USER'S MANUAL

ZEROLINE 60

ILLKO

CONTENTS

1. INTRODUCTION

1.1. Safety

Read this User's Manual carefully and completely and follow all instructions contained therein. Otherwise using of the instrument may be dangerous for operator, for installation under test or for the instrument!

If there is reason to believe that safe operation has become impossible, put the instrument out of operation and secure it against any unintended operation.
Safe operation must be presumed to be no longer possible, if:

- The instrument does not operate properly any longer.
- The instrument, cables, connectors, plugs or accessories exhibits visible damages.
- The instrument was stored under unfavourable conditions for a long period.
- The instrument was exposed to extraordinary stress caused by transport.

Observe the following safety precautions:

- Make sure that the instrument, measuring cables and all other accessories are in flawless condition, e.g. no damaged insulation, no broken cables or plugs etc.
- Connect the ZEROLINE 60 to the mains voltage only for the period of time necessary for the carrying out of a measurement. The maximum allowed connection time is 5 minutes, if the mains voltage is > 250 V / 50 Hz. The instrument must then be disconnected from mains voltage not less then 5 minutes.
- Only a trained, skilled person, who is familiar with hazardous voltage operations, can handle the ZEROLINE 60.
- It is necessary to respect all safety regulations applicable to particular measurement.
- Use only original standard or optional accessories supplied with the instrument by your distributor.
- Do not touch the conductive parts of test tips, crocodile clips etc.
- Test cables are marked as voltage ones (e.g. PE-U) and current ones (e.g. PE-I) because of clearness in this manual. Note that in fact test cables are not marked.

1.2. Explanation of symbols


Warning concerning a point of danger! Read User's Manual and observe all precautions!


Warning concerning a point of danger! Read User's Manual and observe all precautions!


Information, hint.


Protection class II (double insulation).

1.3. Purpose of the ZEROLINE 60

The **ZEROLINE 60** is intended for measurement of:

- Fault loop impedance
- Fault loop resistance – no trip-out of RCD in RCD protected installation
- Prospective short-circuit current
- Line impedance
- Earth resistance (substitute method)
- Voltage U_{L-N} (U_{L-L}), U_{L-PE}
- Frequency

1.4. Applied standards

The ZEROLINE 60 is manufactured and tested in accordance with the following regulations:

Safety	EN 61010-1 + A2 EN 60644-1
EMC	EN 55022 EN 61326-1 EN 61000-4-2, -3, -4, -5, -6, -11
Measurement	EN 61557-1, EN 61557-3

2. DESCRIPTION OF THE INSTRUMENT

2.1. General description

The ZEROLINE 60 is microprocessor based portable measuring instrument, which enables high precision measurement of fault loop impedance and line impedance in TT-system and TN-system.
4-wire connection system eliminates contact resistances. Test current is selectable in 3 steps. TRMS values of voltages / currents are measured in order to secure high precision of measurement. Besides fault loop and line impedance there are calculated:

- Prospective short-circuit current
- 1,5x Z / R
- Max. value of Z / R – value which takes into consideration operating error of the ZEROLINE 60

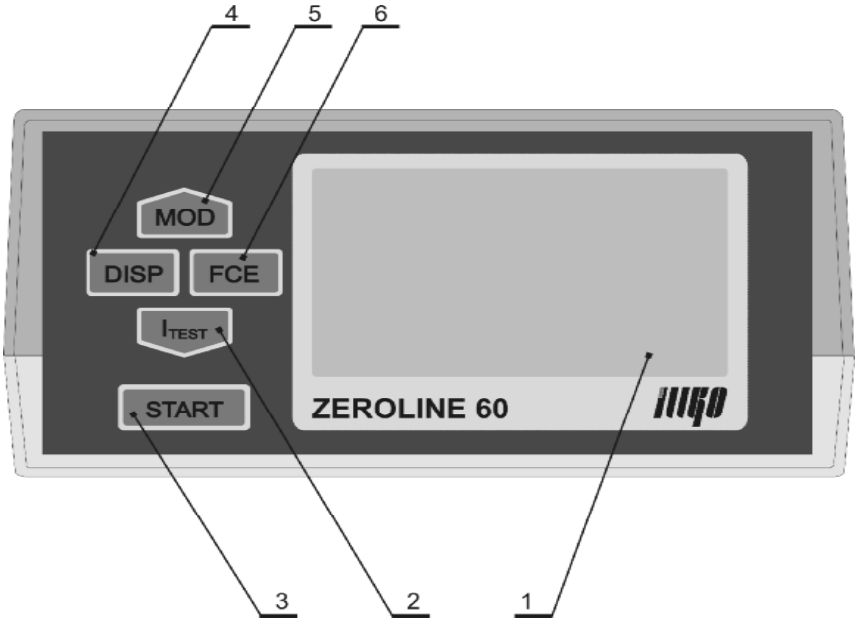
The ZEROLINE 60 has following additional built-in monitoring and safety features:

- Automatic check of dangerous contact voltage on PE – the quick test of prospective contact voltage is carried out automatically before fault loop measurement.
- Automatic check, if test leads are properly connected to tested installation.

