NIM 1000
Net Impedance Meter

USER GUIDE

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Consultation with Megger

The present system manual has been designed as an operating guide and for reference. It is meant to answer your questions and solve your problems in as fast and easy a way as possible. Please start with referring to this manual should any trouble occur.

In doing so, make use of the table of contents and read the relevant paragraph with great attention. Furthermore, check all terminals and connections of the instruments involved.

Should any question remain unanswered or should you need the help of an authorized service station, please contact:

Megger Limited

Archcliffe Road
Kent CT17 9EN
T: +44 (0) 1304 502100
F: +44 (0)1 304 207342
E: uksales@megger.com

Seba Dynatronic
Mess- und Ortungstechnik GmbH

Dr.-Herbert-Iann-Str. 6
D - 96148 Baunach
T: +49 / 9544 / 68 – 0
F: +49 / 9544 / 22 73
E: sales@sebakmt.com

Hagenuk KMT
Kabelmesstechnik GmbH

Röderaue 41
D - 01471 Radeburg / Dresden

T: +49 / 35208 / 84 – 0
F: +49 / 35208 / 84 249
E: sales@sebakmt.com

Megger USA

Valley Forge Corporate Centre
2621 Van Buren Avenue
Norristown, PA 19403 USA
T: 1-610 676 8500
F: 1-610-676-8610
E: DEanfrage@megger.com

Terms of Warranty

Megger accept responsibility for a claim under warranty brought forward by a customer for a product sold by Megger under the terms stated below.

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This warranty does not cover wear parts, lamps, fuses, batteries and accumulators.

Megger reject all further claims under warranty, in particular those from consequential damage. Each component and product replaced in accordance with this warranty becomes the property of Megger.

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This warranty does not apply to any fault or damage caused by exposing a product to conditions not in accordance with this specification, by storing, transporting, or using it improperly, or having it serviced or installed by a workshop not authorized by Megger. All responsibility is disclaimed for damage due to wear, will of God, or connection to foreign components.

For damage resulting from a violation of their duty to repair or re-supply items, Megger can be made liable only in case of severe negligence or intention. Any liability for slight negligence is disclaimed.

Since some states do not allow the exclusion or limitation of an implied warranty or of consequential damage, the limitations of liability described above perhaps may not apply to you.

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1 Basic Notes

Safety precautions

This handbook contains basic instructions for the initial use and operation of the NIM 1000. For this reason, it is important to ensure that the manual is always available to authorised and trained personnel. Operating personnel should read the manual thoroughly. The manufacturer will not be held liable for any injury or damage to personnel or property through failure to observe the safety precautions contained in this handbook.

The specific standards and regulations in each country must also be observed.

Labelling of safety instructions

Important instructions concerning personnel, operational and technical safety are marked in the text as follows:

Symbol	Description
 **WARNING**	Indicates a potential danger of an electric shock that may result in fatal or serious injury.
 **CAUTION**	Indicates a potential danger that may lead to slight or moderate injury.
	The notes contain important information and useful tips for using the system. Failure to observe them can render the measurement results useless.

Working with products from Megger

It is important to observe the general electrical regulations of the country in which the device will be installed and operated, as well as the current national accident prevention regulations and internal company directives (work, operating and safety regulations).

Use genuine accessories to ensure system safety and reliable operation. The use of other parts is not permitted and invalidates the warranty.

Operating staff

This system and its peripheral equipment may only be operated by trained or instructed personnel. Anyone else must be kept away.

The system may only be installed by an authorised electrician. DIN VDE 0104 (EN 50191), DIN VDE 0105 (EN 50110) and the German accident prevention regulations (UVV) define an electrician as someone whose knowledge, experience and familiarity with the applicable regulations enables him to recognise potential hazards.

Repair and maintenance

Repair and maintenance work may only be performed by Megger or authorised service partners. Megger recommends having the system tested and maintained at a Megger service centre once a year.

Megger also offers its customers on-site service. Please contact your service centre as needed.

Declaration of Conformity (CE)

The product meets the following security requirements of the European Council Directives:

- EMC Directive (2004/108/EC)
- Low Voltage Directive (2006/95/EC)
- RoHS Directive (2011/65/EU)

Radiated emission

The device is intended for operation in the industrial segment in accordance with EN 55011. When used at home it could cause interference with other equipment (such as the radio or television).

The interference level from the line complies with the limit curve B (living area), the radiation level complies with the limit curve A (industrial area). Once the living area is sufficiently far away from the planned area of operation (industrial area), equipment there will not be impaired.

Use only as intended

The operating safety is only guaranteed if the delivered system is used as intended. Incorrect use may result in danger to the operator, to the system and the connected equipment.

The thresholds listed in the technical data may not be exceeded under any circumstances. Condensation during the operation of Megger products may result in danger to persons and devices through voltage arc-over. Prevent condensation before and during the measuring mode by cooling the measuring systems sufficiently. The operation of Megger products in direct contact with water, aggressive substances and inflammatory gases and vapours is prohibited.

The NIM 1000 is built to be robust and can withstand the stresses it can expect to be subjected to in demanding everyday use. Nevertheless, it is a precision measuring device which needs to be treated with the appropriate care. This applies in particular to the connection cable and the clamps, which play an important role in ensuring the device remains safe while the results of measurements remain precise.

Procedure in the event that the device malfunctions

The system may only be operated whilst it is in perfect working condition. In the event of damage, irregularities or malfunctions that cannot be resolved with the assistance of the operating instructions, the system must be shut down immediately and labelled accordingly. In such an event, the relevant management must be informed. Please contact Megger Service immediately to eliminate the malfunction. The system may only be started up again once the malfunction has been eliminated.

2 Technical Description

2.1 System Description

Intended use

The NIM 1000 serves to measure network impedance in low voltage networks. In this process, the conductor connections are tested for their current carrying capacity while subjected to typical operating loads and potential flaws are indicated.

With the help of the following range of preventative applications, a consistently good supply quality can be guaranteed, outages prevented and adequate network rating ensured:

- Preventative inspection and uncovering of faults (e.g. neutral conductor fault)
- Determination of the maximum connected / feed-in power
- Monitoring for secure shut-down (rating of fuses)
- Approval of new / modified network sections

Fault detection in low voltage networks is another area of application of the device. For example, the NIM 1000 can be used to trigger a load-dependent fault which can then be located either with the help of a simultaneously connected measuring device or by means of multiple measurements at various connection points.

