



# measurement instruments

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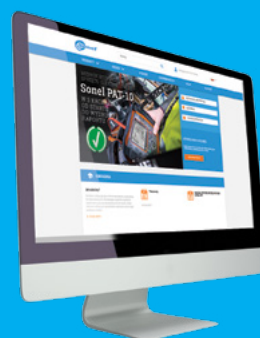
## Quality and safety

Our products have achieved a high position on the market thanks to the continuous development of the technologies and functions of the products we offer and their adaptation to market requirements. This has been confirmed by the following international certificates: **Quality Management System ISO 9001:2008, Environmental Management System ISO 14001:2005, and Occupational Health and Safety Management System PN-N-18001:2004**. Manufactured instruments are compliant with standards **EN 61557, EN 61010 as well as the electromagnetic compatibility directive**, which allows us to bear the full responsibility that comes with the CE mark that we place on our products.



## Be up to date with updates. Visit us online!

Complete product support is available on our website - including current: **meter firmware, drivers, instruction manuals, technical specifications and practical articles** that help to expand knowledge about the theory and practice of taking measurements.



for the latest news, visit:

[www.sonel.pl/en](http://www.sonel.pl/en)

[facebook.com/sonel.measurement.instruments](https://facebook.com/sonel.measurement.instruments)

[youtube.pl/sonelsafilm](https://youtube.pl/sonelsafilm)

## Time has allowed us to gain experience. We are a leader on the market!

**1989** The beginning of activity as the Innovation Implementation Center in Wrocław

**1990** The first digital fault loop tester is created

**1994** The production plant in Świdnica is opened

**1995** The first Polish microprocessor-based insulation resistance meter is created

**1996** Export sales of meters are initiated

**1997** Start-up of surface mounting process in an automated line, and the creation of the first Polish microprocessor-based fault loop impedance meter

**1998** Change of company name and legal entity

**1999** The first Polish microprocessor-based earth resistance meter is manufactured

**2001** Implementation and certification of quality management system

**2004** First multi-function meter

**2006** Sales in over 20 countries around the world

**2008** Relocation to new headquarters and purchase of the most modern SMT assembly line in the world

**2008** Debut on the Warsaw Stock Exchange

**2008** Over 200 jobs

**2010** Thermal imagers added to offer

**2011** Creation of the first Polish safety tester for electrical equipment

**2012** Implementation of SPS production management system

**2013** Expansion onto new markets

**2013** Foxytech founded

**2015** Start of cooperation with Lincoln Electric and acquisition of Lower Silesian Economic Certificate

**2016** Won gold medal at the trade fair in Bielsko-Biała

**2017** Acquisition of PCA accreditation





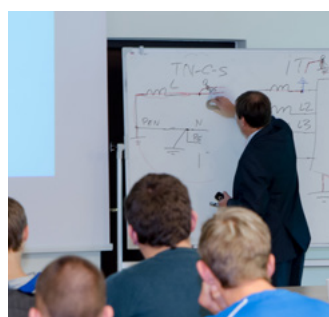
## Modern technologies for you

Our offer is not limited to measuring instruments alone. We also render calibration and rating services in our accredited Calibration and Research Laboratory. Practically any instruments related to shock protection tests can be calibrated at our lab. Besides such instruments, we also test many other meters of electrical quantities, including thermal imagers, pyrometers, illuminance meters and similar instruments.

We offer SMT surface mounting assembly services on a professional, automated assembly line from FUJI. We have two SMT surface assembly lines, a THT thru-hole assembly line and inspection stations. Product assembly takes place in compliance with standard IPC-A-610D.

**We sincerely invite you to cooperate with us!**

**Products from Sonel S.A. are sold in nearly 50 countries around the world.**



## We care about our customers. Grow with us!

Excellent products, good logistical support, efficient guarantee and post-guarantee service as well as customer support after purchase are the most important elements of our success.

During the numerous training seminars, conferences and meetings we organize, we systematically analyze our customers' current needs.

To satisfy these needs, we create new designs of measuring instruments that are fully adapted to users' expectations.

We are also preparing increasingly interesting training formulas. Over the course of training seminars and conferences, our specialists present the latest technological solutions, supported by an interpretation of currently applicable regulations and standards, and conduct practical demonstrations of measurement techniques.

# Electrical safety measurements

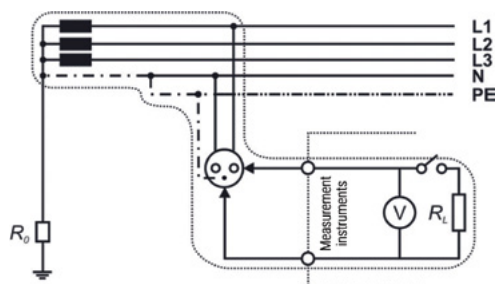
Binding regulations require measurements of an electrical system to be conducted both during commissioning (after completion of assembly and after every modification or expansion of the system) and regularly during its operation. The scope of commissioning of periodical testing is defined in standard HD 60364-6. Requirements posed towards measuring instruments are defined in individual tables of standard EN 61557. Safety measurements cover measurement of fault loop (earth fault or short-circuit) impedance, insulation resistance, continuity of protective connections and equipotential bonding, earth resistance and residual current device parameters, as needed. The instruments used for measurements of this type should have a document confirming their technical serviceability. According to the provisions of the Act on Measures Law, this is the calibration certificate. The period recommended by the manufacturer between individual inspections of an instrument is 13 months.

## Fault loop impedance measurements.

One of the elements of anti-shock protection - protection against indirect contact in circuits equipped with overcurrent protection devices - is based on automatic power cut-off in the event of hazardous touch voltage on accessible current-conducting elements of electrical equipment. When this occurs, current flows through the circuit between the phase and protective conductors, tripping the overcurrent breaker and cutting off power. Since accessible elements may not remain under hazardous touch voltage for too long, this protection must trip within a sufficiently short time, as defined in standards. The condition for proper protection is described by the formula:

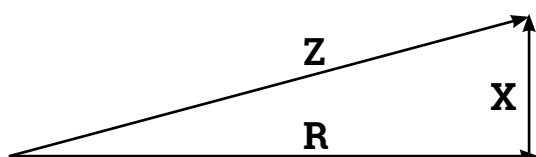
$$Z_s = U_n / I_A$$

where:  $Z_s$  - earth fault loop impedance,  $I_A$  - current tripping overcurrent protection within the required time (depends on time-current curve of the applied protection and required trip time),  $U_n$  - rated phase-to-earth voltage.

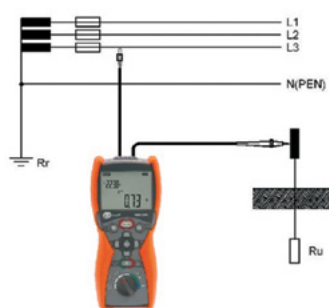


The value of impedance  $Z_s$ , required to determine whether or not protection is correct, must be measured. An "artificial short-circuit" is made during measurement of the fault loop according to the technical method. The instrument measures voltage under no-load conditions and then under short-time duty with a fault loop resistor. The impedance of the fault loop is calculated based on the difference between voltage drops. This measurement is made possible by fault loop impedance meters: MZC-304, MZC-305, MZC-306 and MZC-310S as well as multi-function instruments: MPI-502, MPI-505, MPI-520, MPI-525 and MPI-530 - all of these instruments also indicate the components of impedance, i.e. resistance and reactance.

$$Z = \sqrt{R^2 + X^2}$$



Fault loop impedance meters (besides MZC-310S) also enable measurement in L-PE loops in systems protected by residual current devices without any interference in the circuit. Such measurement, when performed with a current of less than 15 mA, is extended in time, while the resolution of the result amounts to 0.01  $\Omega$ , similarly as in other measurements. The MZC-310S high-current meter enables measurements with a resolution of 0.1 m $\Omega$  (power distribution points, switchboards, substations) using a measurement current up to 280 A, which allows for measurements in compliance with standard EN 61557, even in circuits where milliohm fault loop impedance values are present.



## The MZC-306 meter is distinguished by its capability of performing measurements

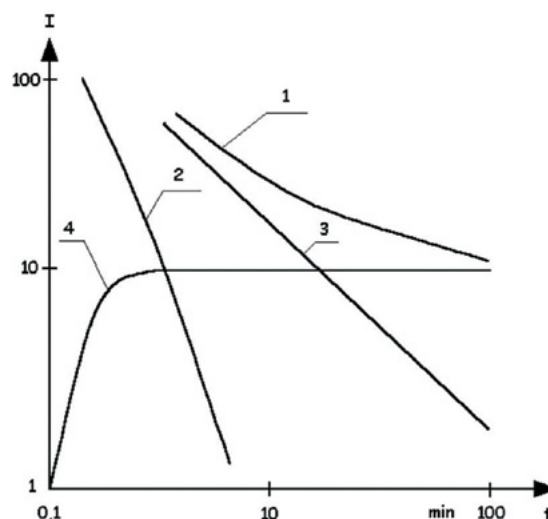
- » for any AC voltages
- » up to 750 V – including in industrial systems.

Fault loop meters can be used to measure earth resistance by means of an auxiliary voltage source (phase conductor). Hence, the measured value is overstated - the result of the measurement is the sum of the resistances of the measured earth electrode, operational earthing, source and phase conductor. However, if this value is less than the maximum value for the tested earthing, it can be considered correct, and there is no need to employ more accurate methods of measurement.

## Measurement of insulation resistance.

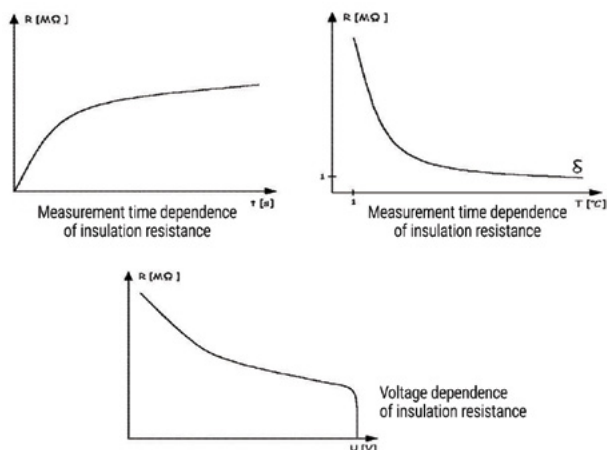
The condition of insulation is of decisive significance to the operational safety and correct operation of electrical systems and equipment, and it additionally guarantees protection against direct contact. Systematic testing of the condition of insulation is indispensable for detecting deteriorating condition and is an inseparable part of inspection and measurement. In the case where industrial equipment is measured, the tendency of changes in resistance values is of decisive significance, as it can indicate gradual deterioration of the insulation's condition. The basic factors that cause degradation of insulation are: electrical and mechanical exposures, chemical aggression, thermal exposures as well as environmental pollution; insulation ages due to the effect of these factors over the course of normal operation. Insulation resistance measurements are conducted with direct current in order to eliminate the influence of capacitance on the result. The method of conducting insulation resistance measurements and the required measurement voltages are defined in standards: HD 60364-6; E-04700; EN 61557-2. After measurement voltage is applied, physical phenomena occur in the insulation, generating a current. During resistance measurement, the following components of current flowing through insulation (1) can be distinguished:

- » capacitive charging current (2) - depends on capacitance (e.g. the length of the measured cable),
- » absorption current (3) - resulting from movement of charges and dipoles in an electric field,
- » insulation leakage current (4) - the sum of currents flowing through the material and on its surface.

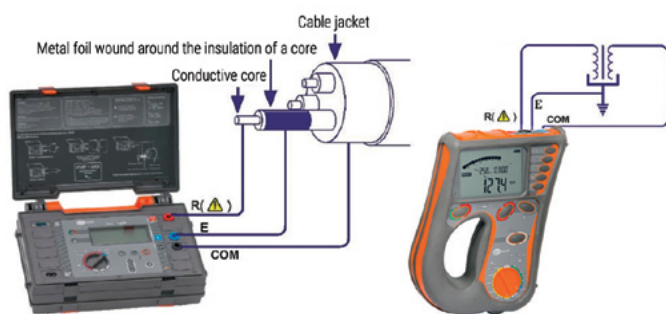


Due to the nature of the current flowing through the insulation, the measured insulation resistance value is affected by the time of measurement as well as by humidity, temperature, measurement voltage and surface cleanliness of the insulating material.





The three-lead method, employed in all advanced instruments, makes it possible to eliminate the influence of surface leakage current. In the case of cables, the core insulation must be wrapped in a metal foil connected to the instrument's shield terminal - only the leakage current flowing through the insulation is measured. Three-lead measurement is recommended whenever one is dealing with large surfaces exposed to pollution (large-diameter cables, HV glands, transformers, HV switches):



It is important to use the 3-lead method when measuring objects with very high resistance values (above 100 MΩ).

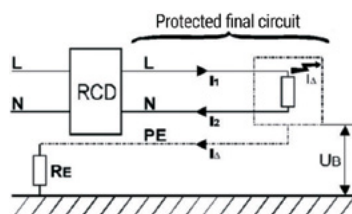
Instruments MIC-10K1, MIC-5050, MIC-5010, MIC-5005, MIC-2510, MIC-30, MIC-2501, MIC-2505, as well as multi-function meter MPI-525 enable performance of insulation measurements within a specific time as well as taking readings at user-defined time intervals. Based on the results obtained, one or two absorption coefficients are calculated, also providing information about the condition of insulation. Before performing measurements, make sure that the measured object is disconnected from the power supply. If voltage is detected on the object (or appears during measurements), the instrument interrupts the measurement and emits an error sound signal. The actual instant resistance value or actual leakage current value is displayed over the course of the measurement. After the measurement is complete, values measured at the time intervals defined by the user (within the range of 1..600 s) are saved, and the instrument discharges the measured object.

#### Measurements of residual current device parameters.

The primary function of a residual current device (RCD) is to provide additional protection against electrical shock through disconnection of power to the protected circuit in the event of excessive earth current in this circuit.

When there are no faults in the circuit protected by the RCD (residual current  $I_{\Delta} = 0$ ), input current  $I_1$  is equal to output current  $I_2$ . When a fault occurs (e.g. insulation breakdown), fault current  $I_{\Delta}$  begins to flow, and the value of current  $I_2$  is less than that of  $I_1$ . The RCD trips (cuts off power) when the measured difference between currents  $I_1$  and  $I_2$  exceeds a defined value specific to the given RCD. When fault current starts flowing, voltage  $U_B$  will appear on the housing of the protected device, according to Ohm's law:

$$U_B = I_{\Delta} \cdot R_E$$

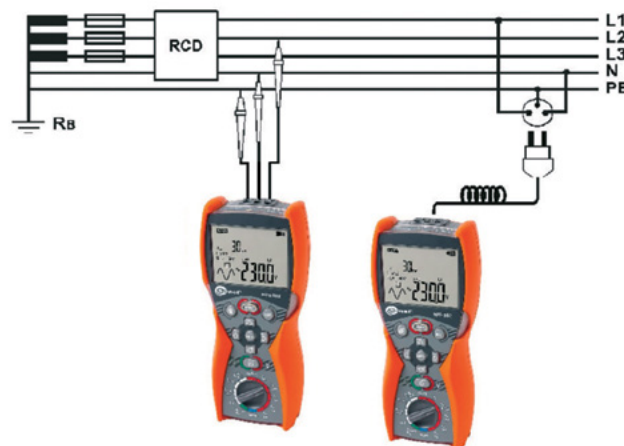


The RCD's rated current  $I_{\Delta n}$  must be selected so that the touch voltage generated as the fault current flows does not exceed the value of maximum long-term voltage  $U_L$ :

$$I_{\Delta n} < U_L / R_E$$

A system equipped with an RCD must have a PE protective conductor for safety reasons. For this reason, residual current devices may not be installed in systems lacking a separate protective conductor. An RCD does not limit the value of fault current, only the duration of its flow. However, since the RCD tripping condition is fault current exceeding the RCD's rated current, the rated current must be selected accordingly to the types of protected loads. With regard to tripping time, residual current devices are divided into: general, short-time delay [G] - intended for loads and circuits with small instant leakage currents, as well as selective [S] - characterized by a minimum inaction time, or the minimum time for which the RCD will not trip despite the difference between the circuit's input and output currents. Depending on the shape of the tripping fault current, RCDs are further divided into: AC type, designated [A], which react to a sinusoidal residual current, A type, designated [AS], which react to sinusoidal current, unidirectional pulsating current and pulsating current with a constant component up to 6 mA, as well as B type, designated [B], reacting to sinusoidal current, unidirectional pulsating current, pulsating current with a constant component and direct current. Residual current devices measurements can be performed by the MRP-201 meter as well as by multi-function meters MPI-502, MPI-505, MPI-508, MPI-520, MPI-525 and MPI-530.

During every measurement procedure (besides measurement of AC voltage), the meter checks whether the resulting touch voltage does not exceed the defined value of maximum long-term voltage. If this value is exceeded, the measurement will be interrupted automatically (i.e. the residual measurement current will be cut off).

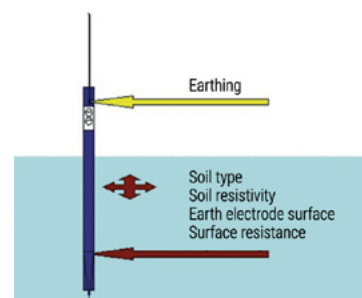


The value of maximum long-term touch voltage can be set to 25 V or 50 V, and additionally to 12.5 V for selective RCDs. RCD tripping time is measured from the start of residual current flow until the RCD trips, and a positive or negative initial phase (or polarity) can be selected. The maximum measured tripping time value is 300 ms, and for measurement of selective RCDs, 500 ms. RCD trip current is measured by inputting a linearly increasing residual current into the tested circuit. This current grows from a value of approx. 30%  $I_{\Delta n}$  until the time at which the RCD trips or  $I_{\Delta n}$  is exceeded for AC type RCDs (140% and 200% for A-type and B-type RCDs, respectively).

Thanks to the application of a touch electrode in meters, RCD measurement instruments can be used to check the correctness of connections in power sockets. If the voltage between the touch electrode and protective conductor (PE) connected to the socket exceeds 50 V, a signal will be emitted.

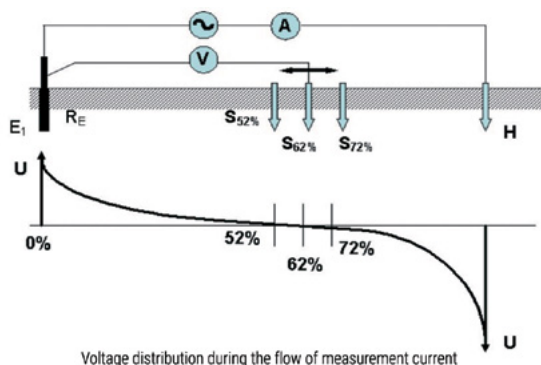
#### Measurements of earth resistance.

Earth resistance measurements are conducted to check electrical systems and to meet requirements concerning shock protection. Besides lightning protection, earthing also performs other safety-related functions (e.g. discharging electrical charges in facilities where there is an explosion hazard). The earthing system is subject to periodical inspections over the course of operation in order to make sure that corrosion or changes in soil resistivity have not significantly altered its parameters.



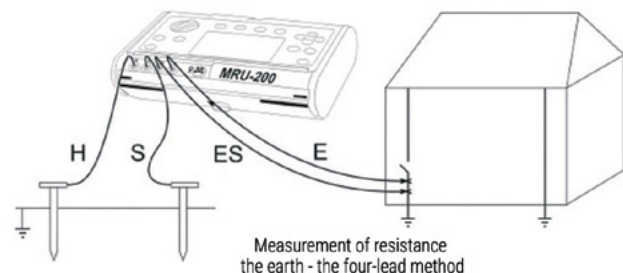
## Measurement methods are described in detail at [www.sonel.pl](http://www.sonel.pl).

Earthing measurements can be performed with multi-function meters equipped with the appropriate function and with specialized MRU-series meters. The technical method is most commonly applied to measure earth resistance – the meter calculates the resistance value by measuring the voltage on the instrument's terminals after measurement current is input. The three-pole potential drop method is used for measurements of individual earthings, and it is based on forcing current flow in the circuit: meter - tested earthing - current electrode - meter. The distances between electrodes should be as large as possible; the current electrode should be found at a distance at least ten times greater than the physical length of the measured earthing; in practice, a distance of approx. 40 m is accepted between the tested earth electrode and the current electrode.

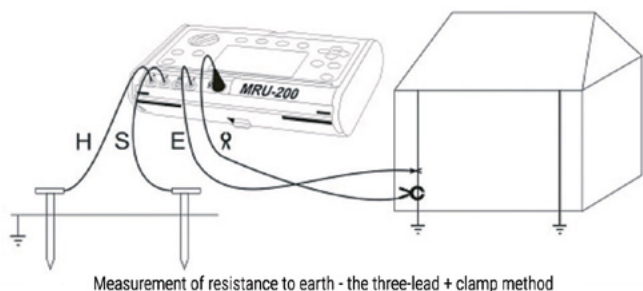


The voltage electrode is driven into the ground between the measured earth electrode and the current electrode, in the so-called zero potential area. In practice, it is recommended to perform three measurements, changing the position of the voltage electrode by 1-2 meters towards and away from the tested earthing. If results are identical, the location where the electrode was driven in was correct. Measurement is performed with current of a frequency that prevents interference and noise of power grid frequency (50 Hz or 60 Hz) and its harmonics. Advanced MRU-series earth resistance meters inspect and signal the magnitude of interfering voltages. In addition, these meters calculate the additional error related to excessive resistance of measuring probes.

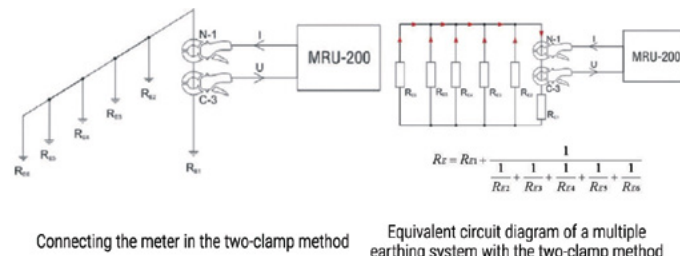
Advanced instruments have the capability of performing measurements by means of the 4-lead method, which makes it possible to eliminate the influence of the lead connecting the meter to the tested earthing.



Inconveniences arising from the need to disconnect individual earth electrodes during multiple earthing system measurements can be surmounted by employing the technical method with the use of an additional clamp (MRU-30, MRU-105, MRU-120, MRU-200, MRU-200-GPS). The current and voltage electrode are positioned similarly as in the three-pole method, but current is measured by the clamp fastened on the tested earthing. The meter calculates resistance on the basis of the current flowing through the examined earth electrode. However, the measurement method involving a clamp may not be used in multiple earthing systems where individual earth electrodes are connected to one another underground.

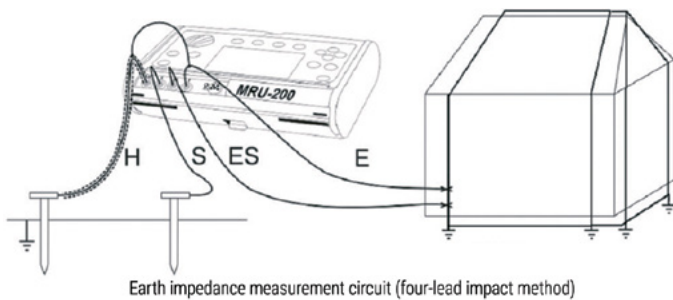


The double-clamp method (MRU-30, MRU-120, MRU-200, MRU-200-GPS, MPI-530) enables resistance measurements of multiple earthing systems without the need to place auxiliary probes in the ground. During this measurement, the current generated by the transmitting clamp flows through the circuit: tested earthing + parallel connection of the remaining earthings, and is measured by the receiving clamp – the circuit's resistance is calculated on this basis. Since parallel connection of several resistances creates a resultant resistant of much lower value, the result is overstated compared to the tested resistance. The difference gets smaller as the number of earthings in the measured object increases.

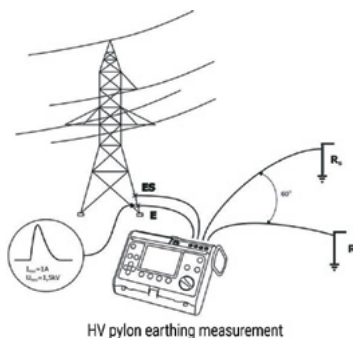




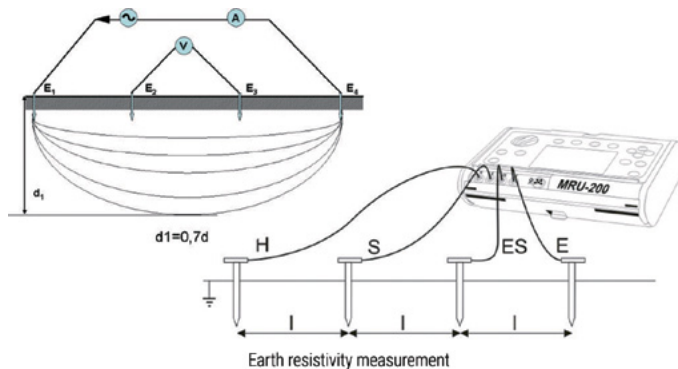
## All instruments are compliant with European Directives concerning electromagnetic compatibility and safety and bear the mark $\text{CE}$



The impulse method may also be used for earthing impedance measurements of HV pylons as it can determine the impedance of the entire pylon's earthing, including both hoop iron systems and the resistance of the pylon's legs, and furthermore, the method can be employed without shutting down the tested HV line or disassembling part of the earthing.



Knowledge of soil resistivity (MRU-30, MRU-105, MRU-120, MRU-200, MRU-200-GPS) is important at the earthing designing stage. With knowledge of the cross-section of the soil, the type of earthing can be chosen – for example, in the case of low soil resistivity values only at a certain depth, a single, deep-buried, vertical earth electrode would be designed, whereas in the case of low resistivity at a shallower depth and rock at a greater depth, a set of earthing systems consisting of shorter vertical earth electrodes connected by a hoop iron would be designed.



Soil resistivity is measured using four electrodes positioned linearly at different distances (Wenner method). Soil resistivity is measured at a depth equal to 0.7 of the distance between pins.

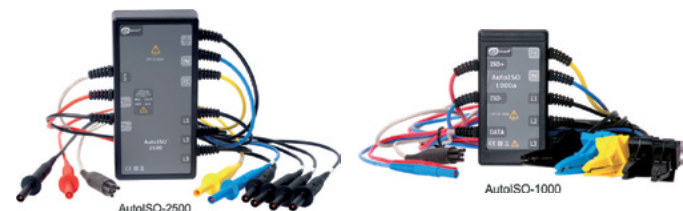
### Measurement accessories

During measurements performed on live systems (fault loop impedance, residual current device parameters, voltage, phase sequence), use test leads terminated by test probes or crocodile clips (meeting relevant measurement category requirements, with anti-slip shape), or use the adapters appropriate for the sockets used to perform measurements.

Meters are connected to a system equipped with sockets via power cord terminated by a plug, or with cords in other cases, and they automatically inspect whether connections are made properly, signaling incorrect connections. Measurements in single-phase sockets are made possible by adapters terminated by a Uni-Schuko plug; measurements are also performed in the case of swapped phase and neutral conductors (without the need for manual swapping or use of additional adapters). Moreover, adapters WS-01 and WS-03 are equipped with buttons for triggering measurements and saving results in the memory. For measurements in three-phase or high-current sockets, one of the following adapters may optionally be used: AGT-16P, AGT-32P, AGT-63P, AGT-16C, AGT-32C for three-phase sockets or AGT-16T and AGT-32T for high-current sockets.



The AutoISO family of adapters, along with the appropriate instrument, makes it possible to measure the insulation resistance of 3-, 4- and 5-core cords without the need for manual selection of pairs and combinations of measured cords. Leads coming out from the adapter are terminated by crocodile clips (depending on the situation, 3, 4 or all 5) and fastened on the cores of the measured cord, after which the measurement is started, and the adapter connected to the meter will perform the entire required sequence of measurements. When applied to an MPI-525 or MIC-2510 meter, the AutoISO-2500 adapter also enables such measurements for cables (with 2500 V voltage).



The TWR-1J adapter makes it possible to inspect the parameters of a residual current device prior to its installation.

Instruments for earthing resistance measurements are delivered with a rich assortment of ergonomic accessories facilitating performance of measurements. Due to the length of test leads used for earthing measurements (50, 30, 25, 15 meters), they are wound onto reels made of frost- and impact-resistant plastic, allowing for quick unwinding or winding of leads.



Sonel also offers the option of supplementing the set with 80 centimeter-long pins along with a special case for them, and a high sensitivity and accuracy clamp (C-3, N-1), enabling earthing measurements without disconnection of test connections, as well as special terminal clamps that guarantee secure contact.

Measurement instruments are delivered with their cases or briefcases, which fit the shape of the appropriate instruments, with partitions and internal holders that also make it possible to carry measurement accessories.

A detailed list of standard and additional accessories can be found on pages 39-40.



## SONEL MPI-530 / MPI-530-IT

index: WMGBMPI530 / WMGBMPI530IT



### Fault loop impedance measurements:

- » impedance measurement with 23 A current (40 A for phase-to-phase voltage), max. resolution 0.001  $\Omega$ ,
- » fault current-limiting resistor: 10  $\Omega$ ,
- » range of measurement voltages: 95...440 V, frequencies 45...65 Hz,
- » fault loop impedance measurement with resolution up to 0.01  $\Omega$  in systems protected with RCDs not tripping at  $I_{\Delta n} \geq 30$  mA,
- » automatic calculation of fault current on the basis of nominal or measured voltage; differentiation of phase-to-neutral and phase-to-phase voltage,
- » measurements using UNI-Schuko plug with measurement triggering button (including for swapped L and N leads) or 1.2 m, 5 m, 10 m or 20 m test leads, with optional use of three-phase socket adapters (AGT),
- » selection of installation protections and automatic evaluation of measurement results.

### Testing of AC, A, F, B and B+ residual current devices:

- » **MPI-530-IT also enables measurements in IT networks,**
- » measurement of general, short-time delay and selective RCDs with rated residual currents of 10, 30, 100, 300, 500 and 1000 mA,
- » function of automatic measurement of all RCD parameters (after pressing the "START" button once, the meter performs the entire defined cycle of measurements, including the capability of earth fault loop impedance measurement with 15 mA current),
- » shape of the input leakage current selected by the user: sinusoidal (start from rising or falling edge), unidirectional pulsating (positive or negative), unidirectional pulsating with direct current offset (positive or negative), constant (positive or negative),
- » measurement of tripping current  $I_A$  with rising current,
- » measurement of tripping time  $t_A$  with currents  $0.5 I_{\Delta n}$ ,  $1 I_{\Delta n}$ ,  $2 I_{\Delta n}$  and  $5 I_{\Delta n}$ ,
- » measurement of touch voltage  $U_B$  and protective conductor resistance  $R_E$  without tripping the RCD,
- » detection of L and N phase swapping in a socket; does not affect measurements,
- » capability of measuring tripping current  $I_A$  as well as actual tripping time  $t_{AI}$  with just one RCD trip,
- » voltage measurements within the range of 95...270 V.

### Measurement of insulation resistance:

- » measurement voltages: 50 V, 100 V, 250 V, 500 V, 1000 V,
- » measurement of insulation resistance up to 10 G $\Omega$ ,
- » capability measurement in-socket by means of UNI-Schuko adapter,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » meter protected against the presence of voltage on the object and the appearance of voltage during measurement,
- » automatic discharge of the measured object's capacitance after completion of measurement,
- » automatic measurement of all resistance combinations of 3-, 4- and 5-core cords by means of the optional AutoISO-1000C adapter

### Earth resistance measurements:

- » according to 3- or 4-lead technical method with 2 auxiliary electrodes,
- » according to 3-lead method with additional clamp,
- » according to double-clamp method,
- » internal power source with frequency appropriate for 50 Hz or 60 Hz power network

### Standard accessories of the meter:

WS-03 adapter for triggering measurement (UNI-Schuko plug)	WAADAWS03
NiMH accumulator (rechargeable battery) 4.8 V 4.2 Ah	WAAKU07
L-2 carrying case	WAFUTL2
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
Sonel Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
earthing measurement test lead with banana plugs on reel; 15 m; blue	WAPRZ015BUBBSZ
earthing measurement test lead with banana plugs on reel; 30 m; red	WAPRZ030REBBSZ
Battery charging cable for 12 V car sockets	WAPRZLAD12SAM
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
2x earth contact pin probe (30 cm)	WASONG30
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
test probe with banana socket; 1 kV; yellow	WASONYEGB1
meter strap (type L-2)	WAPOZSZEKPL
meter power adapter (type Z7)	WAZASZ7
Sonel MPI Mobile	
calibration certificate	

### Soil resistivity measurements according to the Wenner method:

- » measuring range: 0.5  $\Omega$ m...9.99 k $\Omega$ m,
- » distances between electrodes can be set in meters (1...30 m) or feet (1...90 ft).

### Low-voltage continuity testing of protective conductors and equipotential bonding:

- » measuring range according to EN 61557-4: 0.12...400  $\Omega$ , max. resolution 0.01  $\Omega$ ,
- » measurement of protective conductor continuity with current  $\geq 200$  mA in two directions,
- » low-current measurement with sound signaling,
- » voltage on open terminals: 4...9 V,
- » automatic calibration of test leads - leads of any length can be used.

### Illuminance measurement:

- » display range: 0.001/0.01/01 lx...999.9 klx,
- » measurement in lux (lx) or foot-candles (fc),
- » measurement by means of external photodetectors (optional)



MPI-530 / MPI-530-IT meters enable automatic insulation resistance measurement of 3-, 4- and 5-core cords by means of the optional AutoISO-1000C adapter.

### Additional functions of the meter:

- » **Analysis and registration of single-phase network parameters (U, I, cos $\phi$ , P, PF, Q, S, Sn, THD of voltage and current harmonics up to the 40th),**
- » **Quick check of correct connection of PE conductor by means of contact electrode,**
- » **Check of phase sequence and direction of motor revolutions,**
- » **Power supply from accumulator or batteries (optional), built-in quick charger,**
- » **Capability of charging from the power grid or 12 V car lighter socket,**
- » **Tree-structure memory with dynamic management (max. 10,000 entries for each type of measurement),**
- » **Data transmission to PC via USB or Bluetooth®.**

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » power supply of the meter ... Ni-MH accumulator (rechargeable battery) or LR14 alkaline batteries (4 pcs.) ..... (optional)
- » operating temperature range ..... 0 ... +50°C



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### Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$ in 23/40A mode

Measurement with 23/40 A current - measuring range according to EN 61557: **0.130 ...1999  $\Omega$**  (for 1.2 m lead):

Display range	Resolution	Accuracy
0.00...19.999 $\Omega$	0.001 $\Omega$	$\pm(5\% \text{ m.v.} + 0.03 \Omega)$
20.00...199.99 $\Omega$	0.01 $\Omega$	$\pm(5\% \text{ m.v.} + 0.3 \Omega)$
20.00...1999.9 $\Omega$	0.1 $\Omega$	$\pm(5\% \text{ m.v.} + 3 \Omega)$

Nominal voltage: 95...270 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 95...440 V (for  $Z_{L-L}$  - only mode 23/40 A). Frequency: 45...65 Hz.

### Measurement of the $Z_{L-PE}$ fault loop impedance in the RCD mode

Measurement with 15 mA current - measuring range according to EN 61557: **0.50...1999  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(6\% \text{ m.v.} + 10 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	$\pm(6\% \text{ m.v.} + 5 \text{ digits})$
20.0...199.9 $\Omega$	1 $\Omega$	

95...270 V rated voltage

Frequency: 45...65 Hz

### Earthing resistance measurement with two clamps

Display range	Resolution	Accuracy
0.00...99.9 Ω	0.01 Ω	±(10% m.v. + 4 digits)
10.0...19.9 Ω	0.1 Ω	
20.0...99.9 Ω		±(20% m.v. + 4 digits)

Measurement with additional current clamp

Frequency: 45...65 Hz

Interference measurements range: up to 9.99 A

### Measurement of insulation resistance

Measuring range according to EN 61557-2:

- » for  $U_n = 50 \text{ V}$ : 50 k $\Omega$ ...250 M $\Omega$
- » for  $U_n = 100 \text{ V}$ : 100 k $\Omega$ ...500 M $\Omega$
- » for  $U_n = 250 \text{ V}$ : 250 k $\Omega$ ...99 M $\Omega$
- » for  $U_n = 500 \text{ V}$ : 500 k $\Omega$ ...2 G $\Omega$
- » for  $U_n = 1000 \text{ V}$ : 1000 M $\Omega$ ...9.99 G $\Omega$

Display range	Resolution	Accuracy
0...1999 k $\Omega$	1 k $\Omega$	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
2.00...19.99 M $\Omega$	0.01 k $\Omega$	
20.0...199.9 M $\Omega$		
200...999 M $\Omega$	1 k $\Omega$	
1.00...9.99 G $\Omega$	0.01 G $\Omega$	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$

\*\*) no greater than the measuring range for a given voltage.

### Indication of phase sequence

- » Indication of phase sequence: compliant, non-compliant, display of phase-to-phase voltages
- »  $U_{L-L}$  power system voltage range: 95...500 V (45...65 Hz)

### Analysis and recording of single-phase system

- » Measurement of voltage  $U_{L-N}$ : 0...500 V, power measurement P, Q, S: 0...1.5 M (W, var, VA).
- » Frequency range of measured voltages: 45.0...65.0 Hz.
- » Frequency measurement within range 45.0...65.0 Hz for voltages 50...500 V (Accuracy within a maximum of  $\pm 0.1\% \text{ m.v.} + 1 \text{ digit}$ ).
- »  $\cos\phi$  measurement: 0.00...1.00 (resolution 0.01).
- » Measurement of current and voltage harmonics (up to the 40th).
- » THD measurement relative to first harmonic (for U and I).
- » AC current measurement (True RMS) with clamp:

Clamp	Display range	Resolution	Accuracy
C-3, C-6	0.0...99.9 mA	0.1 mA	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$
	100...999 mA	1 mA	
C-3, C-6, F-2, F-3	1.00...9.99 A	0.01 A	$\pm(5\% \text{ m.v.} + 5 \text{ digits})$
	10.0...99.9 A	0.1 A	(C-3, C-6)
	100...999 A	1 A	$\pm(0.1\% \text{ In} + 2 \text{ digits})$
F-1, F-2, F-3	1.00...3.00 kA	0.01 kA	(F-1, F-2, F-3)

### Illuminance measurement

Display range [lx]	Resolution [lx]	Spectral uncertainty	Base uncertainty (accuracy)
0...3.999	0.001	$f1 < 2\%$	$\pm(2\% + 5 \text{ digits})$
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		
40.0 k...399.9 k	0.1 k		

### Measurements of RCD parameters (working voltage range 95...270V):

**RCD trip test and measurement of tripping time  $t_A$**  (for  $t_A$  measurement function)

RCD type	Factor	Range (general and short-time delay)	Range (selective)	Resolution	Accuracy
General, short-time delay and selective	$0.5 \cdot I_{\Delta n}$	0...300 ms	0...500 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$ (for RCD of $I_{\Delta n} = 10 \text{ mA}$ and the measurement with $0.5 \times I_{\Delta n}$ error: $\pm(2\% \text{ m.v.} + 3 \text{ digits})$ )
	$1 \cdot I_{\Delta n}$				
	$2 \cdot I_{\Delta n}$	0...150 ms	0...200 ms		
	$5 \cdot I_{\Delta n}$	0...40 ms	0...150 ms		

Residual current input accuracy: for  $0.5 \cdot I_{\Delta n}$  -8...0% for  $1 \cdot I_{\Delta n}$ ,  $2 \cdot I_{\Delta n}$ ,  $5 \cdot I_{\Delta n}$  0...8%

### Measurement of RCD trip current $I_A$ for sinusoidal residual current (AC type)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	0.3 x IΔn...1.0 x IΔn	± 5% IΔn
30 mA	9.0...30.0 mA			
100 mA	33...100 mA	1 mA		
300 mA	90...300 mA			
500 mA	150...500 mA			
1000 mA	330...1000 mA			

Measurement can be started from the positive or negative half-period of the input leakage current (AC)

### Measurement of RCD trip current $I_A$ for uni-directional residual current and uni-directional current with 6mA direct current offset (type A)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.5...20.0 mA	0.1 mA	$0.35 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	10.5...42.0 mA			
100 mA	35...140 mA			
300 mA	105...420 mA	1 mA		
500 mA	175...700 mA			

Measurement can be started from a positive or negative half-period of the input leakage current

### Measurement of RCD trip current $I_A$ for residual direct current (type B)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	2.0...20.0 mA	0.1 mA	0.2 x I <sub>an</sub> ...2.0 x I <sub>an</sub>	± 10% I <sub>an</sub>
30 mA	6...60.0 mA	1 mA		
100 mA	20...200 mA			
300 mA	60...600 mA			
500 mA	100...1000 mA			


Measurement is possible for positive or negative input leakage current  $I_{\Delta n}$  - nominal value of residual current

### Measurement of RE earth resistance using 3-lead, 4-lead, or 3-lead + clamp technical method

Measuring range according to EN 61557-5: **0.50  $\Omega$ ...1.99 k $\Omega$**  for  $U = 50 \text{ V}$  (3-lead, 4-lead):

Display range	Resolution	Accuracy 3-lead, 4-lead	Accuracy 3-lead with clamp
0.00...9.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 4 \text{ digits})$	$\pm(8\% \text{ m.v.} + 4 \text{ digits})$
10.0...99.9 $\Omega$	0.1 $\Omega$	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$	
100...999 $\Omega$	1 $\Omega$		
1.00...1.99 k $\Omega$	0.01 k $\Omega$		


"m.v." = "measured value"



MPI-530 / MPI-530-IT meters enable measurement of the actual tripping time and trip current of an RCD with just one trip.

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-PN-E 04700 (performance of measurements - commissioning tests)
- » EN 12464 (lighting workplaces)



MPI-530 / MPI-530-IT meters enable accurate measurement of fault loop impedance, including in L-PE loops in networks equipped with RCDs, as well as measurements in sockets with swapped L and N conductors.

## SONEL MPI-525

index: WMGBMPI525



CAT III

CAT IV

IP 54

600V

300V

### Fault loop impedance measurements:

- » impedance measurement with 23 A current (40 A for phase-to-phase voltage),
- » fault current-limiting resistor: 10  $\Omega$ ,
- » range of measurement voltages: 95...440 V, frequencies 45...65 Hz,
- » fault loop impedance measurement with resolution up to 0.01  $\Omega$  in systems protected with RCDs not tripping at  $I_{\Delta n} \geq 30$  mA,
- » automatic fault current calculation; differentiation of phase and phase-to-phase voltage,
- » measurements using UNI-Schuko plug with measurement triggering button (including for swapped L and N leads) or 1.2 m, 5 m, 10 m or 20 m test leads, with optional use of three-phase socket adapters (AGT).

### Testing of AC, A, F, B and B+ residual current devices:

- » measurement of general, short-time delay and selective RCDs with rated residual currents of 10, 30, 100, 300, 500 and 1000 mA,
- » function of automatic measurement of all RCD parameters (after pressing the "START" button once, the meter performs the entire defined cycle of measurements, including the capability of earth fault loop impedance measurement with 15 mA current),
- » shape of the input leakage current selected by the user: sinusoidal (start from rising or falling edge), unidirectional pulsating (positive or negative), unidirectional pulsating with direct current offset (positive or negative), constant (positive or negative),
- » measurement of tripping current  $I_{\Delta}$  with rising current,
- » measurement of tripping time  $t_A$  for currents:  $0.5I_{\Delta n}$ ,  $I_{\Delta n}$ ,  $2I_{\Delta n}$  and  $5I_{\Delta n}$ ,
- » measurement of touch voltage  $U_B$  and protective conductor resistance  $R_E$  without tripping the RCD,
- » detection of L and N phase swapping in a socket; does not affect measurements,
- » capability of measuring tripping current  $I_{\Delta}$  as well as actual tripping time  $t_{\Delta}$  with just one RCD trip,
- » voltage measurements within the range of 95...270 V.

### Measurement of insulation resistance:

- » measurement voltages: 50 V, 100 V, 250 V, 500 V, 1000 V and 2500 V,
- » measurement of insulation resistance up to 10 G $\Omega$ ,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » measurement of 2 absorption coefficients (DAR, PI or Ab1, Ab2)
- » timing of T1, T2, T3 within the range of 1...600 s,
- » meter protected against the presence of voltage on the object and the appearance of voltage during measurement,
- » automatic discharge of the measured object's capacitance after completion of measurement,
- » automatic measurement of all resistance combinations of 3-, 4- and 5-core cords and power cords by means of the optional AutoISO-2500 adapter.

### Earth resistance measurements:

- » measurement according to 3- or 4-lead technical method with 2 auxiliary electrodes,
- » internal power source with frequency appropriate for 50 Hz or 60 Hz power network (selected in the meter).

### Standard accessories of the meter:

WS-03 adapter for triggering measurement (UNI-Schuko plug)	WAADAWS03
NiMH accumulator 4.8 V 4.2 Ah	WAAKU07
L-2 carrying case	WAFUTL2
black "crocodile" clip 11 kV 32 A	WAKROBL32K09
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
Sonei Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
shielded test lead with banana plugs; 5 kV; 1.8 m; black	WAPRZ1X8BLBB
test lead with banana plugs; 5 kV; 1.8 m; red	WAPRZ1X8REBB
earthing measurement test lead with banana plugs on reel; 15 m; blue	WAPRZ015BUBBSZ
earthing measurement test lead with banana plugs on reel; 30 m; red	WAPRZ030REBBSZ
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
2x earth test pin probe (30 cm)	WASONG30
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 5 kV; red	WASONREOGB2
test probe with banana socket; 1 kV; blue	WASONBUOGB1
test probe with banana socket; 1 kV; yellow	WASONYEGB1
meter strap (type L-2)	WAPRZSZEKPL
meter power adapter (type Z7)	WAZASZ7
calibration certificate	



The MPI-525 meter is one of the few multi-function meters capable of measuring insulation resistance with 2500 V voltage.

### Low-voltage resistance measurement of protective conductors and equipotential bonding:

- » measurement of protective conductor continuity with current  $\geq 200$  mA in two directions (according to standard EN 61557-4),
- » low-current measurement with sound and light signaling,
- » automatic calibration of test leads - leads of any length can be used.

### Additional functions of the meter:

- » Quick check of correct connection of PE conductor by means of contact electrode,
- » Check of phase sequence,
- » Memory storing up to 990 records (57,500 individual results), data transmission to PC via USB or radio,
- » Power supply from accumulator or battery (optional), built-in quick charger,
- » Real-time clock (RTC) - time of measurement saved to memory.



MPI-525 enables measurements in sockets with swapped L and N conductors.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » power supply of the meter ... Ni-MH accumulator or LR14 alkaline batteries (4 pcs. - optional)
- » operating temperature range ..... 0...+50 °C



## Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$

Measurement with 23 / 40 A current - measuring range according to EN 61557-3: **0.13...1999  $\Omega$**  (for 1.2 m test lead):

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...1999 $\Omega$	1 $\Omega$	

Nominal voltage: 95...270 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 95...440 V (for  $Z_{L-L}$ )

Frequency: 45...65 Hz

## Measurement of the $Z_{L-PE}$ fault loop impedance in the **RCD** mode

Measurement with 15 mA current, measuring range according to EN 61557-3: **0.50...1999  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(6\% \text{ m.v.} + 10 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	$\pm(6\% \text{ m.v.} + 5 \text{ digits})$
200...1999 $\Omega$	1 $\Omega$	

Rated voltage: 95...270 V

Frequency: 45...65 Hz

## Earth resistance $R_E$ measurement

Measuring range according to EN 61557-5:

**0.50  $\Omega$ ...1.99 k $\Omega$**  for 50 V measurement voltage

**0.56  $\Omega$ ...1.99 k $\Omega$**  for 25 V measurement voltage

Display range	Resolution	Accuracy
0.00...9.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 4 \text{ digits})$
10.0...99.9 $\Omega$	0.1 $\Omega$	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
100...999 $\Omega$	1 $\Omega$	
1.00...1.99 k $\Omega$	0.01 k $\Omega$	

## Measurement of insulation resistance

Measuring range according to EN 61557-2:

for  $U_n = 50 \text{ V}$ : **50 k $\Omega$ ...250 M $\Omega$**

for  $U_n = 100 \text{ V}$ : **100 k $\Omega$ ...500 M $\Omega$**

for  $U_n = 250 \text{ V}$ : **250 k $\Omega$ ...1 G $\Omega$**

for  $U_n = 500 \text{ V}$ : **500 k $\Omega$ ...2 G $\Omega$**

for  $U_n = 1000 \text{ V}$ : **1 M $\Omega$ ...3 G $\Omega$**

for  $U_n = 2500 \text{ V}$ : **2.5 M $\Omega$ ...9.99 G $\Omega$**

Display range *)	Resolution	Accuracy
0...1999 k $\Omega$	1 k $\Omega$	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
2.00...19.99 M $\Omega$	0.01 M $\Omega$	
20.0...199.9 M $\Omega$	0.1 M $\Omega$	
200...999 M $\Omega$	1 M $\Omega$	
1.00...9.99 G $\Omega$	0.01 G $\Omega$	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$

\*\*) no greater than the measuring range for a given voltage.



