MFT-ECO [redacted]

User manual

Release EN 1.02 - 26/07/2022

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1. PRECAUTIONS AND SAFETY MEASURES

The instrument has been designed in compliance with guidelines IEC/EN61557, BS7671 17th and 18th editions and IEC/EN61010, relevant to electronic measuring instruments. Before and after carrying out the measurements, carefully observe the following instructions:

- Do not carry out any voltage or current measurement in humid environments.
- Do not carry out any measurements in case gas, explosive materials or flammables are present, or in dusty environments.
- Avoid any contact with the circuit being measured if no measurements are being carried out.
- Avoid contact with exposed metal parts, with unused measuring leads, etc.
- Do not carry out any measurement in case you find anomalies in the instrument such as deformations, breaks, substance leaks, absence of display on the screen, etc.
- Pay special attention when measuring voltages higher than 25V in special environments (such as construction sites, swimming pools, etc.) and higher than 50V in normal environments, since a risk of electrical shock exists.
- Only use original accessories.

The following symbols are used in this manual:

CAUTION: observe the instructions given in this manual; improper use could damage the instrument, its components or create dangerous situations for the operator.

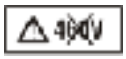
High voltage danger: electrical shock hazard.

Double insulation

AC voltage or current

DC voltage or current

Connection to earth



The symbol indicates that the instrument must not be connected to systems with phase-to-phase rated delta voltage higher than 415V.

1.1. PRELIMINARY INSTRUCTIONS

- This instrument has been designed for use in the environmental conditions specified in § 8.4.1. Do not use in different environmental conditions.
- The instrument may be used for measuring and verifying the safety of electrical systems. Do not use on systems exceeding the limit values specified in § 8.1

- We recommend following the normal safety rules devised to protect the user against dangerous currents and the instrument against incorrect use.
- Only the accessories supplied with the instrument guarantee compliance with safety standards. They must be in good conditions and be replaced with identical models, when necessary.
- Make sure the batteries are correctly installed.
- Before connecting the test leads to the circuit being measured, check that the desired function has been selected

1.2. DURING USE

Please carefully read the following recommendations and instructions:

CAUTION

Failure to comply with the caution notes and/or instructions may damage the instrument and/or its components or be a source of danger for the operator.

- Before changing function, disconnect the test leads from the circuit under test.
- When the instrument is connected to the circuit under test, never touch any terminal, even if unused.
- Avoid measuring resistance if external voltages are present. Even if the instrument is protected, excessive voltage could cause damage.

1.3. AFTER USE

When measurements are completed, turn off the instrument by pressing and holding the **ON/OFF** key for some seconds. If the instrument is not to be used for a long time, remove the batteries and follow the instructions given in § 3.3

1.4. DEFINITION OF MEASUREMENT (OVERVOLTAGE) CATEGORY

Standard "IEC/EN61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements" defines what measurement category, commonly called overvoltage category, is. § 6.7.4: Measured circuits, reads: circuits are divided into the following measurement categories:

- **Measurement category IV** is for measurements performed at the source of a low-voltage installation.
  Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.
- **Measurement category III** is for measurements performed on installations inside buildings.
  Examples are measurements on distribution boards, circuit breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to fixed installation.
- **Measurement category II** is for measurements performed on circuits directly connected to the low-voltage installation.
  Examples are measurements on household appliances, portable tools and similar equipment.

- **Measurement category I** is for measurements performed on circuits not directly connected to MAINS.
  Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS-derived circuits. In the latter case, transient stresses are variable; for that reason, the standard requires that the transient withstand capability of the equipment is made known to the user

2. GENERAL DESCRIPTION

2.1. INSTRUMENT FUNCTIONS

The instrument can perform the following tests:

- **RPE** Continuity test of earth, protective and equipotential conductors with test current higher than 200mA and open-circuit voltage between 4V and 24V
- **MΩ** Measurement of insulation resistance with continuous test voltage of 50V, 100V, 250V, 500V or 1000V DC
- **LOOP** Measurement of line impedance/Loop P-N, P-P, P-E with calculation of the assumed short-circuit current, overall earth resistance without causing the RCD tripping (NoTrip⏚), check of the interruption capacity of magnetothermal protections (MCB) and fuses, protection check in case of indirect contacts with 2-wire and 3-wire connection
- **RCD** Test on molded-case standard, General and Selective RCDs of type A/F (∿⎍/⎍⎍), AC (∿), B/B+ (⎓/⎓+), DD and CCID (∿, ⎓) (country USA) of the following parameters: tripping time, tripping current, contact voltage
- **AUTO** Automatic sequence measurements of NoTrip⏚ and RCD functions with 3-wire connection (TN systems only)
- **1,2,3** Indication of phase sequence with 1-terminal method
- **DMM** Multimeter function for Phase-Neutral, Phase-Phase, Phase-PE voltage measurements and frequency

3. PREPARATION FOR USE

3.1. INITIAL CHECKS

Before shipping, the instrument has been checked from an electric as well as mechanical point of view. All possible precautions have been taken so that the instrument is delivered undamaged. However, we recommend checking it to detect any damage possibly suffered during transport. In case anomalies are found, immediately contact the Dealer. We also recommend checking that the packaging contains all the components. In case of discrepancy, please contact the Dealer. In case the instrument should be returned, please follow the instructions given in § 9.

3.2. INSTRUMENT POWER SUPPLY

The instrument is powered by 6x1.5V alkaline batteries of type AA LR06 supplied with the instrument. The "  " symbol indicates the charge level of the batteries. To replace the batteries refer to § **7.2**.

The instrument is capable of keeping data stored even without batteries.

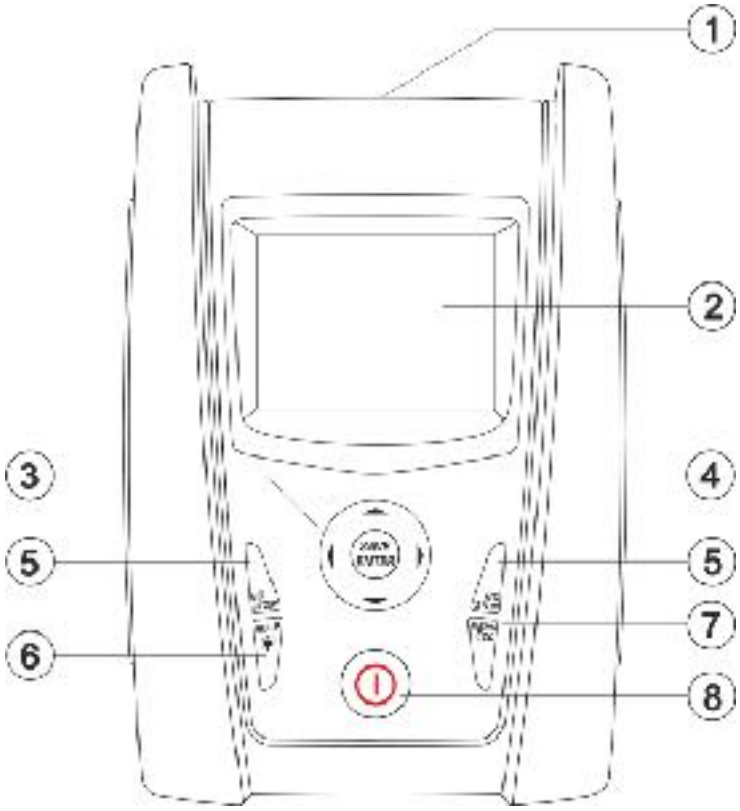
The instrument has an AutoPower OFF function (which can be deactivated) after 10 minutes idling.

3.3. STORAGE

In order to guarantee precise measurement, after a long storage time under extreme environmental conditions, wait for the instrument to come back to normal condition (see § 8.4.1).

4. NOMENCLATURE

4.1. INSTRUMENT DESCRIPTION



CAPTION:

1. Inputs
2. LCD display
3. ▼,▲, ▶, ◀, **SAVE/ENTER** keys
4. Compartment of the connector for optical cable/ USB port
5. **GO/STOP** keys
6. **HELP/** key
7. **ESC/MENU** key
8. **ON/OFF** key

Fig. 1: Description of the front part of the instrument

CAPTION:

1. Connector for remote lead
2. **B1, B3, B4** inputs

Fig. 2: Description of the upper part of the instrument

CAUTION

The instrument performs the check of voltage on PE by comparing the voltage at B4 input and the ground potential induced on instrument side by mean the user's hand, so in order to check voltage on PE, **it's mandatory to hold the instrument case on the left or on the right side**

4.2. DESCRIPTION OF MEASURING LEADS

CAPTION:

1. Hand protection
2. Safe area

Fig. 3: Description of measuring leads

4.3. KEYBOARD DESCRIPTION

The keyboard includes the following keys:

ON/OFF key to switch on/off the instrument

ESC key to exit the selected menu without confirming
MENU key to back to general Menu on each moment

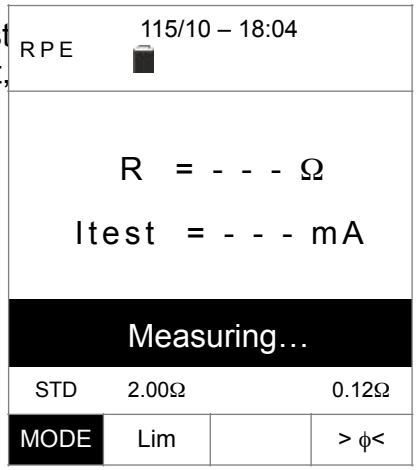
◄ ▲ ► ▼ keys to move the cursor through the different screens in order to select the desired programming parameters
SAVE/ENTER key to save the selected setup parameters (SAVE) and to select from menu the desired function (ENTER)

GO key to start the measurement
STOP key to stop the measurement

HELP key to access the online help and display the possible connections between the instrument and the system for each selected function
key (**<u>continuos pressure</u>**) to adjust the display backlight

4.4. DISPLAY DESCRIPTION

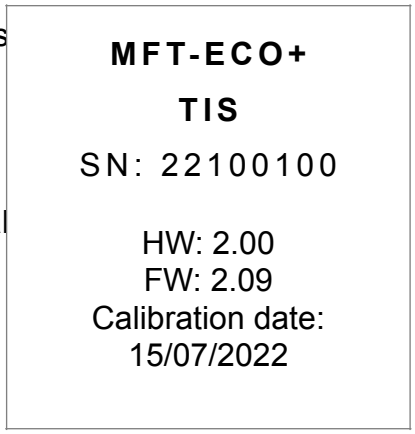
The display is an COG LCD module, 128x128 points. The first line of the display indicates the type of active measurement, the date/time and the battery charge indication



4.5. INITIAL SCREEN

When switching on the instrument, the initial screen appears for a few seconds. It shows:

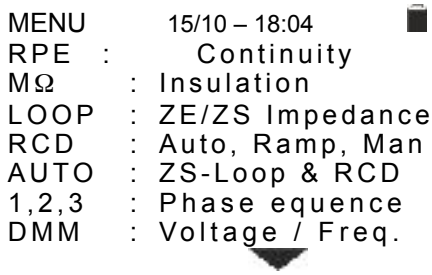
- The instrument model
- The manufacturer
- The serial number (SN:) of the instrument
- The Firmware version of the two instrument's internal microprocessors (FW and HW)
- The date of instrument calibration (Calibration date:)



After a few seconds, the instrument switches to general menu screen

5. GENERAL MENU

Pressing the **MENU/ESC** key in any condition of the instrument allows to go back to the general menu in which internal parameters may be set, the saved measures can be displayed and the desired measuring function may be selected.

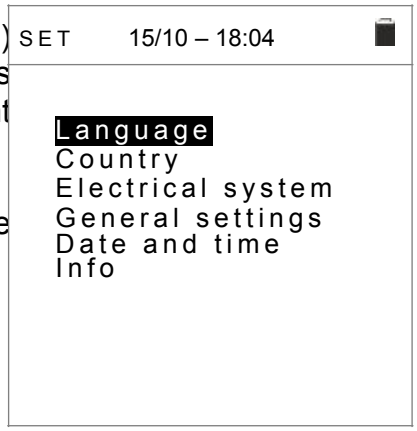


Selecting one of the listed measurements with the cursor and confirming with **ENTER** the instrument shows the desired measurement at display.

5.1. SET – INSTRUMENT SETTINGS

Move the cursor to **SET** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the displays shows the screen which allows accessing the various instrument settings.

The settings will remain valid also after switching off the instrument.



5.1.1. Language

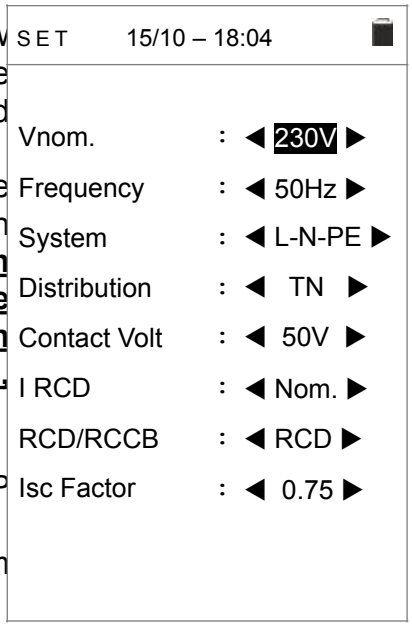
Move the cursor to **Language** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the displays shows the screen which allows setting the instrument language.

Select the desired option by means of the arrow keys (▲,▼). To store settings, press the **ENTER** key, to exit the changes made, press the **ESC** key.

5.1.2. Country

Move the cursor to **Country** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the displays shows the screen in order to select the reference country which have influence on the LOOP and NoTrip measurements.
Select the desired option by means of the arrow keys (▲,▼). To store settings, press the **ENTER** key, to exit the changes made, press the **ESC** key.

5.1.3. Electrical system



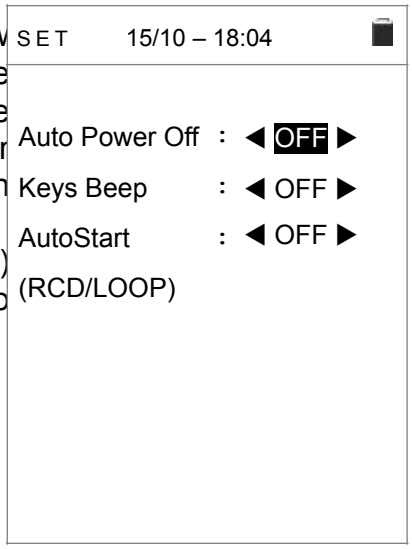
Move the cursor to **Electrical system** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the display shows the screen which allows to set the followed parameters:

- **Vnom** → the Phase-Neutral or Phase-PE nominal voltage (110V,115V,120V, 127V,133V,220V,230V,240V) to use in the calculation of prospectrive short circuit current **in LOOP/RCD measurement for L1, L2, L3, N three-phase systems (L-N-PE system) or the rated voltage between Phase-Phase in LOOP/RCD measurement for L1, L2, PE split-phase systems (L-L-PE system)**
- **Frequency** → the system frequency (50Hz, 60Hz)
- **System** → the type of connection in RCD and LOOP functions (L-N-PE or L-L-PE)
- **Distribution** → the type of electric power supply system (TT, TN or IT)
- **Contact Volt** → the limit of contact voltage (25V, 50V)
- **I RCD** → the type of trip out RCD current visualization (Real, Nom). With “Nom” option the instrument shows the normalized value of trip out current (referred to the nominal current). **Example**: for RCD type A/F with Idn=**30mA** the effective value of normalized trip out current can be up to **30mA**. With “Real” option the instrument shows the effective value of the trip out current by considering the coefficients indicated by the IEC/EN61008 and IEC/EN61009 guidelines (1.414 for RCD type A/F, 1 for RCD type AC, 2 for RCD type B/B+). **Example**: for RCD type A/F with Idn=**30mA** the effective value of trip out current up to **30mA * 1.414 = 42mA**
- **RCD/RCCB** → Selecting “RCD” option the instrument performs the tripping time test with all multipliers in normally conditions. Selecting “RCCB” option, **only for 30mA devices**, the instrument performs tripping time test with x5 multiplier with test current of 250mA (type AC) and 350mA (type A/F)
- **Isc Factor** → (**only for Norvay country**) possibility to select and **the value of ISC factor (0.01 ÷ 1.00) to use in the calculation of prospectrive short circuit current**

Select the desired option by means of the arrow keys (▲,▼). To store settings, press the **ENTER** key, to exit the changes made, press the **ESC** key.

5.1.4. General settings

Move the cursor to **General settings** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the display shows the screen which allows to enable/disable the auto power off, enable/disable the sound of function keay for each pressure and enable/disable the Auto Start function (automatic start) in the RCD and LOOP funtions (see § 5.1.5) Select the desired option by means of the arrow keys (▲,▼) and the (◀, ▶). To store settings, press the **ENTER** key, to exit the changes made, press the **ESC** key



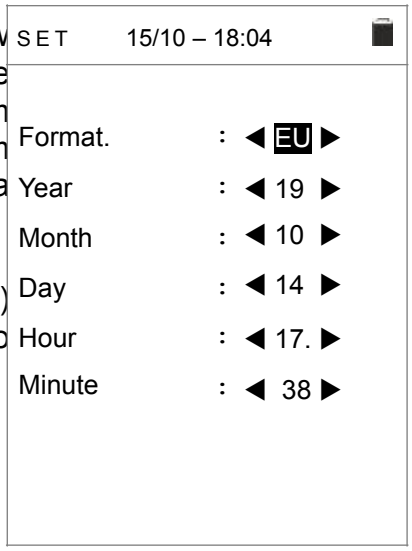
5.1.5. Auto Start feature

The AutoStart feature allows to run automatically the RCD and LOOP measurements. **In order to correct use the AutoStart mode it is NECESSARY to run the FIRST test by pressing the GO/STOP key on the instrument or the START key on the remote lead.**
After first test completion, as soon as the instrument detects in input a steady voltage within the allowed range, run the test without pressing the **GO/STOP** key on the instrument or the **START** key on the remote lead.

5.1.6. Date and time

Move the cursor to **Date and time** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the display shows the screen which allows to set the system date/time. Select “Format” field to set the European system (“DD/MM/YY, hh:mm” **EU** format) or the American systema (“MM/DD/YY hh:mm” **USA** format).

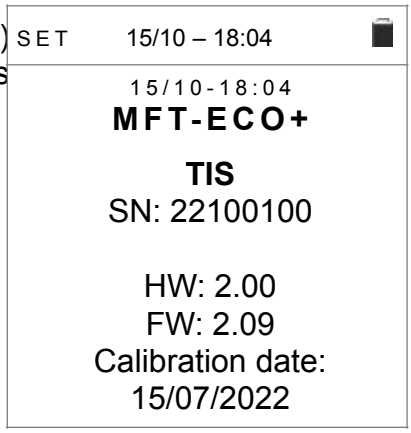
Select the desired option by means of the arrow keys (▲,▼) and the (◀, ▶). To store settings, press the **ENTER** key, to exit the changes made, press the **ESC** key.



5.1.7. Info

Move the cursor to **Info** by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently, the display shows the initial screen as indicated in the screen at side.

Press **ESC** key to return to main menu



6. OPERATING INSTRUCTIONS

6.1. AUTO: AUTOMATIC TEST SEQUENCE (NOTRIP ⏚, RCD)

This function allows to perform in automatic sequence the following measurements (**only for TN systems**):

- ➢ Overall earth resistance without causing the RCD tripping (**NoTrip⏚**)
- ➢ Tripping current and tripping time of **General** RCD type A/F (∿⎍/⎍∿) or AC (∿)

CAUTION

⚠ Testing the RCD's tripping time causes the RCD's tripping. **Therefore, check that there are NO users or loads connected downstream of the RCD being tested which could be damaged by a system downtime.** Disconnect all loads connected downstream of the RCD as they could produce leakage currents further to those produced by the instrument, thus invalidating the results of the test.

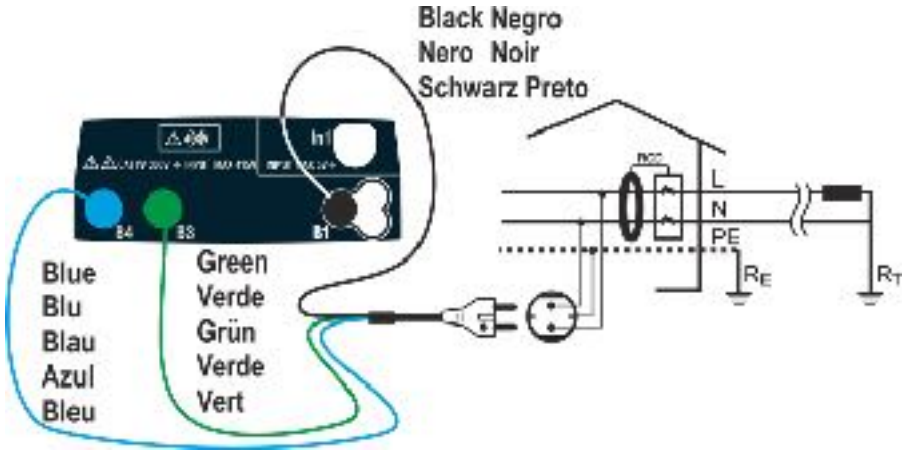


Fig. 4: Instrument connection in L-N-PE single phase system through mains plug

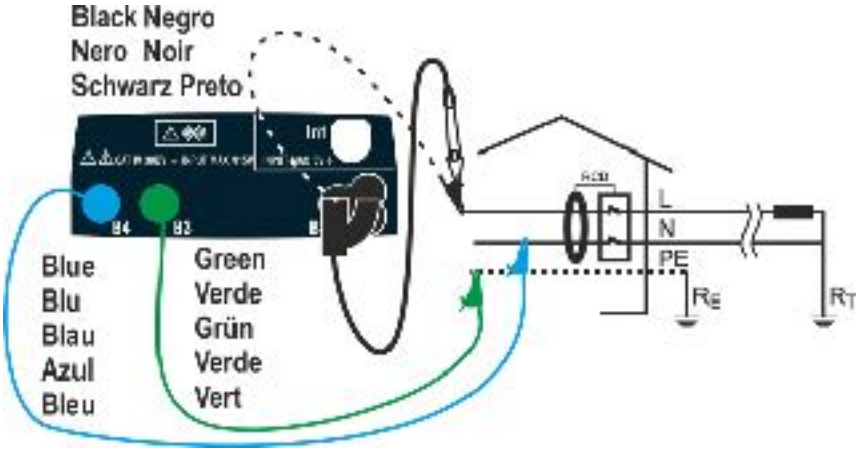


Fig. 5: Instrument connection in L-N-PE single phase system by means of single cables and remote switch probe

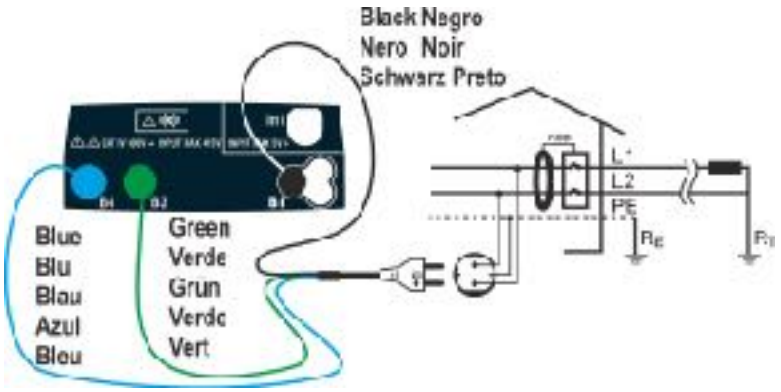


Fig. 6: Instrument connection in L-L-PE split phase system through mains plug

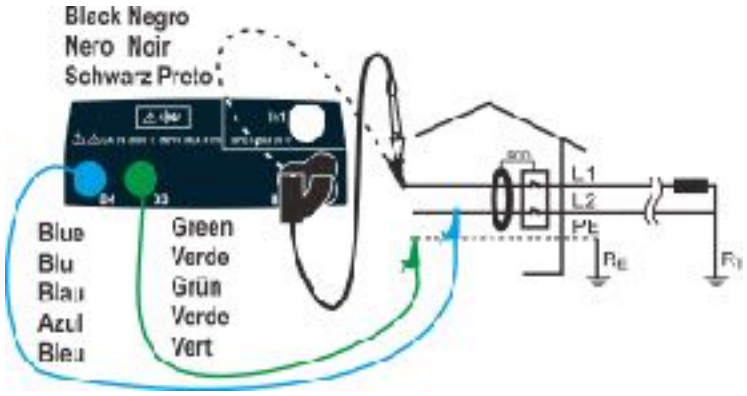
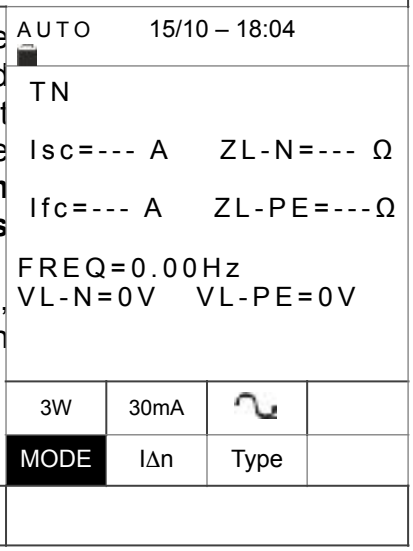


Fig. 7: Instrument connection in L-L-PE split phase system by means of single cables and remote switch probe

Press the **MENU** key, move the cursor to **AUTO** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2** Select the “UK” country (see § 5.1.2), the options “TN”, “25 or 50V”, “50Hz or 60Hz” and the reference voltage in the general settings of the instrument (see § 5.1.3)

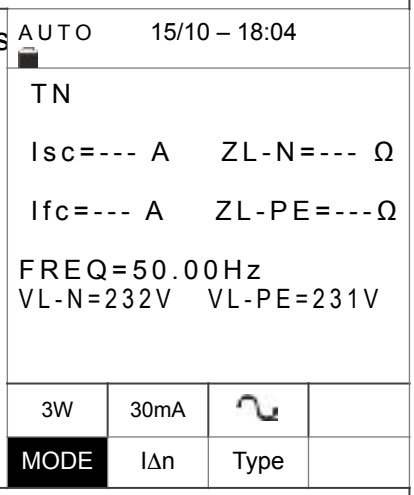


Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value

- ➢ **MODE** → 3-wire connection is the fixed mode
- ➢ **IΔn** → The virtual key allows setting the nominal value of the RCD's tripping current, which may be: **6mA, 10mA, 30mA**
- ➢ **Type** → The virtual key enables the selection of the RCD type, which may be: A/F (∿/⎓) or AC (∿)

Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B1, B3 and B4 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the shuko plug, the alligator clips or the remote lead to the electrical mains according to Fig. 4, Fig. 5, Fig. 6 or Fig. 7

Note the correct voltage values between L-N and L-PE as shown in the screen to the side

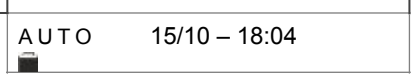


Press the **GO/STOP** key on the instrument or the **START** key on remote lead. The instrument will start the automatic test sequence.

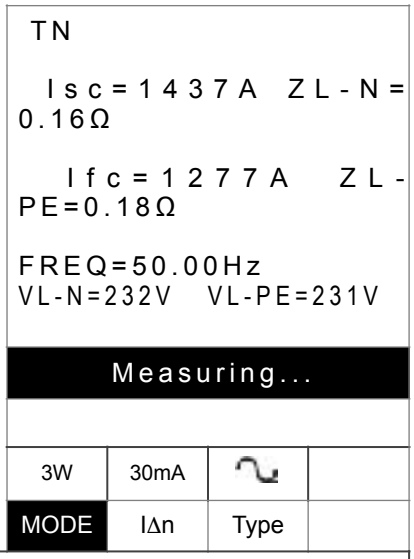
CAUTION

If message "**Measuring…**" appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the mains

The **NoTrip** test starts and the screen to the side

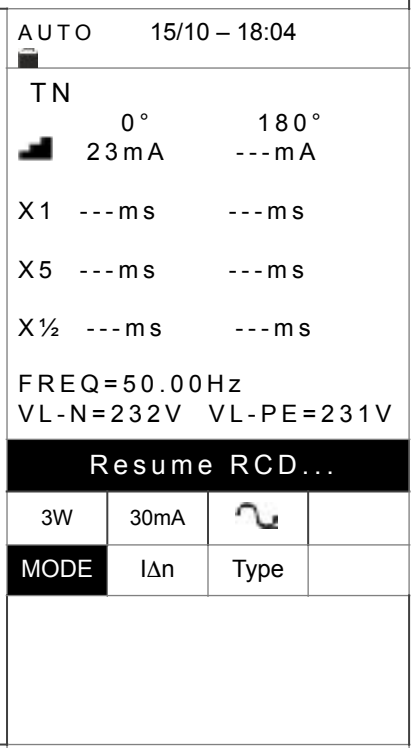


appears on the display. After **approx. 20s** the **NoTri** ends and instantaneously the values of Z_{L-N}, Z_{L-PE}, I_{SC} I_{FCMin} appears on the display. If the results are corr the instrument proceed with progress of the **AUTO** test on the RCD



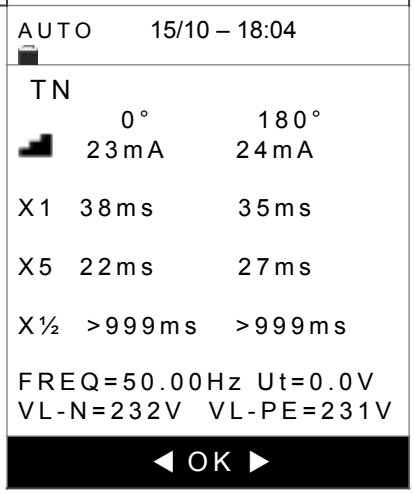
The **AUTO+** mode foresees the automatic execution of 8 measurements in a sequence:

- ➢ (Ramp) with phase 0° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ (Ramp) with phase 180° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 1 with phase 0° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 1 with phase 180° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 5 with phase 0° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 5 with phase 180° (the RCD must trip,reset the switch, message “Resume RCD” is shown
- ➢ IdN x½ with phase 0° (RCD must not trip)
- ➢ IdN x½ with 180° (RCD must not trip, end test)



In case of **positive** result of the all test sequentially performed as **NoTrip** (Z_{L-N} and Z_{L-PE}<199Ω), **RCD tripping times** (see § 10.4) and **RCD tripping current** the “OK” message is shown and the screen to the side is displayed by the instrument.