Function

The device is linked to the low voltage network to be tested by means of the available connection cables (four-conductor measurement with Kelvin clips) and also receives its supply voltage over these wires.

In preparation for a measurement, either a defined measurement period or a target number of measurements can be specified.

To determine the network impedance, the adjustable load current is generated for a short period by means of a semi-conductor circuit-breaker with the appropriate load-resistor. The current and voltage curves are recorded immediately before and while applying the load by means of A/D converters and then analysed by calculation. The result is shown on the display.

When taking measurements on more than one phase, there is automatic switching between the phases.

Features

The NIM 1000 combines the following features in one device:

- Compact and sturdy design for portable use in the field
- Easy and convenient operation via rotary encoder
- Single and three phase measurement
- High test current of up to 1000 A
- Network impedance measurement (resistance and reactance) up to the 10th harmonic
- Logging (export via USB interface)
- Wide range input for the voltage supply

Scope of delivery

The scope of delivery of the system includes the following:

- Basic device
- 4 x Kelvin clips with connection cable (entire length of the connection cables 4 m)
- NIM 1000-A socket adapter
- USB flash drive
- Manual

Check the contents of the package for completeness and visible damage right after receipt. In the case of visible damage, the device must under no circumstances be taken into operation.

If something is missing or damaged, please contact your local sales representative.

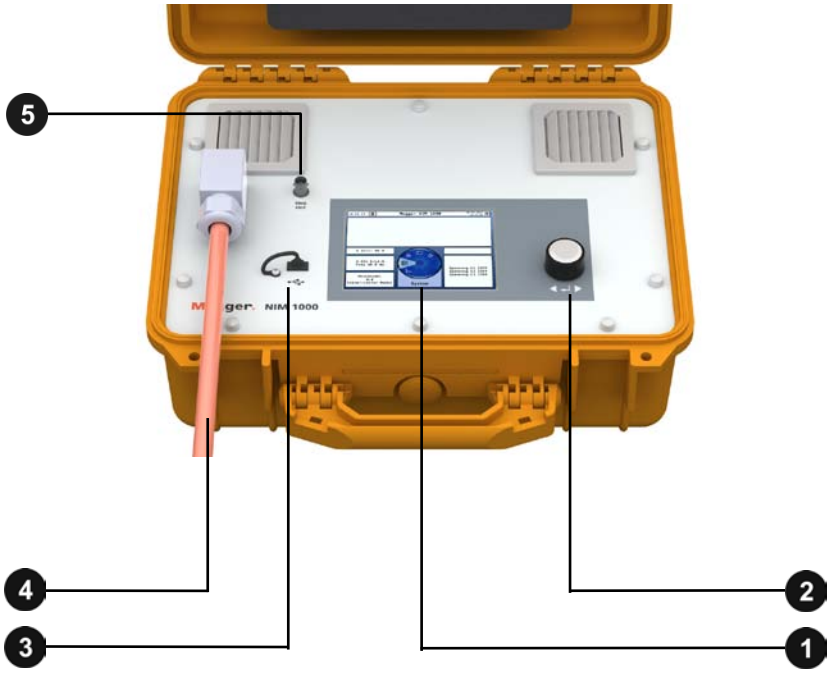
2.2 Technical Data

The NIM 1000 is defined by the following technical parameters:

Parameter	Value
Test current • Range • Maximum current as a peak value (I_{max} depends on the network impedance and the temperature and is, under certain circumstances, significantly lower than the indicated values)	 80 A … 1000 A (adjustable) ≤1000 A at 400 V ≤600 A at 230 V ≤300 A at 115 V
Input voltage (supply voltage at the same time)	100 V ... 480 V, 50/60 Hz (at test terminals) 100 V … 230 V, 50/60 Hz (at Schuko socket)
Operating uncertainty B (in accordance with IEC 61557-3)	Up to 3% ±1 mΩ (see also Annex 1)
Measuring range	10 mΩ … 5 Ω (230 V / 400 V) 10 mΩ … 2,5 Ω (115 V) (See also Annex 2)
Resolution	1 mΩ
Measurement category	300V CAT IV
Safety functions	Temperature monitoring
Display	Transflective sunlight readable 5.7" colour display with a resolution of 640 x 480 pixels
Memory	At least 1000 records of test data
Interfaces	USB 2.0
Operating temperature	-20°C to 55°C
Operating humidity	Max. relative humidity 93% at 30°C
Storage temperature	-30°C to 70°C
Weight	10 kg
Dimensions	410 x 175 x 335 mm
Protection class (in accordance with IEC 61140 (DIN VDE 0140-1))	II
Ingress protection rating (in accordance with IEC 60529 (DIN VDE 0470-1))	IP 50 (open) IP 54 (closed)

2.3 Connections, Controls and Display

The NIM 1000 has the following connection, display and control elements:



Element	Description
1	Display
2	Rotary encoder
3	USB port
4	Connection cables
5	Trigger output