The MPI-525 meter enables automatic insulation resistance measurement of cables and 3-, 4- and 5-core cords by means of the optional AutoISO-2500 adapter.

## Indication of phase sequence

- » Indication of phase sequence: compliant, non-compliant
- »  $U_{L-L}$  power system voltage range: 95...500 V (45...65 Hz)
- » Display of phase-to-phase voltage values

## Low-voltage measurement of circuit continuity and resistance

Testing of protective conductor continuity with  $\pm 200 \text{ mA}$  current measuring range according to EN 61557-4: **0.12...400  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...400 $\Omega$	1 $\Omega$	

- » Voltage on open terminals: 4...9 V
- » Output current at  $R < 2 \Omega$ : min. 200 mA
- » Automatic calibration of test leads
- » Measurements for both current polarities



The MPI-525 meter is one of the few meters capable of accurately measuring fault loop impedance, including in L-PE loops, in networks equipped with residual current devices (measurement with 15 mA current).

## Measurements of RCD parameters (working voltage range 95...270 V):

**RCD trip test and measurement of tripping time  $t_A$  (for  $t_A$  measurement function)**

RCD mode	Factor	Range	Resolution	Accuracy		
General and short-time delay	$0.5 \cdot I_{\Delta n}$	0...300 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$  (for RCD of $I_{\Delta n} = 10\text{mA}$ and the measurement error: $0.5 \cdot I_{\Delta n}$ error: $\pm(2\% \text{ m.v.} + 3 \text{ digits})$ )		
	$1 \cdot I_{\Delta n}$					
	$2 \cdot I_{\Delta n}$	0...150 ms				
Selective	$5 \cdot I_{\Delta n}$	0...40 ms				
	$0.5 \cdot I_{\Delta n}$	0...500 ms				
	$1 \cdot I_{\Delta n}$					
	$2 \cdot I_{\Delta n}$					
		$5 \cdot I_{\Delta n}$			0...150 ms	

Residual current input accuracy: for  $0.5 \cdot I_{\Delta n}$  -8...0% for  $1 \cdot I_{\Delta n}$ ,  $2 \cdot I_{\Delta n}$ ,  $5 \cdot I_{\Delta n}$  0...8%

## Measurement of RCD trip current $I_A$ for sinusoidal residual current (AC type)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	$0.3 \times I_{\Delta n} \dots 1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
30 mA	9.0...30.0 mA			
100 mA	33...100 mA	1 mA		
300 mA	90...300 mA			
500 mA	150...500 mA			
1000 mA	330...1000 mA			

Measurement can be started from the positive or negative half-period of the input leakage current (AC)

## Measurement of RCD trip current $I_A$ for uni-directional residual current and uni-directional current with 6 mA direct current offset (type A, F)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.5...20.0 mA	0.1 mA	$0.35 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	10.5...42.0 mA			
100 mA	35...140 mA			
300 mA	105...420 mA	1 mA		
500 mA	175...700 mA			

Measurement can be started from a positive or negative half-period of the input leakage current

## Measurement of RCD trip current $I_A$ for residual direct current (type B, B+)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	2.0...20.0 mA	0.1 mA	$0.35 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	6...60 mA	1 mA		
100 mA	20...200 mA			
300 mA	60...600 mA			
500 mA	100...1000 mA			

Measurement is possible for both a positive or negative input leakage current  $I_{\Delta n}$  - nominal value of residual current

"m.v." = "measured value"



The MPI-525 meter enables measurement of the actual tripping time and trip current of an RCD with just one trip.

## The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

## SONEL MPI-520 / MPI-520 Start

index: WMGBMPI520 (MPI-520) / WMGBMPI520S (MPI-520 Start)



CAT III

CAT IV

IP 54

600V

300V

### Fault loop impedance measurements:

- » impedance measurement with 23 A current (40 A for phase-to-phase voltage),
- » fault current-limiting resistor: 10  $\Omega$ ,
- » range of measurement voltages: 95...440 V, frequencies 45...65 Hz,
- » fault loop impedance measurement with resolution up to 0.01  $\Omega$  in systems protected with RCDs not tripping at  $I_{\Delta n} \geq 30$  mA,
- » automatic fault current calculation; differentiation of phase and phase-to-phase voltage,
- » measurements using UNI-Schuko plug with measurement triggering button (including for swapped L and N leads) or 1.2 m, 5 m, 10 m or 20 m test leads, with optional use of three-phase socket adapters (AGT).

### Testing of AC, A, F, B and B+ residual current devices:

- » measurement of general, short-time delay and selective RCDs with rated residual currents of 10, 30, 100, 300, 500 and 1000 mA,
- » function of automatic measurement of all RCD parameters (after pressing the "START" button once, the meter performs the entire defined cycle of measurements, including the capability of earth fault loop impedance measurement with 15 mA current),
- » shape of the input leakage current selected by the user: sinusoidal (start from rising or falling edge), unidirectional pulsating (positive or negative), unidirectional pulsating with direct current offset (positive or negative), constant (positive or negative),
- » measurement of tripping current  $I_{\Delta}$  with rising current,
- » measurement of tripping time  $t_A$  for currents:  $0.5xI_{\Delta n}$ ,  $I_{\Delta n}$ ,  $2xI_{\Delta n}$  and  $5xI_{\Delta n}$ ,
- » measurement of touch voltage  $U_b$  and protective conductor resistance  $R_E$  without tripping the RCD,
- » detection of L and N phase swapping in a socket; does not affect measurements,
- » capability of measuring tripping current  $I_{\Delta}$  as well as actual tripping time  $t_A$  with just one RCD trip,
- » voltage measurements within the range of 95...270 V.

### Measurement of insulation resistance:

- » measurement voltages: 50 V, 100 V, 250 V, 500 V, 1000 V,
- » measurement of insulation resistance up to 3 G $\Omega$ ,
- » capability of in-socket measurement by means of UNI-Schuko adapter,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » meter protected against the presence of voltage on the object and the appearance of voltage during measurement,
- » automatic discharge of the measured object's capacitance after completion of measurement,
- » automatic measurement of all resistance combinations of 3-, 4- and 5-core cords by means of the optional AutoISO-1000C adapter.

### Earth resistance measurements:

- » measurement according to 3- or 4-lead technical method with 2 auxiliary electrodes,
- » internal power source with frequency appropriate for 50 Hz or 60 Hz power network (selected in the meter).

### Standard accessories of the meter:

WS-03 adapter for triggering measurement (UNI-Schuko plug)	WAADAWS03
L-2 carrying case	WAFUTL2
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
battery container	WAPQJ1
Sonei Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
earthing measurement test lead with banana plugs on reel; 15 m; blue (MPI-520)	WAPRZ015BUBBSZ
earthing measurement test lead with banana plugs on reel; 30 m; red (MPI-520)	WAPRZ030REBBSZ
USB data transmission cable	WAPRZUSB
2x earth contact test probe (30 cm) (MPI-520)	WASONG30
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
test probe with banana socket; 1 kV; yellow	WASONYEOGB1
meter strap (type L-2)	WAP0ZSZEKPL
calibration certificate	



The MPI-520 and MPI-520 Start meters enable automatic insulation resistance measurement of 3-, 4- and 5-core cords by means of the optional AutoISO-1000C adapter.

### Low-voltage resistance measurement of protective conductors and equipotential bonding:

- » measurement of protective conductor continuity with current  $\geq 200$  mA in two directions (according to standard EN 61557-4),
- » low-current measurement with sound signaling,
- » automatic calibration of test leads - leads of any length can be used.

### Additional functions of the meters:

- » measurement of voltage, frequency and - additionally with a clamp - alternating current,  $\cos\phi$  and power (active, reactive, apparent).
- » quick check of correct connection of PE conductor by means of contact electrode.
- » check of phase sequence.
- » memory storing up to 990 records (57,500 individual results), data transmission to PC via USB or bluetooth.
- » power supply from batteries or accumulator (optional), built-in quick charger.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » power supply of the meter ..... alkaline batteries (4 pcs.) or ..... Ni-MH accumulator (optional)
- » operating temperature range ..... 0...+50  $^{\circ}\text{C}$



MPI-520 and MPI-520 Start enable measurements in sockets with swapped L and N conductors.



### Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$

Measurement with 23/40 A current - measuring range according to EN 61557-3: **0.13...1999  $\Omega$**  (for 1.2 m test lead):

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...1999 $\Omega$	1 $\Omega$	

Nominal voltage: 95...270 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 95...440 V (for  $Z_{L-L}$ )  
Frequency: 45...65 Hz

### Measurement of the $Z_{L-PE}$ fault loop impedance in the [RCD] mode

Measurement with 15 mA current, measuring range according to EN 61557-3: **0.50...1999  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(6\% \text{ m.v.} + 10 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	$\pm(6\% \text{ m.v.} + 5 \text{ digits})$
200...1999 $\Omega$	1 $\Omega$	

Rated voltage: 95...270 V  
Frequency: 45...65 Hz

### Earth resistance $R_E$ measurement

Measuring range according to EN 61557-5:

**0.50  $\Omega$ ...1.99 k $\Omega$**  for 50 V measurement voltage

**0.56  $\Omega$ ...1.99 k $\Omega$**  for 25 V measurement voltage

Display range	Resolution	Accuracy
0.00...9.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 4 \text{ digits})$
10.0...99.9 $\Omega$	0.1 $\Omega$	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
100...999 $\Omega$	1 $\Omega$	
1.00...1.99 k $\Omega$	0.01 k $\Omega$	

### Measurement of insulation resistance

Measuring range according to EN 61557-2:

for  $U_n = 50$  V: **50 k $\Omega$ ...250 M $\Omega$**

for  $U_n = 500$  V: **500 k $\Omega$ ...2 G $\Omega$**

for  $U_n = 100$  V: **100 k $\Omega$ ...500 M $\Omega$**

for  $U_n = 1000$  V: **1 M $\Omega$ ...3 G $\Omega$**

for  $U_n = 250$  V: **250 k $\Omega$ ...1 G $\Omega$**

Display range *	Resolution	Accuracy
0...1999 k $\Omega$	1 k $\Omega$	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
2.00...19.99 M $\Omega$	0.01 k $\Omega$	
20.0...199.9 M $\Omega$	0.1 k $\Omega$	
200...999 M $\Omega$	1 k $\Omega$	
1.00...3.00 G $\Omega$	0.01 G $\Omega$	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$

\*\*) no greater than the measuring range for a given voltage.

\*\*) an additional error of  $\pm 2\%$  is present in measurements when the UNI-Schuko plug is used.

### Low-voltage measurement of circuit continuity and resistance

Testing of protective conductor continuity with  $\pm 200$  mA current  
measuring range according to EN 61557-4: **0.12...400  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...400 $\Omega$	1 $\Omega$	

- » Voltage on open terminals: 4...9 V
- » Output current at  $R < 2 \Omega$ : min. 200 mA
- » Automatic calibration of test leads
- » Measurements for both current polarities

### Indication of phase sequence

- » Indication of phase sequence: compliant, non-compliant
- »  $U_{L-L}$  power system voltage range: 95...500 V (45...65 Hz)
- » Display of phase-to-phase voltage values

### Measurement of alternating voltage and current, $\cos\phi$ and power

- » Power measurement P, Q, S: 0...200k (W, var, VA).
- » Measurement of alternating current (True RMS) using clamp (0...400 A), max. resolution 0.1 mA
- » Measurement of voltage  $U_{L-N}$ : 0...500 V
- » Frequency range of measured voltages: 45.0...65.0 Hz
- » Frequency measurement for voltages 50...500 V within the range of 45.0...65.0 Hz (Accuracy to a maximum of  $\pm 0.1\% \text{ m.v.} + 1 \text{ digit}$ )
- »  $\cos\phi$  measurement: 0.00...1.00 (resolution 0.01)

### Measurements of RCD parameters (working voltage range 95...270 V):

**RCD trip test and measurement of tripping time  $t_A$**  (for  $t_A$  measurement function)

RCD mode	Factor	Range	Resolution	Accuracy	
General and short-time delay	$0.5 \cdot I_{\Delta n}$	0...300 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$	
	$1 \cdot I_{\Delta n}$				
	$2 \cdot I_{\Delta n}$	0...150 ms			
	$5 \cdot I_{\Delta n}$	0...40 ms			
Selective	$0.5 \cdot I_{\Delta n}$	0...500 ms		(for RCD of $I_{\Delta n} = 10\text{mA}$ and the measurement $0.5 \cdot I_{\Delta n}$ error: $\pm(2\% \text{ m.v.} + 3 \text{ digits})$ )	
	$1 \cdot I_{\Delta n}$				
	$2 \cdot I_{\Delta n}$	0...200 ms			
	$5 \cdot I_{\Delta n}$	0...150 ms			

Residual current input accuracy: for  $0.5 * I_{\Delta n}$  -8...0% for  $1 * I_{\Delta n}$ ,  $2 * I_{\Delta n}$ ,  $5 * I_{\Delta n}$  0...8%

**Measurement of RCD trip current  $I_A$  for sinusoidal residual current** (AC type)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	$0.3 \times I_{\Delta n} \dots 1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
30 mA	9.0...30.0 mA			
100 mA	33...100 mA	1 mA		
300 mA	90...300 mA			
500 mA	150...500 mA			
1000 mA	330...1000 mA			

Measurement can be started from the positive or negative half-period of the input leakage current (AC)

**Measurement of RCD trip current  $I_A$  for uni-directional residual current and uni-directional current with 6mA direct current offset** (type A, F)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.5...20.0 mA	0.1 mA	0.35 x IΔn ...2.0 x IΔn	± 10% IΔn
30 mA	10.5...42.0 mA			
100 mA	35...140 mA	1 mA		
300 mA	105...420 mA			
500 mA	175...700 mA			

Measurement can be started from a positive or negative half-period of the input leakage current

**Measurement of RCD trip current  $I_A$  for residual direct current** (type B, B+)

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	2.0...20.0 mA	0.1 mA	0.2 x I <sub>Δn</sub> ...2.0 x I <sub>Δn</sub>	±10% I <sub>Δn</sub>
30 mA	6...60 mA	1 mA		
100 mA	20...200 mA			
300 mA	60...600 mA			
500 mA	100...1000 mA			

Measurement is possible for both a positive or negative input leakage current  
 $I_{\Delta n}$  - nominal value of residual current

"m.v." = "measured value"



The MPI-520 and MPI-520 Start meters enable measurement of the actual tripping time and trip current of an RCD with just one trip.

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



The MPI-520 and MPI-520 Start meters are two of the few meters capable of accurately measuring fault loop impedance, including in L-PE loops, in networks equipped with residual current devices (measurement with 15 mA current).

## SONEL MPI-505

index: WMGBMPI505

**CAT III**  
**600V**

**CAT IV**  
**300V**

**IP 54**



### Measurement of fault loop parameters:

- » measurements of fault loop parameters in networks with rated voltages: 115/200 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V and frequencies of 45...65 Hz,
- » **measurement of fault loop impedance with current 15 mA with the resolution of 0.01Ω, without tripping residual current devices.**

### Testing of AC and A residual current devices:

- » measurement of general and selective residual current devices with nominal residual currents of 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA,
- » measurement of tripping current  $I_{\Delta r}$ ,
- » measurement of the  $t_A$  tripping time for  $1/2I_{\Delta n}$ ,  $I_{\Delta n}$ ,  $2I_{\Delta n}$ ,  $5I_{\Delta n}$ ,
- » measurement of earthing continuity and touch voltage without tripping RCDs,
- » function of automatic measurement of residual current device parameters.

### Measurement of insulation resistance:

- » four insulation resistance measurement voltages: 100 V, 250 V, 500 V and 1000 V.

### Low-voltage resistance measurement of protective conductors and equipotential bonding:

- » measurement of protective conductor continuity with current >200 mA in two directions (according to standard EN 61557),
- » compensation of test lead resistance - any leads can be used,
- » low-current resistance measurement with sound signaling.

### Additional functions of the meters:

- » Quick check of correct connection of PE conductor by means of contact electrode.
- » Alternating voltage measurement.
- » Indication of phase sequence.
- » Memory storing up to 990 results, data transmission to computer via USB interface.

### Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$

Measurement with 23/40 A current - measuring range according to EN 61557-3: **0.13...1999 Ω** (for 1.2 m lead):

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(5% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	
200...1999 Ω	1 Ω	

Nominal operating voltage  $U_{nL-N}$  /  $U_{nL-L}$ : 115/200 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V

Operating voltage range: 100...264 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 100...440 V (for  $Z_{L-L}$ )

Operating frequency range: 45...65 Hz Max. measurement current: 23 A at 230 V (10 ms), 40 A at 400 V (10 ms),

### Measurement of the $Z_{L-PE}$ fault loop impedance in the **RCD** mode

Measuring range according to EN 61557-3: **0.5...1999 Ω**

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(6% m.v. + 10 digits)
20.0...199.9 Ω	0.1 Ω	
200...1999 Ω	1 Ω	±(6% m.v. + 5 digits)

### Standard accessories of the meter:

WS-01 adapter for triggering measurement (UNI-Schuko plug)	WAADAWS01
L-4 carrying case	WAFUTL4
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
Sonei Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
USB data transmission cable	WAPRZUSB
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
test probe with banana socket; 1 kV; yellow	WASONYEOGB1
meter strap (type L-1)	WAPOZSZE2
calibration certificate	

### Measurements of RCD parameters (working voltage range 100...264 V):

RCD trip test and measurement of tripping time  $t_A$  (for  $t_A$  measurement function)

RCD mode	Factor	Range	Resolution	Accuracy
General and short-time delay	$0.5 \cdot I_{\Delta n}$	0...300 ms	1 ms	±(2% m.v. + 2 digits)
	$1 \cdot I_{\Delta n}$			
	$2 \cdot I_{\Delta n}$	0...150 ms		
	$5 \cdot I_{\Delta n}$	0...40 ms		
Selective	$0.5 \cdot I_{\Delta n}$	0...500 ms	1 ms	±(2% m.v. + 2 digits)
	$1 \cdot I_{\Delta n}$			
	$2 \cdot I_{\Delta n}$	0...200 ms		
	$5 \cdot I_{\Delta n}$	0...150 ms		

\* - for  $I_{\Delta n} = 10 \text{ mA}$  and  $0.5 I_{\Delta n}$ , accuracy to + 2% m.v. ± 3 digits

### Measurement of RCD trip current $I_{\Delta r}$ for sinusoidal residual current

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	0.3 x I <sub>Δn</sub> ...1.0 x I <sub>Δn</sub>	±5% I <sub>Δn</sub>
30 mA	9.0...30.0 mA			
100 mA	33...100 mA	1 mA		
300 mA	90...300 mA			
500 mA	150...500 mA			
1000 mA	330...1000 mA			

- » Measurement can be started from the positive or negative half-period of the input leakage current (AC)

### Measurement of RCD trip current $I_{\Delta r}$ for uni-directional pulsating residual current

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	4.0...20.0 mA	0.1 mA	$0.35 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	12.0...42.0 mA			
100 mA	40...140 mA			
300 mA	120...420 mA	1 mA		
500 mA	200...700 mA			

- » Measurement for positive or negative half-periods of the input leakage current
- » Max. measurement current flow time 3200 ms

### Measurement of insulation resistance

Measuring range according to EN 61557-2:

for  $U_n = 100 \text{ V}$ : 100 kΩ...500 MΩ for  $U_n = 500 \text{ V}$ : 500 kΩ...2 GΩ  
for  $U_n = 250 \text{ V}$ : 250 kΩ...1 GΩ for  $U_n = 1000 \text{ V}$ : 1 MΩ...3 GΩ

Display range *	Resolution	Accuracy
0...1999 kΩ	1 kΩ	±(3% m.v. + 8 digits)
2.00...19.99 MΩ	0.01 kΩ	
20.0...199.9 MΩ	0.1 kΩ	
200...1999 GΩ	1 kΩ	
2.00...3.00 GΩ	0.01 GΩ	±(4% m.v. + 6 digits)

\*\* no greater than the measuring range for a given voltage.

- » Voltage detection before measurement
- » Discharging of measured object after measurement

## SONEL MPI-502

index: WMGBMPI502



CAT III

600V

CAT IV

300V

IP 67

BLUETOOTH



MPI-502 is the smallest multi-function meter on the market.

### Measurement of fault loop parameters:

- » fault loop impedance measurement in networks with rated voltages: 220/380 V, 230/400 V, 240/415 V with frequencies of 45...65 Hz, operating voltage range: 180...460 V,
- » readings of fault loop resistance  $R$  and fault loop reactance  $X$ ,
- » measurement of fault loop impedance with 15 mA current without tripping residual current devices,
- » maximum measurement current: 7.6 A (at 230 V), 13.3 A (at 400 V).

### Testing of AC and A residual current devices:

- » measurement of no-delay, short-time delay and selective RCDs with nominal residual currents of 10, 30, 100, 300 and 500 mA,
- » measurement of trip current  $I_{\Delta n}$  and tripping time  $t_A$  for currents of  $0.5 I_{\Delta n}$ ,  $I_{\Delta n}$ ,  $2 \times I_{\Delta n}$ ,  $5 \times I_{\Delta n}$ ,
- » measurement of  $R_e$  and  $U_e$  without RCD tripping,
- » expanded AUTO function for RCD measurement, with capability of measuring  $Z_{L-PE}$  with low current,
- » measurement of  $I_A$  and  $t_A$  in one RCD trip.

### Resistance measurement of protective conductors and equipotential bonding:

- » testing of the continuity of protective conductors with current  $\pm 200$  mA according to standard EN 61557-4,
- » automatic calibration of test leads - any leads can be used,
- » low-current resistance measurement with sound signaling.

### Additional functions of the meter:

- » Detection of L and N phase swapping in a socket and automatic unswapping.
- » Check of correct connection of PE conductor by means of contact electrode.
- » Measurement of network voltage (0...500 V) and frequency.
- » Power supply from LR6 batteries, NiMH accumulators can optionally be applied.
- » Memory storing up to 990 results, wireless data transmission to computer.
- » Backlit keyboard.

### The MPI-505 and MPI-502 instruments meet the requirements set forth in standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



MPI-502 enables measurements in sockets with swapped L and N conductors.

### Standard accessories of the meter:

WS-05 adapter (UNI-Schuko angle plug)	WAADAWS05
M-6 carrying case	WAFUTM6
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
Sonei Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
meter strap (type M-1)	WAPOZSZE4
M-1 housing holder - hanger	WAPOZUCH1
Sonei MIC Mobile	
Sonei Reader software	WAPROREADER
calibration certificate	

### Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$

Measurement with 7.6/13.3 A current - measuring range according to EN 61557-3: **0.13...1999  $\Omega$** 

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...1999 $\Omega$	1 $\Omega$	

### Measurement of earth fault loop impedance $Z_{L-PE}$ in RCD mode

Measurement with 15mA current, measuring range according to EN 61557-3: **0.51...1999  $\Omega$** 

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(6\% \text{ m.v.} + 10 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...1999 $\Omega$	1 $\Omega$	$\pm(6\% \text{ m.v.} + 5 \text{ digits})$

### Measurements of RCD parameters (operating voltage range 180...270 V):

RCD trip test and measurement of tripping time  $t_A$  (for  $t_A$  measurement function)

RCD mode	Factor	Range	Resolution	Accuracy
General and short-time delay	$0.5 * I_{\Delta n}$	0...300 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$
	$1 * I_{\Delta n}$			
	$2 * I_{\Delta n}$	0...150 ms		
	$5 * I_{\Delta n}$	0...40 ms		
Selective	$0.5 * I_{\Delta n}$	0...500 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$
	$1 * I_{\Delta n}$			
	$2 * I_{\Delta n}$	0...200 ms		
	$5 * I_{\Delta n}$	0...150 ms		

### Measurement of RCD trip current $I_{\Delta}$ for sinusoidal residual current

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	$0.3 \times I_{\Delta n} \dots 1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
30 mA	9.0...30.0 mA			
100 mA	33...100 mA	1 mA		
300 mA	90...300 mA			
500 mA	150...500 mA			
1000 mA	330...1000 mA			

- » Measurement can be started from the positive or negative half-period of the input current

### Measurement of RCD trip current $I_{\Delta}$ for uni-directional pulsating residual current

Nominal current	Measuring range	Resolution	Measurement current	Accuracy	
10 mA	4.0...20.0 mA	0.1 mA	$0.35 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$	
30 mA	12.0...42.0 mA				
100 mA	40...140 mA	1 mA	$0.35 \times I_{\Delta n} \dots 1.4 \times I_{\Delta n}$		
300 mA	120...420 mA				

- » Measurement for positive or negative half-periods of the input leakage current



## Comparison of multi-function meters



	MPI-502	MPI-505	MPI-520 / 520 Start	MPI-525	MPI-530 / MPI-530-IT
<b>Fault loop impedance measurement [Ω]</b>	0...1999	0...1999	0...1999	0...1999	0...1999
Fault loop impedance resolution [Ω]	0.01	0.01	0.01	0.01	0.001
Measurement voltages [V]	180...460	100...440	95...440	95...440	95...440
Resolution of fault loop impedance measurement without RCD tripping [Ω]	0.01	0.01	0.01	0.01	0.01
Calculation of fault current according to rated voltage	YES	YES	YES	YES	YES
Calculation of fault current according to measured voltage	—	—	YES	YES	YES
Residual current device measurements	AC, A <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	AC, A <input type="checkbox"/> <input checked="" type="checkbox"/>	AC, A, F, B, B+ <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	AC, A, F, B, B+ <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	AC, A, F, B, B+ <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
Automatic measurement of the full set of parameters	YES	YES	YES	YES	YES
Measurement of tripping current $I_A$ with rising current	10, 30, 100, 300, 500	10, 30, 100, 300, 500, 1000	10, 30, 100, 300, 500, 1000	10, 30, 100, 300, 500, 1000	10, 30, 100, 300, 500, 1000
Simultaneous measurement of $I_A$ and $t_A$ in one RCD trip	YES	YES	YES	YES	YES
Measurement of tripping time for factor of rated current	1/2, 1, 2, 5	1/2, 1, 2, 5	1/2, 1, 2, 5	1/2, 1, 2, 5	1/2, 1, 2, 5
Measurement of touch voltage $U_b$	YES	YES	YES	YES	YES
Detection of L and N swapping	YES	YES	YES	YES	YES
<b>Measurement of insulation resistance</b>	—	YES	YES	YES	YES
Measurement voltages [V]	—	100, 250, 500, 1000	50, 100, 250, 500, 1000	50, 100, 250, 500, 1000, 2500	50, 100, 250, 500, 1000
Measuring range [Ω]	—	3G	3G	10G	10G
Automatic in-socket measurement	—	—	YES	—	YES
Protection against appearance of voltage	—	YES	YES	YES	YES
Automatic discharging of object after measurement	—	YES	YES	YES	YES
Automatic measurement of multi-core cords with AutoISO adapter	—	—	YES	YES	YES
Automatic measurement of multi-core cables with AutoISO adapter	—	—	—	YES	—
Sound signaling of time intervals for characteristics	—	YES	YES	YES	YES
Calculation of absorption coefficients	—	—	—	YES	—
<b>Continuity testing with current <math>\geq 200mA</math></b>	YES	YES	YES	YES	YES
<b>Low-voltage resistance measurement</b>	YES	YES	YES	YES	YES
3-lead earth resistance measurement	—	—	YES	YES	YES
Earth resistance measurement 3-lead / 4-lead / 3-lead + clamp / double-clamp	—	—	—	—	YES
Capability of setting limit for every function	—	—	—	—	YES
<b>Quick check of PE connection</b>	YES	YES	YES	YES	YES
<b>Voltage measurement [V]</b>	0...500	0...440	0...500	0...500	0...500
<b>Frequency measurement [Hz]</b>	YES	—	YES	YES	YES
<b>Alternating current measurement [A]</b>	—	—	optionally 0...400	—	optionally 0...3000
<b>Power and <math>\cos\varphi</math> measurement</b>	—	—	YES	—	YES
<b>Measurement of U harmonics: I up to the 40th</b>	—	—	—	—	YES
<b>THD measurement for U and I</b>	—	—	—	—	YES
<b>Phase sequence check [V]</b>	—	100...440	95...500	95...500	95...500
<b>Memory (records)</b>	990	990	990	990	10,000 for every measurement type
<b>Power supply</b>	batteries / accumulators	batteries / accumulators	batteries / accumulators	accumulators / batteries	accumulators / batteries
<b>Built-in quick charger</b>	—	—	YES	YES	YES
<b>Data transmission</b>	Bluetooth	USB	USB, Bluetooth	USB, Bluetooth	USB, Bluetooth
<b>Dimensions [mm]</b>	220x98x58	260x190x60	288x223x75	288x223x75	288x223x75
<b>Weight [kg]</b>	1	2.1	2.2	2.2	2.2

## SONEL MIC-10k1 / MIC-5050

index: WMGBMIC10K1 / WMGBMIC5050

CAT III

1000V

CAT IV

600V

PN-EN

61557-2

 BLUETOOTH


MEASUREMENT  
OF INSULATION  
RESISTANCE UP  
TO **40TΩ**  
MIC-10K1

### Measurement of insulation resistance:

- up to 40 TΩ for MIC-10k1
- up to 20 TΩ for MIC-5050,
- » measurement voltages selected within the range of:
  - 50...5000 V for MIC-5050 (50...1000 V with step of 10 V, 1...5 kV with step of 25 V)
  - 50...10000 V for MIC-10k1 (50...1000 V with step of 10 V, 1...10 kV with step of 25 V),
- » continuous reading of measured insulation resistance and leakage current,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » measurement time setting - up to 99'59",
- » timing of measurement times T1, T2 and T3 for measurement of one or two absorption coefficients, within the range of 1...600 s,
- » measurement of absorption coefficients Ab1, Ab2, DAR, PI,
- » reading of actual measurement voltage during measurement,
- » measurement current 1.2 mA, 3 mA or 6 mA,
- » two- or three-lead method of insulation resistance measurement,
- » measurements with lead lengths up to 55 m,
- » protection against measurement of live object,
- » supports AutoISO-5000 (for MIC-10k1 at voltage up to 5 kV),
- » capacitance measurement during measurement of  $R_{ISO}$ ,
- » temperature measurement (with the use of the optional WASONT1 probe),
- » measurement with stepped voltage (SV),
- » dielectric discharge (DD) test,
- » damage location (burning function),
- » digital filters for measurements under strong disturbances (10 s, 100 s, 200 s).

### Additional functions of the meters:

- » high immunity to disturbances - in compliance with standard EN-61326,
- » stable measurement in 765 kV substations (optional - only MIC-10s1),
- » measurement of leakage current during insulation resistance measurement,
- » measurement of direct and alternating voltages within the range of 0...750 V,
- » charts plotted on display during measurements,
- » memory storing up to 10,000 results of each type of measurement, including descriptions of measurement points, objects, client names,
- » data transmission to PC via USB connection, Bluetooth® or capability of data transfer via pendrives,
- » supports external wireless Bluetooth® keyboard (optional),
- » easy-to-read, backlit 5.6" LCD graphic display,
- » backlit keyboard,
- » power supply from accumulator (rechargeable battery) packs or power grid,
- » charging during measurement.



The MIC-10k1 and MIC-5050 meters have the function of plotting charts of insulation resistance and leakage current. This chart is displayed in real time during measurement.

### Standard accessories of the meters:

L-4 carrying case	WAFUTL4
black "crocodile" clip 11 kV 32 A	WAKROBL32K09
red "crocodile" clip 11 kV 32 A	WAKRORE32K09
blue "crocodile" clip 11 kV 32 A	WAKROBU32K09
Sonel Reader software	WAPROREADER
shielded test lead with banana plugs; 11 kV; 3 m; black	WAPRZ003BLBBE10K
test lead with banana plugs; 11 kV; 3 m; red	WAPRZ003REBB10K
test lead with banana plugs; 11 kV; 3 m; blue	WAPRZ003BUBB10K
accumulator charging cable (IEC C13 plug)	WAPRZLAD230IEC
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C13 plug)	WAPRZ1X8BLIEC
ST-1 temperature measurement probe	WASONT1
test probe with banana socket; 11 kV; black	WASONBLOGB11
test probe with banana socket; 11 kV; red	WASONREOGB11
calibration certificate	

### Measurement of insulation resistance

Measuring range in compliance with EN 61557-2:

$$R_{ISOmin} = U_{ISOnom} / I_{ISOmax} \dots 40 \text{ T}\Omega \quad (I_{ISOmax} = 1.2 \text{ mA}, 3 \text{ mA or } 6 \text{ mA})$$

Display range	Resolution	Accuracy
0...999 kΩ	1 kΩ	±(3% m.v. + 10 digits)
1.00...9.99 MΩ	0.01 kΩ	
10.0...99.9 MΩ	0.1 kΩ	
100...999 MΩ	1 kΩ	
1.00...9.99 GΩ	0.01 GΩ	
10.0...99.9 GΩ	0.1 GΩ	±(3.5% m.v. + 10 digits)
100...999 GΩ	1 GΩ	
1.00...9.99 TΩ	0.01 TΩ	±(7.5% m.v. + 10 digits)
10.0...20.0 TΩ	0.1 TΩ	±(12.5% m.v. + 10 digits)
10.0...40.0 TΩ*		

\* - only MIC-10k1

### Measured resistance values depending on measurement voltage

Display range	Measuring range	Measuring range for AutoISO-5000
50 V	200 GΩ	20.0 GΩ
100 V	400 GΩ	40.0 GΩ
250 V	1.00 TΩ	100 GΩ
500 V	2.00 TΩ	200 GΩ
1000 V	4.00 TΩ	400 GΩ
2500 V	10.0 TΩ	400 GΩ
5000 V	20.0 TΩ	400 GΩ
10000 V*	40.0 TΩ	

\* - only MIC-10k1

### Capacitance measurement

Display range	Resolution	Accuracy
1...999 nF	1 nF	±(5% m.v. + 5 digits)
1.00...49.99 μF	0.01 μF	

- » Capacitance measurement result displayed after measurement of  $R_{ISO}$



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### Instruments meet the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

## SONEL MIC-5010 / MIC-5005

index: WMGBMIC5010 / WMGBMIC5005

**CAT III**  
**1000V**

**CAT IV**  
**600V**

**PN-EN**  
**61557-2**



MEASUREMENT  
OF INSULATION  
RESISTANCE UP  
TO **15TΩ**

### Measurement of insulation resistance:

- » measurement voltage selected within the range of 50...1000 V in steps of 10 V, within the range of 1000 V...5000 V in steps of 25 V,
- » continuous reading of measured insulation resistance or leakage current,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » measurement time setting - up to 99'59",
- » timing of measurement times T1, T2 and T3 for measurement of one or two absorption coefficients, within the range of 1...600 s,
- » measurement of absorption coefficients Ab1, Ab2, DAR, PI,
- » reading of actual measurement voltage during measurement,
- » measurement current 1.2 mA or 3 mA,
- » protection against measurement of live objects,
- » two- or three-lead method of insulation resistance measurement,
- » measurements with lead lengths up to 20 m,
- » measurement with stepped voltage (SV),
- » dielectric discharge (DD) test.
- » immunity to disturbances - digital filters for measurements under strong disturbances (10 s, 30 s, 60 s).

### Additional functions of the meters:

- » high immunity to disturbances - in compliance with standard EN-61326,
- » testing of the continuity of protective conductors and equipotential bonding with current >200 mA in compliance with standard EN 61557-4 (MIC-5010),
- » configurable limits of minimum and maximum insulation resistance Rcont (MIC-5010),
- » capacitance measurement during measurement of  $R_{ISO}$ ,
- » measurement of leakage current during insulation resistance measurement,
- » measurement of direct and alternating voltages within the range of 0...600 V,
- » 990-cell memory (11,880 entries) with the capability of wireless data transmission to a PC (via bluetooth or via USB cable),
- » power supply from accumulator packs, built-in quick charger,
- » backlit keyboard (MIC-5010),
- » instruments meet the requirements laid down by standard EN 61557.

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » measurement category ..... CAT IV 600 V (CAT III 1000 V) according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP40 (IP67 with closed housing cover)

### Nominal operating conditions:

- » operating temperature range ..... -20...+50 °C
- » storage temperature ..... -25...+70 °C
- » humidity ..... 20%...80%
- » elevation above sea level ..... ≤2000 m
- » reference temperature ..... +23 °C ± 2 °C
- » reference humidity ..... 40%...60%

### Other technical specifications:

- » power supply of the meter ..... built-in lithium-ion accumulator
- » ..... additionally from power grid for MIC10k1 and MIC-5050: 90 V ÷ 260 V 50/60 Hz
- » weight ..... approx. 7 kg
- » dimensions ..... 390x310x170 mm
- » MIC-10k1 and MIC-5050 display ..... graphic LCD 5.6"
- » MIC-5010 and MIC-5005 display ..... segmented LCD
- » transmission of results MIC-10k1 and MIC-5050 ..... USB link or Bluetooth®
- » transmission of results MIC-5010 and MIC-5005 ..... USB link or wireless

### Standard accessories of the meters:

L-4 carrying case	WAFUTL4
black "crocodile" clip 11 kV 32 A	WAKROBL32K09
red "crocodile" clip 11 kV 32 A	WAKRORE32K09
blue "crocodile" clip 11 kV 32 A	WAKROBU32K09
Sonel Reader software	WAPROREADER
shielded test lead with banana plugs; 11 kV; 1.8 m; black	WAPRZ1X8BLBE10K
test lead with banana plugs; 11 kV; 1.8 m; red	WAPRZ1X8REBB10K
test lead with banana plugs; 11 kV; 1.8 m; blue	WAPRZ1X8BUBB10K
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C13 plug)	WAPRZ1X8BLIEC
test probe with banana socket; 11 kV; black	WASONBLOGB11
test probe with banana socket; 11 kV; red	WASONREOGB11
meter strap (type W-1)	WAPPOZSZE5
Sonel Reader software	
calibration certificate	

### Measurement of insulation resistance

Measuring range in compliance with EN 61557-2:

$$R_{ISOmin} = U_{ISONom} / I_{ISOmax} \dots 15 T\Omega \quad (I_{ISOmax} = 1.2 \text{ mA or } 3 \text{ mA})$$

Display range	Resolution	Accuracy
0...999 kΩ	1 kΩ	±(3% m.v. + 10 digits)
1.00...9.99 MΩ	0.01 kΩ	
10.0...99.9 MΩ	0.1 kΩ	
100...999 MΩ	1 kΩ	
1.00...9.99 GΩ	0.01 GΩ	
10.0...99.9 GΩ	0.1 GΩ	±(3.5% m.v. + 10 digits)
100...999 GΩ	1 GΩ	
1.00...9.99 TΩ	0.01 TΩ	±(7.5% m.v. + 10 digits)
10.0...15.0 TΩ	0.1 TΩ	±(12.5% m.v. + 10 digits)

- » Temperature stability of voltage better than 0.2% / °C



The MIC-10k1, MIC-5050, MIC-5010 and MIC-5005 meters are capable of operating in the presence of very large disturbances at substations and switching stations.

### Maximum measured resistance values depending on measurement voltage

Voltage	Measured resistance
250 V	500 GΩ
500 V	1.00 TΩ
1000 V	2.00 TΩ
2500 V	5.00 TΩ
5000 V	15.0 TΩ

### Test of the continuity of protective conductors and equipotential bonding with current >200 mA (MIC-5010)

Measuring range according to EN 61557-4: 0.10...999 Ω

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	
200...999 Ω	1 Ω	±(4% m.v. + 3 digits)

- » Voltage on open terminals: 4.24 V
- » Output current at  $R < 2 \Omega$ :  $I_{min} > 200 \text{ mA}$  ( $I_{sc}$ : 200...250 mA)
- » Compensation of test lead resistance
- » Current flows in two directions, mean resistance value displayed

### Capacitance measurement

Display range	Resolution	Accuracy
1...999 nF	1 nF	±(5% m.v. + 5 digits)
1.00...49.99 μF	0.01 μF	

- » Capacitance measurement result displayed after measurement of  $R_{ISO}$

"m.v." = "measured value"



## SONEL MIC-5001

index: WMGBMIC5001

**CAT III**  
**1000V**

**CAT IV**  
**600V**

**IP 65**



### Measurement of insulation resistance:

- » measurement voltage selected within the range of 50...500 V with steps of 50 V and from 500 to 5000 V with steps of 100 V,
- » continuous reading of measured insulation resistance or leakage current,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » timing of measurement time  $T_1$ ,  $T_2$  and  $T_3$  for measurement of dielectric absorption ratio (DAR) and polarization index (PI),
- » reading of actual measurement voltage during measurement,
- » protection against measurement of live objects,
- » two- or three-lead method of insulation resistance measurement,
- » insulation resistance measurement according to the RampTest method and breakdown voltage measurement with ramping rate up to ~1 kV/s,
- » measurement of direct and alternating voltages within the range of 0...750 V,
- » 990-cell memory (11,880 entries), data transmission to PC via USB cable,
- » power supplied by accumulator,
- » instruments meet the requirements laid down by standard EN 61557,
- » the meter can be powered and charged from an external power adapter or from a car lighter socket.

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1 and IEC 61557
- » measurement category ..... CAT IV 600 V (CAT III 1000 V) according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP65

### Other technical specifications:

- » power supply of the meter ..... SONEL L-1 NiMH LSD 9.6 V accumulator pack
- » ..... 12 V, 2.5 A external power supply
- » meter weight ..... approx. 0.9 kg
- » dimensions ..... 200 x 180 x 77 mm
- » display ..... segmented LCD
- » memory ..... 990 cells, 11,880 entries
- » transmission of results ..... insulated USB cable
- » operating humidity ..... 20 %...90 %

### Standard accessories of the meter:

M-8 carrying case	WAFUTM8
black "crocodile" clip 11 kV 32 A	WAKROBL32K09
red "crocodile" clip 11 kV 32 A	WAKRORE32K09
blue "crocodile" clip 11 kV 32 A	WAKROBU32K09
Sonel Reader software	WAPROREADER
shielded test lead with banana plugs; 5 kV; 1.8 m; black	WAPRZ1X8BLBB
test lead with banana plugs; 5 kV; 1.8 m; red	WAPRZ1X8REBB
test lead with banana plugs; 5 kV; 1.8 m; blue	WAPRZ1X8BUBB
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
test probe with banana socket; 5 kV; black	WASONBLOGB2
test probe with banana socket; 5 kV; red	WASONREOGB2
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

### Insulation resistance measurement (two-lead)

Measuring range according to IEC 61557-2 for  $R_{IS0min} = U_{IS0nom} / I_{IS0max} \dots 5 T \Omega$  ( $I_{IS0max} = 1 \text{ mA}$ )

Display range	Resolution	Accuracy
0.0...999.9 kΩ	0.1 kΩ	±(3% m.v. + 20 digits)
1.000...9.999 MΩ	0.001 kΩ	
10.00...99.99 MΩ	0.01 kΩ	
100.0...999.9 MΩ	0.1 kΩ	
1.000...9.999 GΩ	0.001 GΩ	
10.00...99.99 GΩ	0.01 GΩ	
100.0...999.9 GΩ	0.1 GΩ	±(4% m.v. + 50 digits)
1.000...5.000 TΩ	1 GΩ	

### Measured resistance values depending on measurement voltage

Voltage $U_{IS0}$	Measuring range
up to 100 V	50 GΩ
200 V...400 V	100 GΩ
500 V...900 V	250 GΩ
1000 V...2400 V	500 GΩ
2500 V	1000 GΩ
5000 V	5 TΩ

### Insulation resistance measurement in Ramp Test mode

Display range	Resolution	Accuracy
0.0...999.9 kΩ	0.1 kΩ	±(5% m.v. + 40 digits)
1.000...9.999 MΩ	0.001 kΩ	
10.00...99.99 MΩ	0.01 kΩ	
100.0...999.9 MΩ	0.1 kΩ	
1.000...9.999 GΩ	0.001 GΩ	
10.00...99.99 GΩ	0.01 GΩ	
100.0...999.9 GΩ	0.1 GΩ	
1.000...4.999 TΩ	0.001 TΩ	

### Breakdown voltage measurement in Ramp Test mode

Range	Resolution	Selected $U_{IS0}$	Accuracy
25.0 V ... 99.0 V	0.1 V	≤600 V	± 5% m.v. + 10 digits
100 V ... 600 V	1 V	≤600 V	± 5% m.v. ± 4 digits
25 V ... 999 V	1 V	≤600 V	± 5% m.v. + 5 digits
1.00 kV ... 5.00 kV	10V	≤600 V	± 5% m.v. ± 4 digits

### Measurement of direct and alternating voltage

Range	Resolution	Accuracy
0...299.9 V	0.1 V	±(3% m.v. + 2 digits)
300...750 V	1 V	

- » frequency range: 45...65 Hz



## SONEL MIC-2510 / MIC-2505

index: WMGBMIC2510 (MIC-2510) / WMGBMIC2505 (MIC-2505)

**CAT III**  
**1000V**

**CAT IV**  
**600V**

**IP 54**



### Measurement of insulation resistance:

- » measurement voltages of 500 V, 1000 V, 2500 V (MIC-2510, MIC-2505) and 100 V, 250 V can be selected and configured within the range of 50...2500 V in steps of 10 V (MIC-2510),
- » continuous reading of measured insulation resistance or leakage current,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » registration of resistance and leakage current characteristic (MIC-2510),
- » sound signaling of five-second time intervals, facilitating capture of time characteristics (MIC-2505),
- » timing of measurement times T1, T2 and T3 for measurement of one or two absorption coefficients (Ab1, Ab2 or DAR, PI) within the range of 1...600 s (MIC-2510), or for times of 15 s, 30 s, 60 s, 600 s (MIC-2505),
- » automatic measurement of multi-core cables by means of the optional AutoISO-2500 adapter (MIC-2510),
- » reading of actual measurement voltage during measurement,
- » protection against measurement of live objects,
- » measurement of leakage current during insulation resistance measurement,
- » capacitance measurement during measurement of  $R_{iso}$  (MIC-2510),
- » measurement according to the three-lead method.



MIC-2510 also measures temperature during resistance measurement.

### Continuity test of protective conductors and equipotential bonding (MIC-2510):

- » with current > 200 mA flowing in two directions in compliance with EN 61557-4,
- » low-voltage resistance measurement with sound signaling.

### Other meter functions:

- » Continuous ambient temperature measurement with capability of saving result to memory (MIC-2510).
- » Measurement of direct and alternating voltages within the range of 0...600 V.
- » 990-cell memory (11,880 entries) with the capability of wireless
- » data transmission to a PC via the Bluetooth or USB cable (MIC-2510).
- » Power supply from accumulator packs, built-in quick charger.

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » measurement category ..... CAT IV 600 V (CAT III 1000 V) according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP54

### Other technical specifications:

- » power supply of the meter ..... SONEL L-1 NiMH 9.6 V accumulator pack
- » dimensions ..... approx. 260 x 190 x 60 mm
- » meter weight ..... approx. 1.3 kg
- » display ..... segmented LCD

### Standard accessories of the meter:

NiMH accumulator (rechargeable battery) 9.6 V 2.5 Ah	WAAKU10
L-4 carrying case (MIC-2505)	WAFUTL4
M-7 carrying case	WAFUTM7
black "crocodile" clip 11 kV 32 A	WAKROBL32K09
red "crocodile" clip 11 kV 32 A (MIC-2510)	WAKRORE32K09
blue "crocodile" clip 11 kV 32 A	WAKROBU32K09
Sonei Reader software	WAPROREADER
shielded test lead with banana plugs; 5 kV; 1.8 m; black	WAPRZ1X8BLBB
test lead with banana plugs; 5 kV; 1.8 m; red	WAPRZ1X8REBB
test lead with banana plugs; 5 kV; 1.8 m; blue	WAPRZ1X8BUBB
USB data transmission cable (MIC-2510)	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
test probe with banana socket; 5 kV; black (MIC-2510)	WASONBLOGB2
test probe with banana socket; 5 kV; red	WASONREOGB2
meter strap (type L-1)	WAPRZSZ2
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

### Measurement of insulation resistance

Measuring range according to IEC 61557-2 for  $R_{iso\min} = U_{iso\max} / I_{iso\max} \dots 2 \text{ T}\Omega$  ( $I_{iso\max} = 1 \text{ mA}$ )

Display range	Resolution	Accuracy
0.0...999.9 kΩ	0.1 kΩ	±(3% m.v. + 20 digits)
1.000...9.999 MΩ	0.001 kΩ	
10.00...99.99 MΩ	0.01 kΩ	
100.0...999.9 MΩ	0.1 kΩ	
1.000...9.999 GΩ	0.001 GΩ	
10.00...99.99 GΩ	0.01 GΩ	
100.0...999.9 GΩ	0.1 GΩ	
1.000...2.000 TΩ	0.001 TΩ	

Maximum measured resistance values depending on measurement voltage:

Voltage	Measured resistance
50 V (MIC-2510)	50 GΩ
100 V (MIC-2510)	100 GΩ
250 V (MIC-2510)	250 GΩ
500 V	500 GΩ
1000 V	1 TΩ
2500 V	2 TΩ

### Capacitance measurement (MIC-2510)

Display range	Resolution	Accuracy
1...999 nF	1 nF	±(5% m.v. + 5 digits)
1.00...9.99 μF	0.01 μF	

### Instruments meet the requirements set forth in standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

## SONEL MIC-2501

index: WMGBMIC2501



**CAT IV** **CAT III** **IP 65**  
**600V** **1000V**

### Measurement of insulation resistance:

- » measurement voltage within the range of 100...2500 V, selected in steps of 100 V,
- » continuous reading of measured insulation resistance or leakage current,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » timed measurement times T1, T2 and T3 for measurement of absorption coefficients (Ab/PI/DAR) at 15, 60 and 600 s and polarization index,
- » reading of actual measurement voltage during measurement,
- » protection against measurement of live objects.