- Automatic exchange of L / N terminals, if L / N test leads are connected reversely to tested installation.
- Automatic protection against overheating of internal power circuits.

2.2. Front panel

Fig. A – Front panel



1 - **Matrix LCD** with backlight
2 - $\mathbf{I_{TEST}}$ key
▼ key
3 - **START** key
4 - **DISP** key
5 - **MOD** key
▲ key
6 - **FCE** key

2.3. Included in the set

The set includes all accessories necessary for all basic measurements:

- The ZEROLINE 60 instrument 1 x
- **P2070** Test cable (6-wires) 1 x
- **P4011** Crocodile clip, black 1 x
- **P4013** Crocodile clip, green/yellow 1 x
- **P3011** Test tip, black 1 x
- **P3012** Test tip, blue 1 x
- Neck strip 1 x
- User's Manual 1 x
- Calibration certificate 1 x

2.4. Optional accessories

- **P6120** Bag for the instrument and for some accessories
- **P2071** Test cable with 230 V Euro/Schuko plug
- **P4011** Crocodile clip, black
- **P4013** Crocodile clip, green/yellow
- **P3011** Test tip, black
- **P3012** Test tip, blue

3. PUTTING INTO OPERATION

3.1. Connecting to mains voltage

Make sure that the ZEROLINE 60, measuring cables and all other accessories are in flawless condition, e.g. no damaged insulation, no broken cables or plugs etc. before each connection of the instrument to measured installation.
If there is any reason to believe that safe operation has become impossible, put the instrument out of operation and secure it against any unintended operation, otherwise using of the instrument may be dangerous for operator, for installation under test or for the instrument!

The ZEROLINE 60 is intended for measurements in 230 V / 50 Hz (L-N, L-PE voltage) and 400 V / 50 Hz (L-L voltage) TT-system and TN-system. The instrument has no power switch; it is powered from measured installation.
Use only original standard or optional accessories supplied with the instrument.

The ZEROLINE 60 automatically checks, if measuring cables are connected properly to measured installation. Wrong connection is reported by warning displayed on the LCD.
Warning is also display if measuring cables are connected to voltage < about 200 V / 50 Hz or > about 450 V / 50 Hz.

4. CONFIGURATION

The configuration of the ZEROTEST 60 can be done before measurement. The configuration is written to non-volatile memory and remains valid until next change is done. It is possible to change measuring method, test current, displayed results and language.
Note: language selection may not be available in some firmware releases!

4.1. Measuring mode

Following measuring modes can be cyclically selected by the **5 MOD** key:

- Quick method – suitable for quick measurements where no highest possible accuracy and resolution is required. Test current is hard-set to about 10 A at 230 V / 50 Hz and about 18 A at 400 V / 50 Hz. The **2** $\mathbf{I_{TEST}}$ key is not functional in this mode.
- Positive / negative half waves – it is possible to set test current to about 10, 20 and 30 A at 230 V / 50 Hz by the **2** $\mathbf{I_{TEST}}$ key. The higher test current is set the higher accuracy of measurement is achieved. If the mains voltage is 400 V / 50 Hz, test current is hard-set to about 18 A. Resolution is 0,001 Ω.
- No trip-out of RCD in RCD protected installation – the ZEROLINE 60 automatically injects DC current (which temporarily disables RCD) to the measured installation before and during fault loop resistance measurement. Function of RCD is restored automatically after finishing of measurement. Test current is about 10 A at 230 V / 50 Hz. Measurement is disabled if voltage is 400 V.

The change of measuring mode is possible only if Display I is selected, see chapter 4.3 Display options.

4.2. Test current

The ZEROLINE 60 enables to select three levels of test current. The higher test current is set the higher accuracy of measurement is achieved. The higher test current causes naturally faster warming of some components inside the instrument. The higher test current can in some cases cause shutting-off of fuses and/or circuit breakers in tested installation, especially those with lower short-circuit current ratings.

Test current can be cyclically selected by the **2** $\mathbf{I_{TEST}}$ key. Selectable values are about 10, 20 and 30 A at 230 V / 50 Hz.
It is not possible to select test current in the following cases:

- If the mains voltage is 400 V / 50 Hz, test current is hard-set to about 18 A at 400 V / 50 Hz.
- If quick measuring method is selected, test current is hard-set to about 10 A at 230 V / 50 Hz and about 18 A at 400 V / 50 Hz.
- If no trip-out of RCD is selected, test current is hard-set to about 10 A.

The change of test current is possible only if Display I is selected, see chapter 4.3 Display options.

4.3. Display options

The ZEROLINE 60 enables to select one of three sets of displayed results/parameters cyclically by the **4 DISP** key:

- Display I – there are displayed:
  - Test current
  - Measuring mode
  - Measurement result (if impedance/resistance measurement was carried out)
  - Additional readings – see 4.4.
  - Bar graph of dispersion of measured values

The change of measuring mode and/or test current is possible only if Display I is selected.