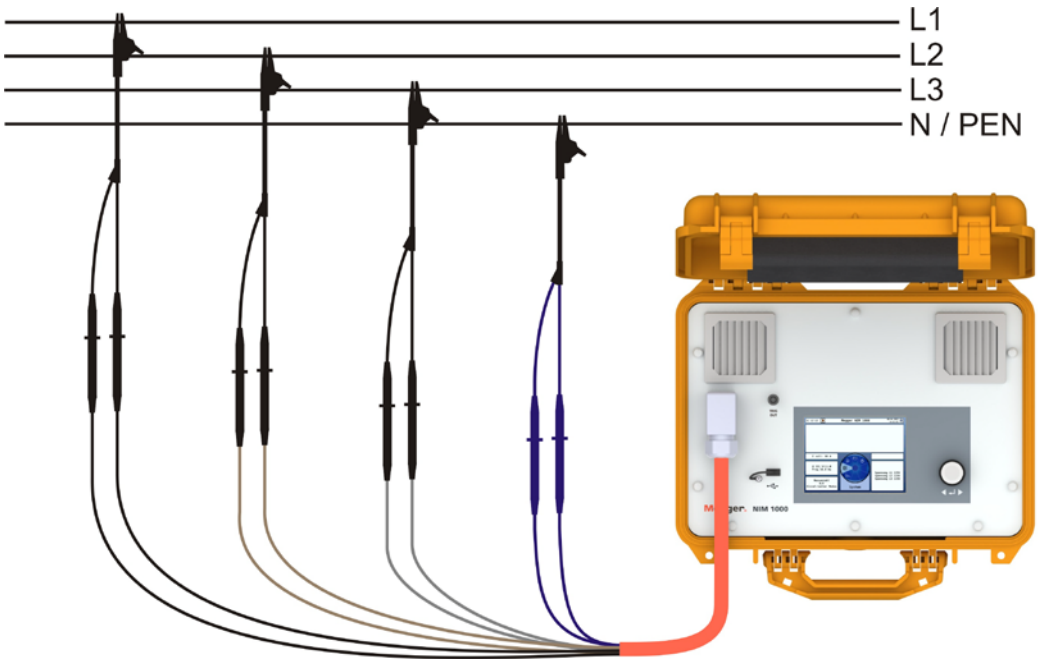
3 Electrical connection

WARNING	**Work on live equipment** The work can only be carried out safely while guaranteeing the protection of the health of all those involved in the work by employing suitable working procedures and using suitable protective equipment. For that reason, the electrical connection of the device must absolutely conform to the nationally applicable regulations for work on live equipment!

WARNING	**Connection sequence** When connecting the device, the two blue connection cables should be connected to the neutral conductor of the low voltage cable first. Not until after that can the live phase conductors be connected. The conductors are disconnected in reverse order: first disconnect the phase conductors, then the neutral conductor.

Connection diagram

The following figure shows the simplified connection diagram for the NIM 1000:



CAUTION	The fused measurement cables are colour-coded (**black = L1, brown = L2, grey = L3, blue = N**). **Only a measurement cable with a matching colourcode may ever be connected to one and the same Kelvin clip!**

Notes

When making electrical connections, the following points should be observed:

- The NIM 1000 is approved for measurements on low voltage installations in the measurement category 300V CAT IV in accordance with IEC 61010-1.
- The input voltage live on the measurement cables serves simultaneously as supply voltage and must remain within the range of 100 V and 480 V.
- The NIM 1000 must be connected to the neutral conductor and at least one phase. If the neutral conductor is not accessible, the blue connection cable must be connected to a free phase conductor.
- The connection should be made based on the principle of four-conductor measurement. So two measurement cables (current and voltage) must be connected to each conductor intended to be measured using a Kelvin clip.

Specific connection-configurations

Using the NIM 1000, measurements can be carried out in both single-conductor mode (just L1–N) as well as in multi-conductor mode (all possible conductor combinations).

Measurements are only carried out on phases which are live with a suitable input voltage. Accordingly, phases which have not been connected will not be taken into account in multiple-conductor mode.

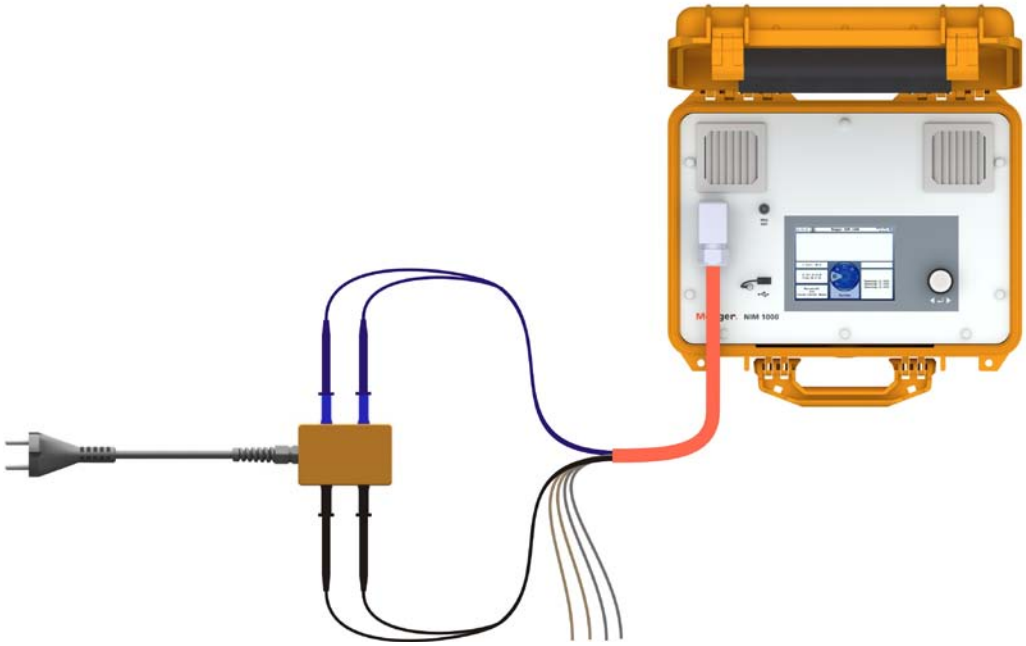
So, for special applications or for time-saving reasons, the conductor combinations to be measured can be purposefully limited in the multiple-conductor mode by using a specific connection configuration. The following table shows some examples of this:

Required measurements	**Phases to be connected**	**Measured conductor pairs** (instead of the 6 possible combinations)
L2–N	N (blue) L2 (brown)	L2–N
L1–L2	N (blue) L1 (black) L2 (brown)	L1–N L2–N L1–L2
L2–L3 L2–N	N (blue) L2 (brown) L3 (grey)	L2–N L3–N L2–L3

Connection to mains socket

Using the included NIM 1000-A adapter, the NIM 1000 can be quickly and safely connected to a mains socket for the purposes of measurement or the export of measurement data. The plug is designed as a Schuko plug (CEE 7/4) but it can also be connected to sockets of different designs without problem using the appropriate accessories.