### In addition:

- » two- or three-lead method of insulation resistance measurement,
- » low-voltage measurement of circuit continuity and resistance,
- » measurement of leakage current during insulation resistance measurement,
- » measurement of direct and alternating voltages within the range of 0...750 V,
- » 990-cell memory (11,880 entries), data transmission to PC via USB cable,
- » power supplied by accumulator (rechargeable battery),
- » the instrument meets the requirements laid down by standard EN 61557,
- » the meter can be powered and charged from an external power adapter or from a car lighter socket.

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » measurement category ..... CAT IV 600 V (CAT III 1000 V) according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP65

### Other technical specifications:

- » power supply of the meter ..... SONE L-1 NiMH LSD 9.6 V accumulator pack, external power supply 12 V, 2.5 A
- » meter weight ..... approx. 0.9 kg
- » dimensions ..... 200x180x77 mm
- » display ..... segmented LCD
- » memory ..... 990 cells, 11,880 entries
- » transmission of results ..... USB

### Standard accessories of the meter:

M-8 carrying case	WAFUTM8
black "crocodile" clip 11 kV 32 A	WAKROBL32K09
red "crocodile" clip 11 kV 32 A	WAKRORE32K09
blue "crocodile" clip 11 kV 32 A	WAKROBU32K09
SoneL Reader software	WAPROREADER
shielded test lead with banana plugs; 5 kV; 1.8 m; black	WAPRZ1X8BLBB
test lead with banana plugs; 5 kV; 1.8 m; red	WAPRZ1X8REBB
test lead with banana plugs; 5 kV; 1.8 m; blue	WAPRZ1X8BUBB
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
test probe with banana socket; 5 kV; black	WASONBLOGB2
test probe with banana socket; 5 kV; red	WASONREGB2
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

### Measurement of insulation resistance

Measuring range according to EN 61557-2 for  $R_{ISOmin} = U_{ISOnom} / I_{ISOmax} \dots 1 \text{ T}\Omega$  ( $I_{ISOmax} = 1 \text{ mA}$ )

Display range	Resolution	Accuracy
0.0...999.9 kΩ	0.1 kΩ	±(3% m.v. + 20 digits)
1.000...9.999 MΩ	0.001 kΩ	
10.00...99.99 MΩ	0.01 kΩ	
100.0...999.9 MΩ	0.1 kΩ	
1.000...9.999 GΩ	0.001 GΩ	
10.00...99.99 GΩ	0.01 GΩ	
100.0...999.9 GΩ	0.1 GΩ	

Maximum measured resistance values depending on measurement voltage:

Voltage	Measured resistance
Up to 100 V	50 GΩ
200 V...400 V	100 GΩ
500 V...900 V	250 GΩ
1000 V...2400 V	500 GΩ
2500 V	1000 GΩ

### Test of the continuity of protective conductors and equipotential bonding with 200 mA current

Measuring range according to EN 61557-4: 0.10...999 Ω

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	
200...999 Ω	1 Ω	±(4% m.v. + 3 digits)

- » Voltage on open terminals: 4...24 V
- » Output current at  $R < 2 \Omega$ :  $I_{SC} > 200 \text{ mA}$
- » Compensation of test lead resistance
- » Current flows in two directions, mean resistance value displayed

### Measurement of direct and alternating voltage

Display range	Resolution	Accuracy
0...299.9 V	0.1 V	±(3% m.v. + 2 digits)
300...750 V	1 V	

- » frequency range: 45...65 Hz

"m.v." = "measured value"  
 $U_{ISO}$  - measurement voltage.



## SONEL MIC-30

index: WMGBMIC30



CAT III

1000V

CAT IV

600V

IP 67

### Measurement of insulation resistance:

- » measurement voltage selected from: 50, 100, 250, 500, 1000 V or freely configurable within the range of 50...1000 V in steps of 10 V,
- » automatic measurement in sockets by means of UNI-Schuko adapter with the capability of configuring pairs of measured conductors,
- » continuous reading of measured insulation resistance or leakage current,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » timing of measurement times T1, T2 and T3 for measurement of one or two absorption coefficients, within the range of 1... 600 seconds.
- » readings of actual measurement voltage during measurement,
- » protection against measurement of live objects,
- » three-lead measurement,
- » measurement of leakage current,
- » capacitance measurement during measurement of  $R_{ISO}$ .

### Continuity test of protective conductors and equipotential bonding:

- » with current  $\geq 200$  mA flowing in two directions in compliance with EN 61557-4.

### Additional functions of the meter:

- » Low-voltage measurement of circuit continuity and resistance.
- » Measurement of direct and alternating voltages within the range of 0...600 V.
- » 990-cell memory (11,880 entries) with the capability of wireless
- » data transmission to a PC via the bluetooth.
- » Backlit keyboard and display.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » power supply of the meter ..... 4 alkaline batteries or Ni-MH accumulators - size AA
- » display ..... segmented LCD

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



MIC-30 makes it possible to perform automatic resistance measurement for all combinations or for any pair of conductors in the socket.

### Standard accessories of the meter:

M-6 carrying case	WAFUTM6
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
Sonei Reader software	WAPROREADER
shielded test lead with banana plugs; 1 kV; 1.2 m; black	WAPRZ1X2BLBBE
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test probe with banana socket; 1 kV; black	WASONBLOGB1
test probe with banana socket; 1 kV; red	WASONREOGB1
meter strap (type M-1)	WAPPOZSZE4
M-1 housing holder - hanger	WAPPOZUCH1
calibration certificate	

### Measurement of insulation resistance

Measuring range according to EN 61557-2 for

- »  $U_n=50V$ : **50 kΩ...250.0 MΩ**
- »  $U_n=100V$ : **100 kΩ...500.0 MΩ**
- »  $U_n=250V$ : **250 kΩ...2.000 GΩ**
- »  $U_n=500V$ : **500 kΩ...20.00 GΩ**
- »  $U_n=1000V$ : **1000 kΩ...100.00 GΩ**

Display range	Resolution	Accuracy
0.0...999.9 kΩ	0.1 kΩ	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$ $\pm(5\% \text{ m.v.} + 8 \text{ digits})^*$
1.000...9.999 MΩ	0.001 kΩ	
10.00...99.99 MΩ	0.01 kΩ	
100.0...250.0 MΩ (for $U_n = 50 \text{ V}$ )	0.1 kΩ	
100.0...500.0 MΩ (for $U_n = 100 \text{ V}$ )	0.1 kΩ	
100.0...999.9 MΩ (for $U_n \geq 250 \text{ V}$ )	0.1 kΩ	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$ $\pm(6\% \text{ m.v.} + 6 \text{ digits})^*$
1.000...2.000 GΩ (for $U_n = 250 \text{ V}$ )	0.001 GΩ	
1.000...9.999 GΩ (for $U_n \geq 500 \text{ V}$ )	0.001 GΩ	
10.00...20.00 GΩ (for $U_n \geq 500 \text{ V}$ ) **	0.01 GΩ	
10.00...99.99 GΩ (for $U_n = 1000 \text{ V}$ )	0.01 GΩ	
100.0 GΩ (for $U_n = 1000 \text{ V}$ )	0.1 GΩ	

\*for WS-04 lead

\*\*for WS-04 lead, range up to 10 GΩ

- » measurements with voltage up to 500 V for WS-04 lead

### Capacitance measurement

Display range	Resolution	Accuracy
1...999 nF	1 nF	$\pm(5\% \text{ m.v.} + 10 \text{ digits})$
1.00...9.99 μF	0.01 μF	

- » Capacitance measurement result displayed after measurement of  $R_{ISO}$
- » For measurement voltages below 100 V and measured resistance of less than 10 MΩ, the error of capacitance measurement is unspecified

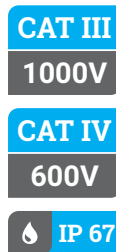
### Test of the continuity of protective conductors and equipotential bonding with 200 mA current

Measuring range according to EN 61557-4: 0.10...1999 Ω

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 Ω	0.1 Ω	
2000...1999 Ω	1 Ω	$\pm(4\% \text{ m.v.} + 3 \text{ digits})$

**SONEL MIC-10**

index: WMGBMIC10

**Measurement of insulation resistance:**

- » measurement voltage selected from: 50, 100, 250, 500, 1000 V,
- » continuous reading of measured insulation resistance,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » readings of actual measurement voltage during measurement,
- » protection against measurement of live objects,
- » three-lead measurement,
- » capacitance measurement during measurement of  $R_{ISO}$ .

**Continuity test of protective conductors and equipotential bonding:**

- » with current  $\geq 200$  mA flowing in two directions in compliance with EN 61557-4.

**Additional functions of the meter:**

- » Low-voltage measurement of circuit continuity and resistance.
- » Measurement of direct and alternating voltages within the range of 0...600 V.
- » Backlit keyboard and display.

**Other technical specifications:**

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » power supply of the meter ..... 4 alkaline batteries or Ni-MH accumulators - size AA
- » display ..... segmented LCD

**The instrument meets the requirements set forth in the standards:**

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



Besides measuring insulation resistance, MIC-10 is capable of performing continuity tests of protective conductors and equipotential bonding in accordance with standard EN 61557.

**Standard accessories of the meter:**

M-6 carrying case	WAFUTM6
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
test lead with banana plugs; 1 kV; 1.2 m; black	WAPRZ1X2BLBB
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test probe with banana socket; 1 kV; black	WASONBLOGB1
test probe with banana socket; 1 kV; red	WASONREOGB1
meter strap (type M-1)	WAPOZSZE4
M-1 housing holder - hanger	WAPOZUCH1
calibration certificate	

**Measurement of insulation resistance**

Measuring range according to EN 61557-2 for

- »  $U_n = 50V$ : **50 k $\Omega$ ...250.0 M $\Omega$**
- »  $U_n = 100V$ : **100 k $\Omega$ ...500.0 M $\Omega$**
- »  $U_n = 250V$ : **250 k $\Omega$ ...2.000 G $\Omega$**
- »  $U_n = 500V$ : **500 k $\Omega$ ...5.00 G $\Omega$**
- »  $U_n = 1000V$ : **1000 k $\Omega$ ...10.00 G $\Omega$**

Display range	Resolution	Accuracy
0.0...999.9 k $\Omega$	0.1 k $\Omega$	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
1.000...9.999 M $\Omega$	0.001 k $\Omega$	
10.00...99.99 M $\Omega$	0.01 k $\Omega$	
100.0...250.0 M $\Omega$ (for $U_n = 50$ V)	0.1 k $\Omega$	
100.0...500.0 M $\Omega$ (for $U_n = 100$ V)	0.1 M $\Omega$	
100.0...999.9 M $\Omega$ (for $U_n \geq 250$ V)	0.1 k $\Omega$	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$
1.000...2.000 G $\Omega$ (for $U_n = 250$ V)	0.001 G $\Omega$	
1.000...5.000 G $\Omega$ (for $U_n \geq 500$ V)	0.001 G $\Omega$	
5.00...10.00 G $\Omega$ (for $U_n = 1000$ V)	0.01 G $\Omega$	

**Capacitance measurement**

Display range	Resolution	Accuracy
1...999 nF	1 nF	$\pm(5\% \text{ m.v.} + 10 \text{ digits})$
1.00...9.99 $\mu$ F	0.01 $\mu$ F	

- » Capacitance measurement result displayed after measurement of  $R_{ISO}$ .
- » For measurement voltages below 100 V and measured resistance of less than 10 M $\Omega$ , the error of capacitance measurement is unspecified.

**Test of the continuity of protective conductors and equipotential bonding with 200 mA current**Measuring range according to EN 61557-4: 0.10...1999  $\Omega$ 

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
2000...1999 $\Omega$	1 $\Omega$	$\pm(4\% \text{ m.v.} + 3 \text{ digits})$

## SONEL MIC-2

index: WMGBMIC2



CAT III

1000V

CAT IV

600V

IP 65

### Measurement of insulation resistance:

- » 250 V or 500 V measurement voltage available for selection,
- » continuous reading of measured insulation resistance,
- » automatic discharge of the measured object's capacitance upon completion of insulation resistance measurement,
- » sound signaling of five-second time intervals, facilitating capture of time characteristics,
- » protection against measurement of live objects.

### Low-voltage resistance measurement within the range of 0...2000 Ω:

- » measurement with current < 10 mA with 0.1 Ω resolution,
- » fast sound signaling for circuits with resistance of less than 10 Ω.

### Additional functions of the meter:

- » Measurement of direct and alternating voltages within the range of 0...600 V:  
- automatic detection of voltage type (direct/alternating).
- » Automatic selection of measuring ranges.
- » Backlit, easy-to-read LCD.
- » Automatic shutdown of instrument when not in use (AUTO-OFF).

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » measurement category ..... CAT IV 600 V (CAT III 1000 V) according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP65

### Other technical specifications:

- » power supply of the meter ..... 2 LR03 batteries (size AAA)  
or 2 AAA accumulators (rechargeable batteries)
- » dimensions ..... approx. 240 x 60 x 30 mm
- » meter weight ..... approx. 0.3 kg
- » measurement current  $R_{ISO}$  ..... 1.2 mA  $\pm$  0.2 mA
- » maximum voltage of disturbances present during  $R_{ISO}$  measurement ..... 20 V
- » number of  $R_{ISO}$  measurements provided by set of alkaline batteries ..... 500
- » time until automatic shutdown (auto-off) ..... 5 minutes
- » electromagnetic compatibility ..... compliant with EN 61000-6-3 and EN 61000-6-2

### Nominal operating conditions:

- » operating temperature range ..... 0...+40 °C
- » reference temperature ..... 23°C  $\pm$  2 °C
- » storage temperature ..... 20...+70 °C

### Standard accessories of the meter:

black "crocodile" clip 1 kV 20 A	WAKROBL20K01
test probe with banana socket; 1 kV; black	WASONBLOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
M-1 housing holder - hanger	WAPOZUCH1
calibration certificate	



MIC-2 is the smallest insulation resistance meter with two measurement voltages.

### Measurement of insulation resistance:

 $U_{ISO} = 250 \text{ V}$ 

Measuring range according to IEC 61557-2: **250 kΩ...1000 MΩ**

Display range	Resolution	Accuracy
1...249 kΩ	1 kΩ	undefined
250...1999 kΩ	1 kΩ	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
2.00...19.99 MΩ	0.01 kΩ	
20.0...199.9 MΩ	0.1 kΩ	
200...1000 MΩ	1 kΩ	

 $U_{ISO} = 500 \text{ V}$ 

Measuring range according to IEC 61557-2: **500 kΩ...1999 MΩ**

Display range	Resolution	Accuracy
1...499 kΩ	1 kΩ	undefined
500...1999 kΩ	1 kΩ	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
2.00...19.99 MΩ	0.01 kΩ	
20.0...199.9 MΩ	0.1 kΩ	
200...1999 MΩ	1 kΩ	

### Resistance measurement

Display range	Resolution	Accuracy
0.0...199.9 Ω	0.1 Ω	$\pm(4\% \text{ m.v.} + 3 \text{ digits})$
200...1999 Ω	1 Ω	

- » continuous sound signal for  $R < 10 \Omega$
- » measurement current (when terminals are connected for  $U_{BAT} > 3.0 \text{ V}$ ): < 10 mA
- » maximum voltage on open terminals: 4...24 V
- » maximum voltage of disturbances present during measurement: +7 V/-1 V DC, 5 V AC

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



In the event of voltage detection in the object during insulation resistance measurements or low-voltage resistance measurements, the MIC-2 meter will automatically switch to voltage measurement mode.



## Probe for measurement of floor and wall resistances

### SONEL PRS-1

index: WASONPRS1GB



#### Optionally for meters:

- » MIC-2510
- » MIC-30
- » MIC-2505
- » MIC-10
- » MIC-2501
- » MPI-520
- » MPI-525
- » MPI-530
- » MPI-520 Start
- » MPI-520
- » MPI-525
- » MPI-530
- » MPI-520 Start
- » MPI-530-IT



#### Measurement of insulation resistance:

- » The Sonel PRS-1 tripod measuring probe, with the shape of an equilateral triangle, has been manufactured according to the guidelines given in standards HD 60364-6 and EN 1081.

#### Comparison of insulation resistance meters



	MIC-10k1	MIC-5050	MIC-5010	MIC-5005	MIC-5001	MIC-2510	MIC-2505	MIC-2501	MIC-30	MIC-10	MIC-2	MPI-530/ MPI-530-IT	MPI-525	MPI-520 MPI-520 Start	MPI-505
Measurement voltage [V]	50...10000	50...5000	50...5000	50...5000	50...5000	50...2500	500,1000, 2500	100...2500	50...1000	50,100,250, 500,1000	250.500	50, 100, 250, 500, 1000	50, 100, 250, 500, 1000, 2500	50, 100, 250, 500, 1000	100, 250, 500, 1000
Measuring range	10 kΩ...40 TΩ	20 kΩ...20 TΩ	20 kΩ...15 TΩ	20 kΩ...15 TΩ	50 kΩ...5 TΩ	50 kΩ...2 TΩ	50 kΩ...2 TΩ	50 kΩ...2 TΩ	50 kΩ...100 GΩ	50 kΩ...10 GΩ	250 kΩ...1999 kΩ	50 kΩ...9.99 GΩ	50 kΩ...9.99 GΩ	50 kΩ...3 GΩ	100 kΩ...3 GΩ
Setting of 3 measurement times *	1...600 s	1...600 s	1...600 s	1...600 s	1...600 s	1...600 s	15, 60, 600 s	1...600 s	1...600 s	—	—	—	1...600 s	—	—
Maximum setting of measurement time	99'59"	99'59"	99'59"	99'59"	99'59"	5'	5'	5'	5'	—	—	—	5'	—	—
Measurement of insulation resistance using the three-terminal method	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	—	—	—	—	—
Measurement of 2 absorption coefficients	YES	YES	YES	YES	YES	YES	YES	YES	YES	—	—	—	YES	—	—
Measurement of leakage current during insulation resistance measurement	YES	YES	YES	YES	YES	YES	YES	YES	YES	—	—	—	—	—	—
Automatic discharging of object after measurement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Built-in quick charger	YES	YES	YES	YES	YES	YES	YES	YES	—	—	—	YES	YES	YES	—
Power supply	accumulator	accumulator	accumulator	accumulator	accumulator	accumulator	accumulator	accumulator	AA batteries or accumulators	AA batteries or accumulators	AA batteries or accumulators	accumulator or batteries	accumulator or batteries	batteries or accumulators	AA batteries or accumulators
Low-voltage resistance measurement	—	—	—	—	—	YES	—	—	YES	YES	YES	YES	YES	YES	YES
Continuity test with current ≥200mA (resolution 0.01Ω)	YES	YES	YES	—	—	YES	—	YES	YES	YES	—	YES	YES	YES	YES
Automatic measurement of 3-, 4- and 5-core cords by means of AutoISO2500 adapter	YES	YES	—	—	—	YES	—	—	—	—	—	YES	YES	YES	—
Automatic measurement of 3-, 4- and 5-core cables by means of AutoISO5000 adapter	YES	YES	—	—	—	YES	—	—	—	—	—	—	YES	—	—
Voltage measurement	0...750 V	0...750 V	0...600 V	0...600 V	0...750 V	0...600 V	0...600 V	0...750 V	0...600 V	0...600 V	0...600 V	0...500 V	0...500 V	0...500 V	0...440 V
Temperature measurement	YES	YES	—	—	—	YES	—	—	—	—	—	—	—	—	—
Plotting of insulation resistance and leakage current characteristics	YES	YES	—	—	YES	YES	—	YES	—	—	—	—	—	—	—
Automatic in-socket measurement	—	—	—	—	—	—	—	—	YES	—	—	YES	—	YES	—
Capacitance measurement	YES	YES	YES	YES	—	YES	—	—	YES	YES	—	—	—	—	—
Memory (number of records)	10000	10000	990	990	990	990	—	990	990	—	—	10,000	990	990	990
Data transmission	USB, Bluetooth	USB, Bluetooth	USB, Bluetooth	USB, Bluetooth	USB	USB, Bluetooth	—	USB	Bluetooth	—	—	USB, Bluetooth	USB, Bluetooth	USB, Bluetooth	USB
Dimensions [mm]	390 x 310 x 170	390 x 310 x 170	390 x 310 x 170	390 x 310 x 170	200 x 180 x 77	260 x 190 x 60	260 x 190 x 60	200 x 180 x 77	200 x 150 x 60	220 x 100 x 60	240 x 60 x 30	295 x 223 x 75	288 x 223 x 75	288 x 223 x 75	260 x 190 x 60
Weight [kg]	7	7	7	7	0.9	1.3	1.3	0.9	0.6	0.6	0.3	2.2	2.2	2.2	2.2

\* - for calculation of Ab1, Ab2, PI, DAR

## SONEL MZC-320S

index: WMGBMZC320



### Fault loop impedance measurement:

- » measurement of very low short circuit loop impedances (with resolution 0,1 mΩ) with a current of 130 A at 230 V; maximum 300 A at 550 V or with a current 24 A at 230 V, maximum 30 A at 550 V (with resolution 0,01 Ω)
- » measurements in installations with rated voltages between: 110/190 V, 115/200 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V i 290/500 V and frequencies 45...65 Hz,
- » ability to perform measurements in short circuit system: phase-phase, phaseprotective, phase-neutral
- » differentiation between the phase voltage and the inter-phase voltage while calculating the short circuit current
- » ability to change the length of test lead,
- » four-pole method, test leads do not require calibration (measurement with current 300 A).

### Additional functions of the meter:

- » touch voltage and touch shock voltage measurement with resistor 1 kΩ).
- » AC voltage measurement in range 0...550V.
- » memory of 999 measurement results with an ability to transfer the data to a PC
- » ability to transmit date thru USB.
- » meter meets the requirements of the standard PN-EN 61557.

### Electric security:

- » type of insulation ..... double, according to EN 61010-1 and IEC 61557
- » measurement category ..... IV 600 V acc. to EN 61010-1
- » protection class acc. EN 60529 ..... IP20 (IP67 with front cover closed)

### Other technical specifications:

- » power supply ..... build in Li-Ion 7,2 V/8,8 Ah
- » resistor limited the current:
  - for 4 pole method 4p ..... 1,8 Ω
  - for two pole method 2p ..... 9,4 Ω for U≤253 V, 19 Ω for U>253 V
- » number of short circuit loop measurements ..... 2000 (4/min.)
- » temperature coefficient ..... ±0,1% measured value /°C
- » dimensions ..... 390 mm x 310 mm x 170 mm
- » weight ..... 6,6 kg

### Standard accessories of the meter:

test lead with banana plug; 1,2m; black	WAPRZ1X2BLBB
test lead with banana plug; 1,2m; yellow	WAPRZ1X2YEBB
pin probe with banana connector - yellow	WASONBLOGB1
pin probe with banana connector - black	WASONYEOGB1
test lead 3m (2 pcs.)	WAPRZ003DZBB
„crocodile“ clip K03	WAKROBL30K03
kelvin clamps (2 pc.)	WAKROKELK06
high-current probe with banana connector (2 pc.)	WASONSPGB1
charger	WAZASZ7
carrying case for accessories	WAFUTL14
USB cable	WAPRZUSB
sonel Reader software	WAPROREADER
manual	
calibration certificate	

### Voltage measurements (True RMS)

Range	Resolution	Accuracy
0...550 V	1 V	±(2% m.v. + 2 digits)

Frequency range: DC, 45...65 Hz

Input impedance of the voltmeter: 200 kΩ

### Short circuit loop parameters measurement using high current (4p, I<sub>max</sub>=300 A)

#### Short circuit resistance R and reactance X display range

Range	Resolution	Accuracy
0...199,9 mΩ	0.1 mΩ	±(2% m.v. + 2 mΩ)
200...1999 mΩ	1 mΩ	impedance reading for a particular measurement

### Short circuit current indication

Measuring range according to IEC 61557: for Un = 230 V 115,0 A...32,0 kA  
for or Un = 400 V 200 A...55,7 kA  
for or Un = 500 V 250 A...69,4 kA

Display range	Resolution	Accuracy
115,0...199,9 A	0 A	Accuracy of the current indication computed, respectively, with the use of resistance measurements
200...1999 A	1 A	
2,00...19,99 kA	0,01 kA	
20,0...199,9 kA	0,1 kA	
200 kA...*	1k A	

\* 230 kA for U<sub>L-N</sub>

400 kA for U<sub>L-L</sub>

### Touch voltage measurements U<sub>sr</sub> and shock voltage U<sub>t</sub>

Display range	Resolution	Accuracy
0...100 V	1 V	±(10% m.v. + digits)

### Short circuit loop parameters measurement using standards current (2p, I<sub>max</sub>=30 A)

#### Short circuit loop impedance Z measurement

Measuring range according to IEC61557: 0,13 Ω...199,9 Ω for test leads length 1,2 m

Display range	Resolution	Accuracy
0,00...19,99 Ω	0,01 Ω	±(2% m.v. + 3 digits)
20,0...199,9 Ω	0,1 Ω	±(3% m.v. + 3 digits)

#### Short circuit resistance R and reactance X display range

Measuring range according to IEC61557: 0,13 Ω...199,9 Ω for test leads length 1,2 m

Display range	Resolution	Accuracy
0,00...19,99 Ω	0,01 Ω	±(2% m.v. +3 digits) impedance reading for a particular measurement
20,0...199,9 Ω	0,1 Ω	±(3% m.v. + 3 digits) impedance reading for a particular measurement

### Short circuit current indication

Display range	Resolution	Accuracy
1,150...1,999 A	0 00 A	Accuracy of the current indication computed, respectively, with the use of resistance measurements
2,00...19,99 A	0,01 A	
20,0...199,9 A	0,1 A	
200...1999 A	1 A	
2,00...19,99 kA	0,01 kA	
20,0...40,0 kA	0,1 kA	

„m.v.“ - measured value.

**SONEL MZC-310S**

index: WMGBMZC310

**CAT III****600V****CAT IV****300V****IP 20****Fault loop impedance measurement:**

- » measurements of very low fault loop impedances (with 0.1 mΩ resolution) with current of 150 A at 230 V; maximum 280 A at 440 V,
- » measurements with current of 23 A at 230V, maximum 42 A at 440 V,
- » measurements in networks with rated voltages: 220/380 V and 230/400 V and frequencies 45...65 Hz,
- » measurement in fault loops: phase to phase, phase to protective earth, phase to neutral,
- » differentiation of phase and phase-to-phase voltage during calculations of fault current,
- » selection of test lead length (23/42 A measurement),
- » four-lead method, no test lead calibration required (150/280 A),
- » measurement and display of fault loop impedance components: resistance  $R_s$  and reactance  $X_s$

**Additional functions of the meter:**

- » Measurement of prospective touch voltage or shock touch voltage (with 1 kΩ resistor).
- » Alternating voltage measurement within the range of 0...440 V.
- » Measurement of frequency.
- » Memory storing up to 990 measurement results, with the capability of data transmission to a PC.



The MZC-310S meter enables measurement of fault loop impedances of very low values (below 0.01 Ω), in compliance with EN 61557.

**The instrument meets the requirements set forth in the standards:**

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

**Other technical specifications:**

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » power supply of the meter ..... LR14 alkaline batteries (size C) (5 pcs.)
- » current-limiting resistor ..... for 4-lead measurement: 1.5 Ω, for 2-lead measurement: 10 Ω
- » number of fault loop measurements (alkaline batteries) ..... at least 2000 (4/min.)
- » ..... at least 4000 (2/min.)
- » temperature coefficient ..... ±0.1% m.v. / °C

**Nominal operating conditions:**

- » operating temperature range ..... 0...+40 °C

**Standard accessories of the meter:**

L-10 carrying case	WAFUTL10
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
4x black "crocodile" clip 1 kV 32 A	WAKROBL30K03
2x Kelvin clamp 1 kV 25 A	WAKROKELK06
Bluetooth mini-keyboard	WAADAMK
Sonel Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; black	WAPRZ1X2BLBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
two-core cord; 3m (10 / 25 A) U1/I1	WAPRZ003DZBBU111
two-core cord; 3m (10 / 25 A) U2/I2	WAPRZ003DZBBU212
RS-232 serial transmission cable	WAPRZRS232
230 V power cord (IEC C13 plug)	WAPRZ1X8BLIEC
test probe with banana socket; 1 kV; black	WASONBLOGB1
test probe with banana socket; 1 kV; yellow	WASONYEOGB1
2x High-current probe with banana sockets; 1 kV	WASONSPGB1
meter strap (Unisonel type)	WAPZSZSE1
reel for winding test lead	WAPZSZSP1
calibration certificate	

**High-current measurement of fault loop parameters (4-lead,  $I_{max} = 280$  A)**

High-current measurement of fault loop impedance  $Z_s$ ;  
measuring range according to EN 61557-3: **7.2 mΩ...1999 mΩ**

Display range	Resolution	Accuracy
0...199.9 mΩ	0.1 mΩ	±(2% m.v. + 2 mΩ)
200...1999 mΩ	1 mΩ	

**Fault current readings**

Measuring range according to EN 61557-3: for  $U_n = 230$  V **115.0 A...32.0 kA**

for  $U_n = 400$  V **200 A...55.7 kA**

Display range	Resolution	Accuracy
115.0...199.9 A	0.1 A	Calculated on the basis of error for fault loop
200...1999 A	1 A	
2.00...19.99 kA	0.01 kA	
20.0...199.9 kA	0.1 kA	
200 kA... *	1 kA	

\*230 kA for  $U_{L-N}$  400 kA for  $U_{L-L}$

**Measurement of touch voltage  $U_{ST}$  and shock voltage  $U_T$** 

Display range	Resolution	Accuracy
0...100 V	1 V	±(10% m.v. + 2 digits)

**Measurement of fault loop impedance  $Z_s$  with standard current (2-lead,  $I_{max} = 42$  A)**

measuring range for 1.2 m leads according to EN 61557: **0.13 Ω...199.9 Ω**

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	±(3% m.v. + 3 digits)



The MZC-310S meter is the only meter on the market that also enables touch voltage or shock voltage measurement, which can be employed during safety assessment of a tested system.



## SONEL MZC-305

index: WMGBMZC305

MEASUREMENT  
IN NETWORKS  
UP TO  
A MAXIMUM OF  
**750V!**



CAT IV

300V

CAT III

600V

IP 54

### Fault loop impedance measurement:

- » fault loop impedance measurement with 0.01Ω resolution,
- » low-current impedance measurement in circuits protected by RCD≥ 30mA with 0.01Ω resolution (100...440V),
- » operates in networks with voltages 110/190V, 115/200V, 127/220V, 220/380V, 230/400V, 240/415V, 290/500V and 400/690 (**operating range 100...750V**), operating frequency 45...65Hz,
- » calculation of fault current,
- » automatic differentiation between phase and phase-to-phase voltage,
- » possibility of applying 1.2; 5; 10; 20 m test leads or an adapter terminated by a power network plug,
- » measurement with swapped L and N conductors,
- » measurement of resistance and reactance components.

### Additional functions of the meters:

- » **Voltage measurement up to 750V AC with 0.1V resolution up to 250V.**
- » **Memory storing up to 990 records, data transmission via USB.**
- » **Battery or accumulator (rechargeable battery) power supply (4 x AA).**
- » **Check of correct connection of PE terminal by means of contact electrode.**

### Instruments meet the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



Meters calculate the value of prospective fault current in compliance with standard HD 60364-6.

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1
- » test leads ..... EN 61010-2-031

### Other technical specifications:

- » meter power supply ..... accumulator pack or (optional) alkaline batteries (MZC-306) alkaline batteries or (optional) Ni-MH accumulators (MZC-305)
- » accumulator or alkaline battery performance ..... at least 3000 measurements
- » display ..... backlit LED

### Nominal operating conditions:

- » operating temperature range ..... 0...+45°C
- » humidity ..... 20-80%

## SONEL MZC-306

index: WMGBMZC306



### Standard accessories of the meter:

WS-05 adapter (UNI-Schuko angle plug)	WAADAWS05
NiMH accumulator (rechargeable battery) 4.8 V 4.2 Ah (MZC-306)	WAAKU07
L-4 carrying case	WAFUTL4
red "crocodile" clip 1 kV 20 A (MZC-305)	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
yellow "crocodile" clip 1 kV 20 A (MZC-305)	WAKROYE20K02
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug) (MZC-306)	WAPRZLAD230
test probe with banana socket; 5 kV; black (MZC-306)	WASONBLOGB2
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 5 kV; red (MZC-306)	WASONREOGB2
test probe with banana socket; 1 kV; blue	WASONBUOGB1
test probe with banana socket; 1 kV; yellow	WASONYEOGB1
meter strap (type L-1)	WAP0ZSZ2E2
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

### Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$

Measuring range according to EN 61557-3 for 1,2m leads: **0.13...1999Ω**

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(5% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	±(4% m.v. + 3 digits)
200...1999 Ω	1 Ω	±(4% m.v. + 3 digits)

Nominal voltage: 100...440 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 100...750 V (for  $Z_{L-L}$ )



The MZC-305 and MZC-306 meters perform fault loop impedance measurements in industrial networks of any voltage up to 750V.

### Measurement of earth fault loop impedance $Z_{L-PE}$ in **RCD** mode

Measuring range according to EN 61557-3 for 1,2 m leads: **0.43...1999 Ω**

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(6% m.v. + 10 digits)
20.0...199.9 Ω	0.1 Ω	±(6% m.v. + 5 digits)
200...1999 Ω	1 Ω	

## SONEL MZC-304

index: WMGBMZC304



CAT III

600V

CAT IV

300V

IP 67

BLUETOOTH

### Measurement of fault loop parameters:

- » fault loop impedance measurement in networks with rated voltages: 220/380 V, 230V/400 V, 240/415 V and frequencies 45...65 Hz,
- » measurement of fault loop impedance with 15 mA current without tripping residual current devices,
- » **detection of L and N phase swapping in a socket and automatic unswapping in the meter,**
- » operating voltage range: 180...270 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 180...460 V (for  $Z_{L-L}$ )
- » operating frequency range: 45...65 Hz,
- » maximum measurement current: 7.6 A for 230 V (3x10ms), 13.3 A for 400 V (3x10 ms),
- » calculation of fault current for nominal voltages,
- » readings of fault loop resistance  $R_s$  and reactance  $X_s$ .

### Low-voltage resistance measurement of protective conductors and equipotential bonding:

- » **continuity test of protective conductors with current  $\pm 200$  mA - in compliance with EN61557,**
- » automatic calibration of test leads - any leads can be used,
- » low-current resistance measurement with sound signaling.

### Additional functions of the meter:

- » Quick check of correct connection of PE conductor by means of contact electrode.
- » Measurement of network voltage and frequency.
- » Power supply from LR6 batteries, Ni-MH accumulators can optionally be applied.
- » Memory storing up to 990 results, wireless data transmission to computer via Bluetooth.
- » Backlit keyboard and display.



The MZC-304 meter calculates the value of prospective fault current in compliance with standard HD 60364-6.

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1
- » test leads ..... EN 61010-2-031
- » measurement category ..... CAT III 600 V (CAT IV 300 V) according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP67

### Other technical specifications:

- » power supply of the meter ..... pack of accumulators or alkaline batteries (size AA, 4 pcs.)
- » accumulator life ..... at least 5000 measurements

### Nominal operating conditions:

- » operating temperature range ..... 0...+50 °C
- » humidity ..... 20-80%

### Standard accessories of the meter:

WS-05 adapter (UNI-Schuko angle plug)	WAADAWS05
M-6 carrying case	WAFUTM6
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
Sonel Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 5 kV; red	WASONREOGB2
test probe with banana socket; 1 kV; blue	WASONBUOGB1
meter strap (type M-1)	WAP0ZSZE4

calibration certificate



The MZC-304 meter measures fault loop impedance with 0.01  $\Omega$  resolution, including in circuits protected by RCDs, without tripping them.

### Measurement of fault loop impedance $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$ , fault loop resistance and reactance.

Measuring range for 1.2 m leads according to EN 61557-3: **0.13  $\Omega$ ...1999  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...1999 $\Omega$	1 $\Omega$	

### Measurement of earth fault loop impedance $Z_{L-PE}$ in RCD mode (without tripping RCD)

Measuring range for 1.2 m leads according to EN 61557-3: **0.51  $\Omega$ ...1999  $\Omega$**

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(6\% \text{ m.v.} + 10 \text{ digits})$
20.0...199.9 $\Omega$	0.1 $\Omega$	
200...1999 $\Omega$	1 $\Omega$	$\pm(6\% \text{ m.v.} + 5 \text{ digits})$

- » does not trip RCDs with  $I_{\Delta N} \geq 30 \text{ mA}$ ,

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



MZC-304 always measures total fault loop impedance as well as its components – resistance and reactance – regardless of the phase shift value.

## Fault loop impedance meter

# SONEL MZC-20E

index: WMGBMZC20E



**CAT III**

**600V**

**CAT IV**

**300V**

**IP 67**

## Fault loop impedance measurement

This meter is dedicated for electrical fitters and testers who render services in single- and multi-family buildings, office buildings, industrial plants and any other buildings equipped with a low-voltage electrical system. The meter is also intended for electrical operation maintenance services.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and IEC 61557
- » measurement category ..... CAT III 300 V according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP67

### Other technical specifications:

- » power supply of the meter ..... LR6 alkaline batteries or size AA Ni-MH accumulators
- » dimensions ..... 220x98x58 mm
- » meter weight with battery pack ..... 509 g
- » storage temperature ..... -20...+70 °C
- » operating temperature range ..... -10...+50 °C
- » humidity ..... 20...80%
- » reference temperature ..... +23...± 2 °C
- » reference humidity ..... 40...60%
- » elevation above sea level ..... < 2000 m
- » time until Auto-OFF ..... max. 900 seconds
- » number of Z measurements (for accumulators) ..... >5000 (2 measurements/minute)
- » display ..... segmented LCD
- » quality standard ..... development, design and production in compliance with ISO 9001
- » the instrument meets the requirements set forth in the standards ..... IEC 61557
- » the instrument is compliant with standards ..... EN 61326-1:2006 and EN 61326-2-2:2006

### Standard accessories of the meter:

M-1 carrying case	WAFUTM1
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
meter strap (type M-1)	WAPOZSZE4
M-1 housing holder - hanger	WAPOZUCH1
calibration certificate	

### Measurement of fault loop impedance $Z_s$ within the range of 0.24...200 Ω

Fault current  $I_k$ : 0.115÷1769 A ( $U_n=230$  V)

AC voltage measurement: 0÷440 V

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.1 Ω	±(2.5% m.v. + 5 digits)
20.0...99.9 Ω	0.1 Ω	±(2.5% m.v. + 3 digits)
100...200 Ω	1 Ω	±(3% m.v. + 3 digits)

- » Nominal operating voltage  $U_{n-LN}/U_{n-L-L}$ : 220/380 V, 230/400 V, 240/415 V
- » Operating voltage range: 180...270 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) or 180...440 V (for  $Z_{L-L}$ )
- » Nominal network frequency  $f_n$ : 50 Hz, 60 Hz
- » Operating frequency range: 45...65 Hz
- » Maximum measurement current: 15.3 A for 230 V (10 ms) and 26.7 A for 400 V (10 ms)

### Readings of fault loop resistance $R_s$ and fault loop reactance $Z_s$ :

Display range	Resolution	Accuracy
0.00...9.99 Ω	0.01 Ω	±(5% m.v. + 5 digits) of $Z_s$ value

- » Calculated and displayed for  $Z_s$  values <10 Ω

### Readings of fault current $I_k$

Measuring ranges according to EN 61557 can be calculated on the basis of  $Z_s$  measurement ranges and nominal voltages.

Display range	Resolution	Accuracy
1.15...9.99 A	0.01 A	Calculated on the basis of uncertainty for fault loop
10.0...99.9 A	0.1 A	
100...999 A	1 A	
1.00...9.99 kA	0.01 kA	
10.0...40.0 kA	0.1 kA	

### Voltage measurement

Display range	Resolution	Accuracy
0...440 V	1V	±(2.5% m.v. + 2 digits)

### Measurement of fault loop impedance $Z_s$

Test lead	$Z_s$ measuring range
1.2 m	0.24...200 Ω
5 m	0.26...200 Ω
10 m	0.28...200 Ω
20 m	0.35...200 Ω





## Comparison of fault loop impedance meters

									
	MZC-310S	MZC-306	MZC-305	MZC-304	MZC-20E	MPI-530	MPI-520/520 Start MPI-525	MPI-505	MPI-502
Rated voltage [V]	220/380 230/400	110/190 115/200 127/220 220/380 230/400 240/415 290/500 400/690	110/190 115/200 127/220 220/380 230/400 240/415 290/500 400/690	220/380 230/400 240/415	220/380 230/400 240/415	110/190 115/200 127/220 220/380 230/400 240/415	110/190 115/200 127/220 220/380 230/400 240/415	115/200 127/220 220/380 230/400 240/415	220/380 230/400 240/415
Operating voltage range	187...440	100...750	100...750	180...460	180...440	95...440	95...440	100...440	180...460
Display range [Ω]	0...199.9	0...1999	0...1999	0...1999	0...200	0...1999	0...1999	0...1999	0...1999
Maximum resolution [Ω]	0.0001	0.01	0.01	0.01	0.01	0.001	0.01	0.01	0.01
Maximum resolution for measurement with 15mA current [Ω]	—	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Max. measurement current [A]	150/280	12.2...36.7	12.2...36.7	7.6/13.3	7.6/13.3	23/44	23/44	23/44	7.6/13.3
Measuring range according to EN 61557 [Ω]	0.0072...199.9	0.13...1999	0.13...1999	0.13...1999	0.24...200	0.13...1999	0.13...1999	0.13...1999	0.13...1999
Display of fault loop resistance and reactance	YES	YES	YES	YES	YES	YES	YES	YES	YES
Calculation of prospective fault current on the basis of rated voltage	YES	YES	YES	YES	YES	YES	YES	YES	YES
Calculation of prospective fault current on the basis of measured voltage	—	—	—	YES	—	YES	—	—	—
Memory (number of each type of measurement)	990	990	990	990	—	10,000	990	990	990
4-lead method	YES	—	—	—	—	—	—	—	—
Measurement of prospective touch and shock voltage	YES	—	—	—	—	—	—	—	—
Selection of test lead length	YES	YES	YES	YES	YES	YES	YES	YES	YES
In-socket measurement by means of adapter - plug	—	Option	Option	YES	—	YES	YES	YES	YES
Triggering of measurements by adapter	—	Option	Option	Option	—	YES	YES	YES	Option
Alternating voltage measurement	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dimensions [mm]	295 x 222 x 95	288 x 223 x 75	26 x 190 x 60	220 x 98 x 58	220 x 98 x 58	288 x 223 x 75	288 x 223 x 75	260 x 190 x 60	220 x 98 x 58
Weight [kg]	2.2	2.2	2.2	1	0.5	2.2	2.2	2.2	1



## Earthing resistance meter

# SONEL MRU-200 / MRU-200-GPS

index: WMGBMRU200 / WMGBMRU200GPS



### Earthing resistance measurements:

- » with auxiliary electrodes (3-lead, 4-lead),
- » with auxiliary electrodes and clamp (for measurement of multiple earthing systems - 3-lead + clamp),
- » with a pair of clamps (without the need to use auxiliary electrodes),

### Additional measurements:

- » auxiliary electrode resistances  $R_s$  and  $R_H$ ,
- » voltages and frequencies of disturbance signal,
- » in the presence of disturbance voltages in networks with frequency 16 2/3 Hz, 50 Hz and 60 Hz as well as 400 Hz (with automatic or manual selection of relevant measurement signal frequency),
- » selection of maximum measurement voltage (25 V and 50 V),
- » calibration of applied clamp,
- » interoperability with ERP-1 adapter.



MRU-200-GPS is the only earthing resistance and impedance meter with the function of determining the geographical coordinates of the location of measurement.

### Earthing resistance measurement:

- » impulse method (without the need to disconnect measured earth electrodes),
- » three types of measurement impulse (4/10  $\mu$ s, 8/20  $\mu$ s, 10/350  $\mu$ s)

### Soil resistivity measurements (Wenner method):

- » distances between electrodes can be input in meters (m) or feet (ft).

### Continuity tests of protective conductors and equipotential bonding:

- » with auto-zeroing function - with current  $\geq 200$  mA - according to EN 61557-4.

### Additional functions of the meter:

- » Memory storing 990 measurements (10 banks with 99 cells each).
- » Built-in GPS receiver (only MRU-200-GPS).
- » Real-time clock (RTC).
- » Data transmission to computer (USB).
- » Reading of accumulator charge state, built-in quick charger.



MRU-200 is a unique meter employing all known methods of measurement and performing measurements with a resolution of 0.001  $\Omega$ .

### Standard accessories of the meters:

NiMH accumulator (rechargeable battery) 4.8 V 4.2 Ah	WAAKU07
L-2 carrying case	WAFUTL2
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
Sone! Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 2.2 m; black	WAPRZ2X2BLBB
earthing measurement test lead with banana plugs on reel; 25m; red	WAPRZ025REBBSZ
earthing measurement test lead with banana plugs on reel; 25m; blue	WAPRZ025BUBBSZ
shielded earthing measurement test lead with banana plugs on reel; 50 m; yellow	WAPRZ050YEBBSZE
Battery charging cable for 12 V car sockets	WAPRZLAD12SAM
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
4x earth contact pin probe (30 cm)	WASONG30
meter strap (type L-2)	WAPRZSZKPL
clamp terminal (banana plug)	WAZACIMA1
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

### Earthing resistance measurement (3- and 4-lead method)

measuring range according to EN 61557-5: **0.100  $\Omega$ ...19.99 k $\Omega$**

Display range	Resolution	Accuracy
0.000...3.999 $\Omega$	0.001 $\Omega$	$\pm(2\% \text{ m.v.} + 4 \text{ digits})$
4.00...39.99 $\Omega$	0.01 $\Omega$	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$
40.0...399.9 $\Omega$	0.1 $\Omega$	
400...3999 $\Omega$	1 $\Omega$	$\pm(5\% \text{ m.v.} + 2 \text{ digits})$
4.00 k $\Omega$ ...19.99 k $\Omega$	0.01 k $\Omega$	

### Resistance measurement of multiple earthing systems with clamp (3-lead + clamp)

Display range	Resolution	Accuracy
0.000...3.999 $\Omega$	0.001 $\Omega$	$\pm(8\% \text{ m.v.} + 4 \text{ digits})$
4.00...39.99 $\Omega$	0.01 $\Omega$	$\pm(8\% \text{ m.v.} + 3 \text{ digits})$
40.0...399.9 $\Omega$	0.1 $\Omega$	
400...1999 $\Omega$	1 $\Omega$	

### Measurement of multiple earthing systems with two clamps

Display range	Resolution	Accuracy
0.00...19.99 $\Omega$	0.01 $\Omega$	$\pm(10\% \text{ m.v.} + 3 \text{ digits})$
20.0...149.9 $\Omega$	0.1 $\Omega$	$\pm(20\% \text{ m.v.} + 3 \text{ digits})$

### Measurement of earthing impedance ( $Z_E$ ) using the impulse method (4-lead)

Display range	Resolution	Accuracy
0.0...99.9 $\Omega$	0.1 $\Omega$	$\pm(2.5\% \text{ m.v.} + 3 \text{ digits})$
100...199 $\Omega$	1 $\Omega$	

### The instrument meets the requirements set forth in standards:

- » EN 62305-1 (lightning protection)
- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » number of measurements provided by set of accumulators ..... > 1200

### Nominal operating conditions:

- » operating temperature range ..... -10...+50  $^{\circ}\text{C}$
- » storage temperature ..... -20...+80  $^{\circ}\text{C}$
- » humidity ..... 20...85%



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## Earthing resistance meter

# SONEL MRU-120

index: WMGBMRU120



**CAT III** **CAT IV** **IP 54**  
**600V** **300V**

### Earthing resistance measurements:

- » with auxiliary electrodes (3-lead, 4-lead),
- » with auxiliary electrodes and clamp (for measurement of multiple earthing systems),
- » with a pair of clamps (without the need to use auxiliary electrodes),
- » frequency of measurement current: 125 Hz (for 50 Hz network) or 150 Hz (for 60 Hz network),

### Additional measurements:

- » auxiliary electrode resistances  $R_S$  and  $R_H$ ,
- » disturbance voltage,
- » frequency of disturbance signal,
- » in the presence of disturbance voltages in networks with frequencies of 50 Hz and 60 Hz,
- » selection of maximum measurement voltage (25 V or 50 V),
- » interoperability with ERP-1 adapter.

