result not OK
R_E	Resistance to earth
Rs	Probe resistance S (potential)
Rh	Probe resistance H (current)

Specific earth resistance (R_o)

Earth resistance should be determined when determining specific parameters of an earthing system (required length and surface area of earthing electrodes, ideal installation depth of the earthing system etc.) in order to obtain a more accurate calculation basis.

Measuring the specific earthing resistance (R_o)

If the voltage between the test terminals is 10 V or more, no earthing resistance measurement is carried out.

1. Use the rotary switch to select **R_E**.
2. Select **R_o** mode.
3. Use **Distance** to specify the distance "a" between the test probes.
4. Connect the measuring lines to the device.
5. Connect the measuring probes to the test points.
6. Check in the status field whether warning messages are displayed.
7. If ▶ appears, press (○). The test is being carried out. The test result is displayed.

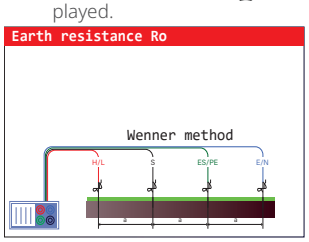

Fig. 35: Connection diagram for specific earthing resistance (R_o) – ρ

Result	Description
✓	Result OK
✗	Result not OK
R_E	Resistance to earth
Rs	Probe resistance S (potential)
Rh	Probe resistance H (current)

Auto test

The adjustable auto test is a user-defined automatic test sequence. The auto test allows a complete test sequence at the push of a button and is particularly suitable for standardised tests.

The auto test includes the following tests:

- Voltage (L-N, L-PE, N-PE)
- Line impedance (L-N)
- Loop impedance (L-PE, without RCD trip)
- Touch voltage
- RCD trip current (RCD)
- RCD tripping time (RCD)
- Insulation resistance (L-N, L-PE, N-PE)

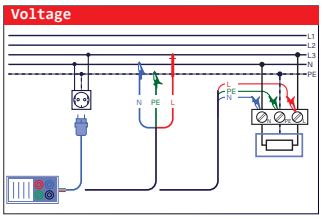

Fig. 36: Connection diagram for auto test

Carrying out an auto test

1. Use the rotary switch to select **AUTO**.
2. Set a limit for each check in the **Settings** menu. You can use the **OFF** setting to deactivate individual checks.
3. Connect the measuring lines to the device.
4. Connect the measuring lines to the measuring point.
5. If ▶ appears, press OK. The tests are carried out one after the other. The test results of the auto test are displayed.

You have to switch the RCD test on again each time the RCD trips. After the last successful RCD partial test, **check mains for de-energisation, then press** OK. Three insulation resistance measurements (L-N, L-PE and N-PE) are then carried out and the result of Riso: L-N is displayed.

If one or more of these measurements are disabled in the auto test settings menu, they are automatically skipped in the measurement sequence.

The measurement results can be transmitted to Sparkify using **NFC** data transmission (see chapter “Data transmission using NFC” on page 60).

Changing the auto test settings

1. Press ⚙ to open the **Settings** menu.
2. Use ▼▲ to select the **Auto sequence** submenu.
3. Press OK to open the submenu.
4. Use ◀▶ to change the value.
5. To save the changes, press OK. Press ← to exit the submenu without saving.

The following settings can be made in the auto test menu:

Function	Settings options	Description
Line impedance Zi	On/off	
Fault loop impedance Zs	On/off	Only “no-trip” variant for circuits with RCD.
Circuit breaker type	gG, gL, B, C, K	Setting affects limit value Z and short-circuit current I_k.
Multiple of the fuse rated current/measuring time for fuses	5 × I_n, 10 × I_n, 15 × I_n, 0.4 s, 5 s	
Rated current of the fuse	2 A, 4 A, 6 A, 10 A, 16 A, 20 A, 25 A, 32 A, 35 A, 40 A, 50 A, 63 A	Rated current affects limit value Z and I_k.
RCD tripping current I_Δ	On/off	
RCD tripping time t	On/Off/1× I Δ_N	Performs all six RCD tripping time measurements. Carries out only the tripping time measurements of both half-waves at 1x I Δ_N.
RCD type	AC, A/F, B/B+	
Rated differential current RCD $I_{\Delta N}$	30 mA, 100 mA, 300 mA	
Insulation resistance Riso	On/Off/1× I Δ_N	
Measurement voltage insulation resistance	50 V, 100 V, 250 V, 500 V, 1000 V	

Internal device memory

The internal memory (memory button) has been retained for possible future additional functions. Details can be found in a later version of these instructions. For data transmission and documentation of the measurement results, we recommend the Wiha Sparkify app.