The connection between the NIM 1000 and the adapter should be established as follows with the help of the **blue** and the **black** connection cables:

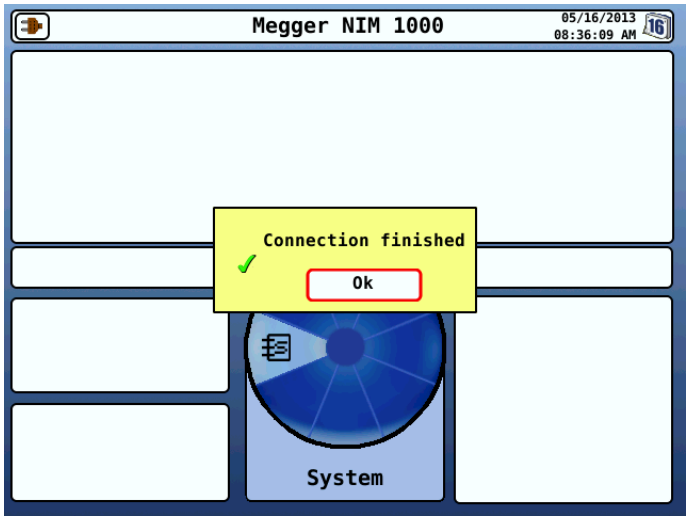


4 Operation

Power on

As soon as one of the three connection cables has been connected to a low voltage phase with sufficient supply voltage (100 V ... 480 V), the NIM 1000 automatically turns on.

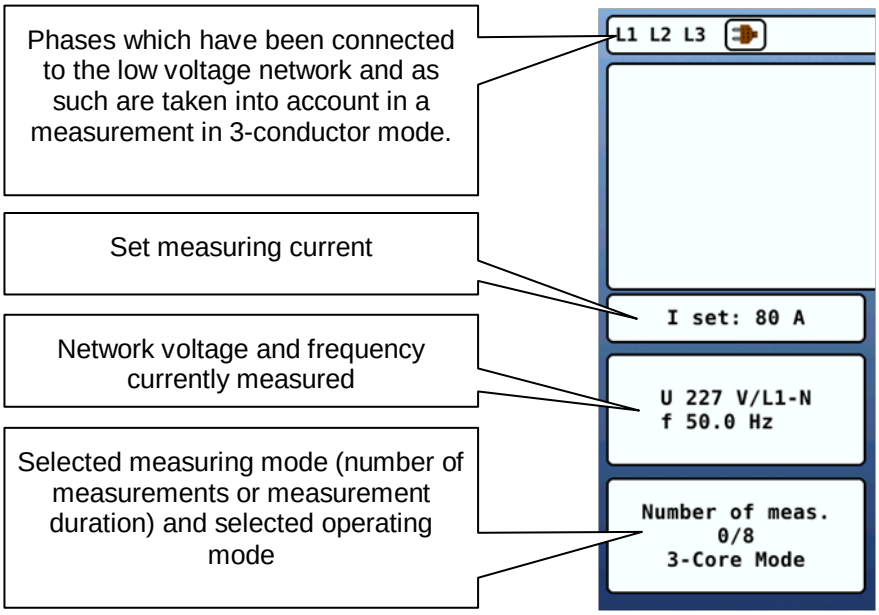
After the short switching on process, the system waits for confirmation from the user that the electrical connection has been finished.



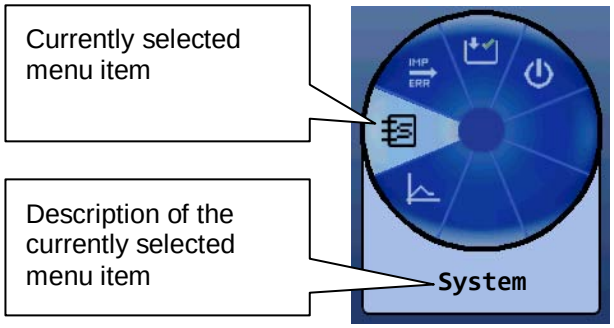
The corresponding dialogue window can be shut by a quick push of the rotary encoder ❷, following which the three phase voltages are measured (audible phase relay switching).

System status

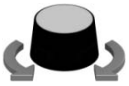
After switching on, the following information on the current status of the system is shown on the left side of the display:



Operating concept Navigation within the menus is effected almost entirely from the circular selection menu:



Operating the system with the rotary encoder 2 is as follows:



- Select the menu item
- Increase or decrease the value of a variable parameter
- Select an option from a selection list

- Call up the selected menu item
- Confirm the setting or the selection made

Each menu (with the exception of the main menu) has a menu item with which one can return to the next higher menu level.

4.1 System Settings

Selecting the menu item takes you directly to the system menu, where the following functions and submenus are available:

Menu item	Description
	Submenu with detailed system information Information on the current versions of the various software components Hardware information (e.g. serial number of the system)
	System settings Setting the interface language. Select the desired language by turning the rotary encoder and activate by pressing it. The language selection is immediately active. In this submenu, the brightness and layout of the display can be adjusted and the background lighting can be switched on or off. Setting the date and time. The value of each segment that has been marked for selection can be adjusted by turning the rotary encoder. Pressing causes the mark to move the next segment. Once the input has been concluded, the changes can either be accepted with **OK** or rejected by selecting **Cancel**.
UP-DATE	When this function is used, a search in respect of firmware and language files is conducted in the directory *nim1000/updates/* on the inserted USB flash drive. The files found are then listed and, using the rotary encoder, these can be selected and imported. A distinction is made between the following file types: *application-x.xx.img* — Updating solely an application to version x.xx *nim1000-xxx.tar* — Importing the language xxx *nim1000-Languages.tar* — Importing all the languages contained in the language file An also possible update of the real-time software of the measuring hardware needs not be initiated via this menu item. Instead of this, it suffices to insert the USB flash drive with the update files into the USB port and confirm the following query.

4.2 Performing Measurements

Selecting the operating mode

By selecting the IMP/ERR menu item in the main menu you will reach a sub menu in which you may select your desired operating mode. In principle, measurements may be carried out either in normal **network impedance measuring mode** or in **fault detection mode**.