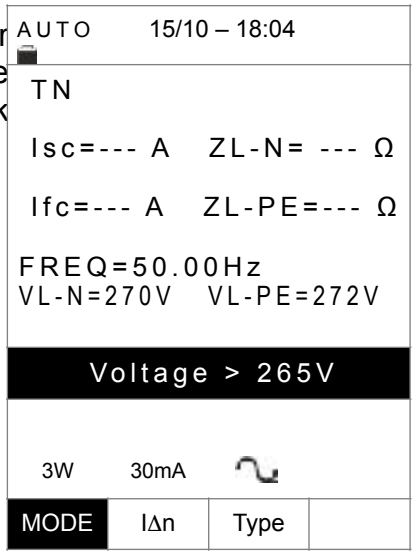
Press the (◀, ▶) in order to show the values of the second available page.



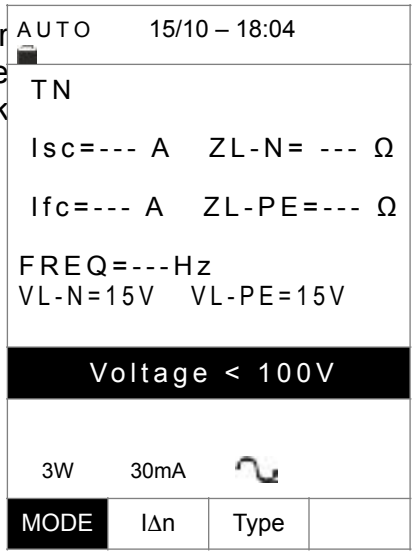
	3W 30mA ~ MODE IΔn Type
In case of **negative** result of the **NoTrip** (Z_{L-N} and/or Z_{L-PE} **>199**Ω), the auto test is automatically blocked, the message “NOT OK” is shown and the screen to the side is displayed.	AUTO 15/10 – 18:04 TN Isc=1437A ZL-N=0.16Ω Ifc=--- A ZL-PE=>199Ω FREQ=50.00Hz VL-N=232V VL-PE=231V ◀ NOT OK ▶... 3W 30mA ~ MODE IΔn Type
In case of **negative** result of the **AUTO+** test, the auto test is automatically blocked, the message “NOT OK” is shown and the screen to the side is displayed.	AUTO 15/10 – 18:04 TN 0° 180° 23mA 24mA X1 >999ms ---ms X5 ---ms ---ms X½ ---ms ---ms FREQ=50.00Hz Ut=0.0V VL-N=232V VL-PE=231V ◀ NOT OK ▶ 3W 30mA ~ MODE IΔn Type

1. Anomalous situations

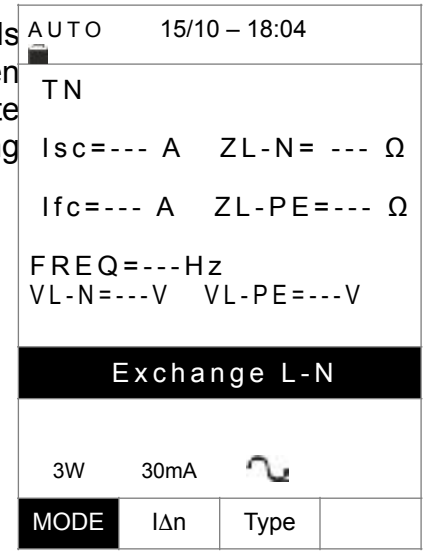
If the instrument detects an L-N or L-PE voltage higher than the maximum limit (265V), it does not carry out the test and displays a screen like the one to the side. Check the connection of measuring cables



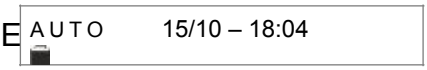
If the instrument detects an L-N or L-PE voltage lower than the minimum limit (100V), it does not carry out the test and displays a screen like the one to the side. Check that the system being tested is supplied



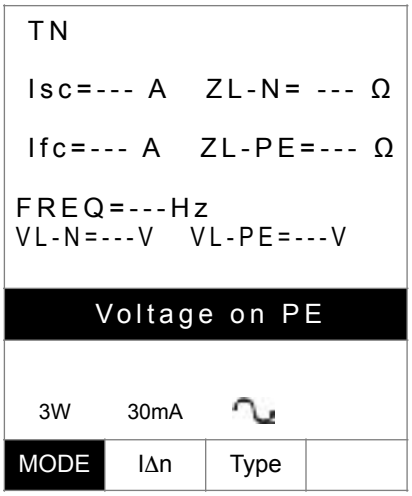
If the instrument detects that the phase and neutral leads are inverted, it does not carry out the test and a screen similar to the one reported to the side is displayed. Rotate the Mains Plug or check the connection of measuring cables



If the instrument detects a danger voltage on PE



conductor, it does not carry out the test and displays a screen like the one to the side



6.2. DMM: MULTIMETER FUNCTION

This function allows to perform real-time measurement of the Phase-Neutral, Phase-PE, Neutral-PE voltage and frequency (Phase-Neutral voltage) with direct connection of the instrument to the AC source.

CAUTION

The maximum admissible input voltage is 460V. Do not measure voltages that exceed the limits indicated in this manual. Exceeding these limits could cause electric shocks to the user and damage to the instrument

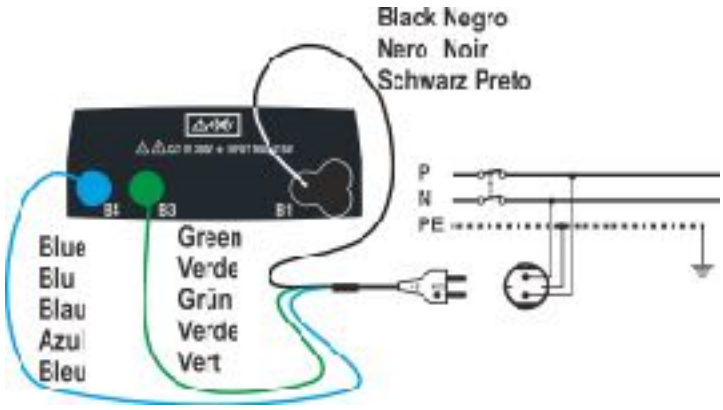


Fig. 8: Instrument connection through Mains Plug

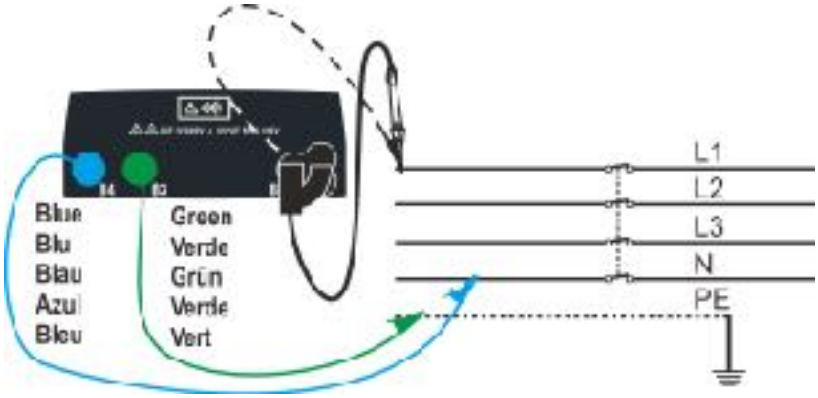
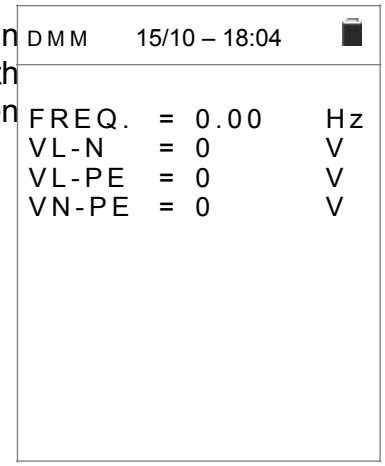


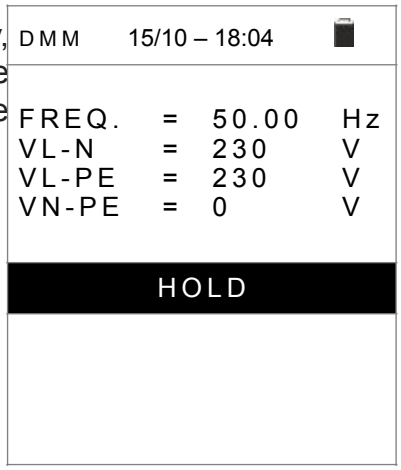
Fig. 9: Instrument connection by means of single cables and remote lead

Press the **MENU** key, move the cursor to **DMM** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side



Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B1, B3 and B4 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the shuko plug, the alligator clips or the remote lead to the electrical mains according to Fig. 8 or Fig. 9

The instrument performs the measurement directly, providing the result on the display as shown in the screen to the side. Press the **GO/STOP** key to fix the result on the display. The message "HOLD" is shown



CAUTION

These data cannot be saved in the instrument's internal memory.

6.3. RPE: CONTINUITY OF PROTECTIVE CONDUCTORS

This function is performed in compliance with standards IEC/EN61557-4, BS7671 17th/ 18th edition and allows measuring the resistance of protective and equipotential conductors.

CAUTION

- The instrument can be used for measurements on installations with overvoltage category CAT IV 300V to earth and max 415V between inputs
- We recommend holding the alligator clip respecting the safety area created by the hand protection (see § 4.2).
- Check that no voltage is present at the ends of the item to be tested before carrying out a continuity test.

The results may be influenced by the presence of auxiliary circuits connected in parallel with the item to be tested or by transient currents.

The following operating modes are available:

- **STD** the test is activated by pressing the **GO/STOP** key (or **START** on the remote lead). Recommended mode
- **TMR** the user can set a sufficiently long time to be able to move the tip on the conductors being examined while the instrument performs the test. For all the duration of the measurement the instrument emits a short acoustic signal every 3 seconds elapsed. The user shall touch the metal part under test while the instrument beeps. If, during the measurement, a result assumes a value higher

than the set limit, the instrument emits a continuous acoustic signal. To stop the test, press the **GO/STOP** key or the **START** key on the remote lead again

- >ϕ<Compensation of the resistance of the cables used for measurement. The instrument automatically subtracts the value of cable resistance from the measured resistance value. **Therefore, it is necessary that this value is measured (by the >ϕ< function) each time the measuring cables are changed or extended**

CAUTION

Continuity test is carried out by supplying a current higher than 200mA in case the resistance does not exceed ca. 5Ω (including resistance of the test cables). For higher resistance values, the instrument carries out the test with a current lower than 200mA.

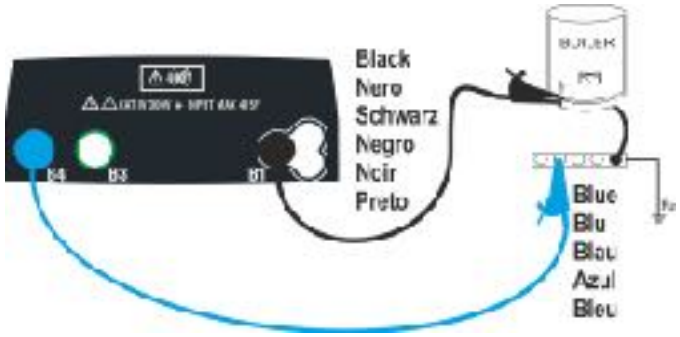


Fig. 10: Continuity test by means of single cables

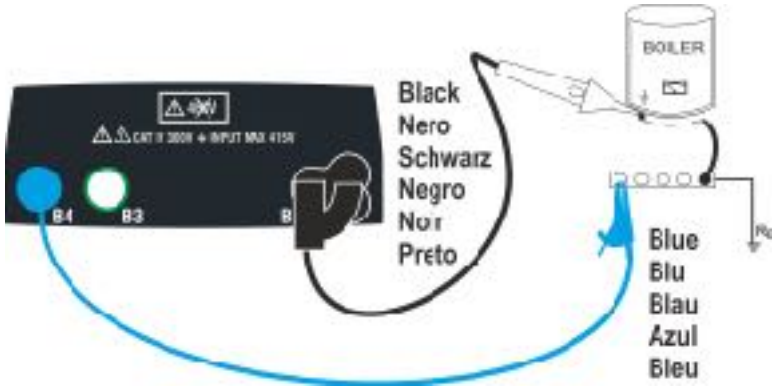


Fig. 11: Continuity test by means of remote lead

Press the **MENU** key, move the cursor to **RPE** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side.

RPE	15/10 – 18:04	
R	=	- - - Ω
Itest	=	- - - mA
STD	2.00 Ω	- - - Ω

MODE	Lim		> ϕ<

Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value:

- ➢ **MODE** → this virtual key allows setting the test mode. The following options are available: **STD, TMR**
- ➢ **Lim** → this virtual key allows the selection of the maximum limit to consider the measured value correct. It is possible to set a limit included in the range: **0.01**Ω **÷ 9.99**Ω in passi da 0.01Ω
- ➢ **Time (TMR mode)** → this virtual key allows you to set the duration of the measurement in the range: **3s ÷ 99s** in passi da 3s

Insert the blue and black connectors of the single cables into the corresponding inpu leads B4 and B1 of the instrument. Apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipola connector into the input lead B1

Should the length of the cables provided be insufficient for the measurement to be performed, extend the blue cable

Select the **>ϕ<** mode to compensate the resistance of the cables used for measuring according to the instructions given in 6.3.2

CAUTION

Before connecting the test leads, make sure that there is no voltage at the ends of the conductor to be tested.

Connect the test leads to the ends of the conductor to be tested as in Fig. 10 o Fig. 11

CAUTION

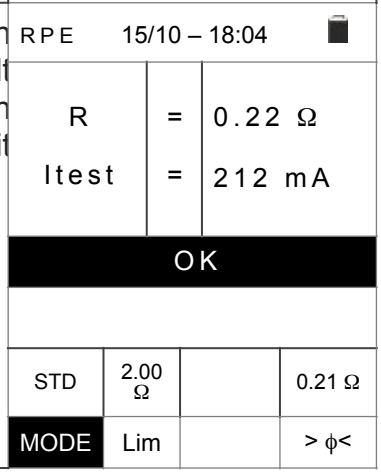
Always make sure, before any test, that the compensation resistance value of the cables is referred to the cables currently used. In case of doubt, repeat the cable calibration procedure as in § 6.3.2

Press the **GO/STOP** key on the instrument or the **START** key on remote lead. The instrument will start the measurement

CAUTION

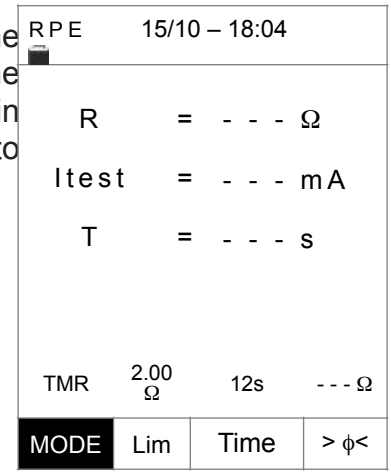
If message “**Measuring…**” appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the conductor under test

At the end of the measurement the instrument shows on the display the message "OK" in case of a positive result (value lower than the set limit threshold) or "NOT OK" in case of negative result (value higher than the set limit threshold

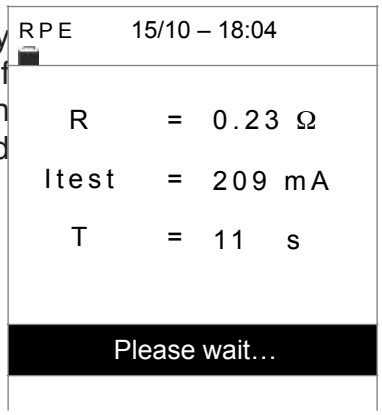


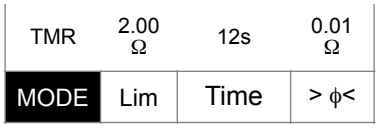
6.3.1. TMR mode

With the arrow keys (▲,▼) select the "TMR" option in the "**Mode**" section. The instrument displays a screen like the one shown to the side, set the measurement duration in the "**Time**" section and follow the steps from point 2 to point 6 of § 6.3

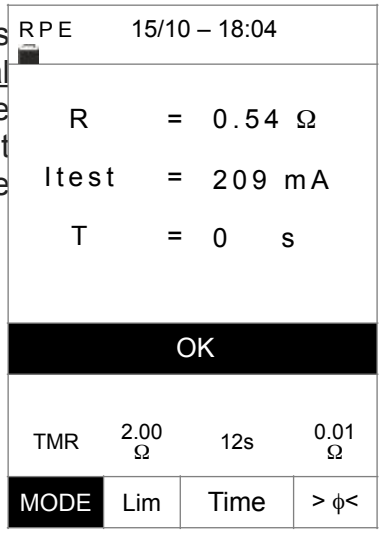


Press **GO/STOP** key on the instrument or the **START** key on the remote lead. The instrument starts a series of continuous measurements for the entire duration set with a countdown by giving a short beep every 3 seconds and alternating the words "**Measuring…**" and "**Please wait…**”





At the end of the set duration time, the instrument shows on the display the maximum value between all the partial measurements performed and the message "**OK**" in case of a positive result (value lower than the set limit threshold) or "**NOT OK**" in case of negative result (value higher than the set limit thresholdE



6.3.2. > ϕ < mode

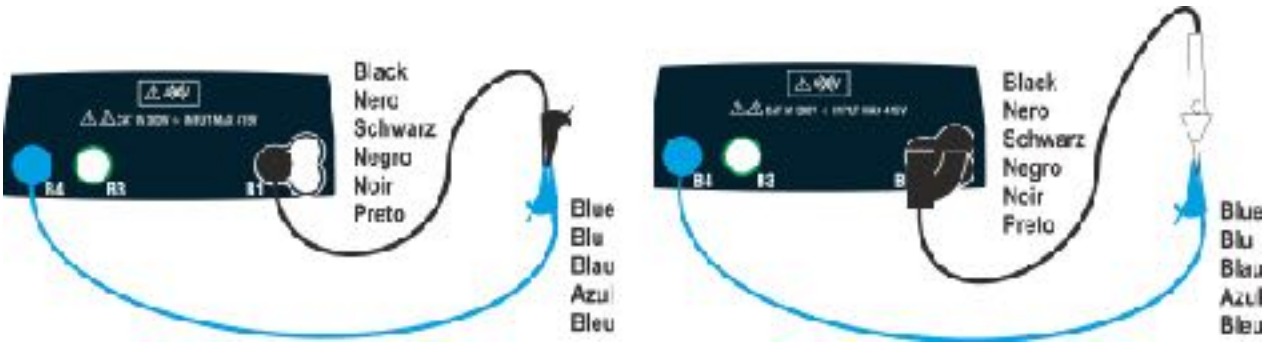


Fig. 12: Compensation of single cables and remote lead resistance

Use the ◀, ▶ keys to select the the virtual key **> ϕ <**

Connect the alligator clips and/or test leads and/or remote prove to the conductor to be tested as in in Fig. 12.

Press the **GO/STOP** key on the instrument or the **START** key on remote lead. The instrument starts the calibration procedure of the cables immediately followed by the verification of the compensated value

CAUTION

If message "**Measuring…**" appears on the display, the instrument is performing measurement. If message "**Verify**" appears on the display, the instrument is verifying the calibrated value. During this whole stage, do not unshort the test leads of the instrument.

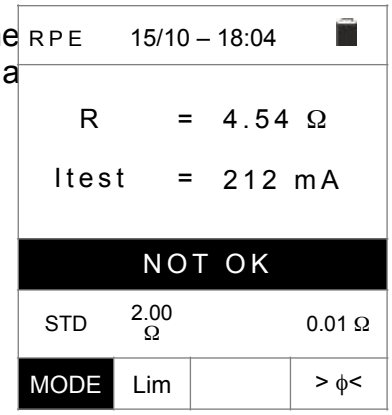
Once calibration is comple-ted, in case the detected value is lower than 5Ω, the instrument gives a double acoustic signal which signals the positive result of the test and displays a screen similar to the one reported here to the side

RPE	15/10 – 18:04		
R	=	- - - Ω	
Itest	=	- - - mA	
STD	2.00 Ω		0.01 Ω
MODE	Lim		> ϕ<

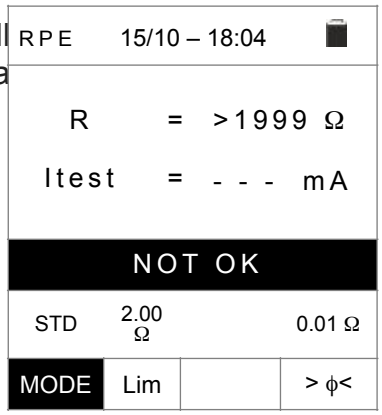
In order to delete the compensation resistance value of the cables, it is necessary to perform a cable calibration procedure with a resistance higher than 5Ω at test leads (e.g. with open test leads).

6.3.3. Anomalous situations

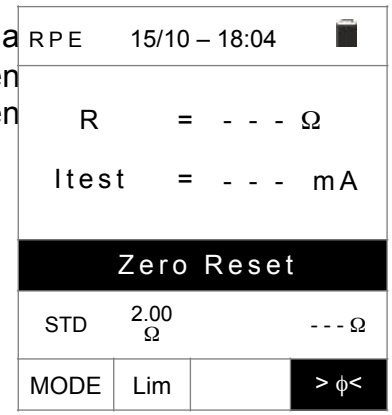
In case the detected value is higher than the set limit, the instrument gives a long acoustic signal and displays a screen similar to the one reported here to the side



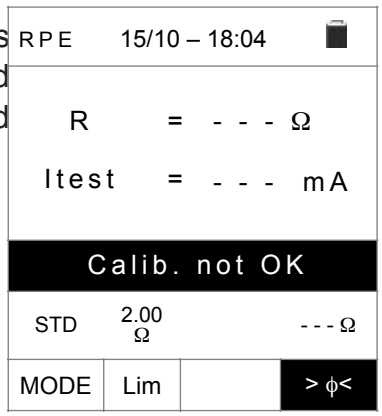
If the instrument detects a resistance higher than the full scale it emits a prolonged acoustic signal and displays a screen like the one to the side



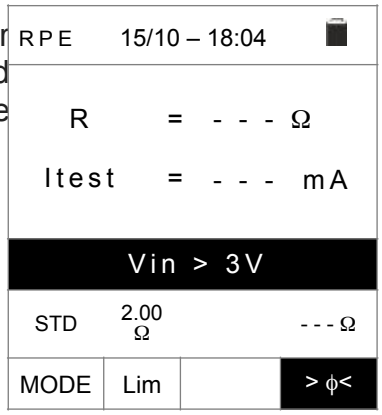
By using the **>ϕ<** mode, in case the instrument detects a calibration reset (performing the operation with open terminals), it gives out a long sound and displays a screen like the one to the side



By using the >ϕ< mode, the instrument detects at its terminals a resistance higher than 5Ω emits a prolonged acoustic signal, resets the compensated value and displays a screen like the one to the side



If the instrument detects at its terminals a voltage higher than 3V it does not perform the test, it emits a prolonged acoustic signal and displays a screen like the one on the side



6.4. MΩ: MEASUREMENT OF INSULATION RESISTANCE

This function is performed in compliance with standards IEC/EN61557-2, BS7671 17th/18th edition and allows measuring the insulation resistance between the active conductors and between each active conductor and the earth. The following operating modes are available:

- **MAN** the test can be carried out between the L-N, L-PE or N-PE conductors and has a fixed duration of 3s when the **GO/STOP** key is pressed on the instrument (or **START** on the remote lead). Recommended mode
- **TMR** the test is carried out between the L-PE conductors and has a programmable duration in the **3s ÷ 999s** range in steps from 1s to the pressing of the **GO/STOP** key on the instrument (or **START** of the remote lead). It is possible to perform **DAR** (Dielectric Absorbtion Ratio) duration test for test time >60s and **PI** (Polarization Index) for test time> 600s (10min)
- **AUTO** the instrument performs an automatic sequence test between the L-N, L-PE and N-PE conductors when the **GO/STOP** key is pressed on the instrument (or **START** of the remote lead

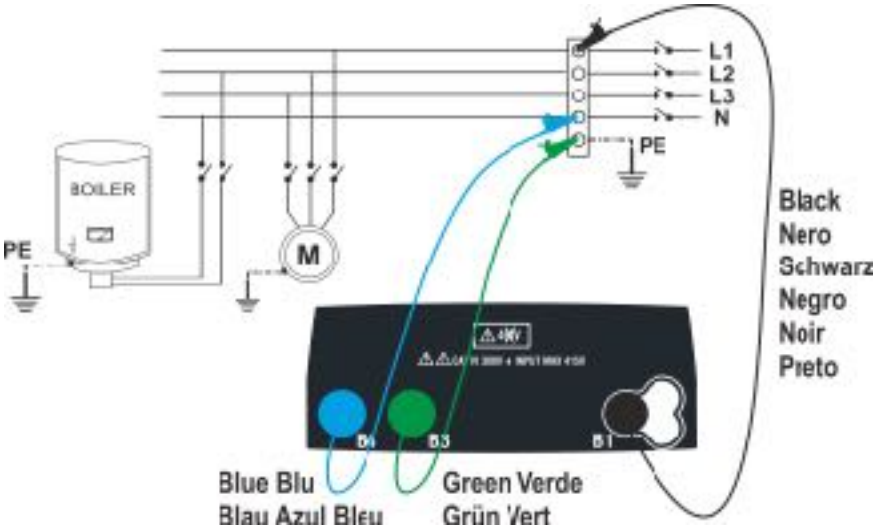


Fig. 13: Insulation test between L-N-PE by means of single cables(MAN and AUTO modes)

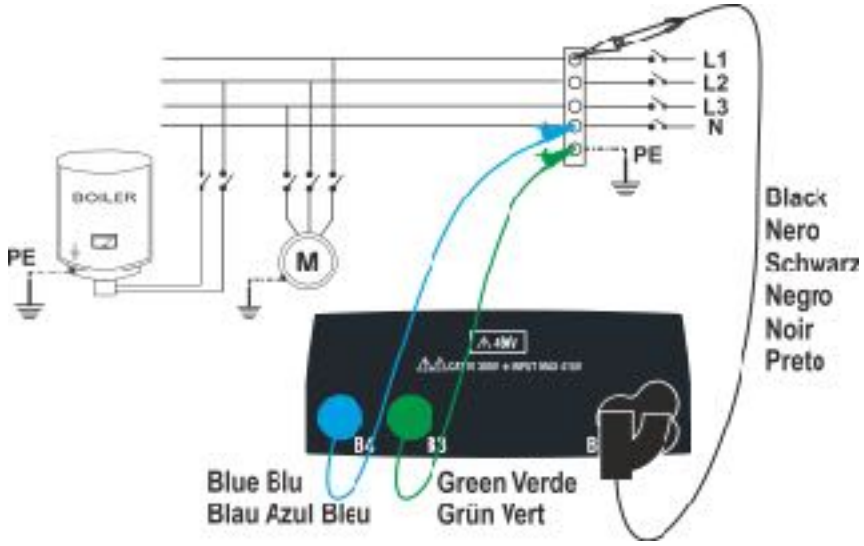


Fig. 14: Insulation between L-N-PE with single cables and remote lead (MAN and AUTO)

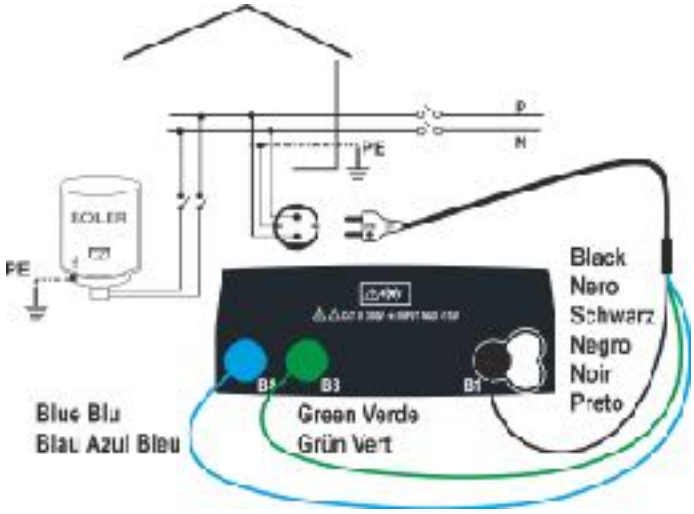


Fig. 15: Insulation between L-N-PE by means of Mains plug (MAN and AUTO)