Documentation with Sparkify via NFC

The data is transferred easily and intuitively using NFC directly into the Sparkify app. All measurement data can be documented easily and efficiently in the app, and measurement logs can be created directly. Users benefit from a fast, paperless and structured collection of all relevant information. The Sparkify app is available for all Android and iOS devices in the Google Play Store and Apple App Store for free download:

Fig. 37: QR code – Google Play Store

Fig. 18: QR code – Apple App Store

Data transmission using NFC

Prepare mobile device:

1. Activate the NFC function in the settings of your smartphone or tablet.
2. Open the Sparkify app.
3. Sign up or log in with your credentials. If you do not want to register, you can proceed as a guest.
   Cloud backup is not available in this case. You can subsequently register in the profile at any time and transfer projects and documentation.
4. Select the appropriate tile to start documentation of the installation check.
5. The project is automatically assigned. To manually assign another project, create a new project or select another project.
6. With the NFC function enabled, hold the mobile device close to the NFC symbol on the device. Make sure that there is no more than 4 cm between the device and the mobile device.
7. Hold the mobile device steady until the app automatically imports the data.
8. Save the documentation.

Data transfer:

The app automatically imports the following data:

- Measurement results
- Timestamp
- Serial number of the device

Troubleshooting:

1. Check that the NFC function is activated on the mobile device.
2. Position the mobile device exactly on the NFC symbol.
3. Keep the mobile device steady and at a maximum distance of 4 cm from the device.
4. Restart the app or mobile device if necessary.
5. Quit other active NFC apps.
6. Repeat the transfer process.
7. If necessary, contact technical support.

Data access and transfer/EU Data Act (Regulation (EU) 2023/2854)

This measuring device generates technical readings during use.

- Direct access: All measured values are shown immediately and in real time on the integrated display.
- Data transmission: In addition, the measured values can be read out via NFC interface. This requires an active readout with a compatible end device at a distance of approx. 10 cm.
- Safety: The NFC transmission is unencrypted. Due to the very short range (near-field communication), unintentional or unauthorised interception is practically impossible and an inherent safety mechanism is provided.
- Data transfer to third parties: The user is entitled to pass on the measured values to third parties (e.g. an app from another company).

No personal data is collected or transferred.

Transport and storage

Keep the original packaging for later shipment, e.g. for calibration. Transport damage due to defective packaging is excluded from the warranty. Transport the device in compliance with the specified permissible environmental conditions (temperature, humidity etc.), see chapter “TECHNICAL SPECIFICATIONS” on page 63. To avoid damage, the batteries should be removed if the measuring device is not used for a long period of time. If the device is nevertheless contaminated by leaking battery cells, contact technical support. We recommend having the device checked by the manufacturer. Only transport the device in the transport container supplied.

Store the device in a dry, enclosed space. If the device has been transported at extreme temperatures, allow it to acclimatise for at least two hours before switching it on.

Replacing the battery

Danger to life due to electrical voltage!
If the device is connected to a system, dangerous voltages may occur in the battery compartment.

- Before opening the battery compartment cover, make sure that all measuring accessories are disconnected and the device is switched off.

1. Loosen the T10 mounting screws and remove the battery compartment cover on the back of the device.
2. Replace the battery. Use rechargeable Ni-MH batteries (type AA) with a capacity ≥ 2300 mAh.
3. Screw the battery compartment cover back onto the back of the device.

Replacing a fuse

Risk of accident due to the use of an incorrect fuse!
If an incorrect fuse is used, there is a risk of fire and a risk that safety devices will fail due to overloading.

- Always replace defective fuses with new ones of the same type.

Fuse	Type	Function
F1	F 4 A / 500 V, 6.3 × 32 mm	General fuses of test terminals L/L1 and N/L2
F2	F 4 A / 500 V, 6.3 × 32 mm	General fuses of test terminals L/L1 and N/L2
F3	M 0.315 A / 250 V, 5 × 20 mm	Protection of the internal low impedance circuits against damage if mains voltage is accidentally applied to test probes

Care

If the device has become dirty through daily use, you can clean it with a damp cloth and some mild household cleaner. Before you start cleaning, make sure that the device is switched off, disconnected from the external power supply and from the other measuring lines. Never use harsh cleaners or solvents. Do not use the device again until it has dried completely.