Normal **network impedance measuring** takes place with a constant measuring current and over a freely-adjustable duration or number of measurements. Only in this mode can the software carry out a load calculation (siehe Seite 5) on the basis of the measured network impedance. However, the suitability of this mode to detect faults is limited, as some faults subside temporarily with higher current flows (e.g. due to fusing or drying out). Depending on the level of the measuring current selected, this could already happen during calibration and so the fault would remain undetected through the measurement.

That is why **fault mode** has been integrated. In this mode, the load current is gradually increased over the course of 8 measurements up to the preset value. All 8 recorded curves are displayed together in one diagram, whereby the relevant changes can be easily identified.

Further sub-division into single and multiple conductor mode gives the following operating modes:

Menu item	Description
L MODE	Network impedance measurement on one conductor The impedance is only measured on the phase which is connected via the black connection cables (L1). This time-saving single-conductor mode is particularly suitable if the results of one phase suffice for the intended purpose of the measurement or if only single-phase measuring is possible anyway (e.g. at sockets).
L1-3 MODE	Network impedance measurement on up to 6 conductor combinations In this mode, all possible conductor combinations (siehe Seite 12) are measured one after the other depending on the connection situation.
ERR MODE	Fault mode on one conductor This serves to trigger a known load-dependent fault on the phase connected to the black connection cables (L1). This mode is recommended if the conspicuous phase has already been identified.
ERR L1-3	Fault mode on up to three conductors In this mode the 8 measurements are carried out on all connected phases (against the neutral conductor). So conclusions on the characteristic of the fault can be drawn from load-dependent impedance changes as well as from the comparison of the phases with one another.

4.2.1 Network Impedance Measurement

4.2.1.1 Setting the Measurement Parameters

By selecting the menu item in the main menu you will reach a sub menu in which you may select the following measurement parameters in preparation for a network impedance measurement.

Menu item	Description
I_{MAX}	Maximum measuring current (80 ... 1000 A) Because the accuracy of the measurement increases with increasing measuring current, as high as possible a measuring current but also one which is appropriate to the capacity of the network should be selected. If the NIM 1000 is connected to a mains socket (with fusing of up to 16 A), the 80 A setting which has been particularly dimensioned for this type of application should be selected!
	Measurement duration (1 … 48 hours) Using the preset measurement duration, a measurement is taken at 15 minute intervals on each involved phase. The number of measurements can also be defined as an alternative to measurement duration (see below). The respective last adopted setting applies.
Σ	Number of measurements (1 … 255) The set number of measurements is carried out in quick succession and while constantly switching between the phases involved. The measurement duration can also be defined as an alternative to the number of measurements (see above). The respective last adopted setting applies.
RESET CAL	Resetting calibration values If the time of calibration was quite a while ago (e.g. after a measurement which lasted a while), it could be useful to reset the calibration values.

Menu item	Description
	Load calculation activation / deactivation This function serves to check whether e.g. a standard compliant connected load or voltage drop can be guaranteed for a specific power supply section, a large-scale consumer or a house connection. One of the following settings may be selected for this purpose: **V_{DIP}** In this setting, the connected load to be guaranteed can be specified before the start of the measurement via the menu item **P**. During the measurement, the expected voltage drop is then calculated and displayed for the specified connected power. **P_{MAX}** In this setting, the maximum permissible voltage drop can be given as a percentage before the start of the measurement via the menu item **U%**. During the measurement, the maximum connected power - which would ensure the voltage drop to be within the specified limit - is then calculated and displayed. **Off** Load calculation deactivated

4.2.1.2 Performing the Measurement

Start measurement

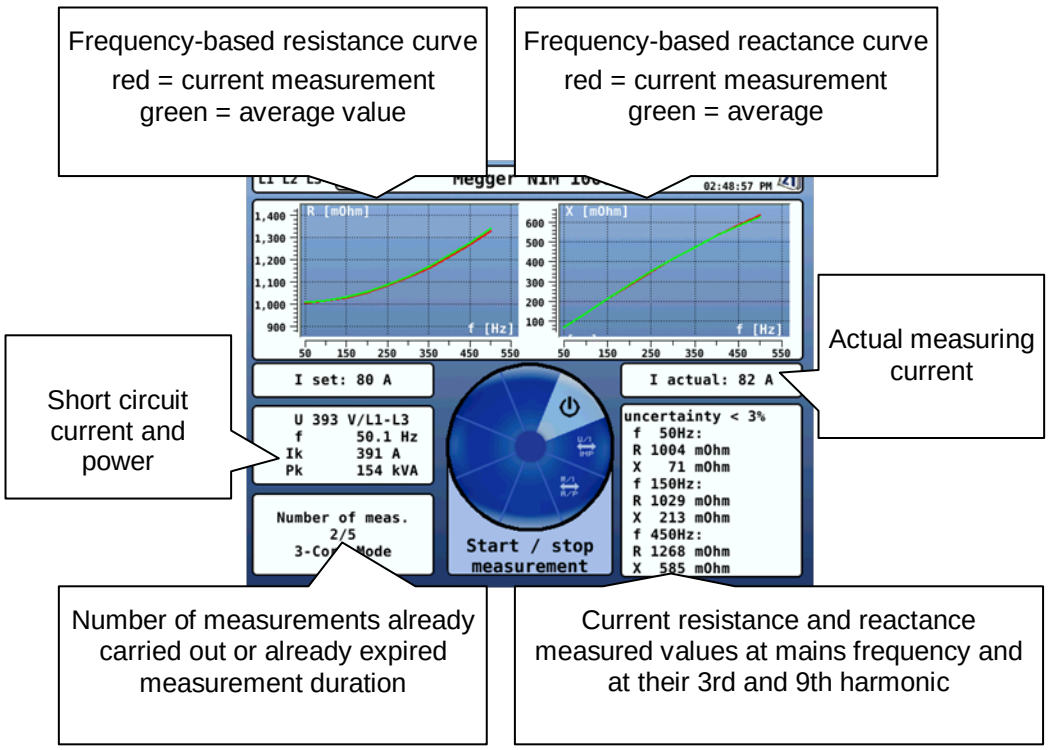
Once all the settings have been carried out and checked, the measurement can be started with the menu item ⏻.

If this is the first measurement after switching on the device or if the calibration values were reset before the measurement (see previous page), calibration will be carried out right after the start in order to set the preset maximum measuring current. A corresponding notice will appear on the display.