### Soil resistivity measurements (Wenner method):

- » distances between electrodes can be input in meters (m) or feet (ft).

### Continuity tests of protective conductors and equipotential bonding:

- » with auto-zeroing function - with current  $\geq 200$  mA
- » in compliance with EN 61557-4.

### Additional functions of the meter:

- » Memory storing 990 measurements (10 banks with 99 cells each).
- » Real-time clock (RTC).
- » Data transmission to computer (USB).
- » Reading of accumulator charge status, built-in quick charger.



MRU-120 makes it possible to measure earthings, even without the use of auxiliary probes, by means of the double-clamp method.

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » number of measurements provided by set of accumulators ..... > 1200

### Nominal operating conditions:

- » operating temperature range ..... -10...+50 °C
- » storage temperature ..... -20...+70 °C
- » humidity ..... 20...80%

### Standard accessories of the meter:

NiMH accumulator (rechargeable battery) 4.8 V 3 Ah for MRU-120	WAAKU08
L-2 carrying case	WAFUTL2
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
Sonel Reader software	WAPROREADER
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 2.2 m; black	WAPRZ2X2BLBB
earthing measurement test lead with banana plugs on reel; 25m; red	WAPRZ025REBBSZ
earthing measurement test lead with banana plugs on reel; 25m; blue	WAPRZ025BUBBSZ
earthing measurement test lead with banana plugs on reel; 50 m; yellow	WAPRZ050YEBBSZ
USB data transmission cable	WAPRZUSB
230 V power cord (IEC C7 plug)	WAPRZLAD230
4x earth contact pin probe (30 cm)	WASONG30
test probe with banana socket; 1 kV; red	WASONRE0GB1
meter strap (type L-2)	WAPRZSZEKPL
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

### Earthing resistance measurement (3- and 4-lead method)

measuring range according to EN 61557-5: **0.30 Ω...19.9 kΩ**

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(2% m.v. + 2 digits)
20.0...199.9 Ω	0.1 Ω	
200...1999 Ω	1 Ω	
2.0 k...9.99 kΩ	0.01 kΩ	±(5% m.v. + 4 digits)
10.0 k...19.9 kΩ	0.1 kΩ	

### Resistance measurement of multiple earthing systems with clamp (3-lead + clamp)

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(8% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	
200...1999 Ω	1 Ω	

### Measurement of multiple earthing systems with two clamps

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(10% m.v. + 3 digits)
20.0...149.9 Ω	0.1 Ω	±(20% m.v. + 3 digits)



MRU-120 allows for measurements of multiple earthing systems without disconnection of test connections, by means of the 3-lead and clamp method or double-clamp method.





# SONEL MRU-30

index: WMGBMRU30



**CAT III**  
**300V**

**IP 65**

## Earthing resistance measurements:

- » with auxiliary electrodes (3-lead and 4-lead),
- » with auxiliary electrodes and clamp (for measurement of multiple earthing systems),
- » with two clamps (for measurement of earthings where it is not possible to apply auxiliary electrodes),
- » soil resistivity (Wenner method),
- » continuity of protective conductors and equipotential bonding (meeting the requirements of EN 61557-4, with auto-zeroing function - with 200mA current).

## In addition:

- » measurement of auxiliary electrode resistances  $R_s$  and  $R_p$ ,
- » measurement of disturbance voltage,
- » measurement in the presence of disturbance voltages in networks with frequencies of 50 Hz and 60 Hz,
- » selection of maximum measurement voltage (25 V and 50 V),
- » in soil resistivity measurements, distances between electrodes can be input in meters (m) or feet (ft),
- » memory storing 990 measurements (10 banks with 99 cells each),
- » calibration of test clamps,
- » data transmission to computer (USB),
- » reading of accumulator charge status.

## Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and EN 61557
- » measurement category ..... CAT III 300V according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP65

## Nominal operating conditions:

- » operating temperature range ..... -10...+50 °C
- » storage temperature ..... -20...+50 °C
- » humidity ..... 20...85%

## Other technical specifications:

- » LCD display ..... segmented, with backlighting
- » dimensions ..... 200x150x74 mm

## Earthing resistance measurement (3- and 4-lead method)

measurement method: technical, in compliance with EN 61557-5

measuring range according to EN 61557-5:2007: **0.53 Ω...9999 Ω** (for 50 V)

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(3% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	
200...1999 Ω	1 Ω	±5% m.v.
2000...9999 Ω	1 Ω	±8% m.v.

- » measurement method: technical, 3-lead and 4-lead,
- » measurement current: >20 mA upon closing of circuit,
- » voltage on open terminals: 25 V AC or 50 V AC available for selection,
- » frequency of measurement current: 125 (for 50 Hz network) or 150 Hz (for 60 Hz network), measurement frequency can be selected in the menu.

## Standard accessories of the meter:

L-10 carrying case	WAFUTL10
M-9 carrying case	WAFUTM9
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 2.2 m; black	WAPRZ2X2BLBB
earthing measurement test lead with banana plugs on reel; 25m; red	WAPRZ025REBBSZ
earthing measurement test lead with banana plugs on reel; 50 m; yellow	WAPRZ050YEBBSZ
230 V power cord (IEC C7 plug)	WAPRZLAD230
USB data transmission cable	WAPRZUSB
test probe with banana socket; 1 kV; red	WASONREOGB1
earth contact pin probe (30 cm)	WASONG30
Sonei Reader software	WAPROREADER
clamp terminal with banana plug termination	WAZACIMA1
meter power adapter (type Z7)	WAZASZ7
calibration certificate	

## Resistance measurement of multiple earthing systems with clamp and auxiliary electrodes (3-lead + clamp)

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(3% m.v. + 3 digits)
20.0...199.9 Ω	0.1 Ω	
200...1999 Ω	1 Ω	±5% m.v.
2000...9999 Ω	1 Ω	±8% m.v.

- » measurement method: technical with the use of clamp and auxiliary electrodes,
- » voltage on open terminals: 25 V AC or 50 V AC available for selection,
- » measurement current: >20 mA upon closing of circuit,
- » frequency of measurement current: 125 (for 50 Hz network) or 150 Hz (for 60 Hz network), manual selection of measurement frequency

## Resistance measurement of multiple earthing systems with two clamps

Display range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	±(10% m.v. + 8 digits)
20.0...199.9 Ω	0.1 Ω	±(20% m.v. + 3 digits)

- » measurement current frequency 125 Hz (for 50 Hz network) or 150 Hz (for 60 Hz network)

## Wenner method of measurement: soil resistivity measurement $\rho=2\pi L R_e$

Display range	Resolution	Accuracy
0.00...9.99 Ωm	0.01 Ωm	depends on accuracy of $R_e$ measurement in 4-lead system, but no lower than ±1 digit
10.0...99.9 Ωm	0.1 Ωm	
100...999 Ωm	1 Ωm	
1.00...9.99 kΩm	0.01 kΩm	
10.0...99.9 kΩm	0.1 kΩm	
100...999 kΩm	1 kΩm	

L – distance between measurement probes: 1...50 m

## Measurement of auxiliary electrode resistances $R_s$ and $R_p$

Display range	Resolution	Accuracy
0...999 Ω	1 Ω	±(5%( $R_s+R_e+R_p$ ) + 8 digits)
1.00k...9.99 kΩ	0.01 kΩ	
10.0...19.9 kΩ	0.1 kΩ	

## Continuity test of protective and equalizing connections

measuring range according to EN 61557-4:2007: 0.13 Ω...1999 Ω

Display range	Resolution	Accuracy
0.00...9.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
10.0...99.9 Ω	0.1 Ω	
100...1999 Ω	1 Ω	

- » method of measurement: technical two-lead,
- » measurement current: >200mA upon closing of circuit,
- » auto-zeroing of test leads.

## Measurement of disturbance voltage $U_N$ (RMS)

Display range	Resolution	Accuracy
0...100 V	1 V	±(5% m.v. + 2 digits)

## SONEL MRU-20

index: WMGBMRU20



CAT III

600V

CAT IV

300V

IP 54

## SONEL MRU-21

index: WMGBMRU21



CAT III

600V

CAT IV

300V

IP 54

### Earthing resistance measurement:

- » with auxiliary electrodes by means of the 3-lead method, measurement for auxiliary electrode resistance up to a maximum of 50 kΩ,

### In addition:

- » measurement of auxiliary electrode resistances  $R_s$  and  $R_H$ ,
- » measurement of disturbance voltage,
- » measurement in the presence of disturbance voltages in the network,
- » selection of maximum measurement voltage (25 V and 50 V).

### 2-lead resistance measurement:

- » auto-zeroing of test leads

### Continuity test of protective conductors and equipotential bonding:

- » meeting the requirements of EN 61557-4, with auto-zeroing function - with 200 mA current.

### Additional functions of the meters:

- » Memory storing up to 990 results, data transmission to computer via USB cable (MRU-21).
- » Reading of battery or accumulator charge status.
- » Power supply from batteries or accumulators (rechargeable batteries).
- » Automatic power down after 5 minutes.



MRU-21 and MRU-20 are the simplest earthing meters, performing measurements in compliance with standard EN 62305.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and PEN 61557
- » LCD display ..... segmented, with backlighting
- » number of measurements provided by set of alkaline batteries ..... 1000 (5 Ω, 2 measurements/min.)
- » dimensions ..... 288x223x75mm
- » weight including batteries ..... 1.4 kg
- » this product meets EMC requirements in compliance with standards ..... EN 61326-1:2006 and EN 61326-2-2:2006
- » power supply of the meter ..... 4 x 1.5 V batteries or type C accumulators (MRU-21)  
8 x AA batteries or accumulators (MRU-20)



MRU-20 has improved resistance to adverse environmental conditions.

### Nominal operating conditions:

- » operating temperature ..... -10...+55 °C
- » storage temperature ..... -20...+70 °C
- » humidity ..... 20...80%

### Standard accessories of the meter:

L-4 carrying case	WAFUTL4
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
battery container (MRU-21)	WAP0J1
battery container (MRU-20)	WAP0J2
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
earthing measurement test lead with banana plugs on reel; 15 m; blue	WAPRZ015BUBBSZ
test lead with banana plugs; 1 kV; 2.2 m; black	WAPRZ2X2BLBB
earthing measurement test lead with banana plugs on reel; 30 m; red	WAPRZ030REBBSZ
USB data transmission cable (MRU-21)	WAPRZUSB
Sonel Reader software	WAPR0READER
meter strap (type L-1) (MRU-20)	WAP0ZSZE2
meter strap (type L-2) (MRU-21)	WAP0ZSZEKPL
calibration certificate	

### Earthing resistance measurement (3-lead)

measuring range according to EN 61557-5:

**0.50 Ω...1.99 kΩ** for  $U_n=50$  V; **0.68 Ω...1.99 kΩ** for  $U_n=25$  V;

Display range	Resolution	Accuracy
0.00...9.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
10.0...99.9 Ω	0.1 Ω	
100...999 Ω	1 Ω	
1.00k...1.99 kΩ	0.01 kΩ	

- » measurement current: >20 mA upon closing of circuit
- » frequency of measurement current: 125 Hz

### Continuity test of protective and equalizing connections

measuring range according to EN 61557-4: **0.13 Ω...199 Ω**

Display range	Resolution	Accuracy
0.00...9.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
10.0...99.9 Ω	0.1 Ω	
100...199 Ω	1 Ω	

### Instruments meet the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)

## Earthing resistance meter

# SONEL MRU-10

index: WMGBMRU10



**CAT IV**

**150V**

**IP 67**

### It allows to take the measurements of:

- » earthing resistance using auxiliary electrodes,
- » earthing resistance using 2-pole method,
- » interference voltage to 100 V,
- » resistance of auxiliary electrodes  $R_H$  and  $R_S$ .

### Additionally:

- » indication of battery state,
- » selection of maximum measuring voltage (25 V and 50 V),
- » Auto-OFF function.

### Standard accessories of the meter:

test lead 30 m, yellow, for MRU (banana plugs, on H-frame reel)	WAPRZ030YEBBN
test lead 15 m, red, for MRU (banana plugs, on H-frame reel)	WAPRZ015REBBN
test lead 2,2 m, black, 1 kV (banana plugs)	WAPRZ2X2BLBB
crocodile clip, black, 1 kV, 20 A	WAKROBL20K01
earth contact test probe (rod) 25 cm, (2 pieces)	WASONG25
M6 carrying case	WAFUTM6
M1 hanging straps	WAPOZSZE4
M1 hanging hook straps	WAPOZUCH1
user manual	
alkaline batteries 1.5V AA, LR6 (4 pieces)	
calibration certificate issued by production laboratory	

### Electric security

- » type of insulation ..... double, according to EN 61010-1 and IEC 61557
- » measurement category ..... CAT IV 150 V wg EN 61010-1
- » protection class acc. to EN 60529 ..... IP67

### Rated operational conditions

- » operation temperature ..... -10...+50°C
- » storage temperature ..... -20...+60°C
- » reference temperature ..... +23 ±2°C
- » humidity ..... 20...90%

### Other technical data:

- » power supply ..... alkaline batteries or NiMH rechargeable batteries size AA (4 pcs.)
- » LCD display ..... segment, backlit
- » dimensions ..... 221 x 102 x 62 mm
- » weight with batteries ..... approx. 660 g

### Measurement of earthing resistance (method 3-pole) $R_E$ 3p

measurement range to IEC 61557-5:2007: 0,53 Ω...9999 Ω for  $U_n=50V$

Display range	Resolution	Accuracy
0,00...19,99 Ω	0,01 Ω	±(3% m.v. + 3 digits)
20,0...199,9 Ω	0,1 Ω	
200...1999 Ω	1 Ω	±5% m.v.
2000...9999 Ω	1 Ω	±8% m.v.

- » Measurement current: under short circuit >20mA.
- » Frequency of measurement current: 125 Hz (for networks 50 Hz) and 150 Hz (for networks 60 Hz).
- » Voltage on open terminals: selectable 25 V AC or 50 V AC.

### Measurement of earthing resistance (method 2-pole) $R_E$ 2p

Display range	Resolution	Accuracy
0,00...19,99 Ω	0,01 Ω	±(3% m.v. + 3 digits)
20,0...199,9 Ω	0,1 Ω	
200...1999 Ω	1 Ω	±5% m.v.
2000...9999 Ω	1 Ω	±8% m.v.

- » Measurement current: under short circuit >20mA.
- » Frequency of measurement current: 125 Hz (for networks 50 Hz) and 150 Hz (for networks 60 Hz).
- » Voltage on open terminals: selectable 25 V AC or 50 V AC.

### Measurement of resistance of auxiliary electrodes $R_H$ i $R_S$

Display range	Resolution	Accuracy
0...999 Ω	1 Ω	±(5% m.v. + 8 digits)
1,00 k...9,99 kΩ	0,01 kΩ	
10,0 k...19,9 kΩ	0,1 kΩ	

### Measurement of interference voltage $U_N$ (RMS)

Display range	Resolution	Accuracy
0...100 V	1 V	±(10% m.v. + 1 digit)





## SONEL ERP-1

index: WAADAERP1 / WAADAERP1V2 / WAADAERP1V3



CAT IV

300V

IP 67

### Earth resistance measurements

**The Sonek ERP-1 adapter serves for earth resistance measurement of e.g. transmission towers by means of flexible clamp - Rogowski coil.**

It is adapted for operation with earth resistance meters from Sonek S.A., which provide the user with the capability of measurement by means of the 3-lead and clamp method. The adapter's ergonomic and convenient housing as well as its simple operation make earth resistance measurements of transmission towers and pylons quick and problem-free.

**The adapter is compatible with meters:**      **Contents of set:**

- » Sonek MRU-120,
- » Sonek MRU-200,
- » Sonek MRU-200-GPS
- » Sonek ERP-1 adapter
- » 3x AA (LR6) 1.5 V battery
- » Instruction Manual

### Set of instruments for earth measurements

	MRU-200/GPS	MRU-120	MRU-30	MRU-21	MRU-20	MRU-10	MPI-525/520/520S	MPI-530/530-IT
Earth resistance measurement according to 3-lead method	YES	YES	YES	YES	YES	YES	YES	YES
Earth resistance measurement according to 4-lead method	YES	YES	YES	—	—	—	—	YES
Maximum resolution [Ω]	0.001	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Measurement of multiple earthing systems according to the technical method using an additional clamp	YES	YES	YES	—	—	—	—	YES
Earth measurement according to impulse method	YES	—	—	—	—	—	—	—
Earth measurement according to double-clamp method	YES	YES	YES	—	—	—	—	YES
Current measurement with clamp	YES	—	YES	—	—	—	MPI-520/520S	YES
Current measurement with flexible clamp (Rogowski coil)	YES	—	—	—	—	—	NO/YES/YES	YES
Continuity test of protective conductors and equipotential bonding according to standard EN 61557	YES	YES	YES	YES	YES	—	YES	YES
Soil resistivity measurement	YES	YES	YES	—	—	—	—	YES
Internal power source	YES	YES	YES	YES	YES	YES	YES	YES
Resistance measurement	YES	YES	YES	YES	YES	YES	YES	YES
Quick charger, accumulator	YES	YES	YES	—	—	—	YES/OPTIONAL/OPTIONAL	YES
Charging from car lighter socket	YES	OPTIONAL	OPTIONAL	—	—	—	OPTIONAL	YES
Memory (records)	990	990	990	990	—	—	990	10,000
Measurement of disturbance voltages	YES	YES	YES	YES	YES	YES	YES	YES
Resistance measurement of auxiliary probes	YES	YES	YES	YES	YES	YES	YES	YES
Dimensions [mm]	288 x 223 x 75	288 x 223 x 75	200 x 180 x 74	288 x 223 x 75	260 x 190 x 60	221 x 102 x 62	288 x 223 x 75	288 x 223 x 75
Weight [kg]	2	2	1.2	1.4	1.3	0.7	2.2	2.2

#### Additional accessories:

FSX-3 flexible clamp	WACEGFSX30KR
FS-2 flexible clamp	WACEGFS20KR
XL8 hard briefcase	WAWALXL8
M6 adapter carrying case	WAFUTM6

#### Bundle sets:

ERP-1 adapter	WAADAERP1
ERP-1 adapter with FS-2 flexible clamp and carrying case	WAADAERP1V2
ERP-1 adapter with FSX-3 flexible clamp and carrying case	WAADAERP1V3

#### Other specifications:

- » storage temperature ..... -20...+80 °C
- » relative humidity of storage ..... 20...85%
- » operating temperature range ..... -10...+50 °C
- » operating humidity ..... 20...85%
- » exterior dimensions ..... 88 x 33 x 146 mm
- » weight with batteries / without batteries ..... 340 g / 270 g
- » protection rating ..... IP67

#### Electrical specifications:

- » measuring range ..... up to 5 A
- » operating frequency ..... 125 Hz (in 50 Hz networks),  
150 Hz (in 60 Hz networks)
- » power supply ..... 3 x LR6 1.5 V battery or 3 x Ni-MH LR6 1.2 V accumulator
- » measurement category ..... CAT IV 300 V according to PN 61010-1

## SONEL MRP-201

index: WMGBMRP201



CAT III

600V

CAT IV

300V

IP 67

### Measurement of residual current devices of all types: AC, A, B:

- » measurement of no-delay, short-time delay and selective RCDs with nominal residual currents  $I_{\Delta n} = 10, 30, 100, 300$  and  $500$  mA,
- » measurement of trip current  $I_A$  and tripping time  $t_A$  at currents  $0.5I_{\Delta n}, 1I_{\Delta n}, 2I_{\Delta n}, 5I_{\Delta n}$ ,
- » simultaneous measurement of trip current  $I_A$  and tripping time  $t_{A\Delta}$ ,
- » measurement of  $R_E$  and  $U_B$  without RCD tripping,
- » AUTO RCD measurement function (automatic measurement of successive selected parameters without the need for triggering),
- » automatic measurement of AC, A and B type RCDs for all current shapes.



MRP-201 measures residual current devices of all types (general, selective, short-time delay - type AC, A, B).

### Additional functions of the meter:

- » Measurement of alternating voltage and frequency.
- » Check of proper protective conductor connection.
- » Memory for measurement results (990 cells, 10,000 entries).
- » Communication with computer via Bluetooth
- » Backlit keyboard.

### The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-E 04700 (performance of measurements - commissioning tests)



MRP-201 has two automatic measurement modes which are particularly useful for measurements of type A and B RCDs.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and PN 61557
- » power supply of the meter ..... alkaline batteries (size AA, 4 pcs.) or accumulator pack (optional)
- » weight ..... 1 kg
- » dimensions ..... 220 x 98 x 58 mm

### Nominal operating conditions:

- » operating temperature range ..... -10...+50 °C
- » storage temperature ..... -20...+70 °C
- » humidity ..... 20...80%

### Standard accessories of the meter:

WS-05 adapter with UNI-SCHUKO angle plug	WAADAWS05
test lead with banana plug terminations; 1.2m; yellow	WAPRZ1X2YEBB
test lead with banana plug terminations; 1.2m; red	WAPRZ1X2REBB
test lead with banana plug terminations; 1.2m; blue	WAPRZ1X2BUBB
"crocodile" clip K02 (CAT III 1000V)	WAKROYE20K02
test probe with banana socket; red (CAT IV 1000V)	WASONREOGB1
test probe with banana socket; blue (CAT IV 1000V)	WASONBUOGB1
M6 carrying case for meter and accessories	WAFUTM6
meter carry strap	WAP0ZSZE4
OR-1 radio data transmission module	WAADAUSBOR1
meter hook hanger	WAP0ZUCH1
4 R6 batteries	
Soneil Reader software	WAPROSONEL
calibration certificate	

### RCD trip test and measurement of tripping time $t_A$

Measuring range according to IEC 61557-6: 0 ms...up to upper limit of displayed value

RCD type	Factor	Measuring range	Resolution	Accuracy
General or short-time delay	$0.5 \cdot I_{\Delta n}$	0...300 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$
	$1 \cdot I_{\Delta n}$	0...150 ms		
	$2 \cdot I_{\Delta n}$	0...40 ms		
Selective	$5 \cdot I_{\Delta n}$	0...500 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$
	$1 \cdot I_{\Delta n}$	0...200 ms		
	$2 \cdot I_{\Delta n}$	0...150 ms		

- » accuracy of residual current input: for  $1 \cdot I_{\Delta n}$ ,  $2 \cdot I_{\Delta n}$  and  $5 \cdot I_{\Delta n}$ : 0...8%; for  $0.5 \cdot I_{\Delta n}$ : -8...0%,
- » operating voltage range: 180...270 V,
- » operating frequency range: 45 Hz...65 Hz.

### Measurement of RCD trip current $I_A$ for sinusoidal residual current

Measuring range according to IEC 61557-6:  $(0.3...1.0)I_{\Delta n}$

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	$0.3 \times I_{\Delta n} \dots 1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
30 mA	9.0...30.0 mA			
100 mA	33...100 mA	1 mA	$0.3 \times I_{\Delta n} \dots 1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
300 mA	90...300 mA			
500 mA	150...500 mA			

- » measurement can be started from the positive or negative half-period of the input leakage current,
- » max. measurement current flow time at  $f = 50.0$  Hz: 7510 ms.

### Measurement of RCD trip current $I_A$ for uni-directional pulsating residual current and uni-directional pulsating current with 6 mA direct current offset

Measuring range according to IEC 61557-6:  $(0.15...1.4)I_{\Delta n}$  for  $I_{\Delta n} > 30$  mA and  $(0.15...2)I_{\Delta n}$  for  $I_{\Delta n} = 10$  mA

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	1.5...20.0 mA	0.1 mA	$0.15 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	4.5...42.0 mA			
100 mA	15...140 mA	1 mA	$0.15 \times I_{\Delta n} \dots 1.4 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
300 mA	45...420 mA			

- » measurement can be started from a positive or negative half-period of the input leakage current
- » max. measurement current flow time at  $f = 50.0$  Hz: 14710 ms.

### Measurement of RCD trip current $I_A$ for direct residual current

Measuring range according to IEC 61557-6:  $(0.2...2)I_{\Delta n}$

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	2.0...20.0 mA	0.1 mA	$0.2 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	6...60 mA			
100 mA	20...200 mA	1 mA	$0.2 \times I_{\Delta n} \dots 2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
300 mA	60...600 mA			

- » measurement is possible for positive or negative leakage current,
- » max. measurement current flow time at  $f = 50.0$  Hz: 4500 ms.

		MPI-530/530T	MPI-525	MPI-520	MPI-520S	MPI-505	MIC-10K1	MIC-5050	MIC-5010	MIC-5001	MIC-2510	MIC-2505	MIC-2501	MIC-30	MIC-10	MIC-2	MPI-201	MRU-20	MRU-21	MRU-30	MRU-120	MRU-200	MRU-206GPS	MZC-305	MZC-304	MZC-306	MZC-310S	MZC-20E	MMR-620	MMR-630	MMR-650	
list of standard meter accessories	index																															
Adapter – USB / RS-232 converter	WAADAUSBRS232																															
Three-phase socket adapter AGT-16C	WAADAAGT16C	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
Three-phase socket adapter AGT-16P	WAADAAGT16P	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
AGT-16T adapter (adapter for industrial sockets)	WAADAAGT16T	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
Three-phase socket adapter AGT-32C	WAADAAGT32C	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
Three-phase socket adapter AGT-32P	WAADAAGT32P	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
AGT-32T adapter (adapter for industrial sockets)	WAADAAGT32T	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
Three-phase socket adapter AGT-63P	WAADAAGT63P	.	.	.	.	.	.							.	.	.	.								.	.	.	.	.	.	.	
AUTO ISO-1000C adapter	WAADAAISO10C	.	.	.	.	.	.																		.	.	.	.	.	.	.	
AUTO ISO-2500 adapter	WAADAAISO25	.	.	.	.	.	.			.															.	.	.	.	.	.	.	
AUTO ISO-5000 adapter	WAADAAISO5						.	.																	.	.	.	.	.	.	.	
ERP-1 adapter for earth resistance measurements of power pylons	WAADAERP1							.	.															.	.	.	.	.	.	.	.	
ERP-1 adapter for earth resistance measurements of power pylons + FS-2 clamp	WAADAERP1V2																							.	.	.	.	.	.	.	.	
ERP-1 adapter for earth resistance measurements of power pylons + FSX-3 clamp	WAADAERP1V3																							.	.	.	.	.	.	.	.	
AC-16 phase splitter adapter	WAADAAC16	.	.	.	.	.	.																.	.	.	.	.	.	.	.	.	
TWR-1J adapter (RCD trip testing adapter)	WAADATWR1J	.	.	.	.	.	.										.							.	.	.	.	.	.	.	.	
WS-01 adapter for triggering measurement (UNI-Schuko plug)	WAADAWS01					1	.										.							.	.	.	.	.	.	.	.	
WS-03 adapter for triggering measurement (UNI-Schuko plug)	WAADAWS03	1	1	1	1																				.	.	.	.	.	.	.	
WS-04 adapter (UNI-Schuko angle plug)	WAADAWS04	.	.	.	.									.											.	.	.	.	.	.	.	
WS-05 adapter (UNI-Schuko angle plug)	WAADAWS05					.	1										1								1	1	1					
WS-06 adapter (PS/2 plug)	WAADAWS06	.																														
WS-07 adapter for measurement of loop impedance Z(L-N)	WAADAWS07																								.	.	.	.	.	.	.	.
NiMH accumulator (rechargeable battery) 4.8V 3Ah for MMR	WAAKU03																														1	1
NiMH accumulator 4.8V 3Ah for MRU-120	WAAKU08																															



list of standard meter accessories	index	MPH 530/530IT	MPH 525	MPH 520	MPH 520S	MPH 505	MPH 502	MIC-10K1	MIC-5050	MIC-5010	MIC-5005	MIC-5001	MIC-2510	MIC-2505	MIC-2501	MIC-30	MIC-10	MIC-2	MRP-201	MRU-20	MRU-21	MRU-30	MRU-120	MRU-200	MRU-200-GPS	MZC-305	MZC-304	MZC-306	MZC-310S	MZC-20E	MMR-620	MMR-630	MMR-650		
Earthing measurement test lead on reel; 25m; red (banana plugs)	WAPRZ025REBBSZ																																		
Earthing measurement test lead on reel; 25m; blue (banana plugs)	WAPRZ025BUBBSZ																																		
Shielded test lead with banana plugs; 11 kV; 3 m; black	WAPRZ003BLBBE10K																																		
Test lead with banana plugs; 11 kV; 3 m; red	WAPRZ003REBB10K																																		
Two-core lead; 3m (10 / 25 A) U1/I1	WAPRZ003DZBBU1I1																																		
Two-core lead; 3m (10 / 25 A) U2/I2	WAPRZ003DZBBU2I2																																		
Test lead with banana plugs; 11 kV; 3 m; blue	WAPRZ003BUBB10K																																		
Earthing measurement test lead on reel; 30 m; red (banana plugs)	WAPRZ030REBBSZ																																		
Shielded test lead with banana plugs; 1 kV; 5 m; black	WAPRZ005BLBBE																																		
Shielded test lead with banana plugs; 11 kV; 5 m; black	WAPRZ005BLBBE10K																																		
Shielded test lead with banana plugs; 5 kV; 5 m; black	WAPRZ005BLBBE5K																																		
Test lead with banana plugs; 1 kV; 5 m; red	WAPRZ005REBB																																		
Test lead with banana plugs; 11 kV; 5 m; red	WAPRZ005REBB10K																																		
Test lead with banana plugs; 5 kV; 5 m; red	WAPRZ005REBB5K																																		
Test lead with banana plugs; 1 kV; 5 m; blue	WAPRZ005BUBB																																		
Test lead with banana plugs; 11 kV; 5 m; blue	WAPRZ005BUBB10K																																		
Test lead with banana plugs; 5 kV; 5 m; blue	WAPRZ005BUBB5K																																		
Test lead with banana plugs; 1 kV; 5 m; yellow	WAPRZ005YEBB																																		
Earthing measurement test lead with banana plugs on reel; 50 m; yellow	WAPRZ050YEBBSZ																																		
Shielded earthing measurement test lead with banana plugs on reel; 50 m; yellow	WAPRZ050YEBBSZE																																		
Earthing measurement test lead on reel; 75 m; red	WAPRZ075REBBSZ																																		
Earthing measurement test lead on reel; 75 m; blue	WAPRZ075BUBBSZ																																		
Earthing measurement test lead on reel; 75 m; yellow	WAPRZ075YEBBSZ																																		
Shielded earthing measurement test lead on reel; 75 m; yellow	WAPRZ075YEBBSZE																																		
Battery charging cable for 12 V car lighter sockets	WAPRZLAD12SAM																																		
Accumulator charging cable (IEC C13 plug)	WAPRZLAD230IEC																																		
USB data transmission cable	WAPRZUSB																																		
RS-232 serial transmission cable	WAPRZRS232																																		
230 V power cord (orange IEC C13 plug)	WAPRZ1X8REIEC																																		
230 V power cord (IEC C13 plug)	WAPRZ1X8BLIEC																																		
230 V power cord (IEC C19 plug)	WAPRZZAS1																																		
230 V power cord (IEC C7 plug)	WAPRZLAD230																																		
LAN network cable terminated by RJ45 plugs	WAPRZRJ45																																		
5 kV calibration box	WAADACSSKV																																		
PRS-1 probe for measurement of floor and wall resistances	WASONPRS1PL																																		
ST-1 temperature measurement probe	WASONT1																																		
ST-3 temperature measurement probe	WASONT3																																		
Earth contact pin probe (15 cm)	WASONG15																																		
Earth contact pin probe (26 cm)	WASONG26																																		
Earth contact pin probe (30 cm)	WASONG30																																		
Earth contact pin probe (80 cm)	WASONG80																																		
Double-tip Kelvin probe (banana sockets)	WASONKEL20GB																																		
Probe of LP-1 luxmeter (PS/2 plug)	WAADALP1																																		
Probe of LP-1 luxmeter + adapter (WS-06 plug)	WAADALP1KPL																																		
Probe of LP-10A luxmeter (PS/2 plug)	WAADALP10A																																		
Probe of LP-10A luxmeter + adapter (WS-06 plug)	WAADALP10AKPL																																		
Probe of LP-10B luxmeter (PS/2 plug)	WAADALP10B																																		
Probe of LP-10B luxmeter + adapter (WS-06 plug)	WAADALP10BKPL																																		
Test probe with banana socket; 1 kV; black	WASONBLOGB1																																		
Test probe with banana socket; 11 kV; black	WASONBLOGB11																																		
Test probe with banana socket; 5 kV; black	WASONBLOGB2																																		
Test probe with banana socket; 1 kV; red (2 m, extendable)	WASONSP2M																																		
Test probe with banana socket; 1 kV; red	WASONREOGB1																																		
Test probe with banana socket; 11 kV; red	WASONREOGB11																																		
Test probe with banana socket; 5 kV; red	WASONREOGB2																																		
Test probe with banana socket; 1 kV; blue	WASONBUOGB1																																		
Test probe with banana socket; 1 kV; yellow	WASONYEOGB1																																		
High-current probe with banana sockets; 1 kV	WASONSPGB1																																		
CS-1 cable simulator	WAADACS1																																		
Meter strap (type L-1)	WAPQZSZ2																																		
Meter strap (type L-2)	WAPQZSZ2KPL																																		
Meter strap (type M-1)	WAPQZSZ4																																		
Meter strap (Unisonel type)	WAPQZSZ1																																		
Meter strap (type W-1)	WAPQZSZ5																																		
Reel for winding test lead	WAPQZSZP1																																		
Ribbon / paper for SATO printer (with glue)	WANAKD2																																		
Color ribbon for SATO printer	WANAKD2BAR																																		
Hard briefcase for ERP-1	WAWALXL8																																		
Hard briefcase for MRU-200	WAWALXL3																																		
Hard briefcase for UV-260	WAWALXL11																																		

# Non-contact temperature measurements

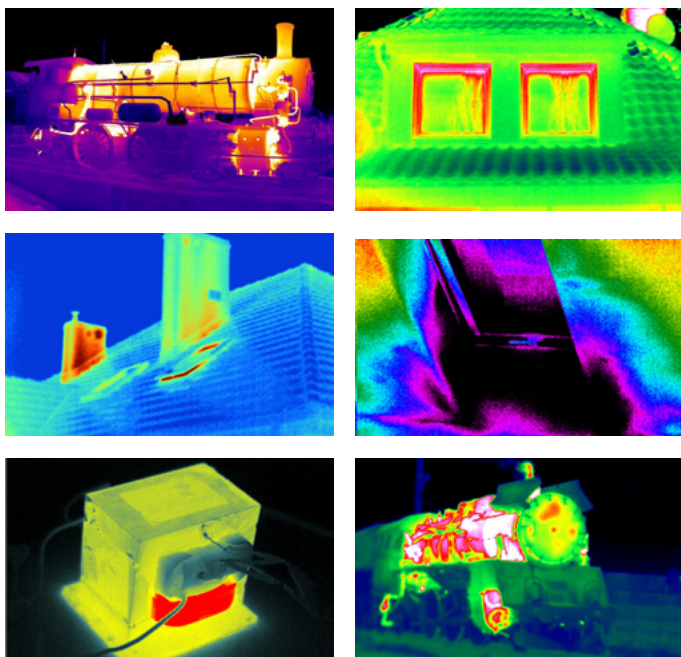


Thermal imaging is a process based on processing infrared radiation, or the heat emitted by objects, into a visible image, making it possible to assess temperature distribution on the surface of the observed object without contact.

This is important wherever it is necessary to measure temperature at inaccessible or hazardous locations and also allows for quick temperature measurement on surfaces of any size or lightning-fast location of heat escape points invisible to the naked eye related to failures in buildings' insulation and construction errors – thermal bridges for example.

In thermographic analysis, contactless measurement in the infrared spectrum is employed to determine the temperature of a surface from a distance. Since all objects with a temperature above absolute zero emit thermal radiation of similar characteristics (called black-body radiation), by measuring the radiation and with knowledge of the emissivity coefficient of a given object, its temperature can be determined.

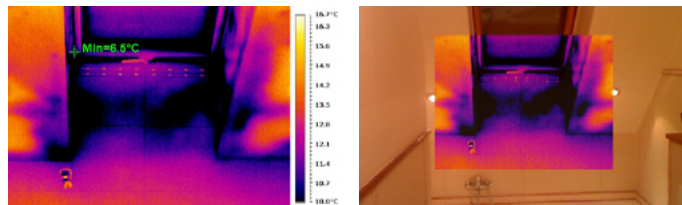
Professional radiometric thermal imaging cameras register temperature separately for each point of the image. For example, in the case of a camera with a 384 x 288 resolution, temperature is registered simultaneously for each of the 110,592 points. This makes it possible to conduct detailed analysis of saved thermal images, which display different temperatures as different colors.



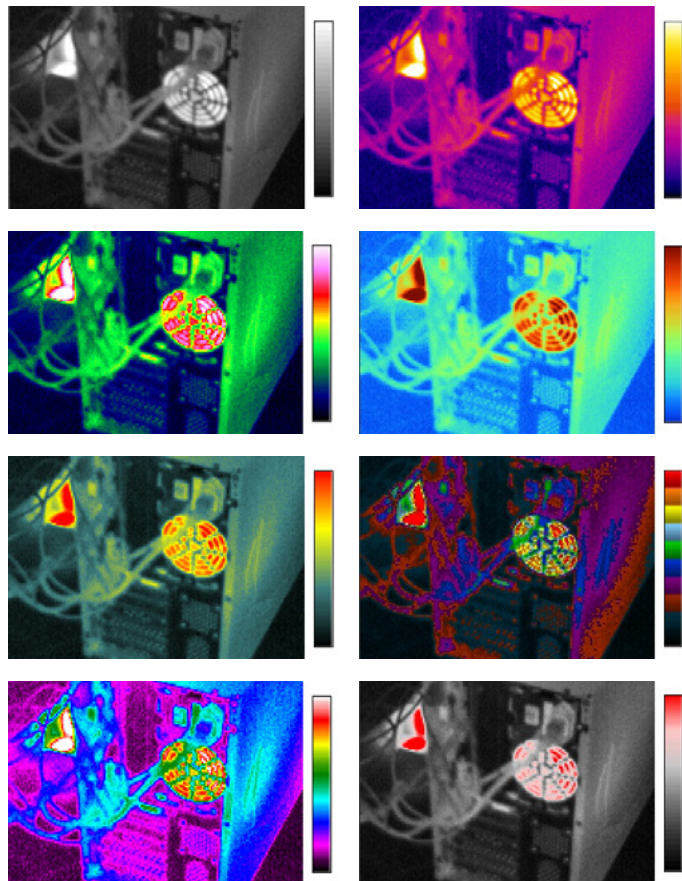
All information saved in a thermogram can be used by specialized software delivered with the thermal imaging camera. During analysis of a thermogram, points with maximum or minimum temperature can be determined, the emissivity coefficient of the whole thermogram or a part of it can be corrected, temperature can be read at any point of the thermogram, mean temperature can be calculated, temperature distribution can be presented in the form of histograms or isotherms, the thermal image can be combined with the real image, just as on the screen of the

camera, which makes it possible to precisely locate places with a specific temperature, and the color palette can be changed arbitrarily to best represent the temperature distribution.

One useful function of thermal imaging cameras is the capability of taking real-life photographs as well as combined image modes enabling combination of the real-life image with the thermal image and displaying an image in which the thermal image overlaps with the real-life image.



A thermal image is presented on-screen in the color palette selected by the user that best represents individual temperature ranges:



Pyrometers are also devices that serve for contactless temperature measurement, and they operate on the basis of analysis of the thermal radiation emitted by the tested object. These devices are applied whenever it is required to measure the temperature of a given object from a distance and where the temperature value at a given point is more important than the temperature distribution throughout the entire object.

The parameters characterizing a pyrometer are: measured temperature ranges, accuracy and distance-to-spot ratio. The narrower the beam, the smaller the spot will be at a given distance, enabling temperature measurement of small, distant objects.





## Thermal imagers

# SONEL KT-670 / KT-650 / KT-560

index: WMXXKT670 / WMXXKT650 / WMXXKT560



IP 54

WiFi

TOUCH SCREEN

	KT-560	KT-650	KT-670
Detector type	400x300	640x480	
Spectral range		8~14um	
Sensitivity	50 mK	40 mK	30 mK
Lens (field of vision / focal distance)	22.6°*17.1°/25 mm (optionally: 42.1°*32.2°/13 mm and 10.4°*7.8°/55 mm)	24.6°*18.5°/25 mm (optionally: 45.4°*34.9°/13 mm and 11.3°*8.5°/55 mm)	
Display	high-quality 5", 1280*720, touch-screen LCD		
Viewfinder	1280*960 LCOS		
Image mode	IR/ Visual / MIF/PIp Infravision		
Zoom	1...4	1...10	
Temperature range	Filter 1: -20 °C...250 °C, Filter 2: 200 °C...800 °C, Optionally: 2000 °C		
Accuracy	±2 °C or 2% of reading (optionally 1 °C or 1% for the range of 0...250 °C)		
Image analysis mode	5 points, 2 lines, 5 areas. Temperature readings: min., max., mean. Isotherms. Dew point. Temp. alarm	8 points, 8 lines, 8 areas. Temperature readings: min., max., mean. Isotherms. Dew point. Temp. alarm	10 points, 10 lines, 10 areas. Temperature readings: min., max., mean. Isotherms. Dew point. Temp. alarm
Palettes	8	10	
Emissivity coefficient	Set from 0.01 to 1.00 or selected from a list of materials		
Measurement correction	Configurable distance, relative humidity, reflected temperature		
Image file format	JPG		
Notes on IR images	Audio (60s), text, graphical		Audio (60s), text, graphical, additional visual photographs
Reports module	PDF reports, report printing via WiFi		
Video file format	H.264 (with temperature data)		
Built-in functions	5MP visual photo camera, LED flashlight, GPS, laser pointer, microphone, speaker, digital compass, lighting sensor.		
Wireless communication	WiFi		WiFi + Bluetooth
Interfaces	SD memory card port, 1 Gb/s LAN, mini HDMI, micro USB 2.0		
Power supply	Li-ion battery (operating time >4 hours), built-in charger, AC power adapter 110-230 V, 50/60 Hz		
Operating temperature range	-15 °C...50 °C		
Storage temperature	-40 °C...70 °C		
Humidity	10%...95%		
Resistance to shocks / vibrations	25G, IEC 60068-2-29/ 2G, IEC 60068-2-6		
Housing	IP54		
Weight	approx. 1.3 kg (with battery)		

## Features:

Based on IR image sensor with 640x480 pixel resolution (KT-560: 400x300) enables high-quality registration of fully radiometric IR images. The new model combines high quality measurement specifications with innovative and intuitive interface software based on a new operating system, creating an intelligent solution in the field of thermal imaging tests. Operating the camera by means of its large, movable touch display is very convenient, and together with the tilting part of the body containing a high-class lens, this is an ideal solution that takes convenience of the camera's use to new heights, particularly at locations where the instrument cannot be held in the standard manner. Strong outdoor lighting is no longer a problem thanks to the application of a built-in viewfinder. Besides IR, visual and PIP mode, the camera has a new image mixing mode, superimposing contours of the visible image onto the IR image. The user can also choose to take static photographs or record video. The series of software tools that is available allows for image analysis in the camera itself, including in live image mode. Every saved IR image can additionally be assigned a description: text, audio and/or graphical. Thanks to its built-in GPS and compass, the camera automatically saves the location where the image was taken. On-site reporting is made possible by a built-in editor of reports in PDF format. The camera has a series of capabilities in terms of connecting to external devices, both wired (LAN, USB, HDMI) and wireless (Wi-Fi, Bluetooth).



Imagers have built-in tools for analysis and generating reports.

## Camera features:

- » image files saved in jpg format (complete image data)
- » recording of IR videos (on SD memory card or computer hard disk)
- » built-in reports module
- » new image combining mode: MIF
- » extensive image analysis tools
- » built-in camera for capturing images within the visible light spectrum: 5 Mpix
- » built-in: GPS, digital compass, LED flashlight, laser pointer
- » interfaces: Micro USB 2.0, Wi-Fi, Gigabit Ethernet, Mini HDMI and SD memory card slot (KT-670: Bluetooth)
- » image refresh rate 50/60 Hz
- » 10x digital zoom for KT-670, 4x for KT-560 and KT-650
- » stable and clear images without a tripod

## Standard imager accessories:

Li-ion accumulator (rechargeable battery) 11.1 V 2.9 Ah x2	WAAKU18
M-11 carrying case	WAFUTM11
16 GB SD memory card	WAPQZSD16
neck strap	WAPQZPAS3
micro-USB data transmission cable	WAPRZUSBMICRO
LAN network cable terminated by RJ45 plugs	WAPRZRJ45
HDMI cable	WAPRZHDMI
hard briefcase	WAWALXL9
power adapter	WAZASZ13
external accumulator charger (KT-670)	WAZASZ14
calibration certificate	

ThermoAnalyze2® software



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## SONEL KT-80 / KT-145

index: WMGBKT80 (KT-80) / WMGBKT145V11 (KT-145v11)



### Common features of KT-80 and KT-145

Radiometric camera	Temperature registered for every point of the image
File format:	JPG with thermogram data
Detector type:	FPA microbolometer (160x120 pixels in KT-145, 80x80 in KT-80)
Spectral range:	8...14 μm
Thermal sensitivity:	≤0.1 °C at 30 °C
Accuracy:	±2 °C or ±2% of reading
Emissivity coefficient	Adjustable from 0.01 to 1.00 (in steps of 0.01)
Measurement properties:	Correction based on distance, relative humidity, reflected temperature (only KT-145)
Optical transmission correction:	Automatic based on signals from sensors
Display:	LCD with high brightness, 3.5" LCD (320x240 pixels), Three-level LCD lighting regulation
Power supply:	Li-Ion 3.7 V 4200 mAh
Charging system:	Accumulator charged while in camera or in an external charger
Battery performance:	up to 4 hours of continuous operation
External power supply:	110/230 VAC, 50/60 Hz
Operating temperature:	-10 °C...50 °C
Storage temperature:	-20 °C...60 °C
Humidity:	10% to 95% without condensation
Housing:	IP43
Shocks:	25G, IEC 68-2-29
Vibrations:	2G, IEC 68-2-29
Communication:	USB, SD memory card (or optionally: SD WiFi)
Weight:	755 g
Dimensions:	103 mm x 98 mm x 258 mm

### Features:

- » a friendly interface that is easy to use without special training,
- » a quick and inexpensive way to start performing infrared diagnostic tests,
- » replaceable high-capacity Li-ion accumulator
- » up to 4 hours of continuous operation,
- » large 3.5-inch screen with high brightness,
- » durable rubber-lined housing,
- » micro USB interface for transmitting data and charging the accumulator,
- » WiFi wireless connectivity (optional),



KT-80 and KT-145 are effective, inexpensive and professional thermal imagers

### Standard accessories of the meter:

Li-ion accumulator (rechargeable battery) 3.7 V 4.2 Ah	WAAKU13
M-7 carrying case (KT-145)	WAFUTM7
SD memory card	WAP0ZSD1
hand strap	WAP0ZPAS1
micro-USB data transmission cable	WAPRZUSBMICRO
Instruction Manual for Sonel ThermoAnalyze2® software	
hand strap	
carrying case (only KT-145)	WAFUTM7



KT-80 and KT-145 have a user-friendly interface that makes it possible to use them even without special training

Parameter	KT-145v11	KT-80
Lens	11 mm	8 mm
Image sensor resolution	160 x 120	80 x 80
Focal length / Field of vision	11 mm / 15.5°X 20.6°	8 mm / 18.5°X 18.5°
Zoom	x2	-
Palettes	6	4
Range of measured temperatures	-20 °C...+350 °C	0 °C...+350 °C
Correction of measurement conditions	Emissivity (0.01-1.00)	
	Ambient temperature	-
	Distance	
Measurement functions	Relative Humidity	-
	Central point, point with max. temperature, point with min. temperature	
Alarm	Alarm for maximum temperature, Alarm for minimum temperature	-



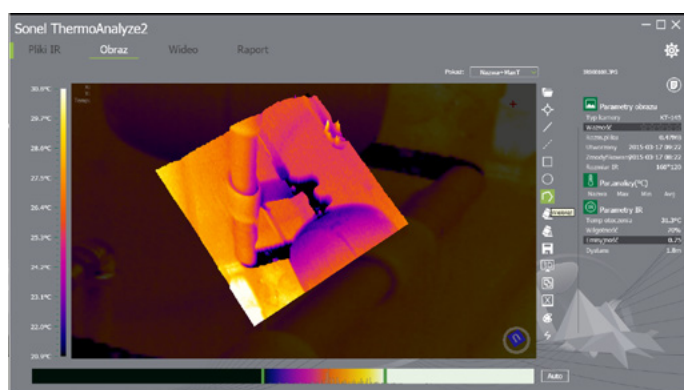
## SONEL THERMOANALYZE 2



Software for analyses and reports, included with the set of thermal imagers.