Maintenance and calibration

Each brand new Wiha MFT measuring device undergoes a manufacturer's calibration prior to shipment. A corresponding calibration certificate is enclosed with the device. Wiha recommends that the device be calibrated at regular intervals of 12 months (365 days) from the time of initial commissioning in order to ensure measurement accuracy and compliance with standards in the long term.

It is up to the user to determine a suitable calibration interval. Factors such as frequency of use, operating environment or internal company requirements (e.g. quality management requirements) should be taken into account when making this decision.

Wiha offers an optional, fee-based calibration service. For more information, including online ordering and return process, visit:

How calibration works at Wiha:

1. Order the calibration in the Wiha online shop.
2. You will receive a shipping label you can use to safely send your device to Wiha
3. The measuring device is professionally calibrated at Wiha
4. After successful calibration, the device is returned to you with a calibration certificate

If the device does not pass the calibration test, Wiha will contact you to coordinate all further steps individually.

Disposal

Danger to the environment if disposed of incorrectly!
Incorrect disposal can pose a risk to the environment.

Remove the battery ("Replacing the battery" on page 61) before disposing of your installation tester.
Never dispose of the battery and your installation tester as household waste.

Have electrical waste and electronic components disposed of by approved specialist companies.

If in doubt, obtain information on environmentally sound disposal from your local authority or specialist disposal companies.

Service and warranty

If the device is no longer functional, you have questions or need information, please contact an authorised Wiha Werkzeuge customer centre:

The warranty is void in the event of damage to property or personal injury caused by non-compliance with these instructions or if the type plate is lost.
The type plate is located on the back of the device.

Customer Service
Wiha Werkzeuge GmbH
Obertalstraße 3–7
78136 Schonach
GERMANY

Phone: +49 77 22 959-400
Email: tech-support@wiha.com
Website: www.wiha.com

Technical specifications

General data

Specification	Value
Power supply	9 V_{DC} (6 × 1.5 V Ni-MH batteries, size AA)
Power supply unit	12 V_{DC} / 1000 mA
Charging time	~ 6 hours
Operation	~ 15 hours (depending on usage)
Overvoltage category	CAT III / 600 V; CAT IV / 300 V
Protection classification	Double insulation
Degree of pollution	2
Protection class	IP42
Display	480 × 320 TFT LCD
COM port	USB
Dimensions (W × H × W)	25 cm × 10.7 cm × 13.5 cm
Weight (without battery)	1.30 kg
Operating temperatures	0 °C – 40 °C
Relative humidity	Max. 95%, without condensation
Storage temperatures	-10 °C – +70 °C

Technical parameters

Insulation resistance

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
Insulation resistance: Rated voltage 50 V DC Measuring range according to DIN EN IEC 61557: 50 kΩ – 80 MΩ		
0.1 – 80.0	(0.100 – 1.999) 0.001 (2.00 – 80.00) 0.01	± (5% of M. + 3 digit)
Insulation resistance: Rated voltages 100 V DC and 250 V DC Measuring range according to DIN EN IEC 61557: 100 kΩ – 199.9 MΩ		
0.1 – 199.9	(0.100 – 1.999) 0.001 (2.00 – 99.99) 0.01 (100.0 – 199.9) 0.1	± (5% of M. + 3 digit)
Insulation resistance: Rated voltages 500 V DC and 1000 V DC Measuring range according to DIN EN IEC 61557: 500 kΩ – 199.9 MΩ		
0.1 – 199.9	(0.100 – 1.999) 0.001 (2.00 – 99.99) 0.01 (100.0 – 199.9) 0.1	± (2% of M. + 3 digit)
200 – 999	(200.0 – 999) 1	± (10% of M.)

Measuring range (V)	Resolution (V)	Accuracy
Voltage		
0 – 1200	1	± (3% of M. + 3 digit)

Specification	Value
Test voltages	50 V DC, 100 V DC, 250 V DC, 500 V DC, 1000 V DC
No load voltage	0% – 20% of the rated voltage
Current measurement	Min. 1 mA at $R_N = U_N$ 1 kΩ/V
Short-circuit current	Max. 15 mA
Number of possible tests with new batteries	Max 1000 (with 2300 mAh batteries)

If the device becomes damp, the measurement results may be affected. In this case, the device and accessories should be dried for at least 24 hours.