Performing the measurement

Depending on the settings, the individual measurements will take place either in quick succession (depending on the measuring current 2 to 10 seconds) or at 15 minute intervals, switching between the involved phases.

The following measured values are shown on the display and continually updated during the running measuring process as standard.



Using the two menu items, the diagram types may be switched between as follows:

R/I R/P	Impedance resistance and reactance	⟺	Impedance amount and phase shift angle
U/I IMP	Impedance resistance and reactance	⟺	Current and voltage curve of the period in which the measurement took place

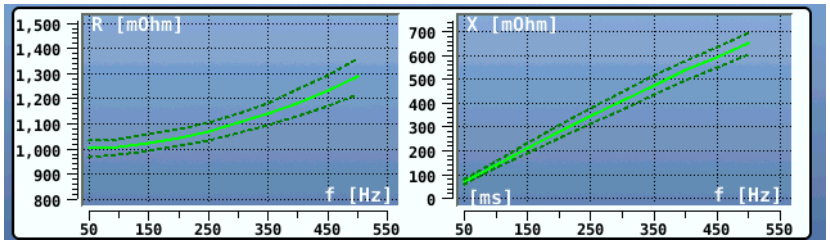
Ending the measurement

The measurement will end automatically as soon as the preset number of measurements or the preset measurement time has been reached. The measurement can be manually deactivated at any time via the ⏻ menu item.

4.2.1.3 Analysing Measurement Results

Comparing curves

The red curve is hidden on completion of the measurement. Instead, dark-green envelope curves are marked above and underneath the light-green medium value curve, these envelope curves represent the upper and lower limit of 99.7% of the measured values.



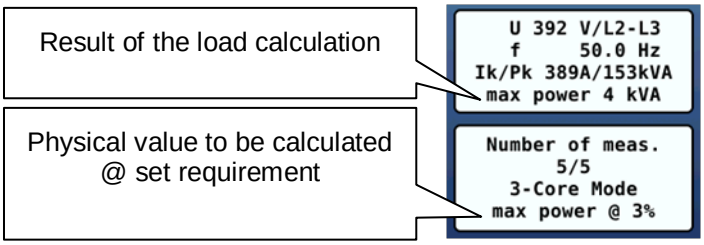
To be able to carry out a comparison between the measured conductor combinations in the case of measuring more than one conductor, the following selection menu must be called up via the ➡ menu item:

The conductor combination to be displayed is selected by turning the rotary encoder.

Selecting the **PEN** option will display the **calculated** impedance of the PEN conductor. However, depending on the type of network and earthing conditions, these values do not necessarily match those of the neutral conductor!

Result of the load calculation

The results of any load calculation (siehe Seite 19) which may have been carried out can be read on the left part of the display:



4.2.2 Measuring in Fault Mode

4.2.2.1 Preparing Measurement

Setting maximum measuring current

By selecting the menu item in the main menu you will reach a sub menu in which you may preset the maximum measuring current via the I_{MAX} menu item.

In fault mode, the current is increased as linearly as possible over 8 measurements up to the set maximum value in this case.

If the NIM 1000 is connected to a mains socket (with fusing of up to 16 A), the 80 A setting which has been particularly dimensioned for this type of application should be selected!

Connecting the trigger output to a reflectometer

In the case of intermittent faults in particular, it is recommended that you carry out a fault location at the same time as the fault trips. For this purpose, a suitable reflectometer must be connected to the same low voltage cable and hooked up to the NIM 1000 via the trigger output **5**.

The triggering of the reflectometer takes place at the time of each respective impedance measurement by means of a short 12 V voltage pulse at the trigger output.

For more details about commissioning and configuring the reflectometer, please read the accompanying instructions.

4.2.2.2 Performing the Measurement

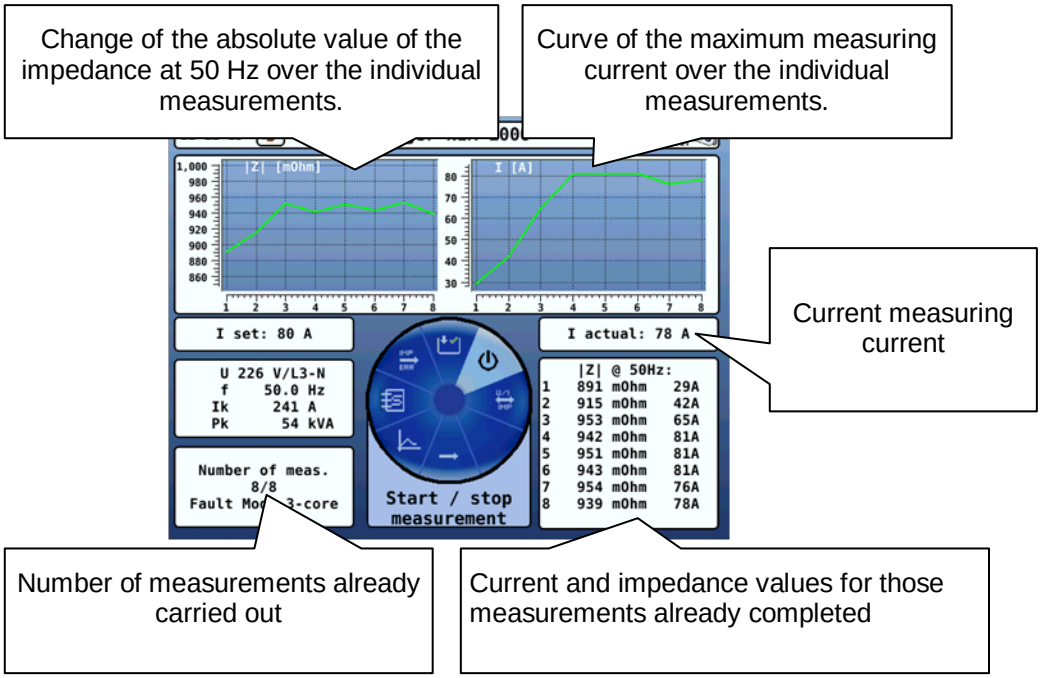
Starting the measurement

Once all the settings have been carried out and checked, the measurement can be started with the menu item ⏻.