Capability of correcting the emissivity coefficient throughout the entire thermogram or part of it – the coefficient can be corrected individually for each selected area.

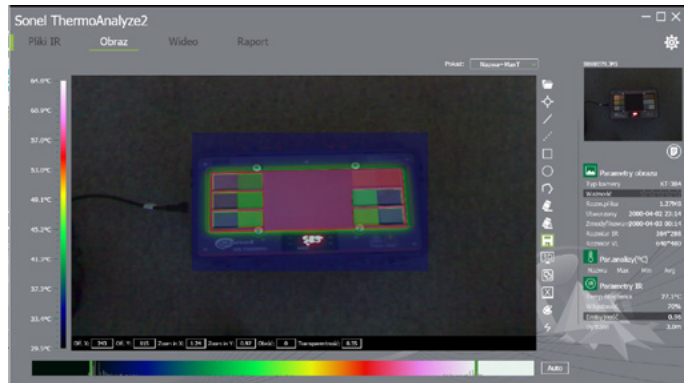
Selection of areas of interest – drawing of a rectangular area, oval area, area of any shape.



Temperature reading at any point – after scrolling the cursor over to the “Information” window, temperature readouts are displayed continuously along with current coordinates, and other recorded information (maximum temperature, humidity, emissivity).



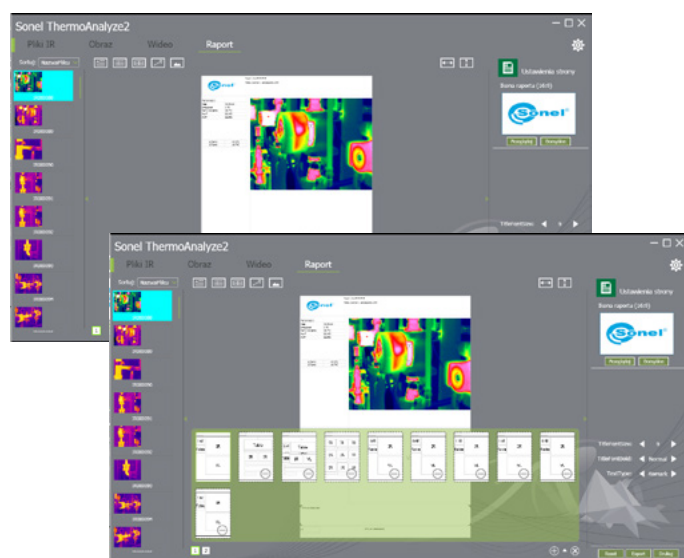
Infra Fusion technology – a thermogram is superimposed onto a part of the visible image, in any palette selected by the user. The thermogram is applied with the selected transparency, making it possible to optimally display and mark areas of interest.



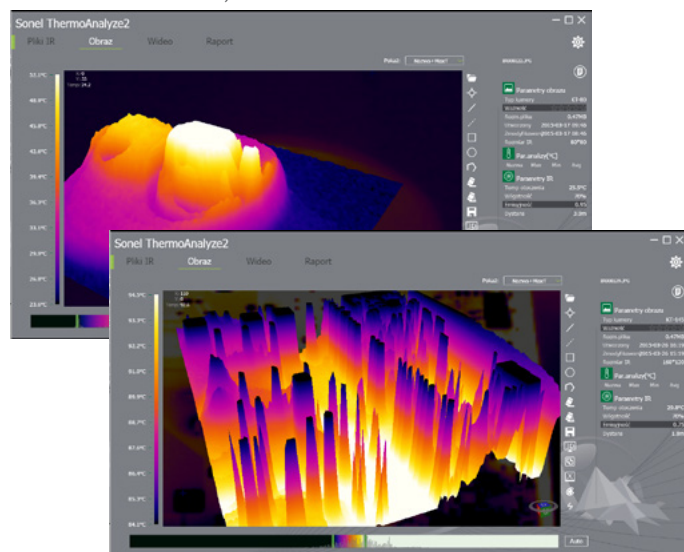
Interest, particularly when it is difficult to visually compare points on the thermogram with details on the visible image of the observed object.

Determination and reading of minimum, maximum and mean temperature for the entire area and in every marked area of interest. Selection of segment (straight line or polyline).

Easy report creation, “drag-and-drop” desired elements into the report – thermograms and the visible images corresponding to them.



All corrections applied and characteristic points are saved for further analysis at a later time. Selection of the visually optimal color palette (among 9 available in the application) for the best visualization of temperature changes. Configuration of the temperature range for the best imaging of temperature distribution (manual or automatic mode available).



The software has an unlimited license - it can be used simultaneously on multiple devices.

## Pyrometer

# SONEL DIT-500 / DIT-130

index: WMXXDIT130 / WMXXDIT500



### Measurements:

- » accurate contactless temperature measurement,
- » temperature measurement with K probe.

### Additional functions of the meters:

- » Modern housing design,
- » Automatic Data Hold function (holding displayed measurement data),
- » Automatic power-off,
- » °C/°F unit selector,
- » Digitally regulated emissivity coefficient within the range from 0.10 to 1.00,
- » Display of maximum, minimum, average and differential temperature,
- » Backlit liquid-crystal display,
- » Automatic range selection,
- » Resolution 0.1°C (0.1°F),
- » Measurement lock,
- » Alarm for high and low temperature values,
- » Rapid reaction to temperature changes (below 150 ms) (DIT-500),
- » Double laser sight (DIT-500),
- » Data memory (LOG) for 100 measurements (DIT-500),
- » Transmission of current readings to computer via USB cable (DIT-500),
- » Data memory (LOG) for 20 measurements (DIT-130).

### Other technical specifications:

- » LCD display ..... segmented, with backlight
- » spectral sensitivity ..... 8~14 μm
- » emissivity ..... digitally adjusted from 0.10 to 1.00
- » semi-conductor laser diode ..... output power <1 mW,
- » ..... wavelength 630~670 nm, class 2(II) laser
- » power supply ..... 9 V alkaline battery, NEDA 1604A or IEC 6LR61

### Nominal operating conditions:

- » operating temperature range ..... 0...+50°C
- » storage temperature ..... -20...+60°C
- » humidity ..... 10...90%

### DIT-130:

- » indication of range overflow ..... the display will read symbols "OL", "OL"
- » response time ..... under 1 second
- » weight ..... 290 g
- » dimensions ..... 190x111x48 mm

### DIT-500:

- » indication of range overflow ..... the display will read the symbol "----"
- » responsetime ..... 150 ms
- » weight ..... 350 g
- » dimensions ..... 230x155x54 mm

### Standard equipment of DIT-500 meter:

mini-USB data transmission cable	WAPRZUSBMNIB5
temperature measurement probe (type K)	WASONTEMK

### Standard equipment of DIT-130 meter:

temperature measurement probe (type K)	WASONTEMK
----------------------------------------	-----------

### Infrared temperature range for DIT-130

Infrared temperature range	D:S	Resolution	Accuracy	
-32...380°C -25.6...716°F	13:1	0.1°C 0.1°F	-32...-20°C -25.6...-4°F	±5°C ±9°F
			-20...200°C -4...392°F	±(1.5% m.v. + 2°C) ±(1.5% m.v. + 3.6°F)
			200...380°C 392...716°F	±(2.0% m.v. + 2°C) ±(2.0% m.v. + 3.6°F)

### Infrared temperature range for DIT-500

Infrared temperature range	D:S	Resolution	Accuracy	
-50...999.9°C -58...999.9°F		0.1°C 0.1°F	-50...20°C -58...68°F	±2.5°C ±4.5°F
			20...400°C 68...752°F	±(1.0% m.v. + 1°C) ±(1.0% m.v. + 1.8°F)
1000...1600°C 1000...2912°F	50:1	1°C 1°F	400...800°C 752...1472°F	±(1.5% m.v. + 2°C) ±(1.5% m.v. + 3.6°F)
			800...1600°C 1472...2912°F	±2.5% m.v.

### Temperature range for K probe

Infrared temperature range	Resolution	Accuracy
-50...999.9°C -58...999.9°F	0.1°C 0.1°F	±(1.5% m.v. + 3°C) ±(1.5% m.v. + 5°F)
1000...1370°C 1000...2498°F	1°C 1°F	±(1.5% m.v. + 2°C) ±(1.5% m.v. + 3.6°F)

"D:S" = "distance-to-spot ratio"

"m.v." = "measured value"





## SONEL UV-260

index: WMXXV260



### Specifications of UV section

Image type	Monochromatic
Minimum UV sensitivity	3 x 10 <sup>-18</sup> W / cm <sup>2</sup>
Minimum detectable discharge	1.5 pC from a distance of 8 meters
Spectral range	UV 240 ... 280 nm
Field of vision (WxS)	5.5° x 4.0°
Sharpness setting	Automatic and manual (UV and visible spectrum)
Sharpness range	2 m. ... ∞
Detector life	Non-consumable
Frequency:	50Hz/60 Hz

### Specifications of visible spectrum section

Image type	Full color
Accuracy of UV/visible image superposition	Better than 1 milliradian
Minimum sensitivity	0.1 lux
Zoom	26x optical and 12x digital

### Display

Type	Unfolding 5.7" VGA touch LCD
Video standard	PAL/NTSC
Imaging modes	Combined (UV & visible) / only UV / only visible
Discharge color	White, red, blue

### Processing and communication

Video standard	H.264
Alarm	LED
Operation	Buttons and touch LCD
Audio module	Microphone input for audio notes
GPS module	Yes

### Data storage

Memory type	SD memory card
Image file format	JPG
Video file format	AVI
Memory capacity	8000 images or >4 hours of video (for 2GB card)
File transfer	Via card reader

### Power supply

Power consumption	10 W
Accumulator type	Li-Ion (2 pcs. in set)
Operating time on battery power	2 hours
Charging	External charger
External power supply	9-12 V, 10 VA
Power adapter	110-240 VAC, 50-60 Hz/12 VDC 3.8 A

### Other specifications

Operating temperature range	-10 °C ... 50 °C
Storage temperature	-25 °C ... 60 °C
Relative Humidity	95% without condensation
Dimensions	238 mm x 165 mm X 91 mm
Weight	2.5 kg
Power input	YES
SD card slot	YES
Video output	BNC
Audio input / output	Microphone / headphones

### Standard accessories of the instrument:

2x Li-Ion accumulator (rechargeable battery) 7.2 V 2.2 Ah	WAAKU22
Battery charging cable for 12 V car sockets	WAPRZLAD12SAM1
RCA/RCA video cable	WAPRZVIDRCA
camera strap	WAPZSZEU260
hard briefcase	WAWALXL11
external accumulator charger	WAADALB220

### Description of the device:

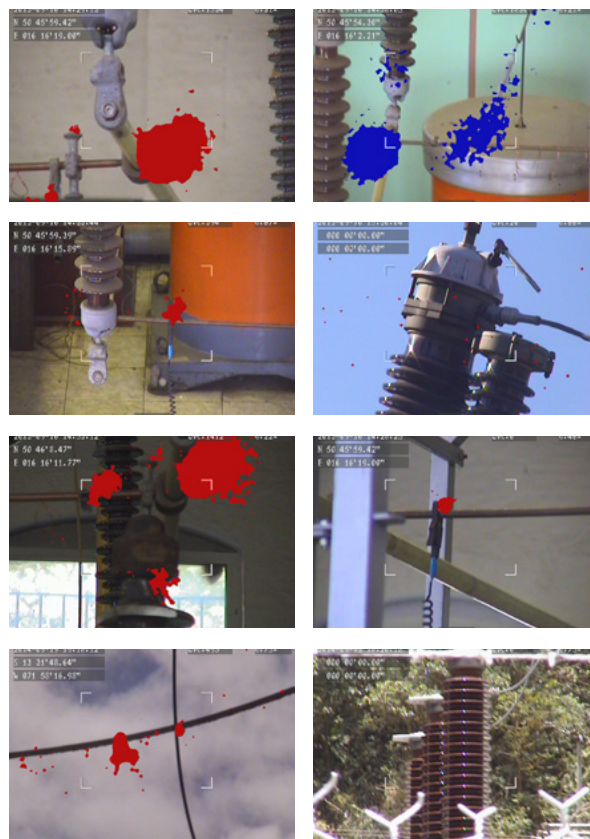
The UV-260 is a high-class, professional, and simultaneously lightweight and intuitive device enabling quick and simple remote diagnostics of a system without interfering in its operation. Its design, placing emphasis on high functionality, allows for detection and monitoring of corona, arc and surface discharges in power engineering. This is a way to continuously analyze the technical condition of equipment, e.g. an HV power line, and locate problems before damage or serious failure occurs.



UV-260 is the latest innovative solution in the field of UV radiation detection!

### Additional features:

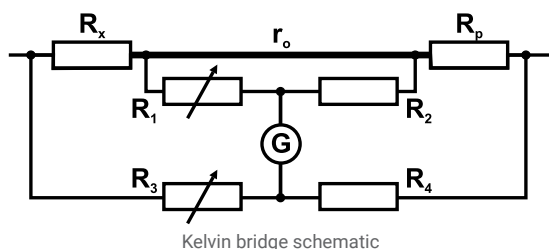
- » precise location of discharge sources,
- » recording and playback of videos and images,
- » high UV sensitivity,
- » automatic sharpness for UV and visible image,
- » automatic noise reduction,
- » 5.7" touch LCD,
- » no sensitivity to sunlight during operation in full daylight,
- » additional LED alarm in the event of UV radiation detection,
- » built-in GPS,
- » UV Analysis software for data transmission and generating reports.



## Low resistance measurements

Measurements of low resistances are performed during testing of the resistance of: welded connections, main equipotential bondings, contacts, cable connections and low-resistance coils. Meters for measurement of low resistances can also be used to test the windings of motors and transformers. These tests also cover quality control of soldered connections and the continuity of earthing conductors.

Low resistance measurements can be performed according to several methods. The most popular ones are the technical method and the Kelvin bridge method (six-arm bridge). For low resistance values on the order of micro-ohms, the resistances of leads and contact pairs at connection points play a significant role, which is why the bridge's design provides separate current and voltage terminals at resistors  $R_x$  and  $R_p$ . It is recommended for all other resistors to have a resistance 1000 times greater than the resistance of leads.



In the bridge's equilibrium state, the current flowing in the galvanometer's branch is equal to zero. The formula for measured resistance is:

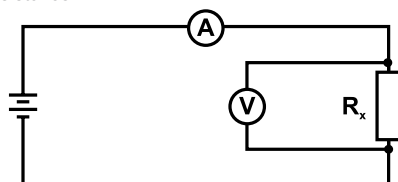
$$R_x = \frac{R_p R_1}{R_2}$$

The accuracy of measurement using a Kelvin bridge is affected by the deviation due to insensitivity, which is particularly visible in the case of low resistances on the order of  $R_x = 10^{-6} \dots 10^{-5} \Omega$ . Accuracy also depends on the accuracy of the standard, which related to the manufacturing quality of individual elements of the bridge. Additional errors may occur during measurement, arising from current overloads of the measured and reference resistors, temperature changes, and the presence of additional electromotor forces in the system.

In light of the flaws and limitations of traditional technical bridges, the current trend is to build electronic meters for low resistance measurements within the range from single-digit micro- to several hundred ohms. Instruments make it possible to measure very low resistances with resolution even up to  $0,1 \mu\Omega$ . Simplicity of operation, the application of different measurement modes and interoperability with a computer are important features of modern micro-ohmmeters. These instruments measure resistance according to the technical method. Any conducting element can be described by the formula according to Ohm's law:

$$R_x = \frac{U_x}{I}$$

$U_x$  - voltage drop on the given element,  
 $I$  - intensity of flowing current,  
 $R_x$  - measured resistance.



Resistance measurement according to the technical method (system with correctly measured voltage)

A system with correctly measured voltage is applied in the case of low resistances, where the current flowing through the measured element is many times greater than the current of the voltmeter measuring the voltage drop on this object. Resistance obtained as the result of measurement is calculated by means of the dependency:

$$R_x = \frac{U_x}{I - I_v}$$

$I_v$  - current flowing through voltmeter.

At a very high voltmeter resistance, the current flowing in its circuit is negligibly small, therefore the resistance of test leads does not affect the result of measurement. This is the so-called four-lead (4-terminal) method. This type of measurement, which eliminates the influence of lead resistance, is applied in the MMR series of low resistance meters.



Measurements with MMR-650 instrument

Due to the very low values of measured resistances, the four-lead method has been applied, enabling performance of accurate measurements without accounting for the influence of test leads' resistance (parasitic resistance). Therefore, there is no need for manual calibration of the meter and test leads, however this is still possible (in the case where e.g. a different type of measuring termination is applied), and the instrument's factory calibration settings can be restored at any time.

Before starting measurement, the maximum measurement current is selected with-in the range from 0.1 mA to 10 A using the switch knob. The measuring range, and hence the current, is selected manually or automatically. In certain cases (e.g. the object's maximum power output is exceeded), it may be desirable to limit the maximum current flowing through the tested object. MMR-620 has a blockade that makes it possible to set a maximum limit on the value of the measurement current.

The instrument measures resistance by running a current through the measured object (via current leads) while simultaneously monitoring the voltage drop on voltage terminals. A break in any circuit will be signaled appropriately, and resistance measurement will not be possible.

### Operating mode:

The user selects the method of measurement in one of several available modes:

- » in manual mode, every measurement must be triggered by the operator using the "Start" button,
- » in automatic mode, measurement begins when the last measurement terminal is connected,
- » in continuous mode, measurements are performed periodically every 3 seconds (resistance mode) or continuously (induction mode).

Measurements can be performed with current flowing in only one direction or in two opposite directions. Testing with uni-directional current speeds up measurements, however the two-directional current test eliminates errors arising from the presence of internal voltages and electrothermal forces in the measured object. During measurement with two-directional current, the mean resistance value from two measurements, with currents flowing in opposite directions, is displayed as the main result. Besides this, supplementary results are also displayed, i.e. resistance  $R_f$  for current flowing in the conventional "forward" direction and resistance  $R_r$  for current flowing in the conventional "reverse" direction.

The normal duration of the measurement is 3 seconds. To measure an object that is inductive in nature, an extended measurement time can be selected. For objects with high inductance, the time of measurement is extended to several minutes, and the measured object is discharged after the measurement is complete.

It is possible to apply an accelerated measurement mode for equipment of an inductive nature (FAST mode), which speeds up the measurement procedure but has slightly worse accuracy.

Window operating mode enables setting of upper and lower limits between which the measurement result must be found. Results beyond this range are signaled by two long sound signals.

The limits of the tolerable variability range of results are defined by the user.

In the case where automatic and continuous modes are used, exceeding of defined ranges will interrupt the series of measurements, and the instrument will await the operator's reaction.



## Low resistance meters

# SONEL MMR-650

index: WMGBMMR650



### Resistance measurement

Range	Resolution	Measurement current	Accuracy*
0...999.9 $\mu\Omega$	0.1 $\mu\Omega$	10 A (20 mV)	$\pm(0.25\% + 2 \text{ digits})$
1.0000...1.9999 m $\Omega$	0.0001 m $\Omega$		
2.000...19.999 m $\Omega$	0.001 m $\Omega$		
20.00...199.9 m $\Omega$	0.01 m $\Omega$	10 A/1 A (2 V/200 mV)	
200.0...999.9 m $\Omega$	0.1 m $\Omega$	1 A/0.1 A (2 V/200 mV)	
1.0000...1.9999 $\Omega$	0.0001 $\Omega$	0.1 A (2 V)	
2.000...19.999 $\Omega$	0.001 $\Omega$	10 mA (2 V)	
20.00...199.99 $\Omega$	0.01 $\Omega$	1 mA (2 V)	

\*for resistive objects

### Standard accessories of the meter:

L-11 carrying case	WAFUTL11
2x Kelvin clamp 1 kV 25 A	WAKROKELK06
two-core lead; 3m (10 / 25 A) U1/I1	WAPRZ003DZBBU1I1
two-core lead; 3m (10 / 25 A) U2/I2	WAPRZ003DZBBU2I2
230 V power cord (IEC C13 plug)	WAPRZ1X8BLIEC
230 V power cord (IEC C7 plug)	WAPRZLAD230
USB data transmission cable	WAPRZUSB
2x double-tip Kelvin probe (banana sockets)	WASONKEL20GB
ST-1 temperature measurement probe	WASONT1



MMR-650 enables measurements of resistant and inductive objects, including amorphous core transformers.



<b>CAT IV</b>	<b>CAT III</b>	<b>IP 67</b>	<b>IP 54</b>
<b>300V</b>	<b>600V</b>	closed briefcase	open briefcase

### Measurements of objects resistive in nature:

Low resistance meter for resistant and inductive objects, including amorphous core transformers. This product is intended for professional power engineering, railway engineering and companies in which low resistance measurements are performed (welded and soldered connections, equipotential bondings, earthing conductors, contacts, threaded joints, windings of motors, transformers and other resistive and inductive objects). The meter can additionally operate in a production line (e.g. in final production control).

It is an innovative combination of an instrument with high measuring specifications and a modern user interface as well as an expansive data management system. Wireless data exchange, expanded by a 2D barcode system and the capability of printing ID labels for tested objects, introduces a new quality of work, allowing the user to perform a broad range of measurements.

### Additional functions of the meters:

- » Measurement of resistant and inductive objects (including amorphous core transformers),
- » Automatic temperature compensation function (temperature probe),
- » Function of determining the temperature of a motor under load,
- » Transformer core demagnetization function,
- » High immunity to disturbances,
- » 4-lead measurement,
- » Measurement voltage up to 10 V,
- » Limits and signaling when they are exceeded,
- » Li-Ion accumulator and 90 – 260 VAC network power supply,
- » IP54 – open briefcase, IP67 – closed briefcase,
- » Durable, shock-resistant meter design,
- » Interoperability with printer and 2D barcode reader,
- » Touch screen, intuitive user interface,
- » USB, WiFi, LAN (optional),
- » Operating temperature from -10 to +50°C,
- » Category 600 V CAT III / 300 V CAT IV,
- » Protection against external voltage up to 600 VDC,
- » Interoperability with Sonel PE, Sonel Reader software.



## SONEL MMR-630 / MMR-620

index: WMGBMMR630 (MMR-630) / WMGBMMR620 (MMR-620)



CAT III

300V

IP 54

### Measurements of objects resistive in nature:

- » welded and soldered connections, equipotential bondings, earthing conductors,
- » contacts, welds of rails, conductors and cables,
- » measurement according to the four-lead method.

### Measurements of objects inductive in nature:

- » motor and transformer windings, low-resistance coils.

### Additional functions of the meters:

Automatic or manual selection of measuring range (measurement of objects of an inductive nature).

### Selection of measurement mode according to the type of measured object:

- » fast measurement (3 seconds) for measurement of objects of a resistive nature,
- » extended measurement for testing of objects of an inductive nature (accelerated mode, with slightly worse accuracy, available); with automatic discharging of the object after measurement.

### Selection of measurement mode depending on application (including control of product series):

- » measurement in normal mode - triggered when the "START" button is pressed,
- » measurement in automatic mode - the instrument awaits connection of all four test leads to the object, after which it automatically start measurement in one or both directions and calculates the mean resistance value,
- » measurement in continuous mode - the meter repeats successive measurement cycles with breaks every 3 seconds (for objects of a resistive nature) or performs measurement continuously (for objects of an inductive nature).

### Window mode:

- » makes it possible to set an upper and lower limit between which the measurement result is to be found; sound signal triggered when the result is beyond this range.

Capability of performing measurements even under disturbances of a value five times greater than the measured signal.

### Instruments meet the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)



Micro-ohmmeters from the MMR series enable accurate winding resistance measurements of electrical motors and power transformers.

### Standard accessories of the meters:

NiMH accumulator (rechargeable battery) 4.8V 3Ah for MMR	WAAKU03
L-1 carrying case	WAFUTL1
4x black "crocodile" clip 1 kV 32 A	WAKROBL30K03
2x Kelvin clamp 1 kV 25 A	WAKROKELK06
two-core cord; 3m (10 / 25 A) U1/I1	WAPRZ003DZBBU111
two-core cord; 3m (10 / 25 A) U2/I2	WAPRZ003DZBBU212
230 V power cord (IEC C7 plug) (MMR-630)	WAPRZLAD230
RS-232 serial transmission cable	WAPRZRS232
2x double-tip Kelvin probe (banana sockets)	WASONKEL20GB
meter strap (Unisonel type)	WAPOZSZE1

### Resistance measurement

MMR-620		MMR-630		Measurement current
Range	Resolution	Range	Resolution	
0...999 $\mu\Omega^*$	1 $\mu\Omega$	0...999.9 $\mu\Omega^*$	0.1 $\mu\Omega$	10 A
1.000...1.999 m $\Omega$	0.001 m $\Omega$	1.0000...1.9999 m $\Omega$	0.0001 m $\Omega$	
2.00...19.99 m $\Omega$	0.01 m $\Omega$	2.000...19.999 m $\Omega$	0.001 m $\Omega$	
20.0...199.9 m $\Omega$	0.1 m $\Omega$	20.00...199.99 m $\Omega$	0.01 m $\Omega$	1 A
200...999 m $\Omega$	1 m $\Omega$	200...999.9 m $\Omega$	0.1 m $\Omega$	0.1 A
1.000...1.999 $\Omega$	0.001 $\Omega$	1.0000...1.9999 $\Omega$	0.0001 $\Omega$	
2.00...19.99 $\Omega$	0.01 $\Omega$	2.000...19.999 $\Omega$	0.001 $\Omega$	
20.0...199.9 $\Omega$	0.1 $\Omega$	20.00...199.99 $\Omega$	0.01 $\Omega$	1 mA
200...1999 $\Omega$	1 $\Omega$	200.0...1999.9 $\Omega$	0.1 $\Omega$	0.1 mA

Voltage for full 200 mV scale besides \*) - 20 mV

Accuracy  $\pm(0.25\% \text{ m.v.} + 2 \text{ digits})$ , input impedance of the voltmeter:  $\geq 200 \text{ k}\Omega$

"m.v." = "measured value"

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and IEC 61557
- » meter power supply ..... SONEL/Ni-MH 4.8 V accumulator pack
- » charger ..... built-in
- » accumulator charging time ..... approx. 2.5 hours
- » number of measurements with 10 A current ..... 300
- » time until auto-OFF ..... 120 seconds
- » electric hum immunity ..... additional error  $\leq 1\%$  for 50 Hz voltage  $\leq 100 \text{ mV rms}$
- » maximum lead resistance for 10A current ..... 0.1  $\Omega$
- » maximum inductance of measured object ..... 40 H
- » measurement current input accuracy .....  $\pm 10\%$
- » time of resistance measurement:
  - resistance mode, with two-directional current flow ..... 3 seconds
  - induction mode ..... up to several minutes, depending on resistance and inductance of object
- » dimensions ..... 295 x 222 x 95 mm
- » meter weight ..... approx. 1.7 kg
- » operating temperature range ..... 0...+40  $^{\circ}\text{C}$



# Cable and underground infrastructure locators

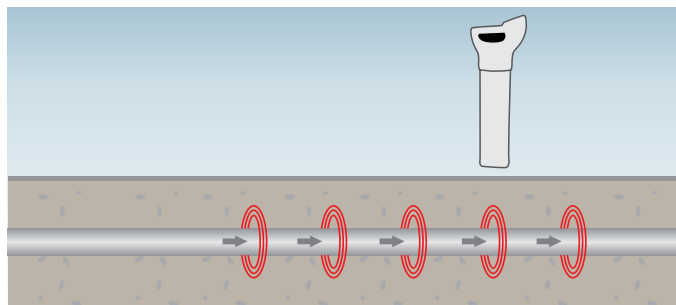


Earthworks that involve not only various types of excavations but also laying of sewer pipes, water pipes and cables are associated with a high risk of damaging underground utility systems, which may lead to a dangerous accident. European Union law imposes the obligation of ensuring safety of workers, third parties and private property on the contractor. To limit the risk of an accident, a series of activities are performed, which includes obligatory location of existing underground systems. Since one can never be sure that all underground systems have been plotted on the map, an additional check is required in order to identify all potentially hazardous systems, and this can be performed thanks to cable locators.

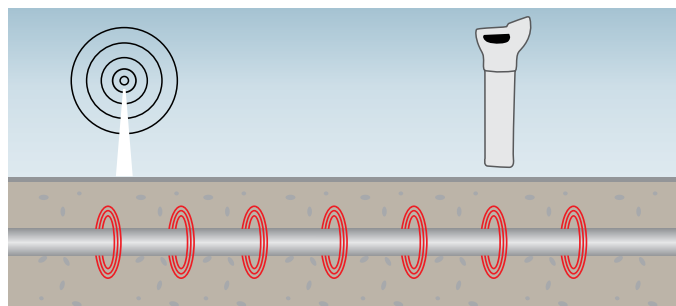
The LKZ-1000 locator set makes it possible to accurately determine the depth of route of current-conducting systems (power and telecommunications cables as well as metal pipes), as well as plastic and concrete pipelines by means of additional probes. Earthworks are performed under difficult conditions (moisture, dirt), so both instruments have an IP54 protection rating, and when the cover is closed, the transmitter has a protection rating of IP67.

Location and tracing of underground infrastructure are characterized by high diversity of conditions under which they are performed. The LKZ-1000 set can operate in several different modes, adapted to the given situation:

**Power** - used to locate electrical cables. This is a passive mode, since the signal is generated intrinsically by the live cable without the transmitter's involvement.



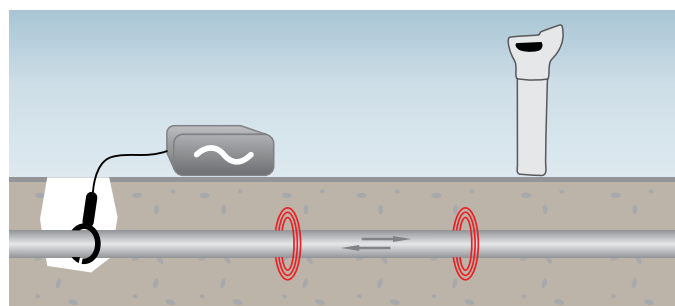
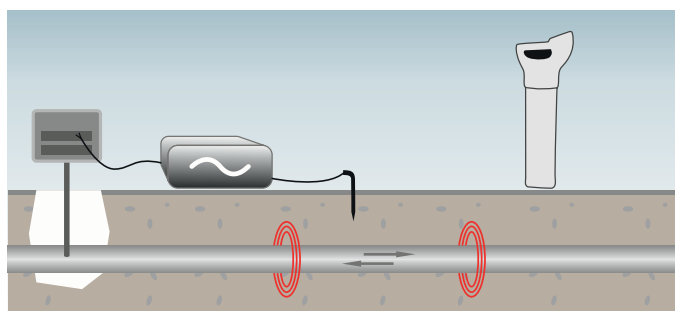
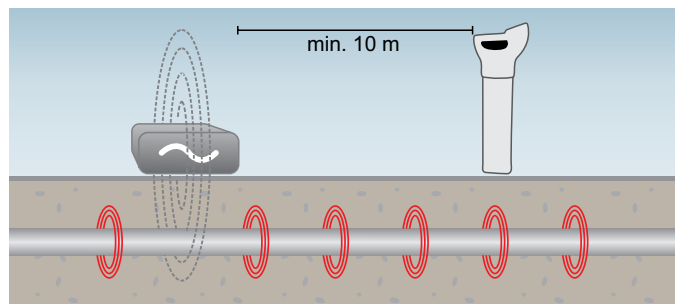
**Radio** - used to locate metal objects (pipes, rebar), which re-emit radio signals. This is also a passive method, as the signal is already present in the object itself, which re-emits radio waves.



**8 kHz** - used for precise location of a specific system (cable, pipe, etc.). The 8 kHz frequency of the generated signal has better range than the 33 kHz frequency and has a lesser tendency of signal penetration to other objects. This method requires the use of a signal generator and is an active method.

**33 kHz** - used for location of a precisely defined system (cable, pipe, etc.). This frequency is the one most commonly used to locate underground systems. It provides the best effectiveness, however it has a greater tendency of signal penetration to other systems. This method also requires the use of a signal generator and is an active method.

The LKN-1000 generator (transmitter) makes it possible to generate the tracked signal in the traced system. Depending on the situation, in active modes, the transmitter can be connected:



Automatic mode combines the benefits of Radio and Power modes, and it is very convenient during preliminary combing of the terrain.

The LKZ-1000 set also makes it possible to precisely determine the depth of a specific system, up to 3 m. Operation in 8 kHz or 33 kHz active modes is then required, in which both the transmitter and receiver are used.

In metal systems, the signal can be generated without wires through induction, direct connection of leads, or with the use of a transmission clamp. In non-conducting systems, the signal can be generated by introducing a transmission probe (in the form of a wound cable or "floating" probe) directly into the system that is sought (plastic, concrete pipes, etc.). Thanks to the application of additional probes, besides determining the direction and depth of pipes, the point of their obstruction can also be determined.

Thanks to an intuitive menu and transparent, graphic display, the LKO-1000 is very simple to operate. It also has a series of options and functions that improve safety and convenience of work.





## SONEL LKZ-2000

index: WMXXLKZ2000



IP 65

### A new model in the LKZ series - stronger and easier to use!

The diversity and concentration of underground infrastructure are still growing. Identifying underground systems was never as difficult and important a task as it is today. Location allows us to infer the actual position of an underground system and determine the proper location for current works, as well as to prevent accidents caused by damage to the underground objects.

The Sonel LKZ-2000 locator set has a series of unique functions that assist in selecting the appropriate location mode. The most important feature distinguishing this instrument from the competition is its capability of analyzing disturbances present at the place where location is performed, facilitating selection of the best frequency under difficult conditions. This makes it possible to avoid selection of an ineffective frequency, significantly accelerating and facilitating work with the locator.

### The best system under the most demanding conditions:

- » power engineering
- » construction
- » railway
- » telecommunications
- » refineries
- » sanitary infrastructure
- » heat distribution networks
- » transmission pipelines

### Locator

- » **Mode / Frequency:** POWER passive mode: 50 Hz, 100 Hz, 450 Hz / 60 Hz, 120 Hz, 540 Hz, RADIO passive mode: 15 kHz to 60 kHz, Active mode (with transmitter): 512 Hz, 3140 Hz, 8192 Hz, 32768 Hz and 83.1 kHz
- » **Antenna configuration:** Single peak value, double peak value, neutral point, full field
- » **Depth measurement range:** POWER mode up to 3m., RADIO mode up to 2 m., Modes with active transmitter up to 4.6 m., Probe mode up to 6 m.
- » **Accuracy of measurement (error):** 5% depth in linear or probe mode (from 0.2 m to 4.6 m.), 10% depth in probe mode (from 4.6 m to 6 m).
- » **Bluetooth:** for remote transmitter control
- » **Batteries:** 2 x LR20
- » **Operating time with battery power for LKO:** up to 60 hours (at 20°C)
- » **Auto-OFF:** Capability of selecting auto-OFF time, after 5, 10, 20 or 30 minutes
- » **Operating temperature range:** -20°C to 50°C
- » **Dimensions:** 700 mm (H) x 325 mm (L) x 122 mm (W)
- » **Weight:** 2.18 kg including batteries
- » **IP rating:** IP65

### Transmitter

- » **Operating frequencies:** 512 Hz, 3140 Hz, 8192 Hz, 32768 Hz, 83,1 kHz, 200 kHz
- » **Output power control:** 5 levels
- » **Power in induction mode (max):** 3 W
- » **Power for galvanic connection (max):** 12 W (for impedance of connected object: 100 Ω)
- » **Batteries:** up to 100 hours (level 2 output power at 20°C)
- » **Auto-OFF:** Capability of selecting auto-OFF time, after 1, 2, 3, 4, 5, 6, 7, 8 hours
- » **Operating temperature range:** -20°C to 50°C
- » **Dimensions:** 255 mm (H) x 190 mm (D) x 305 mm (W)
- » **Weight:** 3.5 kg including batteries
- » **IP rating:** IP65



LKO-2000 enables remote control and configuration of the transmitter.

### Standard accessories of the meter:

carry bag	WAFUTL9
A frame	WAADALKZRA
power adapter with accumulator pack for transmitter	WAAKU14
5" transmission clamp	WACEGN3
NAD-1 transmission probe (8kHz, 33kHz) ("floating")	WASONNAD1
transmission lead on reel for location of non-metal systems	WAPRZPN30 / WAPRZPN50 / WAPRZPN80
BIK probe for wireless cable identification	WASONBIK



Using the A-frame, a cable earth fault can be located.





## SONEL LKZ-1500

index: WMXXLKZ1500



The LKZ-1500 locator set, consisting of a transmitter and receiver, allows for location, identification and tracking of the route of objects buried in the earth, i.e.:

- » power cords and cables, control cables, telecommunications cables,
- » underground elements of lightning protection systems, cathodic protection systems,
- » water and sewage systems,
- » fuel transmission systems: gas pipelines, pipelines,
- » heating systems and insulated pipes.

The locator is intended for electrical power and fitting companies, companies that perform earthworks, construction, railway engineering, refineries, water mains and sanitary systems, heating companies and geodetic companies.

### Locator functions:

- » determination of cable orientation, cable position relative to receiver's axis (equipped with "compass" function),
- » determination of current value and cable depth, in both active mode (with transmitter) and passive mode (without transmitter),
- » plotting the route of the object on the map. Memory up to 10,000 points - coordinates.
- » capability of locating cable damage.

Thanks to any GPS module and dedicated software (LKZ Terminal), the instrument will make it possible to plot the route of an object or mark its position on the map. Wireless communication of receiver with GPS module - via Bluetooth.

### Transmitter:

- » transmitter power: 10 W (in steps of 1 W, 2 W, 5 W, 10 W),
- » operation in direct galvanic or inductive connection mode: clamp (N-1) or internal transmitting antenna,
- » transmission in continuous mode or with a constant interval extending operating time with accumulator power (12 V/7 Ah accumulator)
- » briefcase housing, segmented display,
- » operating temperature range from -30 °C to + 55 °C
- » dimensions: 275 mm x 250 mm x 180 mm

### Receiver:

#### Operation in a broad frequency range – mode:

- » passive (50 Hz-60 Hz, 100 Hz, 300 Hz, 550 Hz, 1450 Hz),
- » ether (48 Hz - 14 kHz),
- » radio (10 kHz - 36 kHz),
- » active 273 Hz, 491 Hz, 526 Hz, 982 Hz, 1024 Hz, 2000 Hz, 2048 Hz, 8440 Hz, 8928 Hz,

- 9820 Hz, 10000 Hz, 32768 Hz,
- » cable damage – earth fault detection (A-frame or DK1 probe),
- » power supply from replaceable accumulator or batteries (5 LR6 AA),
- » graphic display visualizing the orientation and depth of the object as well as the direction of current flow.
- » depth of location up to 6m
- » dimensions: 700x300x140
- » operating temperature range from -20°C to + 55°C



Thanks to saving of object coordinates, it is possible to reconstruct its orientation in future works.

### Standard accessories of the meter:

LKN-1500 cable locator - transmitter	WMXXLKN1500
LKO-1500 cable locator - receiver	WMXXLKO1500
test lead with banana plug terminations; 5m; blue	WAPRZ005BUBB
test lead with banana plug terminations; 5m; red	WAPRZ005REBB
blue "crocodile" clip K02	WAKROBU20K02
red "crocodile" clip K02	WAKRORE20K02
earth contact pin probe 23cm	WASONG23
Z16 accumulator charging adapter	WAZASZ16
Z17 accumulator charging adapter	WAZASZ17
L13 carrying case	WAFUTL13
LKO-1500 anti-sunlight screen	WAPOZSL4
NiMH accumulator (rechargeable battery) 6V, 2Ah	WAAKU23
battery container	WAPOJ3



Thanks to the application of the DK1-E probe, the instrument is capable of locating cable damage (exterior cable sheath to earth) at locations where it is not possible to apply the A-frame (e.g. concrete, asphalt pavement).



## SONEL LKZ-1000

Index: WMXXLKZ1000



IP 54

The improved LKN-1000 transmitter generates a signal that is 10 times stronger than in the previous model, allowing for:

- » tracking of underground systems over longer distances,
- » better detection of underground systems under adverse conditions with strong disturbances,
- » easier depth determination,
- » better detectability of multiple underground systems simultaneously,
- » four adjustable output signal power levels, up to 10 W,
- » durable, water-resistant housing with IP65 protection rating, more compact and lightweight, designed for work under difficult conditions,
- » three operating modes to choose from, 8 kHz and 33 kHz, and in galvanic mode, 8 kHz and 33 kHz simultaneously,
- » easy-to-read visual and sound signals facilitating operation,
- » additional built-in test function enabling independent checking of all functions before starting work,
- » control buttons found on the housing's exterior, allowing for control while the housing is closed, affording better protection against mechanical and water damage.

### Functions of the set:

- » passive or active tracing modes,
- » detection of live underground cables,
- » detection of underground cables not carrying current (radio mode),
- » detection of underground cables not carrying current using the transmitter (galvanic or inductive connection, or by means of clamp),
- » tracing of metal or non-conducting pipes by means of additional probe,
- » tracing of non-conducting pipelines by means of "floating" probe,
- » tracing of a specific cable,
- » determination of cable depth,
- » automatic detection sensitivity regulation,
- » 5 operating modes,
- » shallow cable warning,
- » cable depth measurement up to 3 m,
- » determination of direction of cable route,
- » contrast display, automatic backlighting of LCD.

### Electrical safety:

- » protection rating of LKN-1000 transmitter housing according to EN 60529 ..... IP65 (closed cover)
- » housing protection rating of LKO-1000 locator according to EN 60529 ..... IP54

### Other technical specifications:

- » transmitter power supply ..... 4 x LR20 battery
- » transmitter dimensions ..... 180 mm x 280 mm x 260 mm
- » transmitter weight ..... < 2.4 kg
- » maximum locator range ..... 3 m
- » receiver power supply ..... 6 x LR6 battery
- » receiver dimensions ..... 760 mm x 250 mm x 85 mm
- » receiver weight ..... < 2.9 kg

### Standard accessories of the instrument:

LKO-1000 locator	WMXXLKO1000
LKN-1000 transmitter	WMXXLKN1000
L6 carrying case	WAFUTL6
set of leads with crocodile clips	WAPRZLKZ1000
earth contact pin probe	WASONG15
batteries	

### Work modes:

- » passive 50 Hz and 60 Hz - enables location of live conductors and cables (POWER)
- » passive RADIO (15-30 kHz) - enables quick, non-selective location of underground infrastructure of a minimum length of 100 m (metal installations)
- » active (with transmitter) (8 kHz and 33 kHz) enables:
  - location in induction mode (it is enough to place the transmitter above the located object)
  - location by means of direct connection of the transmitter to an object not carrying electrical current
  - location by means of transmission clamp (the clamp is to be fastened onto the tested object)
  - location with the use of a transmission lead or transmission probes (enables location of non-metal objects)
  - location by means of splitting adapter (direct connection of LKN-1000 transmitter to a 230 V network socket).

The set also has a series of options and functions that improve safety and convenience of work:

- » **Hazard zone** – this function generates an alarm signal indicating the proximity (within a radius of approx. 30 cm) of cables being located. It works in Power, 8 kHz or 33 kHz operating modes, as well as in automatic mode.
- » **Auto-test** – allows for independent receiver control. After the test is passed, the receiver's display will read PAS, if the test is not passed, ERR will be displayed.
- » **Automatic mode** - combines the benefits of simultaneous detection in Power and Radio mode. Makes it possible to confirm the presence of underground infrastructure in the initial phase of location, making detection easier and safer.
- » **Automatic display backlighting** – the installed lighting sensor automatically activates display backlighting when it is necessary.
- » **Digital signal strength reading** – this function additionally activates digital reading of signal strength on the display, facilitating location of underground installations.



Automatic mode - combines the benefits of simultaneous detection in power and radio mode, making it possible to confirm the presence of underground infrastructure in the initial location phase.





## SONEL LKZ-720

index: WMGBLKZ720



**CAT III**

**600V**

**IP 67**

### Location of conductors and cables, both live and inactive:

- » detection of conductors in ceilings, walls and floors,
- » location of breaks in conductors,
- » tracing the route of installations throughout the entire building,
- » identification of plug-in sockets and throw-over switches in the building's installation,
- » location of faults between conductors,
- » tracing the route of shielded cables,
- » tracing the route of conductors in metal pipes,
- » fuse identification in a switchgear,
- » cable tracking,
- » tracking of the route of conducting pipes of the water or central heating system,
- » contactless detection of live conductors.

### Additional functions of locators:

- » 3D function in receiver – detection of the direction of transmitted current flow and precise location of the object,
- » phase detection mode,
- » receiver operation with four transmitters at the same time - when detecting breaks or differentiating conductors,
- » flashlight with bright LED diode,
- » headphone socket in receiver,
- » backlit screens for work in the darkness,
- » transmission of battery charge status and transmitter settings to receiver,
- » operation in a broad rated voltage range, up to 500 V<sub>rms</sub>,
- » voltage measurement of object up to 500 V<sub>rms</sub>,
- » three levels of transmitted signal,
- » automatic or manual selection of transmission modes,
- » five transmission modes – voltage, current, current-voltage, power and clamp,
- » software updating via USB,
- » additional accessories enabling more precise location – such as a contact or contactless probe and measurement clamp.

### Standard accessories of the meter:

M-6 carrying case	WAFUTM6
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
LKO-720 receiver	WMGBLK0720
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; blue	WAPRZ1X2BUBB
test lead with banana plugs on reel; 1 kV; 20 m; red	WAPRZ020REBBSZ
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; blue	WASONBUOGB1
earth contact pin probe (26 cm)	WASONG26
non-contact probe	WASONBDOT

### Electrical safety:

- » type of insulation ..... double, as per EN 61010-1
- » transmitter measurement category ..... CAT III 600V according to EN 61010-1
- » transmitter housing protection rating according to EN 60529 ..... IP67
- » receiver housing protection rating according to EN 60529 ..... IP40

### Other technical specifications:

- » transmitter power supply ... four AA alkaline batteries or Ni-MH accumulators
- » maximum transmitter operating voltage ..... 500 V rms
- » maximum depth of the analysed object ..... ("I" mode) 2 m
- » maximum range of contactless neon probe ..... 50 cm (in air),  
5 cm (in concrete)
- » receiver power supply ..... 9 V 6LR61 alkaline battery

### Nominal operating conditions:

- » operating temperature range ..... -10...+50 °C





## Reflectometer

# SONEL TDR-410

index: WMGBTDR410



IP 54

### Functionality:

- » location of damage in power cables,
- » location of damage in copper telecommunications cables,
- » location of damage in coaxial cables,
- » location of damage in infrastructural cabling,
- » detection of breaks, faults, damage caused by moisture or other changes in cable impedance,
- » graphical presentation of type of cable damage along with automatic reading of distance to fault location on screen.