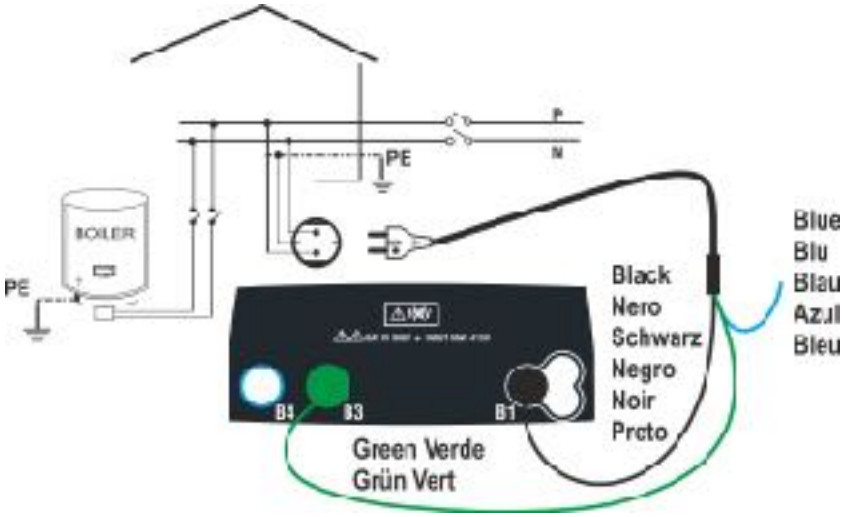


Fig. 16: Insulation between L-PE by means of Mains plug (TMR mode)

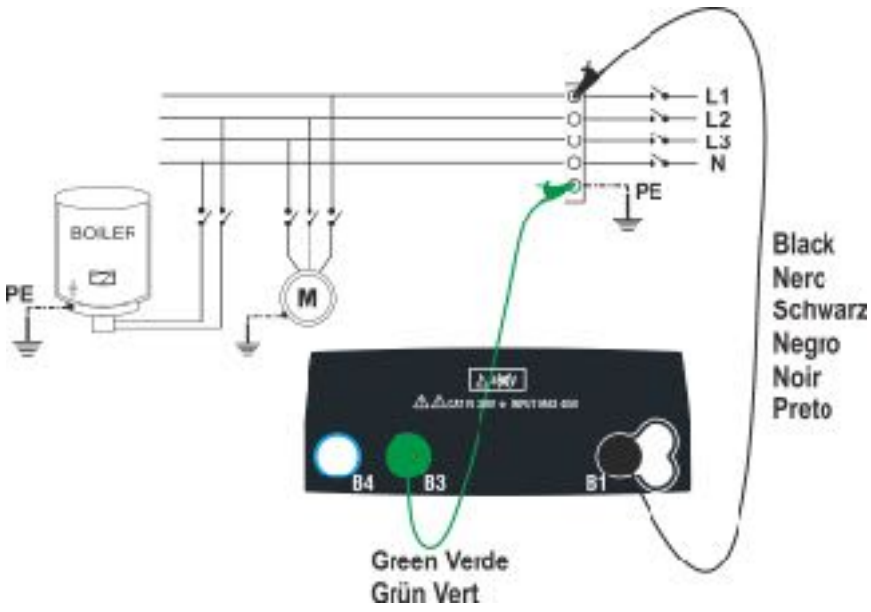


Fig. 17: Insulation between L-PE by means of single cables (TMR mode)

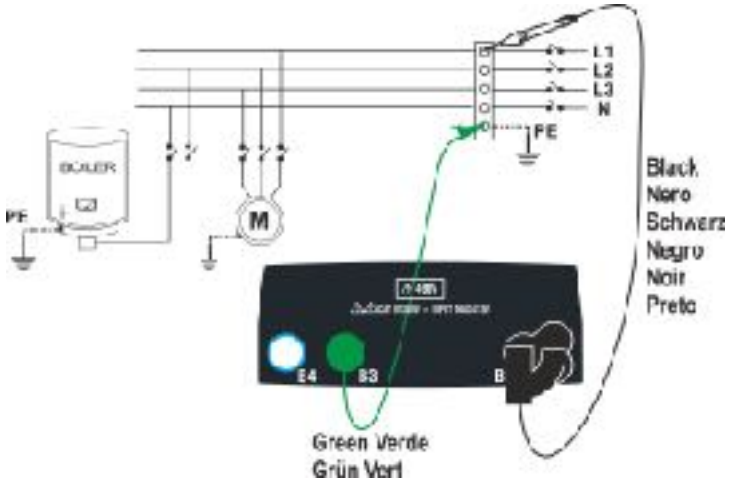
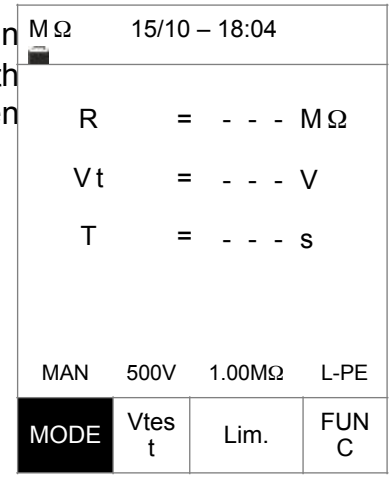


Fig. 18: Insulation between L-PE by means of single cable and remote lead (TMR mode)

Press the **MENU** key, move the cursor to **MΩ** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side



Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value:

➢ **MODE** → This key allows setting the test mode. The following options are

We suggest setting the value of the voltage supplied while measuring and the minimum limit to consider the measure correct according to the prescriptions of the reference standard (see § 10.2)

Insert the green and black connectors of the single cables into the corresponding inpu leads B1, B3, B4 (MAN and AUTO modes) or B1, B3 (TMR mode) of the instrument Apply the relevant alligator clips to the free ends of the cables. It is also possible tc use the remote lead by inserting its multipolar connector into the input lead B1. Shoulc the length of the cables provided be insufficient for the measurement to be performed extend the green cable

CAUTION

- Disconnect any cable not strictly involved in measurement
- Before connecting the test leads, make sure that there is no voltage at the ends of the conductors to be tested

Connect the test leads and rempte lead to the ends of the conductors to be tested as Fig. 13, Fig. 14, Fig. 15, Fig. 16, Fig. 17, or Fig. 18

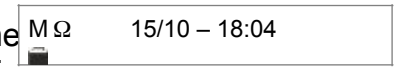
Press the **GO/STOP** key **for few seconds** on the instrument or the **START** key on remote lead. The instrument will start the measurement

CAUTION

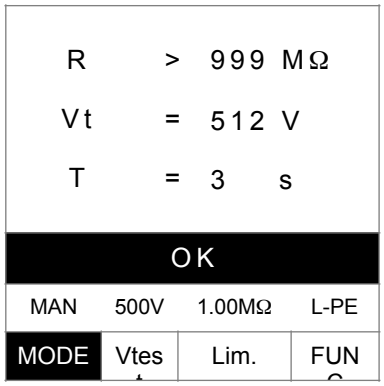
If message "**Measuring…**" appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the conductors under test, as the circuit being tested could remain charged with a dangerous voltage due to the stray capacitances of the system

Regardless of the operating mode selected, the instrument, at the end of each test, applies a resistance to the output leads to discharge the stray capacitances in the circuit

At the end of the measurement (fixed duration of 3s) the

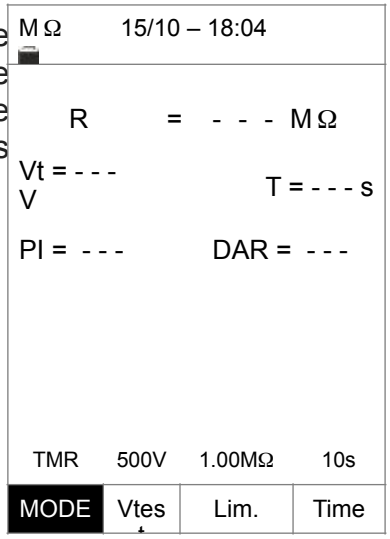


instrument shows on the display the message "**OK**" in case of a positive result (value higher than the set minimum limit threshold) or "**NOT OK**" in case of negative result (value lower than the minimum limit threshold set). The indication "**>999MΩ**" indicates the out of scale of the instrument which, normally, appears to be the best possible result

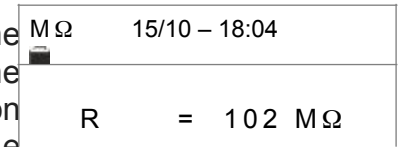


6.4.1. TMR mode

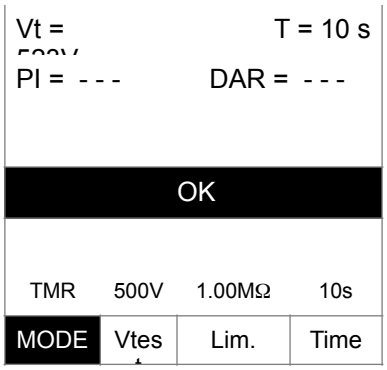
With the arrow keys (▲,▼) select the "TMR" option in the "**Mode**" section. The instrument displays a screen like the one shown on the side. Set the duration of the measurement in the "**Time**" section and follow the steps from point 2 to point 5 of § 6.4



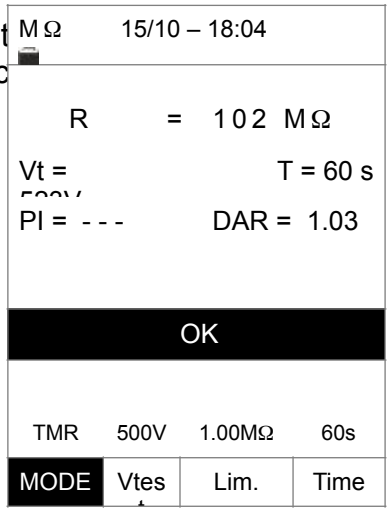
Press the **GO/STOP** key **<u>for few seconds</u>** on the instrument or the **START** key on the remote lead. The instrument starts the measurement for the entire duration set showing the "**Measuring**" message. The



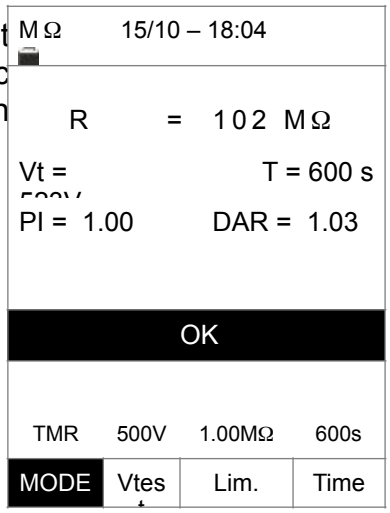
set showing the **Measuring...** message. The instrument shows the message "**OK**" on the display in case of a positive result (value higher than the set minimum threshold) or "**NOT OK**" in case of negative result (value lower than the minimum limit set



With a **measurement duration ≥ 60s** the instrument shows the indication of the DAR parameter (Dielectric Absorbtion Ratio) as shown in the screen to the side

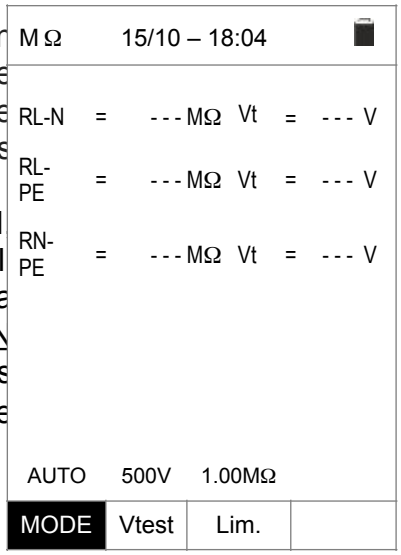


With a **measurement duration ≥ 600s** the instrument shows the indication of the DAR parameter (Dielectric Absorbtion Ratio) and of the PI prameter (Polarisation Index) as shown in the screen to the side

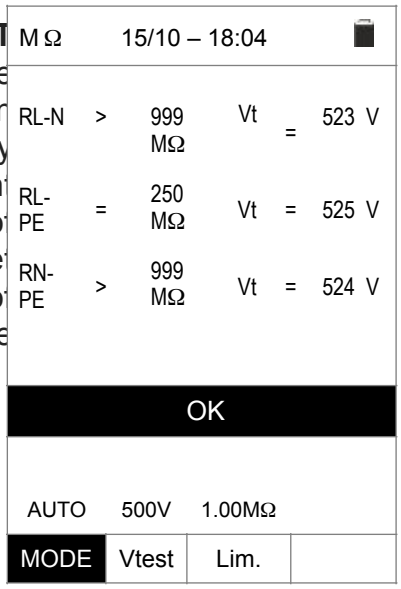


6.4.2. AUTO mode

With the arrow keys (▲,▼) select the "AUTO" option in the "**Mode**" section. The instrument displays a screen like the one shown on the side. Set the duration of the measurement in the "**Time**" section and follow the steps from point 2 to point 5 of § 6.4.
The instrument performs the insulation test between: L-N L-PE and N-PE. Since some loads could be still connected between L-N, the instrument performs a preliminary test by using 50V as test voltage. If the RL-N is higher than 50kΩ a new insulation test between L-N is performed by using the Vtest value. Finally the instrument performs L-PE and N-PE insulation test

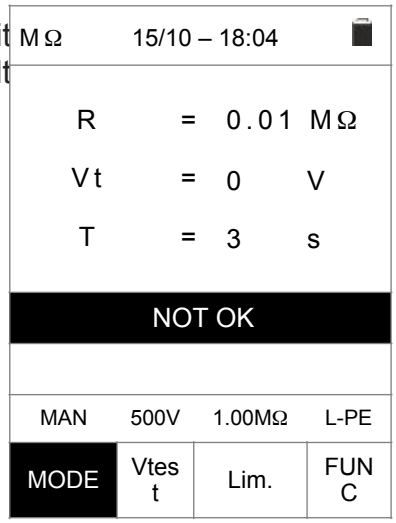


Press the **GO/STOP** key on the instrument or the **START** key on the remote lead. The instrument starts the automatic sequential measurement of the insulation resistance between L-N, L-PE and N-PE respectively by showing the "**Measuring…**" message. the instrument shows the message "**OK**" on the display in case of positive result of each test (value higher than the set minimum limit threshold) or "**NOT OK**" in case of negative result of at least one test (value lower than the set minimum limit threshold)

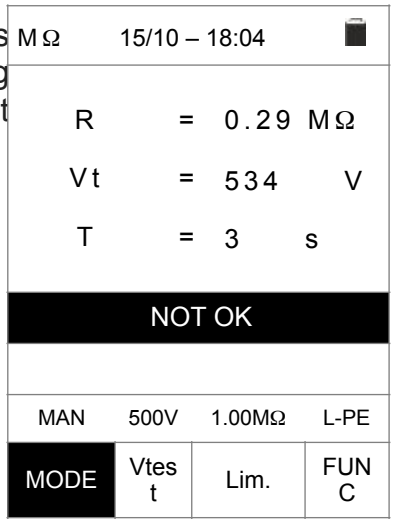


6.4.3. Anomalous situations

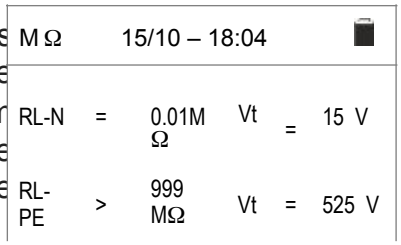
If the instrument fails to generate the nominal voltage, it emits a long acoustic signal to indicate the negative result of the test and displays a screen like the one on the side

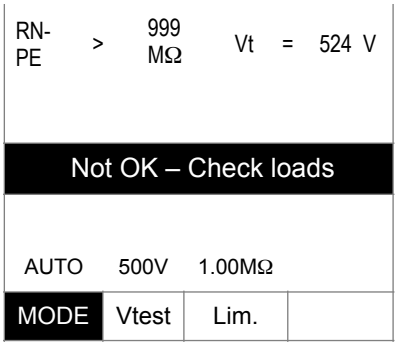


At the end of the test, if the measured resistance value is lower than the set limit, the instrument emits a long acoustic signal to indicate the negative result of the test and displays a screen like the one on the side

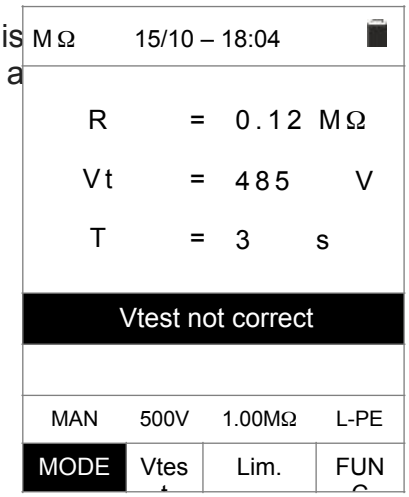


In AUTO mode if the insulation measurement L-N is <50kΩ = 0.05MΩ, all the tests are completed or if the **STOP** key has been pressed, if RL-PE and RN-PE> Lim and Vt> Vnom the instrument shows the screen like the one on the side. Disconnect the loads and resume the test

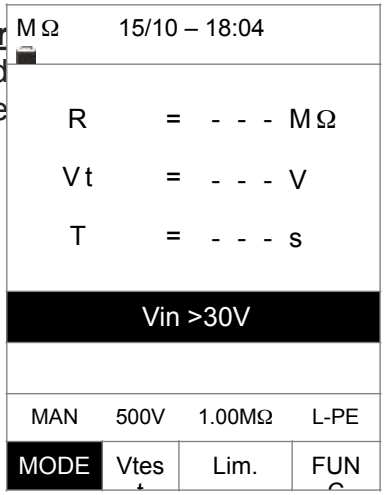




At the end of the test, if the value of the test voltage is lower than the nominal value, the instrument displays a screen like the one on the side



If the instrument detects at its terminals a voltage **higher than 30V** it does not perform the test, it emits a prolonged acoustic signal and displays a screen like the one on the side



6.5. RCD: TEST ON DIFFERENTIAL SWITCHES

This function is performed in compliance with standard IEC/EN61557-6, BS7671 17th edition and allows measuring the tripping time and current of molded case differential switches of type **A/F** (⎍/⎍), **AC** (∿), **B/B+** (⎓/⎓), **CCID** (∿,⎓) (USA country) and **DD** (compliance with IEC62955 standard), being General (G), Selective (S).

CAUTION

⚠ The instrument performs the check of voltage on PE by comparing the voltage at B4 input and the ground potential induced on instrument side by mean the user's hand, so in order to check voltage on PE, **it's mandatory to hold the instrument case on the left or on the right side**

CAUTION

- Some combinations of test parameters can be not available in compliance with the technical specification of the instrument and the RCD tables (see § 8.1 – **the empty cells of RCD tables means not available situations**)

The following operating modes are available:

- **AUTO** the instrument performs tripping time measurement automatically with a leakage current equal to half, once or five times the set value of nominal current and with a leakage current in phase with the positive (↑) and negative (↓) half-wave of the mains voltage. Recommended mode for RDC test
- **AUTO** the instrument performs tripping time measurement automatically with a leakage current equal to half, once or five times the set value of nominal current and with a leakage current in phase with the positive (↑) and negative (↓) half-wave of the mains voltage and also real tripping current
- **x½** the instrument performs tripping time measurement with a leakage current equal to half the set value of nominal current with the positive (↑) and negative (↓) half-wave of the mains voltage
- **x1** the instrument performs tripping time measurement with a leakage current equal to once the set value of nominal current with the positive (↑) and negative (↓) half-wave of the mains voltage
- **x5** the instrument performs tripping time measurement with a leakage current equal to five times the set value of nominal current with the positive (↑) and negative (↓) half-wave of the mains voltage
- the instrument performs measurement with an increasing leakage current. This test could be performed to determine the real tripping current of the RCD with the positive (↑) and negative (↓) half-wave of the mains voltage

CAUTION

Testing an RCD causes the RCD's tripping. **Therefore, check that there are NO users or loads connected downstream of the RCD being tested which could be damaged by a system downtime.**
If possible, disconnect all loads connected downstream of the RCD as they could produce leakage currents further to those produced by the instrument, thus invalidating the results of the test.

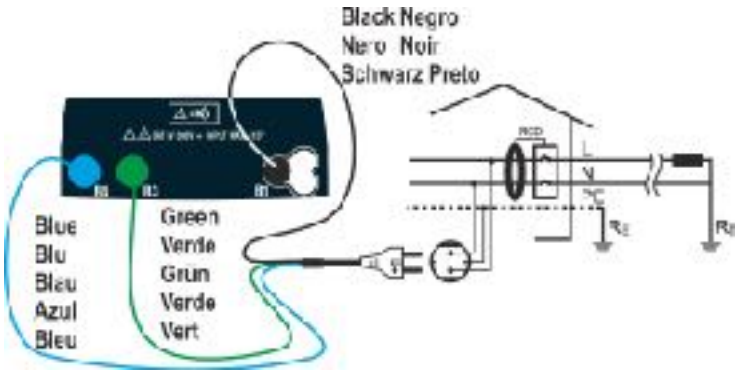


Fig. 19: Connection for single-phase L-N-PE system by means of mains plug

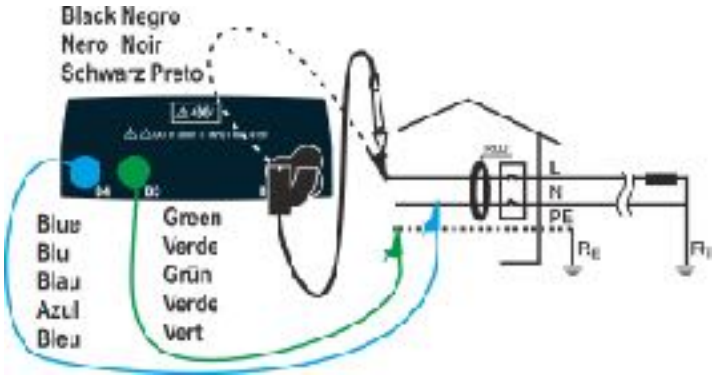


Fig. 20: Connection for single-phase L-N-PE system with single cables and remote switch probe

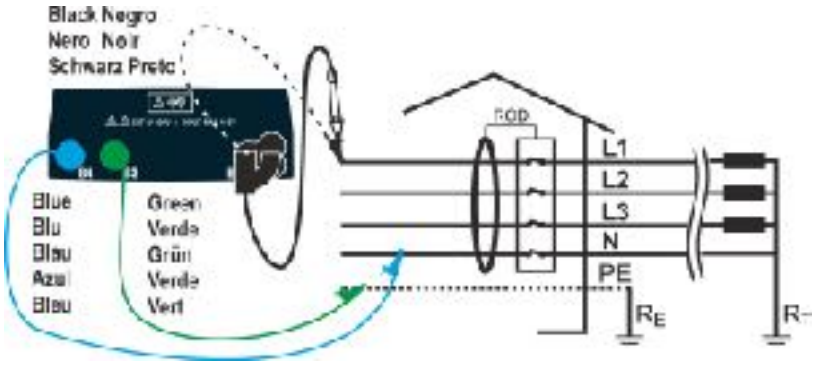


Fig. 21: Connection for three-phase L1-L2-L3-N system by means of single cables and remote switch probe

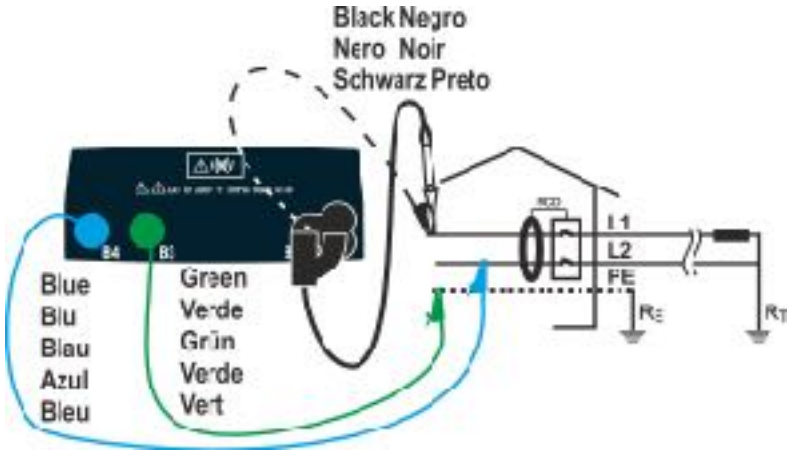


Fig. 22: Connection for L1-L2-PE split-phase system by means of single cables and remote switch probe

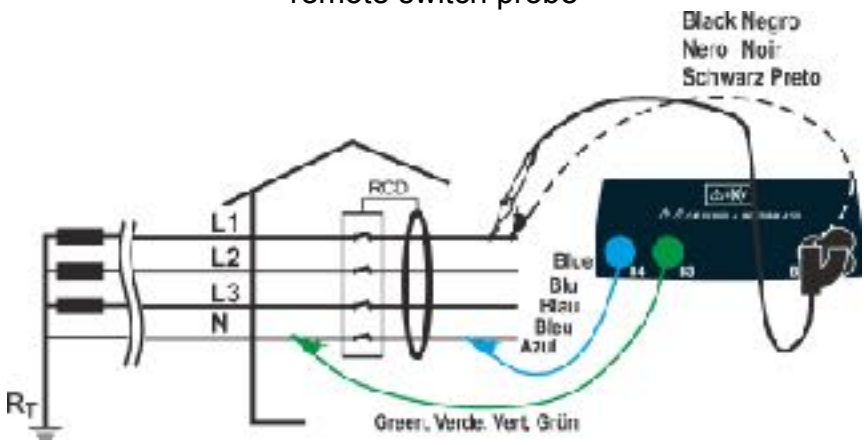
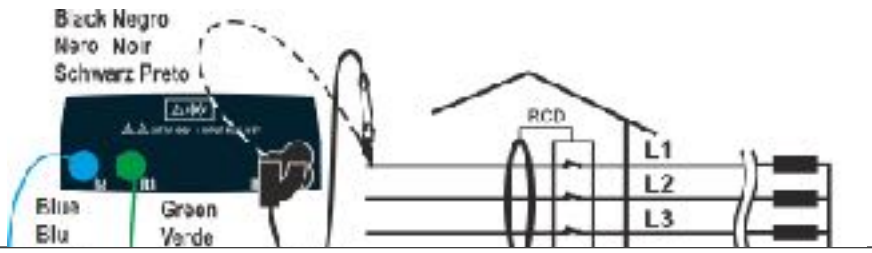
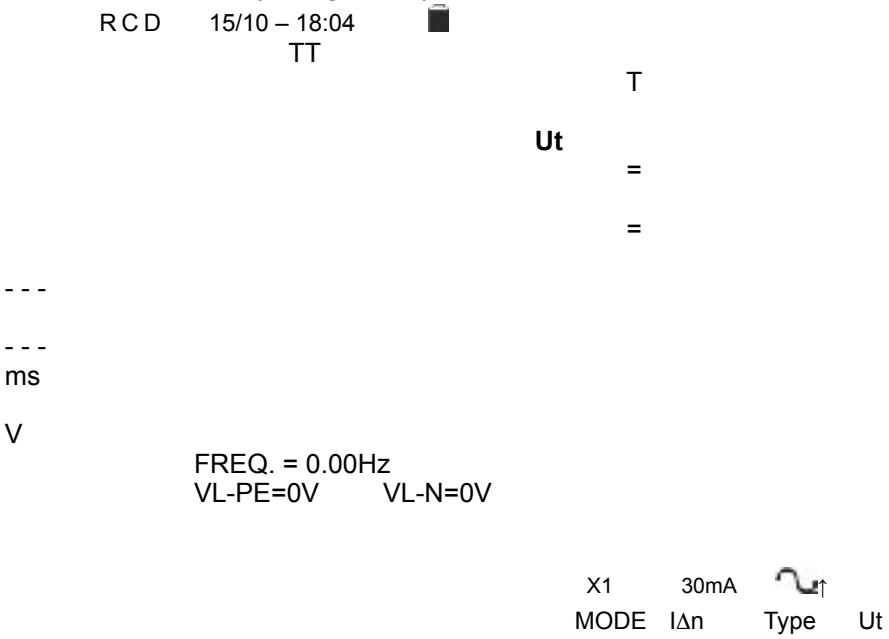


Fig. 23: Connection for three-phase L1-L2-L3-N (no PE) system by means of single cables and remote switch probe



Press the **MENU** key, move the cursor to **RCD** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**
Select the "UK" country (see § 5.1.2), the options "TN, TN or IT", "25 or 50V", "50Hz or 60Hz", the "L-N-PE or L-L-PE" system and the reference voltage in the general settings of the instrument (see § 5.1.3).