- Display II – mains voltage U_{L-PE}, U_{L-N} and frequency are displayed
- Display III – all values referred to performed measurement are displayed:
  - Measured impedance Z or resistance R
  - 1.5x measured impedance $Z_{1,5}$ or resistance $R_{1,5}$ (where 1.5 is safety coefficient in some countries)
  - Z_{MAX} or R_{MAX} – max. value of Z or R which takes into consideration operating error of the ZEROLINE 60
  - Prospective short-circuit current I_K

4.4. Setting of Display I and setting of language

It is possible to select two additional readings which will be displayed on two modifiable lines of the Display I:

- Prospective short-circuit current I_K
- 1.5x measured impedance $Z_{1,5}$ or resistance $R_{1,5}$ (where 1.5 is safety coefficient in some countries)
- Z_{MAX} or R_{MAX} – max. value of Z or R which takes into consideration operating error of the ZEROLINE 60
- Resistive part of impedance R
- Voltage U_{L-N}

Use the **6 FCE** key to select modifiable line. Pointer marks first line. Select the required reading by using the **5 MOD** key and **2 I_{TEST}** key.
Use the **6 FCE** key again to select another modifiable line. Pointer marks second line. Select the required reading by using the **5 MOD** key and **2 I_{TEST}** key.

It is possible to select language:

Use the **6 FCE** key again to select language. Pointer marks currently selected language. Select the required language by using the **5 MOD** key and **2 I_{TEST}** key.
Note: language selection may not be available in some firmware releases!

Use the **6 FCE** key again. Pointer disappears - settings are thereby finished.

5. MEASUREMENTS

Accuracy of fault loop / line impedance measurement significantly depends on short-term mains voltage stability during measurement.

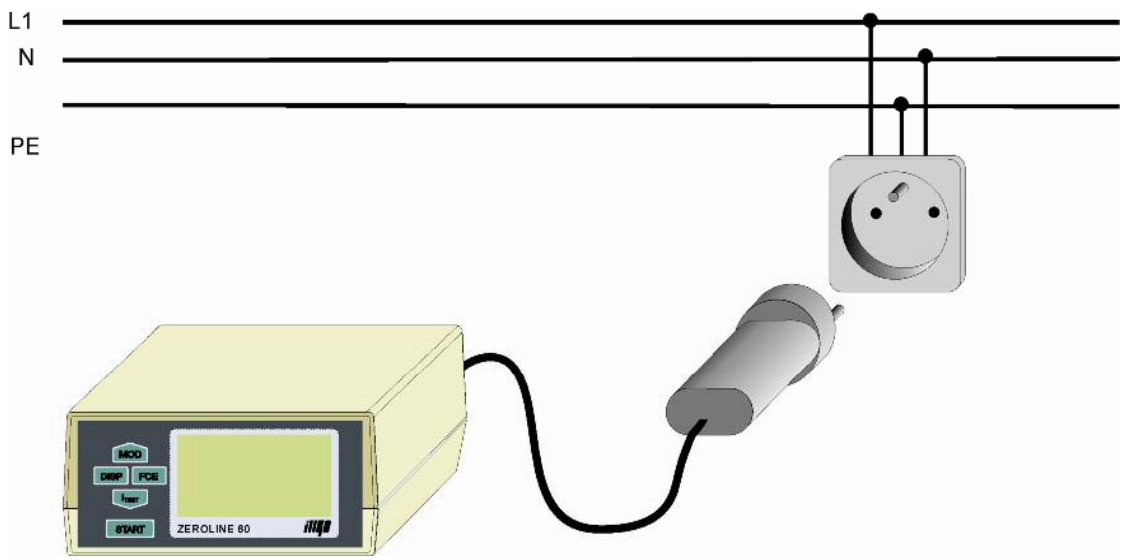
If there are disturbances present in measured installation during measurement by means of standard measuring instrument, the result of impedance measurement is often distorted and the accuracy of measurement can be quite poor. Due to the fact that disturbances are often random, it is almost impossible to find proper moment for measurement. Therefore if impedance measurement should be precise, it should be repeated more times and from obtained result should be then selected the result, which is likeliest – for example value which was obtained most often. Such measurement can be adversely affected by operator, especially if high dispersion of measured values exists.

In comparison with above mentioned, the ZEROLINE 60 executes automatically during each measurement up to few tens of measuring cycles, which are carried out in a longer period of time. Obtained set of measured values is mathematically processed afterwards. The displayed impedance has low uncertainty and high accuracy as a result of described method. The high number of measuring cycles during each measurement increases the accuracy, but it causes higher power dissipation of some components inside the instrument, too. If temperature inside exceeds allowed limit, the message "TEMPERATURE OVER" is displayed and measurement is blocked until the temperature drops down. In order operator would not be detained due to overheating of the instrument it is not recommended to repeat measurements unnecessarily.

Dispersion of measured values can be checked on the bar graph in bottom right part of the LCD. Dispersion of constituent sets of measurements are represented by columns of different height, if Display I is selected. If measurement was carried out and there were no significant disturbances, height of all columns is approximately similar. If their height is noticeably different, there were significant disturbances present during measurement.