Low impedance measurement (R_{LOW})

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to DIN EN IEC 61557: 0.1 Ω – 1999 Ω		
0.1 – 20.0	(0.10 – 19.99) 0.01 (2.00 – 80.00) 0.01	± (3% of M. + 3 digit)
20 – 1999	(20.0 – 99.9) 0.1 (100 – 1999) 1	± 5% of M.

Specification	Value
Rated voltage	5 V DC
Test current	Min. 200 mA at 2 Ω load resistance
Measuring line compensation	Max. 5 Ω
Number of possible tests with new batteries	Max. 1400 (with 2300 mAh batteries)

Continuity test (low current measurement)

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.1 – 1999	(0.1 – 99.9) 0.1 (100 – 1999) 1	± (5% of M. + 3 digit)

Specification	Value
No load voltage	5 V DC
Short-circuit current	Max. 7 mA
Measuring line compensation	Max. 5 Ω

RCD test

Specification	Value
Nominal fault current	6 mA, 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA
Accuracy of nominal fault current	-0 / +0.1 I_Δ; $I_\Delta = I_{\Delta N}$, 2 $I_{\Delta N}$, 5 $I_{\Delta N}$ -0.1 I_Δ / +0; I_Δ = ½ $I_{\Delta N}$
Type of test current	Sine (AC), DC (B), pulsed (A)
RCD type	General (G, not delayed), selective (S, time delayed), EVSE
Input polarity of test current	0°, 180°
Voltage range	93 V – 134 V; 185 V – 266 V; 45 Hz – 65 Hz

	½ × $I_{\Delta N}$			1 × $I_{\Delta N}$			2 × $I_{\Delta N}$		
$I_{\Delta N}$ (mA)	AC	A	B	AC	A	B	AC	A	B
6 (*)	3	2.1	3	6	12	12	12	24	24
10	5	3.5	5	10	20	20	20	40	40
30	15	10.5	15	30	42	60	60	84	120
100	50	35	50	100	141	200	200	282	400
300	150	105	150	300	424	600	600	848	-
500	250	175	250	500	707	1000	1000	1410	-
650 (*)	325	228	325	650	919	1300	1300	-	-
1000 (*)	500	350	500	1000	1410	-	2000	-	-

5 × $I_{\Delta N}$			RCD $I_{\Delta N}$		
AC	A	B	AC	A	B
30	60	60	×	×	×
50	100	100	×	×	×
150	212	30	×	×	×
500	707	1000	×	×	×
1500	-	-	×	×	×
2500	-	-	×	×	×
-	-	-	×	×	×
-	-	-	×	×	×

Touch voltage

Measuring range (V)	Resolution (V)	Accuracy
Measuring range according to DIN EN IEC 61557-6: 3.0 V – 49.0 V at a maximum touch voltage of 25 V Measuring range according to DIN EN IEC 61557-6: 3.0 V – 99.0 V at a maximum touch voltage of 50 V		
3.0 – 9.9	0.1	(-0 %/+10 % of M. + 5 digit)
10.0 – 99.9	0.1	(-0 %/+10 % of M. + 5 digit)

Specification	Value
Test current	Max. 0.5 $I_{\Delta N}$
Limit for touch voltage	25 V, 50 V

Tripping time

	½ × $I_{\Delta N}$	$I_{\Delta N}$	2 × $I_{\Delta N}$	5 × $I_{\Delta N}$
General (non-delayed) RCDs	t_Δ > 300 ms	t_Δ < 300 ms	t_Δ < 150 ms	t_Δ < 40 ms
Selective (time-delayed) RCDs	t_Δ > 500 ms	130 ms < t_Δ < 500 ms	60 ms < t_Δ < 200 ms	50 ms < t_Δ < 150 ms

Tripping times according to BS 7671:

	½ × $I_{\Delta N}$*	$I_{\Delta N}$	2 × $I_{\Delta N}$	5 × $I_{\Delta N}$
General (non-delayed) RCDs	t_Δ > 1999 ms	t_Δ < 300 ms	t_Δ < 150 ms	t_Δ < 40 ms
Selective (time-delayed) RCDs	t_Δ > 1999 ms	130 ms < t_Δ < 500 ms	60 ms < t_Δ < 200 ms	50 ms < t_Δ < 150 ms

*) At a test current of ½ $I_{\Delta N}$, the RCD must not trip.