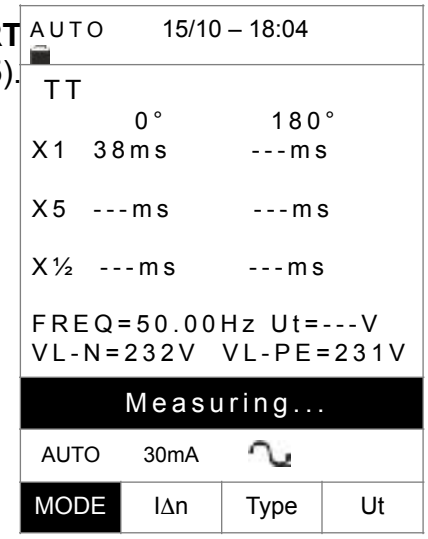
Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value**:**

- ➢ **MODE** → The virtual key allows setting the measuring mode of the instrument, which may be: **AUTO, AUTO, x½, x1, x5,**
- ➢ **IΔn** → The virtual key allows setting the nominal value of the RCD's tripping current, which may be: **5mA, 6mA, 10mA, 20mA, 30mA, 100mA, 300mA, 500mA, 650mA, 1000mA**
- ➢ **Type** → The virtual key enables the selection of the RCD type, which may be: **A/F** (- General), **A/F**(S - Selective), **AC** (- General), **AC** (S - Selective), **B/B+** (/), **DD** with polarity positive (↑) or negative (↓) and **CCID** , **CCID** with polarity positive (↑) or negative (↓)
- ➢ **Ut** → The virtual key allows setting the possible visualization of the contact voltage value at the end of measurement. Options: **Ut** or **NoUt**

Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote probe by inserting its multipolar connector into the input lead B1. Connect the shuko plug, the alligator clips or the remote probe to the electrical mains according to Fig. 19, Fig. 20, Fig. 21, Fig. 22, Fig. 23, Fig. 24

6.5.1. AUTO mode

Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement

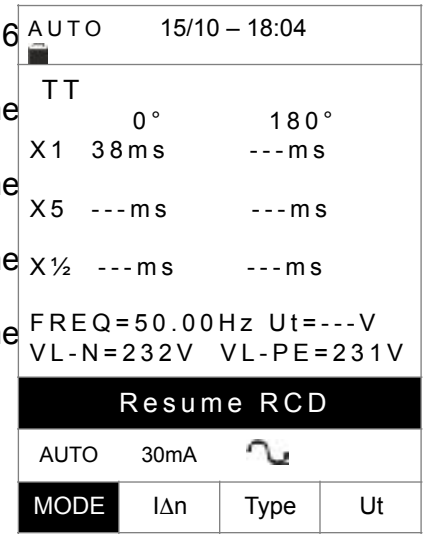


CAUTION

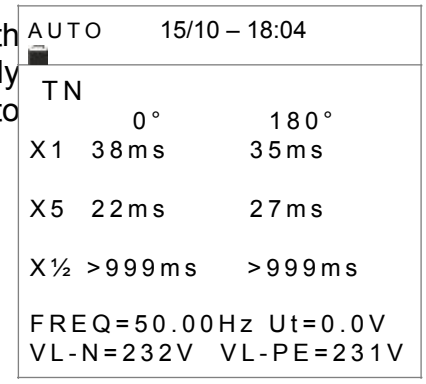
If message "**Measuring…**" appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the mains.

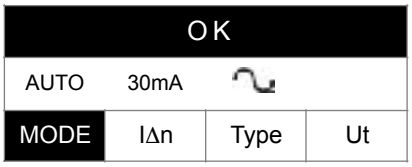
The **AUTO** mode foresees the automatic execution of 6 measurements in a sequence:

- ➢ IdN x 1 with phase 0° (the RCD must trip,reset the switch, message "Resume RCD" is shown)
- ➢ IdN x 1 with phase 180° (the RCD must trip,reset the switch, message "Resume RCD" is shown)
- ➢ IdN x 5 with phase 0° (the RCD must trip,reset the switch, message "Resume RCD" is shown)
- ➢ IdN x 5 with phase 180° (the RCD must trip,reset the switch, message "Resume RCD" is shown
- ➢ IdN x½ with phase 0° (RCD must not trip)
- ➢ IdN x½ with 180° (RCD must not trip, end test



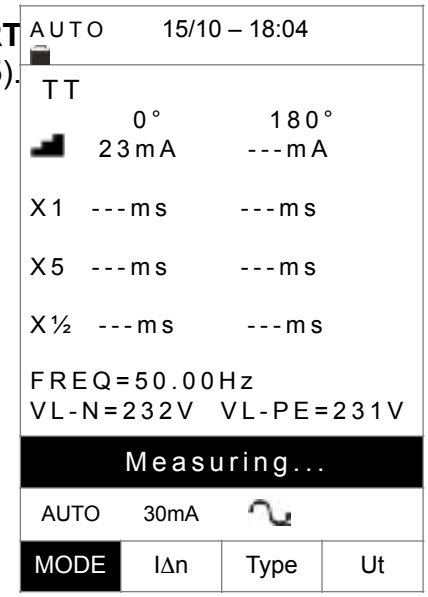
In case of **positive** result (all tripping times comply with what indicated in 10.4) of the all test sequentially performed the "**OK**" message is shown and the screen to the side is displayed by the instrument.





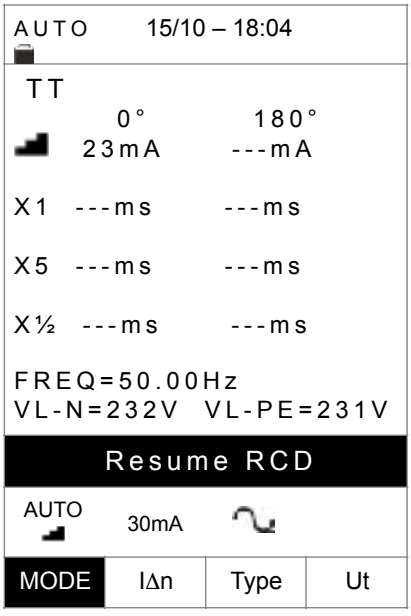
6.5.2. AUTO mode

Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement

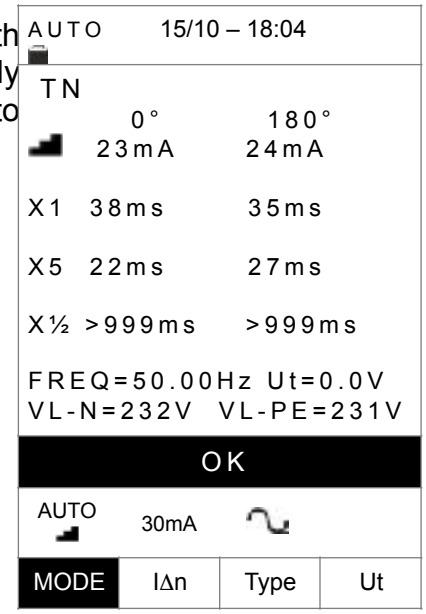


The **AUTO** mode foresees the automatic execution of 8 measurements in a sequence:

- ➢ (Ramp) with phase 0° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ (Ramp) with phase 180° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 1 with phase 0° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 1 with phase 180° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 5 with phase 0° (the RCD must trip,reset the switch, message “Resume RCD” is shown)
- ➢ IdN x 5 with phase 180° (the RCD must trip,reset the switch, message “Resume RCD” is shown
- ➢ IdN x½ with phase 0° (RCD must not trip)
- ➢ IdN x½ with 180° (RCD must not trip, end test



In case of **positive** result (all tripping times comply with what indicated in 10.4) of the all test sequentially performed the "**OK**" message is shown and the screen to the side is displayed by the instrument.



6.5.3. x½, x1, x5 modes

Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement

RCD 15/10 – 18:04

TT

T

Ut

=

=

- - -

- - -

ms

V

FREQ. = 0.00Hz

VL-PE=0V VL-N=0V

Measuring...

X1 30mA +

MODE IΔn Type Ut

CAUTION

If message "**Measuring…**" appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the mains.

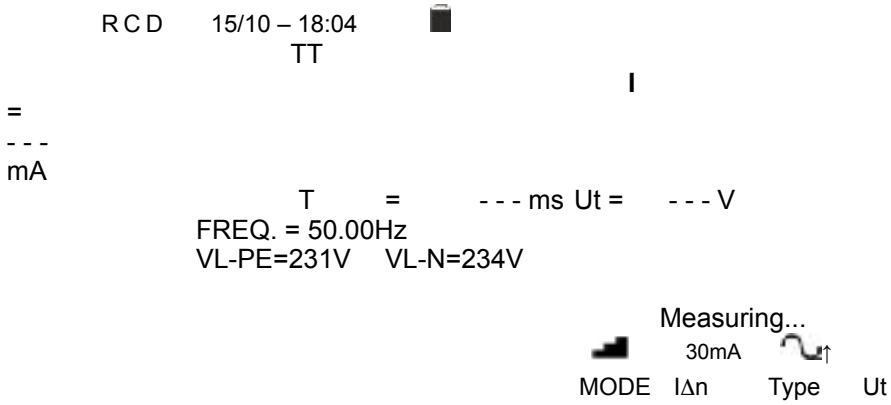
When the RCD trips and separates the circuit, if the tripping time is within the limits reported in 10.4, the instrument gives a double acoustic signal which signals the

6.5.4. ▟ mode

The standard defines the tripping times for RCDs at nominal current. The ▟ mode is used to detect the tripping time at tripping current (which could also be lower than the nominal voltage.

Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement

.

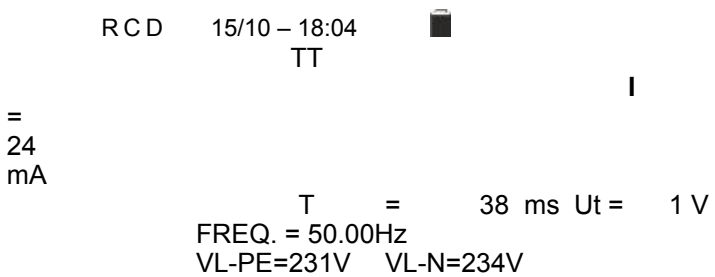


CAUTION

If message "**Measuring…**" appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the mains.

According to standard EN61008, the test for selective RCDs requires an interval of 60 seconds between the tests. **The ▟ mode is therefore unavailable for selective RCDs, both of A and of AC type**.

When the RCD trips and separates the circuit, if the tripping current and tripping time are within the limits reported in § 10.4, the instrument gives a double acoustic signal which signals the "**OK**" message is shown and the screen to the side is displayed by the instrument



6.5.5. DD mode

The standard IEC62955 defines the tripping times and current for **RCD-DD (Detecting Devices)** types at nominal current of **6mA** only. **The x1 and ▟ options are only available in this mode**.

Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement

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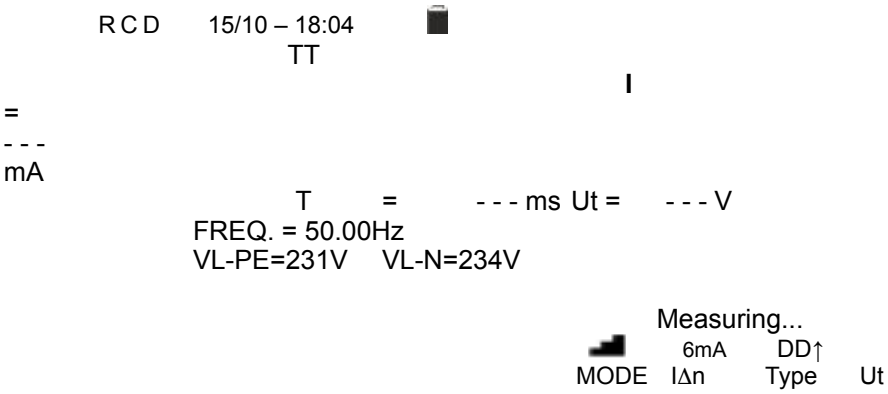
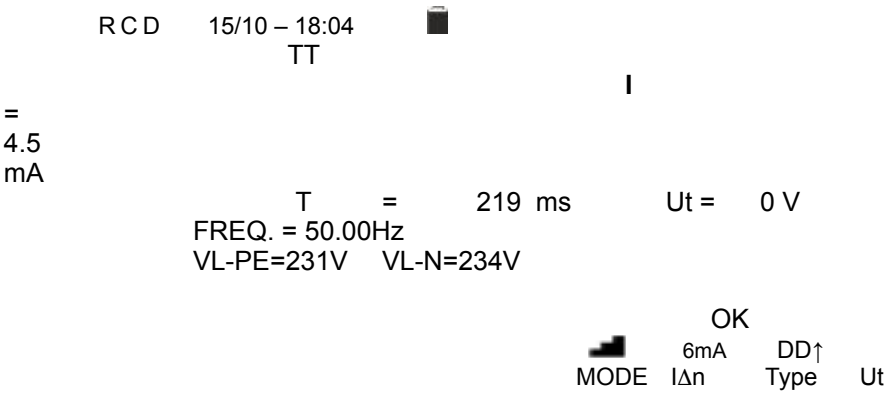
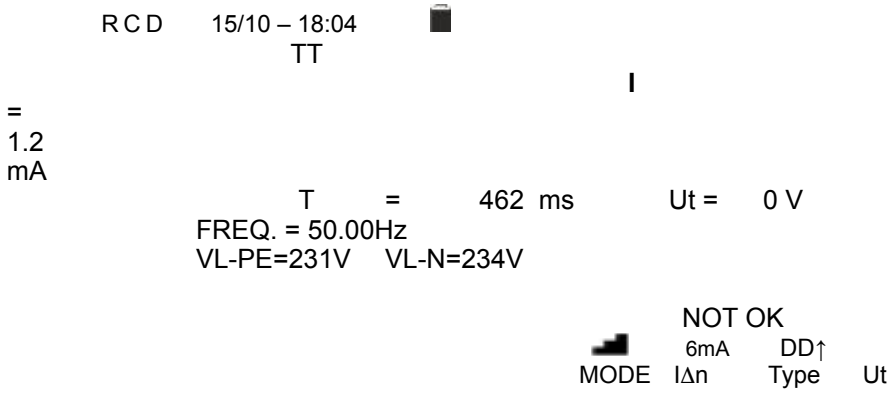


When the RCD trips and separates the circuit, if the tripping current and tripping time are within the limits reported in § 8.1, the instrument gives a double acoustic signal which signals the "**OK**" message is shown and the screen to the side is displayed by the instrument



When the RCD trips and separates the circuit, if the tripping current and tripping time are NOT within the limits reported in § 8.1, the instrument gives a double acoustic signal which signals the "**NOT OK**" message is shown and the screen to the side is displayed by the instrument



8. Press the **SAVE** key to store the test result in the instrument's memory (see § 7.1) or the **ESC/MENU** key to exit the screen without saving and go back to the main measuring screen

6.5.6. CCID mode (TN systems – USA country)

The instrument allows to measure the tripping times and current for **RCD** types **CCID∿** (sinusoidal waveform) or **CCID⎓** (continue waveform) at nominal currents of **5mA** or **20mA**. **<u>The x1 and ▟ options are only available in this mode</u>**

Press the **GO/STOP** key on the instrument, the **START** key on the remote switch probe or use the AutoStart feature (see § 5.1.5). The instrument will start the measurement.

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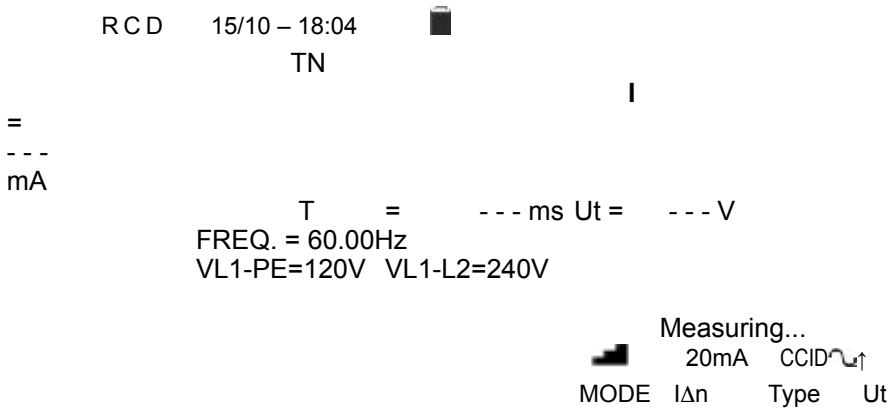
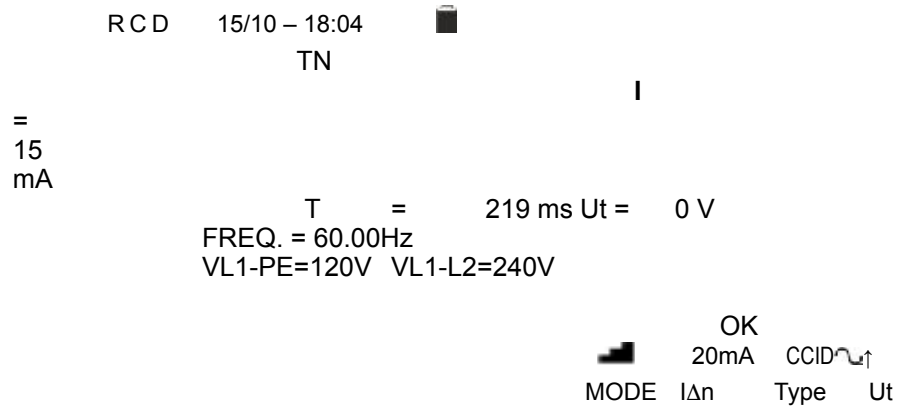


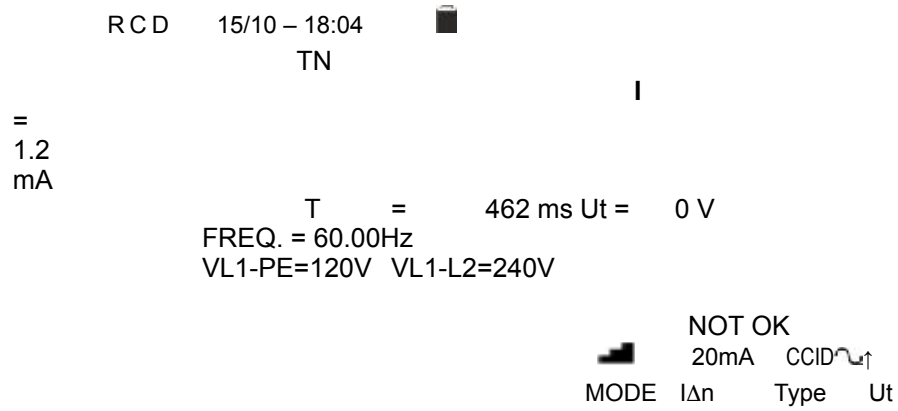
CAUTION

If message "**Measuring…**" appears on the display, the instrument is performing measurement. During this whole stage, do not disconnect the test leads of the instrument from the mains.

When the RCD trips and breaks the circuit, if the tripping current and tripping time are within the limits reported in § 8.1, the instrument gives a double acoustic signal, shows the "**OK**" message and displays the screen to the side.



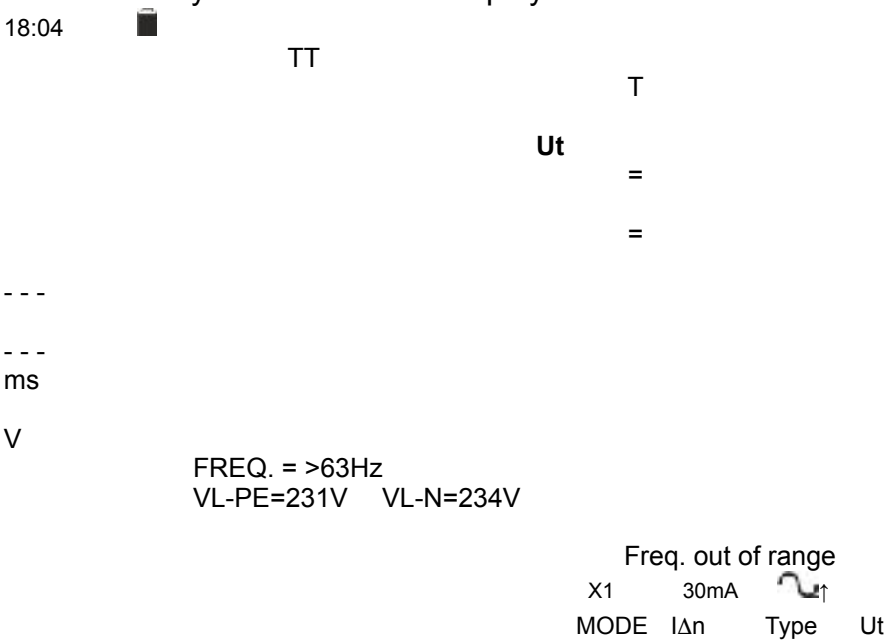
When the RCD trips and breaks the circuit, if the tripping current and tripping time are external the limits reported in § 8.1, the instrument gives a double acoustic signal, shows the "**NOT OK**" message and displays the screen to the side.



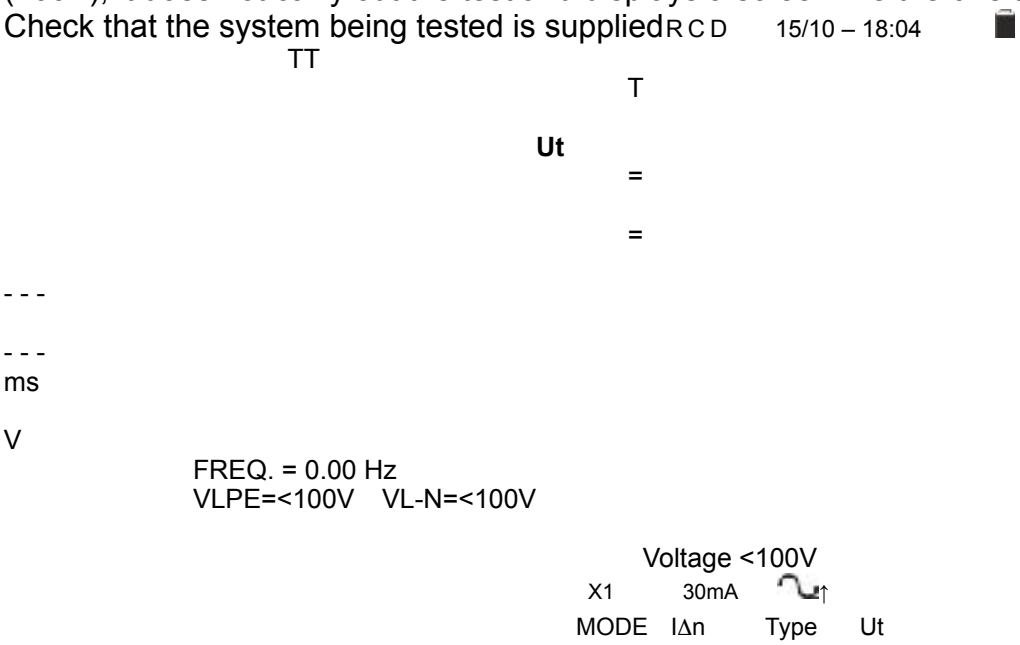
8. Press the **SAVE** key to store the test result in the instrument's memory (see § 7.1) or the **ESC/MENU** key to exit the screen without saving and go back to the main measuring screen

6.5.7. Anomalous situations

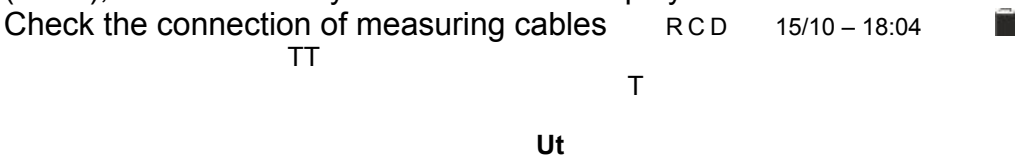
If the instrument detects a frequescy higher than the maximum limit (63Hz), it does not carry out the test and displays a screen like the one to the side



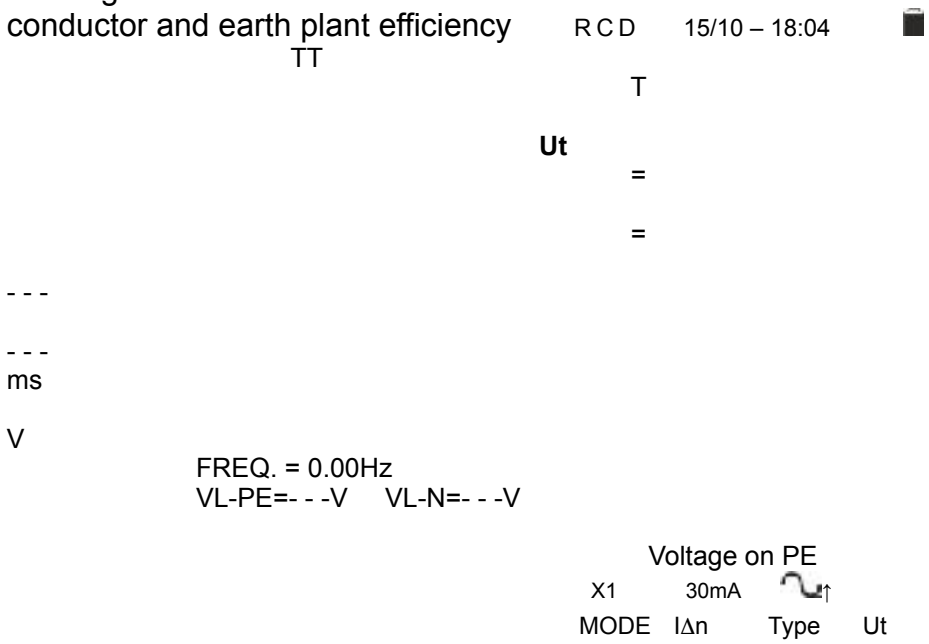
If the instrument detects an L-N or L-PE voltage lower than the minimum limit (100V), it does not carry out the test and displays a screen like the one to the side. Check that the system being tested is supplied



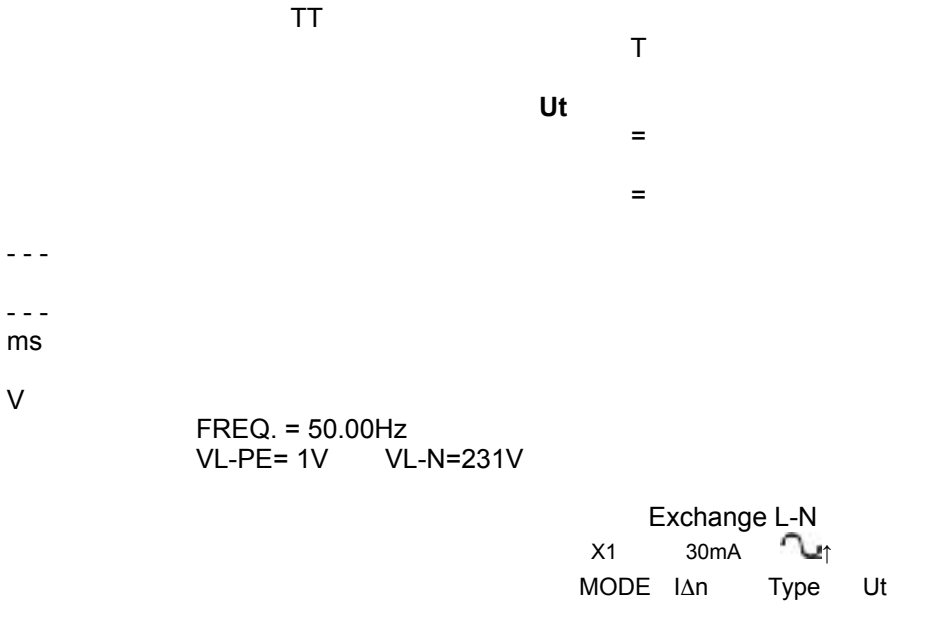
If the instrument detects an L-N or L-PE voltage higher than the maximum limit (265V), it does not carry out the test and displays a screen like the one to the side. Check the connection of measuring cables



If the instrument detects a dangerious voltage on PE conductor it provides the warning screen shown to the side and blocks the execution of the tests. Check the PE conductor and earth plant efficiency

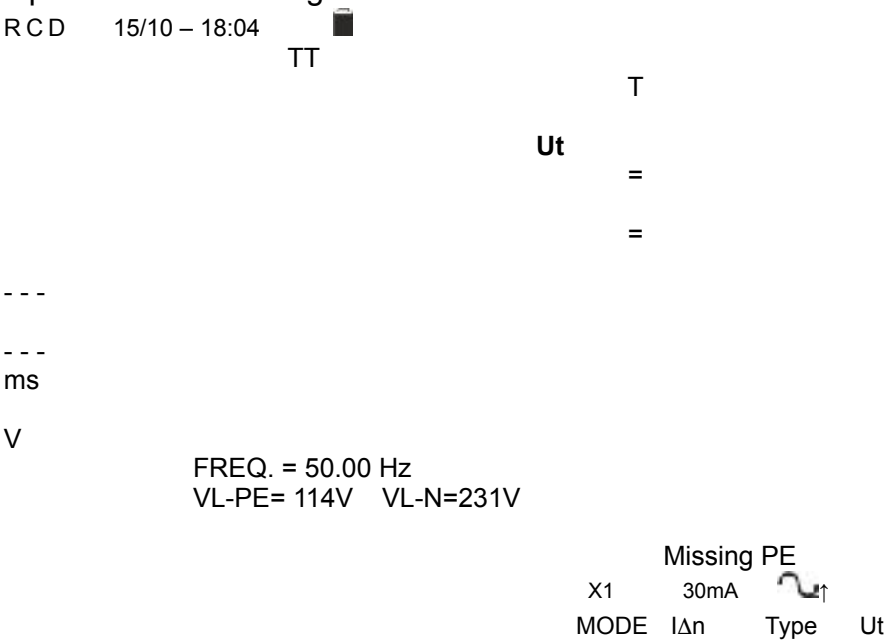


If the instrument detects that the phase L and neutral N leads are inverted, it does not carry out the test and a screen similar to the one reported to the side is displayed. Rotate the Mains Plug or check the connection of measuring cables