5.1. Fault loop impedance in 230 V outlet by means of optional test cable

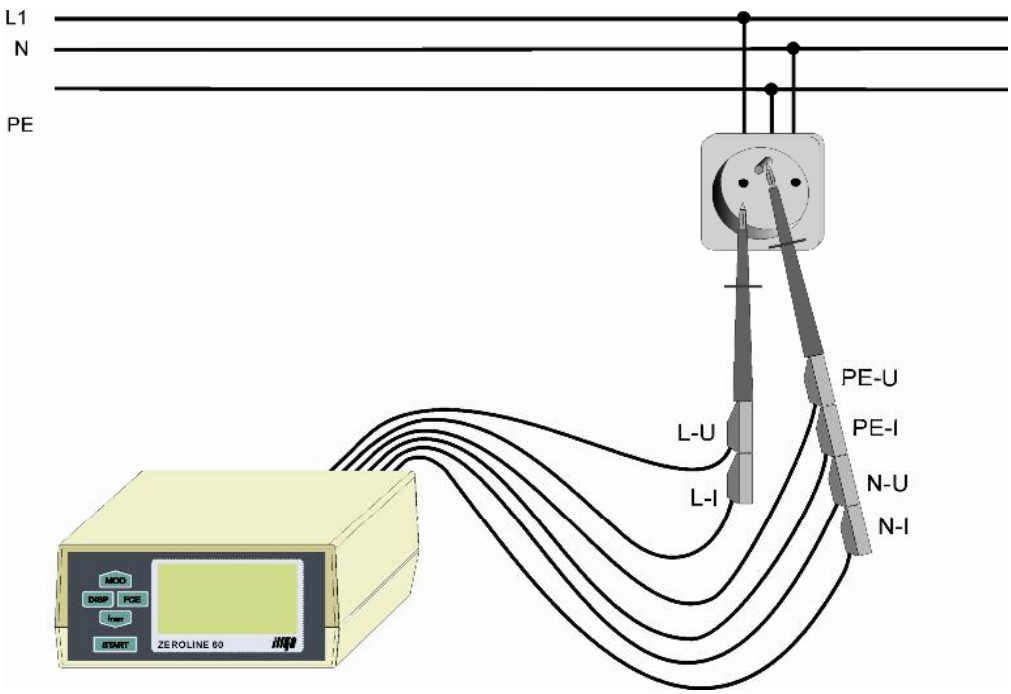
1. Connect connector of test cable to the ZEROLINE 60.
2. Connect plug of test cable to tested 230 V outlet.
3. Select measuring mode (see 4.1), test current (see 4.2.) and possibly Display I (see 4.4).
4. Press the 3 **START** key and release it. Measurement starts.
5. Result is displayed on LCD after measurement is finished.
6. It is possible to display additional measured values by repetitive pressing/releasing of the **4 DISP** key.



Fault loop impedance in 230 V outlet by means of optional test cable

5.2. Fault loop impedance in 230 V and 400 V outlet by means of standard test cable

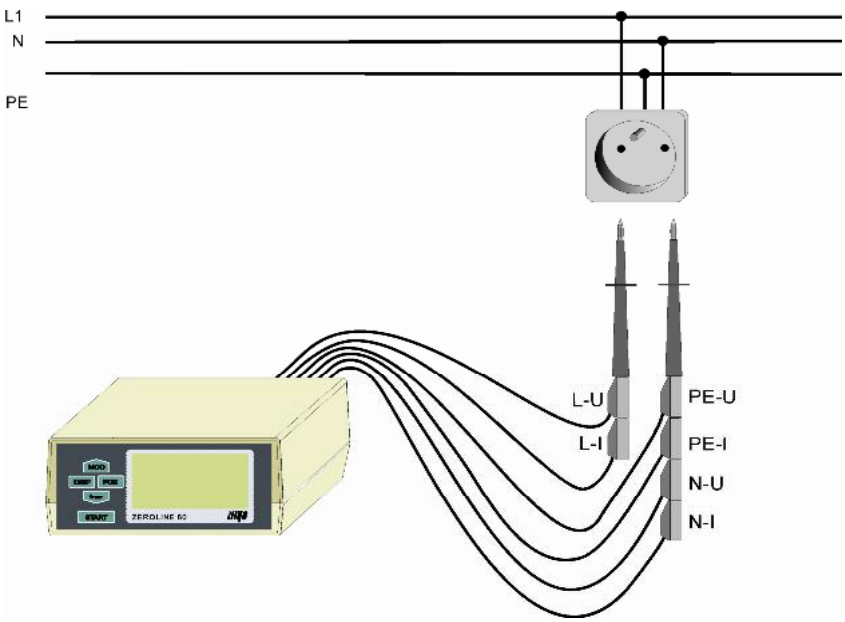
1. Connect connector of test cable to the ZEROLINE 60.
2. Stack banana plugs of black test leads L-U and L-I and connect it to black test tip.
3. Stack banana plugs of blue test leads N-U and N-I and yellow test leads PE-U and PE-I and connect it to blue test tip.
4. Connect blue test tip to PE terminal and black test tip to L terminal. **Do not touch conductive parts of test tips.**
5. Select measuring mode (see 4.1), test current (see 4.2.) and possibly Display I (see 4.4).
6. Press the 3 **START** key and release it. Measurement starts.
7. Result is displayed on LCD after measurement is finished.
8. It is possible to display additional measured values by repetitive pressing/releasing of the **4 DISP** key.