Tripping times according to DIN EN IEC 62955:

	$I_{\Delta N}$DC	10 × $I_{\Delta N}$DC	33 × $I_{\Delta N}$DC
RCD 6 mA_{DC}	t_Δ > 1999 ms	t_Δ < 300 ms	t_Δ < 150 ms

	$I_{\Delta N}$	2 × $I_{\Delta N}$	5 × $I_{\Delta N}$	167 × $I_{\Delta N}$
RCD 30 mA_{AC}	without tripping	t_Δ < 300 ms	t_Δ < 80 ms	t_Δ < 80 ms

Measuring range (ms)	Resolution (ms)	Accuracy
The entire measuring range meets the requirements of DIN EN IEC 61557-6. The specified accuracies apply to the entire operating range.		
0.0 – 500.0	0.1	± 3 ms

Specification	Value
Test current	½ × $I_{\Delta N}$, $I_{\Delta N}$, 2 × $I_{\Delta N}$, 5 × $I_{\Delta N}$
Limit for touch voltage	25 V, 50 V

Tripping current

Measuring range (Δ)	Resolution (Δ)	Accuracy
Measuring range corresponds to DIN EN IEC 61557-6 at $I_{\Delta N}$ ≥10 mA. The specified accuracies apply to the entire operating range.		
0.2 × $I_{\Delta N}$ – 1.1 × $I_{\Delta N}$ (type AC)	0.05 × $I_{\Delta N}$	± 0.1 × $I_{\Delta N}$
0.2 × $I_{\Delta N}$ – 1.5 × $I_{\Delta N}$ (type A, $I_{\Delta N}$ ≥ 30 mA)	0.05 × $I_{\Delta N}$	± 0.1 × $I_{\Delta N}$
0.2 × $I_{\Delta N}$ – 2.2 × $I_{\Delta N}$ (type A, I_ΔN ≥ 10 mA)	0.05 × $I_{\Delta N}$	± 0.1 × $I_{\Delta N}$
0.2 × $I_{\Delta N}$ – 2.2 × $I_{\Delta N}$ (type B)	0.05 × $I_{\Delta N}$	± 0.1 × $I_{\Delta N}$

Measuring range (ms)	Resolution (ms)	Accuracy
Tripping time		
0.0 – 300.0	1	± 3 ms

Measuring range (V)	Resolution (V)	Accuracy
Touch voltage		
3.0 – 9.9	0.1	-0 %/+10 % of M. + 5 digit
10.0 – 99.9	0.1	-0 %/+10 % of M. + 5 digit

Fault loop impedance and expected short-circuit current Z_s (L-PE, mode: no RCD), I_k (with RCD tripping)

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to DIN EN IEC 61557-3: 0.25 Ω – 1999 Ω		
0.2 – 9999	(0.20 – 19.99) 0.01 (20 – 99.9) 0.1 (100 – 9999) 1	± (5% of M. + 5 digit)

Measuring range (A)	Resolution (A)	Accuracy
Expected short-circuit current (calculated value)		
0.00 – 19.99	0.01	Observe the accuracy of the fault loop impedance measurement
20.00 – 99.9	0.1	
100 – 999	1	
1.00 k – 9.99 k	10	
10.0 k – 100 k	100	

Specification	Value
Test current (at 230 V)	3.4 A, 50 Hz sine wave ≤ (10 ms ≤ t_{LOAD} ≤ 15 ms)
Rated voltage range	93 V – 134 V; 185 V – 266 V (45 Hz – 65 Hz)

Z_s (L-PE, mode: std.RCD & alt.RCD), I_k (without RCD tripping)

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to DIN EN IEC 61557-3: 0.75 Ω – 1999 Ω		
0.4 – 19.99	(0.40 – 19.99) 0.01	± (5% of M. + 10 digit)
20.0 – 9999	(20 – 99.9) 0.1 (100 – 9999) 1	± 10% of M.