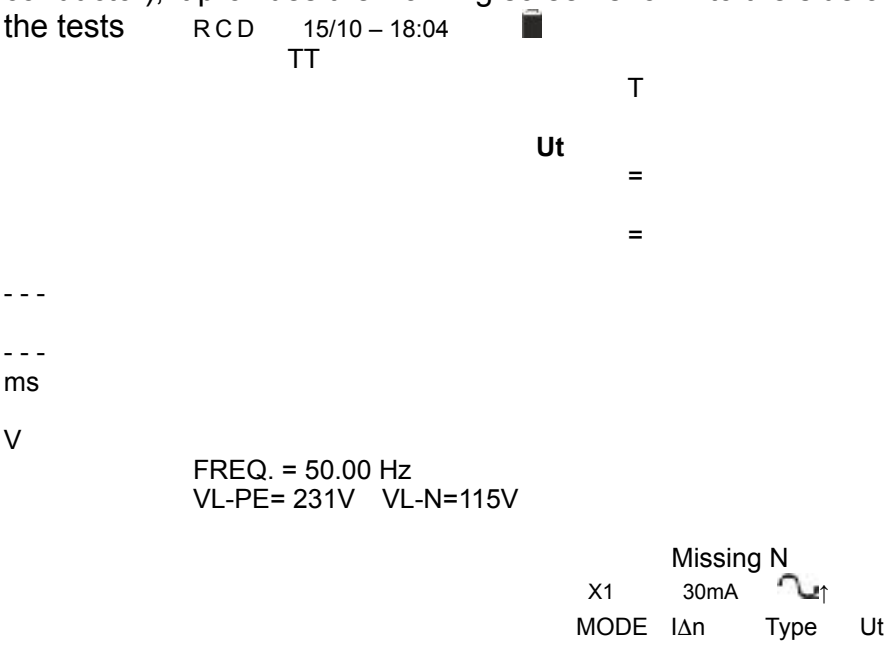


If the instrument detects that the phase and PE leads are inverted, it does not

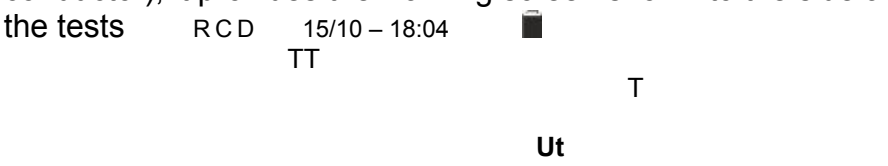
If the instrument detects the absence of the signal to terminal B3 (PE conductor), it provides the warning screen shown to the side and blocks the execution of the tests



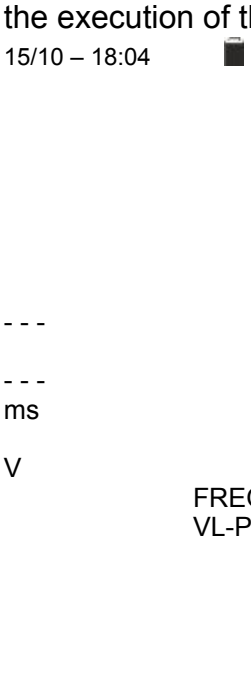
If the instrument detects the absence of the signal to terminal B4 (neutral conductor), it provides the warning screen shown to the side and blocks the execution of the tests



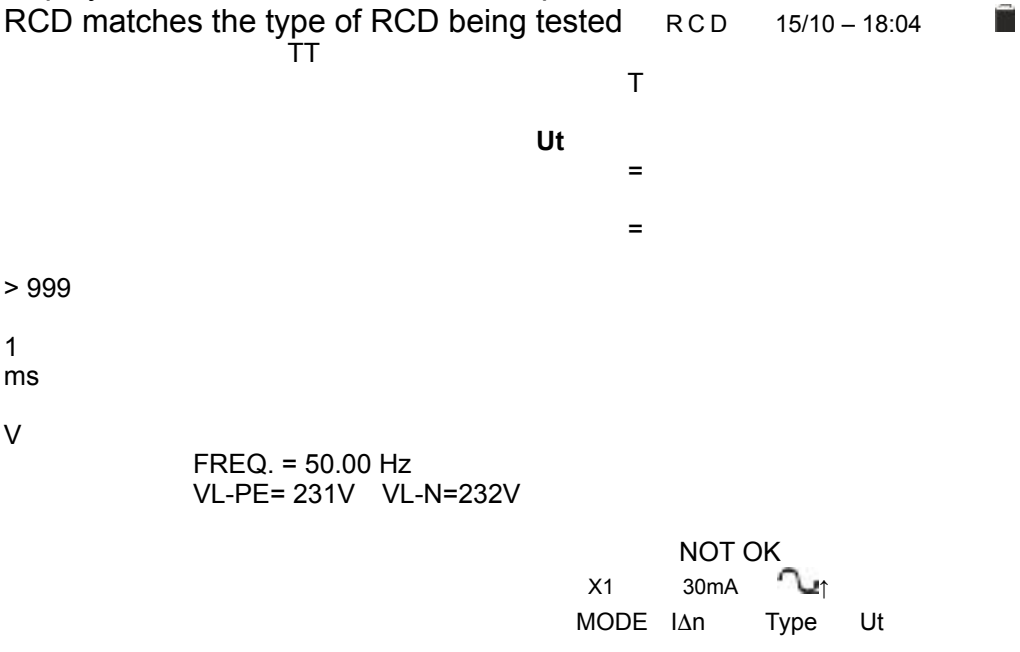
If the instrument detects the absence of the signal to terminal B1 (phase conductor), it provides the warning screen shown to the side and blocks the execution of the tests



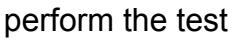
If the instrument detects a dangerious contact voltage Ut (over the set limit 25V or 50V) in the starting pre-test, it provides the warning screen shown to the side and blocks the execution of the tests. Check the PE conductor and earth plant efficiency



If the RCD does not trip within the maximum duration of the test, the instrument gives a long acoustic signal which signals the negative result of the test and then displays a screen similar to the one reported here to the side. Check that the set type of RCD matches the type of RCD being tested



If the instrument detects in the input terminals a too high external impedance such that it can not provides the nominal current, it provides the warning screen shown to the side and blocks the test. Disconnect the possible loads downstream the LCD before perform the test



6.6. LOOP: LINE IMPEDANCE/LOOP AND OVERALL EARTH RESISTANCE

This function is performed in compliance with standard IEC/EN61557-3, BS7671 17th/18th edition and allows measuring the line impedance, the fault loop impedance and the prospective short-circuit current.

CAUTION

Depending on the selected electrical system (TT, TN or IT) some kind of connection and function modes are disabled by the instruments (see Table 1)

The following operating modes are available:

- **L-N** Standard (STD) measurement of the line impedance between the phase conductor and the neutral conductor and calculation of the prospective phase-to-neutral short-circuit current for L-N-PE and L-L-PE systems
- **L-L** Standard (STD) measurement of the line impedance between the two phase conductors and calculation of the pospective phase-to-phase short-circuit current for L-N-PE and L-L-PE systems
- **L-PE** Standard (STD) measurement of the fault loop impedance between the phase conductor and the earth conductor and calculation of the prospective phase-to-earth short-circuit current for L-N-PE and L-L-PE systems
- **No Trip** ⏚ Loop impedance without causing the protections tripping in TN systems (see § 10.7) and Global earth resistance (TT systems) with neutral (3-wire) and without neutral (2-wire) (see § 10.8)
- **L1-L2** Standard (STD) measurement of the line impedance between the two phase conductor L1 and L2 of a split-phase systems and the earth conductor and calculation of the prospective phase-to-earth short-circuit current for L-L-PE systems
- **L1-PE** Standard (STD) measurement of the fault loop impedance between the phase conductor and the earth conductor of a split-phase systems and calculation of the prospective phase-to-earth short-circuit current for L-L-PE systems

CAUTION

The instrument performs the check of voltage on PE by comparing the voltage at B4 input and the ground potential induced on instrument side by mean the user's hand, so in order to check voltage on PE, **it's mandatory to hold the instrument case on the left or on the right side**

CAUTION

The measurement of line impedance or fault loop impedance involves the circulation of a maximum current according to the technical specifications of the instrument (see § 8.1). This could cause the tripping of possible magnetothermal or differential protections at lower tripping

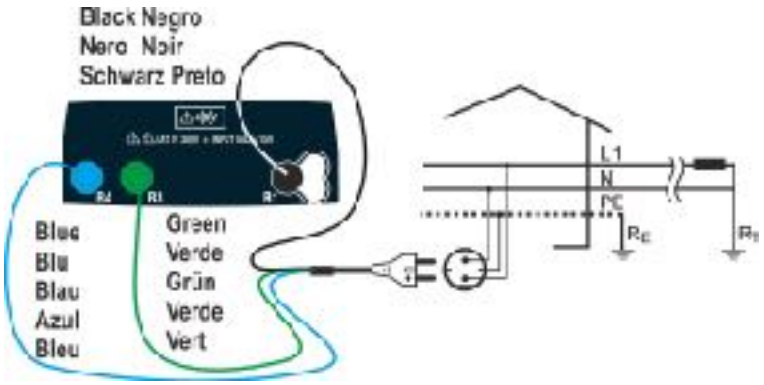


Fig. 25: L-N/L1-PE test for single-phase/split-phase systems with mains plug

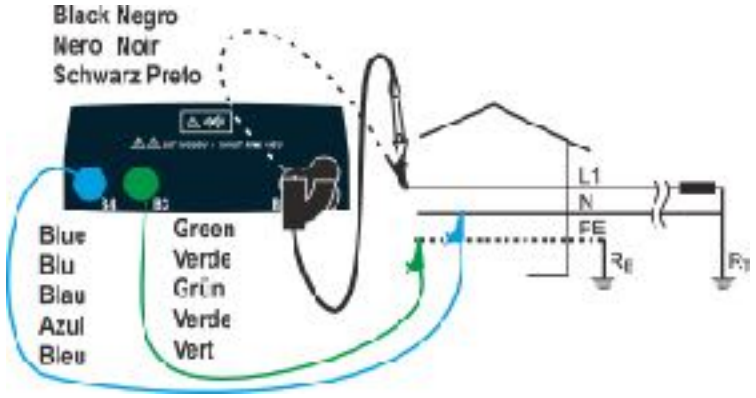


Fig. 26: L-N/L1-PE test for single-phase/split-phase systems with cables and remote probe

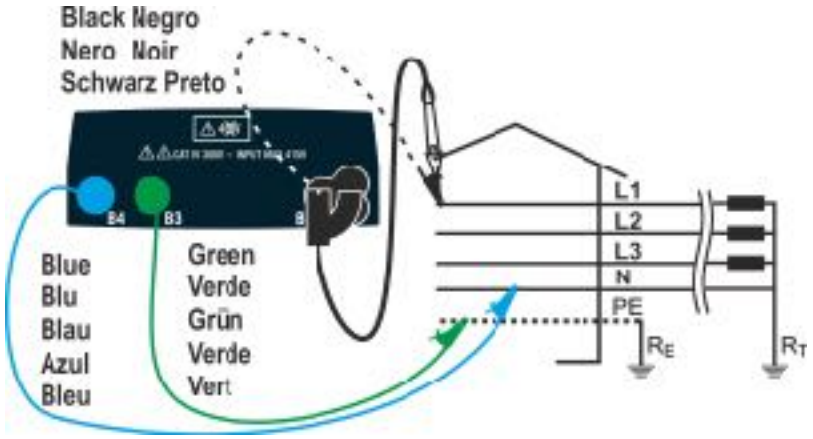


Fig. 27: L-N/L1-PE test for three-phase with single cables and remote probe

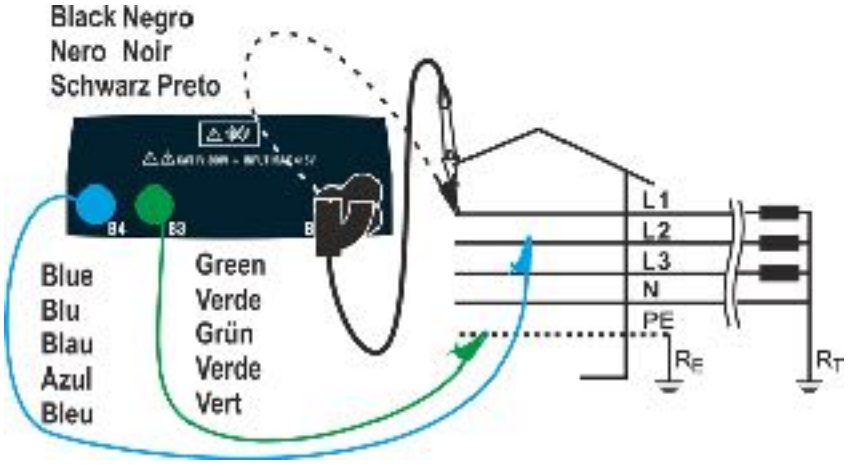
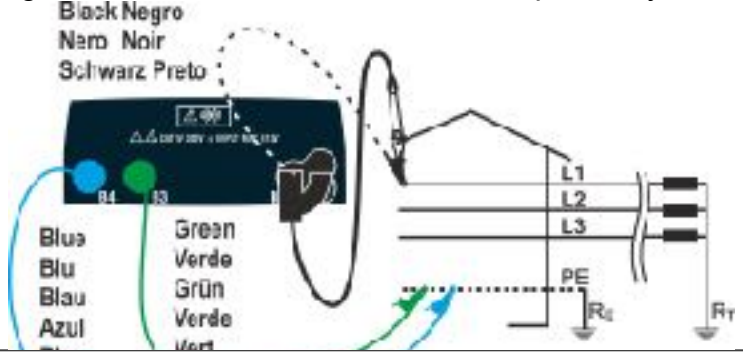


Fig. 28: L1-L2 measurement for three-phase systems



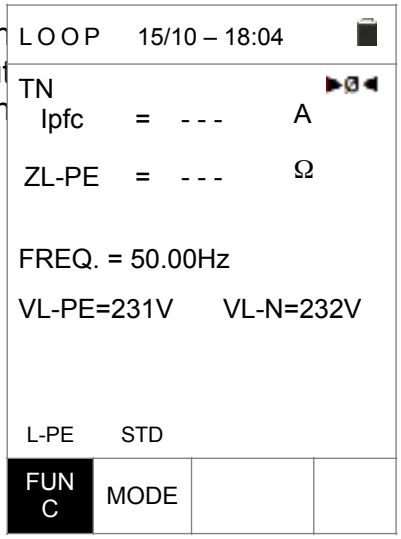
Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value

- ➢ **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be: **L-N, L-L** or **L-PE** (single-phase/three-phase systems) or **L1-PE, L1-L2** (split-phase systems)
- ➢ **MODE** → the virtual key allows setting the instrument's operating mode. Select the **STD** option

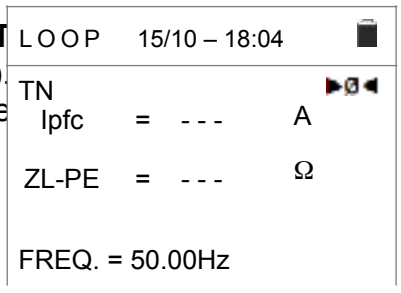
If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

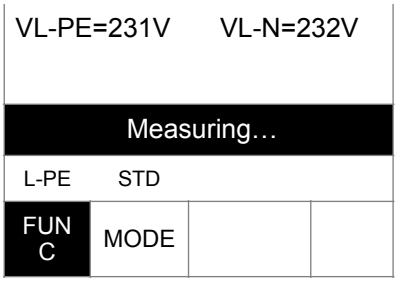
Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 25, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 30, Fig. 31, Fig. 32, Fig. 33 or Fig. 34

Note the presence of the correct voltage values between L-N and L-PE corresponding to the selections carried out in the initial phase (see § 5.1.3) as shown in the screen to the side.

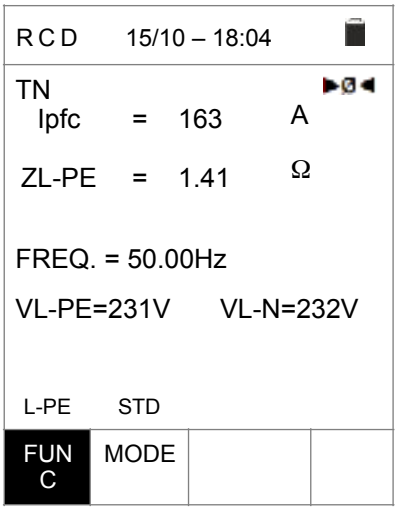


Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display





During this whole stage, do not disconnect the measuring leads of the instrument from the system under test. The following screen appears on the instrument's display.



The value of the assumed short-circuit current (Ipfc) is shown in the upper part of the display, while the Line/ Loop Z_{L-PE} impedance is shown in the bottom part of the display.

The Standard (Std) assumed short-circuit current (Isc) is calculated using the following formulas:

$$I_{SCL-PE} = \frac{U_{NOM}}{Z_{L-PE}} \qquad I_{SCL-N} = \frac{U_{NOM}}{Z_{L-N}}$$

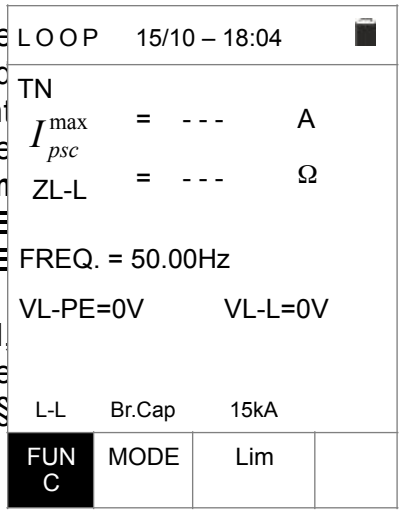
$$I_{SCL-L} = \frac{\sqrt{3}\,U_{NOM}}{Z_{L-L}}$$

Z_{MEAS} = measured L-L,L-N,L-PE loop impedance
U_{NOM} = nominal voltage (depend on the system)

6.6.4. Br.Cap mode – Verify of breaking capacity of protection device

Press the **MENU** key, move the cursor to **LOOP** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**

Select the “UK” country (see § 5.1.2), the options “TN, TN or IT”, “25 or 50V”, “50Hz or 60Hz” and the reference voltage in the general settings of the instrument (see § 5.1.3).



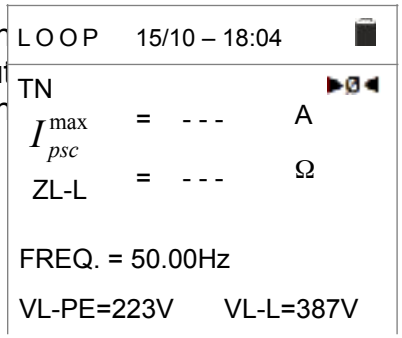
Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value

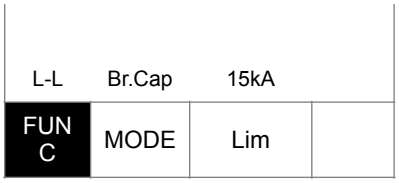
- ➢ **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be: **L-N, L-L** or **L-PE** (single-phase/three-phase systems) or **L1-PE, L1-L2** (split-phase systems)
- ➢ **MODE** → the virtual key allows setting the instrument’s operating mode. Select the **Br.Cap** option
- ➢ **Lim** → the virtual key allows to set the maximum tripping current expressed in "kA" that the protection must interrupt in the range: **0.1kA ÷ 999kA**

If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

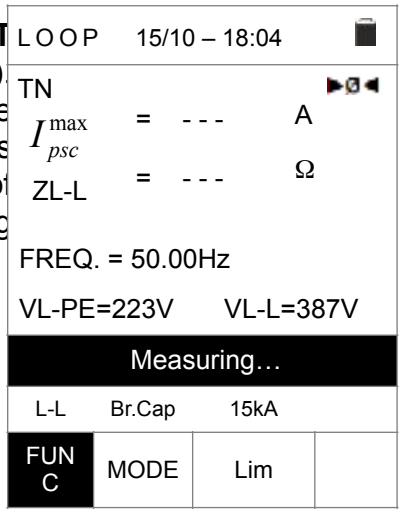
Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 25, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 30, Fig. 31, Fig. 32, Fig. 33 or Fig. 34

Note the presence of the correct voltage values between L-L and L-PE corresponding to the selections carried out in the initial phase (see § 5.1.3) as shown in the screen to the side

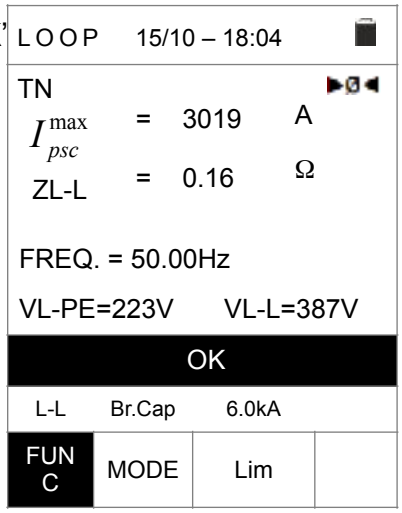




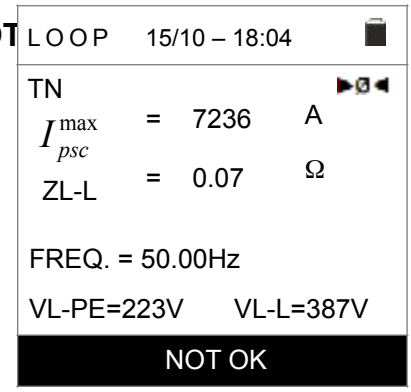
Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads of the instrument from the system under test. The following screen appears on the instrument's display

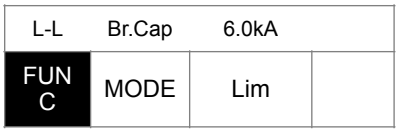


In case of **positive** result (IpscMAX < Lim) the "**OK**" outcome message is shown at display.



In case of **negative** result (IpscMAX > Lim) the "**NOT OK**" outcome message is shown at display

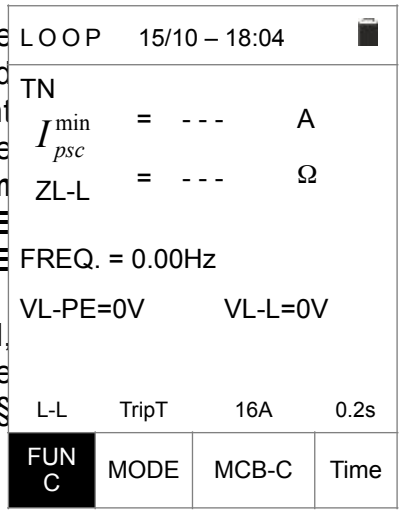




6.6.5. TripT - Verify of protection coordination

Press the **MENU** key, move the cursor to **LOOP** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**

Select the “UK” country (see § 5.1.2), the options “TN, TN or IT”, “25 or 50V”, “50Hz or 60Hz” and the reference voltage in the general settings of the instrument (see § 5.1.3)



Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value

- ➢ **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be: **L-N, L-L** or **L-PE** (single-phase/three-phase systems) or **L1-PE, L1-L2** (split-phase systems)
- ➢ **MODE** → the virtual key allows setting the instrument’s operating mode. Select the **TripT** option
- ➢ **Type of protection** → the virtual key allows to set type of protection (**Fuse** of type **BS88-2**, **BS88-3**, **BS3036**, **BS1362** or magnetothermal **MCB** in curve **B, C, D** – UK country) and the respeticve nominal currents considering the below available values:

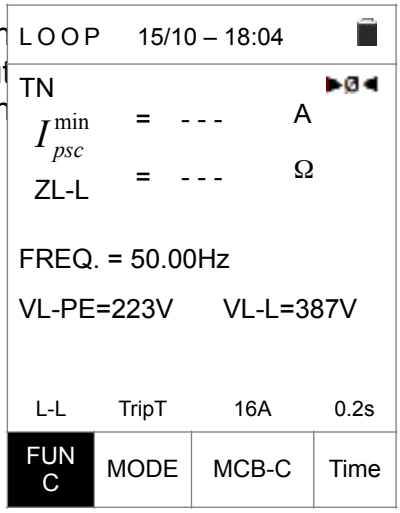
  MCB curve B, C, D → 3A, 6A, 10A, 16A, 20A,25A,32A,40A,50A,63A,80A,100A,125A

  Fuse BS88-2 → 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A, 80A,

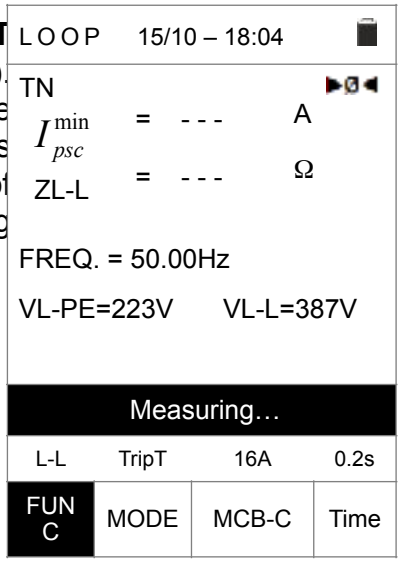
If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 25, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 30, Fig. 31, Fig. 32, Fig. 33 or Fig. 34

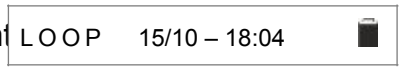
Note the presence of the correct voltage values between L-L and L-PE corresponding to the selections carried out in the initial phase (see § 5.1.3) as shown in the screen to the side



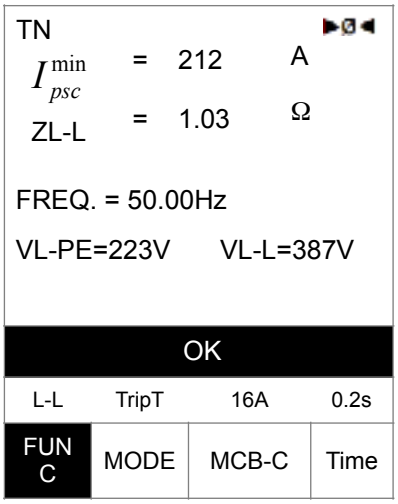
Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads of the instrument from the system under test. The following screen appears on the instrument's display



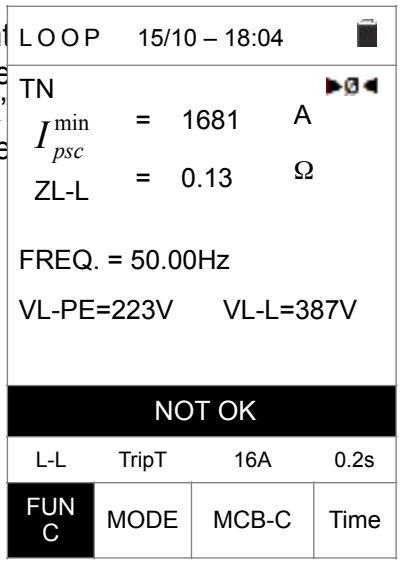
In case of **positive** result (minimum short-circuit current



interrupted by the protection device within the time indicated by the performed selections), the "**OK**" message and the screen to the side is displayed by the instrument



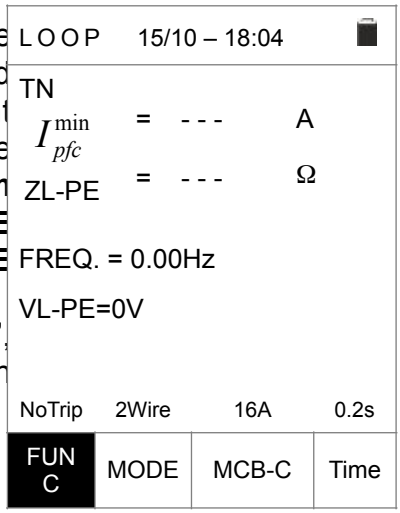
In case of **negative** result (minimum short-circuit current NOT interrupted by the protection device within the time indicated by the performed selections), the "**NOT OK**" message and the screen to the side is displayed by the instrument



6.6.6. NoTrip 2-wire test - Verify of protection against indirect contacts

Press the **MENU** key, move the cursor to **LOOP** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**

Select the "UK" country (see § 5.1.2), the options "TN", "25 or 50V", "50Hz or 60Hz" and the reference voltage in the general settings of the instrument (see § 5.1.3).