Performing the measurement

In fault mode, the measurements take place in quick succession. Starting at a low value, the measuring current is increased as linearly a possible by a certain amount with each measurement and, after 8 measurements, reaches the set maximum value.

The following measured values are shown on the display and continually updated during the running measuring process as standard:



Using the U/I IMP menu item, the diagram types can be switched between as follows:

Impedance (absolute) and measuring current (maximum)	⟺	Current and voltage curve of the period in which the measurement was carried out (for all measurements up until this point)

Ending the measurement

Measuring ends automatically as soon as the 8 measurements have been carried out on all involved phases. The measurement can be manually deactivated at any time via the menu item ⏻.

4.2.2.3 Identifying and Locating Faults

Comparing curves

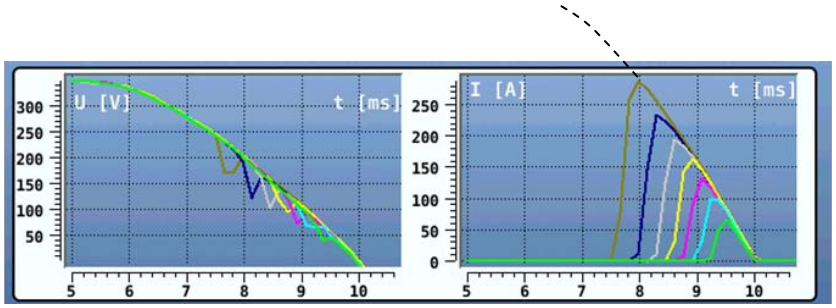
Following the measurement, the measured values and curves can be examined for any conspicuous jumps and thus the triggering or subsiding of the fault at a certain measuring current value can be detected.

As is the case even during the measurement, different diagram types can be switched between using the U/I IMP menu item (see also the previous page).

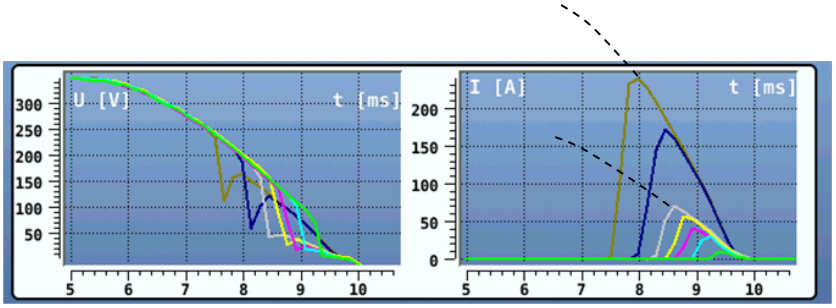
The curve of current and voltage in particular can be very useful when it comes to identifying a fault. The following applies in principle: As soon as a fault has been tripped in the course of the measurements, this is marked by diverging envelope curves.

This is very easy to see in the current curve in the example depicted below. While in the case of the inconspicuous measurement the envelope curve (broken black line) is identical for all curves, in the case of the faulty phase two different envelope curves are clearly recognisable.

Inconspicuous measurement:



Conspicuous measurement:



In order to be able to undertake a comparison between the measured conductors when measuring multiple conductors, the following selection menu must be called up via the ➡ menu item:

The conductor to be displayed is selected by turning the rotary encoder.

Locating faults

Information on the position of an identified fault can primarily be gained from the reflectograms recorded along with the measurement (siehe Seite 22).

If this option of fault prelocation is not available, the affected network section at the least can be identified by means of additional measurements at different connection points (using a process of elimination).

4.3 Exporting the Measured Data

Once a measurement has been completed, the measured data recorded is written to the internal memory of the NIM 1000. Measurement data records already contained in the memory will not be overwritten in this process and, thanks to the non-volatile memory, the data will be maintained permanently too.

As soon as at least one data measurement record is stored in the memory, an export of data can be initiated using the  menu item in the main menu. Here, all data measurement records stored in the memory are written into the *\nim1000\measurements* folder of the plugged-in USB flash drive and deleted upon successful transfer from the internal memory. The files in CSV format (comma separated values) can be viewed later in the comfort of the workplace using any CSV-capable application (e.g. Excel).

5 Maintenance and care

Repair and maintenance

Repair and maintenance work may only be performed by Megger or authorised service partners. Megger recommends having the system tested and maintained at a Megger service centre once a year.

Megger also offers its customers on-site service. Please contact your service centre as needed.

It is not necessary to open the housing of the device to commission and operate the system. Opening the housing causes the immediate termination of all warranty claims!

The connections and connection leads of the system must be regularly tested to ensure that they are free of defects and intact, in accordance with the applicable national and company-specific arrangements.

Storage

If the device is not used for a lengthy period, it should be stored in a dust-free and dry environment.