Measuring range (A)	Resolution (A)	Accuracy
Expected short-circuit current (calculated value)		
0.00 – 19.99	0.01	Observe the accuracy of the fault loop impedance measurement
20.00 – 99.9	0.1	
100 – 999	1	
1.00 k – 9.99 k	10	
10.0 k – 100 k	100	

Specification	Value
Rated voltage range	93 V – 134 V; 185 V – 266 V (45 Hz – 65 Hz)

Fault loop impedance; fault loop impedance RCD type A, 30 mA, trip inhibit (no trip) and with alternative RCD type and trip inhibit (no trip)

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

Line impedance and expected short-circuit current

Rated input voltage U_N	Voltage range
115 V	93 V ≤ U_{L-PE} < 134 V
230 V	185 V ≤ U_{L-PE} ≤ 266 V
400 V	321 V ≤ U_{L-PE} ≤ 485 V

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to DIN EN IEC 61557-3: 0.25 Ω – 1999 Ω		
0.2 – 9999	(0.20 – 19.99) 0.01 (20 – 99.9) 0.1 (100 – 9999) 1	± (5% of M. + 5 digit)

Measuring range (A)	Resolution (A)	Accuracy
Expected short-circuit current (calculated value)		
0.00 – 19.99	0.01	Observe the accuracy of the Line impedance measurement
20.00 – 99.9	0.1	
100 – 999	1	
1.00 k – 9.99 k	10	
10.0 k – 100 k	100	

Specification	Value
Test current (at 230 V)	3.4 A, 50Hz sine wave (10 ms ≤ t_{LOAD} ≤ 15 ms)
Rated voltage range	93 V – 134 V; 185 V – 266 V, 321 V – 485 V (45 Hz – 65 Hz)

Measuring range (%)	Resolution (%)	Accuracy
Voltage drop		
0.0 – 9.9	0.1	Observe the accuracy of the line measurement (calculated value)

Voltage and frequency measurement

Measuring range (V)	Resolution (V)	Accuracy
0 – 550	1	± (2% of M. + 2 digit)

Specification	Value
Clockwise rotating field	1-2-3
Anticlockwise rotating field	3-2-1
Frequency range	0 Hz, 45 Hz – 400 Hz

Measuring range (Hz)	Resolution (Hz)	Accuracy
10 – 499	0.1	± (0.2% of M. + 1 digit)

Specification	Value
Rated voltage range	10 V – 550 V

Phase sequence

Measuring range according to EN 61557-7:

Specification	Value
Clockwise rotating field	1-2-3
Anticlockwise rotating field	3-2-1
Rated voltage range	93 V_{AC} – 550 V_{AC}
Frequency range	45 Hz – 400 Hz

Earthing resistance
Earthing resistance measurement (R_E), 3-wire, 4-wire

Measuring range (Ω)	Resolution (Ω)	Accuracy
Measuring range according to EN 61557-5: 100 Ω – 1999 Ω		
1.0 – 9999	(1.00 – 19.99) 0.01 (20 – 199.9) 0.1 (200 – 9999) 1	± (5% of M. + 5 digit)

Specification	Value
Rh and Rs are to be considered as guide values.	
Max. resistance Rh of auxiliary earth electrode	100 R_E or 50 kΩ (lower value takes precedence)
Max. probe resistance Rs	100 R_E or 50 kΩ (lower value takes precedence)
Additional fault in sensor resistance at Rh_{max} or Rs_{max}	± (10% of M. + 10 digit)
Additional fault at 3 V voltage noise (50 Hz)	± (5% of M. + 10 digit)
No load voltage	< 30 V_{AC}
Short-circuit current	< 30 mA
Test voltage frequency	126.9 Hz
Type of test voltage	Sine wave

Specific earth resistance (R_O)

Measuring range (Ω)	Resolution (Ω)	Accuracy
Rh and Rs are to be considered as guide values.		
6.0 Ωm – 99.9 Ωm	0.1 Ωm	± (5% of M. + 5 digit)
100 Ωm – 999 Ωm	1 Ωm	± (5% of M. + 5 digit)
1.0 kΩm – 9.99 kΩm	0.01 kΩm	± 10% of M. at R_e 2 kΩ – 19.99 kΩ
10.0 kΩm – 99.9 kΩm	0.1 kΩm	± 10% of M. at R_e 2 kΩ – 19.99 kΩ
100 kΩm – 9999 kΩm	1 kΩm	± 20% of M. at R_e > 20 kΩ

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