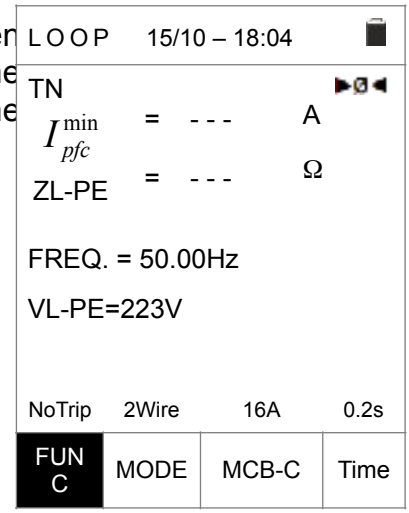


Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify

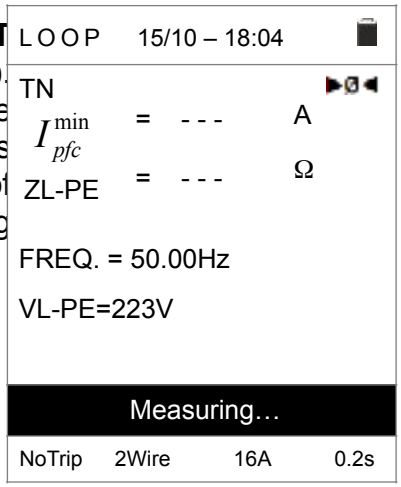
If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

Insert the green and black connectors of the three-pin shuko cable into the corresponding input leads B3 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 31, Fig. 32 or Fig. 33

Note the presence of the correct voltage values between L-PE corresponding to the selections carried out in the initial phase (see § 5.1.3) as shown in the screen to the side

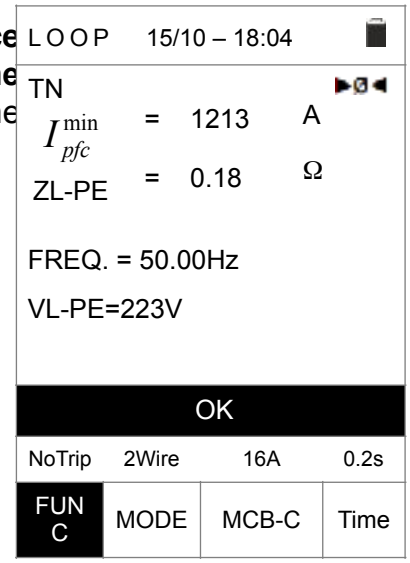


Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads of the instrument from the system under test. The following screen appears on the instrument's display

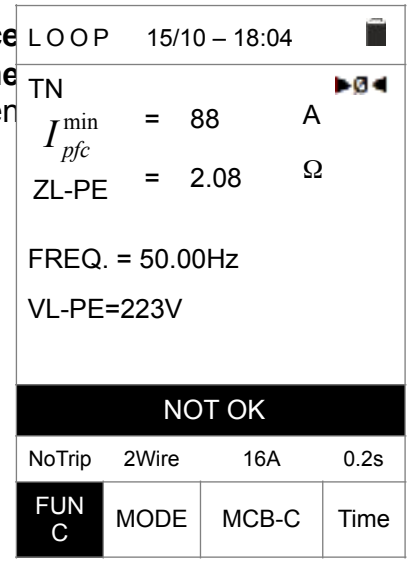


FUNC	MODE	MCB-C	Time

In case of **positive** result (**Z_{L-PE} ≤ to limit impedance relative to protection device within the specified time** – see § 10.10), the "**OK**" message and the screen to the side is displayed by the instrument

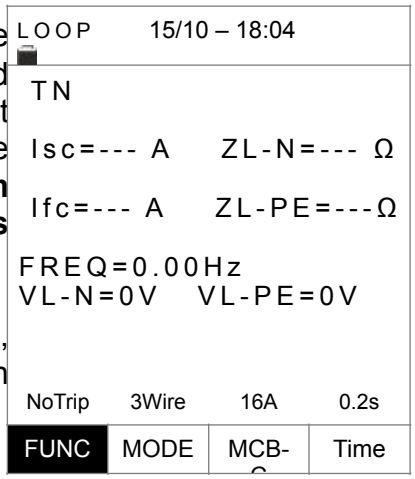


In case of **negative** result (**Z_{L-PE} > to limit impedance relative to protection device within the specified time** – see § 10.10), the "**NOT OK**" message and the screen to the side is displayed by the instrument



6.6.7. NoTrip 3-wire test - Verify of protection against indirect contacts

Press the **MENU** key, move the cursor to **AUTO** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**



Select the “UK” country (see § 5.1.2), the options “TN”, “25 or 50V”, “50Hz or 60Hz” and the reference voltage in the general settings of the instrument (see § 5.1.3)

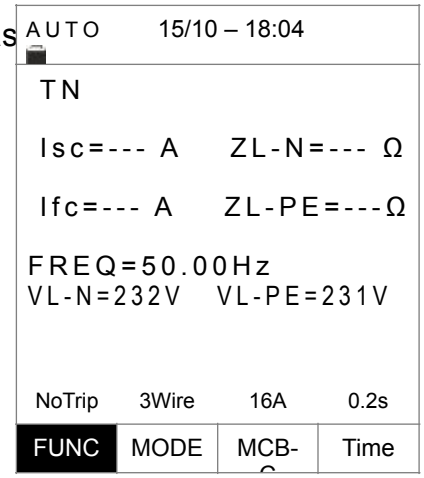
Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value

- ➢ **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be: **NoTrip**
- ➢ **MODE** → the virtual key allows setting the instrument’s operating mode. Select the **3Wire** option
- ➢ **Type of protection** → the virtual key allows to set type of protection (**Fuse** of type **BS88-2**, **BS88-3**, **BS3036**, **BS1362** or magnetothermal **MCB** in curve **B, C, D** – UK country) and the respeticve nominal currents considering the below available values:
  MCB curve B,C,D → 3A,6A,10A,16A, 20A,25A,32A,40A,50A,63A,80A,100A,125A
  Fuse BS88-2 → 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A, 80A, 100A, 125A,160A, 200A
  Fuse BS88-3 → 5A, 16A, 20A, 32A, 45A, 63A, 80A, 100A
  Fuse BS3036 → 5A, 15A, 20A, 30A, 45A, 60A, 100A
  Fuse BS1362 → 3A, 13A
  press **SAVE** key to save the selected parameter and retire to the measurement screen
- ➢ **Time** → the virtual key allows to set type of protection tripping time among the

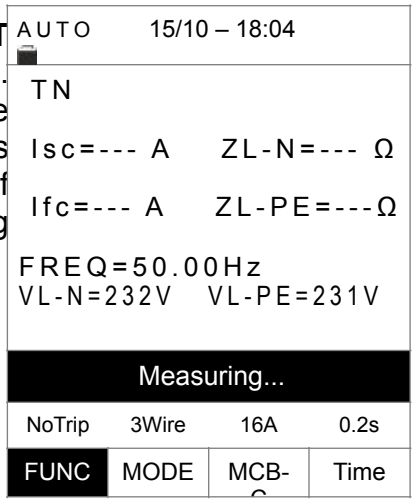
If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 25, Fig. 26, Fig. 27, Fig. 28 or Fig. 29

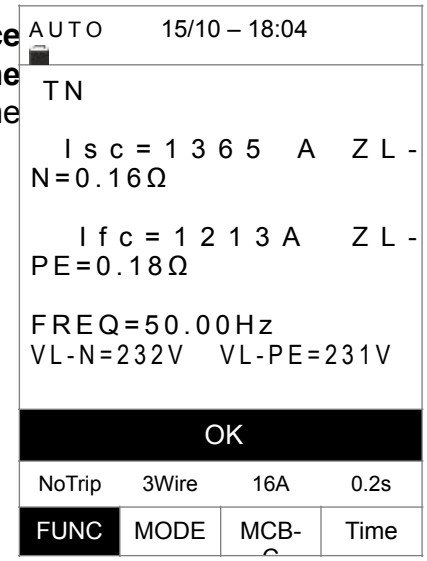
Note the correct voltage values between L-N and L-PE as shown in the screen to the side



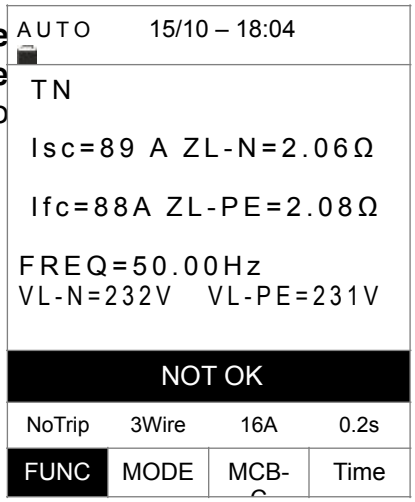
Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads of the instrument from the system under test. The following screen appears on the instrument's display



In case of **positive** result (Z_{L-PE} **≤ to limit impedance relative to protection device within the specified time** – see § 10.10), the "**OK**" message and the screen to the side is displayed by the instrument



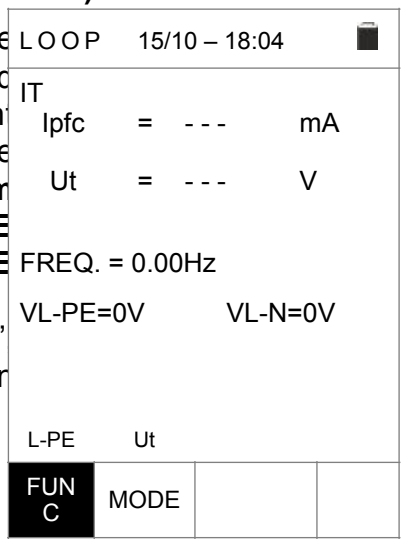
In case of **negative** result (Z_{L-PE} **> to limit impedance relative to protection device within the specified time** – see § 10.10), the "**NOT OK**" message and the screen to the side is displayed by the instrument



6.6.8. Verify of protection against indirect contacts (IT systems)

Press the **MENU** key, move the cursor to **LOOP** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**

Select the "UK" country (see § 5.1.2), the options "IT" "25 or 50V", "50Hz or 60Hz" and the reference voltage in the general settings of the instrument (see § 5.1.3).



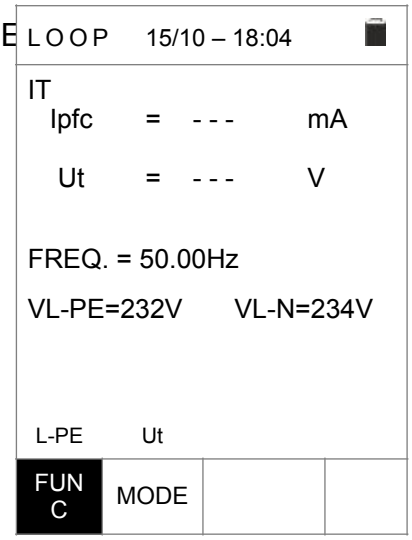
Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value:

➢ **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be **L-PE** (single-phase/three-phase systems) or **L1-PE** (split-phase systems)

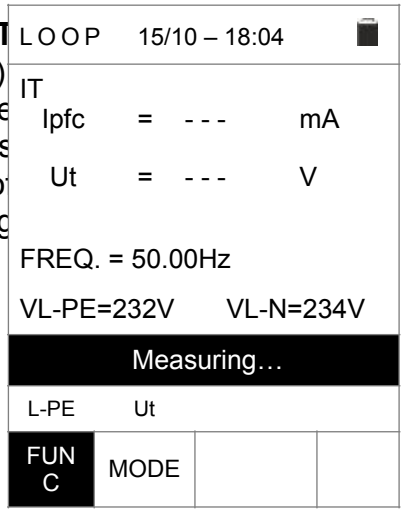
If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 30

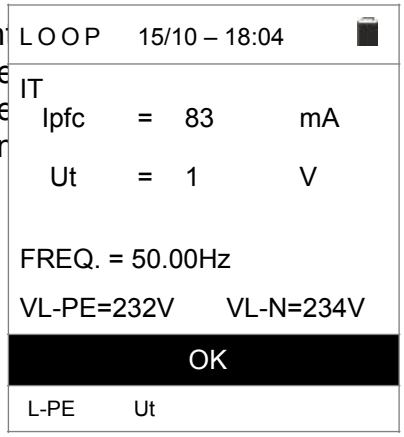
Note the correct voltage values between L-N and L-PE as shown in the screen to the side



Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5) The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads o the instrument from the system under test. The following screen appears on the instrument's display



In case of **positive** result (contact voltage at the poin <50V or <25V), the "**OK**" message and the screen to the side is displayed by the instrument which contains the value of the first fault current measured, expressed ir **mA** (see §)



FUNC	MODE		

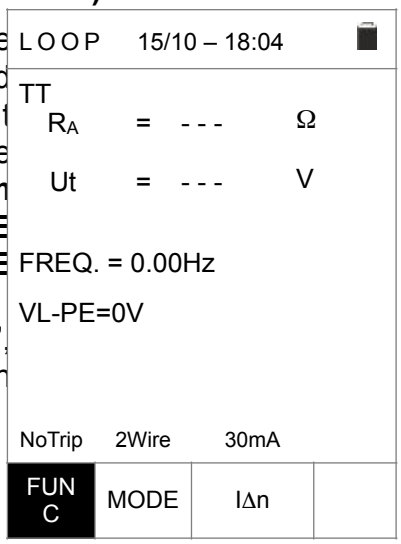
In case of **negative** result (contact voltage at the poin
>50V or >25V) the "**NOT OK**" message and the screen to
the side is displayed by the instrument the screen to the
side

LOOP	15/10 – 18:04		
IT			
Ipfc	=	>999	mA
Ut	=	>50	V
FREQ. = 50.00Hz			
VL-PE=232V		VL-N=234V	
NOT OK			
L-PE	Ut		
FUNC	MODE		

6.6.9. Verify of protection against indirect contacts (TT systems)

Press the **MENU** key, move the cursor to **LOOP** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**

Select the “UK” country (see § 5.1.2), the options “TT”, “25 or 50V”, “50Hz or 60Hz” and the reference voltage in the general settings of the instrument (see § 5.1.3).



Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value:

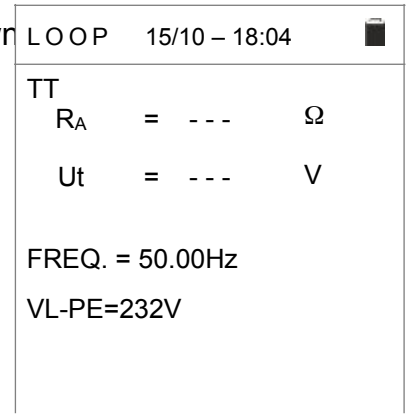
- **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be **NoTrip**
- **MODE** → fixed **2-Wire** mode
- **IΔn** → The virtual key allows setting the nominal value of the RCD’s tripping current, which may be: **6mA, 10mA, 30mA, 100mA, 300mA, 500mA, 650mA, 1000mA**

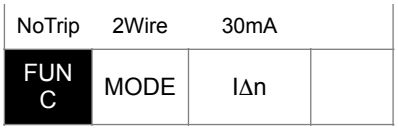
press **SAVE** key to save the selected parameter and retire to the measurement screen

If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

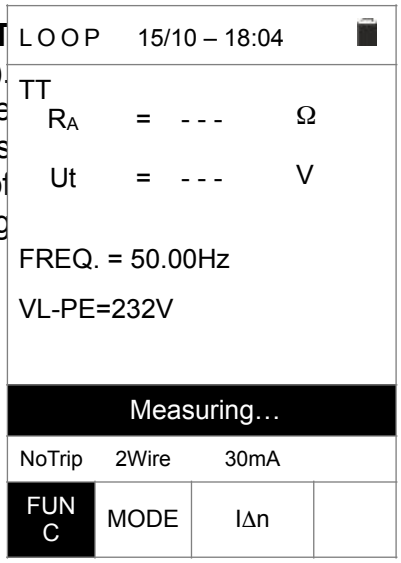
Insert the green and black connectors of the three-pin shuko cable into the corresponding input leads B3 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 31, Fig. 32 or Fig. 33

Note the correct voltage values between L-PE as shown in the screen to the side

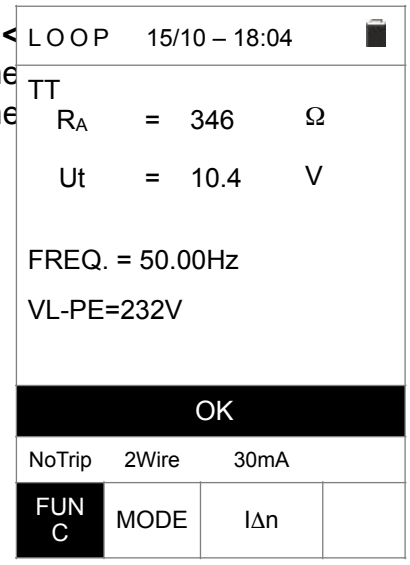




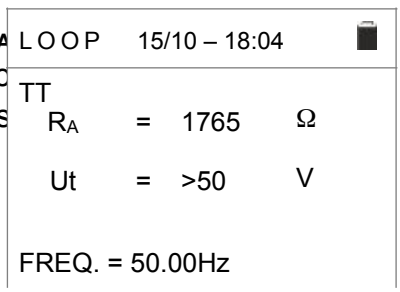
Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads of the instrument from the system under test. The following screen appears on the instrument's display

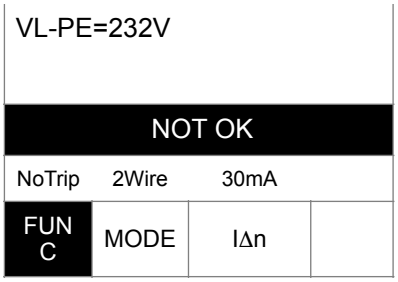


In case of **positive** result (**overall earth resistance R_A < (Utlim/IΔn**), the "**OK**" message and the screen to the side is displayed by the instrument which contains the contact voltage value in the secondary display



In case of **negative** result (**overall earth resistance R_A > (Utlim/IΔn**), the "**NOT OK**" message and the screen to the side is displayed by the instrument which contains the contact voltage value in the secondary display

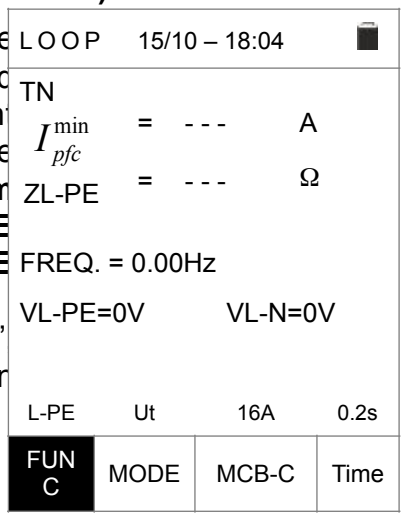




6.6.10. Verify of protection against indirect contacts (TN systems)

Press the **MENU** key, move the cursor to **LOOP** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side **in case of single-phase L-N-PE electrical system selected (see § 5.1.3). For split-phase L-L-PE systems the voltages indicated change in VL1-PE and VL1-L2**

Select the “UK” country (see § 5.1.2), the options “TN” “25 or 50V”, “50Hz or 60Hz” and the reference voltage in the general settings of the instrument (see § 5.1.3).



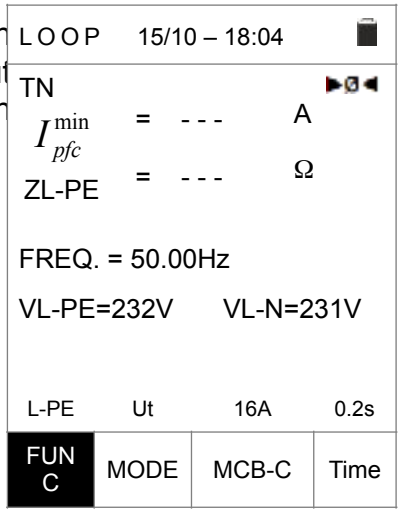
Use the ◀, ▶ keys to select the parameter to be modified, and the ▲, ▼ keys to modify the parameter value

- ➢ **FUNC** → the virtual key allows setting the measuring mode of the instrument, which may be **L-PE** (single-phase/three-phase systems) or **L1-PE** (split-phase systems)
- ➢ **MODE** → the virtual key allows setting the instrument’s operating mode. Select the **Ut** option
- ➢ **Type of protection** → the virtual key allows to set type of protection (**Fuse** of type **BS88-2**, **BS88-3**, **BS3036**, **BS1362** or magnetothermal **MCB** in curve **B, C, D** – UK country) and the respeticve nominal currents considering the below available values:

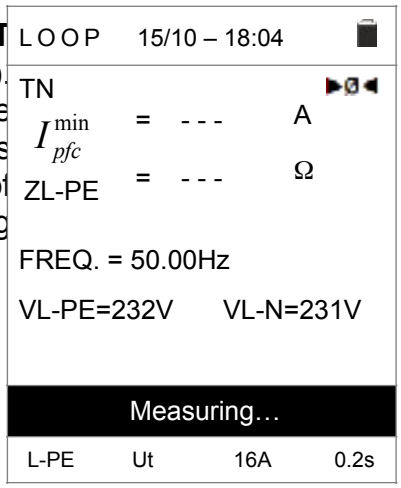
If possible, disconnect all loads connected downstream of the measured point, as the impedance of these users could distort the test results. Perform the preliminary calibration of the test leads as described in § 6.6.2

Insert the green, blue and black connectors of the three-pin shuko cable into the corresponding input leads B3, B4 and B1 of the instrument. As an alternative, use the single cables and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the Mains Plug, the alligator clips or the remote lead to the electrical mains according to Fig. 25, Fig. 26, Fig. 27, Fig. 28 or Fig. 29

Note the presence of the correct voltage values between L-N and L-PE corresponding to the selections carried out in the initial phase (see § 5.1.3) as shown in the screen to the side

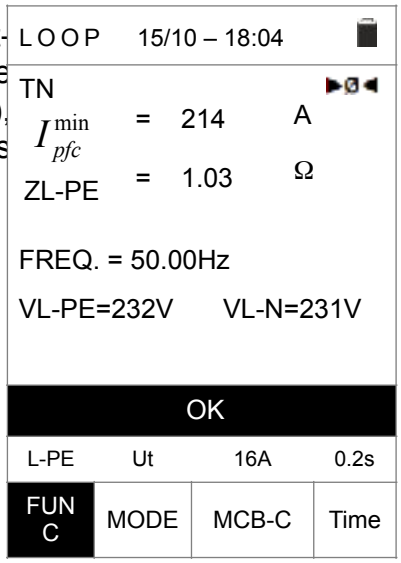


Press the **GO/STOP** key on the instrument, the **START** key on remote lead or the AutoStart feature (see § 5.1.5). The instrument will start the measurement amd the "**Measuring…**" message is shown at display. During this whole stage, do not disconnect the measuring leads or the instrument from the system under test. The following screen appears on the instrument's display

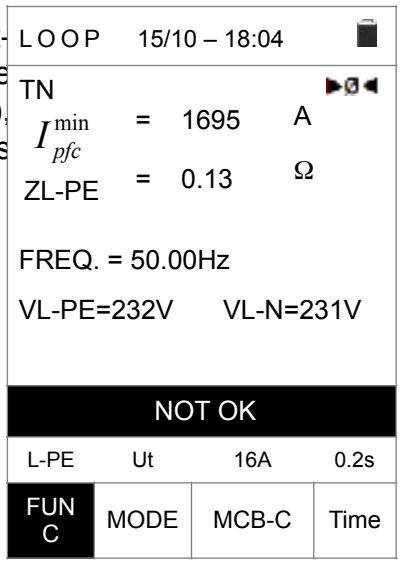


FUN C	MODE	MCB-C	Time

In case of **positive** result (calculated minimum short-circuit current HIGHER than tripping current of the protection device within the specified time – see § 10.6), the "**OK**" message and the screen to the side is displayed by the instrument

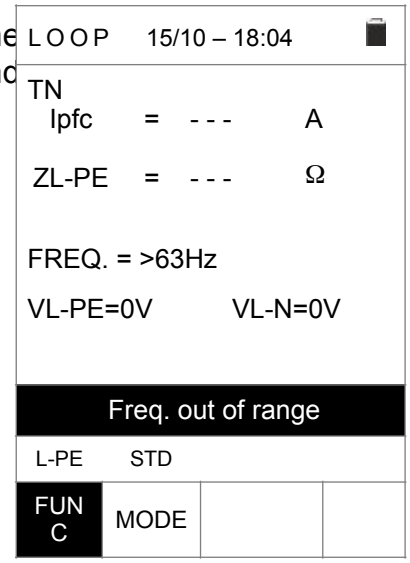


In case of **negative** result (calculated minimum short-circuit current LOWER than tripping current of the protection device within the specified time – see § 10.6), the "**NOT OK**" message and the screen to the side is displayed by the instrument

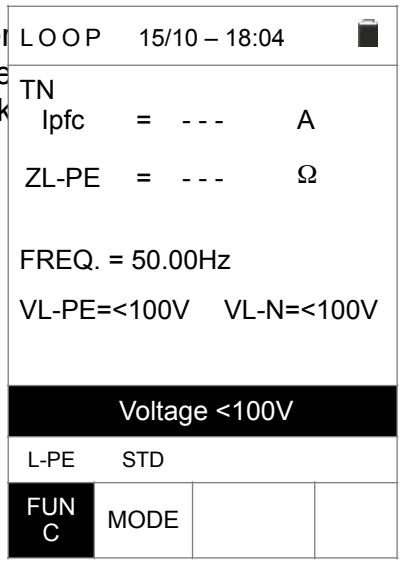


6.6.11. Anomalous situations

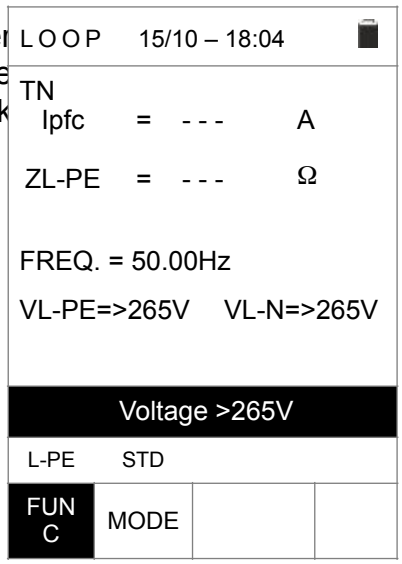
If the instrument detects a frequescy higher than the maximum limit (63Hz), it does not carry out the test and displays a screen like the one to the side



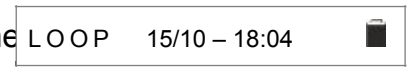
If the instrument detects an L-N or L-PE voltage lower than the minimum limit (100V), it does not carry out the test and displays a screen like the one to the side. Check that the system being tested is supplied



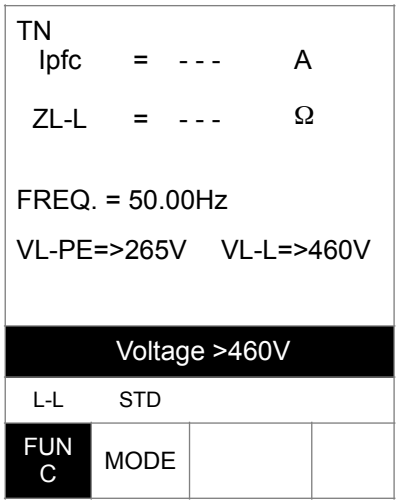
If the instrument detects an L-N or L-PE voltage higher than the maximum limit (265V), it does not carry out the test and displays a screen like the one to the side. Check the connection of measuring cables



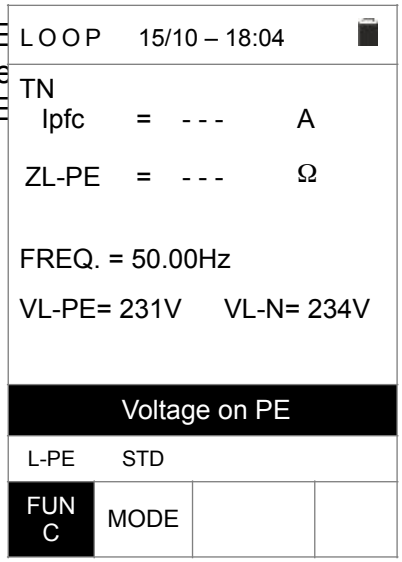
If the instrument detects an L-L voltage higher than the



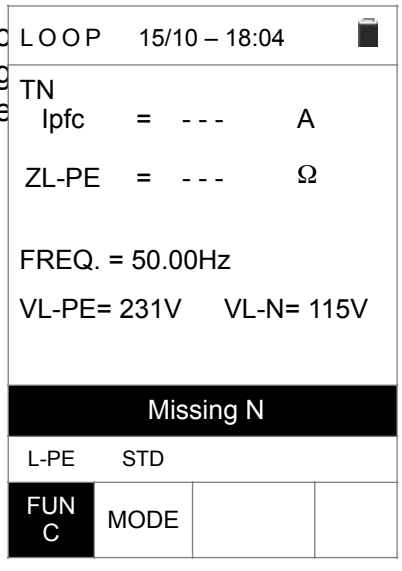
maximum limit (460V), it does not carry out the test and displays a screen like the one to the side. Check the connection of measuring cables



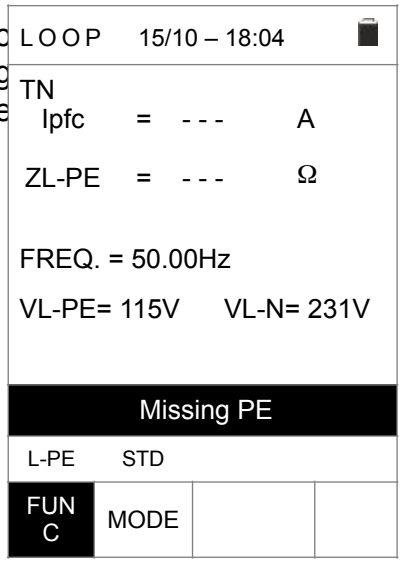
If the instrument detects a dangerous voltage on PE conductor it provides the warning screen shown to the side and blocks the execution of the tests. Check the PE conductor and earth plant efficiency



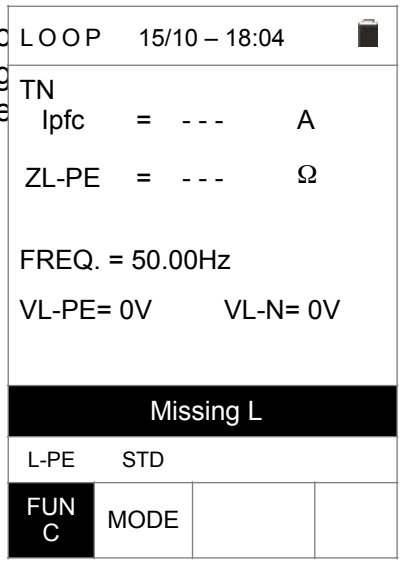
If the instrument detects the absence of the signal to terminal B4 (neutral conductor), it provides the warning screen shown to the side and blocks the execution of the tests



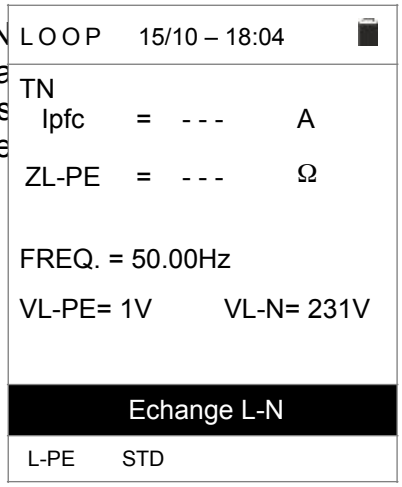
If the instrument detects the absence of the signal to terminal B3 (PE conductor), it provides the warning screen shown to the side and blocks the execution of the tests



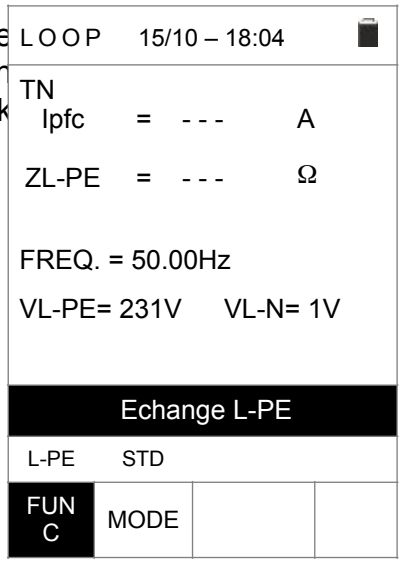
If the instrument detects the absence of the signal to terminal B1 (phase conductor), it provides the warning screen shown to the side and blocks the execution of the tests



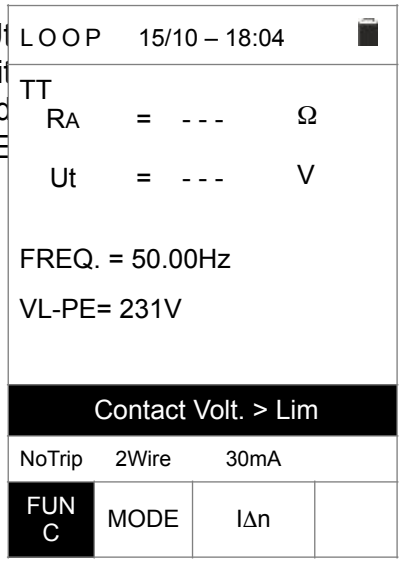
If the instrument detects that the phase L and neutral N leads are inverted, it does not carry out the test and a screen similar to the one reported to the side is displayed. Rotate the Mains Plug or check the connection of measuring cables



If the instrument detects that the phase and PE leads are inverted, it does not carry out the test and a screen similar to the one reported to the side is displayed. Check the connection of measuring cables



If the instrument detects a dangerous contact voltage Ut (over the set limit 25V or 50V) in the starting pre-test, it provides the warning screen shown to the side and blocks the execution of the tests. Check the PE conductor and earth plant efficiency



6.7. 1,2,3: PHASE SEQUENCE AND PHASE CONCORDANCE TEST

This function is performed in compliance with standards IEC/EN61557-7 and allows testing the phase sequence and concordance **with 1-wire method** by direct contact with live parts (**not on cables with insulating sheath**).