### Characteristic features:

- » automatic or manual operating mode,
- » automatic fault location (AFL) function,
- » operating mode with manual selection of range and sensitivity,
- » single measurement triggered manually or continuous scanning,
- » 11 available measuring ranges from 7 m to 4000 m, selected in manual mode or automatically,
- » maximum length of tested cable: up to 4000 m from one end of the cable,
- » measurement "dead zone" limited to 0.5 m,
- » 2.5" LCD with backlighting,
- » sensitivity set manually or adjusted automatically,
- » adjustable impedance matching,
- » regulation of propagation coefficient from 1% to 99%,
- » watertight and mechanically durable housing,

### Nominal operating conditions:

- » operating temperature range ..... -10...+50 °C

### Technical data:

- » measuring ranges ..... 7, 15, 30, 60, 120, 250, 500 m, 1, 2, 3, 4 km
- » range selection ..... manual or automatic
- » resolution ..... approx. 1% of selected range
- » accuracy of measurement ..... 1% of range
- » sensitivity ..... at least 3 pixels on reflection from fault at a distance of 4 km on a 0.6mm copper cable
- » propagation coefficient ..... 1%...99% or 2.5...148.5 m/μs
- » output impulse ..... 5 V<sub>pp</sub> (open circuit)
- » output impedance ..... regulated - 25, 50, 75 and 100 Ω
- » width of output impulse ..... 3 ns ... 3 μs (automatic for selected range)
- » scanning mode ..... single measurement or continuous measurement (2 measurements per second)
- » tone generator ..... 810...1110 Hz
- » power supply ..... 4 x AA 1.5 V alkaline battery or 4 x Ni-MH AA accumulator
- » operating time with set of batteries ..... 30 hours of continuous scanning
- » auto-OFF ..... after 1, 2, 3, 5 min. or disabled
- » display ..... 64 x 128 pixel LCD with backlighting
- » operating temperature ..... 10 °C ... +50 °C
- » storage temperature ..... 20 °C ... +70 °C
- » dimensions ..... 165 mm x 90 mm x 37 mm
- » weight ..... 350 g
- » safety standards ..... EN61010-1; EN 60950, EMC BS/EN 61326-1
- » housing ..... IP54

### Standard accessories of the meter:

M-2 carrying case	WAFUTM2
black "crocodile" clip 1 kV 20 A	WAKROBL20K01
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
two-core lead for TDR; 0.6 m	WAPRZ0X6DZBB
AA 1.5V alkaline batteries – 4 pcs.	

## Reflectometer

# SONEL TDR-420

index: WMGBTDR420



IP 67

### Functionality:

- » location damaged power cables,
- » fault location copper telecom cables,
- » coaxial cable fault location,
- » fault location wiring infrastructure,
- » detection of breaks, short circuits, damage caused by dampness and other changes in impedance of the cable,
- » graphic depiction of damage the cable with automatic indication the distance to fault on the screen.

### Characteristic features:

- » manual operating mode,
- » operating mode with manual selection of range and sensitivity,
- » single measurement triggered manually or continuous scanning,
- » 11 available measuring ranges from 7 m to 6000 m, selected in manual mode
- » maximum length of tested cable: up to 6000 m from one end of the cable,
- » measurement "dead zone" limited to 0.6 m,
- » 2.5" LCD with backlighting,
- » single measurement triggered manually or continuous scanning,
- » sensitivity set manually or adjusted automatically,
- » adjustable impedance matching, regulation of propagation coefficient from 1% to 99%,
- » watertight and mechanically durable housing (IP67).

### Technical data:

- » ranges meters ..... 7 m, 15 m, 30 m, 60 m, 120 m, 250 m, 500 m, 1 km, 2 km, 3 km, 6 km
- » ranges feet ..... 20, 45, 90, 180, 360, 750, 1500, 3000, 6000, 10000, 20000 ft.
- » range selection ..... manual range control
- » accuracy ..... 1% of selected range\*
- » resolution ..... approx 1% of range
- » minimum cable length ..... 4 m (14ft)
- » velocity factor ..... adjustable from 10% to 99%
- » output pulse ..... 5 volts peak to peak into open circuit
- » output impedance ..... selectable 25, 50, 75, 100, 120 Ω
- » output pulse ..... width 3 ns to 3 μs, automatic with range
- » scan rate ..... up to 3 scans/second or scan held
- » tone generator ..... 810 – 1100 Hz
- » battery life ..... 8 hours continuous scanning
- » power supply ..... alkaline batteries or NiMH rechargeable batteries size AA, on-screen battery indicator
- » power down selectable ..... 1, 3, 5, 10, 15 minutes or disabled
- » display ..... 3.5" color LCD TFT, 320x240 pixels
- » voltage protection ..... 400 V DC / 250 V AC
- » operating temp ..... -20 °C / 70 °C
- » storage temp ..... -30 °C / 80 °C
- » dimensions ..... 221 x 102 x 62 mm
- » weight ..... 487 g (with batteries)
- » safety ..... IEC 61010-1, EN 60950
- » EMC ..... BS/EN 61326-1
- » water/dust proof ..... IP67

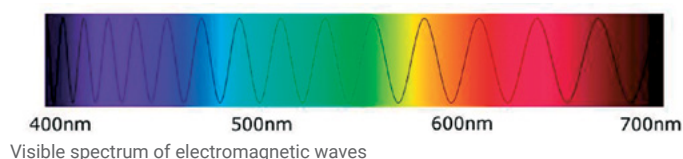
### Standard accessories of the meter:

double-wire test lead 0.6 m for TDR (banana plugs)	WAPRZ0X6DZBB
crocodile clip, red, 1 kV, 20 A	WAKRORE20K02
crocodile clip, black, 1 kV, 20 A	WAKROBL20K01
M6 carrying case	WAFUTM6
alkaline batteries 1.5 V AA (4 pieces)	
user manual	

# Illuminance measurements

A person's perception and psychophysical conditions depend on the environment in which they are currently present to a very large extent. Light stimuli are a decisive factor that affects mental comfort - presence in places with lighting that is unnatural for humans may not only accelerate fatigue and cause visual impairments but also cause a series of other diseases seemingly unrelated to the influence of light on the human body. The possibility of negative lighting impact on humans is of particular significance in the context of work safety and productivity. The perception of light stimuli depends on the individual characteristics of every person, nevertheless, it is similar even for different people, which is why the relevant laws have been laid down to regulate required lighting values and types at places occupied by people and where people work.

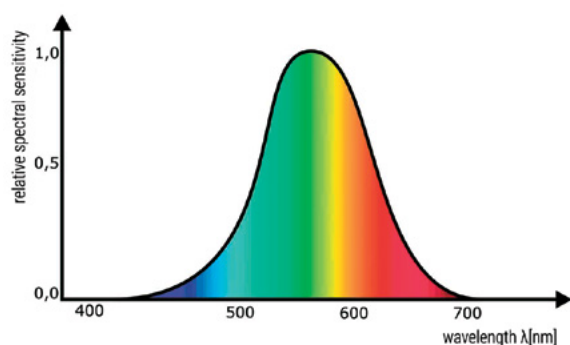
The light visible to humans is an electromagnetic wave with a wavelength from approx. 380 to approx. 780 nm. The sensitivity of the human eye is not identical under every conditions; this is due to the structure and distribution of receptors inside the eye and the nature of light itself.



Under daylight conditions, the eye is the most sensitive to green colors, while at night or in very poor lighting, this sensitivity shifts in the direction of blue colors (hence the subjective perception that everything is gray at night) - see the drawing at the bottom of the page.

Despite the eye's adaptive capacity depending on lighting intensity, during measurements, it is required for the instrument's characteristic to correspond to that of an eye adapted to brightness. The spectral curve corresponding to such sensitivity is called the photopic curve  $V_\lambda$ , and it is useful for calculating photometric quantities. When determining the criteria for selection of lighting properties, both the guidelines of the International Commission on Illumination (CIE), defining optimal conditions for lighting of rooms according to their purpose, and local regulations, being Polish Standards in our case, must be accounted for.

The position of the Polish Committee for Standardization is that the application of Polish Standards may not be imposed nor prohibited, **however the withdrawal of a standard does not signify that it has been invalidated, and decidedly does not constitute prohibition of its application.** Therefore, when conducting illumination tests, besides the current standard: EN 12464-1 "Light and lighting. Lighting of workplaces. Part 1: Indoor workplaces", **the provisions of standards E-02033 "Indoor electrical lighting"** (containing requirements concerning minimum illuminance values of typical workstations) and standards E-02034 and E-02035 can serve as a guide; however it should be noted that the given values (including in the current standard) correspond to minimum recommendations given by CIE. Nevertheless, standard E-02033 recommended increasing **required values in all situations where an error due to poor perception** could result in an accident, or where the majority of employees are over 40 years of age; or decreasing these values if, for example, work at a given location was short-term in nature. CIE recommendations define threshold luminance values for optimal perception conditions, but since it is easier to measure illuminance values, requirements are given for this quantity. In addition, the recommended uniformity of illuminance in field of vision is also given, or how the place where the subject of work is found may be exposed. Excessive non-uniformity of lighting (e.g. unshielded light sources in field of vision) may cause glare, which may limit the ability to identify details or cause discomfort



Spectral sensitivity chart for daytime vision.

time of eye adaptation to changes. This is why the level of light ripple and flickering is significant.

**The color of light** is another factor that has a significant influence on the comfort of people occupying a room. The most optimal lighting is when the spectral composition is the most similar to daylight. Light sources are classified according to color temperature into warm, white and cool light. It is recommended to use light sources of a warm color at lower illuminances (up to 300-500 lx). Color temperature can be determined on the basis of the color rendering index (Ra), which reflects the difference in the colors of an object lit by natural light and tested light. For example, ordinary lightbulbs are light sources with a relatively high Ra index.

Fluorescent lamps with an index above 70 can be used in most production rooms. Sources with an index below 70 (mercury, sodium lamps) are used wherever color differentiation is of secondary importance (corridor, warehouse lighting, etc.).

Measurements of parameters allowing for assessment of lighting conditions should be performed during commissioning of new lighting equipment, during modernization of existing lighting, or periodically, every 5 years. **It is recommended to perform tests no less frequently than every 2 years.** Measurements of lighting equipment in rooms are to be performed in the absence of external lighting, with windows completely covered, and if this is not possible, at night. The tester's silhouette may not affect the result, thus the person performing measurements should wear dark clothing and be as far as possible from the point where measurements are performed. An instrument capable of ensuring the furthest distance of the sensor from the measured object is the optimal meter. Measurements should be performed on the work plane (e.g. desktop) by placing the sensor directly on the plane at the same angle as the plane. If discharge lamps are applied as light sources, they should be switched on at least half an hour before measurement. Discharge lamps may not be new, and they should have operated for at least 100 hours prior to measurements (for halogen lightbulbs and lighting, this requirement is only one hour, and measurements can be performed immediately after lighting is switched on).

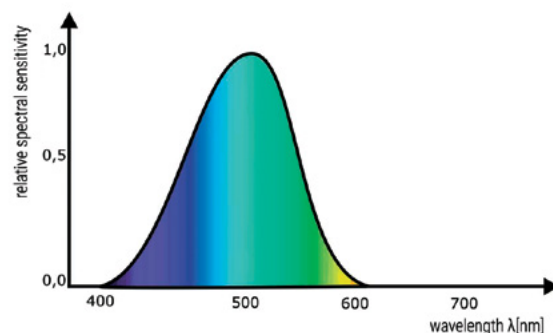
Because standard EN 12464-1 defines only the scope of verification procedures, the withdrawn standards E-02033 and E04040.03 can serve as a guide when determining the details of measurement.

In rooms with specific workstations, measurement points are determined directly at every station (usually 4-9 points). In small rooms, measurements are performed every 1m (a grid can be superimposed on the drawing). For larger rooms, it will be useful to apply the formula from standard E-02033, which allows for calculation of the minimum number of measurement points for a given room, depending on dimensions and the height of light source suspension. Based on measurements, **lighting uniformity** can be calculated for the given location (work plane, passage-way).

For measurement of indoor lighting with daylight, measurements that will allow for determination of the daylight factor must be performed. For this purpose, measurements are performed simultaneously outside and inside of rooms with lighting through windows or skylights by means of two illuminance meters (here, the real-time clock applied in illuminance meters will facilitate measurements).

In turn, during **emergency lighting measurements**, we are dealing with very low lighting intensity values, and the instrument that is used must be capable of measuring such values. The case is similar in high-risk zones, where it is required to check uniformity of illuminance with very high resolution.

When selecting the instrument, one must **make sure that it has a calibration certificate, since the photoelectric cell being the sensor ages over time**, which is why it must undergo periodical metrological inspection. An instrument with a silicon cell will be a superior choice, as such a cell requires calibration every 13 months (every 6 months in the case of selenium cells). The sensor must be equipped with diagonal light incidence correction (cosine characteristic). The spectral sensitivity characteristic  $V_\lambda$  must be adapted to the requirements of the CIE curve.



Spectral sensitivity chart for nighttime vision.

Uniformity of illumination should also be maintained over time, due the specific

**SONEL LXP-2 / LXP-10B / LXP-10A**

index: WMXXLXP2 / WMXXLXP10B / WMXXLXP10A

**The most important features of these instruments include:**

- » maximum resolution of light measurement LXP-2: 0.1 lx (0.01 fc), LXP-10B: 0.01 lx (0.001 fc), LXP-10A: 0.001 lx (0.001 fc),
- » high accuracy of measurements,
- » Data-hold function, used to hold displayed measurement values on the screen,
- » automatic zeroing,
- » no need to apply correction coefficients for different light sources (LXP-10B and LXP-10A),
- » spectral sensitivity guarantees proper illuminance measurement regardless of the nature of radiation,
- » peak-hold function, enabling measurement of peak light impulse signal with a duration over 0.1 s (0.4 s for LXP-2 with LP-1 probes) and under 1 s,
- » automatic power down after 5, 10 or 15 minutes of inactivity,
- » measurements of maximum and minimum (MIN MAX) values,
- » measurements of relative (REL) values,
- » large and easy-to-read backlit display,
- » USB cable for connecting the instrument to a computer,
- » data transmission via radio connection by means of optional OR-1 adapter (only LXP-10B, LXP-10A),
- » four measuring ranges - LXP-2, five ranges - LXP-10B, six ranges - LXP-10A,
- » writing of 99 (for LXP-2) or 999 (for LXP-10B, LXP-10A) results to memory, which can be read in the meter or on a computer,
- » data logger with memory storing up to 16,000 values, with capability of reading on PC,
- » measurement of different light sources, including LEDs (LXP-10A).

**Other technical specifications:**

- » display ..... 3½ digits, LCD with 40-segment bar indicator
- » exceeding of range ..... "OL" symbol
- » spectral sensitivity ..... CIE photopic curve (CIE human eye sensitivity curve)
- » cosine matching error (f2') ..... ±3%
- » sampling ..... 1.3 times/s
- » power source ..... 9 V battery or 8.4 V accumulator
- » photodetector ..... one silicon photodiode and spectral curve filter
- » memory ..... 99 results (LXP-2), 999 results (LXP-10)
- » photodetector lead length ..... approx. 150 cm
- » photodetector dimensions ..... 115 mm × 60 mm × 20 mm
- » meter dimensions ..... 170 mm × 80 mm × 40 mm
- » weight ..... 390 g
- » communication interface ..... USB and radio link (only LXP-10B, LXP-10A)

**Nominal operating conditions:**

- » operating temperature and humidity ..... 0...50°C  
and relative humidity ..... 0% to 80%
- » storage temperature and humidity ..... -20...70°C  
and relative humidity ..... 0% to 70%

**Standard accessories of the meter:**

USB data transmission cable terminated by USB - USB MINI-B 5 plugs	WAPRZUSBMINIB5
Sonel Reader	WAPROREADER
calibration certificate	



LXP-10B and LXP-10A enable wireless data transfer to a PC via the OR-1 adapter

**Illuminance measurement LP-1 Probe**

Display range [lx]	Resolution [lx]	Spectral uncertainty	Base uncertainty (accuracy)
0...399.9	0.1	f1 < 6%	±(5% + 5 digits)
400...3999	1		
4.00 k...19.99 k	0.01 k		
Display range [fc]	Resolution [fc]	Spectral uncertainty	Base uncertainty (accuracy)
0.00...39.99	0.01	f1 < 6%	±(5% + 5 digits)
40.0...399.9	0.1		
400...1999	1		

- » result displayed in lx or fc
- » meter class B

**Illuminance measurement LP-10B Probe**

Display range [lx]	Resolution [lx]	Spectral uncertainty	Base uncertainty (accuracy)
0.00...39.99	0.01	f1 < 6%	±(5% + 5 digits)
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		
40.0 k...399.9 k	0.1 k		
Display range [fc]	Resolution [fc]	Spectral uncertainty	Base uncertainty (accuracy)
0.00...3.999	0.001	f1 < 6%	±(5% + 5 digits)
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4 k...39.99 k	0.01 k		

- » result displayed in lx or fc
- » meter class B

**Illuminance measurement LP-10A Probe**

Display range [lx]	Resolution [lx]	Spectral uncertainty	Base uncertainty (accuracy)
0...3.999	0.001	f1 < 2%	±(2% + 5 digits)
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		
40.0 k...399.9 k	0.1 k		
Display range [lx]	Resolution [lx]	Spectral uncertainty	Base uncertainty (accuracy)
0...3.999	0.001	f1 < 2%	±(2% + 5 digits)
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		

- » result displayed in lx or fc (result in fc displayed with reduced resolution due to limitations of the display)
- » meter class A



# Power quality analysis

Manmade electricity is a typical commercial product. Thus, it is subject to the same rules that apply to all goods, with consideration of the fact that both suppliers and users have an impact on final power quality since they use the same power grid. Power quality parameters, criteria and conditions for their assessment, as well as rules of transmission and operation have been unambiguously defined. Inspection of power quality parameters, consumption conditions and registration of all exceeded tolerances is required as power flows through the grid. On this basis, a statistical assessment of the compliance of registered parameters with applicable standards, legal requirements and contracts is created. The result is statement of compliance that unambiguously concludes assessment, or non-compliance, which is associated with further analysis of the problem to indicate liability, which may be linked to financial consequences.

The availability of electricity has resulted in universal power supply to industrial equipment and facilities, public facilities and the vast majority of households from public power grids. Rapid technical progress has caused typical electrical appliances of a linear nature, such as: motors, lightbulbs, resistance heaters to be equipped with additional power electronics ensuring easy control of energy flow as well as control over power and performance. As a consequence of this progress, due in part to cost minimization, solutions have been significantly simplified, resulting in a much higher level of current and voltage distortions as well as of disturbances. Phenomena not previously encountered, deteriorating power quality and causing additional losses, appeared in power networks, which is particularly perceivable with such widespread use.

Power electronics for general use have inconspicuously low powers, however their very large quantity may have a significant impact on power quality in public power grids.

Power electronics on an industrial scale involve much greater active and reactive powers, systematically repeating changes of load and of the character of reactive power, asymmetries of single- and two-phase loads, current distortions, voltage dips induced by instant network overloads and equipment failures. This is why undesirable voltage fluctuations causing light flicker, short-term voltage dips, higher levels of voltage and current harmonics, and dangerous resonance phenomena occur in industrial power supply networks. Discontinuities and breaks in power supply, causing losses on production lines and even threatening workers' lives, are also not without significance. The larger number of harmful phenomena causes faster and unpredictable wear of machine parts, making planning of overhauls difficult. The risk of losses due to unpredicted failures also increased significantly.

Two fundamental functions are expected for instruments for analysis and diagnostics of power quality. One is assessment of compliance or the degree of non-compliance of power parameters with established standards and legal requirements - all instruments available on the market are capable of doing this. The second function is to capture quality-deteriorating phenomena as well as phenomena impeding effective operation of power equipment, and to ensure universal diagnostics for various types of networks with different rated voltages. Implementation of this function in instrument solutions is an initiative taken by manufacturers of measuring instruments.

Our company's offer encompasses a wide range of products adapted to users' needs: **Class S: PQM-700, Class A/S: PQM-701, Class A: PQM-702, PQM-703, PQM-710, PQM-711.**

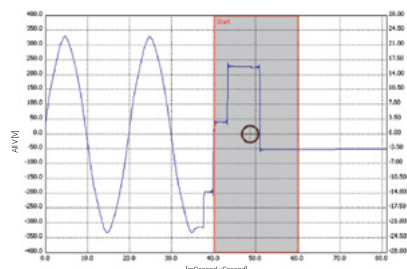
Analizers in the PQM-7xx family, with a broad range of accessories, are tasked with registration in high-speed memory of up to 4500 network parameters simultaneously, including: mean, MIN and MAX values, supplemented by registration of current and voltage oscillograms at the end of every averaging cycle. Voltage flares, dips and breaks are monitored with registration of oscillograms and RMS(1/2) charts. In addition, violations of tolerances or tolerable levels of other parameters are checked. Quick registration of the progression of unstable states up to 6000 V is also possible in the case of PQM-703/711. Thanks to well thought out solutions, analyzers can operate continuously **with power supply from the measured network up to 760 V AC with CAT IV 600 V** overvoltage resistance, within a broad temperature range. Analyzers also maintain their complete functionality for more than 8 hours on their own battery power. Class A instruments have a **built-in GPS** that ensures high time accuracy, as well as a GSM modem for long-distance remote connectivity.

A USB cable is used for short-distance communication, and certain analyzers also have built-in OR-1 radio or Wi-Fi modules.

Thanks to the measurements gathered by PQM analyzers, it is possible to:

**Assess power quality** in reference to the regulation applicable in Poland or standard EN 50160. A compliance assessment report indicates which parameters are outside of threshold values, as a percentage of the observation period. Mean voltage and frequency, asymmetry, flicker coefficient Plt, THD U, and voltage harmonic values are subject to assessment, and the maximum mean 15-min active power and tg are also indicated depending on requirements.

**Diagnostics and identification of voltage dips** indicating the cause of their occurrence. Based on simultaneous registration of mean and limit values as well as RMS(1/2) of voltages and currents, it is possible to indicate whether dips originate from the outside or were caused by the operation of in-house equipment. Oscillogram registration makes it possible to capture unstable states during outages, returns, and very steep voltage changes.

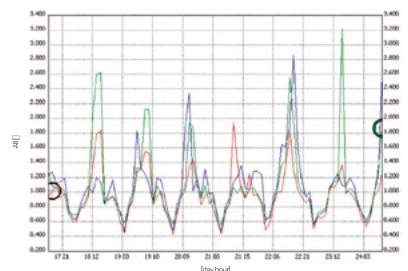


Example of distorted current progression.

Pst coefficient and propagation of changes and simultaneous synchronous registration at several points in the network make it possible to indicate the direction of the source of turbulent loads.

**Active and reactive power diagnostics** help to select the parameters of the compensator that eliminate fines for violations of reactive power and also serve to verify the effectiveness and operating conditions of the reactive power compensation battery, ensuring failure-free operation.

**Voltage and current asymmetry diagnostics** allows for assessment of the operating conditions of electrical machinery with a rotating field on the basis of the behaviors of symmetrical components of voltages and currents. Uneven operation of three-phase motors powered directly from the network and disturbances of transformer operation with the possibility of ferroresonances can be identified on the basis of co-dependencies between individual parameters and the progression of symmetrical components. Detection of such phenomena may reduce the risk of failure, improving the effects of machinery operation.

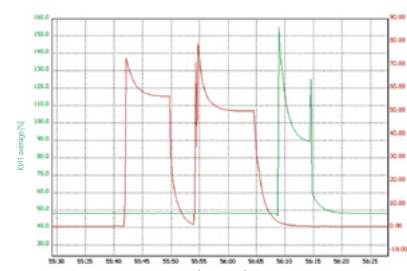


Example of distorted current progression.

**Diagnostics of harmonic phenomena** on the basis of the behaviors of voltage, current and power harmonics make it possible to assess the effects of powering non-linear equipment and their influence on power network parameters and power quality. A high level of harmonics generates additional thermal losses in elements of the power system, posing a threat to the operation of these devices and generating additional costs. It is also possible to assess threats to other power equipment powered from the network that increase the risk of unforeseen failures.

**Diagnostics of inter-harmonic phenomena** allow for identification of unstable states and dangerous network behavior that could pose a risk to the operation of other equipment. These phenomena may occur at any frequency. Inter-harmonics complement harmonic in analysis of the 0 - 2500 Hz band.

**Diagnostics of unstable states** on the basis of quick voltage registrations, sampled with a frequency up to 10 MHz within the voltage range of +/- 6000 V. It is possible to detect rapid overvoltage phenomena that pose a threat to power electronics equipment and insulating elements. This may indicate the absence or unserviceability of overvoltage protection or faulty operation of a device, which may lead to failures and unnecessary losses.



Example of distorted current progression.

## SONEL PQM-711 / PQM-710

index: WMGBPQM711 / WMGBPQM710



The instrument is intended for operation in networks:

- » with rated frequency 50/60 Hz,
- » with rated voltages: 64/110 V, 110/190 V, 115/200 V, 120/208 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V, 254/440 V, 277/480 V, 290/500 V, 400/690 V,
- » with direct current,
- » in the following configurations:
  - single-phase,
  - two-phase with common N,
  - three-phase - star with and without N conductor,
  - three-phase - delta.
- » A built-in accumulator allows for at least two hour of operation.

Measured parameters:

- » voltages L1, L2, L3, N-PE (five measurement inputs) – mean, minimum and maximum values, instant values within the range up to 1000 V, interoperability with voltage transformers,
- » currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, instant values, direct current measurement within the range up to 3 kA (depending on applied current clamp), interoperability with current transformers,
- » crest factors for current (CFI) and voltage (CFV),
- » frequency within the range of 40 Hz – 70 Hz,
- » active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » calculation of reactive power using the:
  - Budeanu method,
  - IEEE 1459,
- » active energy ( $E_p$ ), reactive energy ( $E_q$ ), apparent energy ( $E_s$ ),
- » power factor (PF),  $\cos\phi$ ,  $\tan\phi$ ,
- » K factor (transformer overload due to harmonics),
- » harmonics up to the 50th in voltage and current,
- » interharmonics measured as groups,
- » total harmonic distortion THD for current and voltage,
- » short-term ( $P_{ST}$ ) and long-term ( $P_{LT}$ ) light flicker index (in compliance with EN 61000-4-15 class A),
- » asymmetry of voltages and currents,
- » registration of overvoltages, voltage dips and breaks along with oscillograms,
- » event logging for current along with oscillograms (up to 1 s) as well as 10 ms RMS charts with maximum registration time of 30 s,
- » registration of current and voltage oscillograms after every averaging period,
- » measurement of control signals up to 3000 Hz,
- » **measurement of transients up to  $\pm 8000$  V with maximum sampling frequency of 10 MHz.** The minimum transient time that can be registered is 650 ns (only PQM-711).



Thanks to built-in WiFi communication and a 10" tablet included in the standard version, PQM-711/710 series analyzers enable wireless configuration and data analysis thanks to the specially developed Sonel Analysis Tablet software.

## Standard accessories of the meters:

magnetic adapter (set of 4 pcs.)	WAADAUMAGKPL
voltage adapter with M4 / M6 thread	WAADAM4M6
AC-16 phase splitter adapter	WAADAAAC16
Li-ion accumulator 3.6 V 4.5 Ah (replacement by Sonel service)	WAAKU11
AZ-1 power adapter (network plug / banana plugs)	WAADAAZ1
L-8 carrying case (backpack)	WAFUTL8
3x black "crocodile" clip 1 kV 20 A	WAKROBL20K01
2x red "crocodile" clip 1 kV 20 A	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
2x fasteners for bands used for fastening on pylons	WAPOZUCH4
band for fastening on pylon (set)	WAPOZOPAKPL
USB data transmission cable	WAPRZUSB
tablet	Tablet
fastener for latching onto DIN (ISO) busbar with stabilizing connectors	WAPOZUCH3
calibration certificate	



PQM-711/710 have an independent power source, making them particularly suited for measurements behind voltage transformers.

The instrument meets the requirements set forth in the standards:

- » EN 61000-4-30 (class A) (electromagnetic compatibility - measurement methods)
- » EN 61000-4-7 (class I) (measurements of harmonics)
- » EN 61000-4-15 (class A) (light flicker)
- » EN 50160 (supply voltage measurements)
- » EN 61010-1 (safety of measuring instruments)



PQM-711 enables measurement of transients up to  $\pm 8000$  V with maximum sampling frequency of 10 MHz.

Other technical specifications on page 62

## Power quality analyzers

# SONEL PQM-707

index: WMGBPQM707 / WMGBPQM707NC

**CAT IV**

**600V**



**IP 51**

**NETWORK**

**AC/DC**

**TOUCH SCREEN**



### Measured parameters:

- » Voltages L1, L2, L3, N-PE (five measurement inputs) – mean, minimum and maximum values within the range up to 760 V, interoperability with voltage transformers,
- » Currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, current measurement within the range up to 3 kA (depending on applied current clamp), interoperability with current transformers,
- » Crest factors for current (CFI) and voltage (CFV),
- » Frequency within the range of 40Hz – 70Hz,
- » Active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » Power registration: Budeanu method, IEEE 1459,
- » Active energy ( $E_p$ ), reactive energy ( $E_q$ ), apparent energy ( $E_s$ ),
- » Power factor (PF),  $\cos\phi$ ,  $\tan\phi$ ,
- » Harmonics up to the 50th in voltage and current,
- » Total harmonic distortion THD for current and voltage,
- » Short-term ( $P_{st}$ ) and long-term ( $P_{lt}$ ) light flicker index (in compliance with EN 61000-4-15 class S),
- » Asymmetry of voltages (in compliance with EN 61000-4-30 class S) and currents,
- » Event logging for current and voltage along with oscillograms and half-period RMS charts,
- » Inrush current,
- » Energy cost calculator\*\*,
- » All parameters are registered in compliance with class S according to standard EN 61000-4-30.

### Analyzer parameters

Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0...760.0 V	0.01 % Unom	±0.5% Unom
Crest factor	Voltage	1.00...10.00 ( $\leq 1.65$ for 690 V voltage)	0.01	±5%
	Current	1.00...10.00 ( $\leq 3.6$ Inom)	0.01	± 5% m.v.
Alternating voltage TRMS	—	depending on clamp*	0.01% Inom	±2% m.v. for m.v. $\geq 10\%$ Inom ±2% Inom for m.v. $< 10\%$ Inom (error does not account for clamp error)
Frequency:	—	40.00...70.00 Hz	0.01Hz	±0.05 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (instrument transformers, clamp)	up to four places after the decimal point	depending on configuration (instrument transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (instrument transformers, clamp)	up to four places after the decimal point	as power error
$\cos\phi$ and power factor (PF)	—	0.00...1.00	0.01	±0.03
$\tan\phi$	—	0.00...10.00	0.01	depends on error of active and reactive power
Harmonics	Voltage	as for alternating voltage True RMS	as for alternating voltage True RMS	±5% m.v. for m.v. $\geq 3\%$ Unom ±0.15% Unom for m.v. $< 3\%$ Unom
	Current	as for alternating current True RMS	as for alternating current True RMS	±5% m.v. for m.v. $\geq 10\%$ Inom ±0.5% Inom for m.v. $< 10\%$ Inom
THD	Voltage	0.0...100.0% (relative to rms value)	0.1%	±5%
	Current			±5%
Flicker index	—	0.40...10.00	0.01	±10%
Asymmetry factor	Voltage and current	0.0...10.0%	0.1%	±0.15% (absolute error)
Inrush current	Current	depending on clamp	0.01% Inom	±4% m.v. for m.v. $\geq 10\%$ Inom ±4% Inom for m.v. $< 10\%$ Inom (RMS1/2)

\*F-1A, F-2A, F-3A clamp: 0..3000 A (10000 Ap-p) \*C-4A clamp: 0..1000 A (3600 Ap-p) \*C-5A clamp: 0..1000 A (3600 Ap-p) \*C-6A clamp: 0..10 A (36 Ap-p) \*C-7A clamp: 0..100 A (360 Ap-p)

### Standard accessories of the meter:

magnetic adapter (set of 4 pcs.)	WAADAUMAGKPL
AC-16 phase splitter adapter	WAADAAC16
AZ-2 power adapter (IEC C7 plug / banana plugs)	WAADAAZ2
Li-Ion accumulator (rechargeable battery) 11.1 V 3.4 Ah	WAAKU15
4x F-3A flexible clamp (Ø 120mm)	WACEGF3AOKR
L-4 carrying case	WAFUTL4
L-1 carrying case	WAFUTL1
3x black "crocodile" clip 1 kV 20 A	WAKROBL20K01
2x red "crocodile" clip 1 kV 20 A	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
3x test lead with banana plugs; 1 kV; 2.2 m; black	WAPRZ2X2BLBB
test lead with banana plugs; 1 kV; 2.2 m; blue	WAPRZ2X2BUBB
test lead with banana plugs; 1 kV; 2.2 m; yellow-green	WAPRZ2X2YEBB
230 V power cord (IEC C7 plug)	WAPRZLAD230
Battery charging cable for 12 V car sockets	WAPRZLAD12SAM
USB data transmission cable	WAPRZUSB
meter strap (type L-2)	WAPOZSZEKPL
calibration certificate	

### The instrument is intended for operation in networks:

- » **with rated frequency** 50/60 Hz,
- » **with rated voltages:** 64/110 V; 110/190 V; 115/200 V; 127/220 V; 220/380 V; 230/400 V; 240/415 V; 254/440 V; 290/500 V, 400/690 V,
- » **with direct current.**

### Supported network configurations:

- » single-phase,
- » two-phase with common N,
- » three-phase - star with and without N conductor,
- » three-phase - triangle.



## SONEL PQM-703 / PQM-702

index: WMGBPQM703 / WMGBPQM702



The instrument is intended for operation in networks:

- » with rated frequency 50/60 Hz,
- » with rated voltages: 64/110V, 110/190 V, 115/200 V, 120/280V, 127/220 V, 220/380 V, 230/400 V, 240/415 V, 254/440 V, 277/480V, 290/500 V, 400/690 V,
- » with direct current,
- » in the following configurations:
  - single-phase,
  - two-phase with common N,
  - three-phase - star with and without N conductor,
  - three-phase - delta.
- » a built-in accumulator allows for at least two hour of operation.



PQM-703/702 series analyzers can be powered from the L phase and are intended for direct use in all types of networks from 64 V to 690 V, with particular emphasis on measurements on low-voltage pylons, due to the simplicity of their connection.

Measured parameters:

- » voltages L1, L2, L3, N-PE (five measurement inputs) – mean, minimum and maximum values, instant values within the range up to 1000 V, interoperability with voltage transformers,
- » currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, instant values, direct current measurement within the range up to 3 kA (depending on applied current clamp), interoperability with current transformers,
- » crest factors for current (CFI) and voltage (CFU),
- » frequency within the range of 40 Hz – 70 Hz,
- » active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » calculation of reactive power using the:
  - Budeanu method,
  - IEEE 1459,
- » active energy ( $E_p$ ), reactive energy ( $E_q$ ), apparent energy ( $E_s$ ),
- » power factor (PF),  $\cos\phi$ ,  $\tan\phi$ ,
- » K factor (transformer overload due to harmonics),
- » harmonics up to the 50th in voltage and current,
- » interharmonics measured as groups,
- » total harmonic distortion THD for current and voltage,
- » short-term ( $P_{ST}$ ) and long-term ( $P_{LT}$ ) light flicker index (in compliance with EN 61000-4-15 class A),
- » asymmetry of voltages and currents,
- » registration of overvoltages, voltage dips and breaks along with oscillograms,
- » event logging for current along with oscillograms (up to 1 s) as well as 10 ms RMS charts with maximum registration time of 30 s,
- » registration of current and voltage oscillograms after every averaging period,
- » measurement of control signals up to 3000 Hz,
- » measurement of transients up to  $\pm 8000$  V with maximum sampling frequency of 10 MHz. The minimum transient time that can be registered is 650 ns (only PQM-703).

### Standard accessories of the meters:

magnetic adapter (set of 4 pcs.)	WAADAUMAGKPL
voltage adapter with M4 / M6 thread	WAADAM4M6
AC-16 phase splitter adapter	WAADAAC16
Li-Ion accumulator (rechargeable battery) 3.6 V 4.5 Ah	WAAKU11
AZ-1 power adapter (network plug / banana plugs)	WAADAAZ1
3x black "crocodile" clip 1 kV 20 A	WAKROBL20K01
2x red "crocodile" clip 1 kV 20 A	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
2x fasteners for bands used for fastening on pylons	WAPOZUCH4
band for fastening on pylon (set)	WAPOZOPAKPL
USB data transmission cable	WAPRZUSB
fastener for latching onto DIN (ISO) busbar with stabilizing connectors	WAPOZUCH3
handcase	WAWALXL2
calibration certificate	

The instrument meets the requirements set forth in the standards:

- » EN 61000-4-30 (class A) (electromagnetic compatibility - measurement methods)
- » EN 61000-4-7 (class I) (measurements of harmonics)
- » EN 61000-4-15 (class A) (light flicker)
- » EN 50160 (supply voltage measurements)
- » EN 61010-1 (safety of measuring instruments)



PQM-703/702 have a built-in GSM modem and GPS module with an anti-theft function, sending a text message notification in the event of a change of location.



Other technical specifications on page 67

## Analyzer parameters

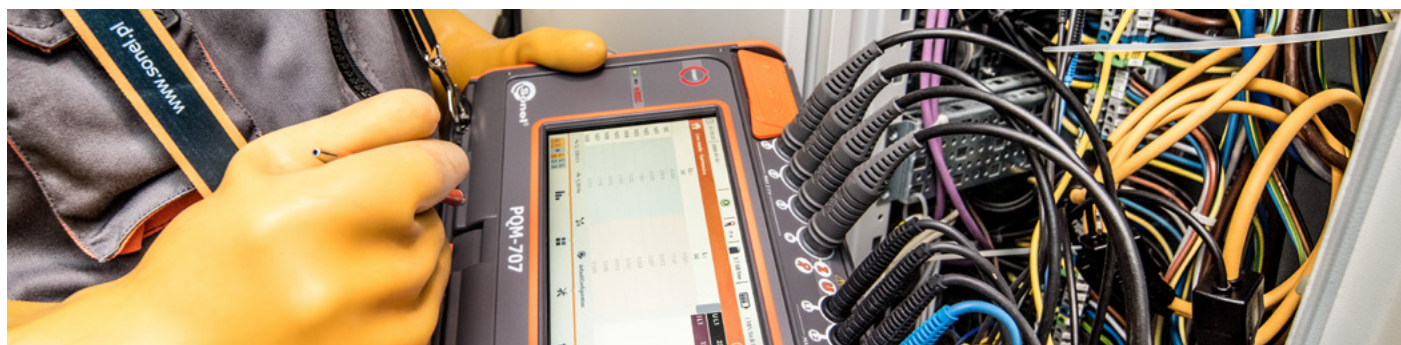
Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0...760.0 V	0.01% Un	±0.1% Un
Crest factor	Voltage	1.00...10.00 (≤1.65 for 690 V voltage)	0.01	±5%
	Current	1.00...10.00 (≤3.6 Inom)	0.01	± 5% m.v.
Alternating voltage TRMS	—	depending on clamp*	0.01 % of nominal range	±0.1% of nominal range (error does not account for clamp error)
Frequency:	—	40.00...70.00 Hz	0.01 Hz	±0.01 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (instrument transformers, clamp)	up to four places after the decimal point	depending on configuration (instrument transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (instrument transformers, clamp)	up to four places after the decimal point	as power error
cosφ and power factor (PF)	—	0.00...1.00	0.01	±0.03
Tgφ	—	0.00...10.00	0.01	depends on error of active and reactive power
Harmonics and inter-harmonics	Voltage	as for alternating voltage True RMS	as for alternating current True RMS	±5% Uh for Uh<1% Un ±0.05% Un for Uh<1% Un
	Current	as for alternating current True RMS	as for alternating current True RMS	± 5% Ih for Ih<3% In ± 0.15% In for Ih<3% In
THD	Voltage	0.0...100.0% (relative to rms value)	0.1%	±5%
	Current			±5%
Active and reactive power of harmonics	—	depending on configuration (instrument transformers, clamp)	depends on minimum current and voltage values	—
Angle between current and voltage harmonics	—	-180.0...+180.0°	0.1°	±(h x 1°)
K-Factor	—	1.0...50.0	0.1	±10%
Flicker index	—	0.20...10.00	0.01	±5%
Voltage asymmetry	Voltage and current	0.0...20.0%	0.1%	±0.15% (absolute error)
Measurement of control signals	Voltage	5...3000 Hz	0.01 Hz	±0.15% Uh for 1...3% Uh, 5% Un for 3...15% Uh
Measurement of transients (PQM-711/703)		±6000 V	5 V	±(5% + 25 V)

\* F-1A, F-2A, F-3A clamp: 0..3000 A (10000 Ap-p) \*C-4A clamp: 0..1000 A (3600Ap-p)\*C-5A clamp: 0..1000 A (3600 Ap-p) \*C-6A clamp: 0..10 A (36 Ap-p) \* C-7A clamp: 0..100 A (360 Ap-p)

## Optional accessories for analyzer



	C-4A WACEGC4AOKR	C-5A WACEGC5AOKR	C-6A WACEGC6AOKR	C-7A WACEGC7AOKR	F-1A WACEGF1AOKR	F-2A WACEGF2AOKR	F-3A WACEGF3AOKR
Rated current	1000 A AC	1000 A AC 1400 A DC	10 A AC	100 A AC	3000 A AC		
Max. overload current	1200 A AC	1000 A AC 3000 A DC	20 A AC	100 A AC	10 kA AC		
Minimum measurable current	100 mA	500 mA	10 mA	20 mA	1 A		
Frequency:	30 Hz...10 kHz	Dc...5 kHz	40 Hz...10 kHz	40 Hz...1 kHz	40 Hz...10 kHz		
Output signal level	1 mV / 1 A	1mV / 1 A	100 mV / 1 A	5 mV / 1 A	38.8 μV / 1 A		
Max. diameter of measured conductor	52 mm	39 mm	20 mm	24 mm	360 mm	235 mm	120 mm
Minimum accuracy	≤0.5%	≤1.5%	≤1%	0.5%	1%		
Battery power	—	+	—	—	—		
Lead length	2.2 m	2.2 m	2.2 m	3 m	2.2 m		
Measurement category	IV 300 V	IV 300 V	IV 300 V	III 300 V	IV 600 V		
IP rating	IP40				IP67		



# SONEL PQM-700

Index: WMGBPQM700

CAT IV

300V

IP 65



The instrument is intended for operation in networks:

- » **with rated frequency** 50/60 Hz.
- » **with rated voltages:** 64/110 V; 110/190 V; 115/200 V; 120/208 V; 127/220 V; 220/380 V; 230/400 V; 240/415 V; 254/440 V; 277/480 V; 290/500 V; 400/690 V,
- » **with direct current,**
- » in the following configurations:
  - single-phase,
  - two-phase with common N,
  - three-phase - star with and without N conductor,
  - three-phase - triangle.

Measured parameters (EN 50160-4-30 class S):

- » voltages L1, L2, L3 (four measurement inputs) – mean, minimum and maximum values, instant values within the range up to 760 V, interoperability with voltage transformers,
- » currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, instant values, current measurement within the range up to 3 kA (depending on applied current clamp), interoperability with current transformers,
- » crest factors for current (CFI) and voltage (CFU),
- » frequency within the range of 40Hz – 70Hz,
- » active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » calculation of reactive power using the:
  - Budeanu method,
  - IEEE 1459,
- » active energy ( $E_p$ ), reactive energy ( $E_q$ ), apparent energy ( $E_s$ ),
- » power factor (PF),  $\cos\phi$ ,  $\tan\phi$ ,
- » harmonics up to the 40th in voltage and current,

Analyzer parameters

Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0...760.0 V	0.01 % Un	±0.5% Un
Crest factor	Voltage	1.00...10.00 (≤1.65 for 690 V voltage)	0.01	±5%
	Current	1.00...10.00 (≤3.6 Inom)	0.01	± 5% m.v.
Alternating voltage TRMS	—	depending on clamp*	0.01 % of nominal range	±1% of nominal range (error does not account for clamp error)
Frequency:	—	40.00...70.00 Hz	0.01Hz	±0.05 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (instrument transformers, clamp)	up to four places after the decimal point	depending on configuration (instrument transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (instrument transformers, clamp)	up to four places after the decimal point	as power error
$\cos\phi$ and power factor (PF)	—	0.00...1.00	0.01	±0.03
$\tan\phi$	—	0.00...10.00	0.01	depends on error of active and reactive power
Harmonics	Voltage	as for alternating voltage True RMS	as for alternating voltage True RMS	±5% Uh for Uh>1% Un ±0.05% Un for Uh<1% Un
	Current	as for alternating voltage True RMS	as for alternating voltage True RMS	± 5% Ih for Ih>3% In ± 0.15% In for Ih<3% In
THD	Voltage	0.0...100.0% (relative to rms value)	0.1%	±5%
	Current			±5%
Flicker index	—	0.40...10.00	0.01	±10%
Asymmetry factor	Voltage and current	0.0...10.0%	0.1%	±0.3% (absolute error)

\* F-1A, F-2A, F-3A clamp: 0..3000 A (10000 Ap-p) \*C-4A clamp: 0..1000 A (3600 Ap-p) \*C-5A clamp: 0..1000 A (3600 Ap-p) \*C-6A clamp: 0..10 A (36 Ap-p) \*C-7A clamp: 0..100 A (360 Ap-p)

- » total harmonic distortion THD for current and voltage,
- » short-term ( $P_{ST}$ ) and long-term ( $P_{LT}$ ) light flicker index (in compliance with EN 61000-4-15 class S),
- » asymmetry of voltages (in compliance with EN 61000-4-30 class S) and currents,
- » event logging for current and voltage along with oscillograms and half-period RMS charts,
- » all parameters are registered in compliance with class **S** according to standard EN 61000-4-30.

Standard accessories of the meter:

Li-ion accumulator 3.6 V 4.5 Ah (replacement by Sonel service)	WAAKU11
AZ-1 power adapter (network plug / banana plugs)	WAADAAZ1
L-5 carrying case	WAFUTL5
3x black "crocodile" clip 1 kV 20 A	WAKROBL20K01
2x red "crocodile" clip 1 kV 20 A	WAKRORE20K02
blue "crocodile" clip 1 kV 20 A	WAKROBU20K02
2x fasteners for bands used for fastening on pylons	WAPOZUCH4
band for fastening on pylon (set)	WAPOZOPAKPL
USB data transmission cable	WAPRZUSB
DIN rail mounting bracket	WAPOZUCH3
bands for mounting the analyzer on a pole (2 pcs.)	WAPOZUCH4
fastener for latching onto DIN (ISO) busbar with stabilizing connectors	WAPOZUCH3
calibration certificate	



PQM-700 has an independent power source, making it particularly suited for measurements on voltage transformers.

The device conforms to class S according to EN 61000-4-30

- » EN 61000-4-30 (electromagnetic compatibility - measurement methods)
- » EN 61000-4-7 (measurements of harmonics)
- » EN 61000-4-15 (light flicker)
- » EN 50160 (supply voltage measurements)
- » EN 61010-1 (safety of measuring instruments)
- » EN 61326 (electromagnetic compatibility - electrical equipment for measurement)

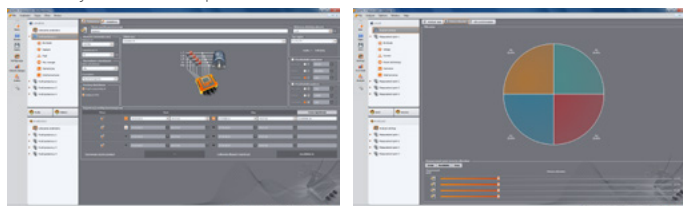


## SONEL ANALYSIS



"SONEL Analysis" software - application delivered as standard equipment, indispensable for working with PQM-series analyzers. It enables:

- » analyzer configuration,
- » data reading from logger,
- » preview of network parameters in real time (with capability of reading via GSM modem),
- » deletion of data in the analyzer,
- » data presentation in tables,
- » data presentation in charts,
- » data analysis in compliance with standard EN 50160 (reports) and other user-defined reference conditions,
- » independent support of multiple analyzers,
- » analyzer firmware updates.



### Analyzer configuration

The application enables configuration of all analyzer settings. Configuration is performed on a computer and then sent to the analyzer. A configuration can also be saved on a hard disk or other data carriers for later use.

### The application enables configuration of, among other things:

- » selection of measurement points and arbitrary memory assignment to individual measurement points,
- » configurable analyzer time,
- » button blockade,
- » PIN code protection against unauthorized access by third parties,
- » configurable averaging time,
- » selection of current and voltage transformers,
- » selection of triggering mode (instant after an event occurs or according to set time schedule),
- » selection of clamp type, selection of additional parameters to be registered in N and PE conductors,
- » selection of the network type for which the analyzer will register all parameters set by the user.

The analyzer has four, mutually independent measurement points. Each measurement point can be configured separately so that four different registrations can be performed later without the need for reprogramming the analyzer in each instance.

### The following can be configured for each measurement point:

- » whether the analyzer is to perform registration in terms of compliance with standard EN 50160 (and the Minister's Regulation on power quality standards) and/or according to user-defined parameters,
- » the user may define whether the logger will save instant, mean, maximum or minimum values for each parameter,
- » limits can be defined for most parameters, and the analyzer will log an event if these limits are crossed.