Fault loop impedance in 230 V and 400 V outlet by means of standard test cable

5.3. Line impedance in 230 V and 400 V outlet by means of standard test cable

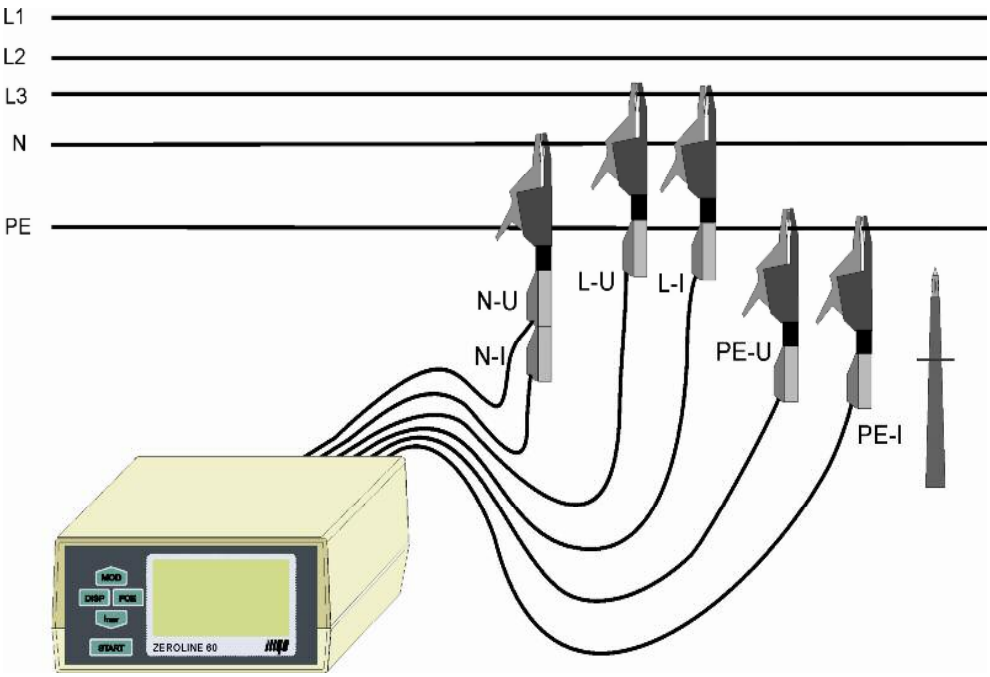
1. Connect connector of test cable to the ZEROLINE 60.
2. Stack banana plugs of black test leads L-U and L-I and connect it to black test tip.
3. Stack banana plugs of blue test leads N-U and N-I and yellow test leads PE-U and PE-I and connect it to blue test tip.
4. Connect blue test tip to N terminal and black test tip to L terminal. **Do not touch conductive parts of test tips.**
5. Select measuring mode (see 4.1), test current (see 4.2.) and possibly Display I (see 4.4).
6. Press the 3 **START** key and release it. Measurement starts.
7. Result is displayed on LCD after measurement is finished.
8. It is possible to display additional measured values by repetitive pressing/releasing of the **4 DISP** key.