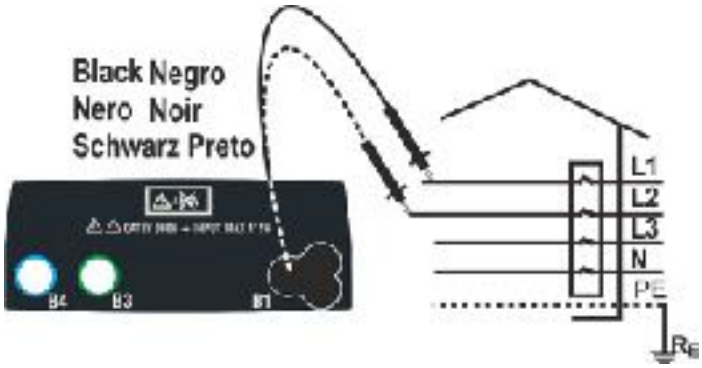


Fig. 35: Phase sequence check with terminal lead

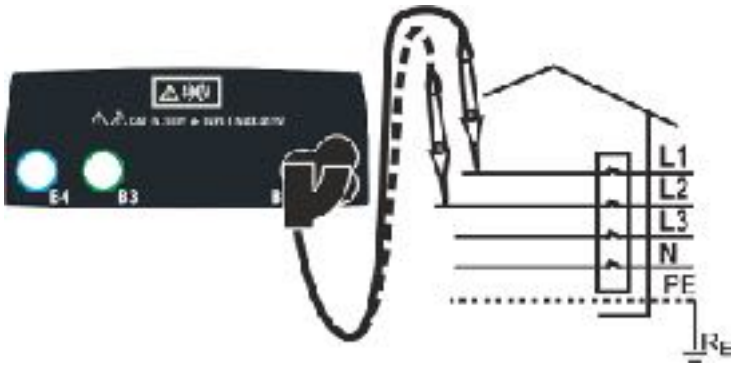
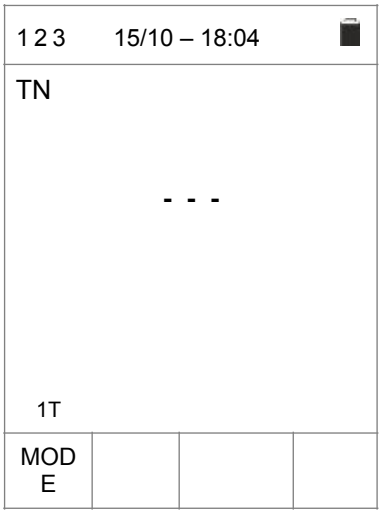


Fig. 36: Phase sequence check with remote lead

Press the **MENU** key, move the cursor to **123** in the main menu by means of the arrow keys (▲,▼) and confirm with **ENTER**. Subsequently the instrument displays a screen similar to the one reported here to the side

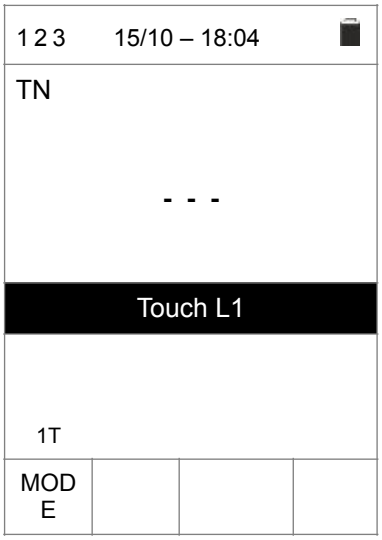


Insert the black lead connector into the corresponding input lead B1 of the instrument. As an alternative, use the single cable and apply the relevant alligator clips to the free ends of the cables. It is also possible to use the remote lead by inserting its multipolar connector into the input lead B1. Connect the alligator clips or the remote lead to the electrical mains according to Fig. 35 or Fig. 36

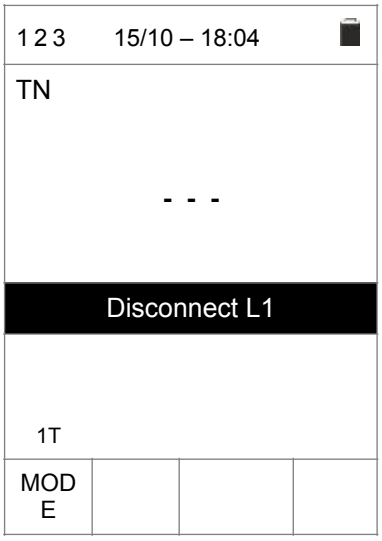
Press the **GO/STOP** key on the instrument or the **START** key on the remote lead. The instrument will start the test.

The "**Touch L1**" message is shown on the display to indicate the waiting for the instrument to be connected to the L1 phase of the system being tested.

Touch the live part of L1 phase



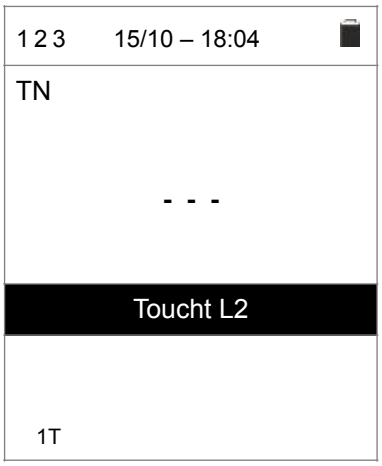
The instrument gives out a long sound until input voltage is present. At the end of phase L1 acquisition, the instrument is in standby waiting for the signal on phase L2 and showing the symbol of "**Disconnect L1**" as shown in the screen to the side



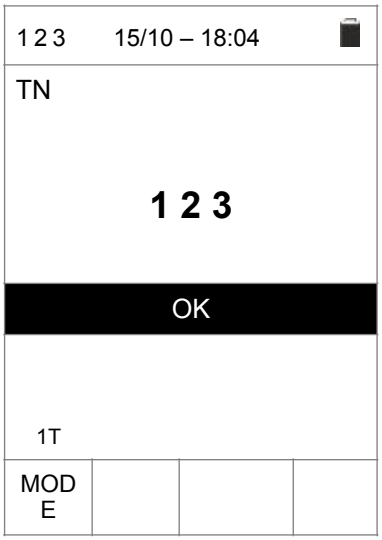
Under these conditions, connect the alligator clips, the tips or the remote lead to phase L2 in accordance to Fig. 35 or Fig. 36.

The "**Touch L2**" message is shown on the display to indicate the waiting for the instrument to be connected to the L2 phase of the system being tested.

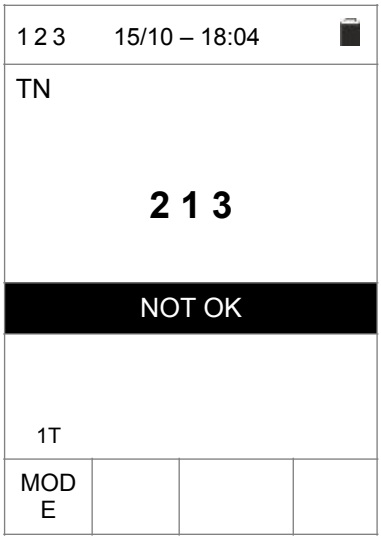
Touch the live part of L2 phase



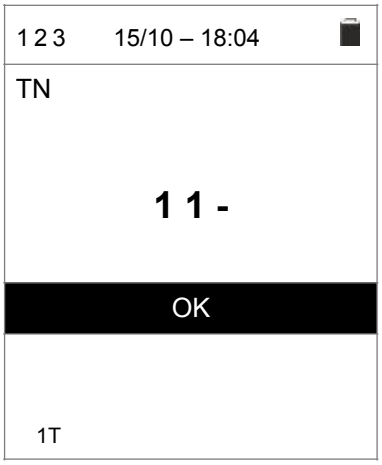
The instrument gives out a long sound until input voltage is present. At the end of the test, if the detected phase sequence is correct, the instrument displays a screen like the one shown to the side (result "**123**") and the "**OK**" message.



At the end of the test, if the detected phase sequence is incorrect, the instrument displays a screen like the one shown to the side (result "**213**") and the "**NOT OK**" message



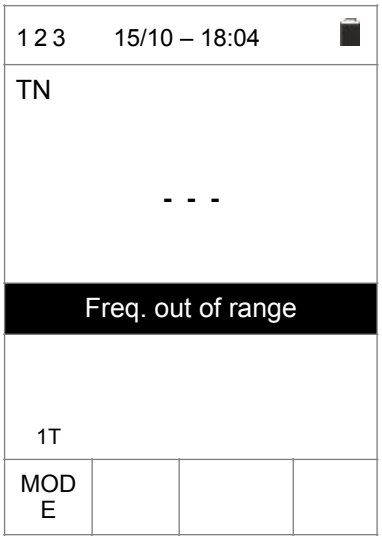
At the end of the test, if the two detected voltages are in phase (**phase concordance between two distinct three-phase systems**), the instrument displays a screen like the one to the side (result "**11-**") and the "**OK**" message



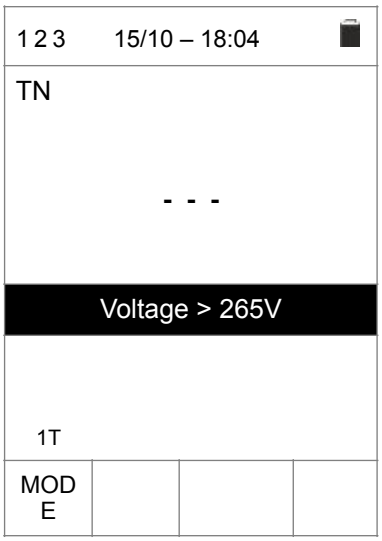
MODE			

6.7.1. Anomalous situations

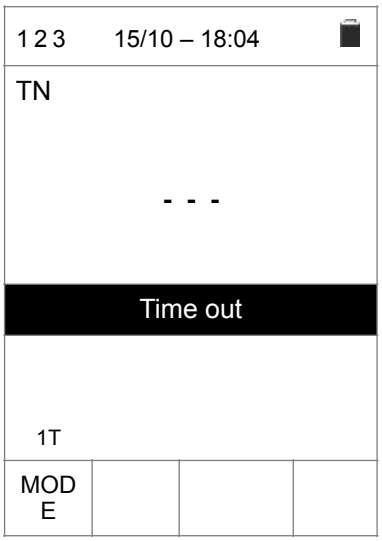
If the instrument detects an input voltage frequency exceeding the allowed full scale, it will display a screen like the one to the side



If the instrument detects an input L-PE voltage exceeding the 265V, it will display a screen like the one to the side



If between the test start and the acquisition of the first voltage or between the acquisition of the first and second voltage, a time longer than around 10s has elapsed, the instrument displays a screen like the one to the side. It is necessary to repeat the test



7. MAINTENANCE

7.1. GENERAL INFORMATION

- ➢ While using and storing the instrument, carefully observe the recommendations listed in this manual in order to prevent possible damage or danger during use.
- ➢ Do not use the instrument in environments with high humidity levels or high temperatures. Do not expose to direct sunlight
- ➢ Always switch off the instrument after use. Should the instrument remain unused for a long time, remove the batteries to avoid liquid leaks that could damage the instruments internal circuits.

7.2. REPLACEMENT OF THE BATTERIES

When the LCD display shows the low battery symbol "", replace the alkaline batteries.

CAUTION

Only expert and trained technicians should perform this operation. Before carrying out this operation, make sure you have disconnected all cables from the input terminals.

1. Switch off the instrument by pressing the **ON/OFF** key.
2. Remove the cables from the input leads
3. Loosen the battery compartment cover fastening screw and remove the cover.
4. Remove all the batteries from the battery compartment and replace them with new batteries of the right type only (§ 8.3) making sure to respect the indicated polarities
5. Restore the battery compartment cover into place and fasten it by mean of the relevant screw.
6. Do not scatter old batteries into the environment. Use the relevant containers for disposal

7.3. CLEANING THE INSTRUMENT

Use a soft and dry cloth to clean the instrument. Never use wet cloths, solvents, water, etc.

7.4. END OF LIFE

CAUTION: the symbol on the instrument indicates that the appliance and its accessories must be collected separately and correctly disposed of.

8. TECHNICAL SPECIFICATIONS

Accuracy is calculated as: ±[%reading + (no. of digits) * resolution] at 23°C, <80%RH

8.1. TECHNICAL CHARACTERISTICS

AC TRMS voltage

Range [V]	Resolution [V]	Accuracy
15 ÷ 460	1	±(3%rdg + 2dgt)

Frequency

Range [Hz]	Resolution [Hz]	Accuracy
47.50 ÷ 52.50 / 57.00 ÷ 63.00	0.1	±(0.1%rdg+1dgt)

Continuity of protective conductor (RPE)

Range [Ω]	Resolution [Ω]	Accuracy
0.00 ÷ 9.99	0.01	±(5.0%rdg + 3dgt)
10.0 ÷ 99.9	0.1	
100 ÷ 1999	1	

Test current: >200mA DC up to 5Ω (test leads included)
Test current generated: 1mA resolution, range 0 ÷ 250mA
Tensione a vuoto: 4 < V_0 < 24VDC
Safety protection: error message for input voltage >10V

Insulation resistance (MΩ)

Test voltage [V]	Range [MΩ]	Resolution [MΩ]	Accuracy
50	0.01 ÷ 9.99	0.01	±(2.0%rdg + 2dgt)
	10.0 ÷ 49.9	0.1	
	50.0 ÷ 99.9		±(5.0%rdg + 2dgt)
100	0.01 ÷ 9.99	0.01	±(2.0%rdg + 2dgt)
	10.0 ÷ 99.9	0.1	
	100 ÷ 199	1	±(5.0%rdg + 2dgt)
250	0.01 ÷ 9.99	0.01	±(2.0%rdg + 2dgt)
	10.0 ÷ 199.9	0.1	
	200 ÷ 249	1	
	250 ÷ 499		±(5.0%rdg + 2dgt)
500	0.01 ÷ 9.99	0.01	±(2.0%rdg + 2dgt)
	10.0 ÷ 199.9	0.1	
	200 ÷ 499	1	
	500 ÷ 999		±(5.0%rdg + 2dgt)
1000	0.01 ÷ 9.99	0.01	±(2.0%rdg + 2dgt)
	10.0 ÷ 199.9	0.1	
	200 ÷ 1999	1	

Open-circuit voltage rated test voltage -0% +10%
Rated measuring current: >1mA with 1kΩ x Vnom (50V, 100V, 250V, 1000V), >2.2mA with 230kΩ @ 500V
Short-circuit current <6.0mA for each test voltage
Safety protection: error message for input voltage >30V

Line/Loop impedance (Phase-Phase, Phase-Neutral, Phase-Earth)

Range [Ω]	Resolution [Ω]	Accuracy
0.01 ÷ 9.99	0.01	±(5%rdg + 3dgt)
10.0 ÷ 199.9	0.1	

Maximum test current: 3.31A (at 265V); 5.71A (at 457V)
P-N/P-P Test voltage: (100V ÷265V) / (100V÷460V); 50/60Hz ±5%
Protection types: MCB (B, C, D, K), Fuse (aM, gG, BS882-2,BS88-3, BS3036, BS1362)

First fault current – IT systems

Range [mA]	Resolution [mA]	Accuracy
0.1 ÷ 0.9	0.1	±(5%rdg+1dgt)
1 ÷ 999	1	±(5%rdg + 3dgt)

Limit contact voltage (ULIM) : 25V, 50V

Test on RCD protection (Molded case type)

Differential protection type (RCD): AC(∿),A/F(⩘),B/B+(⎓), CCID (∿,⎓ - USA country),General (G), Selective (S)

Single -phase systems (L-N-PE)

Voltage range L-PE, L-N: 100V 265V RCD type AC, A/F, B/B+ and CCID (IN ≤100mA)
190V 265V RCD type B/B+ (IN = 300mA)
Voltage range N-PE: <10V

Split-phase systems (phase delay VL1-PE, VL2-PE = 180° or phase delay VL1-PE, VL2-PE = 120°)

Voltage range L1-PE, L1-L2: 100V ÷265V RCD type AC, A/F, B/B+ and CCID (IΔN ≤100mA)
Voltage range L2-PE: 0V÷265V RCD type AC, A/F
0V÷min[(VL1-PE-100V) and (VL1-L2-100V), RCD type B/B+ (IΔN ≤100mA)
Rated tripping currents (IΔN): 5mA, 6mA,10mA, 20mA, 30mA, 100mA, 300mA, 500mA, 650mA, 1000mA
Frequency: 50/60Hz ± 5%

Molded case type RCD tripping current ⟋ - (for General RCD only)

RCD type	IN	Range I_N [mA]	Resolution [mA]	Accuracy
CCID	5mA, 20mA	(0.2 ÷ 1.3) $I_{\Delta N}$	≤ 0.1$I_{\Delta N}$	- 0%, +10%$I_{\Delta N}$
AC, A/F, B/B+	6mA,10mA			
AC, A/F, B/B+	30mA ≤IΔN ≤300mA	(0.2 ÷ 1.1) $I_{\Delta N}$		- 0%, +5%$I_{\Delta N}$
AC, A/F	500mA ≤IΔN ≤650mA			

Measurement duration of Molded case type RCD tripping time – TT/TN (L-N-PE systems)

	x 1/2		x 1		x 5		AUTO		⟋		AUTO+⟋	
\	G	S	G	S	G	S	G	S	G	S	G	S
5mA												
AC												
A/F												
B/B+												
CCID			999						310			
6mA												
AC	999	999	999	999	50	150	✓	✓	310		✓	
A/F	999	999	999	999	50	150	✓	✓	310		✓	
B/B+	999	999	999	999					310			
CCID												

10mA	AC 999 999 A/F 999 999 B/B+ 999 999 CCID	999 999 999 999 999 999	50 150 50 150	✓ ✓ ✓ ✓	310 310 310	✓ ✓
20mA	AC A/F B/B+ CCID	999			310	
30mA	AC 999 999 A/F 999 999 B/B+ 999 999 CCID	999 999 999 999 999 999	50 150 50 150	✓ ✓ ✓ ✓	310 310 310	✓ ✓
100mA	AC 999 999 A/F 999 999 B/B+ 999 999 CCID	999 999 999 999 999 999	50 150 50 150	✓ ✓ ✓ ✓	310 310 310	
300mA	AC 999 999 A/F 999 999 B/B+ 999 999 CCID	999 999 999 999 999 999	50 150 50 150	✓ ✓ ✓ ✓	310 310 310	
500mA **650mA**	AC 999 999 A/F 999 999 B/B+ CCID	999 999 999 999	50 150	✓ ✓	310 310	
1000mA	AC 999 999 A/F 999 999 B/B+ CCID	999 999				

Table with duration of tripping time measurement [ms] - Resolution: 1ms, Accuracy:±(2.0%reading + 2digits)

Measurement duration of Molded case type RCD tripping time – IT (L-N-PE systems)

	x 1/2 \ G S	**x 1** G S	**x 5** G S	**AUTO** G S	 G S	**AUTO+**  G S
6mA **10mA** **30mA**	AC 999 999 A/F 999 999 B/B+ 999	999 999 999 999 999 999	50 150 50 150	✓ ✓ ✓ ✓	310 310 310	✓ ✓

100mA 300mA	AC 999 999 A/F 999 999 B/ B+ 999	99 9 999 99 9 999 99 9	5 0 150 5 0 150	✓ ✓ ✓ ✓	31 0 31 0 31 0	
500mA 650mA	AC 999 999 A/F 999 999 B/ B+	99 9 999 99 9 999	5 0 150	✓ ✓		
1000m A	AC 999 999 A/F 999 999 B/ B+	99 9 999 99 9 999				

Table with duration of tripping time measurement [ms] - Resolution: 1ms, Accuracy:±(2.0%reading + 2digits)

Test on RCD protection (DD type)
Differential protection type (RCD): DD type (compliance with IEC62955 guideline), General (G)
Single -phase systems (L-N-PE)
Voltage range L-PE, L-N: 100V ÷265V
Voltage range N-PE: <10V
Split-phase systems (phase delay VL1-PE, VL2-PE = 180° or phase delay VL1-PE, VL2-PE = 120°)
Voltage range L1-PE, L1-L2: 100V ÷265V
Voltage range L2-PE: 0V÷min[(VL1-PE-100V) and (VL1-L2-100V)]
Rated tripping currents (IΔN): 6mA
Frequency: 50/60Hz ± 5%

DD type RCD tripping current - (for General RCD only)

RCD type	IΔN	Range [mA]	Resolution [mA]	Accuracy
DD	6mA	(0.2 ÷ 1.1) $I_{\Delta N}$	≤ 0.1$I_{\Delta N}$	- 0%, +10%$I_{\Delta N}$

DD type RCD tripping time x1 - (for General RCD only)

RCD type	IΔN	Range [ms]	Resolution [ms]	Accuracy
DD	6mA	10000	1	±(2%rdg + 2digits)

Overall earth resistance without RCD tripping (NoTrip)
Voltage range Phase-Earth, Phase-Neutral: 100 ÷ 265V, Frequency: 50/60Hz ± 5%

Overall earth resistance in systems with Neutral (3-wire) – (30mA or higher RCD)

Range [Ω]	Resolution [Ω]	Accuracy
0.05 ÷ 9.99	0.01	±(5%rdg +8dgt)
10.0 ÷ 199.9	0.1	

Overall earth resistance in systems with Neutral (3-wire) – (6mA and 10mA RCD)

Range [Ω]	Resolution [Ω]	Accuracy
0.05 ÷ 9.99	0.01	±(5%rdg +30dgt)

10.0 ÷ 199.9	0.1	±(5%rdg +30dgt)

Overall earth resistance in systems withot Neutral (2-wire) – (30mA or higher RCD)

Range [Ω]	Resolution [Ω]	Accuracy
0.05 ÷ 9.99	0.01	±(5%rdg +8dgt)
10.0 ÷ 99.9	0.1	
100 ÷ 1999	1	

Overall earth resistance in systems withou Neutral (2-wire) – (6mA and 10mA RCD)

Range [Ω]	Resolution [Ω]	Accuracy
0.05 ÷ 9.99	0.01	±(5%rdg +30dgt)
10.0 ÷ 99.9	0.1	
100 ÷ 1999	1	

Contact voltage (measured during RCD and NoTrip⏚ test)

Range [V]	Resolution [V]	Accuracy
0 ÷ Ut LIM	0.1	-0%, +(5.0% rdg + 3V)

Phase rotation with 1 test lead

Voltage range P-N, P-PE[V]	Frequency range
100 ÷ 265	50Hz/60Hz ± 5%

Measurement is only carried out by direct contact with metal live parts (**not on insulation sheath**).

8.2. REFERENCE GUIDELINES

Safety:	IEC/EN61010-1, IEC/EN61557-1, -2, -3, -4, -6, -10
EMC :	IEC/EN61326-1
Technical documentation:	IEC/EN61187
Safety of accessories:	IEC/EN61010-031, IEC/EN61010-2-032, IEC/EN61010-2-030, IEC/EN61010-2-033, IEC/EN61010-2-034
Insulation:	double insulation
Pollution level:	2
Max operating altitude:	2000m (6562ft)
Measurement category:	CAT IV 300V to earth, maximum 415V between inputs
RPE:	IEC/EN61557-4,BS7671 17th/18th ed., AS/NZS3000/3017
MΩ:	IEC/EN61557-2,BS7671 17th/18th ed., AS/NZS3000/3017
RCD:	IEC/EN61557-6 (only on Phase-Neutral-Earth systems)
RCD-DD:	IEC62955
RCD-CCID:	UL2231-2
LOOP P-P, P-N, P-PE:	IEC/EN61557-3,BS7671 17th/18th ed., AS/NZS3000/3017
Multifunction:	IEC/EN61557-10,BS7671 17th/18thed., AS/NZS3000/3017

8.3. GENERAL CHARACTERISTICS

Mechanical characteristics

Dimensions (L x W x H):	225 x 165 x 75mm ; (9 x 6 x 3in)
Weight (batteries included):	1.2kg ; (42 ounces)
Mechanical protection:	IP40

Power supply

Battery type:	6x1.5V alkaline batteries type AA IEC LR06 MN1500
Low battery indication:	low battery symbol “” on the display
Battery life:	> 500 tests for each function
Auto Power OFF:	after 10 minutes idling (if activated)

Miscellaneous

Display:	COG Black/white graphic LCD, 320x240pxl

8.4. ENVIRONMENT

8.4.1. Environmental conditions for use

Reference temperature:	23°C ± 5°C ; (73°F ± 41°F)
Operating temperature:	0°C ÷ 40°C ; (32°F ÷ 104°F)
Allowable relative humidity:	<80%RH
Storage temperature:	-10°C ÷ 60°C ; (14°F ÷ 140°F)
Storage humidity:	<80%RH

This instrument satisfies the requirements of Low Voltage Directive 2014/35/EU (LVD) and of EMC Directive 2014/35/EU
This instrument satisfies the requirements of European Directive 2011/65/EU (RoHS) and 2012/19/EU (WEEE)

9. SERVICE

9.1. WARRANTY CONDITIONS

This instrument is warranted against any material or manufacturing defect, in compliance with the general sales conditions. During the warranty period, defective parts may be replaced. However, the manufacturer reserves the right to repair or replace the product. Should the instrument be returned to the After-sales Service or to a Dealer, transport will be at the Customers charge. However, shipment will be agreed in advance. A report will always be enclosed to a shipment, stating the reasons for the products return. Only use original packaging for shipment. Any damage due to the use of non-original packaging material will be charged to the Customer. The manufacturer declines any responsibility for injury to people or damage to property.

The warranty shall not apply in the following cases:

- Repair and/or replacement of accessories and battery (not covered by warranty).
- Repairs that may become necessary as a consequence of an incorrect use of the instrument or due to its use together with non-compatible appliances.
- Repairs that may become necessary as a consequence of improper packaging.
- Repairs which may become necessary as a consequence of interventions performed by unauthorized personnel.
- Modifications to the instrument performed without the manufacturer's explicit authorization.
- Use not provided for in the instruments specifications or in the instruction manual.

Our products are patented and our trademarks are registered. The manufacturer reserves the right to make changes in the specifications and prices if this is due to improvements in technology.

9.2. SERVICE

If the instrument does not operate properly, before contacting the After-sales Service, please check the conditions of batteries and cables and replace them, if necessary. Should the instrument still operate improperly, check that the product is operated according to the instructions given in this manual. Should the instrument be returned to the After-sales Service or to a Dealer, transport will be at the Customer's charge. However, shipment will be agreed in advance. A report will always be enclosed to a shipment, stating the reasons for the products return. Only use original packaging for shipment; any damage due to the use of non-original packaging material will be charged to the Customer.