Caring for the display

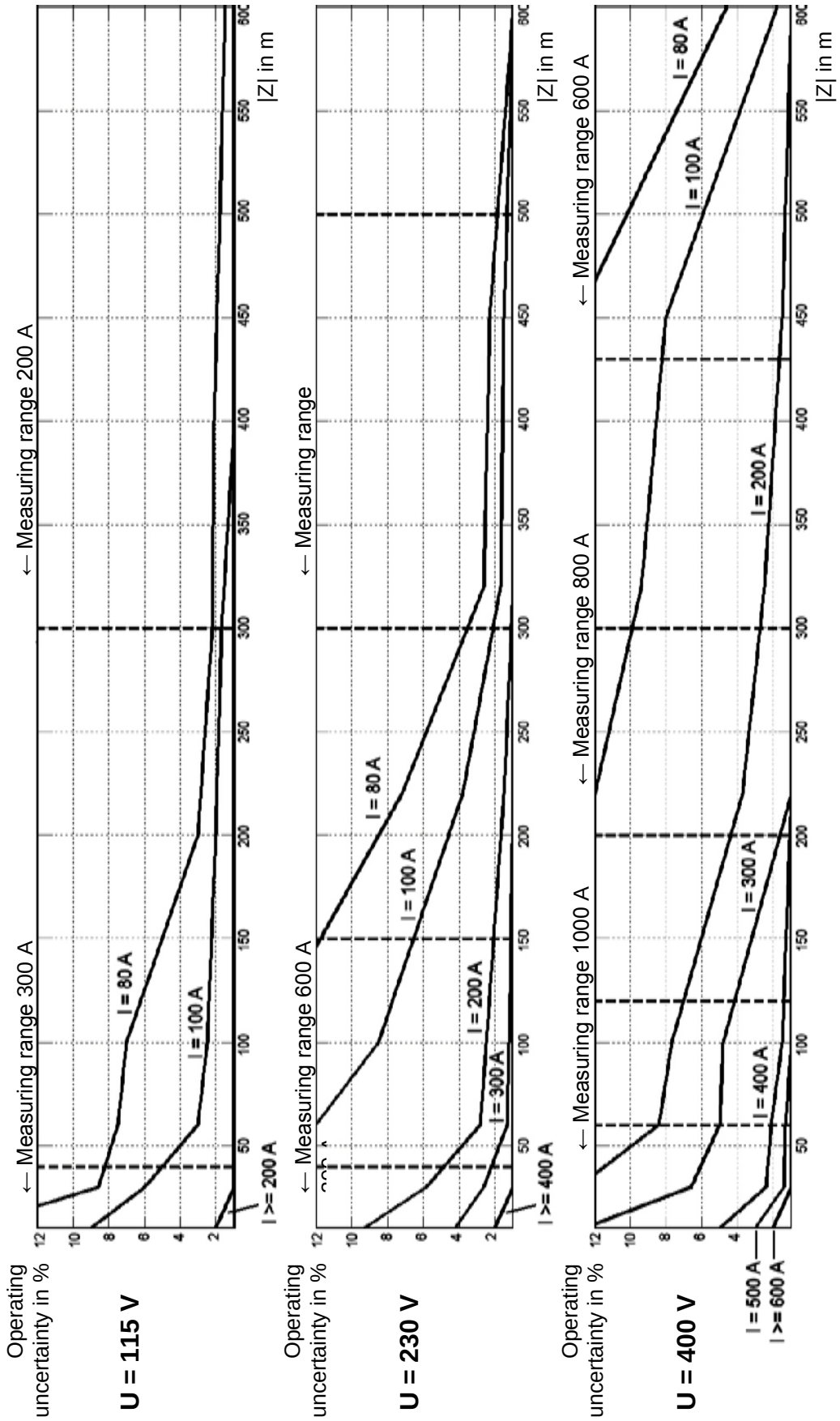
Do not clean the display with aggressive products such as solvents or spirits.

Instead, use lukewarm water and a soft, lint-free cloth for wet wiping, or a microfibre cloth for dry wiping.

Replacing fuses

Each connection cable is fused in the area of the plug connector with a T 25A H 440V micro-fuse (6.3 mm x 32 mm) which may be replaced independently if need be.

Annex 1: Measuring Accuracy



Voltage	Operating uncertainty	Current and measuring range
115 V	3% ± 1 mΩ	≥ 200 A for |Z| > 10 mΩ 100 A for |Z| > 200 m Ω 80 A for |Z| > 500 m Ω
	5% ± 1 mΩ	100 A for 40 m Ω < |Z| < 200 mΩ 80 A for 150 m Ω < |Z| < 500 mΩ
	10% ± 1 mΩ	100 A for 10 m Ω < |Z| < 40 mΩ 80 A for 30 m Ω < |Z| < 150 mΩ
230 V	3% ± 1 mΩ	≥ 400 A for |Z| > 10 mΩ 300 A for |Z| > 45 m Ω 200 A for |Z| > 150 m Ω 100 A for |Z| > 300 m Ω 80 A for |Z| > 500 m Ω
	5% ± 1 mΩ	300 A for 10 m Ω < |Z| < 45 mΩ 200 A for 45 m Ω < |Z| < 150 mΩ 100 A for 200 m Ω < |Z| < 300 mΩ 80 A for 275 m Ω < |Z| < 500 mΩ
	10% ± 1 mΩ	200 A for 20 m Ω < |Z| < 45 mΩ 100 A for 80 mΩ < |Z| < 200 mΩ 80 A for 180 m Ω < |Z| < 275 mΩ
400 V	3% ± 1 mΩ	≥ 600 A for |Z| > 10 mΩ 500 A for |Z| > 25 m Ω 400 A for |Z| > 70 m Ω 300 A for |Z| > 190 m Ω 200 A for |Z| > 400 m Ω 100 A for |Z| > 600 m Ω
	5% ± 1 mΩ	500 A for 10 m Ω < |Z| < 25 mΩ 400 A for 10 m Ω < |Z| < 70 mΩ 300 A for 90 m Ω < |Z| < 190 mΩ 200 A for 180 m Ω < |Z| < 400 mΩ 100 A for 525 m Ω < |Z| < 600 mΩ 80 A for 600 m Ω < |Z|
	10% ± 1 mΩ	300 A for 20 m Ω < |Z| < 90 mΩ 200 A for 50 m Ω < |Z| < 180 mΩ 100 A for 300 m Ω < |Z| < 525 mΩ 80 A for 500 m Ω < |Z| < 600 mΩ

Annex 2: Measuring Range

Voltage	Current range	Measuring range
115 V	300 A	|Z| < 40 mΩ
	200 A	|Z| < 300 mΩ
	100 A	|Z| < 1100 mΩ
230 V	80 A	|Z| < 2500 mΩ
	600 A	|Z| < 40 mΩ
	500 A	|Z| < 150 mΩ
400 V	400 A	|Z| < 300 mΩ
	300 A	|Z| < 500 mΩ
	200 A	|Z| < 1000 mΩ
	100 A	|Z| < 2500 mΩ
	80 A	|Z| < 5000 mΩ
	1000 A	|Z| < 60 mΩ
	900 A	|Z| < 120 mΩ
	800 A	|Z| < 200 mΩ
	700 A	|Z| < 300 mΩ
	600 A	|Z| < 430 mΩ
	500 A	|Z| < 620 mΩ
	400 A	|Z| < 900 mΩ
	300 A	|Z| < 1400 mΩ
	200 A	|Z| < 2300 mΩ
	80 A / 100 A	|Z| < 5000 mΩ