Line impedance in 230 V and 400 V outlet by means of standard test cable

5.4. Fault loop impedance in switchboard

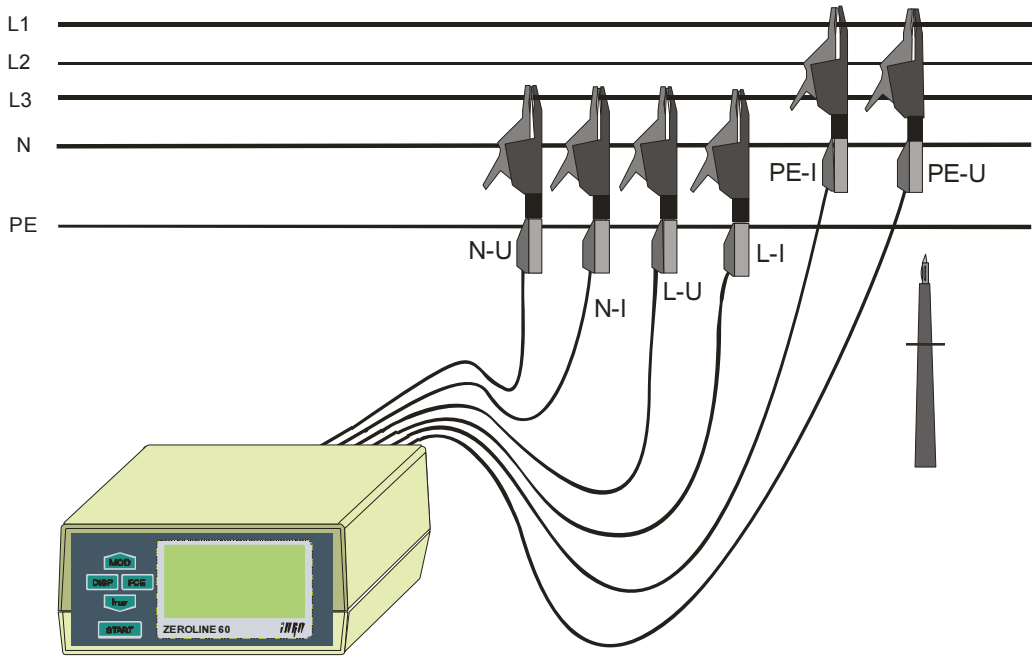
1. Connect connector of test cable to the ZEROLINE 60.
2. Connect yellow test leads PE-U and PE-I by means of crocodile clips to PE conductor.
3. Stack banana plugs of blue test leads N-U and N-I and connect it by means of crocodile clip to N conductor.
4. Connect black test leads L-U and L-I by means of crocodile clips to L conductor. You can use test tips instead of crocodile clips if necessary.
   Do not touch conductive parts of crocodile clips or test tips.
5. Select measuring mode (see 4.1), test current (see 4.2.) and possibly Display I (see 4.4).
6. Press the 3 **START** key and release it. Measurement starts.
7. Result is displayed on LCD after measurement is finished.
8. It is possible to display additional measured values by repetitive pressing/releasing of the **4 DISP** key.



Fault loop impedance in switchboard

5.5. Line impedance in switchboard

1. Connect connector of test cable to the ZEROLINE 60.
2. Connect yellow test leads PE-U and PE-I by means of crocodile clips to N conductor.
3. Connect blue test leads N-U and N-I by means of crocodile clips to N conductor.
4. Connect black test leads L-U and L-I by means of crocodile clips to L conductor. You can use test tips instead of crocodile clips if necessary. **Do not touch conductive parts of crocodile clips or test tips.**
5. Select measuring mode (see 4.1), test current (see 4.2.) and possibly Display I (see 4.4).
6. Press the 3 **START** key and release it. Measurement starts.
7. Result is displayed on LCD after measurement is finished.
8. It is possible to display additional measured values by repetitive pressing/releasing of the **4 DISP** key.