### Readout of current data

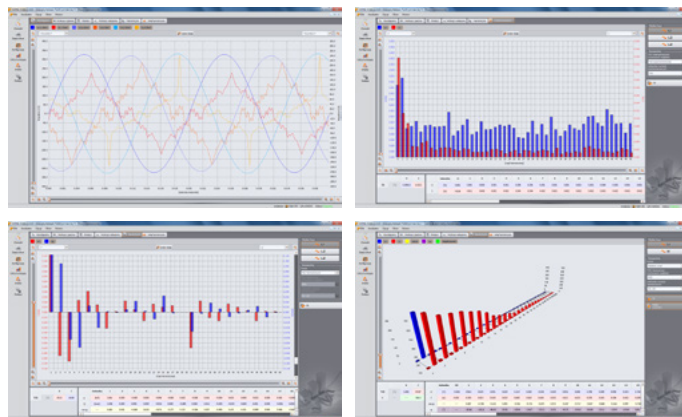
Sone! Analysis software enables readout of selected parameters and their visualization on the computer screen in real time. These parameters are measured independently from the registration saved on the memory card.

The user can view:

- » charts of voltage and current progression (oscilloscope),
- » charts of voltage and current over time,
- » phasor diagrams,
- » measurements of multiple parameters,
- » harmonics and harmonic powers,
- » inter-harmonics.

### Data analysis

Using the application, the user can read and analyze data saved on the memory card. Read data can also be saved on the computer's hard disk for later processing. Thanks to this, archiving of data from successive registrations is possible.



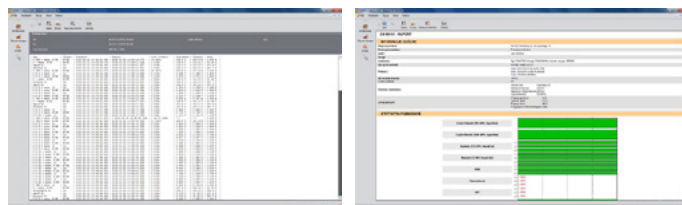
After data reading, the user can conduct analysis. There are three windows to choose from:

- » General – all individual types of data are displayed in the form of dots (Measurements, Events and Oscillograms),
- » Measurements – all measurement types registered are displayed in the form of dots according to averaging time (voltage, frequency, etc.),
- » Events – all types of detected events are displayed in the form of dots (**dips, overvoltages, breaks, etc.**),
- » Configuration – all settings with which data was registered are displayed.

Various types of charts are available in the application, enabling the user to view data registered by the analyzer in a simple way:

- » Time chart – displays the progressions of selected parameters over time,
- » Oscillogram – instant progressions of voltages and currents during events or at the end of an averaging cycle,
- » Harmonics chart – bar graph presenting the level of harmonics of orders 1...50,
- » Value/Time chart – displays events in the form of dots as a function of the duration of these events.

User-defined reports can be generated using data read from the analyzer, which can then be saved to a hard disk in PDF, HTML, CSV or TXT file format. The application enables generation of a report on compliance with standard EN 50160 and the systems regulation.



Download  
**Sone! Analysis Mobile**  
for free from



Google Play

# Safety of electrical equipment

The rules and obligations concerning use of various types of electrical equipment, in both private and professional life, are defined by a broad range of regulations, which, besides imposing the obligation of creating products compliant with the relevant standards on the manufacturer, **also impose responsibility for the technical condition of this equipment and tools on their owners.** These regulations additionally define proper performance of regular tests and inspections as well as checks of equipment after repairs. Therefore, it is worth inspecting the technical condition of owned electrical equipment in the proper manner and with the appropriate frequency. Defective equipment, often damaged without the user's knowledge, poses a great threat to the user, but it can also be the cause of serious financial loss, e.g. in the event of a fire. In such a case, if it is proven that equipment was not fully operational (e.g. damaged insulation), the manufacturer's liability for the incident is transferred to the owner, and in addition, this may constitute grounds for the insurer's refusal to pay damages.

In Poland, there are currently no clearly defined standards setting forth the responsibility for, scope or time-periods of tests of electric tools and other electrical equipment (including equipment that is often neglected in terms of safety - extension cords, power cords, office appliances) over the course of operation. **However, there is an obligation to proceed in accordance with recognized technical principles.** According to the current legal status, electrical equipment must be operated and inspected according to the guidelines given in the instruction manual provided by the manufacturer. However, the information found in instruction manuals is often insufficient, and in such a case, other sources of knowledge can be used, as long as the information contained therein do not contradict the instruction manual. The subject of tests is raised in many regulations and directives, such as: the Labor Code, Regulation of the Minister of Economy, Act on fire safety, in construction law, energy law, etc. Additionally, standards such as EN 60745-1 lay down the rules of performing such tests for manufacturers, including tolerable values of measured parameters. European standards can also be applied, including the most well-known VDE 701 and VDE 702.

Every tester who uses a safety meter for electrical equipment assumes great responsibility for the both the health and life of users, as well as for their property, when making the decision on whether or not to approve tested equipment for use. Such a person should have a professional meter at their disposal, guaranteeing high accuracy and correct results.

The functions and technical specifications of testers for electrical equipment should allow for complete inspection of the technical condition of electrical equipment and tools, including checks of basic parameters of three-phase equipment. In addition, to ensure the user's work safety and proper measurement results, instruments should be capable of measuring the parameters of the power network (i.e. voltage, frequency, continuity resistance and voltage on protective conductor) immediately after start-up. The capability of performing tests in automatic mode, with configuration of custom measurement sequences of parameters selected by the user, as well as in manual mode is very useful – due to the diversity of tests and standards for different equipment:

**Preliminary test, visual inspection of tested device** - the meter does a preliminary check of L-N circuit continuity and enables fuse checking, then indicates the moment at which visual inspection of the tested equipment is to take place on its screen - for obvious reasons, the user must perform visual inspection on their own before performing further measurements. After visual inspection is complete, the user inputs a positive or negative assessment. A visual inspection should consist of:

- » housing check (absence of mechanical damage),
- » check of network power switch (can it be switched on and off),
- » check of the power cord and plug (no breaks in insulation, overheating),
- » fuse check (does value conform to specifications).

**Resistance measurement of protective earth conductor (PE) with current of 200mA, 10A or 25A** - different standards required measurements using one among the listed current values, and it must additionally be possible to perform auto-zeroing of test leads in order to eliminate additional measurement error (or the 4-lead method is applied). The device inputting current must have high performance, supplying direct current. Continuity tests must be performed in two ways, with the involvement of the measured socket or conductors by themselves, which allows for testing of cables or equipment without a network power plug.

**Insulation resistance testing.** 500V voltage is required, however the instrument may also provide other measurement voltages that may be useful if the test is based on specific regulations. Two possibilities of performing measurement should be available, with the involvement of the measured socket or cables by themselves.

**Leakage current measurement** – capability of measuring equivalent leakage current, differential leakage current, touch leakage current and PE leakage current. The instrument should enable measurements within a wide frequency band.

**Power measurement** – inspection of whether the device consumes the power



specified by the manufacturer, including the voltage and current measured during inspection.

**IEC cable and extension cord test** - automatic inspection of basic parameters of IEC cables, and additionally, after the proper adapter is applied, of extension cords and cables terminated by the IEC-60320-C5 plug, a.k.a. the "clover-leaf". The sequence of measurements is performed automatically, and it includes

- » insulation resistance measurement of PE conductor,
- » (continuity) resistance measurement of PE conductor,
- » continuity test of L and N conductors and check for short-circuit between them,
- » polarity check.

In all measurement functions where necessary, measurement duration settings and result limits must be configurable, enabling comparison of a given result with the set limit and automatic "compliant" or "non-compliant" assessment.

The capability of saving results to memory or printing results immediately after measurement is a very useful and convenient feature of measuring instruments. Both measurement sequences and individual measurements (performed in manual mode) can be saved. It is possible to assign barcodes according to the type of measured equipment.

Software making it possible to keep a database of tested equipment (and reminding of the time of next inspection), create and print abbreviated and expanded measurement reports, and to create reports compliant with the relevant standards (VDE 0701:1, VDE 0701:200, VDE 0701:240, VDE 0701:260, DIN VDE 0702, EN 61010, EN 60335, EN 60950, IEC 601.1) is a helpful addition.

	First start-up and modifications	Tests after repair	Periodical tests	Type tests / procedural tests
Equipment tested in compliance with standards	DIN VDE 0751:2001	DIN VDE 0701:0702 DIN VDE 0751:2001 EN 62353 IEC 60601	DIN VDE 0701:0702 E-08400:1988 DIN VDE 0751:2001 British standards EN 62353 IEC 60601 EN 60974-4 DIN EN 60950/50116	EN 61010 DIN EN 60335/50106 EN 60745-1 IEC 60601
Laboratory instruments		•	•	
Measuring and inspection instruments		•	•	•
Voltage-generating equipment		•	•	
Electric tools		•	•	•
Heating equipment		•	•	•
Equipment with electrical drive		•	•	•
Lighting lamps		•	•	•
Multimedia and telecommunications devices		•	•	•
Cable reels, extension cords, connector cables		•	•	•
Data processing devices and office appliances		•	•	•
Electrical equipment for medical applications, components of applications	•	•	•	•
Welding equipment			•	

## SONEL PAT-820 / PAT-815 / PAT-810

index: WMGBPAT820 / WMGBPAT815 / WMGBPAT810



### Basic functions of the instrument:

- » resistance measurement of protective conductor with current: **200 mA (PAT-810/815/820), 10 A and 25 A (only PAT-815/820)** (protection class I),
- » insulation resistance measurement - three measurement voltages: **100 V and 250 V (only PAT-815/820) and 500 V (PAT-810/815/820)**,
- » measurement of equivalent leakage current,
- » measurement of differential leakage current,
- » measurement of touch leakage current,
- » power measurement,
- » measurement of electricity consumption,
- » IEC cable test,
- » measurement of network voltage and frequency,
- » testing of RCD parameters,
- » current measurement with clamp (only PAT-820/815),
- » **flash test / high-voltage test (only PAT-820)**

### In addition:

- » automatic selection of measuring range,
- » professional software for data processing and report generation,
- » compatibility with barcode reader and printer,
- » compatibility with pendrive portable storage devices,
- » large, easy-to-read touch display,
- » ergonomic operation.

### Electrical safety:

- » this product meets EMC requirements ..... in compliance with standard EN 61326-1:2013 and EN 61326-2-2:2013
- » type of insulation ..... CAT II 300V according to EN 61010-1
- » housing protection rating according to EN 60529 ..... IP40 (IP67 when briefcase is closed)

### Other technical specifications:

- » power supply of the meter ..... 195...265 V, 50 Hz
- » load current ..... max. 16 A (230 V)
- » data transmission to PC computer ..... USB 2.0 cable
- » dimensions ..... 330x235x120mm
- » meter weight ..... approx. 6.2 kg
- » elevation above sea level ..... < 3000 m.
- » display ..... LCD TFT 7" 800x480

### Nominal operating conditions:

- » operating temperature range ..... 10...+50°C
- » storage temperature ..... -20...+70°C
- » humidity ..... 20...80%

### Standard accessories of the meters:

x2 fuse 0314 015.VXP 15 A 250 VAC 6.3x32 mm Littlefuse	WAPOZB15PAT
test lead with banana plugs; 5 kV; 1.8 m; red (PAT-820)	WAPRZ1X8REBB
USB data transmission cable	WAPRZUSB
test lead terminated by crocodile clip; 1.8 m; orange (10 / 25 A)	WAPRZ1X8ORKS
230 V power cord (IEC C19 plug)	WAPRZZAS1

### Optional accessories of the meters:

IEC adapter for testing of IEC leads terminated by "clover-leaf" connector	WAADAPATIEC1
C-3 current clamp (measurement)	WACEGC3OKR
three-phase socket adapter; 16A	WAADAPAT16P
switchable three-phase socket adapter; 16A	WAADAPAT16PR
three-phase socket adapter; 32A	WAADAPAT32P
switchable three-phase socket adapter; 32A	WAADAPAT32PR
industrial socket adapter; 16A	WAADAPAT16F1
industrial socket adapter; 32A	WAADAPAT32F1
lead - Schuko/IEC adapter (for extension cord testing)	WAADAPATIEC2
Sonel PAT+ software	WAPROSONPAT2
USB barcode reader	WAADACK2D
portable USB report/code printer	WAADAD2

### Resistance measurement of protective earth conductor

- » configurable upper limit within the range: 10 mΩ ...1.99 Ω with resolution of 0.01 Ω
- » configurable measurement time 1...60 s with resolution of 1 s

### Resistance measurement of protective earth conductor I=200 mA (protection class I)

Display range	Resolution	Accuracy
0.00...0.99 Ω	0.01 Ω	±(4% m.v. + 2 digits)
1.00...19.99 Ω		±(4% m.v. + 3 digits)

- » measurement current: ≥200 mA for R<0.2...1.99 Ω

### Resistance measurement of protective earth conductor I=10 A (protection class I) (only PAT-815/820)

Display range	Resolution	Accuracy
0...999 mΩ	1 mΩ	±(3% m.v. + 4 digits)
1.00...1.99 Ω	0.01 Ω	

- » technical method of measurement ensuring high accuracy of obtained results
- » measurement current: ≥ 10 A for R ≤ 0.5 Ω

### Resistance measurement of protective earth conductor I=25A (protection class I) (only PAT-815/820)

Display range	Resolution	Accuracy
0...999 mΩ	1 mΩ	±(3% m.v. + 4 digits)
1.00...1.99 Ω	0.01 Ω	

- » technical method of measurement ensuring high accuracy of obtained results
- » measurement current: ≥ 25 A for R ≤ 0.2 Ω

### Flash test / high-voltage test (only PAT-820)

Display range	Resolution	Accuracy
0.00...2.5 mA	0.01 mA	±(5% m.v. + 5 digits)

- » measurement voltage: 1500 V AC, 3000 V AC
- » measurement time: configurable within the range of: 2...180 s

### Measurement of insulation resistance

Measuring range according to IEC 61557-2 for:

Un=100 V: **100 kΩ...99.9 MΩ** (only PAT-820/815)

Un=250V: **250 kΩ...199.9 MΩ** (only PAT-820/815)

Un=500V: **500 kΩ...599.9 MΩ**

U <sub>n</sub> displayed	Display range	Resolution	Accuracy
100 V	0...1999 kΩ	1 kΩ	±(5% m.v. + 8 digits)
	2.0...19.99 MΩ	0.01 kΩ	
	20.0...99.9 MΩ	0.1 kΩ	
250 V	0...1999 kΩ	1 kΩ	
	2.00...19.99 MΩ	0.01 kΩ	
	20.0...199.9 MΩ	0.1 kΩ	
500 V	0...1999 kΩ	1 kΩ	
	2...19.99 MΩ	0.01 kΩ	
	20.0...599.9 MΩ	0.1 kΩ	



- » automatic discharge of the measured object's capacitance upon completion of measurement
- » protection against measurement of live objects
- » max. output current 1.4 mA

#### Measurement of PE leakage current and differential leakage current:

Display range	Resolution	Accuracy
0.00...3.99 mA	0.01 mA	$\pm(5\% \text{ m.v.} + 2 \text{ digits})$
4.0...19.9 mA	0.1 mA	

- » configurable measurement limit within the range: 0.01...9.9 mA with resolution 0.01 mA/0.1 mA
- » configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s
- » at half of the measurement time, the meter automatically changes the polarity of the measuring network socket and displays a greater value

#### Measurement of equivalent leakage current:

Display range	Resolution	Accuracy
0.00...3.99 mA	0.01 mA	$\pm(5\% \text{ m.v.} + 2 \text{ digits})$
4.0...19.9 mA	0.1 mA	

- » configurable measurement limit within the range: 0.01...9.9 mA with resolution 0.01 mA/0.1 mA
- » configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s
- » open-circuit voltage: 25...50 V

#### Measurement of touch leakage current:

Display range	Resolution	Accuracy
0.000...4.999 mA	0.001 mA	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$

- » configurable measurement limit within the range: 0.01...1.99 mA with resolution of 0.01 mA
- » configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

#### Testing of RCD parameters

RCD trip test and measurement of tripping time  $t_A$

RCD type	Factor	Range	Resolution	Accuracy
General	$0.5 \cdot I_{\Delta n}$	0...300 ms	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$
	$1 \cdot I_{\Delta n}$			
	$2 \cdot I_{\Delta n}$	0...150 ms		
	$5 \cdot I_{\Delta n}$	0...40 ms		

1) - for RCD of  $I_{\Delta n} = 10 \text{ mA}$  and the measurement  $0.5 I_{\Delta n}$  error:  $\pm 2\% \text{ m.v.} \pm 3 \text{ digits}$

Measurement of RCD trip current  $I_A$  for sinusoidal residual current

Measuring range according to IEC 61557:  $(0.3...1.0) I_{\Delta n}$

Nominal current	Measuring range	Resolution	Measurement current	Accuracy
10 mA	3.3...10.0 mA	0.1 mA	$0.3 \times I_{\Delta n} \dots 1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
15 mA	4.5...15.0 mA			
30 mA	9.0...30.0 mA			

- » measurement can be started from a positive or negative half-period of the input leakage current
- » max. measurement current flow time 3200 ms

#### Apparent power measurement

Display range	Resolution	Accuracy
0...999 VA	1 VA	$\pm(5\% \text{ m.v.} + 2 \text{ digits})$
1...3.99 kVA	0.01 kVA	

configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

#### Active power measurement

Display range	Resolution	Accuracy
0...999 W	1 VA	$\pm(5\% \text{ m.v.} + 3 \text{ digits})$
1.00 k...3.99 kW	0.01 kW	

configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

#### Power factor PF

Display range	Resolution	Accuracy
0.00...1.00	0.01	$\pm(10\% \text{ m.v.} + 3 \text{ digits})$

#### Current measurement during power measurement

Display range	Resolution	Accuracy
0.00...15.99 A	0.01 A	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$



#### Current measurement with clamp during power measurement

Display range	Resolution	Accuracy
100 mA...999 mA	1 mA	$\pm(5\% \text{ m.v.} + 5 \text{ digits})$
1.00 A...9.99 A	0.01 A	
10.0 A...24.9 A	0.1 A	

The accuracy given in the table does not account for the accuracy of the measuring clamp

#### The instrument enables measurements in compliance with:

- » EN 60745-1 Hand-held motor-operated electric tools. Safety. Part 1: General requirements.
- » EN 61029 Safety of transportable motor-operated electric tools. General requirements.
- » EN 60335-1 Household and similar electrical appliances. Safety. General requirements.
- » EN 60950 Safety of information technology equipment.
- » EN 61557-6 Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems.
- » VDE 0404-1 Prüf- und Messeinrichtungen zum Prüfen der elektrischen Sicherheit von elektrischen Geräten. Teil 1: Allgemeine Anforderungen.
- » VDE 0404-2 Prüf- und Messeinrichtungen zum Prüfen der elektrischen Sicherheit von elektrischen Geräten. Teil 2: Prüfeinrichtungen für Prüfungen nach Instandsetzung, Änderung oder für Wiederholungsprüfungen.
- » VDE 0701-0702 Prüfung nach Instandsetzung, Änderung elektrischer Geräte. Wiederholungsprüfung elektrischer Geräte. Allgemeine Anforderungen für die elektrische Sicherheit.
- » AS/NZS 3760:2010 In-service safety inspection and testing of electrical equipment.

## SONEL PAT-806

index: WMGBPAT806

PN-EN

60974-4

CAT II

300V

IP 40



### Basic functions of the instrument:

- » measurement of arc welding equipment parameters (EN 60974-4):
  - measurement of rated voltage of welding equipment in a no-load state,
  - measurement of leakage current of welding circuit II
  - measurement of primary leakage current.
- » resistance measurement of protective conductor with current: 200 mA, 10 A, 25 A (protection class I),
- » insulation resistance measurement - three measurement voltages: 100 V, 250 V and 500 V,
- » measurement of equivalent leakage current,
- » measurement of PE leakage current,
- » measurement of differential leakage current,
- » measurement of touch leakage current,
- » power measurement,
- » measurement of electricity consumption,
- » IEC cable test,
- » fuse check (voltage: 4...8 V AC, max. current 5 mA)
- » check of L-N circuit resistance,
- » measurement of network voltage and frequency.

### Additional meter features:

- » automatic selection of measuring range,
- » 990 memory cells for storing measurement results with the capability of data transmission to a PC via USB cable or printing,
- » professional software for data processing and report generation,
- » compatibility with barcode reader and printer,
- » compatibility with pendrive portable storage devices,
- » large, easy-to-read display with backlighting,
- » ergonomic operation.

### Electrical safety:

- » this product meets EMC requirements ..... in compliance with standard EN 61326-1:2009 and EN 61326-2-2:2006
- » type of insulation ..... according to EN 61010-1 and IEC 61557
- » housing protection rating according to EN 60529 ..... IP40

### Other technical specifications:

- » power supply of the meter ..... 187...265 V, 50 Hz
- » load current ..... max. 16 A (230 V)
- » memory ..... 990 cells
- » data transmission to PC computer ..... USB cable
- » dimensions ..... 330x235x120mm
- » meter weight ..... approx. 4.75kg

### Nominal operating conditions:

- » operating temperature range ..... 0...+40°C
- » storage temperature ..... -20...+70°C
- » humidity ..... 20...80%

### Standard accessories of the meter:

2X fuse 0314 015.VXP 15 A 250 VAC 6.3x32 mm Littlefuse	WAP0ZB15PAT
L-5 carrying case	WAFUTL5
2X black "crocodile" clip 1 kV 32 A	WAKROBL30K03
Kelvin clamp 1 kV 25 A	WAKROKELK06
USB data transmission cable	WAPRZUSB
two-core cord; 1.2 m (10 / 25 A) U2/I2	WAPRZ1X2DZBB2
2X test lead with banana plugs; 1 kV; 1.2 m; black (2.5 mm <sup>2</sup> )	WAPRZ1X2BLBB2X5
230 V power cord (IEC C19 plug)	WAPRZZAS1
test probe with banana socket; 1 kV; black (CAT II 1000 V)	WASONBLOGB3
high-current probe with banana sockets; 1 kV	WASONSPGB1

### Measurement of rated voltage of welding equipment in a no-load state:

$U_R$  (r.m.s.) voltage measurement

Display range	Resolution	Accuracy
5.0...170.0 V	0.1 V	±(2.5% m.v. + 5 digits)

configurable upper limit within the range: 5.0...170.0 V resolution 1 V

$U_p$  (peak) voltage measurement:

Display range	Resolution	Accuracy
5.0...240.0 V	0.1 V	±(2.5% m.v. + 5 digits)

configurable upper limit within the range: 5.0...240.0 V resolution 1 V

### Measurement of leakage current of welding circuit II:

Display range	Resolution	Accuracy
0.00...14.99 mAV	0.01 mA	±(5% m.v. + 5 digits)

- » current measurement band arises from applied measuring system, compliant with EN 60974-4
- » configurable upper limit within the range: 0.10 mA...14.90 mA resolution 0.1 mA
- » configurable measurement time within the range: 3 s...60 s with resolution 1 s
- » a system according to standard EN 60974-4 was used

### Resistance measurement of protective earth conductor

- » configurable upper limit within the range: 10 mΩ ...1.99 Ω with resolution of 0.01 Ω
- » configurable measurement time 1...60 s with resolution of 1 s

### Resistance measurement of protective earth conductor I=200 mA (only protection class I)

Display range	Resolution	Accuracy
0.00...0.99 Ω	0.01 Ω	±(4% m.v. + 2 digits)
1.00...19.99 Ω		±(4% m.v. + 3 digits)

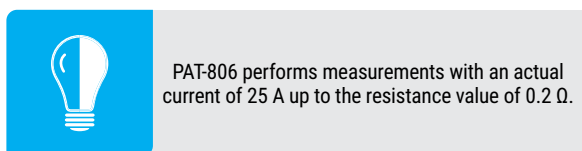
- » measurement current: 200 mA for R=0.2...1.99 Ω

### Resistance measurement of protective earth conductor I=10 A (only protection class I)

Display range	Resolution	Accuracy
0...999 mΩ	1 mΩ	±(3% m.v. + 4 digits)
1.00...1.99 Ω	0.01 Ω	±(3% m.v. + 40 digits)*

\* for two-lead measurement

- » voltage on output under no load <12 V AC
- » technical method of measurement ensuring high accuracy of obtained results
- » measurement current: ≥10 A for R≤0.5 Ω



### Resistance measurement of protective earth conductor I=25 A (protection class I)

Display range	Resolution	Accuracy
0...999 mΩ	1 mΩ	±(3% m.v. + 40 digits)*
1.00...1.99 Ω	0.01 Ω	

\* for two-lead measurement

- » technical method of measurement ensuring high accuracy of obtained results
- » measurement current: ≥ 25 A for R ≤ 0.2 Ω

### L-N circuit resistance measurement

Display range	Resolution	Accuracy
0.0...999 Ω	1 Ω	±(5% m.v. +5 digits)
1.00...4.99 kΩ	0.01 kΩ	

- » measurement voltage: 4...8 V AC, short-circuit current: max. 5 mA
- » short-circuit current: max. 5 mA

### Measurement of PE leakage current and differential leakage current:

Display range	Resolution	Accuracy
0.00...3.99 mA	0.01 mA	±(5% m.v. +2 digits)
4.0...19.9 mA	0.1 mA	

- » configurable measurement limit within the range: 0.01...9.9 mA with resolution 0.01 mA/0.1 mA
- » configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s
- » at half of the measurement time, the meter automatically changes the polarity of the measuring network socket and displays a greater value
- » current measurement band 40 Hz...100 kHz (for PE leakage current) or 20 Hz...100 kHz (for differential current)

### Measurement of equivalent leakage current:

Display range	Resolution	Accuracy
0.00...3.99 mA	0.01 mA	±(5% m.v. +2 digits)
4.0...19.9 mA	0.1 mA	

- » configurable measurement limit within the range: 0.01...9.9 mA with resolution 0.01 mA/0.1 mA
- » configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s
- » open-circuit voltage: 25...50V

### Measurement of touch leakage current:

Display range	Resolution	Accuracy
0.000...4.999 mA	0.001 mA	±(5% m.v. +3 digits)

- » configurable measurement limit within the range: 0.01...1.99 mA with resolution of 0.01 mA
- » configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

### Apparent power measurement:

Display range	Resolution	Accuracy
0...999 VA	1 VA	±(5% m.v. +3 digits)
1...3.99 kVA	0.01 kVA	

configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

### Measurement of electricity consumption:

Display range	Resolution	Accuracy
0.00...15.99 A	0.01 A	±(2% m.v. + 3 digits)

configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

### Measurement of network voltage and voltage on measured socket:

Display range	Resolution	Accuracy
187.0...265.0 V	0.1 V	±(2% m.v. + 2 digits)

### Network frequency measurement:

Display range	Resolution	Accuracy
45.0...55.0 Hz	0.1 Hz	±(2% m.v. + 2 digits)

configurable measurement time: continuous measurement (Cont) or 1...60 s with resolution of 1 s

### Network PE voltage measurement:

Display range	Resolution	Accuracy
0.0...59.9 V	0.1 V	±(2% m.v. + 2 digits)

measurement of network voltage between PE and N of meter's power supply  
\* - accuracy unspecified for U < 5 V

### Measurement of insulation resistance

Measuring range according to IEC 61557-2 for: U<sub>n</sub>=100 V: **100 kΩ...99.9 MΩ**

U<sub>n</sub>=250V: **250 kΩ...199.9 MΩ**, U<sub>n</sub>=500V: **500 kΩ...599.9 MΩ**

U <sub>n</sub>	Display range	Resolution	Accuracy
100 V	0...1999 kΩ	1 kΩ	±(5% m.v. +8 digits)
	2.0...19.99 MΩ	0.01 kΩ	
	20.0...99.9 MΩ	0.1 kΩ	
250 V	0...1999 kΩ	1 kΩ	
	2.00...19.99 MΩ	0.01 kΩ	
	20.0...199.9 MΩ	0.1 kΩ	
500 V	0...1999 kΩ	1 kΩ	
	2...19.99 MΩ	0.01 kΩ	
	20.0...599.9 MΩ	0.1 kΩ	

- » configurable measurement limit within the range: 0.01...9.9 MΩ with resolution of 0.1 MΩ
- » configurable measurement time: continuous measurement (Cont) or from 4 s to 3 min. with resolution of 1 s
- » automatic discharge of the measured object's capacitance upon completion of measurement
- » protection against measurement of live objects
- » max. output current 1.4 mA

### Optional accessories of the meter:

two-core lead; 1.2 m (10 / 25A) U1/I1	WAPRZ1X2DZBB1
two-core lead; 1.2 m (10 / 25A) U2/I2	WAPRZ1X2DZBB2
Sonel high-current probe	WASONSPGB1
Kelvin clamp	WAKROKELK06
black "crocodile" clip 1 kV	WAKROBL20K01
test lead with (2) banana plug terminations; 1.2 m; black	WAPRZ1X2BLBB
black probe; 1 kV	WASONBLOGB3
lead - Schuko/IEC adapter (for extension cord testing)	WAADAPATIEC2
three-phase socket adapter; 16 A	WAADAPAT16P
switchable three-phase socket adapter; 16 A	WAADAPAT16PR
three-phase socket adapter; 32A	WAADAPAT32P
switchable three-phase socket adapter; 32 A	WAADAPAT32PR
industrial socket adapter; 16 A	WAADAPAT16F1
industrial socket adapter; 32 A	WAADAPAT32F1
PAT IPE adapter	WAADAPATIEPE
IEC adapter for testing of IEC leads terminated by "clover-leaf" connector	WAADAPATIEC1
Sonel PAT software	WAPROSONPAT1
USB barcode reader	WAADACK1
portable USB report/code printer	WAADAD1
labels for tested devices: OPERATIONAL (roll – 50 labels)	WANAKSPR
labels for tested devices: INOPERATIVE (roll – 50 labels)	WANAKNSPR
labels with barcodes (roll – 100 labels)	WANAKKODPAS
adhesive tape for printer	WANAKD1



PAT-806 is also intended for inspecting three-phase equipment.

### The instrument enables measurements in compliance with:

- » EN 60745-1: Hand-held motor-operated electric tools. Safety. Part 1: General requirements.
- » EN 61029: Safety of transportable motor-operated electric tools. General requirements.
- » EN 60335-1: Household and similar electrical appliances. General requirements.
- » EN 60950: Safety of information technology equipment.
- » EN 60974-4: Arc welding equipment - Part 4: Periodic inspection and testing.
- » VDE 0404-1: Prüf- und Messeinrichtungen zum Prüfen der elektrischen Sicherheit von elektrischen Geräten. Teil 1: Allgemeine Anforderungen.
- » VDE 0404-2: Prüf- und Messeinrichtungen zum Prüfen der elektrischen Sicherheit von elektrischen Geräten. Teil 2: Prüfeinrichtungen für Prüfungen nach Instandsetzung, Änderung oder für Wiederholungsprüfungen.
- » VDE 0701-0702 Prüfung nach Instandsetzung, Änderung elektrischer Geräte. Wiederholungsprüfung elektrischer Geräte. Allgemeine Anforderungen für die elektrische Sicherheit.





## SONEL PAT-1 / PAT-2 / PAT-2E / PAT-10

index: WMGBPAT1 / WMGBPAT2 / WMGBPAT2E / WMGBPAT10



LED	R <sub>PE</sub> 10A
CAT II	IP 40
300V	WiFi

### Features:

Innovative combination of small overall dimensions (and the transportability of the device related to this) with advanced measurement systems allowing for complete performance of automatic measurements for electrical devices as well as IEC cables and extension cords (including those with PRCD). Complete set of tests performed after just one press of the START button. The meter's configuration capabilities allow for modification of the method of the instrument's operation, which makes it even better adapted to the user's needs. In situations where it is necessary to perform unit measurements without the need to perform the entire, complex measurement procedure, PATs from Sonel enable operation in single measurement mode (of a given type - so-called manual measurements). All meters in this series additionally enable performance of basic measurements without an external power source, in emergency situations where there is no network power, simplified test sets can be initiated in battery operating mode.

Small overall dimensions, light weight and a specially designed carrying case for the meter and accessories provide convenience of use and high mobility of the instrument. Wireless communication with a printer\* allows for organization of the location where measurements are performed without a tangle of unnecessary cables. Saving of results to memory\* and integration of results in PC software additionally broaden the instrument's functionality.

### Basic functions of the PAT-10 instrument

- » diode indicating result assessment,
- » quick access to measurement procedures,
- » compact housing, ergonomic carrying case,
- » automatic selection of measuring ranges,
- » resistance measurement of protective conductor with current: 200 mA, 10 A.
- » measurement of insulation resistance.
- » measurement of PRCD trip time.
- » measurement of equivalent, differential and touch leakage current,
- » IEC cable test,
- » saving of results to memory,
- » compatibility with Sonel Reader and Sonel PAT plus software (optional).

### PAT-1 Basic accessories

orange "crocodile" K02; red	WAKRORE20K02
test lead; 1.2 m; red	WAPRZ1X2REBB2X5
test probe; red	WASONREOGB1
IEC power cord; orange plug	WAPRZ1X8REIEC
Sonel Reader	WAPROREADER
Instruction Manual	

### PAT-2/2E/10 Basic accessories

orange "crocodile" K02; red	WAKRORE20K02
test probe; red	WASONREOGB1
test lead; 1.2 m; red	WAPRZ1X2REBB2X5
IEC power cord; orange plug	WAPRZ1X8REIEC
USB cable	WAPRZUSB
M12 carrying case for meter and accessories	WAFUTM12
set of back-up fuses (PAT-2E, PAT-10)	WAPOZB16PAT
Sonel Reader	WAPROREADER

### The instrument can be used for tests of equipment, including tests compliant with standards:

- » EN 60745 - 1: Hand-held motor-operated electric tools. Safety. Part 1: General requirements.
- » EN 61029: Safety of transportable motor-operated electric tools. General requirements.
- » EN 60335 - 1: Household and similar electrical appliances. General requirements.
- » EN 60950: Safety of information technology equipment.
- » EN 61557-6 Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems.
- » VDE 0701-0702 Prüfung nach Instandsetzung, Änderung elektrischer Geräte. Wiederholungsprüfung elektrischer Geräte. Allgemeine Anforderungen für die elektrische Sicherheit.

Model	PAT-1	PAT-2	PAT-2E	PAT-10
Visual assessment	+	+	+	+
Resistance measurement of protective earth conductor I = 200 mA	+(0.01...19.99 Ω)	+(0.01...19.99 Ω)	+(0.01...19.99 Ω)	+(0.01...19.99 Ω)
Resistance measurement of protective earth conductor I = 10 A	-	-	-	+(0.001...1.99 Ω)
Insulation resistance measurement U = 250 V	-	-	-	+(0.01...99.9 MΩ)
Insulation resistance measurement U = 500 V	+(0.01...99.9 MΩ)	+(0.01...99.9 MΩ)	+(0.01...99.9 MΩ)	+(0.01...99.9 MΩ)
Measurement of equivalent leakage current	+(0.01...19.9 mA)	+(0.01...19.9 mA)	+(0.01...19.9 mA)	+(0.01...19.9 mA)
Measurement of touch leakage current	-	-	+(0.001...4.999 mA)	+(0.001...4.999 mA)
Measurement of differential leakage current	-	-	+(0.10...19.9 mA)	+(0.10...19.9 mA)
IEC cable test (R <sub>iso</sub> , R <sub>pe</sub> , polarity)	+	+	+	+
PRCD test (tripping time for I <sub>Δn</sub> :x1/x5; 0° and 180°)	-	-	10 mA, 30 mA	10 mA, 30 mA
Built-in memory for results / transmission to computer	-	+	+	+
WiFi	-	+	+	+
Compatible with printer	-	+	+	+
Meter configuration from computer	+	+	+	+
Power supply	Built-in accumulator (measurements can be performed during charging)	Built-in accumulator (measurements can be performed during charging)	Network power supply: 220V; 230V; 240V 50 Hz (or 60Hz) / built-in accumulator	Network power supply: 220V; 230V; 240V 50 Hz (or 60Hz) / built-in accumulator
Measurement category CAT II 300V	+	+	+	+
Weight [kg] / size [cm]	approx. 1.40 kg / 200 mm x 180 mm x 77 mm	approx. 1.40 kg / 200 mm x 180 mm x 77 mm	approx. 1.40 kg / 200 mm x 180 mm x 77 mm	approx. 1.40 kg / 200 mm x 180 mm x 77 mm

## Software

### SONEL PAT+

index: WAPROSONPAT2



This software is intended for companies that perform safety measurements of electrical equipment.

Applications are compatible with Sonel PAT-series meters. Data saved by the meter is entered into the test report for the selected item of equipment.

- » Perfect for production plants, electrical tool rental services, repair and maintenance services, etc.
- » Hierarchical data entry structure - a device is assigned to a specific company or department.
- » Capability of gathering information about a given piece of equipment.
- » Tracking the test history of a device.
- » Capability of advanced meter configuration via software.
- » Label printing on standard adhesive papers.
- » Capability of creating a custom measurement standard using the report editor.
- » Capability of scheduling measurements - every device contains a "Measurement cycle" list - the application automatically displays devices whose testing deadline is approaching or has expired.

#### Available report forms:

- » full report on one test - on an A4 page, with complete data about the device and a complete series of tests,
- » test history for device - all measurement results are printed according to defined criteria (from a given period),
- » abbreviated report/record sheet - prints the test history with basic information about the device and information on approval for use.

#### Report printing according to the following standards:

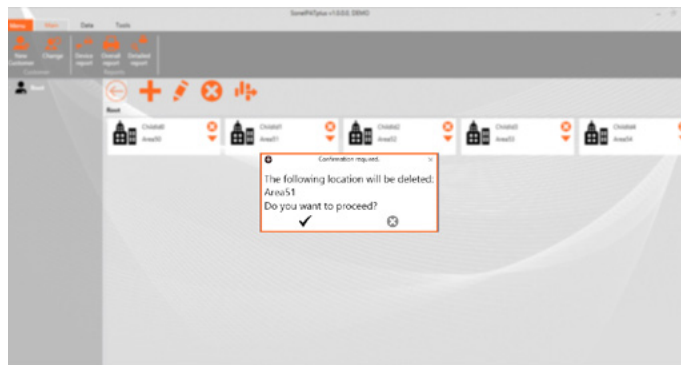
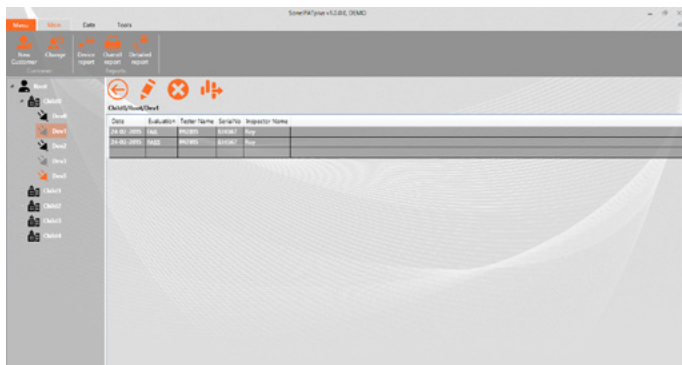
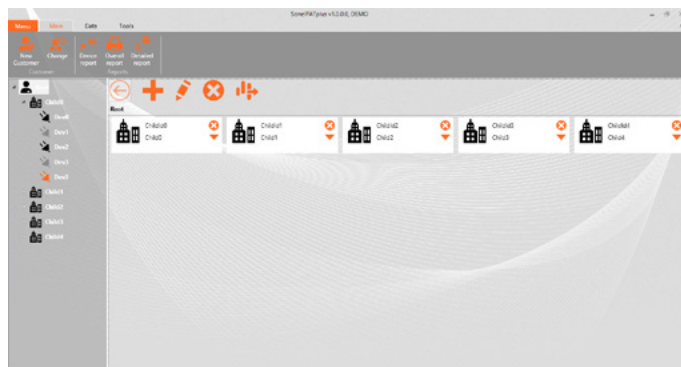
VDE 0701:1, VDE 0701:200, VDE 0701:240, VDE 0701:260, DIN VDE 0702, EN 61010, EN 60335, EN 60950, IEC 60601, EN62353

#### Hardware requirements:

Windows XP SP2, Windows Vista, Windows 7, Windows 8/8.1

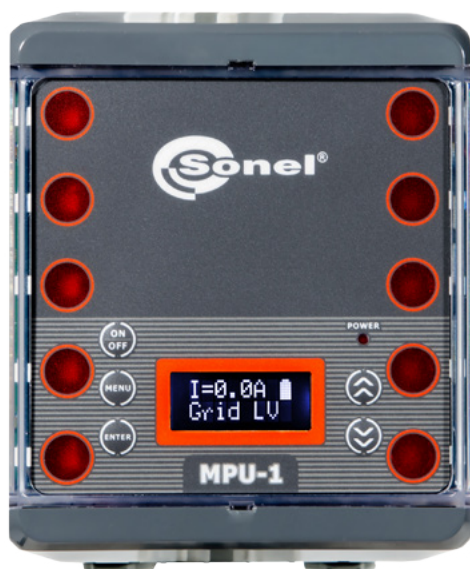
Internet Explorer: 6.0 or higher

FrameWork 2.0 or higher



## SONEL MPU-1

Index: WMGBMPU1




### Features:

MPU-1 is intended for monitoring (measurement) of leakage current in power networks of alternating current, low and medium voltage, and serves for performing measurements whose results determine the safety status of the monitored system from the perspective of flowing leakage current. The instrument enables setting of the safe threshold value of flowing leakage current, above which a visual and sound alarm is activated.

### The most important features of the MPU-1 instrument include:

- » continuous monitoring of alternating current flowing through earthing,
- » measurement on one or two clamps simultaneously, in the case of measurement using two clamps, the current value is summed, and this provides the capability of measuring spun poles with independent clamps for each component pole,
- » diode indicator of operating mode,
- » alarm in the event of flow of current greater than the alarm threshold (factory setting 1A), sound and visual alarm (speaker built into the housing),
- » measurement with flexible Sonel F-series clamps (Rogowski coil) with a max. length of 2 m,
- » measurements in low- and medium-voltage networks with frequency of 50Hz or 60Hz,
- » automatic selection of measuring range,
- » monitoring of battery charge,
- » ergonomic operation.

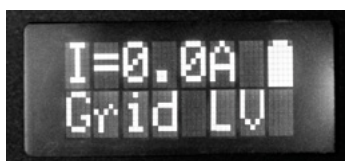
### Measurement of leakage currents flowing through clamp:

Display range	Resolution	Accuracy
0.1..9.9 A	0.01 A	±(5% m.v. + 2 digits)
10..99 A	0.1 A	±(5% m.v. + 2 digits)

- » frequency range: 50Hz or 60Hz
- » flexible current clamp – F-1



Operation in medium-voltage mode - the display reads the value of the set alarm threshold and indicates the accumulator charge status.



Operation in low-voltage mode - the display reads the value of the measured current flowing through the clamp and indicates the accumulator charge state.

### Standard equipment:

L5 transport briefcase	WAWALL5
network adapter for accumulator charging	WAZASZ11
power cord	WAPRZLAD230
set of bands for fastening the signaler and clamp	WAPZOPAKPL
calibration certificate	

### Additional equipment:

F-1A flexible clamp (ø 38 cm)	WACEGF10KR
F-2A flexible clamp (ø 25 cm)	WACEGF20KR
F-3A flexible clamp (ø 12 cm)	WACEGF30KR
F-4A flexible clamp (circumference 200 cm)	WACEGF40KR
charging cable for car lighter socket (12V)	WAPRZLAD1212V2



The standard kit includes a transport briefcase for the signaler, standard and additional accessories.

### Technical data:

- » housing protection rating according to EN 60529 ..... IP67
- » instrument power supply ..... accumulator pack  
SONEL NiMH 9.4V 2.1Ah
- » parameters of accumulator charger power adapter ..... 100 V..240 V,  
50 Hz..60 Hz
- » operating time for standby mode ..... 18h
- » operating time for alarm mode ..... 3h
- » alarm threshold setting range ..... 0.5A..9.9 A
- » dimensions ..... 125x150x95mm
- » weight of instrument with accumulators ..... approx. 1.1 kg
- » operating temperature range ..... -10..+50°C
- » charger operating temperature range ..... +10..+35°C
- » reference temperature ..... 23 ±2°C
- » storage temperature ..... -20..+80°C
- » relative humidity ..... 20..85%
- » nominal relative humidity ..... 40..60%
- » elevation above sea level ..... <2000 m
- » quality standard .....  
development, design and production in compliance with ISO 9001
- » this product meets EMC requirements in compliance with standards .....  
EN 61326-1:2013  
and EN 61326-2-2:2013



## Clamp meters

### SONEL CMP-400 / CMP-401

index: WMXXCMP400 (CMP-400) / WMXXCMP401 (CMP-401)



#### Measurements:

- » measurement of alternating current up to 400 A,
- » measurement of direct current up to 400 A (CMP-401),
- » measurement of direct and alternating voltage up to 600 V,
- » measurement of resistance and continuity testing of connections with acoustic signaling of circuit continuity resistance (for a value smaller than 50  $\Omega$ ),
- » measurement of temperature (Fahrenheit or Celsius),
- » measurement of frequency,
- » measurement of capacity (CMP-401 only),
- » diode test.

#### Additional functions of the meters:

- » non-contact neon lamp,
- » safe, insulated measurement clamp,
- » reinforced, impact resistant enclosure,
- » automatic selection of ranges with the capability of switching over to the manual selection mode,
- » HOLD function, allowing for freezing the result on the display,
- » backlit LCD,
- » Relative measurement function,
- » Indication of range overflow.

#### Other technical specifications:

- » power supply of the meter ..... 9 V battery, type 6LR61
- » display ..... 4000 readings, backlit LCD
- » continuity test .....  $I < 0.5$  mA, sound signal for  $R < 50$   $\Omega$
- » diode test .....  $I = 0.3$  mA,  $U_0 = 1.5$  V DC
- » indication of range overflow ..... 'OL' symbol is displayed
- » frequency of measurements ..... 2 readings per second
- » input impedance ..... 10 M $\Omega$  (V DC and V AC)
- » clamp size ..... opening 30 mm (1.2")
- » auto-off timeout ..... approx. 30 minutes
- » dimensions ..... 197x70x40 mm
- » weight ..... 183 g
- » compliance with standards ..... EN 61010-1, EN 61010-2-032
- » quality standard ..... ISO 9001

#### Nominal operating conditions:

- » operating temperature range ..... 5...+40°C
- » storage temperature ..... -20...+60°C
- » operating humidity ..... max. 80% up to 31°C
- » ..... decreasing linearly to 50% at 40°C
- » operating attitude ..... max. 2000 m

#### Standard accessories of the meters:

test lead – measurement set	WAPRZCMP1
temperature measurement probe (type K)	WASONTEMK
9 V battery	
case	

#### Measurement of alternating and direct voltage

Displayed range	Resolution	Accuracy		Accuracy
		CMP-400 (AC)	CMP-401 (AC)	CMP-400-401 (DC)
400.0 mV	0.1 mV	$\pm(1.5\% \text{ m.v.} + 30 \text{ digits})$	$\pm(1.5\% \text{ m.v.} + 30 \text{ digits})$	$\pm(0.8\% \text{ m.v.} + 2 \text{ digits})$
4.000 V	0.001 V	$\pm(1.8\% \text{ m.v.} + 8 \text{ digits})$	$\pm(1.5\% \text{ m.v.} + 5 \text{ digits})$	$\pm(1.5\% \text{ m.v.} + 2 \text{ digits})$
40.00 V	0.01 V			
400.0 V	0.1 V			
600.0 V	1 V	$\pm(2.5\% \text{ m.v.} + 8 \text{ digits})$	$\pm(2\% \text{ m.v.} + 5 \text{ digits})$	$\pm(2\% \text{ m.v.} + 2 \text{ digits})$

frequency range: 50 Hz...400 Hz

#### Alternating current measurement

Range display	Resolution	Accuracy CMP-400	Accuracy CMP-401
4.000 A	0.001 A	$\pm(2.5\% \text{ m.v.} + 12 \text{ digits})$	no range
40.00 A	0.01 A	$\pm(2.5\% \text{ m.v.} + 8 \text{ digits})$	$\pm(2.5\% \text{ m.v.} + 8 \text{ digits})$
400.0 A	0.1 A	$\pm(2.8\% \text{ m.v.} + 8 \text{ digits})$	$\pm(2.8\% \text{ m.v.} + 5 \text{ digits})$

frequency range: 50 Hz...60 Hz

#### Measurement of direct current (only CMP-401)

Display range	Resolution	Accuracy
4.00 A	0.0011 A	$\pm(2.5\% \text{ m.v.} + 5 \text{ digits})$
400.0 A	0.1 A	$\pm(2.8\% \text{ m.v.} + 5 \text{ digits})$

#### Resistance measurement

Display range	Resolution	Accuracy
400.0 $\Omega$	0.1 $\Omega$	$\pm(1\% \text{ m.v.} + 4 \text{ digits})$
4.000 k $\Omega$	0.001 k $\Omega$	$\pm(1.5\% \text{ m.v.} + 2 \text{ digits})$
40.00 k $\Omega$	0.01 k $\Omega$	
400.0 k $\Omega$	0.1 k $\Omega$	
4.000 M $\Omega$	0.001 M $\Omega$	$\pm(2.5\% \text{ m.v.} + 3 \text{ digits})$
40.00 M $\Omega$	0.01 M $\Omega$	$\pm(3.5\% \text{ m.v.} + 5 \text{ digits})$

"m.v." = "measured value"

#### Clamp meter of leakage current

### SONEL CMP-200

index: WMXXCMP200

#### Measurement of alternating current up to 200 A

- » high resolution (0.1 mA),
- » 3 measuring subranges: 200 mA, 2 A, 200 A.