10. THEORETICAL APPENDIXES

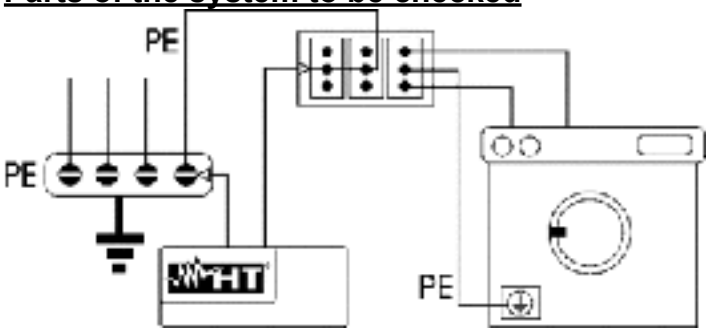
10.1. CONTINUITY OF PROTECTIVE CONDUCTORS

Check the continuity of:

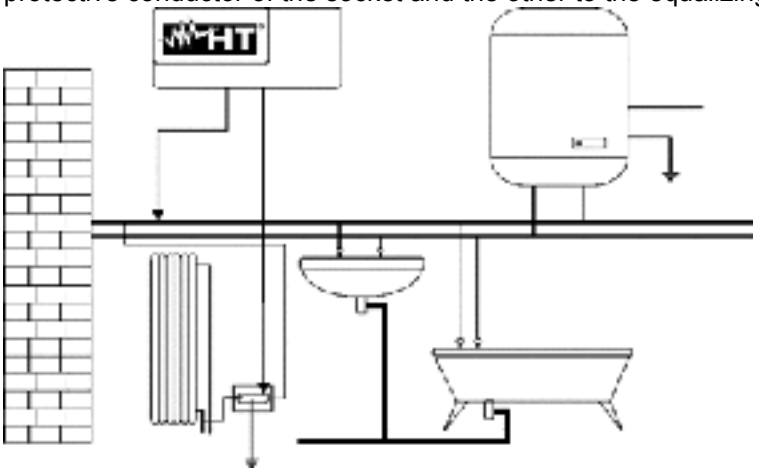
- Protective conductors (PE), main equalizing potential conductors (EQP), secondary equalizing potential conductors (EQS) in TT and TN-S systems
- Neutral conductors having functions of protective conductors (PEN) in TN-C system.

This test is to be preceded by a visual check verifying the existence of yellow-green protective and equalizing potential conductors as well as compliance of the sections used with the standards requirements.

Parts of the system to be checked



Connect one of the test leads to the protective conductor of the socket and the other to the equalizing potential node of the earth installation.



Connect one of the test leads to the external mass (in this case the water pipe) and the other to the earth installation using for example the protective conductor of the closest socket.

Fig. 37: Examples for continuity measurements on conductors

Check the continuity among:

- Earth poles of all the plug sockets and earth collector or node
- Earth terminals of class I appliances (boilers, etc.) and earth collector or node
- Main external masses (water tubes, gas pipes, etc.) and earth collector or node
- Additional external masses between each other and to earth terminal.

Allowable values

The standards do not require the measurement of continuity resistance and the comparison of the results with limit values. The standards simply require that the instrument in use warns the operator if the test was not carried out with a current of at least 200mA and an open circuit voltage ranging from 4 to 24V. The resistance values may be calculated according to the sections and lengths of the conductors under test. In

general, if the instrument detects values of some ohms, the test may be considered as successful.

10.2. INSULATION RESISTANCE

Purpose of the test

Check that the insulation resistance of the installation complies with the requirements of the applicable guidelines. This test has to be performed with the circuit being tested not powered and with the possible loads it supplies disconnected.

Allowable values

The values of the measured voltage and of the minimum insulation resistance can be taken from the following table

Circuit nominal voltage [V]	Test voltage [V]	Insulation resistance [MΩ]
SELV and PELV *	250	≥ 0,250
Up to/equal to 500 V, except for the above-mentioned circuits	500	≥ 1,000
Over 500 V	1000	≥ 1,000
* The terms SELV and PELV replace, in the standards new wording, the old definitions of “Very low safety voltage” or “Very low functional voltage”		

Table 3: Most common test types, insulation resistance measurement

Parts of the system to be checked

Check that the insulation resistance between:

- ➢ Each active conductor and the earth (the neutral conductor is considered as an active conductor except in TN-C power supply systems, where it is considered as part of the earthing (PEN)). During this measurement, all active conductors may be connected to each other. Should the measurement result not to be within the limits prescribed by the standards, the test must be repeated separately for each single conductor
- ➢ The active conductors. The guidelines recommends also checking the insulation between active conductors when this is possible

If the system includes electronic devices, it is necessary to disconnect them from the system to prevent any damage. Should this not be possible, only perform the test between active conductors (which, in this case, must be connected to each other) and the earth connection.

In the presence of a very extended circuit, wires running side by side constitute a capacity that the instrument must load in order to obtain a correct measurement; in this case it is advisable to hold the start button of the measurement (in case you run the test in manual mode) until the result is stable.

The **"> full scale"** message indicates that the insulation resistance measured by the instrument is higher than the maximum measurable resistance, this result is obviously much higher than the minimum limits in the standard table above, so the insulation at that point is to be considered compliant

10.3. CHECKING CIRCUIT SEPARATION

A **SELV** system is a zero-category system or safety extra low voltage system characterized by power supply from an independent (e.g. batteries, small generator set) or safety source (e.g. safety transformer), protective separation from other electrical systems (double or reinforced insulation or earthed metal screen) and absence of earthed points (insulated from the earth).

A **PELV** system is a zero-category system or protective extra low voltage system characterized by power supply from an independent (e.g. batteries, small generator set) or safety source (e.g. safety transformer), protective separation from other electrical systems (double or reinforced insulation or earthed metal screen) and, unlike **SELV** systems, presence of earthed points (not insulated from the earth).

A system with **Electrical Separation** is a system characterized by a power supply from an insulation transformer or independent source with equivalent characteristics (e.g. motor generator set), protective separation from other electrical systems (insulation no lower than that of the insulation transformer), protective separation to earth (insulation no lower than that of the insulation transformer).

Purpose of the test

The test, to be performed if protection is obtained through separation must check that the insulation resistance measured as described below (according to the type of separation) complies with the limits reported in the table relating to insulation measurements.

Parts of the system to be checked

- **SELV** System (Safety Extra Low Voltage):
  - ✓ Measure the resistance between the active parts of the circuit being tested (separated) and the active parts of the other circuits.
  - ✓ Measure the resistance between the active parts of the circuit to be tested (separated) and the earth.

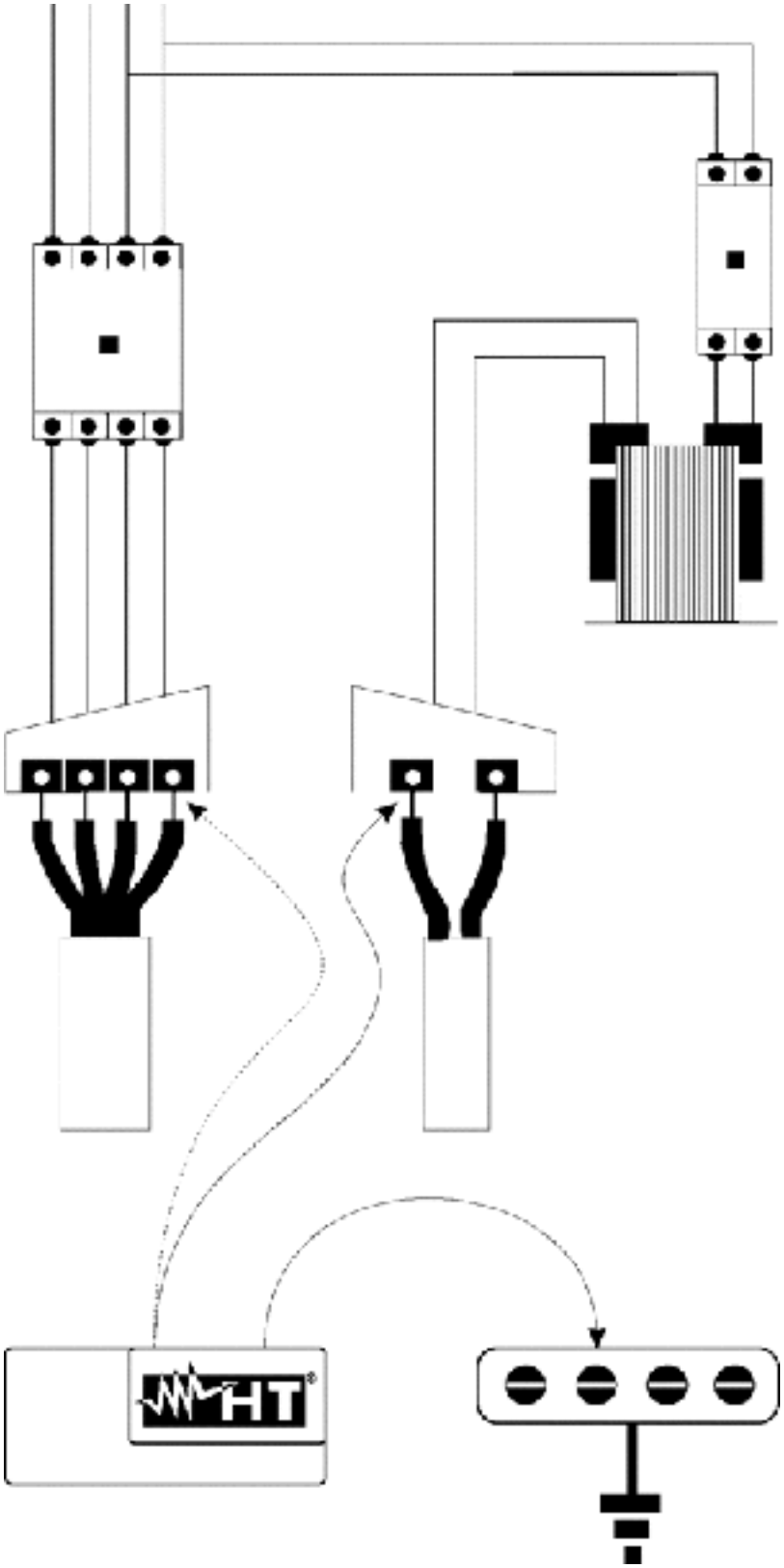
- **PELV** System (Protective Extra Low Voltage):
  - ✓ Measure the resistance between the active parts of the circuit being tested (separated) and the active parts of the other circuits.

- **Electrical separation**:
  - ✓ Measure the resistance between the active parts of the circuit being tested (separated) and the active parts of the other circuits.
  - ✓ Measure the resistance between the active parts of the circuit to be tested (separated) and the earth.

Allowable values

The test has a positive result when the insulation resistance shows values higher or equal to those indicated in Table 3.

EXAMPLE OF SEPARATION TEST BETWEEN ELECTRICAL CIRCUITS



Insulation or safety transformer separating the circuits

TEST BETWEEN ACTIVE PARTS
Connect an instrument probe to one of the two conductors of the separated circuit and the other to one of the conductors of a non-separated circuit.

TEST BETWEEN ACTIVE PARTS AND EARTH
Connect an instrument probe to one of the two conductors of the separated circuit and the other to the equalizing potential node. This test must be performed for SELV circuits or circuits with electrical separation only.

Equalizing potential node

Fig. 38: Separation measurements between the circuits of a system

10.4. TEST ON DIFFERENTIAL SWITCHES (RCD)

Purpose of the test

Checking that the General (G) and Selective (S) differential protection devices have been correctly installed and adjusted and that they maintain their characteristics over time. The check must make sure that the differential switch trips at a current not higher than its nominal operating current IdN and that the tripping time meets the following conditions, according to the case:

- The tripping time does not exceed the maximum time as prescribed by the standard for differential switches of a General type (according to what described in Table 4).
- The tripping time is between the minimum and the maximum tripping time for differential switches of a Selective type (according to what described in Table 4).

The differential switch test performed with the test key helps so that no “gluing effect” jeopardizes the operation of the device if it has remained unused for a long time. This test is only performed to ascertain the mechanical functionality of the device and it is not sufficient to declare the devices conformity to the standard regarding differential current devices. According to statistics, switch verification through test key, if performed once a month, reduces to a half the devices malfunction rate. However, this test only detects 24% of the defective differential switches.

Parts of the system to be checked

All differential switches must be tested upon installation. In low-voltage systems, it is advisable to perform this test, fundamental in order to guarantee a correct safety level. In medical rooms, this test must be performed periodically on all differential switches as prescribed by the guidelines.

Allowable values

On each molded type RCD two tests must be performed on each differential switch: a test with a leakage current beginning in phase with the positive half-wave of voltage (0°) and a test with a leakage current beginning in phase with the negative half-wave of voltage (180°). The result to be considered is the higher one. The test with ½In must not cause the differential switch tripping.

RCD type	IdN x 1	IdN x 5 *	Description
General	0.3s	0.04s	Maximum tripping time in seconds
Selective S	0.13s	0.05s	Minimum tripping time in seconds
	0.5s	0.15s	Maximum tripping time in seconds

Table 4: Tripping times for general and selective differential switches

Trip-out times compliance with AS/NZS 3017 guideline (**)

		½ IΔn (*)	IΔn	5 x IΔn	
RCD type	**IdN [mA]**	**tΔ [ms]**			**Note**
I	≤10	>999ms	40		Maximum tripping time
II	>10 ≤ 30		300	40	
III	> 30				

IV [S]	> 30		500	150	
			130	50	Minimum non-actuating time

Table 5: Tripping times for general and selective differential switches in AUS/NZ country

(*) Minimum test period for current of ½ IΔn, RCD shall no trip-out
(**) Test current and measurement accuracy correspond to AS/NZS 3017 requirements

Measurement of tripping current for protection differential switches

- ➢ This test aims at checking the real tripping current of general differential switches (**it does not apply to selective differential switches**).
- ➢ In the presence of differential switches with selectable tripping current, it is useful to perform this test in order to check the real tripping current of the differential switch. For differential switches with fixed differential current, this test may be performed in order to detect possible leakages of the users connected to the system.
- ➢ Should an earth system not be available, perform the test by connecting the instrument to a terminal on a conductor downstream of the differential device and a terminal on the other conductor upstream of the device.
- ➢ Tripping current must be between ½Idn and Idn

10.5. VERIFY OF THE BREAKING CAPACITY OF PROTECTION DEVICES

Purpose of the test

Checking that the breaking capacity of the protection device is higher than the maximum fault current possible in the system.

Parts of the system to be checked

The test must be performed at the point in which the maximum short-circuit current is possible, normally immediately downstream of the protection device to be checked.
The test must be performed between phase and phase (Z_{pp}) in three-phase systems and between phase and neutral (Z_{pn}) in single-phase systems.

Allowable values

The instrument performs the comparison between the measured value and the value calculated according to the following relationships:

$$BC > I_{MAX\,3\Phi} = C_{MAX} \cdot \frac{\frac{U_{L-L}^{NOM}}{\sqrt{3}}}{\frac{Z_{L-L}}{2}}$$

Three-phase systems

$$BC > I_{MAX\,L-N} = C_{MAX} \cdot \frac{U_{L-N}^{NOM}}{Z_{L-N}}$$

Single-phase systems

where: BC = breaking capacity of protection device
Z_{LL} = Impedance measured between phase and phase
Z_{LN} = Impedance measured between phase and neutral

Measured voltage	U_{NOM}	C_{MAX}
230V-10% < Vmeasured < 230V+ 10%	230V	1.05

230V+10% < Vmeasured < 400V- 10%	Vmeasured	1.10
400V-10% < Vmeasured < 400V+ 10%	400V	1.05

10.6. VERIFY OF PROTECTION AGAINST INDIRECT CONTACTS IN TN SYSTEMS

Purpose of the test

The protection against indirect contacts in the TN systems must be guarantee by means a protection device against the overcurrents (typically MCB or fuse) which swich off the power supply of the circuit or the electrical equipment in case of fault between an active part and a ground mass or a protection conductor within a interval not exceeding at 5s, sufficient for the equipments, or in compliance with the times declared in the following table. For other countries refer to the respective guidelines.

Uo [V]	Trip out time of protection [s]
50 ÷ 120	0.8
120 ÷ 230	0.4
230 ÷ 400	0.2
>400	0.1

Table 6: Tripping times for protection devices

Uo = nominal AC voltage refer to ground of the system

The above conditions is satisfied by the following relationshisp:

$$\mathbf{Zs * Ia \leq Uo}$$

where:

Zs = Fault Loop P-PE impedance which includes the phase winding of the transformer, the line conductor up to the fault point and the protective conductor from the fault point to the star center of the transformer

Ia = Tripping current of the protection device within the specified time in Table 6

Uo = nominal AC voltage refer to ground

CAUTION

⚠ The instrument must be used to measure fault loop impedance values at least 10 times higher than the resolution value of the instrument in order to minimize errors.

Parts of the system to be checked

The test must necessarily be performed on TN and IT systems not protected by differential devices.

Allowable values

The measurement is aimed at ensuring that in every point of the system the followed relationships are satisfied:

$$Ia \leq I_{MIN\ P-PE} = C_{MIN} \cdot \frac{U_{P-PE}^{NOM}}{Z_{P-PE}}$$

Measured voltage	U_{NOM}	C_{MIN}
230V-10% < Vmeasured < 230V+ 10%	230V	0.95
230V+10% < Vmeasured < 400V- 10%	Vmeasured	1.00
400V-10% < Vmeasured < 400V+ 10%	400V	0.95

Depending on the set values of phase-phase, phase-neutral or phase-PE voltage (see § 5.1.3) and the measured value of fault loop impedance, the instrument calculates the **minimum value** of the assumed short-circuit current to be interrupted by the protection device. For proper coordination, this value MUST always be greater than or equal to the **Ia** value of the tripping current of the type of protection considered.

The **Ia** reference value (see Fig. 39) depends on:

- ➢ Protection type (curve)
- ➢ Rated current of the protection device
- ➢ Time of fault extinction by the protection

Tipically: Ia = 3÷5In (curve B), Ia = 5÷10In (curve C), Ia = 10÷20In (curves D,K

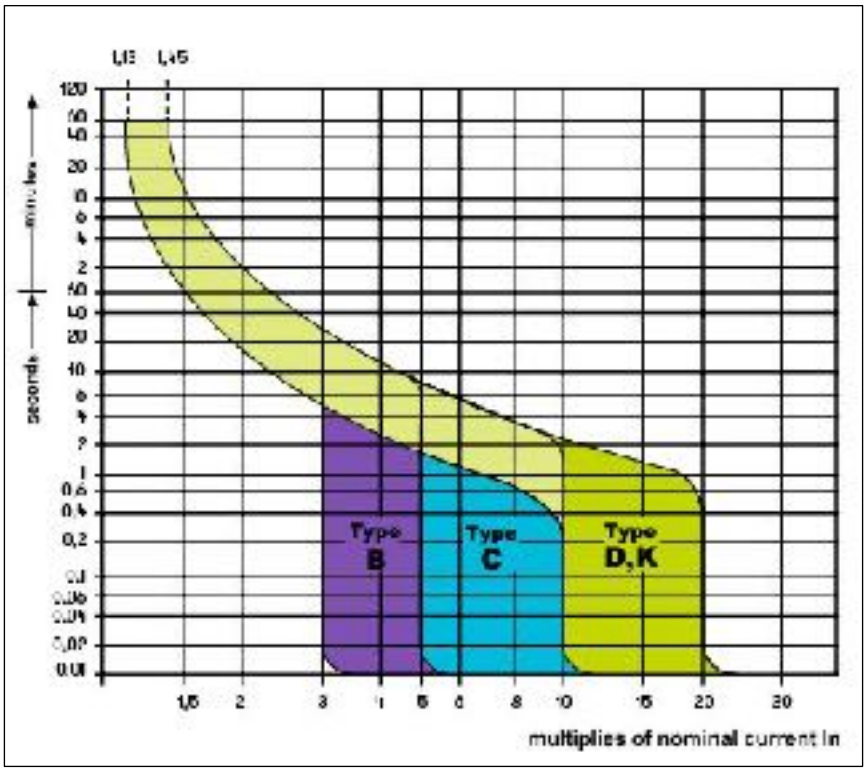


Fig. 39: Example of curves relative to magnetothermal (MCB) protection

The instrument allows the selection (*) of the following parameters:

- MCB current (B, C, K, D curves) selectable among values: **3,6,10,16,20,25,32,40,50,63,80,100,125**
- Nominal current Fuse BS88-2 selectable among values: **2**, **4**, **6, 10, 16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160, 200A**
- Nominal current Fuse BS88-3 selectable among values: **5,16,20,32,45,63,80,100A**
- Nominal current Fuse BS3036 selectable among values: **5,15,20,30,45,60,100A**
- Nominal current Fuse BS1362 selectable among values: **3,13A**
- Time of fault extinction by the protection selectable among: **0.1s, 0.2s, 0.4s, 1s, 5s**

(*) The values could be subject to variations

10.7. NO TRIP TEST IN TN SYSTEMS

The protection against indirect contacts in the TN systems must be guarantee by means a protection device against the overcurrents (typically MCB or fuse) which swich off the power supply of the circuit or the electrical equipment in case of fault between an active part and a ground mass or a protection conductor within a interval not exceeding at 5s, sufficient for the equipments.

Parts of the system to be checked

The test must be performed at the point in which the minimum short-circuit current is possible, normally immediately downstream of the protection device to be checked.
The test must be performed between phase and PE (Z_{L-PE}) and between phase and neutral (Z_{L-N}) in three-phase systems or single-phase systems.

Allowable values

The measurement is aimed at ensuring that in every point of the system the followed relationships are satisfied:

$$Z_{L\text{-}PE} \leq Z_{LIM} \quad (1)$$

$$Z_{L\text{-}N} \leq Z_{LIM} \quad (2)$$

where:

$Z_{L\text{-}PE}$	=	Impedance measured between phase and PE
$Z_{L\text{-}N}$	=	Impedance measured between phase and neutral
Z_{LIM}	=	Maximum limit impedance depending on type (MCB or Fuse) and tripping time of the selected protection (values depending on countries)

The following selections (*) are available on the instrument:

- ➢ MCB current (B, C, K, D curves) selectable among values: **3,6,10,16,20,25,32,40,50,63,80,100,125**
- ➢ Nominal current Fuse BS88-2 selectable among values: **2**, **4**, **6, 10, 16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160, 200A**
- ➢ Nominal current Fuse BS88-3 selectable among values: **5,16,20,32,45,63,80,100A**
- ➢ Nominal current Fuse BS3036 selectable among values: **5,15,20,30,45,60,100A**
- ➢ Nominal current Fuse BS1362 selectable among values: **3,13A**
- ➢ Time of fault extinction by the protection selectable among: **0.1s, 0.2s, 0.4s, 1s, 5s**

(*) The values could be subject to variations

10.8. VERIFY OF PROTECTION AGAINST INDIRECT CONTACTS IN TT SYSTEMS

Purpose of the test

Checking that the protection device is coordinated with the value of earth resistance. We cannot assume a priori a reference limit value for earth resistance as a reference when checking the measurements result. It is necessary to check each time that the coordination prescribed by the standard is met.

Parts of the system to be checked

Earth installation in operating conditions. The test must be performed without disconnecting the earth rods.

Allowable values
The value of earth resistance, however measured, must satisfy the following relation:

$$R_A < 50 / I_a$$

where: R_A = resistance measured of earth installation whose value can be determined with the following measurements:
- Impedance of the fault ring (*)
- Earth resistance with two wires in socket (**)
- Earth resistance obtained by the measurement of contact voltage U_t (**)
- Earth resistance obtained by the tripping time test of the RCDs (A, AC), RCD S (A, AC) (**)

I_a = tripping current of the automatic RCD or rated tripping current of the RCD (in case of RCD S 2 IdN) in ampere

50 = safety limit voltage (reduced down to 25V in special environments)

(*) If the system protection is obtained through a differential switch, the measurement must be performed upstream of this switch or downstream of it by short-circuiting the switch in order to prevent it from tripping.

(**) These methods, although not currently foreseen by guidelines provide values that have been proven indicative of the earth resistance by numerous comparisons with the three-wire method.

EXAMPLE OF EARTH RESISTANCE CHECK
System protected by a 30mA differential switch.

➢ Let us measure the earth resistance by using one of the above-mentioned methods.
➢ In order to understand if the system resistance is to be considered as compliant with the standards, we need to multiply the value found by 0.03A (30mA).
➢ If the result is lower than 50V (or 25V for special environments), the system can be considered as coordinated, as it satisfies the relationship indicated above.
➢ When dealing with 30mA differential switches (as in almost all civil systems), the maximum allowable earth resistance is **50/0.03=1666**Ω. This enables using also the indicated simplified methods which, although they do not provide an extremely precise value, provide a sufficiently approximated value for coordination calculation.

10.9. VERIFY OF PROTECTION AGAINST INDIRECT CONTACTS IN IT SYSTEMS

In IT systems the active parts must be isolated from the ground or be connected to earth through an impedance of sufficiently high value. In the case of a single earth fault current of the first fault is weak and therefore it is not necessary to interrupt the circuit. This connection can be made to the neutral point of the system or to an artificial neutral point. If there is no neutral point, can be connected to earth through an impedance of a line conductor. It must, however, take precautions to avoid the risk of harmful physiological effects on people in contact with conductive parts simultaneously accessible in the case of a double earth fault.

Purpose of the test

Verify that the impedance of the ground probe in which the mass are connected satisfyteh following relationship:

$$Z_E * I_d \leq U_L$$

where:

Z_E = L-PE impedance of the ground probe in which the mass are connected

Id = L-PE current of first fault (typically expressed in mA)

U_L = Limit contact voltage 25V or 50V

Parts of the system to be checked

The earth system under operating conditions. The verification should be performed without disconnecting the ground probes.

10.10. VERIFY OF PROTECTION COORDINATION L-L, L-N AND L-PE

Purpose of the test

Test the coordination of protective devices (typically MCB or fuse) present in a Single-phase or Three-phase installation as a function of the limit time of fault extinction by the protection set by the user and the calculated value of the short-circuit current.

Parts of the system to be checked

The test must be performed at the point in which the minimum short-circuit current is possible, normally at the end of the line controlled by the protection device in the normal condition of the line. The test must performed between Phase-Phase in the Three-phase installations and between Phase-PE or Phase-PE in the Single-phase installation

Allowable values

The instrument performs the comparison between the calculated value of short-circuit current and the **Ia** = tripping current of the protection device within the specified time, accordinf to to following expressions:

$$I_{SC\,L-L\_Min2\Phi} > I_a$$ Three-phase system → Loop L-L impedance

$$I_{SC\,L-N\_Min} > I_a$$ Single-phase system → Loop L-N impedance

$$I_{SC\,L-PE\_Min} > I_a$$ Single-phase system → Loop L-PE impedance

where:

Isc L-L_Min2F	=	Prospective short-circuit current minimum double phase L-L
Isc L-N_Min	=	Prospective short-circuit current minimum L-N
Isc L-PE_Min	=	Prospective short-circuit current minimum L-PE

The calculation of prospective short-circuit current is performed by the instrument based on the fault loop impedance measurement in compliance with the following relationships:

$$I_{SC\,L-L\_Min2\Phi} = C_{MIN} \cdot \frac{U_{L-L}^{NOM}}{Z_{L-L}}$$ **Phase – Phase**

$$I_{SC\,L-N\_Min} = C_{MIN} \cdot \frac{U_{L-N}^{NOM}}{Z_{L-N}}$$ **Phase – Neutral**

$$I_{SC\,L-PE\_Min} = C_{MIN} \cdot \frac{U_{L-PE}^{NOM}}{Z_{L-PE}}$$ **Phase – PE**

Measured voltage	U_{NOM}	C_{MIN}
230V-10% < Vmeasured < 230V+ 10%	230V	0,95
230V+10% < Vmeasured < 400V- 10%	Vmeasured	1,00
400V-10% < Vmeasured < 400V+ 10%	400V	0,95

where:

U L-L	=	Nominal Phase-Phase voltage
U L-N	=	Nominal Phase-Neutral voltage
U L-PE	=	Nominal Phase-PE voltage
Z L-L	=	Impedance Phase-Phase measured

Z L-N = Impedance Phase-Neutral measured

Z L-PE = Impedance Phase-PE measured

CAUTION

The instrument must be used to measure fault loop impedance values at least 10 times higher than the resolution value of the instrument in order to minimize errors.

Depending on the set values of nominal voltage (see § 5.1.3) and the measured value of fault loop impedance, the instrument calculates the **minimum value** of the assumed short-circuit current to be interrupted by the protection device. For proper coordination, this value MUST always be greater than or equal to the **Ia** value of the tripping current of the type of protection considered.

The **Ia** reference value depends on:

- ➢ Protection type (curve)
- ➢ Rated current of the protection device
- ➢ Time of fault extinction by the protection

The instrument allows the selection (*) of the following parameters:

- ➢ MCB current (B, C, K, D curves) selectable among values: **3,6,10,16,20,25,32,40,50,63,80,100,125**
- ➢ Nominal current Fuse BS88-2 selectable among values: **2**, **4**, **6, 10, 16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160, 200A**
- ➢ Nominal current Fuse BS88-3 selectable among values: **5,16,20,32,45,63,80,100A**
- ➢ Nominal current Fuse BS3036 selectable among values: **5,15,20,30,45,60,100A**
- ➢ Nominal current Fuse BS1362 selectable among values: **3,13A**
- ➢ Time of fault extinction by the protection selectable among: **0.1s, 0.2s, 0.4s, 1s, 5s**

(*) The values could be subject to variations

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