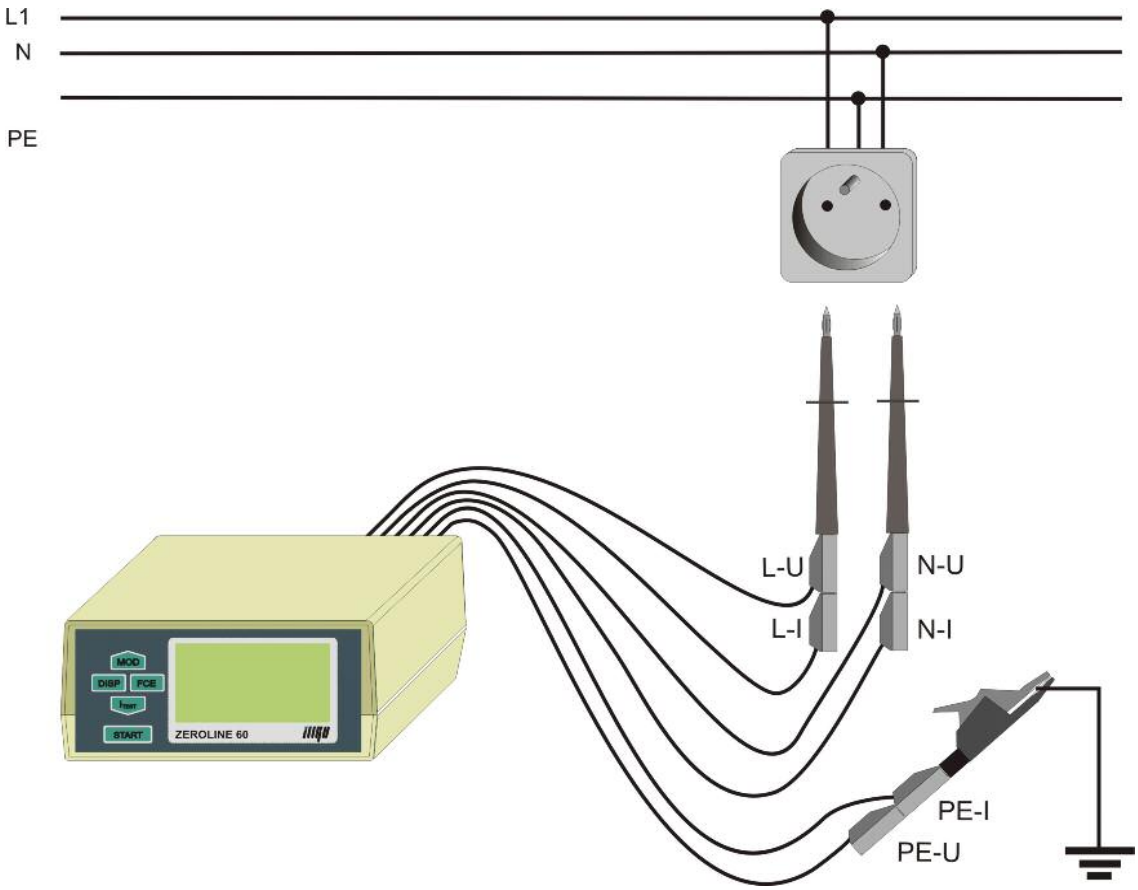


Line impedance in switchboard

5.6. Earth resistance

This alternative method is usable if mains voltage is available in the place of measurement. Two measurements should be carried out:

1. Line resistance Ri as described in chapter 5.3.
2. Resistance Re*. Measuring procedure is the same as described in chapter 5.3 except connection of test leads according to the following picture:



Earth resistance – alternative method

Resistance Re* comprises of earth resistance and L conductor resistance. It means that earth resistance Re is lower than measured value Re* and can be calculated more accurately:

$$Re \approx Re^* - \frac{R_i}{2}$$

Re Earth resistance [Ω]
Re* Line resistance including resistance of L conductor [Ω]
Ri Line resistance [Ω]

5.7. Fault loop resistance – no trip-out of RCD in RCD protected installation

High test current applied during fault loop impedance measurement normally causes trip-out of RCD.

The ZEROLINE 60 offer function, which enables measurement of fault loop impedance in

circuit equipped with RCD. If mentioned function is selected, then instrument automatically injects DC current (which temporarily disables RCD) to the measured installation before and during fault loop resistance measurement. Function of RCD is restored automatically after finishing of measurement. Test current is about 10 A at 230 V / 50 Hz. Measurement is disabled if voltage is 400 V.

WARNING:
Described method is not applicable both for electronic RCDs and for B type (smooth DC current) RCDs. Even in other cases it is not possible to avoid unexpected tripping-out of any RCD. Therefore make sure before measurement that in measured installation there are not operating appliances which could be damaged, which could lost data or which could cause any other damage and/or injury as consequence of power failure caused by RCD trip-out.

Connection and measurement procedure is similar as described in chapter 5.1 and 5.4. Proper measuring mode (see chapter 4.1) must be selected!
It is also possible to use standard test cable in 230 V mains outlet. In such case stack banana plugs of blue test leads N-U and N-I and connect it to N terminal, stack banana plugs of black test leads L-U and L-I and connect it to L terminal, stack banana plugs of yellow test leads PE-U and PE-I and connect it to PE terminal.

Test current is about 10 A at 230 V / 50 Hz. Measurement is disabled if voltage is 400 V.

6. MAINTENANCE, SERVICE, CALIBRATION

Maintenance

Regularly check the technical safety and integrity of insulation of measuring cables, plastic case and all accessories. Plastic case should not be polluted with substances, which can noticeably degrade case's insulation quality.
Use soft cloth, slightly moistened with lukewarm soap water for plastic case cleaning. Do not spill cleaning liquid over the instrument! Do not use cleaning liquids based on petrol, hydrocarbons etc. Wait until the instrument becomes totally dry before using it!

Do not expose the instrument to temperatures over 70 °C, otherwise the plastic case can be damaged!

Calibration

Measuring instruments should be regularly calibrated. We recommend interval of calibration 1 year. Furthermore we recommend carrying out calibration after each repair.

Service

Unauthorized persons are not allowed to open the ZEROLINE 60.

There are no replaceable components inside the instrument except fuses – see chapter 7.

Any claims for guarantee will become invalid in the event of damage that results from non-observance of the User's Manual. We do not accept responsibility for such damage.

Contact your local distributor for further information.

Manufacturer

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7. FUSES

The ZEROLINE 60 includes three fuses replaceable by user.

- **F1: F 315 mA / 500 V, 32 x 6,3 mm.** Power supply of the instrument
  If the F1 has blown, the ZEROLINE 60 does not turn on after connecting to mains voltage.
- **F2, F3: T 6,3 A / 500 V, 32 x 6,3 mm.** Load part of the instrument.
  If the F2 and/or F3 has blown, the message "CHECK CONNECTION" is displayed.

Disconnect all test leads before replacement of fuse!
Replace blown fuse with original one only, otherwise the instrument may be damaged and/or operator's safety impaired.
It is not allowed to connect the instrument to voltage without secured fuse cover.