#### Additional functions of the meter:

- » 3½-digit display (max. 1999),
- » white backlighting of display,
- » interior clamp diameter 30 mm (1.2"),
- » "HOLD" function, allowing for freezing the measurement result on the display,
- » "MAX" function, freezing of maximum values,
- » automatic power down of instrument when not in use,
- » reinforced, impact resistant enclosure.

#### Current measurement

Display range	Resolution	Accuracy
199.9 mA	0.1 mA	$\pm(5\% \text{ m.v.} + 8 \text{ digits})$
1.999 A	0.001 A	$\pm(5\% \text{ m.v.} + 10 \text{ digits})$
199.9 A	0.1 A	$\pm(2.5\% \text{ m.v.} + 10 \text{ digits})$



## Clamp meter

# SONEL CMP-1006

index: WMXXCMP1006



### Standard accessories of the meter:

test lead – measurement set	WAPRZCMP1
temperature measurement probe (type K)	WASONTEK
9 V battery	
case	

### Measurements:

- » measurement of alternating current (TRUE RMS) and direct current up to 1000 A,
- » measurement of initial starting current (very high sampling frequency - INRUSH function),
- » measurement of direct and alternating voltage (TRUE RMS) up to 600 V,
- » measurement of resistance and continuity testing of connections with acoustic signaling of circuit continuity resistance (for a value smaller than 40  $\Omega$ ),
- » measurement of temperature (Fahrenheit or Celsius),
- » measurement of frequency,
- » measurement of duty cycle,
- » diode test.

### Additional functions of the meter:

- » safe, insulated measurement clamp,
- » automatic selection of ranges with the capability of switching over to the manual selection modes,
- » "HOLD" - freezes the result on the display,
- » backlit LCD,
- » "DCA ZERO" - relative measurement mode for direct current - capability of zeroing the instrument at any time and returning to measurement in absolute mode,
- » holding of minimum and maximum values,
- » indication of range overflow,
- » automatic power down.

### Measurement of direct and alternating (TRUE RMS) current

Display range	Resolution	Accuracy (DC)	Accuracy (AC)
0...659.9 A	0.1 A	$\pm(2.5\% \text{ m.v.} + 5 \text{ digits})$	$\pm(2.5\% \text{ m.v.} + 8 \text{ digits})$ for $f=45\ldots 65\text{Hz}$
660...1000 A	1 A	$\pm(2.8\% \text{ m.v.} + 8 \text{ digits})$	$\pm(2.8\% \text{ m.v.} + 8 \text{ digits})$ for $f=45\ldots 65\text{Hz}$

### Measurement of direct and alternating (TRUE RMS) voltage

Display range	Resolution	Accuracy (DC)	Accuracy (AC)
0...6.599 V	0.001 V	$\pm(1.5\% \text{ m.v.} + 3 \text{ digits})$	$\pm(1.8\% \text{ m.v.} + 5 \text{ digits})$ for $f = 45\ldots 65 \text{ Hz}$
6.60...65.99 V	0.01 V		
66.0...600.0 V	0.1 V		

### Measurement of frequency

Display range	Resolution	Accuracy
30.0...659.9 Hz	0.1 Hz	$\pm(1.2\% \text{ m.v.} + 2 \text{ digits})$
0.660...6.599 kHz	0.001 kHz	sensitivity: 30...5 kHz:10 Vrms min. 5 kHz...15 kHz:40 Vrms min.
6.60...15.00 kHz	0.01 kHz	for 20%...80% of duty cycle

### Resistance measurement

Display range	Resolution	Accuracy
0.0...659.9 $\Omega$	0.1 $\Omega$	$\pm(1.0\% \text{ m.v.} + 4 \text{ digits})$
0.660...6.599 k $\Omega$	0.001 k $\Omega$	$\pm(1.5\% \text{ m.v.} + 2 \text{ digits})$
6.60...65.99 k $\Omega$	0.01 k $\Omega$	
66.0...659.9 k $\Omega$	0.1 k $\Omega$	$\pm(2.5\% \text{ m.v.} + 3 \text{ digits})$
0.660...6.599 M $\Omega$	0.001 M $\Omega$	
6.6...66.0 M $\Omega$	0.1 M $\Omega$	$\pm(3.5\% \text{ m.v.} + 5 \text{ digits})$

"m.v." = "measured value"

### Other technical specifications:

- » power supply of the meter ..... 9 V battery, type 6LR61
- » display ..... 6600 readings, backlit LCD
- » continuity test ..... threshold 40  $\Omega$ ; measurement current < 0.5 mA
- » diode test ..... typical measurement current 0.3 mA  
typical voltage of open circuit < 3 V DC
- » indication of low battery charge ..... 'BAT' symbol is displayed
- » indication of range overflow ..... 'OL' symbol is displayed
- » frequency of measurements ..... 2 readings per second,  
(nominal)
- » INRUSH ..... integration time 100 ms
- » temperature sensor ..... K type thermoelectric probe
- » input impedance ..... 10 M $\Omega$  (V DC and V AC)
- » AC band width ..... 50...400 Hz (A AC and V AC)
- » auto-off timeout ..... approx. 25 minutes
- » dimensions ..... 229x80x49mm
- » weight ..... 303 g
- » compliance with standards ..... EN 61010-1, EN 61010-2-032

### Nominal operating conditions:

- » interior clamp diameter .....  $\varnothing=36 \times 52 \text{ mm}$
- » operating temperature range ..... +5...+40°C
- » storage temperature ..... -20...+60°C
- » operating humidity ..... max. 80% up to 31°C  
decreasing linearly to 50% at 40°C
- » storage humidity ..... < 80%
- » operating elevation ..... max. 2000 m

### Adapter facilitating current measurements

## SONEL AC-16

index: WAADAAC16

- » ratio x1, x10
- » voltage, maximum current: 230 V AC, 16 A max.



The adapter can be applied with any type of clamp meter.

## Clamp meter

# SONEL CMP-2000

index: WMXXCMP2000



CAT IV

600V

CAT III

1000V

IP 20

### Standard accessories of the meter:

test lead – measurement set	WAPRZCMP1
temperature measurement probe (type K)	WASONTEMK
9 V battery	
case	

### Measurements:

- » measurement of alternating current (TRUE RMS) up to 1500 A and direct current up to 2000 A,
- » measurement of initial starting current (very high sampling frequency - INRUSH function),
- » measurement of direct voltage up to 1000 V and alternating voltage (TRUE RMS) up to 750 V,
- » measurement of resistance and continuity test of connections with acoustic signaling of circuit continuity resistance (for a value smaller than 30 Ω),
- » capacitance measurement,
- » measurement of temperature (Fahrenheit or Celsius),
- » measurement of frequency,
- » measurement of duty cycle,
- » diode test.

### Additional functions of the meter:

- » safe, insulated measurement clamp,
- » automatic selection of measuring ranges,
- » "HOLD" function, allowing for freezing the result on the display.
- » backlit LCD,
- » "DC ZERO" function, relative measurement mode for direct current - capability of zeroing the instrument at any time and returning to measurement in absolute mode,
- » holding of minimum and maximum values,
- » indication of range overflow,
- » automatic power down after 30 minutes.

### Measurement of direct current

Display range	Resolution	Accuracy (AC)
0.0...659.9 A	0.1 A	±(2.0% m.v. + 5 digits)
660...2000 A	1 A	(3.0% m.v. + 5 digits) for 660...1000 A ±(5.0% m.v. + 5 digits) for 1000...2000 A

### Measurement of alternating current (TRUE RMS)

Display range	Resolution	Accuracy
0.0...659.9 A	0.1 A	±(2.0% m.v. + 10 digits) for 50...60 Hz ±(3.0% m.v. + 10 digits) for 61...400 Hz ±(2.5% m.v. + 10 digits) for 50...60 Hz and 660...1000 A
660...1500 A	1 A	±(3.5% m.v. + 10 digits) for 61...400 Hz and 660...1000 A ±(5.0% m.v. + 10 digits) for 50...400 Hz and 1000...1500 A

### Measurement of direct voltage

Display range	Resolution	Accuracy
0.000...6.599 V	0.001 V	±(0.5% m.v. + 2 digits)
6.60...65.99 V	0.01 V	
66.0...659.9 V	0.1 V	
660...1000 V	1 V	

### Alternating voltage measurement (True RMS)

Display range	Resolution	Accuracy
0.000...6.599 V	0.001 V	±(1.5% m.v. + 8 digits) for 50...500 Hz
6.60...65.99 V	0.01 V	
66.0...659.9 V	0.1 V	
660...750 V	1 V	

### Resistance measurement

Display range	Resolution	Accuracy
0.0...659.9 Ω	0.1 Ω	±(1.0% m.v. + 5 digits)
0.660...6.599 kΩ	0.001 kΩ	
6.60...65.99 kΩ	0.01 kΩ	
66.0...659.9 kΩ	0.1 kΩ	±(2.0% m.v. + 5 digits)
0.660...6.599 MΩ	0.001 MΩ	
6.60...66.00 MΩ	0.01 MΩ	±(3.5% m.v. + 5 digits)

### Capacitance measurement

Display range	Resolution	Accuracy
0.0...6.599 nF	0.001 nF	±(3.0% m.v. + 30 digits)
6.60...65.99 nF	0.01 nF	±(3.0% m.v. + 10 digits)
66.0...659.9 nF	0.1 nF	±(3.0% m.v. + 30 digits)
6.660...6.599 μF	0.001 μF	±(3.0% m.v. + 10 digits)
6.60...65.99 μF	0.01 μF	
66.0...659.9 μF	0.1 μF	
0.660...6.599 mF	0.001 mF	±(5% m.v. + 10 digits)

### Measurement of frequency

Display range	Resolution	Accuracy
10.00...65.99 Hz	0.01 Hz	±(0.1% m.v. + 5 digits)
66.0...659.9 Hz	0.1 Hz	
0.660...6.599 kHz	0.001 kHz	
6.60...65.99 kHz	0.01 kHz	
66.0...659.9 kHz	0.1 kHz	
0.660...1.000 MHz	0.001 MHz	

### Measurement of duty cycle

Display range	Resolution	Accuracy
5...95%	0.1%	±(2.0% m.v. + 10 digits)

frequency range: 40 Hz...20 kHz.

"m.v." = "measured value"

### Other technical specifications:

- » power supply of the meter ..... 9 V battery, type 6LR61
- » display ..... readout of 6600 readings, 66-segment bar graph display, backlit LCD
- » continuity test ..... threshold 30 Ω
- » diode test ..... I = 0.8 mA
- » indication of range overflow ..... 'OL' symbol is displayed
- » input impedance ..... approx. 10 MΩ
- » capability of opening clamp ..... cable Ø 57 mm  
bus bar 70 x 18 mm
- » auto-off timeout ..... 30 minutes
- » dimensions ..... 281 x 108 x 53 mm
- » weight ..... 570 g with battery
- » compliance with standards ..... EN 61010-1, EN 61010-2-032
- » quality standard ..... ISO 9001

### Nominal operating conditions:

- » operating temperature range ..... 0...+50°C
- » storage temperature ..... -20...+60°C



# SONEL CMM-40

index: WMXXCMM40



CAT III

1000V

CAT IV

600V

IP 67

## Standard accessories of the meter:

test lead – measurement set	WAPRZCMP1
temperature measurement probe (type K)	WASONTEMK
case	
watertight socket protection plug (2 pcs.)	
9 V battery	

## Measurements:

- » direct and alternating (TRUE RMS) voltage,
- » direct and alternating (TRUE RMS) current,
- » resistance,
- » frequency,
- » work cycle,
- » temperature,
- » diode test,
- » current loop 4-20 mA%.

## Additional functions of the meter:

- » Automatic or manual changing of ranges.
- » HOLD function, enabling reading of measurements under conditions of insufficient lighting or at locations difficult to access.
- » REL function enabling performance of relative measurements.
- » MAX/MIN function.
- » Peak value holding function.
- » Memory storing up to 2000 measurement results.
- » Sound signaling of circuit continuity (Beeper).
- » Automatic power down of instrument when not in use.
- » 4½ digit display (max. 40000).

## Measurement of direct and alternating (TRUE RMS) voltage

Display range	Resolution	Accuracy (AC)	Accuracy (DC)
400.00 mV	0.01 mV	±(1% m.v. + 40 digits)	±(0.06% m.v. + 4 digits)
4.0000 V	0.0001 V	±(1% m.v. + 30 digits)	
40.000 V	0.001 V		
400.00 V	0.01 V		
1000.0 V	0.1 V		±(0.1% m.v. + 5 digits)

frequency range 50...1000Hz.

## Measurement of direct and alternating (TRUE RMS) current

Display range	Resolution	Accuracy
400.00 µA	0.01 µA	for DC ±(1,0% m.v. + 3 digits) for AC ±(1,5% m.v. + 30 digits)
4.000.0 µA	0.1 µA	
40.000 mA	0.001 mA	
400.00 mA	0.01 mA	
10.000 A	0.001 A	

20A: maximum 30 seconds with reduced accuracy.

## Resistance measurement

Display range	Resolution	Accuracy
400.00 Ω	0.01 Ω	±(0.3% m.v. + 9 digits)
4.0000 kΩ	0.0001 kΩ	±(0.3% m.v. + 4 digits)
40.000 kΩ	0.001 kΩ	
400.00 kΩ	0.01 kΩ	
4.0000 MΩ	0.0001 MΩ	±(2.0% m.v. + 10 digits)
40.000 MΩ	0.001 MΩ	

## Capacitance measurement

Display range	Resolution	Accuracy
40.000 nF	0.001 nF	±(3.5% m.v. + 40 digits)
400.00 nF	0.01 nF	
4.0000 µF	0.0001 µF	±(3.5% m.v. + 10 digits)
40.000 µF	0.001 µF	
400.00 µF	0.01 µF	
4000.0 µF	0.1 µF	±(5.0% m.v. + 10 digits)
40.000 mF	0.001 mF	

## Electronic frequency measurement

Display range	Resolution	Accuracy
40.000 Hz	0.001 Hz	±(0.1% m.v. + 1 digit)
400.00 Hz	0.01 Hz	
4.0000 kHz	0.0001 kHz	
40.000 kHz	0.001 kHz	
400.00 kHz	0.01 kHz	
4.0000 MHz	0.0001 MHz	
40.000 MHz	0.001 MHz	unspecified value
100.00 MHz	0.01 MHz	

Sensitivity: minimum effective voltage value 0.8 V at 20% to 80% of duty cycle and &lt;100 kHz; minimum effective voltage value 5 V at 20% to 80% of duty cycle and &gt; 100 kHz.

## Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and IEC 61557
- » power supply of the meter ..... 9 V battery, type 6LR61
- » diode test ..... I=0.9 mA, U<sub>0</sub>=2.8 V DC
- » continuity test ..... I < 0.35 mA, sound signal for R < 35 Ω
- » indication of range overflow ..... "OL" symbol
- » crest factor ..... ≤ 3 for full 500 V range  
decreasing linearly to ≤ 1.5 at 1000 V
- » PEAK value ..... captures peak values >1 ms
- » frequency of measurements ..... 2 readings per second
- » input impedance ..... > 10 MΩ (VDC) > 9 MΩ (VAC)
- » display ..... LCD with bar graph, 4½ digits (max. 40000)
- » number of results in memory ..... 2000
- » dimensions ..... 187x81x55mm
- » meter weight ..... 342 g
- » fuses ..... mA, µA range: 0.5 A/1000 V fast-acting ceramic  
A range: 10 A/1000 V fast-acting ceramic
- » idle time until auto-OFF ..... 15 minutes
- » compliance with standards ..... EN 61010-1, EN 61010-2-032

## Nominal operating conditions:

- » operating temperature range ..... 0...+40°C
- » storage temperature ..... -20...+60°C
- » humidity ..... max 80% up to 31°C, decreasing linearly to 50% at 40°C
- » operating attitude ..... max. 2000 m

## Multimeter

# SONEL CMM-10

index: WMXXCMM10



CAT II

600V

IP 40

### Standard accessories of the meter:

test lead – measurement set	WAPRZCMP1
temperature measurement probe (type K)	WASONTEMK
9V battery	

### Measurements:

- » direct and alternating voltage,
- » direct and alternating current,
- » resistance,
- » frequency
- » capacitance,
- » work cycle,
- » temperature,
- » diode test.

### Additional functions of the meter:

- » Automatic or manual changing of ranges,
- » HOLD function, enabling reading of measurements under conditions of insufficient lighting or at locations difficult to access,
- » REL function enabling performance of relative measurements,
- » Sound signaling of circuit continuity (Beeper),
- » Automatic power down of instrument when not in use,
- » 3 and 7/8 digit display (max. 5000).

### Measurement of alternating and direct voltage

Display range	Resolution	Accuracy (AC)	Accuracy (DC)
400.0 mV	0.1 mV	±(1.5% m.v. + 70 digits)	±(0.5% m.v. + 2 digits)
4.000 V	0.001 V	±(1.2% m.v. + 3 digits)	
40.00 V	0.01 V		±(1.2% m.v. + 2 digits)
400.0 V	0.1 V	±(1.5% m.v. + 3 digits)	
600 V	1 V	±(2.0% m.v. + 4 digits)	±(1.5% m.v. + 2 digits)

- » input impedance: 7.8 MΩ,
- » frequency range 50...400 Hz.

### Measurement of alternating and direct current

Display range	Resolution	Accuracy (AC)	Accuracy (DC)
400.0 μA	0.1 μA	±(1.5% m.v. + 5 digits)	±(1.0% m.v. + 3 digits)
4.000 mA	1 μA		
40.00 mA	0.01 mA	±(1.8% m.v. + 5 digits)	±(1.5% m.v. + 3 digits)
400.0 mA	0.1 mA		
4.000 A	0.001 A		
10.00 A	0.01 A	±(3.0% m.v. + 7 digits)	±(2.5% m.v. + 5 digits)

### Resistance measurement

Display range	Resolution	Accuracy
400.0 Ω	0.1 Ω	±(1.2% m.v. + 4 digits)
4.000 kΩ	0.001 kΩ	±(1.0% m.v. + 2 digits)
40.00 kΩ	0.01 kΩ	
400.0 kΩ	0.1 kΩ	±(1.2% m.v. + 2 digits)
4.000 MΩ	0.001 MΩ	
40.00 MΩ	0.01 MΩ	±(2.0% m.v. + 3 digits)

### Capacitance measurement

Display range	Resolution	Accuracy
40.00 nF	0.01 nF	±(5.0% m.v. + 7 digits)
400.0 nF	0.1 nF	
4.000 μF	0.001 μF	±(3.0% m.v. + 5 digits)
40.00 μF	0.01 μF	
100.0 μF	0.1 μF	±(5.0% m.v. + 5 digits)

### Measurement of frequency

Display range	Resolution	Accuracy
5.000 Hz	0.001 Hz	±(1.5% m.v. + 5 digits)
50.00 Hz	0.01 Hz	
500.0 Hz	0.1 Hz	
5.000 kHz	0.001 kHz	±(1.2% m.v. + 3 digits)
50.00 kHz	0.01 kHz	
500.0 kHz	0.1 kHz	
5.000 MHz	0.001 MHz	±(1.5% m.v. + 4 digits)
10.00 MHz	0.01 MHz	

sensitivity: minimum effective voltage value 8V.

### Measurement of duty cycle

Display range	Resolution	Accuracy
0.1...99.9%	0.1%	±(1.2% m.v. + 2 digits)

- » sensitivity: minimum effective voltage value 8 V,
- » impulse width: 100 μs - 100 ms,
- » frequency range 5 Hz...150 kHz.

### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1 and IEC 61557
- » power supply of the meter ..... 9 V battery, type 6LR61
- » diode test ..... I=0.3mA, U<sub>0</sub>=1.5 V DC
- » continuity test ..... I < 0.3 mA, sound signal for R < 50 Ω
- » indication of range overflow ..... "OL" symbol
- » frequency of measurements ..... 2 readings per second
- » input impedance ..... 7.8 MΩ (V AC/DC)
- » display ..... LCD, 5000 reading with function indicators
- » dimensions ..... 138 x 68 x 37 mm
- » meter weight ..... 210 g
- » fuses ..... mA, μA range: 0.5 A/250 V fast-acting  
range: 10 A/250 V fast-acting
- » idle time until auto-OFF ..... 30 minutes
- » compliance with standards ..... EN 61010-1, EN 61010-2-032

### Nominal operating conditions:

- » operating temperature ..... 0...+50°C at humidity <70%
- » storage temperature ..... -20...+60°C at humidity <80%

### Non-contact AC voltage detector

# SONEL VT-2

index: WMXXVT2

- » signaling: light and sound
- » voltage range: 90~1000 VAC (50/60 Hz)
- » measurement category: III 1000 V
- » power supply: 2x 1.5 V (LR03) batteries



CAT III

1000V

## SONEL TKF-12 / TKF-13

index: WMGBTKF12 (TKF-12) / WMGBTKF13 (TKF-13)

**CAT III**

**600V**

**CAT IV**

**300V**

**IP 42**



The instrument meets the requirements set forth in the standards:

- » EN 61010-1 (general and particular requirements related to safety)
- » EN 61010-031 (general and particular requirements related to safety)
- » EN 61326 (electromagnetic compatibility)
- » EN 61557 (requirements for measurement instruments)
- » HD 60364-6 (performance of measurements - checking)
- » HD 60364-4-41 (performance of measurements - shock protection)
- » PN-PN-E 04700 (performance of measurements - commissioning tests)



TKF-13 makes it possible to determine the direction of motor revolutions, in both no-voltage state and without contact while the motor is running.

### TKF-12

#### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1
- » tester power supply ..... from tested network, up to 15 min. for max. voltage
- » dimensions (with holster and without leads) ..... 130 x 72 x 31 mm
- » weight without leads ..... approx. 200 g

#### Nominal operating conditions:

- » range of nominal phase-to-phase voltages ..... 120...690 V AC
- » maximum operating phase-to-phase voltage ..... 760 V AC
- » frequency range ..... 10...70 Hz
- » operating temperature range ..... -10...+45°C
- » storage temperature ..... -20...+60°C

### TKF-13:

#### Other technical specifications:

- » type of insulation ..... double, as per EN 61010-1
- » tester power supply ..... 6LR61 (9 V) alkaline battery
- » dimensions (with holster and without leads) ..... 130 x 72 x 31 mm
- » weight without leads ..... approx. 150 g
- » battery charge diode flash period ..... approx. 1 s
- » idle time until automatic power off ..... approx. 5 min

#### Nominal operating conditions:

- » range of operating phase-to-phase voltages ..... 120...690 V AC
- » range of motor EMF voltages ..... 1...760 V AC
- » frequency range ..... 2...70 Hz
- » operating temperature range ..... -10...+45°C
- » storage temperature ..... -20...+60°C

#### Standard equipment:

black "crocodile" clip 1 kV 20 A	WAKROBL20K01
test lead with banana plugs; 1 kV; 1.2 m; black	WAPRZ1X2BLBB
test lead with banana plugs; 1 kV; 1.2 m; red	WAPRZ1X2REBB
test lead with banana plugs; 1 kV; 1.2 m; yellow	WAPRZ1X2YEBB
test probe with banana socket; 1 kV; black	WASONBLOGB1
test probe with banana socket; 1 kV; red	WASONREOGB1
test probe with banana socket; 1 kV; yellow	WASONYEGB1

#### Additional equipment:

Three-phase socket adapter AGT-32C	WAADAAGT32C
Three-phase socket adapter AGT-32P	WAADAAGT32P
Three-phase socket adapter AGT-63P	WAADAAGT63P
Three-phase socket adapter AGT-16C	WAADAAGT16C
Three-phase socket adapter AGT-16P	WAADAAGT16P
S-3 carrying case	WAFUTS3
red "crocodile" clip 1 kV 20 A	WAKRORE20K02
yellow "crocodile" clip 1 kV 20 A	WAKROYE20K02
test lead with banana plugs; 1 kV; 10 m; red (TKF-13)	WAPRZ010REBB
test lead with banana plugs; 1 kV; 2.2 m; black (TKF-13)	WAPRZ2X2BLBB

### TKF-12:

- » indication of phase sequence (field rotation direction) in networks with nominal phase-to-phase voltages 120...690 V AC by means of LEDs,
- » operation in networks with frequency 10...70 Hz,
- » indication of the presence of voltages in individual phases by means of neon lamps,
- » power supply from tested network (continuous operation up to 15 minutes at max. voltage),
- » protection against incorrect reading of field rotation direction (reading only when connected to three different phases).

### TKF-13:

- » indication of phase sequence (field rotation direction) in networks with nominal phase-to-phase voltages 120...690 V AC by means of LEDs,
- » operation in networks with frequency 2...70 Hz,
- » indication of the presence of voltages in individual phases by means of neon lamps,
- » indication of the direction of motor revolutions:
  - in voltage-free state with the use of test leads,
  - without contact, while the motor is running,
- » magnetic field detection,
- » automatic power off of meter when not in use.



## SONEL DB-1

index: WMGBDB1



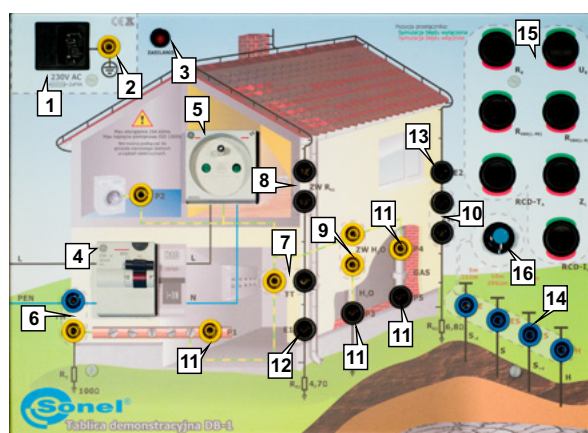
The DB-1 board makes it possible to demonstrate the method of performing the following tests:

- » fault loop impedance for assessment of the automatic power cutoff condition,
- » RCD parameters,
- » earthing resistance,
- » soil resistivity,
- » continuity test of equipotential bonding,
- » insulation resistance,
- » power network voltage.

It is possible to simulate typical failures and irregularities in the receiving network.

**Technical specifications of DB-1 board and properties of individual functions:**

- » Fault loop impedance:
  - measurement of L-N short-circuit with impulse currents up to 25 A and 60 ms,
  - measurement of L-PE earth fault loop with impulse currents up to 20 mA.
- » RCD parameters (30 mA device):
  - measurement of RCD trip time,
  - measurement of RCD trip current,
  - earth resistance measurement,
  - touch voltage measurement.
- » Soil resistivity:
  - resistivity measurement for three soil types (14  $\Omega\text{m}$ ; 300  $\Omega\text{m}$ ; 6.2 k $\Omega\text{m}$ ).
- » Earthing resistance.
  - Measurement by method:
    - two-lead,
    - three-lead,
    - four-lead,
    - three-lead with clamp,
    - double clamp,
    - with the use of fault loop meter.
- » Continuity of connections:
  - measurement of equipotential bonding and connections of accessible parts.
- » Insulation resistance:
  - measurement of L-N insulation,
  - measurement of L-PE insulation,
  - measurement of N-PE insulation.
- » Voltage measurement:
  - voltage measurement in power socket.
- » Simulation of irregularities:
  - no continuity of earth conductor (RE),
  - safe voltage exceeded during RCD measurement (UB),
  - leakage current (I<sub>Err</sub>),
  - insufficient L-N insulation resistance ( $R_{iso}(L-N)$ ),
  - insufficient L-PE insulation resistance ( $R_{iso}(L-PE)$ ),
  - excessive fault loop impedance ( $Z_L$ ), 230 V network socket.



- 1) Power Socket
- 2) Additional PE socket.
- 3) 230 V power indicator lamp.
- 4) Residual current device.
- 5) Test jack.
- 6) TN network cramp.
- 7) TT network cramp.
- 8) Socket of earth electrode RE1 (ZW RE1).
- 9) Socket of equipotential bonding of H2O pipe (ZW H2O).
- 10) Socket of earth electrode RE2 (ZW RE2).
- 11) Measurement point
- 12) Measurement point of earth electrode RE1 (E1).
- 13) Measurement point of earth electrode RE2 (E2).
- 14) Measuring electrode sockets.
- 15) Irregularity selection switches.
- 16) Soil type switch for soil resistivity measurements.



The DB-1 demonstration board makes it possible to simulate various faults and irregularities in an electrical network.

### Other technical specifications:

- » power supply from network ..... 230 V
- » dimensions ..... 405x300x140mm
- » weight of device ..... approx. 3.6 kg
- » quality standard ..... development, design and production in compliance with ISO 9001
- » protection ..... 2 x T3, 14A 250V, or 2xF4A 250 V
- » power consumption ..... approx. 15 mW
- » RCD type ..... 30 mA type AC

### Nominal operating conditions:

- » operating temperature range ..... +10...+40°C
- » storage temperature ..... -20...+60°C
- » humidity ..... 20...80%

## SONEL DB-THERMO

index: WMGBDBTHERMO



### Standard equipment:

power cord,	
heating panel screening plate,	
Instruction Manual	

The **DB-THERMO** board is an indispensable device during any training on contactless temperature measurements and thermal imaging with the use of thermographic cameras. DB-Thermo helps to understand the phenomena related to the emissivity of different materials and the influence of surface type on temperature measurement.

The **DB-THERMO** set includes instructions describing **all topics concerning thermal imaging**. The device is enclosed in a solid briefcase housing with a detachable cover.

**DB-THERMO** has a heating panel with an emissivity of 0.96 as well as plates made of various typical materials, with matte and polished surfaces. A programmable controller keeps watch over the temperature of the heating panel. The user may select a **temperature from within the range of 40-60°C**. The LED display reads the current panel temperature.



The **DB-THERMO** demonstration board has a built-in programmable controller that stands vigil over the temperature of the heating panel.

**Main plate with 0.96 emissivity - matte blackened aluminum (110 x 110 mm).**  
**Emissivity of materials (70 x 30 mm plates):**

Material:	Emissivity	
	polished	matte
Copper	0.05	0.51
Brass	0.05	0.54
Steel	0.05	0.62
Laminate	approx. 0.95	approx. 0.96
Aluminum	0.05	0.65
Chromium steel	0.05	0.67

### Other technical specifications:

» plate temperature regulation range	from 40 °C to 60°C
» max. power consumption	250 VA
» plate temperature reading accuracy	±1%
» resolution of temperature readings	0.1°C
» resolution of temperature settings	0.1°C
» hysteresis	±3°C
» temperature stabilization time	3 min.
» power supply from network	230 V
» dimensions (width/length/height)	330 x 260 x 140 mm
» weight of device	approx. 3 kg
» display	LED, 4 digits (11mm) with graphical icons
» heating panel dimensions	275 x 110 mm

### Electrical safety:

» protection	2 x F1A 250 V
» thermal protection	75°C



# SRP-50k0-5T0 / SRP-50k0-10G0 / SRP-50k0-100G0 / SRP-10G0-10T0

index: WMXXSRP50K05T0 / WMXXSRP50K010G0 / WMXXSRP50K0100G0 / WMXXSRP10G010T0



Standard programmable resistors are a source of high resistances used as standard equipment for calibration and testing of analog and digital insulation resistance meters.

The resistance obtained thanks to these resistors can be kept under external direct voltage up to **5000 V (SRP-50k0-5T0)**, **2500 V (SRP-50k0-10G0 i SRP-50k0-100G0)** for a long time, under the condition that current in the measurement circuit does not exceed the value of 1.5 mA (3 mA for SRP-50k0-5T0) or **10000 V (SRP-10G0-10T0)**.

The required resistance is set by the user by means of the standard resistor's touch keyboard or external PC application (except SRP-10G0-10T0). Setting of the required value is automatic thanks to commutation of a precision resistance matrix. The control processor calculates the required combination of resistors providing the proper precision of the resultant resistance.

## Standard equipment:

SRP software	.
test lead with banana plugs; 1.8 m; 5 kV; blue	WAPRZ1X8BUBB
test lead with banana plugs; 1.8 m; 5 kV; red	WAPRZ1X8REBB
shielded test lead with banana plugs; 2.2 m; black	WAPRZ2X2BLBBE
power cord	
calibration certificate	

Standard programmable resistors are intended for operation at ambient temperatures within the range from 10 to 30°C, relative humidity of air from 25 to 60%, and atmospheric pressure from 630 to 800 mmHg.

## Technical specifications of SRP-50k0-5T0:

Display range	Resolution	Accuracy
0.05...999.95 MΩ	0.05 kΩ	1,5% s.v.
0.001...999.999 GΩ	0.001 GΩ	
0.0001...5.0000 TΩ	0.0001 TΩ	

## Technical specifications of SRP-50k0-10G0 and SRP-50k0-100G0:

Display range	Resolution	Accuracy	
		SRP-50k0-10G0	SRP-50k0-100G0
50...20000 kΩ	50 kΩ	0,1% s.v.	0.05% s.v.
20050...100000 kΩ	50 kΩ	0,2% s.v.	0,1% s.v.
100.1...200.0 MΩ	0.1 kΩ	0,2% s.v.	0,1% s.v.
200.1...1000.0 MΩ	0.1 kΩ	0,5% s.v.	0,2% s.v.
1.001...2.000 GΩ	0.001 GΩ	0,5% s.v.	0,2% s.v.
2.001...10.000 GΩ	0.001 GΩ	1,0% s.v.	0,5% s.v.
10.001...100.000 GΩ*	0.001 GΩ	-	0,5% s.v.

only SRP-50k0-100G0; "s.v." = "set value"

## Technical specifications of SRP-10G0-10T0:

Display range	Resolution	Accuracy
10...999 GΩ	10 GΩ	1% s.v.
1...10 TΩ	0.1 TΩ	1,5% s.v.

## Other technical specifications:

- » supply voltage U ..... 100...240 V AC (50/60 Hz)
- » maximum power consumption ..... 75 VA
- » operating temperature range ..... +10...30°C
- » maximum current in measuring circuit ..... 3 mA (SRP-50k0-5T0)
- » maximum current in measuring circuit ..... 1.5 mA (SRP-50k0-10G0 and SRP-50k0-100G0)
- » maximum operating voltage ..... 5000 V DC (SRP-10G0-10T0)
- » maximum operating voltage ..... 2500 V DC (SRP-50k0-10G0 and SRP-50k0-100G0),  
10000 (SRP-10G0-10T0)
- » long-term resistor stability ..... <1%
- » dimensions ..... 540 x 450 x 200 mm
- » weight ..... approx. 16 kg
- » max. operating elevation ..... 2000 m

## About the application:

The SRP application serves for inter-operation between resistance calibrators and a computer.

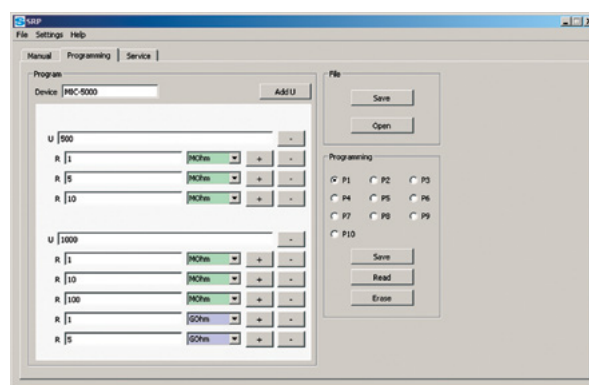
The application is easy to use and a useful tool in the process of testing devices by means of a calibrator. The calibrator connects to a computer via USB port.



The SRP-50k0-5T0 standard programmable resistor makes it possible to set any resistance within the range of 50 kΩ...5 TΩ for voltage up to 5 kV.

## Capabilities of the application:

- » remote calibrator control,
- » creation and saving of automatic programs for testing of equipment,
- » resistor settings include a keyboard lock and time until switching to sleep mode,
- » change of display brightness and keyboard response sounds,
- » language selection in application,
- » firmware update from computer via USB interface.





## SRM resistance decade boxes

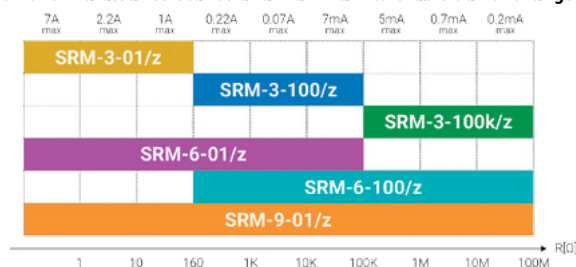
### SRM-x-y/z



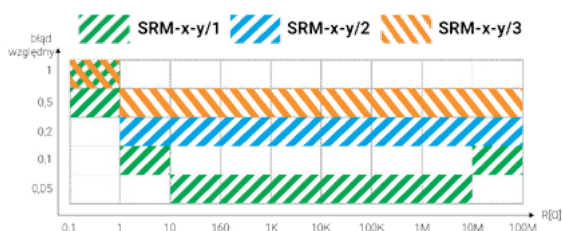
#### Functions of the instrument:

- » High accuracy, up to 0.05%
- » Ranges from 0.1  $\Omega$  to 111,111,111  $\Omega$
- » Easy-to-read and comprehensive graphical description of the instrument
- » Functional test jacks
- » Durable and resistant design
- » Available in variants with 3, 6 and 9 sections

#### Comparison of simulated resistance and maximum tolerable current ranges



#### Comparison of relative errors according to measuring ranges of SRM resistance decade boxes



**x** - number of decades (3, 6 or 9)

**y** - minimum resistance range:

**01** - (0.1  $\Omega$ ; 3, 6, 9 decades)

**100** - (100  $\Omega$ ; 3, 6 decades)

**100k** - (100 k $\Omega$ ; 3 decades)

**z** - accuracy class:

**1** - high (0.05%)

**2** - medium (0.2%)

**3** - low (0.5%)

SRM-series resistance decade boxes have been developed with laboratories and institutions requiring the most accurate readings in mind. High-precision decade boxes meet the expectations of even the most demanding customers. A metal housing effectively protects the instrument against mechanical damage. Applied resistors are characterized by excellent accuracy and long-term stability. Descriptions on the housing clearly inform the user of the set resistance value. Test jacks make it possible to connect the instrument by means of a banana plug, spade plug and insulated lead terminations. The housing has rubber legs that stabilize the instrument's position on the measurement table. The resistance decade box also includes the instruction manual and calibration certificate.

#### Technical specifications:

- » stability ..... up to  $\pm 20$  ppm/year
- » long-term stability ..... up to  $\pm 25$  ppm/3 years
- » temperature coefficient ..... up to  $\pm 5$  ppm/ $^{\circ}\text{C}$
- » initial resistance .....  $R_0 \leq 0.025 \pm 0.0025 [\Omega]$
- » insulation test voltage ..... 2000 V
- » insulation resistance ..... 10 G $\Omega$
- » operating temperature range ..... 10-35 $^{\circ}\text{C}$
- » relative humidity ..... 25-80%

#### Dimensions:

- » SRM-3-y/z ..... 215x147x160 [mm]
- » SRM-6-y/z ..... 540x147x160 [mm]
- » SRM-9-y/z ..... 472x260x160 [mm]

#### Weight:

- » SRM-3-y/z ..... approx. 3 kg
- » SRM-6-y/z ..... approx. 6 kg
- » SRM-9-y/z ..... approx. 9 kg

## Fault loop resistance decade box

### SONEL SRM-0R1-4k1



The SRM-0R1-4k1 resistance decade box has been developed with laboratories and institutions requiring the most accurate readings in mind. This high-precision decade box will meet the expectations of even the most demanding customers. A metal housing effectively protects the instrument against mechanical damage. Applied resistors are characterized by excellent accuracy and long-term stability. Descriptions on the housing clearly inform the user of the set resistance value. Test jacks make it possible to connect the instrument by means of a banana plug, spade plug and insulated lead terminations. The housing has rubber legs that stabilize the instrument's position on the measurement table. A built-in cooling system powered from a 230 VAC 50 Hz network has been applied in the decade box.

#### Functions of the instrument:

- » High accuracy, up to 0.05%,
- » Ranges from 0.1  $\Omega$  to 4111  $\Omega$ ,
- » Easy-to-read and comprehensive descriptions of the instrument,
- » Functional test jacks,
- » Durable and resistant design,
- » Built-in cooling system.

#### Technical specifications:

- » stability ..... up to  $\pm 50$  ppm/year
- » long-term stability ..... up to  $\pm 75$  ppm/3 years
- » temperature coefficient ..... up to  $\pm 5$  ppm/ $^{\circ}\text{C}$
- » initial resistance .....  $R_0 \leq 0.025 \pm 0.0025 [\Omega]$
- » maximum operating voltage ..... 450 V
- » insulation resistance .....  $\geq 100 \text{ M}\Omega$
- » measurement cycle time Tmeas .....  $\leq 30\text{-}40$  ms
- » cooling time (pause) Tpaus. .... for Umeas up to 230 V  $\geq 20$  s, for Umeas up to 450 V  $\geq 25$  s.
- » dimensions ..... 500x340x170 mm
- » weight ..... no greater than 12 kg
- » operating temperature range ..... 10-30 $^{\circ}\text{C}$
- » relative humidity ..... 25-60%

# SMT AND THT ASSEMBLY

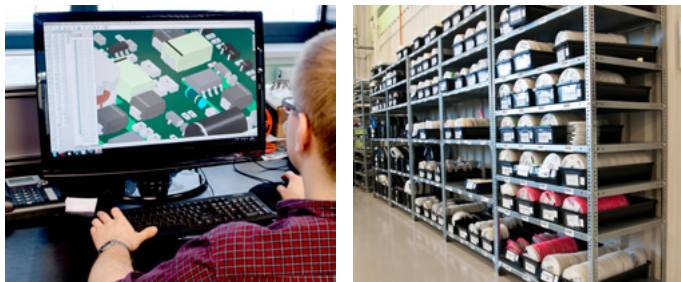
Our meters are manufactured based on the latest SMT and THT electronics assembly technologies. Besides manufacturing measuring instruments, we also render comprehensive surface mounting and through-hole assembly.

## Designing

The creation of a new product depends on the designing process. For this purpose, we have picked a specialized team of designers, who will create the perfect solution for you needs through their determination and enormous potential.

## Tester construction

In order to dispel all doubts as to the proper functioning of our electronic systems, they undergo tests individually designed by us.



## Production

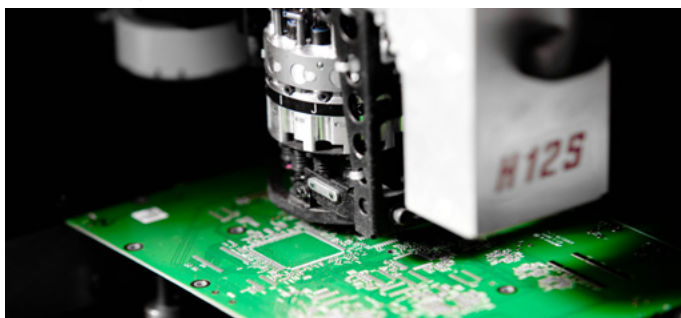
We understand production to be the process of product creation. In our book, production means quality, precision, time, and above all, a perfectly filled order, in which we apply modern technology combined with a vast pool of knowledge.



## Production line

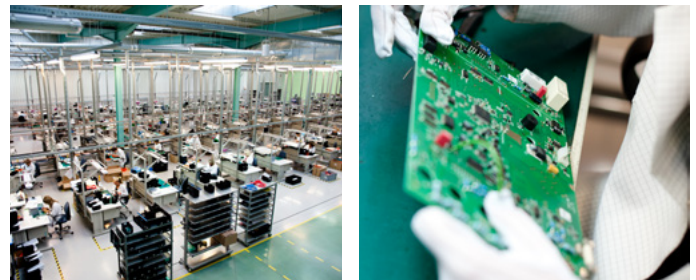
### SMT:

- » MPM MOMENTUM screen printer,
- » FUJI NXT automatic mounter, 6 modules,
- » Ersa HOTFLOW 2/20 reflow soldering furnace (soldering in nitrogen atmosphere with residual oxygen analyzer),
- » ASYS conveyor line,
- » DEK 265 screen printer,
- » FUJI GLII dispenser,
- » FUJI FCP-III-4000 fast automatic mounter,
- » FUJI FIP-III universal mounter, (in addition, laser system for geometry control of terminals).



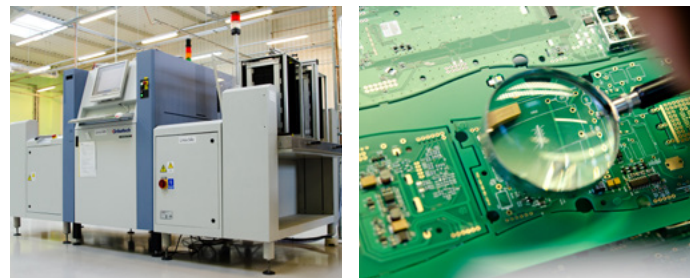
### THT:

- » Ersa-WAVE 330 wave soldering system (soldering in nitrogen atmosphere).
- » 70 stations of manual and supplementary assembly.



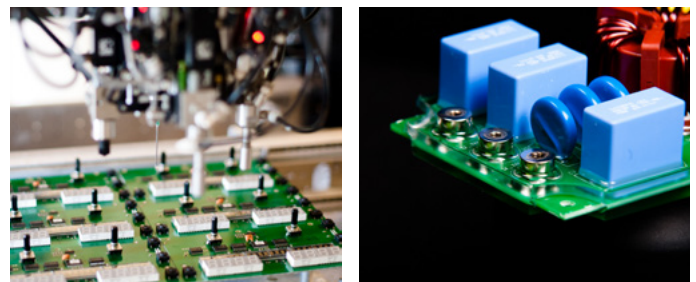
### » Inspection and testing

- » AOI ORBOTECH S-22 automatic optical tester, equipped with nine cameras,
- » electrical testing of printed circuits,
- » AOI (Automatic Optical Inspection),
- » ionic cleanliness test (ionograph),
- » function tests.



### Protective coatings

Programmable selective casting (capability of selecting any area on a circuit board's surface) with lacquer or resin protective coating is performed automatically. Because of this, we achieve better productivity and save valuable time in the entire production process.



### Repair and Maintenance

We offer assembly and disassembly, repair and maintenance of elements as an additional service.

### Quality and environment

We perform every order with the appropriate accuracy in the proper environment (ionic cleanliness tests), and thus, we ensure that your product is of the highest quality.



# LABORATORY

SONEL Testing and Calibration Laboratory has been accredited by the Polish Center of Accreditation for the calibration of measuring instruments AP 173 in the following field - electrical properties in DC and LF circuits: voltage and current (DC), voltage and current (AC), resistance (DC), electrical power.

SONEL Testing and Calibration Laboratory offers validation and calibration services for the following instruments used for measuring electrical and non-electrical parameters. The following instrument types are calibrated:

Meters for measurements of electrical properties and parameters of power networks:

- » voltage meters,
- » current meters (including clamp meters),
- » circuit breakers (RCD) meters,
- » insulation resistance meters,
- » earthing resistance meters,
- » short-circuit loop impedance meters,
- » resistance meters,
- » power quality analyzers,
- » energy meters,
- » multimeters,
- » multifunction meters covering the functions of the above-mentioned instruments,

Standards of electrical properties:

- » calibrators,
- » resistance standards,

Instruments for the measurements of non-electrical:

- » pyrometers,
- » lux meters,
- » thermo-imaging cameras.

The Calibration Certificate is a document confirming compliance of the tested instrument's parameters with those declared by the manufacturer, in reference to the national standard, with determination of measurement uncertainty.

According to ILAC G24:2007 „Guidelines for the determination of calibration intervals of measuring instruments”, SONEL S.A. recommends periodical metrological inspection of the instruments it manufactures no less frequently than once every 13 months.



AP 173

For new instruments provided with the Calibration Certificate or Validation Certificate at the factory, re-calibration should be performed within 13 months from the date of purchase, however, no later than 25 months from the date of purchase. The Calibration Certificate is a document issued by the manufacturer for a new instrument leaving the factory. Any subsequent metrological inspection is performed by Sonel Testing and Calibration Laboratory and the respective document is called a Validation or Re-Calibration Certificate.

## ATTENTION:

In the case of instruments used for tests related to shock protection, the person performing measurements should have absolute certainty as to the operability of the instrument that is applied. Measurements performed with an inoperative meter may lead to incorrect assessment of the effectiveness of health protection and even cause a threat to human life.







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