8. TECHNICAL SPECIFICATION

8.1. General data

Protective class……... II (double insulation)
Over voltage class..... CAT III/300V
Pollution degree…..... 2
Degree of protection…..... IP 40
Reference condition:
Line voltage…… 230 V±1% / 50 Hz±1 %
Ambient temperature.....(23 ± 2) °C
Humidity.....45 ÷ 55 % RH @ 23°C
Position ….....arbitrary
Operating condition
Line voltage.....200 ÷ 440 V / 50 Hz
Ambient temperature.....0 °C ÷ 40 °C
Humidity ….....max 75% RH @ 23 °C
(condensation not allowed)
Quiescent current……
……about 25 mA @ 230 V / 50 Hz
Fuses …….power supply: F315 mA / 500 V
load: T6,3 A / 500 V
Dimensions ….....150 x 190 x 70 mm
Mass…….....about 1,6 kg
Case resistance to temperature .....70 °C
Storage temperature / storage humidity…..
……...-10° C ÷ 50 ° C / max. 75 % RH

8.2. Functions

Fault loop resistance – Quick method

Measuring range	0.00 Ω ÷ 20.00 Ω
Operating range of use (according to EN 61557-3)	0.20 Ω ÷ 20.00 Ω
Resolution	0.01 Ω
Reference error	±(3 % of R + 5 D)
Operating error	±(4 % of R + 5 D)
Test current	about 10 A (at 230 V / 50 Hz)
4-wire connection	yes

Fault loop impedance – positive / negative half waves – 10 A

Measuring range	0.000 Ω ÷ 5.000 Ω
Operating range of use (according to EN 61557-3)	0.060 Ω ÷ 5.000 Ω
Resolution	0.001 Ω
Reference error	±(3 % of R + 10 D)
Operating error	±(4 % of R + 15 D)
Test current	about 10 A (at 230 V / 50 Hz)
4-wire connection	yes

Fault loop impedance – positive / negative half waves – 20 A

Measuring range	0.000 Ω ÷ 3.000 Ω
Operating range of use (according to EN 61557-3)	0.040 Ω ÷ 3.000 Ω
Resolution	0.001 Ω
Reference error	±(3 % of R + 8 D)
Operating error	±(4 % of R + 10 D)
Test current	about 20 A (at 230 V / 50 Hz)
4-wire connection	yes

Fault loop impedance – positive / negative half waves – 30 A

Measuring range	0.000 Ω ÷ 1.500 Ω
Operating range of use (according to EN 61557-3)	0.038 Ω ÷ 1.500 Ω
Resolution	0.001 Ω
Reference error	±(2 % of R + 8 D)
Operating error	±(3 % of R + 10 D)
Test current	about 30 A (at 230 V / 50 Hz)
4-wire connection	yes

Fault loop resistance – no trip-out of RCD in RCD protected installation

Measuring range	0.00 Ω ÷ 20.00 Ω
Operating range of use (according to EN 61557-3)	0.42 Ω ÷ 20.00 Ω
Resolution	0.01Ω
Reference error	±(5 % of R + 8 D)
Operating error	±(6 % of R + 10 D)
Test current	about 10 A (at 230 V / 50 Hz)
4-wire connection	no

Line resistance – Quick method

Measuring range	0.00 Ω ÷ 20.00 Ω
Operating range of use (according to EN 61557-3)	0.20 Ω ÷ 20.00 Ω
Resolution	0.01 Ω
Reference error	±(3 % of R + 5 D)
Operating error	±(4 % of R + 5 D)
Test current	about 10 A (at 230 V / 50 Hz) about 18 A (at 400 V / 50 Hz)
4-wire connection	yes

Line impedance – positive / negative half waves – 10 / 18 A

Measuring range	0.000 Ω ÷ 5.000 Ω
Operating range of use (according to EN 61557-3)	0.057 Ω ÷ 5.000 Ω
Resolution	0.001 Ω
Reference error	±(2,5 % of R + 10 D)
Operating error	±(3,5 % of R + 15 D)
Test current	about 10 A (at 230 V / 50 Hz) about 18 A (at 400 V / 50 Hz)
4-wire connection	yes

Voltage L-PE

Measuring range	200 V ÷ 440 V
Resolution	1 V
Reference error	±(2 % of R + 3 D)
Operating error	±(3 % of R + 5 D)

Voltage L-N / L-L

Measuring range	200 V ÷ 440 V
Resolution	1 V
Reference error	±(2 % of R + 3 D)
Operating error	±(3 % of R + 5 D)

Prospective short-circuit current I_K

Measuring range	2.3 A ÷ 23 kA
Resolution	0.1 A / 1 A / 10 A
Reference error	±(Z measurement reference error + 2 D)
Operating error	±(Z measurement operating error + 2 D)

I_K calculation: $I_K = U_{nominal} / Z$
$U_{nominal}$ = 230 V if $U_{L-N, L-PE}$ = 200 V ÷ 265 V; $U_{nominal}$ = 400 V if U_{L-L} = 345 V ÷ 440 V

Frequency f

Measuring range	48.00 ÷ 52.00 Hz
Resolution	0.01 Hz
Reference error	±(2 % of R + 10 D)
Operating error	±(3 % of R + 10 D)

Notes:
R - Reading
D - Digit

9. ECOLOGY

Transportation packing

It is made of corrugated board; it is recyclable.

Instrument

This symbol signifies that the product should not be thrown away to municipal waste at end-of-life.

Please dispose of this product according to the relevant statutory requirements.

09/09 – R4-E